RESEARCH ARTICLE

REVISED **Adherence to iron and folic acid supplementation during pregnancy among postnatal mothers seeking maternal and child healthcare at Kakamega level 5 hospital in Kenya: a cross-sectional study** [version 2; peer review: 1 approved, 1 approved with reservations]

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Abstract

Background: Maternal anaemia is a public health problem worldwide, and its aetiology is linked to iron deficiency. The high nutrient demand during pregnancy exacerbates the condition. To meet the increased nutritional demand, supplementation of iron and folic acid (IFA) is key. The supplements are provided freely to pregnant women during antenatal visits at public health facilities, however, their uptake and adherence in Kenya remain unacceptably low.

Methods: A hospital-based cross-sectional study involving 241 postnatal mothers seeking maternal and child healthcare (MCH) care at Kakamega level 5 hospital was conducted. Both quantitative and qualitative data were collected. Quantitative data were collected from 241 eligible postnatal mothers, while qualitative data were obtained through key informant interviews with community health volunteers and healthcare providers.

Results: There was a moderate adherence to IFA supplementation (60.6%) during pregnancy among postnatal mothers seeking MCH care at Kakamega level 5 hospital. Some of the reasons for non-adherence stated by the respondents included; IFA related side effects (41.3%), forgetfulness (37.3%) and bad smell of the IFA supplements (10.3%). Higher IFA adherence was noted among the primigravida participants (OR=2.704; 95% CI: 1.262, 5.793; p=0.010) compared to multigravida participants, and those with a higher knowledge level of anaemia (OR=3.215; 95% CI: 1.346, 7.68; p=0.009) compared to their

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counterparts with low anaemia knowledge. Other factors that showed correlation with IFA adherence were: IFA education, pregnancy counselling before conception and the number of antenatal care visits attained.

Conclusion: There is a moderate adherence to IFA supplementation during pregnancy among mothers seeking MCH at Kakamega level 5 hospital. The greatest impediments of IFA compliance during pregnancy are IFA side effects, forgetfulness and the bad smell of the IFA tablets. Therefore, providing IFA education to pregnant mothers incorporated with probable ways of managing the IFA side effects would contribute to IFA supplementation adherence.

Keywords

Adherence, compliance, Iron and Folic Acid, postnatal, primigravida, multigravida, Kakamega, Kenya

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REVISED Amendments from Version 1

We inserted a few sentences in the introduction to bring out the fact that some of the factors influencing IFA adherence are beyond the control of the mothers. We have added some information in the methodology to make the qualitative aspect clear and expounded on how we reduced the social desirability bias. At the beginning of our qualitative findings in the results section, we have provided more information regarding how frequent the mothers were given IFA supplements. In the first paragraph of the discussion, we have compared the findings of this study and those of similar studies in Kenya. We have inserted two paragraphs towards the end of the discussion section of this article to make our discussion better. We have also added more information to the limitation section. Separately, we have added more references to the article.

Any further responses from the reviewers can be found at the end of the article

Introduction

Maternal anaemia remains a public health problem worldwide[1]. The World Health Organization (WHO) defines anaemia among pregnant women as having haemoglobin levels of less than 11.0g/dl[2]. Anaemia in pregnant women has been attributed to iron deficiency[3]. The condition is exacerbated by the high nutrient demand during pregnancy[4]. Globally, 38% of pregnant women have been reported to be anaemic with the highest burden being in Africa[1]. The WHO reports that 55.8% of pregnant women in Sub Saharan Africa (SSA) are anaemic[1]. In Kenya, it is estimated that 55.1% of pregnant women have iron-deficiency anaemia[5]. A study conducted at Kakamega level 5 hospital noted a 38.9% anaemia prevalence among pregnant women seeking antenatal care (ANC) at the facility[6].

To reduce incidences of maternal anaemia, the WHO recommends iron and folic acid (IFA) supplementation to all pregnant women[7]. According to WHO guidelines, daily 30mg–60mg of iron and 0.4 mg of folic acid supplements are essential to all pregnant women and their uptake should be commenced as early as possible once pregnancy has been confirmed[8]. However, strict adherence to IFA is required for better outcomes[9]. Evidence suggests that IFA uptake during pregnancy reduces the chances of iron-deficiency anaemia to a great extent[10]. Moreover, adequate IFA ensures the wellness of the developing foetus by reducing incidences of neural tube defects, puerperal sepsis, and congenital heart defects[7]. A randomized clinical study conducted in the western part of Kenya also attributed IFA supplementation to the reduced risks of low birth weight and prematurity[11].

To ensure equitable access, the government of Kenya provides IFA supplements to all pregnant women seeking ANC in public health facilities at no cost[12]. However, despite all these efforts, adherence to IFA among pregnant women in Kenya remains poor[12,13]. Although there has been a gradual national upward trend in self-reported IFA adherence from 2.5% in 2010 to 8% in 2014[14], it is clear that the adherence is still low. In western Kenya, where Kakamega level 5 hospital is located,

IFA adherence is even lower compared to the national prevalence (6.9%)[15].

The causes of poor adherence to IFA uptake in Kenya are multidimensional with most of these causes emanating from the behavioral practices and perceptions of the pregnant women towards IFA. Inaccessibility to ANC services could be the leading contributor to this poor trend[16]. Surprisingly, poor adherence has also been confirmed among pregnant women who regularly visit health facilities for ANC[9,17,18]. Inadequate knowledge of anaemia, and forgetfulness have also been linked as key barriers to IFA supplementation adherence in various studies[9,19,20]. Nonetheless, some causes of poor adherence to IFA are way beyond control of the pregnant mothers, such as IFA stock-outs at the ANC facilities. The side effects resulting from IFA consumption also discourage pregnant mothers from IFA compliance[13]. Although these side effects are common with IFA use, many pregnant women seem to be unaware that practices such as taking the supplements alongside meals or just before going to bed help to alleviate the side effects. The persistently high prevalence of maternal anaemia coupled with poor adherence to IFA supplementation creates a need for more understanding of the possible causes of the poor adherence trend. Therefore, this study sought to investigate the possible determinants of IFA supplementation adherence during pregnancy among postnatal mothers seeking maternal and child healthcare (MCH) care at Kakamega level 5 hospital.

Methods
Study site
The study was conducted at Kakamega level 5 hospital located in western Kenya. The hospital serves as the main referral public health facility in Kakamega county of Kenya. This facility is located within Kakamega town and has bed capacity of 449, according to the Kenya Master Health facility List (KMHFL) of 2021[21].

Study design
A cross-sectional study was conducted between May and August 2020. The study targeted postnatal mothers of 0–6 months post-delivery seeking MCH care at Kakamega level 5 hospital. The sample size was calculated based on Cochran formula[22] as shown below:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

To achieve our desired sample size (n), we set the standard normal deviation (Z) at 1.96 with 5% as the level of accuracy (d). A prevalence (P) of 32.7% was used basing on the findings of a similar study conducted in a similar county of Kenya. A total of 339 participants were therefore needed (n) but since our target population of 0–6 months postnatal mothers was less than 10000, the sample size was adjusted as shown[22]:

$$nf = \frac{n}{1+n/N}$$

The approximate total number of women that were anticipated to seek postnatal care (PNC) services during the 3 months of data collection in Kakamega level 5 hospital was attained by multiplying the average monthly PNC attendance by 3. According to the 2019 District Health Information system (DHIS2) data, the average number of women (with children aged 0–6 months) who sought MCH services at this facility every month was 277. We therefore anticipated that 831 mothers would be encountered during the 3 months of data collection (277 X 3=831). Therefore:

$$nf = \frac{339}{1 + (339/831)} = 241$$

We catered for nonresponse by proceeding to another respondent until the required sample size was achieved.

Data collection

Quantitative data – semi-structured questionnaire. Quantitative data were collected at the postnatal section of Kakamega level 5 hospital among postnatal mothers of 15–49 years. We targeted the postnatal mothers who had just delivered in the maternity wards and those who had brought their babies for a routine check-up within six months post-delivery. We were keen to ensure that all the postnatal mothers interviewed were seeking healthcare services related to MCH care. However, the postnatal mothers who were critically ill such that they wouldn't speak to us comfortably were excluded from the study. An electronic version of a semi-structured questionnaire developed in the Research Electronic Data Capture tool (REDCap) was used to collect the data (see data dictionary codebook for questions in *Underlying data*[23]). We scheduled appointments in two sessions every day; the morning session and the afternoon session. About 10 participants were interviewed each day with each of the interviews lasting for approximately 30 minutes. Study participants were recruited once they had obtained the MCH care that they needed.

The purpose of the study was explained to each potential participant after which a written consent was sought. Participants of less than 18 years were only interviewed if they were accompanied by a guardian who provided written consent on their behalf. Every potential study participant who consented to the study was directed to a separate room where a face-to-face interview was conducted. However, interviews with mothers who had just delivered were conducted at their respective bedsides in the ward. We avoided instances where the participants could provide inaccurate responses for social desirability by: 1) Explaining the justification of the study that we only intended to use the data to influence policies meant to improve IFA uptake in pregnancy and avoid pregnancy complications and 2). Assuring the participants of their confidentiality such that they were not going to be victimised in any way based on their responses. Further, we sought permission from the hospital management to allow our interviewer to interact with the mothers within the clinics without wearing a medical regalia such as a white coat to avoid creating any impression that he was a healthcare provider consequently risking responses of social desirability.

The questionnaire used in the data collection was divided into five sections: socio-demographic characteristics of the participants, health system-related characteristics, participant's knowledge of anaemia, participant's attitude towards ANC healthcare provider and IFA adherence. Adherence to IFA supplementation was established by asking the participants about the average number of IFA tablets taken per week throughout the gestation period. Participant's knowledge of anaemia was ascertained using a set of 10 questions focusing on anaemia causes, haemoglobin level boosting foods, consequences of anaemia and its prevention mechanisms. All the responses provided by the respondents were entered in REDCap[24], after which they were uploaded to KEMRI WELLCOME TRUST server every day.

