



## Research article

# Determinant factors of poor adherence to iron supplementation among pregnant women in Ethiopia: A large population-based study



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## ABSTRACT

**Introduction:** Anemia during pregnancy increases the risk of premature delivery as well as maternal and child mortality. More than 40% and almost one-third of pregnant women are anemic worldwide and in Ethiopia respectively. Iron supplementation is important to prevent anemia during pregnancy in developing countries including Ethiopia. Despite this fact, it is at a substandard level in Ethiopia. Therefore, this study was conducted to identify the determinant factors of poor adherence to iron supplementation among pregnant women in Ethiopia. **Methods:** A cross-sectional study was conducted based on the EDHS data for 2016 from two city administrations and nine regions of Ethiopia. A total of 3,266 women were included. Bivariable and multivariable logistic regression analysis was employed. P-value < 0.05 and odds ratios were used to determine the significance and strength of association.

**Results:** Those pregnant women who had no mobile telephone [AOR; 0.79, 95% CI (0.65–0.95)], a history of cigarette smoking & alcohol use [AOR; 0.20, 95% CI (0.09–0.45)] and [AOR; 0.77, 95% CI (0.64–0.93)], and less than four antenatal care visits [AOR; 0.56, 95% CI (0.46, 0.68)] had higher odds of poor adherence.

**Conclusion:** Not having a mobile telephone, a history of smoking and alcohol use, and less than four antenatal care visits were determinant factors of poor adherence to iron supplementation. It is important to empower women, strengthen communication for behavioral change, and give attention to counseling pregnant women.

## 1. Introduction

During pregnancy, the requirement nutrients increase as a result of physiological changes and fetal growth [1]. As a result of the excess amount of blood the body produces to provide nutrients for the fetus, women who are pregnant are at an increased risk to develop anemia [2]. It is estimated that more than 40% of pregnant women are anemic worldwide and as a minimum half of this anemia burden is attributed to the deficiency of iron. During pregnancy, the deficiency of folic acid and iron can affect maternal health, the pregnancy, and the development of the fetus [3].

Low hemoglobin levels are associated with moderate to severe anemia among pregnant women which leads to a higher risk of preterm delivery and mortality in the mother and her child [4]. Growth and development may be affected by iron deficiency anemia in utero as well as in the long term [5, 6]. It is the commonest type of anemia during pregnancy in the United States experienced by approximately 15–25% of all pregnancies [2].

In Ethiopia, the prevalence of anemia was 31.7% and nearly one-third of women develop anemia during pregnancy [7]. Supplementation of iron, fortification of iron with staple foods, education about health and nutrition, parasitic infection control, and improvement of sanitation are some of the interventions used to prevent iron-deficiency anemia during pregnancy [8]. Additional iron is required for women during pregnancy to prevent deficiency of iron and ensure the availability of sufficient storage of iron [9].

Iron supplementation is used widely by women during pregnancy to minimize the risk of deficiency of iron and anemia in most developing countries [3]. Routine supplementation of iron at the time of pregnancy is a good strategy to prevent anemia in low and middle-income countries, in which adequate iron can't obtain from traditional diets and where increased losses from diverse infections are common [10]. Iron supplementation daily decreases the risk of anemia during pregnancy by 70% and deficiency of iron by 57% at 39 weeks of gestation [3].

Different kinds of the literature indicated that number of antenatal care visits during pregnancy [11, 12, 13, 14], Educational status [11, 15,

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16], Age [11, 17, 18], time of first antenatal visit [12, 15, 16, 19, 20], counseling on the benefit of iron supplementation [12, 17, 20, 21], number of children [20], residence [18], family size [15], and history of anemia during pregnancy [14, 19, 21] were determinants of pregnant mothers' adherence to supplementation of iron.

In Ethiopia, the adherence to supplementation of iron during pregnancy is still at a substandard level and has not fulfilled the recommendations of the World Health Organization (WHO). Therefore, this study was intended to assess the determinant factors of poor adherence to supplementation of iron among women in Ethiopia.