Qualitative data – key informant interviews. The quantitative data were complemented by the key informant interviews (KIIs) with healthcare providers and the community health volunteers (CHVs) attached to the hospital. The first author administered all the KIIs. A total of five healthcare providers purposively selected within the hospital and all the 11 CHVs attached to the hospital participated in the KIIs. We were keen to interview all the 11 CHVs attached to the facility because most of them came from different sub-ethnicities within the area, and this would allow us to deeply investigate the socio-cultural determinants of IFA adherence (data not presented in this article). As for the healthcare providers, the KIIs were stopped immediately the saturation point was attained as we did not want to cause more inconvenience towards provision of care. Neither of the targeted healthcare providers nor CHVs refused to take part in the study. The health care providers who provided feedback to the KIIs comprised of: PNC in-charge, ANC in-charge, PNC nurse, PNC pharmacist-in-charge and the MCH nutritionist in-charge. The KIIs with the healthcare providers took place at the hospital within their respective departments during individuals' shift. We were flexible in scheduling the KIIs with the healthcare providers and only spoke to each one of them at the time that seemed convenient for them. This was to ensure that the interviews did not compromise their service provision to the patients. The KIIs with CHVs either took place at their respective homes or within Kakamega level 5 hospital. Those who were interviewed at the facility had accompanied a patient to the facility to help them obtain care. We chose to interview some CHVs at their respective homes to avoid them incurring transport and other costs related to travelling to the facility. The KIIs reported in this study were based on different, but strongly related KII guides prepared to suit either CHVs or healthcare providers (see KII guide in the *Extended data*[23]). The KII guides also acted as checklists to help the interviewer ascertain that all the relevant information required was collected. All the KIIs lasted between 30–45 minutes and were audio-recorded after the participants had given written informed consent to participate. All the interviews were conducted in secluded areas to ensure privacy of the respondents.

Data analysis

During analysis, the quantitative data were exported from the server to a Microsoft Excel CSV file after which a data cleaning process followed.

Adherence to IFA supplementation: This was the main outcome variable in this study. Respondents who took at least five IFA tablets per week throughout their gestation period were classified as adherent, while those who took less than five tablets per week throughout pregnancy were non-adherent.

Knowledge of anaemia: Anaemia knowledge was determined by scoring the responses to the ten questions assessing knowledge level of anaemia. The questions inquired on anaemia causes, consequences and its prevention. Each of the ten questions answered correctly was awarded a score of '1' while a wrong response or admitting not being aware was awarded a score of '0'. The total expected score of anaemia knowledge was 10 and this was used to calculate the percentage score of each participant. The respondents with a score that was equal to or greater than 50% were assumed to have a higher knowledge of anaemia while those with a score below 50% were treated as having low knowledge of anaemia[25].

Attitude towards ANC healthcare provider: We also established the attitude of the respondents towards ANC healthcare provider using a Likert scale. Five questions were asked on attitude, with responses ranging from strongly disagree, disagree, neutral, agree and strongly agree. The responses were scored in ascending order, with strongly disagree being scored a '1' while strongly agree was scored a '5'. The scores were summed up and later converted into percentages. Respondents were considered to have a positive attitude towards ANC healthcare provider if they scored at least 70%, while those who scored below 70% were assumed to have a negative attitude towards ANC healthcare provider[26].

The cleaned verified data were then imported to R statistical software version 3.5.2 [2018–12–20] for analyses. The respondents' socio-demographic characteristics and the prevalence of IFA compliance were summarized using descriptive statistics such as means, proportions and percentage frequencies. Some variables were also re-grouped into categories based on certain set thresholds. For example, mothers' age was re-categorized into groups, IFA adherence classified as adherent or non-adherent, gravidity as primigravida and multigravida, while the education level of the mother was categorized into primary, secondary and college levels. Equally, the number of ANC visits attained by the mothers were segregated into two and below ANC visits and at least 3 ANC visits. Associations between adherence to IFA supplementation and its putative determinants were investigated through univariable and multivariable logistic regression. P values of less than 0.05 were interpreted as significant.

Qualitative data analysis began with the transcription of the recorded audio, but we did not return the transcripts to the interviewees for checking and verification. The first and second author conducted a deductive coding to organize the data into themes using the qualitative data analysis software NVivo 12 (QSR International, Australia).

Ethical clearance
Ethical clearance for this study was sought from the Ethical Review Board of Daystar University (approval number: DU-ERB- 000415). Daystar University Ethical Review Board was considered for ethical approval as we were keen to have the study protocol reviewed within the anticipated timelines. The National Commission for Science, Technology and Innovation (NACOSTI) granted the research license. Approvals were also obtained from the hospital in-charge of Kakamega level 5 hospital and the head of the PNC section.

Results
Socio-demographic characteristics of the respondents
A total of 241 mothers seeking MCH care at Kakamega level 5 hospital were interviewed between May and August 2020. The average age of the mothers was 24.9±5.3 years with an age range of 15–43 years. As shown in Table 1, the majority (68.1%) of the respondents belonged in the age category of 19–29 years. Only a few of the respondents had formal employment (19.9%) while 22.4% were students. Most of the mothers interviewed (41.1%) had attained a secondary school level of education. Also, all the respondents admitted to belonging to one religion or another with the majority being Christians (95.9%). More than three-quarters of the mothers (85.5%) resided at a distance greater than 30 minutes to their ANC facilities with motorcycles being the most preferred means of transport (62.2%). A large proportion of the mothers had a high knowledge of anaemia (85.5%). All the respondents admitted to having been given IFA at any one point during ANC and out of these, slightly over half (51.0%) reported having experienced side effects as a result of IFA consumption.

Obstetric related characteristics of the respondents
As shown in Table 2, out of all the respondents interviewed, over two-thirds (76.8%) had completed at most 3 months post-delivery. Almost half of the mothers were multigravida (47.7%) and a few reported having had either a birth complication (12.1%) or miscarriage (4.6%). Most of the respondents (76.3%) had never had a pregnancy counselling session with a healthcare provider before getting pregnant. The majority of the mothers (71.8%) sought their first ANC services with a gestation period of more than 8 weeks and many of them attended ANC at least 3 times (92.9%).

Although most of the mothers interviewed in this study had visited the facility to obtain delivery care (33.9%), other MCH services sought included; child immunization (29.5%), child growth monitoring (28.2%), child treatment (6.4%) among others, as shown in Figure 1.

Prevalence of IFA adherence
The overall prevalence of IFA adherence among the studied respondents was 60.6% with 146 (146/241) mothers having reported taking at least five IFA tablets per week throughout pregnancy. Out of the IFA non-compliant cohort, slightly more than one third (35.3%) consumed three to four IFA tablets per week on average throughout pregnancy. The highest adherence was observed among the single mothers (79.7%), followed by younger mothers of 18 years and below (76.9%). There was a similar trend of IFA compliance among Muslims and Christians, 60% and 60.6%, respectively. About eight in every 10 of the mothers who never experienced any IFA related side effects (75.9%) were IFA compliant. Less than half (41.7%)

Table 1. Socio-demographic characteristics of the respondents, Kakamega level 5 hospital, Kenya, 2020.

Variable	n	%	95% CI
Mother's age (years)			
≤18	26	10.8	7.3, 15.6
19–29	164	68.1	61.7, 73.9
≥30	51	21.2	16.3, 27.0
Occupation			
Formal	48	19.9	15.2, 25.6
Non-formal	70	29.0	23.5, 35.3
Housewife	69	28.6	23.1, 34.9
Student	54	22.4	17.4, 28.3
Education level			
Primary	48	19.9	15.2, 25.6
Secondary	99	41.1	34.9, 47.6
College	94	39.0	32.9, 45.5
Marital status			
Married	172	71.4	65.1, 76.9
Single	69	28.6	23.1, 34.9
Religion			
Christian	231	95.9	92.3, 97.9
Muslim	10	4.1	2.1, 7.7
Distance to ANC facility			
>30 Minutes	206	85.5	80.2, 89.5
≤30 Minutes	35	14.5	10.5, 19.8
Transport mode to ANC facility			
Walking	73	30.3	24.6, 36.6
Motorcycle	150	62.2	55.8, 68.3
Matatu	18	7.5	4.6, 11.7
Anaemia knowledge			
Low	35	14.5	10.5, 19.8
High	206	85.5	80.2, 89.5
IFA side effects			
No	118	49.0	42.5, 55.4
Yes	123	51.0	44.6, 57.5

Table 2. Obstetric related characteristics of the studied respondents, Kakamega level 5 hospital, Kenya, 2020.

Variables	n	%	95% CI
Postpartum duration (in months)			
≤1	133	55.2	48.7, 61.5
2	28	11.6	8.0, 16.5
3	24	10	6.7, 14.6
4	25	10.4	7.0, 15.1
5	13	5.3	3.0, 9.3
6	18	7.5	4.6, 11.7
Gravidity			
Primigravida	126	52.3	45.8, 58.7
Multigravida	115	47.7	41.3, 54.2
Birth complication			
No	212	88.0	83.0, 91.7
Yes	29	12.1	8.3, 17.0
Miscarriage			
No	230	95.4	91.8, 97.6
Yes	11	4.6	2.4, 8.2
Counselling before pregnancy			
No	184	76.3	70.4, 81.5
Yes	57	23.7	18.5, 29.6
First ANC gestation			
≤8 weeks	68	28.2	22.7, 34.4
>8 weeks	173	71.8	65.6, 77.3
ANC visits			
≥3 Times	224	92.9	88.7, 95.7
≤2 Times	17	7.1	4.3, 11.3

(61.2%) as compared to their counterparts residing more than 30 minutes away from their facilities of ANC (57.1%), as shown in Table 3.

A total of 95 (39.4%) respondents were not IFA compliant. Out of this cohort, the majority of the mothers (41.3%) attributed the non-compliance to IFA related side effects. Other common reasons for non-adherence stated by the respondents were: forgetfulness (37.3%), bad smell of the IFA tablets (10.3%) and pharmacophobia (6.3%), as shown in Table 4.

A total of 123 (51%) mothers experienced IFA related side effects. Out of this, almost half (48.0%) were non-compliant.

of the respondents with a primary education level took IFA as recommended. Mothers who resided within 30 minutes distance from their ANC facilities had a slightly higher adherence
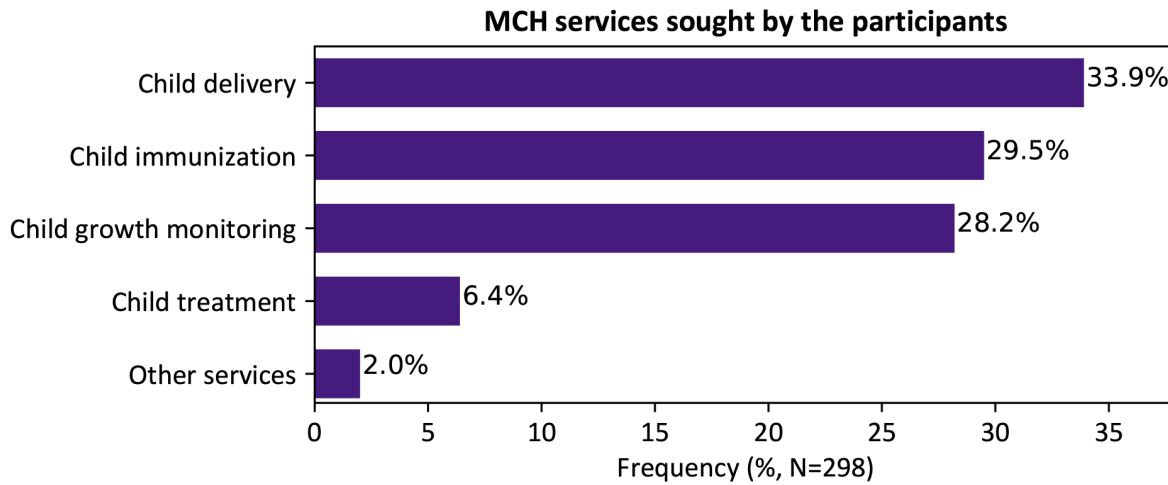
MCH services sought by the participants

Figure 1. Maternal and child healthcare services sought by respondents, Kakamega level 5 hospital, Kenya, 2020.

The most prevalent side effects were vomiting (41.3%), nausea (26.9%) and dizziness (18.6%). Slightly over half (52.2%) of the mothers who experienced vomiting while on IFA were non-compliant. About 48.4% of those who felt dizzy due to IFA consumption and the majority of the mothers who experienced IFA related diarrhoea could not comply with IFA supplementation (Figure 2).

Socio-demographic determinants of IFA adherence
Investigation of IFA adherence trends through univariable logistic regression was conducted. Specifically, it was noted that postnatal mothers who were at least 30 years of age were less likely to be IFA compliant as compared to their younger counterparts of 18 years and below, (OR=0.267, 95% CI: 0.086, 0.741; p=0.015). Mothers with a primary level of education had their odds of being IFA compliant reduced by 60% as compared to mothers who had acquired a college level of education, (OR=0.405, 95% CI: 0.196, 0.819; p=0.013). Similarly, the study established reduced odds of IFA adherence among the respondents who had attended ANC for at most two times as well as those who had reported experiencing IFA related side effects, (OR=0.327, 95%CI: 0.109, 0.893; p=0.034) and (OR=0.476, 95% CI: 0.279, 0.804; p=0.006), respectively. Unlike mothers in marriage, single mothers were 3.5 times more likely to be IFA compliant (OR=3.497,95% CI: 1.852, 6.971; p<0.001). The primigravida mothers were almost four-fold more likely to be IFA compliant as compared to multigravida mothers (OR=3.559, 95%CI: 2.081, 6.187; p<0.001). Equally, the respondents who seemed to have higher anaemia knowledge were noted to have elevated odds of adhering to IFA supplementation, (OR=2.676, 95% CI: 1.296, 5.680; p=0.009) (Table 5).

In order to understand the independent association between IFA adherence and the socio-demographic factors, all the variables with crude P values of less than 0.2 were fitted to a multivariable model. These included: mother's age, mother's education level, marital status, gravidity, mother's knowledge of anaemia, number of ANC visits, and IFA related side effects. The multivariable model confirmed the independent correlation between IFA adherence and gravidity (OR=2.704, 95% CI: 1.262, 5.793; p=0.010), mother's anaemia knowledge (OR=3.215, 95% CI: 1.346, 7.68; p=0.009), number of ANC visits (OR=0.273, 95% CI: 0.081, 0.916; p=0.036) and IFA side effects (OR=0.444, 95% CI: 0.246, 0.803; p=0.007), as shown in Table 6.

Health system-related determinants of IFA adherence
Univariable analysis was used to identify possible health system related factors influencing IFA supplementation adherence. Mothers who received education on IFA were almost three times more likely to be IFA compliant as compared to those who did not receive education on IFA (OR=2.728, 95% CI: 1.297, 5.921; p=0.009). Similarly, attending pregnancy counselling sessions prior to conception played a significant role on IFA adherence. The study revealed that mothers who sought pregnancy counselling sessions were more than twice likely to be IFA compliant as compared to their counterparts who never attended pregnancy counselling sessions before conception (OR=2.415, 95% CI: 1.262, 4.859; p<0.01). Unlike mothers who had a negative attitude towards ANC healthcare provider, mothers who had a positive attitude towards ANC healthcare provider were up to 2.4 times more likely to be IFA compliant (OR=2.357, 95% CI: 1.124, 5.052; p=0.024), as shown in Table 7.

According to the KIIs with CHVs, poor attitude towards ANC healthcare provider is partially contributed by the long turnaround time taken during ANC visits.

> "There are still others who prefer enrolling for ANC a bit late say three to four months due in pregnancy. They just want to buy time, especially when they think

Table 3. Prevalence of IFA adherence among the respondents, Kakamega level 5 hospital, Kenya, 2020.

Variables		IFA adherence					
		Average number of IFA tablets taken by respondents per week					
	Total (N)	0-2	%	3-4	%	5-7	%
Mother's age							
≤18	26	0	0	6	23.1	20	76.9
19-29	164	6	3.7	56	34.1	102	62.2
≥30	51	4	7.8	23	45.1	24	47.1
Education level							
Primary	48	1	2.2	27	56.3	20	41.7
Secondary	99	4	4.0	29	29.3	66	66.7
College	94	5	5.3	29	30.9	60	63.8
Marital status							
Married	172	8	4.7	73	42.4	91	52.9
Single	69	2	2.9	12	17.4	55	79.7
Distance to ANC							
>30 mins	35	3	8.6	12	34.3	20	57.1
≤30 mins	206	7	3.4	73	35.4	126	61.2
Side effects							
No	118	4	3.7	32	29.6	82	75.9
Yes	123	6	5.0	53	43.8	64	52.9
Occupation							
Formal	48	3	6.3	14	29.2	31	64.6
Non-formal	70	2	2.9	30	42.9	38	54.3
Housewife	69	3	4.3	27	39.1	39	56.5
Student	54	2	3.7	14	25.9	38	70.4
Religion							
Christian	231	10	4.3	81	35.1	140	60.6
Muslim	10	0	0	4	40.0	6	60.0
Total		10	4.149	85	35.3	146	60.6

Overall Iron and Folic Acid (IFA) prevalence **(60.6%)**.

of the long queue that awaits them at the ANC. They complain that they take a lot of time at ANC…" (KII: CHV).

All the health system related factors that showed a p≤0.2 in the univariable logistic regression were subjected to a multivariable model. Precisely, IFA education, having had a pregnancy counselling session and mother's attitude towards ANC healthcare provider were adjusted for in the multivariable model. Having had a pregnancy counselling session with a healthcare provider before conception and having received education on IFA showed independent association with IFA adherence, (OR=2.086, 95% CI: 1.071, 4.255; p=0.036) and (OR=2.372, 95% CI: 1.109, 5.218; p=0.028) respectively (Table 8).

The correlation between hospital IFA stockouts and IFA adherence was not statistically significant. Only 12% of the

Table 4. Reasons for non-compliance as stated by the respondents, Kakamega level 5 hospital, Kenya, 2020.

Non-adherence reason	Responses	%	95% CI
Side effects	52	41.3	32.68, 50.40
Forgetfulness	47	37.3	29.00, 46.41
Bad smell	13	10.3	5.83, 17.32
Pharmacophobia	8	6.3	2.98, 12.53
Make the fetus grow bigger	4	3.2	1.02, 8.42
Unaware of IFA importance	1	0.8	0.04, 4.99
Ran out of supplements	1	0.8	0.04, 4.99
Total	**126**	**100**	

IFA related side effects reported among the participants
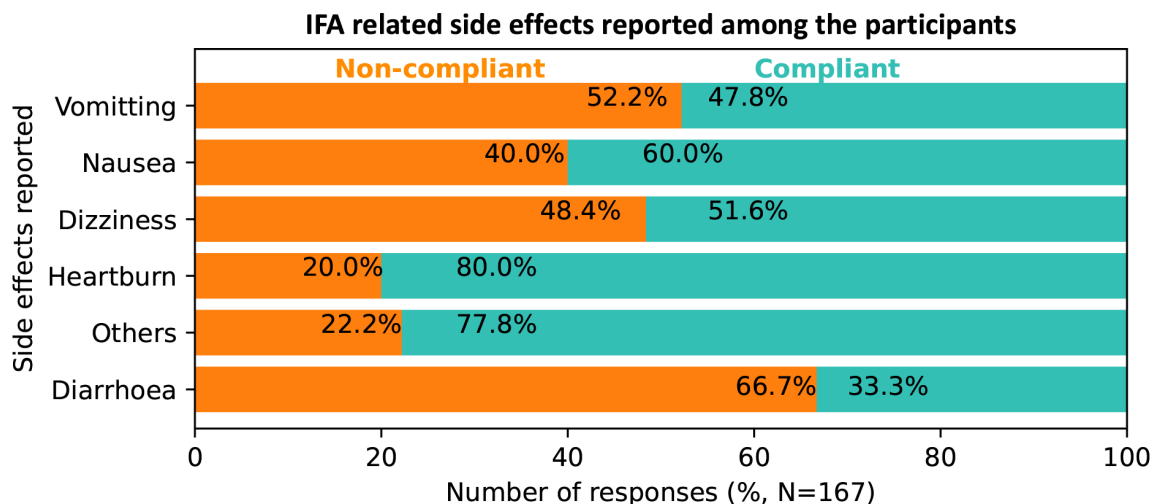
Figure 2. Variations in iron and folic acid (IFA) compliance according to the side effects experienced among respondents, Kakamega level 5 hospital, Kenya, 2020.

participants interviewed reported not having been given IFA supplements during ANC visits because the facility had run out of stock. However, this only happened once in almost all the 12% of the cases. Separately, KIIs with healthcare workers also revealed that the facility runs out of the supplements at times, although not very often. Despite the existence of clear channels on how to source for the IFA tablets, it would take a lot of time for the officer in charge to be notified of the IFA stock-outs. The respondent felt that the situation was exacerbated by delayed communications among the staff and this, to some extent, resulted to missed opportunities for taking IFA.