## 2. Methods and materials

### 2.1. Study design and setting

A population-based cross-sectional study was conducted. The survey was conducted in all parts of Ethiopia (nine regional states and two city administrations) [23]. The states are subdivided into zones, zones into Woredas, and Woredas into Kebele.

### 2.2. Participants of the study

Those women who had a child born in the last 5 years and given or bought iron tablets/syrup were included in the study.

### 2.3. Data sources

The Ethiopia Demographic Health Survey (EDHS) 2016, was used for this study which is the latest survey. The survey is the fourth DHS conducted in Ethiopia. Data were collected from 18<sup>th</sup> January to 27<sup>th</sup> June 27, 2016 [22]. It is a survey designed to provide population and health indicators at the national and regional levels which are collected using a structured, interviewer-administered questionnaire every 5 years. The 2016 EDHS used five questionnaires including the household questionnaire, the woman's questionnaire, the man's questionnaire, the biomarker questionnaire, and the health facility questionnaire. These questionnaires were adapted from the DHS Program's standard demographic and health survey questionnaires to reflect the population and health issues relevant to Ethiopia. For the current study, data collected using the woman's questionnaire to collect information from all eligible women age 15–49 were used. These women were asked questions regarding background characteristics (including age, education, and media exposure), birth history, antenatal, delivery, and postnatal care, and behavioral characteristics (alcohol use, smoking, and chat chewing).

### 2.4. Sample size and sampling procedure

A two-stage stratified cluster sampling was used. The nine regional states and two city administrations were stratified into urban and rural areas except for Addis Ababa, which gave 21 sampling strata. Enumeration areas (EAs) samples were selected individually in each stratum in two stages. Before the selection of samples, stratification and proportional allocation was done by organizing the sampling frame within each sampling stratum at each lower administrative level. In the first stage, probability proportional to size selection was used by selecting 645 EAs. A household listing operation was applied in the selected EAs which were used as the sampling frame for the selection of households in the second stage. The selected large EAs with more than 200 households were segmented to reduce the task of household listing. For the survey, only one segment was designated with a probability proportional to the segment size. Household listing was prepared only in the selected segment.

In the second stage of choice, a specific number of 28 households per cluster were selected with an equal probability systematic selection from the newly formed household listing. The survey interviewer interviewed only pre-selected households. No replacements or changes of the pre-

selected households were allowed in the implementing stages to prevent bias. The sampling frame used for the 2016 EDHS was the frame of Population and Housing Census (PHC) conducted in Ethiopia in 2007. The sampling frame contains information about the EA location, type of residence, and the predictable number of households. A total of 3, 266 women were included in this study. A multistage sampling procedure was employed by considering the sampling variation.

## 2.5. Operational definitions

### 2.5.1. Adherence (good/poor)

Study participants who used iron supplements for at least 90 days in their last pregnancy were grouped as having good adherence, and those women who took iron supplements for less than 90 days were grouped as having poor adherence.

## 2.6. Data processing and analysis

Data were cleaned and checked for completeness before analysis and analyzed using SPSS version 20. Bivariable and multivariable logistic regression analyses were computed to identify factors associated with poor adherence. Variables with a p-value <0.2 at the bivariable level were entered into the multivariable analysis to control for possible confounding factors. Multicollinearity was checked using the variance inflation factor.

## 2.7. Data quality assurance

The pretest was conducted in Bishoftu from October 1–28, 2015 for EDHS 2016 using in-class and biomarker training as well as field practice days. The pretest consisted of in-class training, biomarker training, and field practice days. Sixty trainees who had experience with household surveys or were involved in previous surveys have participated. The lessons (like interviewing techniques, how to administer the paper and electronic questionnaires, and unclear questions and ambiguous words) obtained from the pretest were used for modifications to the questionnaires. The training was delivered by different experts and specialists working in the Federal Ministry of Health to cover programs and policies specific to Ethiopia.