"…*As I said, we need to have a nutritionist in every room but that's almost impossible for now. So sometimes when I'm compiling monthly reports, I notice that the mothers have not been issued with the supplements for some time. When you make follow-ups,*

you will be told that IFA had run out of stock. But the problem is that they did not communicate because I could have looked for the supplements somewhere else even if it means borrowing from another facility…" (KII: healthcare provider).

We also learned that the ANC healthcare providers experienced challenges in providing IFA education and general MCH talks to ANC seeking mothers. They attributed this to health system disruptions caused by the COVID-19 pandemic whereby the ANC services were shifted to another department to create more space for COVID 19 patients as indicated in transcripts below.

"*Before we came here, we got some space at the eye clinic. But it was even smaller than this. We tried giving health talks there and you would find yourself*

Table 5. Univariable logistic regression model demonstrating socio-demographic risk factors for IFA adherence, Kakamega level 5 hospital, Kenya, 2020.

Variables	Beta	Std. Error	Z value	OR (95% CI)	P value
Mother's age (Years)					
18	Ref				
19–29	-0.706	0.493	-1.434	0.494 (0.173, 1.23)	0.152
≥30	-1.322	0.544	-2.432	**0.267 (0.086, 0.741)**	**0.015**
Education level					
College	Ref				
Secondary	0.125	0.303	0.414	1.133 (0.626, 2.055)	0.679
Primary	-0.905	0.363	-2.491	**0.405 (0.196, 0.819)**	**0.013**
Marital status					
Married	Ref				
Single	1.252	0.t336	3.725	**3.497 (1.852, 6.971)**	**<0.001**
Gravidity					
Multigravida	Ref				
Primigravida	1.269	0.278	4.575	**3.559 (2.081, 6.187)**	**<0.001**
Birth complication					
No	Ref				
Yes	-0.412	0.398	-1.036	0.662 (0.303, 1.457)	0.300
Anaemia knowledge					
Low	Ref				
High	0.984	0.374	2.629	**2.676 (1.296, 5.680)**	**0.009**
ANC visits					
≥3	Ref				
≤2	-1.117	0.526	-2.124	**0.327 (0.109, 0.893)**	**0.034**
Distance to ANC					
>30 mins	Ref				
≤30 mins	0.167	0.370	0.450	1.181 (0.564, 2.432)	0.653
IFA side effects					
No	Ref				
Yes	-0.742	0.269	-2.754	**0.476 (0.279, 0.804)**	**0.006**

Standard Error (Std. Error), odds Ratio (OR), Significant (P<0.05).

talking to a group of eye patients, ANC mothers and under-five mothers. It was such a bad confusion and we had to move from there to this orthopaedic department. The space here still doesn't allow for such talks though. That is as it is for now…" (KII: healthcare provider).

"Did you notice that even the sitting space is not enough? We have no space for more benches. Some mothers are standing as you can see. In fact, this has impacted negatively on our ANC visiting trends. It seems mothers are no longer motivated to come for ANC as they feel that the place is congested to an

Table 6. Multivariable logistic regression model demonstrating socio-demographic risk factors for IFA adherence, Kakamega level 5 hospital, Kenya, 2020.

Variables	Estimate	Std. Error	Z value	OR (95% CI)	P value
Mother's age (Years)					
≤18	Ref				
19–29	-0.356	0.615	-1.578	0.701 (0.21, 2.339)	0.563
≥30	-0.196	0.747	-0.263	0.822 (0.19, 3.553)	0.793
Education level					
College	Ref				
Secondary	0.295	0.359	0.822	1.344 (0.664, 2.718)	0.411
Primary	-0.481	0.428	-1.125	0.618 (0.267, 1.429)	0.260
Marital status					
Married	Ref				
Single	0.712	0.447	1.592	2.037 (0.848, 4.893)	0.111
Gravidity					
Multigravida	Ref				
Primigravida	0.995	0.389	2.559	**2.704 (1.262, 5.793)**	**0.010**
Anaemia knowledge					
Low	Ref				
High	1.168	0.444	2.629	**3.215 (1.346, 7.68)**	**0.009**
ANC visits					
≥3	Ref				
≤2	-1.300	0.618	-2.102	**0.273 (0.081, 0.916)**	**0.036**
IFA side effects					
No	Ref				
Yes	-0.811	0.302	-2.687	**0.444 (0.246, 0.803)**	**0.007**

Standard Error (Std. Error), odds Ratio (OR), Significant (P<0.05)

extend that they miss a place to sit…" (KII: healthcare provider).

As indicated in the following verbatim, healthcare workers at the ANC section experience a heavy workload very often. This is partly due to the limited number of staff as well as the rigorous writing involved in their line of duty.

> *"I'm the only one here and the two ladies you see over there are interns, the other lady is a casual on the hospital's payroll. And there is a lot of writing involved by the way. We do not have enough computers and the few that we have keep on hanging…"* (KII: healthcare provider).

Discussion

There is moderate adherence to IFA supplementation (60.6%) during pregnancy among mothers seeking MCH care at Kakamega level 5 hospital. The finding is consistent with similar studies conducted in a sub-city of Ethiopia (60.9%), as well as a metropolitan area of Ghana (58.8%)[27,28]. The IFA supplementation prevalence was however higher as compared to 32.7% reported in Kiambu county of Kenya[13] and 20.3% among rural communities of North Western Tanzania[29], but lower than 71% reported in India[30] and 68.6% in Niger[31]. Other similar studies conducted in a nursing home in Nairobi and Thika level 5 hospital of Kenya reported IFA adherence prevalence of 42% and 25% respectively[32,33]. The moderately higher IFA supplementation prevalence recorded in the current study could be attributed to the fact that the study was conducted in a hospital located within a town. This implies that the hospital is very accessible and the mothers seeking MCH care within the hospital have more access to information as they are likely to be residing closer to town. Similarly, it is also possible that the difference in the definition of adherence thresholds among the various studies

Table 7. Univariable logistic regression model demonstrating health system-related risk factors for IFA adherence, Kakamega level 5 hospital, Kenya, 2020.

Variables	Beta	Std. Error	Z value	OR (95% CI)	P value
IFA education					
No	Ref				
Yes	1.004	0.384	2.611	**2.728 (1.297, 5.921)**	**0.009**
Pregnancy counselling					
No	Ref				
Yes	0.882	0.342	2.581	**2.415 (1.262, 4.859)**	**<0.01**
Turnaround Time					
Longer than expected	Ref				
As expected,	0.342	0.321	1.067	1.408 (0.747, 2.640)	0.286
IFA stock out					
No	Ref				
Yes	-0.253	0.400	-0.634	0.776 (0.355, 1.723)	0.526
Attitude towards ANC healthcare provider					
Negative	Ref				
Positive	0.856	0.381	2.253	**2.357 (1.124, 5.052)**	**0.024**

Table 8. Multivariable logistic regression model demonstrating health system-related risk factors for IFA adherence, Kakamega level 5 hospital, Kenya, 2020.

Variables	Beta	Std. Error	Z value	AOR (95% CI)	P value
IFA education					
No	Ref				
Yes	0.864	0.392	2.203	**2.372 (1.109, 5.218)**	**0.028**
Pregnancy counselling					
No	Ref				
Yes	0.735	0.350	2.102	**2.086 (1.071, 4.255)**	**0.036**
Attitude towards ANC healthcare provider					
Negative	Ref				
Positive	0.641	0.400	1.637	1.900 (0.884, 4.150)	0.102

contributed to the adherence prevalence disparities. Nevertheless, the moderate IFA adherence at Kakamega level 5 hospital suggests that pregnant mothers seeking MCH care in this facility and their unborn babies are still exposed to some risks of gestational maternal anaemia. This is because pregnant mothers are expected to comply with daily IFA uptake throughout the gestation period as in accordance with the WHO guidelines[8].

Participants who experienced IFA related side effects were less likely to be IFA compliant (OR=0.44, 95% CI: 0.246, 0.803; p=0.007). Equally, most of the respondents who admitted not

having adhered to IFA supplementation during their gestation period mentioned side effects (41.3%), forgetfulness (37.3%) and the bad smell of the supplements (10.3%) as the main challenges. Similar reasons for non-adherence have also been reported among pregnant women in India[34] and Ghana[28]. In Ethiopia, Nasir *et al.* observed that more than half of the mothers who were IFA non-compliant either attributed the poor trend to IFA related side effects or forgetfulness[35]. Most mothers do not seem to know how to manage IFA related side-effects and this makes them give up on the supplements quite easily. Out of the 123 mothers who reported to have experienced some side effects due to IFA consumption, almost 90% of them either stopped taking the supplements or let the side effects subside on their own. There is a need for health care providers to include education on the management of IFA related side effects as part of ANC counselling. Practices such as taking IFA alongside meals or just before going to bed as well as eating plenty of vegetables and fruits have been linked to reduced IFA side effects[13]. Forgetfulness among IFA users could be reduced by encouraging mothers to embrace modern technology reminders or take the supplements at specific times, such as after meals, every morning, and just before going to bed. The women could also ask a reliable member of the family or friend to remind them to take the supplements. Besides, the recent development involving the use of intravenous iron to combat maternal anaemia could be adopted. More than 1000mg doses of ferric carboxymaltose can be administered in smaller doses at an interval of seven days and this could save the mothers from having to remember to take the IFA tablets daily. Moreover, the intravenous iron would also suit those who dislike the smell of the IFA tablets as well as pregnant mothers with comorbidities such as kidney disease. Separately, the bad smell of the supplements could be eliminated by use of iron gel capsules in the manufacture of these supplements so that mothers do not smell or taste the tablets before ingestion.