## 2.8. Ethical statement

Before conducting the study permission was granted to download and use the data from <http://www.dhs.program.com>. Ethical clearance was obtained from the Institution Review Board of Demographic and Health Surveys (DHS) Program, ICF International. The procedures for DHS public-use data sets were approved by the Institution Review Board. Identifiers for respondents, households, or sample communities were not allowed in any way and names of individuals or household addresses were not included in the data files. The number for each EA in the data file does not have labels to show their names or locations. There were no patients or members of the public involved since this study used a publicly available data set.

## 3. Result

### 3.1. Information-related and socio-demographic characteristics of the respondents

In this study, a total of 3266 participants were involved. The mean age of respondents was  $27.9 \pm 9.2$  SD and more than half (52.7%) of them were found within the age range of 20–29 years. More than half (58.6%) of the study participants gave their first birth at the age of less than 20 years old. The majority (71.0%) of study participants were rural dwellers. One thousand four hundred and seven (43.1%) study participants were orthodox in religion and nearly half (50.2%) of them had no

education. More than two-thirds (69.7%) of the respondents have four and fewer children. One thousand four hundred seventy-seven (45.3%) study participants were rich (richer and richest). The majority of respondents had no history of listening to the radio (67.5%), watching television (68.4%), and reading newspapers or magazines (87.2%). Nearly two-thirds (65.3%) of the study participants didn't own a mobile telephone (Table 1).

### 3.2. Health-related and behavioral characteristics of the respondents

Almost all (99.2%), nearly two-thirds (63.0%), and the majority (89.7%) of the study participants had no history of smoking cigarettes, alcohol use, and chat chewing respectively. Regarding the number of antenatal visits, more than half (55.6%) of the study participants had four or more antenatal care visits during their pregnancy (Table 2).

### 3.3. Determinants of poor adherence to iron supplementation

On bivariable logistic regression analysis residence, owns a mobile telephone, smoking, alcohol use, number of children, age at first birth, and number of antenatal visits during pregnancy were associated with poor adherence ( $p$ -value  $<0.2$ ). Using multivariable logistic regression analysis, smoking, alcohol use, owns a mobile telephone, and the number of antenatal visits during pregnancy were significantly associated with

poor adherence to iron supplementation among pregnant women in Ethiopia.

Those pregnant women who had a mobile telephone were 79% times more likely to adhere to iron supplementation than those pregnant women who had no mobile telephone [AOR; 0.79, 95% CI (0.65–0.95)]. Women who smoke cigarettes were 80% times less likely to adhere to iron supplementation than those pregnant women who didn't smoke cigarettes [AOR; 0.20, 95% CI (0.09–0.45)]. Those pregnant women who had a history of alcohol use were 23% times less likely to adhere to iron supplementation than those pregnant women who didn't have a history of alcohol use [AOR; 0.77, 95% CI (0.64–0.93)]. Women who had four or more antenatal care visits during pregnancy were 56% times more likely to adhere to iron supplementation than their counterparts [AOR; 0.56, 95% CI (0.46,0.68)] (Table 3).

## 4. Discussion

The adherence of pregnant women to folic acid and iron supplementation is very important to prevent and treat anemia resulting from iron deficiency. As a result, this study was intended to identify the determinant factors of poor adherence to iron supplementation during pregnancy. Accordingly, smoking, alcohol use, own a mobile telephone, and the number of antenatal visits during pregnancy were determinants of poor adherence. Unlike previously published articles on this topic, this article comes up with additional factors associated with poor adherence