There was a correlation between gravidity and IFA adherence. Primigravida mothers were almost three times more likely to be IFA compliant as compared to multigravida respondents. This is in line with other studies conducted in Kenya and India[13,31]. However, this finding is not consistent with Alemayu *et al.* and Niguse *et al.* who observed higher odds of IFA compliance among multigravida mothers in Ethiopia,[17,36]. The low IFA compliance among the multigravida mothers could be attributed to their experience with delivery and IFA usage. Some studies have shown that women who experience unpleasant side effects with IFA or have a history of good birth outcomes may not appreciate the need to adhere to IFA in their consecutive pregnancies[37]. Therefore, sensitizing multigravida mothers on the importance of adhering to IFA supplementation during subsequent pregnancies regardless of the previous past experiences is key.

Mothers who attained fewer ANC visits were less likely to be IFA compliant. Precisely, the respondents who attained a maximum of two ANC visits had up to 70% reduced chances of being IFA compliant. A large population-based study conducted among pregnant women in SSA noted higher odds of IFA compliance among women with at least four ANC visits[38]. In Ethiopia, Molla *et al.* observed that women with at least four ANC visits were almost seven times more likely to be IFA compliant while Tarekegn *et al.* reported higher IFA compliance among women who had attained at least 3 ANC visits,[39,40].Generally, ANC visits correlate positively with IFA adherence. A higher number of ANC visits indicates more frequency of contact between the mother and the healthcare provider. This provides a good opportunity for the healthcare provider to encourage the mothers to use the supplements as required. The mothers also get their supplements replenished through such visits to ensure that they do not run out of IFA. Besides, they could share any challenges encountered while taking the supplements with the healthcare provider and be advised accordingly. The WHO recommends at least eight[3] ANC visits in pregnancy and therefore encouraging pregnant women to complete the recommended number of visits is likely to have a positive influence on IFA compliance.

Women who had a higher knowledge of anaemia were more than three times likely to be IFA adherent as compared to their counterparts of low anaemia knowledge. Similar findings have also been reported in other studies elsewhere,[28,39,41]. It is possible that having higher knowledge of anaemia enables a mother to understand the aetiology of anaemia, its prevention measures as well as the deleterious effects that the condition could cause to the mother and her unborn baby. This makes the mothers appreciate the importance of taking IFA as recommended.

Pregnancy counselling before conception and ANC education on the importance of IFA adherence showed association with IFA adherence. This study revealed that women who received education on the importance of IFA during ANC were 2.4 times more likely to be IFA compliant as compared to their counterparts who had no education with regards to IFA supplementation. Just like IFA education, mothers who attended pregnancy counselling sessions before conception had higher odds of IFA compliance. This is consistent with other reports where IFA education during ANC or pregnancy counselling improved the uptake of the supplements[13,27]. Women's desire for clear information and counselling regarding the benefits and risks of IFA supplements has been reported elsewhere[42]. Being educated on the importance of IFA helps mothers to appreciate the need to take the supplements consequently leading to compliance. Unfortunately, KIIs with ANC health care workers revealed that the staff were almost unable to provide this crucial education to ANC mothers as at the time of the study due to health system disruptions caused by the COVID-19 pandemic[43] that led to a shift in location of ANC services. Moreover, the understaffing at the ANC department and the rigorous documentation involved within this section barely leaves enough opportunity for individual health talk between a mother and the health care provider. The Ministry of Health should put measures in place to ensure uninterrupted continued provision of

essential health care services such as MCH even in times of pandemics like COVID-19.

Although the study reveals some critical factors associated with IFA adherence, it is worth noting that IFA compliance is a complex issue that depends on a wider array of enablers, barriers, and other intervening factors. For instance, a woman's access to ANC depends on a cascade of intervening factors such as their mental health, autonomy, workloads, social support as well as quality and accessibility of health services. Also, the determinants identified in this survey were based IFA adherence definition of at least five tablets per week throughout pregnancy. Our definition of IFA adherence seems to have a higher threshold compared to other studies that defined IFA adherence as having taken at least 90 tablets of IFA throughout gestation. In fact, other studies define adherence as having consumed at least four or five tablets of IFA in a week preceding the study[13]. Our definition of IFA adherence was motivated by the current WHO guidelines that require daily intake of IFA tablets from conception to birth[8]. It is possible that the findings of this study might have been different were it that another definition of IFA adherence was adopted.

This study relied on self-reported IFA adherence, which may not be the gold standard approach of determining IFA compliance. Self-reported adherence studies are non-invasive, less expensive, easy to administer and pose a minimal patient burden[44]. The best alternative would have been a longitudinal study to measure IFA compliance in the entire gestation period through the pill count method. However, the pill count method requires more resources, and it would have been almost unachievable considering the fact that the study was conducted during the COVID-19 pandemic with restricted movements within the country. Equally, self-reported adherence is prone to recall bias. Usually, studies assessing IFA adherence have recall periods ranging from as short as seven days to as long as five years as used in KDHS[15]. Although shorter recall periods of 7 days of IFA use during pregnancy are frequently used in other studies, the method is not without disadvantages either. Firstly, measuring IFA use in a single week during pregnancy makes it difficult to infer whether the mother will be compliant throughout the gestation, especially with the current change of IFA adherence guidelines by WHO from 90-day use of IFA to daily use throughout pregnancy[4]. Secondly, as reported by Stirratt *et al.*, such short recall periods experience a ceiling effect which results in overestimation of the adherence[44]. Chang et al. report that in salience, some pregnancy healthcare indicators could be accurately remembered up to 20 months post-delivery[45]. Other studies show that long recall periods of more than 1 year are prone to recall bias unless the event is very salient[46]. Therefore, a trade-off between the extent of information and bias is almost inevitable when determining the length of the recall period in self-reported compliance studies[47]. Nonetheless, researchers need to consider the salience of the event when determining the length of the recall period. Pregnancy itself is a salient event in a woman's life and evidence shows that mothers are likely to recall most of the healthcare indicators

within our stipulated cut-off or 0-6 months post-delivery[45]. We are therefore confident that our findings were not affected much by the recall bias. The authors, however, acknowledge that it would have been better to conduct this study among mothers who had just delivered, such as at most one month post-delivery. Our decision to include mothers of 0-6 months post-delivery was also partly contributed by the COVID-19 pandemic. The number of mothers seeking MCH care in the selected facility during the pandemic was low. This would have made it difficult to attain our targeted sample size within the anticipated 3 months duration.

Study limitation

The study was likely to have been affected by recall bias as the mothers had to recall their IFA usage trends during their gestation period. However, we minimized this bias by only selecting mothers of 0–6 months post-delivery. Similarly, it is possible this study could have been affected by social desirability. This is because in self-reported surveys, the respondents might be tempted to provide responses to please the interviewer. For instance, the participants in this case could have provided responses indicating that they are compliant to IFA supplementation when in true sense they do not adhere. We tried to minimize this effect by: 1) Explaining the purpose of the study that we only intended to use the data to influence policies meant to improve IFA uptake in pregnancy and avoid pregnancy complications and 2). Assuring the participants of their confidentiality such that they were not going to be victimised in any way based on their responses. Further, we sought permission from the hospital management to allow our interviewer to interact with the mothers within the clinics without wearing a medical regalia such as a white coat to avoid creating any impression that the interviewer was a healthcare provider consequently risking responses of social desirability. Separately, some participants may have faced a challenge in trying to estimate the average number of IFA tablets consumed per week throughout the gestation period. However, we tried as much as possible to help them understand how to estimate this. In some instances, we interpreted the question further by asking them about the average number of days per week in which they consumed the supplements throughout pregnancy. Further, the authors acknowledge that their failure to specify the gestation interval over which adherence was measured made it difficult for the study to have a specific common gestation duration over which adherence was assessed. This is because the participants enrolled for ANC at different weeks of gestation. We, however, did not classify mothers who began ANC with less than 3 months to delivery as adherent as we reasoned that they had taken the supplements for a limited duration compared to their counterparts. The authors also acknowledge that there was a weakness in the way some critical variables were used in the analysis. Some continuous variables in this study such as the anaemia knowledge, mother's attitude towards ANC healthcare provider and the number of IFA tablets consumed per week were converted into binary variables. According to Altman *et al.*, such conversion results in loss of some information[48]. Most importantly, this survey was a cross-sectional study and therefore it is difficult to ascribe causality.

It is difficult to tell whether the determinants revealed in this study preceded the outcome indeed.

Conclusion

There is moderate adherence to IFA supplementation during pregnancy among mothers seeking MCH at Kakamega level 5 hospital. This suggests that there is still a need for improvement to meet the WHO recommendations where pregnant mothers are encouraged to take IFA supplements every day throughout pregnancy. The greatest impediments of IFA compliance are IFA related side effects, forgetfulness and the bad smell of the IFA tablets. Therefore, education on how to cope up with such anticipated outcomes should be provided to all pregnant mothers during ANC visits.

Data availability

Underlying data

Harvard Dataverse: Replication Data for: Adherence to Iron and Folic Acid supplementation during pregnancy among postnatal mothers seeking Maternal and Child Healthcare at Kakamega level 5 hospital in Kenya, https://doi.org/10.7910/DVN/ZEYYSZ[23].

The interview transcripts derived from the KIIs conducted in this study have not been made available for open access because this would violate the privacy that we initially assured all our study participants. Intermediary data in the form of quotes are avaliable throughout the Results section that reflect the data collected. Reasonable access to the interview transcripts may be granted after the application of access permission by downloading and filling this online form and then sending it to the Data Governing Committee at KEMRI-Wellcome Trust (dgc@kemri-wellcome.org). The applicant must however prove

beyond reasonable doubt that the confidentiality of the study participants will not be compromised in any way before data access is granted.

Extended data

Harvard Dataverse: Replication Data for: Adherence to Iron and Folic Acid supplementation during pregnancy among postnatal mothers seeking Maternal and Child Healthcare at Kakamega level 5 hospital in Kenya, https://doi.org/10.7910/DVN/ZEYYSZ[23].

This project contains the following extended data:

- KII guide (CHV)

- KII guide (healthcare provider)

Reporting guidelines

Harvard Dataverse: COREQ checklist for 'Adherence to Iron and Folic Acid supplementation during pregnancy among postnatal mothers seeking Maternal and Child Healthcare at Kakamega level 5 hospital in Kenya', https://doi.org/10.7910/DVN/ZEYYSZ[23].

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

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PubMed Abstract | **Publisher Full Text** | **Free Full Text**

Open Peer Review

Current Peer Review Status: ❓ ✅

Version 2

Reviewer Report 20 July 2021

https://doi.org/10.21956/wellcomeopenres.18803.r44786

✅ **Martin N. Mwangi** (ID)

Training and Research Unit of Excellence (TRUE), College of Medicine, University of Malawi, Blantyre, Malawi

I have reviewed the edited paper and noted that the requested edits were addressed fully. I have no further comments to make.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Anaemia and Iron Deficiency Anaemia in pregnancy and early childhood, Nutrition and Infectious Diseases, Nutritional epidemiology, Public Health Nutrition.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Reviewer Report 15 June 2021

https://doi.org/10.21956/wellcomeopenres.18414.r43854

❓ **Martin N. Mwangi** (ID)

Training and Research Unit of Excellence (TRUE), College of Medicine, University of Malawi, Blantyre, Malawi

This is a well written paper about a study that sought to investigate the possible determinants of Iron and Folic Acid (IFA) supplementation adherence during pregnancy among postnatal mothers seeking maternal and child healthcare at a referral hospital in Western Kenya. Using a mixed methods approach, the authors explore barriers to IFA uptake among pregnant women.

Introduction
The background information section is well written. Important and recent references on the topic are cited. In paragraph 2, as part of our research in the same Western region of Kenya, the effect of iron supplementation on low birth weight was clearly demonstrated and thus this work deserves mention in relation to the effect of iron supplements on birth weight (see cited article).

Methods
The methods section is well structured and contains most of the relevant information.
1. Adherence to IFA supplementation was the primary outcome and was defined as taking at least five IFA tablets per week throughout the gestation period. The authors do not explain why other less strict definitions such as the WHO definition (iron folate supplements ≥ 90 days or 4 days per week during the pregnancy period) were not sufficient for this population. One wonders to what magnitude the conclusions would change if the criteria stated here (≥ 90 days or 4 days per week) is used.

2. Qualitative data – key informant interviews (KIIs): the KIIs with healthcare providers and the community health volunteers (CHVs) attached to the hospital were well received and accepted by the respondents. What is missing is an explanation of how the authors determined whether all vital information was already collected from a respondent. In addition, how the authors determined the stop point for the KIIs. Did they rely on a saturation point for example?

Results
The results section is clearly structured with adequate tables and figures. Because correlations are not causal the authors should be careful not to ascribe causality to otherwise correlated outcomes.

Discussion
Paragraph one of the discussion reports the main finding of the study. More comparative data on the same outcome from other Kenyan counties could have been reported to aid generalisability.

Paragraph two of the discussion ends with suggestions on how to reduce forgetfulness among IFA users. The authors should include recent developments or strategies such as the use of intravenous iron for example ferric carboxymaltose to combat maternal anaemia in pregnancy.

Bad smell has been noted to be among the top three reasons for non-compliance as reported by the participants of the study. The discussion could explore ways to overcome bad smells, for example in the manufacture of iron gel capsules so that pregnant mothers do not smell or taste the capsules before ingesting them. Other strategies could be outlined as well.

Recall bias is not adequately discussed in the study yet the primary outcome (adherence to IFA supplementation during pregnancy) relied on the ability of participants to recall past events. The recall period is long especially if a participant was recruited in the 3-6 months postpartum period.

The paper could benefit from a discussion on strategies applied to reduce the impact of recall bias on the primary outcome.

General edits:
- Introduction, paragraph 3 first sentence should read: "To ensure equitable access, the government *of Kenya* provides…"

- Introduction, last sentence, the word "care" seems to be repeated.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?
No source data required

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Anaemia and Iron Deficiency Anaemia in pregnancy and early childhood, Nutrition and Infectious Diseases, Nutritional epidemiology, Public Health Nutrition.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 29 Jun 2021

Felix Bahati, KEMRI Wellcome Trust, Nairobi, Kenya

This is a well written paper about a study that sought to investigate the possible determinants of Iron and Folic Acid (IFA) supplementation adherence during pregnancy among postnatal mothers seeking maternal and child healthcare at a referral hospital in Western Kenya. Using a mixed methods approach, the authors explore barriers to IFA uptake among pregnant women.

Introduction

The background information section is well written. Important and recent references on the topic are cited. In paragraph 2, as part of our research in the same Western region of Kenya, the effect of iron supplementation on low birth weight was clearly demonstrated and thus this work deserves mention in relation to the effect of iron supplements on birth weight (see cited article).

We appreciate the reviewer for making us aware about this interesting study. The findings of the interventional study cited by the reviewer in Western Kenya proved that the supplements reduced the risk of low birth weight by 58% as well as prematurity. We have cited this work in paragraph 2 of our introduction to clearly show the significance of IFA supplementation.

Methods
The methods section is well structured and contains most of the relevant information.
1. Adherence to IFA supplementation was the primary outcome and was defined as taking at least five IFA tablets per week throughout the gestation period. The authors do not explain why other less strict definitions such as the WHO definition (iron folate supplements ≥90 days or 4 days per week during the pregnancy period) were not sufficient for this population. One wonders to what magnitude the conclusions would change if the criteria stated here (≥90 days or 4 days per week) is used.

As the reviewer notes, this study had slightly higher threshold of defining IFA adherence compared to other studies that used a lower threshold. Our adherence definition was motivated by the current WHO guidelines that require pregnant mothers to take IFA tablets daily throughout pregnancy. Unlike the previous guidelines, the current WHO guidelines are stressing on the need for daily intake rather than achieving the previous cut-off of 90 tablets. We reasoned that the daily IFA intake advocated by the WHO throughout gestation coupled with the current ANC guideline of 8 ANC visits from the previous 4, signifies the need for mothers to consume the supplements daily. We therefore designed our study with an aim of defining adherence that would be in line with the current guidelines which gives it a greater chance of having significant policy implication. We, however, acknowledge the reviewers thought that maybe there would be some significant changes were it that another less strict adherence was used. We have brought out this issue by explaining in our first paragraph of the discussion that probably this could be the reason as to why our adherence prevalence could not match other studies done elsewhere. Besides, we have added a second last paragraph in the discussion section which partly highlights this issue.

1. Qualitative data – key informant interviews (KIIs): the KIIs with healthcare providers and the community health volunteers (CHVs) attached to the hospital were well received and accepted by the respondents. What is missing is an explanation of how the authors determined whether all vital information was already collected from a respondent. In addition, how the authors determined the stop point for the KIIs. Did they rely on a saturation point for example?

Actually, the KII guides used by the interviewer also served as the checklists to ensure that all the relevant information required was discussed during the interview. We conducted KIIs with two groups of respondents in this study; the CHVs and healthcare providers. We conducted KIIs with all the CHVs (11) attached to the hospital. This was because, we knew that most of them came from different sub-ethnicities within the area and therefore this would give us an opportunity to

understand deeply the socio-cultural factors affecting IFA adherence (data not presented in this article). As for the healthcare providers, we were keen to cause very minimal inconveniences to care provision and therefore stopped immediately the themes reached the saturation point. We realize that this is a crucial information that we should have provided in the methodology section as the reviewer suggests. We added this information in the methodology section within the 'Qualitative data – key informant interviews' section.

Results
The results section is clearly structured with adequate tables and figures. Because correlations are not causal the authors should be careful not to ascribe causality to otherwise correlated outcomes.

This is a very crucial observation that was also raised by reviewer #1. We have therefore rephrased all the sentences in the discussion section that we thought could be easily misinterpreted to mean causality when in real sense the scope of our analysis was correlation.

Discussion
Paragraph one of the discussion reports the main finding of the study. More comparative data on the same outcome from other Kenyan counties could have been reported to aid generalisability.

Although there is a paucity of data in this area, the authors have identified a few relevant studies conducted in other Kenyan counties and made the necessary comparison. Please see references …and…

Paragraph two of the discussion ends with suggestions on how to reduce forgetfulness among IFA users. The authors should include recent developments or strategies such as the use of intravenous iron for example ferric carboxymaltose to combat maternal anaemia in pregnancy.

We commend the reviewer for this insight. We learnt that more than 1000mg doses of Ferric carboxymaltose could be administered to mothers in smaller divided doses administered at an interval on 7 days. This could save the mothers from the daily intake of the IFA tablets. We have included this in paragraph two of our discussion as suggested by the reviewer.
Bad smell has been noted to be among the top three reasons for non-compliance as reported by the participants of the study. The discussion could explore ways to overcome bad smells, for example in the manufacture of iron gel capsules so that pregnant mothers do not smell or taste the capsules before ingesting them. Other strategies could be outlined as well.

Although many participants in our study complained about the bad smell of these tablets, we had not thought of a way of eliminating the bad smell without interfering with the efficacy of the supplements. We think that the adoption of an iron gel capsule as suggested by the reviewer would be helpful in eliminating the smell. We have suggested this in our discussion as recommended by the reviewer. Unfortunately, we couldn't think of other appropriate strategies that could help alleviate this problem but stand ready to cite them if the reviewer suggests such

other strategies.

Recall bias is not adequately discussed in the study yet the primary outcome (adherence to IFA supplementation during pregnancy) relied on the ability of participants to recall past events. The recall period is long especially if a participant was recruited in the 3-6 months postpartum period. The paper could benefit from a discussion on strategies applied to reduce the impact of recall bias on the primary outcome.

We have added a whole paragraph in the discussion section to address the recall bias issue. We have cited evidence supporting our recall period of 0-6 months. Generally, pregnancy is a very important event in the lifetime of most women. According to other researchers, when an event is salient, the respondents tend to remember it even 20 months afterwards. This coupled with overall assessment of an event i.e asking the respondent to gauge their overall use of IFA in gestation rather than specific weeks/stages of gestation makes it easier for participants to remember. We are therefore confident that the findings reported in this article are relevant and were not influenced by recall bias to a great extent. We have also edited table 2 and provided the total number of respondents that we interviewed at every monthly interval post-delivery as suggested by the reviewer. The limitation section has also been updated to clearly show the recall period was a weakness in this study.