**Table 1.** Information-related and socio-demographic characteristics of pregnant women in Ethiopia, 2016 (n = 3266).

Variables	Category	Frequency (n = 3266)	Percentage (100%)
Age	15–19 years	167	5.1
	20–29 years	1721	52.7
	30–39 years	1140	34.9
	40–49 years	238	7.3
Age at first birth	Less than 20 years	1915	58.6
	20 years and above	1351	41.4
Residence	Rural	2319	71.0
	Urban	947	29.0
Religion	Orthodox	1407	43.1
	Muslim	1307	40.1
	Catholic	17	0.5
	Protestant	508	15.5
	Traditional	10	0.3
	Other	17	0.5
Highest educational level	No education	1639	50.2
	Primary	1048	32.1
	Secondary	359	11.0
	Higher	220	6.7
Number of Children	Four or less	2275	69.7
	More than four	991	30.3
Wealth index	Poor	1320	40.3
	Middle	469	14.4
	Rich	1477	45.3
Frequency of reading newspaper or magazine	Not at all	2850	87.2
	Less than once a week	319	9.8
	At least once a week	97	3.0
Frequency of listening to a radio	Not at all	2206	67.5
	Less than once a week	544	16.7
	At least once a week	516	15.8
Frequency of watching television	Not at all	2234	68.4
	Less than once a week	342	10.5
	At least once a week	690	21.1
Owns a mobile telephone	Yes	1133	34.7
	No	2133	65.3

**Table 2.** Health-related and behavioral characteristics of pregnant women in Ethiopia, 2016 (n = 3266).

Variables	Category	Frequency (n = 3266)	Percentage (100%)
Smoking	Yes	25	0.8
	No	3241	99.2
Alcohol use	Yes	1208	37.0
	No	2058	63.0
Chat chewing	Yes	337	10.3
	No	2929	89.7
Number of antenatal visits during pregnancy	Less than four	1450	44.4
	Four or more	1816	55.6

**Table 3.** Bivariable and multivariable logistic regression analysis to identify determinant factors of poor adherence to iron supplementation among pregnant women in Ethiopia, 2016 (n = 3266).

Variables		Adherence status		OR with 95% CI		P-value
		Poor	Good	Crude	Adjusted	
Residence	Urban	209	738	1	1	0.448
	Rural	375	1944	1.47 (1.22, 1.77)	1.10 (0.86, 1.40)	
Owns a mobile telephone	No	341	1792	0.70 (0.58, 0.84)	0.79 (0.65, 0.95)*	0.013
	Yes	243	890	1	1	
Smoking	No	572	2669	1	1	<0.001
	Yes	12	13	0.23 (0.11, 0.51)	0.20 (0.09, 0.45)*	
Alcohol use	No	330	1728	1	1	0.006
	Yes	254	954	0.72 (0.60, 0.86)	0.77 (0.64, 0.93)*	
Number of children	Four and less	435	1840	1	1	0.182
	More than four	149	842	1.34 (1.09, 1.64)	1.16 (0.93, 1.44)	
Age at first birth	Less than 20 years	317	1598	1	1	0.369
	20 years and above	267	1084	0.81 (0.67, 0.96)	0.92 (0.76, 1.11)	
Number of antenatal visits	Less than four	185	1265	0.52 (0.43, 0.63)	0.56 (0.46, 0.68)*	<0.001
	Four or more	399	1417	1	1	

\* Statistically significant at p-value <0.05.

including behavioral factors (smoking and alcohol use) and own a mobile telephone.

Pregnant women who had a mobile telephone were 79% times more likely to adhere to iron supplementation compared to their counterparts. Studies conducted in Asia, India, and Bangladesh reported similar findings [23, 24, 25]. This might be due to pregnant women may obtain treatment support from health professionals including medication adherence and appointment reminders through text messaging. Mobile text messaging was effective in creating awareness of antenatal care and bringing behavioral change among pregnant women by connecting them to the healthcare system [26]. Messages through the text are an actual notice instrument to encourage better patient appointments and obedience [27]. Medication notices sent via mobile phones can be used to minimize forgetfulness and improve adherence to medication [28]. Women and the healthcare system easily communicate with each other through mobile phones, which can develop the pregnant woman's adherence to recommendations [29].

Pregnant women who smoke cigarettes and had a history of alcohol use were 80% and 23% times less likely to adhere to iron supplementation than their counterparts respectively. Similar findings were reported by studies conducted in Portsmouth, Denmark, rural Nepal, and Scandinavia [30, 31, 32, 33]. This might be due to pregnant women who smoke cigarettes and drink alcohol may become less responsible for fetal health and themselves. They may also forget to take iron tablets [34]. Smokers and alcohol users might also become careless about the health of the fetus and their health as well and they might not have gotten by campaigns of public health. Poor health behaviors are associated with lower adherence to the prescribed treatment [35, 36]. In general, substance use is associated with poor medication adherence [37].

Similarly, having less than four antenatal care visits during pregnancy was associated with poor adherence to iron supplementation during pregnancy. Other studies have also reported similar findings [11, 12, 13, 14, 38, 39, 40]. This might be because as pregnant women had more antenatal care visits, their interaction with a health professional will increase. Frequent attendance of antenatal care by mothers ends up with continuous monitoring of hemoglobin levels and receiving adequate information regarding the symptoms and signs of pregnancy-related problems. This enables a pregnant mother to take iron tablets and adhere to the recommendations. The counseling and health education about the importance of adhering to iron supplementation delivered by health personnel may inspire them to adhere to the recommendation.

**Strengths of the study:** The study used a large sample size by incorporating all regions of the country that enhance the generalizability of the findings.

**The study has some limitations:** We were unable to incorporate essential factors like the attitude of health care providers towards patients and waiting times to get services in the analysis since the study relied on secondary data. The study also shared the limitation of a cross-sectional study in which the cause/effect and the temporal relationship could not be established. Since respondents were asked to recall information from as long as five years before the survey there might also be recall bias.

## 5. Conclusion

Pregnant women who had no mobile telephone, who had a history of smoking and alcohol use, and had less than four antenatal care visits increase the odds of poor adherence to iron supplementation in Ethiopia.

It is important to empower women, strengthen communication for behavioral change by emphasizing alcohol use and cigarette smoking cessation, and give attention to counseling pregnant women on the benefits of increasing the number of antenatal visits before or during prenatal consultations.

## Declarations

### Author contribution statement

Enyew Getaneh Mekonen: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Samrawit Abebe Alemu: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

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### Data availability statement

Data will be made available on request.

### Declaration of interests statement

The authors declare no conflict of interest.

### Additional information

No additional information is available for this paper.