General edits:
   ○ Introduction, paragraph 3 first sentence should read: "To ensure equitable access, the government **of Kenya** provides..."
This has been rectified

   ○ Introduction, last sentence, the word "care" seems to be repeated.
This has been edited.
   ○ **Is the work clearly and accurately presented and does it cite the current literature?**
Yes
   ○ **Is the study design appropriate and is the work technically sound?**
Yes
   ○ **Are sufficient details of methods and analysis provided to allow replication by others?**
Partly
   ○ **If applicable, is the statistical analysis and its interpretation appropriate?**
Partly
   ○ **Are all the source data underlying the results available to ensure full reproducibility?**
No source data required
   ○ **Are the conclusions drawn adequately supported by the results?**
Yes

Competing Interests
No competing interests were disclosed.

Reviewer Expertise
Anaemia and Iron Deficiency Anaemia in pregnancy and early childhood, Nutrition and Infectious Diseases, Nutritional epidemiology, Public Health Nutrition.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.
We very much appreciate Reviewer 2's comments and we believe the paper is better as a result of the changes that we have made. We have made significant changes to the text in the discussion section to reduce the assumption that we are ascribing causality which is far beyond the scope of this study. Further, the limitations section is expanded, and we have edited the text to ensure the reader understands the limitations of the data. We, however, remain confident, that the key points of this article are still entirely valid. Most importantly, the reviewer has helped in spotting areas requiring edits, made some suggestions as possible solution to the problems encountered by pour participants and also reminded us of the study limitations.

Competing Interests: I'm the lead author of this article

Reviewer Report 28 May 2021

https://doi.org/10.21956/wellcomeopenres.18414.r43773

?   **Katherine L. Dickin** (iD)

Master of Public Health Program, Population Medicine and Diagnostic Sciences, Cornell University, Ithaca, NY, USA

The purpose of this research was to identify possible determinants of IFA supplementation adherence during pregnancy at a hospital in Kenya. The study used mixed methods, surveying mothers postnatally and interviewing health care providers on factors reported to influence adherence. This study adds to a body of literature documenting barriers to IFA supplementation across contexts and identifies implications for programs to improve nutritional care during pregnancy. The paper is well-written and clear. Concerns include the lack of clarity on how the primary outcome was defined and collected and the analytic choice to create binary variables, as well as the tendency to ascribe causal relationships to associations.

Specific comments

Introduction
Importantly, the introduction acknowledged multiple factors that contribute to poor "adherence" since this term can imply a lack of cooperation. The authors note other barriers such as stock-outs at health facilities as such their use of "adherence" reflects more than just behavioral lapses on part of women.

Methods
1. The recall period of up to 6 months for postnatal mothers reporting IFA intake sees long. What evidence is there that asking so long after pregnancy did not affect the data? The paper states that many were interviewed within 3 months of delivery, but it would be helpful to clarify how many responded at various intervals and whether any differences were found in data across these time points periods. Appropriately, the possibility of recall bias acknowledged under "study limitations".

2. A strength of this paper is that the survey data was complemented with key informant interviews (KIIs) with health care providers. In the future, it would be useful to include KIIs with mothers to gather their in-depth perspectives on barriers and facilitators of supplementation.

3. I am not clear on the specifics of how the primary outcome was determined and the questionnaire does not appear to be available. The paper states "adherence to IFA supplementation was established by asking the participants about the average number of IFA tablets taken per week throughout the gestation period." Was the question open-ended or multiple choice? Were mothers asked about the number of weeks or was it assumed to be "throughout gestation"? Since the majority of women attended ANC after 8 weeks, and likely quite late in pregnancy for some, how was this handled when asking about adherence "throughout gestation"? How did mothers estimate average intake per week? What was done to guard against social desirability, i.e. mothers answering as they believed was expected of them?

4. The definition of adherence as "at least five IFA tablets per week throughout gestation period" is quite a high bar, given evidence of the effectiveness of even intermittent supplementation and reports that women may adhere better when first experiencing resolution of fatigue and other anemia symptoms or in early stages of supplementation. Consider analyzing adherence as a continuous variable, or at least with multiple levels of adherence.

5. The same concern applies to other variables such as knowledge, attitudes about providers, and even the number of ANC visits attained by the mothers. Converting the data to binary variables results in a loss of information (See Altman *et al.* BMJ. 2006 *The cost of dichotomising continuous variables* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1458573/) [1] and reduces the power of the analysis. It also makes results hard to interpret, since no evidence is presented on the basis for the cut points, making them appear rather arbitrary.

Results
1. In Table 3, it seems adherence was considered in increments (e.g. 0-2 and 3-4 and 5-7

tabs/day) but without statistical testing of differences. There is also a lack of statistical testing reported on side effects and other compliant/non-compliant comparisons. For example: "A total of 123 (51%) mothers experienced IFA related side effects. Out of this, almost half (48.0%) were non-compliant. The most prevalent side effects were vomiting (41.3%), nausea (26.9%) and dizziness (18.6%). Slightly over half (52.2%) of the mothers who experienced vomiting while on IFA were non-compliant." There is inadequate analysis provided to support the statement in the discussion that "Participants who experienced IFA related side effects were less likely to be IFA compliant."

2. The study includes helpful findings on factors related to potential barriers such as distance from the facility. It is notable that most mothers had a high level of knowledge of anemia. Given the concern about stockouts, it would have been good to know how often women were given IFA.

3. There are important program implications from the finding that "mothers who received education on IFA were almost three times more likely to be IFA compliant as compared to those who did not receive education on IFA (OR=2.728, 95% CI: 1.297, 5.921; p=0.009)". Women's desire for clear information and counseling on antenatal supplementation has been reported elsewhere (e.g. *Ethiopian women's perspectives on antenatal care and iron-folic acid supplementation: Insights for translating global antenatal calcium guidelines into practice.* Birhanu, *et al.* Maternal & child nutrition 2018 https://onlinelibrary.wiley.com/doi/pdf/10.1111/mcn.12424)[2]

4. Caution is needed in interpreting associations. The paper suggests causality in the statement that "attending pregnancy counselling sessions prior to conception played a significant role on IFA adherence" but this could be due to confounding if, for example, women who are very health-oriented or who have concerns due to reproductive history are more likely to seek counseling prior to pregnancy and also to be more adherent to supplementation.

Discussion
1. While it is useful to compare results to what has been reported in other papers, not all cited papers define compliance in the same way, limiting interpretation. Adherence definitions could be responsible for differences attributed by the authors to accessibility of the hospital, etc. For example, a common definition that was used in the cited Ethiopian and Tanzanian studies is 90 days of consumption, whereas the compliance definition in this analysis would have been over 125.

2. Some interpretations assumed that correlations were causal. There is likely to be collinearity of multiple variables with the number of ANC visits (which provide more info, more supplements, potentially more support, and indicate time and access to services), for example. Associations explored in this paper are a step toward understanding supplementation but there is a need to recognize underlying factors related to women's mental health, autonomy, workloads, mobility, and social support, as well as quality and accessibility of health services.

3. **Study limitations:** consider also noting the risk of social desirability of responses, given quite high levels of reported adherence, and the difficulty in estimating "on average"

intake. Also the limits on drawing conclusions about causality from the associations found in this analysis.

Conclusions are reasonable, despite some over-interpretation of causality in the discussion.

References
1. Altman DG, Royston P: The cost of dichotomising continuous variables.*BMJ*. 2006; **332** (7549): 1080 PubMed Abstract | Publisher Full Text
2. Birhanu Z, Chapleau GM, Ortolano SE, Mamo G, et al.: Ethiopian women's perspectives on antenatal care and iron-folic acid supplementation: Insights for translating global antenatal calcium guidelines into practice.*Matern Child Nutr*. **14 Suppl 1**. PubMed Abstract | Publisher Full Text

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?
No source data required

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Maternal and child nutrition, social and behavior change, qualitative and mixed methods research, nutrition program implementation and effectiveness

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 29 Jun 2021

Felix Bahati, KEMRI Wellcome Trust, Nairobi, Kenya

The purpose of this research was to identify possible determinants of IFA supplementation adherence during pregnancy at a hospital in Kenya. The study used mixed methods, surveying mothers postnatally and interviewing health care providers on factors reported to

influence adherence. This study adds to a body of literature documenting barriers to IFA supplementation across contexts and identifies implications for programs to improve nutritional care during pregnancy. The paper is well-written and clear. Concerns include the lack of clarity on how the primary outcome was defined and collected and the analytic choice to create binary variables, as well as the tendency to ascribe causal relationships to associations.

Specific comments

Introduction
Importantly, the introduction acknowledged multiple factors that contribute to poor "adherence" since this term can imply a lack of cooperation. The authors note other barriers such as stock-outs at health facilities as such their use of "adherence" reflects more than just behavioral lapses on part of women.

We appreciate that we had used the term 'adherence' to imply that mothers are not taking the supplements as required without acknowledging the fact that some of the reasons behind such non-adherence trends are way beyond their control. A good example is the IFA stock-out within facilities as pointed out by the reviewer, something that these mothers may not have control about. We have therefore edited the fourth paragraph of our introduction to include a statement clearly stating that some of these causes of poor adherence are beyond the control of these women.

Methods
1. The recall period of up to 6 months for postnatal mothers reporting IFA intake sees long. What evidence is there that asking so long after pregnancy did not affect the data? The paper states that many were interviewed within 3 months of delivery, but it would be helpful to clarify how many responded at various intervals and whether any differences were found in data across these time points periods. Appropriately, the possibility of recall bias acknowledged under "study limitations".

We have added a whole paragraph in the discussion section to address the recall bias issue. We have cited evidence supporting our recall period of 0-6 months. Generally, pregnancy is a very important event in the lifetime of most women. According to other researchers, when an event is salient, the respondents tend to remember it even 20 months afterwards. This coupled with overall assessment of an event i.e asking the respondent to gauge their overall use of IFA in gestation rather than specific weeks/stages of gestation makes it easier for participants to remember. We are therefore confident that the findings reported in this article are relevant and were not influenced by recall bias to a great extent. We have also edited table 2 and provided the total number of respondents that we interviewed at every monthly interval post-delivery as suggested by the reviewer. The limitation section has also been updated to clearly show the recall period was a weakness in this study.

1. A strength of this paper is that the survey data was complemented with key informant interviews (KIIs) with health care providers. In the future, it would be useful to include KIIs with mothers to gather their in-depth perspectives on barriers and facilitators of supplementation.

We thank the reviewer for this useful direction. This is a good suggestion that could help us unmask more barriers and facilitators of IFA supplementation that we may not have achieved with the semi-structured questionnaire that was used in the current study. We shall consider this in our future studies.