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## References

- [1] A. Imdad, M.Y. Yakoob, Z.A. Bhutta, The effect of folic acid, protein energy, and multiple micronutrient supplements in pregnancy on stillbirths, *BMC Publ. Health* 11 (S3) (2011) S4.
- [2] Anemia during Pregnancy, American pregnancy association, Jul 11, 2017.
- [3] W.H.O. Daily, Iron and Folic Acid Supplementation in Pregnant Women: a Guideline. Daily Iron and Folic Acid Supplementation in Pregnant Women: Guideline, 2012.
- [4] J. Murphy, Haemoglobin Concentrations for the Diagnosis of Anemia and Assessment of Severity. Vitamin and Mineral Nutrition Information System, World Health Organization, Geneva, 2011.
- [5] B. Lozoff, E. Jimenez, J.B. Smith, The double burden of iron deficiency in infancy and low socioeconomic status: a longitudinal analysis of cognitive test scores to age 19 years, *Arch. Pediatr. Adolesc. Med.* 160 (11) (2006) 1108–1113.
- [6] U. WHO, UNU. Iron Deficiency Anemia: Assessment, Prevention, and Control. A Guide for Programme Managers, WHO, Geneva, 2001.
- [7] G.M. Kassa, A.A. Muche, A.K. Berhe, G.A. Fekadu, Prevalence and determinants of anemia among pregnant women in Ethiopia; a systematic review and meta-analysis, *BMC Hematol.* 17 (1) (2017) 17.
- [8] I.N.A.C. Group, Guidelines for the Eradication of Iron Deficiency Anemia: a Report, Nutrition Foundation, 1977.
- [9] T.H. Bothwell, Iron requirements in pregnancy and strategies to meet them, *Am. J. Clin. Nutr.* 72 (1) (2000) 257S–264S.
- [10] E. Müngen, Iron supplementation in pregnancy, *J. Perinat. Med.* 31 (5) (2003) 420–426.
- [11] D.M. Ba, P. Ssentongo, K.H. Kjerulff, M. Na, G. Liu, X. Gao, et al., Adherence to iron supplementation in 22 sub-Saharan African countries and associated factors among pregnant women: a large population-based study, *Curr. Dev. Nutr.* 3 (12) (2019) nzz120.
- [12] A. Demis, B. Geda, T. Alemayehu, H. Abebe, Iron, and folic acid supplementation adherence among pregnant women attending antenatal care in North Wollo Zone northern Ethiopia: an institution-based cross-sectional study, *BMC Res. Notes* 12 (1) (2019) 107.
- [13] M. Getachew, M. Abay, H. Zelalem, T. Gebremedhin, T. Grum, A. Bayray, Magnitude and factors associated with adherence to Iron-folic acid supplementation among pregnant women in Eritrean refugee camps, northern Ethiopia, *BMC Pregnancy Childbirth* 18 (1) (2018) 1–8.
- [14] T. Molla, T. Guadu, E.A. Muhammad, M.T. Hunegnaw, Factors associated with adherence to iron folate supplementation among pregnant women in West Dembia district, northwest Ethiopia: a cross-sectional study, *BMC Res. Notes* 12 (1) (2019) 1–6.
- [15] G. Agegnehu, A. Atenafu, H. Dagne, B. Dagnew, Adherence to Iron and folic acid supplement and associated factors among antenatal care attendant mothers in lay Armachiho health centers, northwest, Ethiopia, *BioRxiv* 2018 (2017) 493916.
- [16] B.B. Nasir, A.M. Fentie, M.K. Adisu, Adherence to iron and folic acid supplementation and prevalence of anemia among pregnant women attending antenatal care clinic at Tikur Anbessa Specialized Hospital, Ethiopia, *PloS One* 15 (5) (2020), e0232625.
- [17] T.G. Gebremichael, T.G. Welesamuel, Adherence to iron-folic acid supplement and associated factors among antenatal care attending pregnant mothers in governmental health institutions of Adwa town, Tigray, Ethiopia: cross-sectional study, *PloS One* 15 (1) (2020), e0227090.
- [18] A. Titilayo, M. Palamuleni, O. Omisakin, Sociodemographic factors influencing adherence to antenatal iron supplementation recommendations among pregnant women in Malawi: analysis of data from the 2010 Malawi demographic and health survey, *Malawi Med. J.* 28 (1) (2016) 1–5.
- [19] N. Boti, T. Bekele, W. Godana, E. Getahun, F. Gebremeskel, B. Tsegaye, et al., Adherence to Iron-Folate supplementation and associated factors among Pastoralist's pregnant women in Burji districts, Segen area People's zone, southern Ethiopia: a community-based cross-sectional study, *Int. J. Reproduct. Med.* 2018 (2018).
- [20] W.B. Lyoba, J.D. Mwakatoga, C. Festo, J. Mrema, E. Elisaria, Adherence to iron-folic acid supplementation and associated factors among pregnant women in Kasulu communities in North-Western Tanzania, *Int. J. Reproduct. Med.* (2020) 2020.