1. I am not clear on the specifics of how the primary outcome was determined and the questionnaire does not appear to be available. The paper states "adherence to IFA supplementation was established by asking the participants about the average number of IFA tablets taken per week throughout the gestation period." Was the question open-ended or multiple choice? Were mothers asked about the number of weeks or was it assumed to be "throughout gestation"? Since the majority of women attended ANC after 8 weeks, and likely quite late in pregnancy for some, how was this handled when asking about adherence "throughout gestation"? How did mothers estimate average intake per week? What was done to guard against social desirability, i.e. mothers answering as they believed was expected of them?

We measured adherence to IFA supplementation during pregnancy using a set of two questions. Firstly, we asked the respondent whether they took the IFA tablets faithfully throughout pregnancy as recommended by the healthcare provider, "Did you take the IFA supplements faithfully as recommended by the health care provider? (Yes/No)". This was confirmed further by asking about the average number of IFA tablets that the respondents consumed per week throughout the gestation, "On average, how many IFA tablets did you used to take every week throughout pregnancy? (open ended)." Although we had assumed taking the IFA tablets faithfully as recommended to mean taking IFA daily as WHO recommends, we noticed that some respondents who reported taking the tablets faithfully also reported taking as low as three IFA tablets per week on average. For the sake of standardization of our primary outcome, we defined adherence as having taken at least five IFA tablets per week throughout pregnancy (Similar to having used the supplements for an average of at least 5 days per week throughout the gestation). Although the respondents were classified as either adherent or non-adherent based on the number of tablets consumed, we did not classify respondents who started ANC less than 3 months due to delivery as compliant. This was because we reasoned that they had consumed the supplements for a shorter duration compared to others. Nonetheless, the authors acknowledge that by measuring adherence throughout gestation without specifying weeks, we failed to establish a specific interval over which adherence was measured. We have further acknowledged this in the limitation section. All in all, it would have been difficult for the respondents to remember their IFA use patterns had we specified some gestation weeks. We avoided instances where the participants could provide inaccurate responses for social desirability by: 1) Explaining the justification of the study that we only intended to use the data to influence policies meant to improve IFA uptake in pregnancy and avoid pregnancy complications and 2). Assuring the participants of their confidentiality such that they were not going to be victimised in any way based on their responses. Further, we sought permission from the hospital management to allow our interviewer to interact with the mothers within the clinics without wearing a medical regalia such as a white coat to avoid creating any impression that he was a healthcare provider consequently risking responses of social desirability.

1. The definition of adherence as "at least five IFA tablets per week throughout gestation period" is quite a high bar, given evidence of the effectiveness of even intermittent supplementation and reports that women may adhere better when first experiencing resolution of fatigue and other anemia symptoms or in early stages of

supplementation. Consider analyzing adherence as a continuous variable, or at least with multiple levels of adherence.

We understand the point that the reviewer is trying to put across here. Taking an average of five tablets of IFA per week may seem quite higher. We have added a small section in the discussion section to highlight this and make our readers aware. We realized that we based much of this study on the current WHO guidelines of IFA supplementation and tried as much as possible to stick to their recommendation of adherence as daily intake of IFA right from conception to birth. This might have made us set the bar quite high. Our reasoning was also informed by other studies conducted in other parts of Kenya where more than 4 IFA tablets per week were used as a cut off for adherence. Despite such studies having focused a specific week among ANC seeking mothers, the fact remains that the assumption is that the mothers will stick to the same trend throughout pregnancy. We are confident that our findings suit well with the current WHO IFA supplementation guidelines and can easily inform policies within this context. The reviewer's preference on the use of adherence as a continuous variable is a keen observation and justified. We overlooked this during our analysis, and fully concur with the reviewer that it would have been better to use adherence as a continuous variable or establish various levels of adherence. This is a weakness in our data analysis approaches and we have stated it in the limitations. We believe that our table 3 highlights some various levels of adherence to some extent.

1. The same concern applies to other variables such as knowledge, attitudes about providers, and even the number of ANC visits attained by the mothers. Converting the data to binary variables results in a loss of information (See Altman *et al.* BMJ. 2006 *The cost of dichotomising continuous variables* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1458573/)[1] and reduces the power of the analysis. It also makes results hard to interpret, since no evidence is presented on the basis for the cut points, making them appear rather arbitrary.

Actually, the reviewer made us realize that by converting the continuous variables into binary we sacrificed clarity and the statistical rigor in favour of brevity. As already stated above, we have discussed this as a limitation in the limitation section.

Results

1. In Table 3, it seems adherence was considered in increments (e.g. 0-2 and 3-4 and 5-7 tabs/day) but without statistical testing of differences. There is also a lack of statistical testing reported on side effects and other compliant/non-compliant comparisons. For example: "A total of 123 (51%) mothers experienced IFA related side effects. Out of this, almost half (48.0%) were non-compliant. The most prevalent side effects were vomiting (41.3%), nausea (26.9%) and dizziness (18.6%). Slightly over half (52.2%) of the mothers who experienced vomiting while on IFA were non-compliant." There is inadequate analysis provided to support the statement in the discussion that "Participants who experienced IFA related side effects were less likely to be IFA compliant."

" Participants who experienced IFA related side effects were less likely to be IFA compliant' was based on the odds ratios obtained from the multivariable logistic regression presented in table 6 and not the descriptive statistics as the reviewer depicts.

1. The study includes helpful findings on factors related to potential barriers such as distance from the facility. It is notable that most mothers had a high level of knowledge of anemia. Given the concern about stockouts, it would have been good to know how often women were given IFA.

○ *We did not collect this information directly as stated by the reviewer. This information was collected indirectly by asking the health care providers about IFA stock-outs. As one of the health care providers noted during the KII, "... As I said, we need to have a nutritionist in every room but that's almost impossible for now. So sometimes when I'm compiling monthly reports, I notice that the mothers have not been issued with the supplements for some time. When you make follow-ups, you will be told that IFA had run out of stock. But the problem is that they did not communicate because I could have looked for the supplements somewhere else even if it means borrowing from another facility..." (KII: healthcare provider). We also asked the mothers whether there was a time that they visited ANC and were not issued with supplements due to stock outs. Only 12 % (n=29) of the mothers said that they failed to get IFA tablets during ANC due to stock outs of the commodity at the facility. In almost all the 12% of the cases, this only happened once. We have included the sentences below in the results section to show how often the participants were given the supplements. "*Only 12% of the participants interviewed reported not having been given IFA supplements during ANC visits because the facility had run out of stock. However, this only happened once in almost all the 12% of the cases. Separately, KIIs with healthcare workers also revealed that the facility runs out of the supplements at times, although not very often."

1. There are important program implications from the finding that "mothers who received education on IFA were almost three times more likely to be IFA compliant as compared to those who did not receive education on IFA (OR=2.728, 95% CI: 1.297, 5.921; p=0.009)". Women's desire for clear information and counseling on antenatal supplementation has been reported elsewhere (e.g. *Ethiopian women's perspectives on antenatal care and iron-folic acid supplementation: Insights for translating global antenatal calcium guidelines into practice.* Birhanu, *et al.* Maternal & child nutrition 2018 https://onlinelibrary.wiley.com/doi/pdf/10.1111/mcn.12424)[2]

We have read the suggested work and even cited it in the discussion (ref no..) to make our discussion even better.

1. Caution is needed in interpreting associations. The paper suggests causality in the statement that "attending pregnancy counselling sessions prior to conception played a significant role on IFA adherence" but this could be due to confounding if, for example, women who are very health-oriented or who have concerns due to reproductive history are more likely to seek counseling prior to pregnancy and also to be more adherent to supplementation.

We acknowledge that the statement highlighted by the reviewer could easily be misinterpreted to mean that we are ascribing ANC attendance to causality which is wrong. We have rephrased the sentence to imply an association between ANC counselling and adherence.

Discussion
1. While it is useful to compare results to what has been reported in other papers, not all cited papers define compliance in the same way, limiting interpretation. Adherence definitions could be responsible for differences attributed by the authors to accessibility of the hospital, etc. For example, a common definition that was used in the cited Ethiopian and Tanzanian studies is 90 days of consumption, whereas the compliance definition in this analysis would have been over 125.

The reviewer's thought on the possible reason for the disparities in IFA adherence prevalence

between our study and other similar studies conducted elsewhere is indeed more apt than what we thought could be due to hospital accessibility. We have therefore re-adjusted the first paragraph to include the reviewer's thought.

1. Some interpretations assumed that correlations were causal. There is likely to be collinearity of multiple variables with the number of ANC visits (which provide more info, more supplements, potentially more support, and indicate time and access to services), for example. Associations explored in this paper are a step toward understanding supplementation but there is a need to recognize underlying factors related to women's mental health, autonomy, workloads, mobility, and social support, as well as quality and accessibility of health services.

The scope of this study was to establish the associations and not to ascribe causality. We have therefore rephrased all the sentences that seemed to portray causality rather than association. Besides, we have provided a section in the discussion clearly stating that the association revealed in this study are subject to collinearity as elaborated by the reviewer.

1. **Study limitations:** consider also noting the risk of social desirability of responses, given quite high levels of reported adherence, and the difficulty in estimating "on average" intake. Also the limits on drawing conclusions about causality from the associations found in this analysis.

All the observation raised here by the reviewer have been considered partly in the discussion and fully in the limitation section.

Conclusions are reasonable, despite some over-interpretation of causality in the discussion.

○ **Is the work clearly and accurately presented and does it cite the current literature?**

Yes

○ **Is the study design appropriate and is the work technically sound?**

Yes

○ **Are sufficient details of methods and analysis provided to allow replication by others?**

Partly

○ **If applicable, is the statistical analysis and its interpretation appropriate?**

Partly

○ **Are all the source data underlying the results available to ensure full reproducibility?**

No source data required

○ **Are the conclusions drawn adequately supported by the results?**

Partly

Generally, we very much appreciate Reviewer 1's comments and we believe the paper is stronger and more precise as a result of the changes we have made in response. We have made significant changes to the text to reduce assumptions/causality misinterpretations and instead speak to the data we have. Further, the limitations section is expanded, and we have edited the text to ensure the reader understands the limitations of the study. We believe, however, that the key points of the text are still entirely valid.

Competing Interests: I'm the lead author of this article