- [21] A.D. Gebremariam, S.A. Tiruneh, B.A. Abate, M.T. Engidaw, D.T. Asnakew, Adherence to iron with folic acid supplementation and its associated factors among pregnant women attending antenatal care follow-up at Debre Tabor General Hospital, Ethiopia, 2017, *PloS One* 14 (1) (2019), e0210086.
- [22] C.S. Agency, ICF, Ethiopia Demographic and Health Survey 2016: Key Indicators Report, CSA and ICF, Addis Ababa, Ethiopia, and Rockville, Maryland, USA, 2016.
- [23] A. Chourasia, C.M. Pandey, A. Awasthi, Factors influencing the consumption of iron and folic acid supplementations in high focus states of India, *Clin. Epidemiol. Global Health* 5 (4) (2017) 180–184.
- [24] M.M. Islam, M.S. Masud, Determinants of frequency and contents of antenatal care visits in Bangladesh: assessing the extent of compliance with the WHO recommendations, *PloS One* 13 (9) (2018), e0204752.
- [25] K. Warvadekar, J. Reddy, S. Sharma, K.A. Dearden, M.K. Raut, Socio-demographic and economic determinants of adherence to iron intake among pregnant women in selected low and lower middle income countries in Asia: insights from a cross-country analysis of global demographic and health surveys, *Intl. J. Comm. Med. Publ. Health* 5 (4) (2018) 1552–1569.
- [26] E. Indira, P. Thomas, M. Hari, Mobile text messages-A silent revolution for A sound antenatal care, *Ind. J. Publ. Health Res. Dev.* 8 (4) (2017) 563–569.
- [27] F.J. Schwebel, M.E. Larimer, Using text message reminders in health care services: a narrative literature review, *Internet interventions* 13 (2018) 82–104.
- [28] M. Vervloet, A.J. Linn, J.C. van Weert, D.H. De Bakker, M.L. Bouvy, L. Van Dijk, The effectiveness of interventions using electronic reminders to improve adherence to chronic medication: a systematic review of the literature, *J. Am. Med. Inf. Assoc.* 19 (5) (2012) 696–704.
- [29] S.I. DeSouza, M. Rashmi, A.P. Vasanthi, S.M. Joseph, R. Rodrigues, Mobile phones: the next step towards healthcare delivery in rural India? *PloS One* 9 (8) (2014), e104895.
- [30] V.K. Knudsen, H.S. Hansen, L. Ovesen, T.B. Mikkelsen, S.F. Olsen, Iron supplement use among Danish pregnant women, *Publ. Health Nutr.* 10 (10) (2007) 1104–1110.
- [31] B. Kulkarni, P. Christian, S.C. LeClerq, S.K. Khatri, Determinants of compliance to antenatal micronutrient supplementation and women's perceptions of supplement use in rural Nepal, *Publ. Health Nutr.* 13 (1) (2010) 82–90.
- [32] F. Mathews, P. Yudkin, R.F. Smith, A. Neil, Nutrient intakes during pregnancy: the influence of smoking status and age, *J. Epidemiol. Community Health* 54 (1) (2000) 17–23.
- [33] H. Nordeng, A. Eskild, B.-I. Nesheim, I. Aursnes, G. Jacobsen, Guidelines for iron supplementation in pregnancy: compliance among 431 parous Scandinavian women, *Eur. J. Clin. Pharmacol.* 59 (2) (2003) 163–168.
- [34] C. Haslam, W. Lawrence, Health-related behavior and beliefs of pregnant smokers, *Health Psychol.* 23 (5) (2004) 486.
- [35] A. Ahmed, A. Karter, J. Liu, Alcohol consumption is inversely associated with adherence to diabetes self-care behaviors, *Diabet. Med.* 23 (7) (2006) 795–802.
- [36] S. Bazargan-Hejazi, M. Bazargan, E. Hardin, E.G. Bing, Alcohol use and adherence to prescribed therapy among under-served Latino and African-American patients using emergency department services, *Ethn. Dis.* 15 (2) (2005) 267–275.
- [37] M. Tesfaye, K. Adorjan, W. Krahel, E. Tesfaye, Y. Yitayih, R. Strobl, et al., Khat and Alcohol Use Disorders Predict Poorer Adherence to Anti-tuberculosis Medications in Southwest Ethiopia: A Prospective Cohort Study, 2019.
- [38] T.M. Birhanu, M.K. Birarra, F.A. Mekonnen, Compliance to iron and folic acid supplementation in pregnancy, Northwest Ethiopia, *BMC Res. Notes* 11 (1) (2018) 1–5.
- [39] T.G. Gebremichael, H. Haftu, T.A. Gereziher, Time to start and adherence to iron-folate supplement for pregnant women in antenatal care follow up; Northern Ethiopia, *Patient Prefer. Adherence* 13 (2019) 1057.
- [40] T.S. Kiwanuka, S. Ononge, P. Kiondo, F. Namusoke, Adherence to iron supplements among women receiving antenatal care at Mulago National Referral Hospital, Uganda-cross-sectional study, *BMC Res. Notes* 10 (1) (2017) 510.