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Title: **Strategies of Controlling Iron Deficiency Among Pregnant Women in the Peripheral Health Zones of Kinshasa, Democratic Republic of the Congo**

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Strategies of Controlling Iron Deficiency among Pregnant Women in the Peripheral Health Zones of Kinshasa, Democratic Republic of the Congo

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ABSTRACT

Anemia is the most widespread nutritional problem in the world. Its incidence rate is higher in South Asia and sub-Saharan Africa, where it affects a large proportion of women and children. The problem is accentuated where intestinal parasitic infection and malaria are common and this increases the morbidity and mortality rate. The current study attempted to evaluate the effectiveness of strategies involved in the control system of iron deficiency anemia in pregnant women. This study comprised of a quantitative, cross-sectional, and analytical design. Two reference health structures were chosen, namely Kimbanseke General Reference Hospital and Kinkole General Reference Hospital. The sample size consisted of 250 pregnant women. The data collection involved hemoglobin, thick drop, and stool analysis to assess the hematological and health status of surveyed pregnant women. Moreover, a questionnaire was used to collect socio-demographic data. The chi-square test was used to compare the variables and logistic regression was used to determine the effectiveness of applied strategies in order to control iron deficiency. Respondents were assured about the confidentiality of their responses and interviews were conducted in a secluded setting. The findings showed that the predominant age group was 20-24 years (34.0%), while most respondents were in the second semester of pregnancy (49.6%). Furthermore, most respondents had a secondary education (69.2%), their main activity was selling (47.2%), and most of them were married (84.0%). The level of hemoglobin was less than 11g/dl in most of the respondents (55.6%), while 66% were multigravida with the space between pregnancy of 12-24 months (57.8%). The stool analysis of most respondents showed the presence of yeast (24%), although the presence of some parasites were observed as well. For the thick drop, most respondents were diagnosed with malaria (77.6%). The iron supplementation, deworming, and counseling during the antenatal sessions proved effective against iron deficiency anemia. Given the seriousness of the situation in pregnant women, it is necessary that these strategies of effectiveness must be applied for a good management of anemia.

Keywords: anemia, control, iron deficiency, Kinshasa, pregnant women, strategy

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1. INTRODUCTION

According to the World Health Organization (WHO), anemia refers to any pathological condition in which the blood concentration of hemoglobin is abnormally low due to the deficiency of one or more essential nutrients. The threshold value varies according to age and gender (13 g/dl in men, 12 g/dl in women, and children and 14 g/dl in newborns). In pregnant women, anemia is declared when the hemoglobin level goes below 11 g/dl. This is the most common form of micronutrient deficiency in the world [1]. Anemia is a ubiquitous problem affecting approximately two million people in the world. This deficiency can be either of dietary origin or caused by blood loss or destruction of hemoglobin by various diseases, such as malaria [2]. Most cases of anemia are caused by the deficiency of iron, which is necessary for body to produce red blood cells [3–5].

Anemia is a worldwide health problem, especially in developing countries. Its highest incidence is reported in South Asia and sub-Saharan Africa, where the disease affects a large proportion of women of childbearing age and pre-school children [6]. In areas, where intestinal parasitic infection and malaria are common, the problem is compounded and results are in the form of reduced work performance, increased morbidity and mortality rates during pregnancy, higher risk of infection, decreased mental ability, and behavioral changes in children [7–9]. Anemia is most commonly caused by iron deficiency, also known as martial deficiency, with approximately two billion people affected worldwide. The combination of anemia and martial deficiency is referred to as iron deficiency anemia [4, 10]. The flow of iron in the body is organized around the functional needs for iron constituted by the labile exchange pool of ferrous iron [Fe^{2+}], the possibilities of transport (transferrin), capture and the mechanisms of regulation, recycling and absorption of ferric iron [Fe^{3+}], regulated by the action of hepcidin, which is a hepatic hypodermic hormone [3]. These exchanges of metabolic iron are closely linked to redox modifications of iron, hence the importance of certain reducing molecules, such as vitamin C [3].

The causes of dietary iron deficiency are frequent in physiological situations of increased need, particularly in pregnant women who must transfer 400 mg of iron to the fetus, who lose 300 mg of iron at delivery, and who provide 100 mg of iron to their baby during the first four months of breastfeeding [11, 12]. Dietary iron comes in two forms, namely hemic and non-hemic. The first one is present mainly in meat and fish, with a good absorption capacity of about 30%. Whereas, the second is present in vegetables mainly, with a low absorption coefficient of about 3-5% (improved by vitamin C). Several studies attempted to understand the evolution of absorption during pregnancy. At the beginning of pregnancy, the absorption capacity of iron decreases around 1 to 2.5%, then raised to 10% at 24 weeks and increased 5 to 9 times between the first and third trimesters [13–16]. Starting from a normal and balanced meal, mixing animal and vegetable intakes, the daily quantities of iron absorption are around 4.4, 1.9 and 5 mg, respectively in the 1st, 2nd and 3rd trimesters of pregnancy [13].

Iron deficiency can be caused by a diet low in iron, parasitic infestations (schistosomiasis and hookworm), iron malabsorption in celiac disease, gastrectomy, digestive hemorrhage, or gastrointestinal lesions that are usually latent [17]. Moreover, pregnancy may also be a cause of iron deficiency to the future

mother because the fetus uses the mother's iron to make its own red blood cells [17]. In addition to the consequences common to all individuals, iron deficiency anemia increases the risk of urinary tract infection (UTI), pyelonephritis, and pre-eclampsia in pregnant women [18]. Iron deficiency anemia in pregnant women also has fetal consequences, such as the risk of prematurity, perinatal mortality or low birth weight [19]. It also leads to martial deficiencies with or without anemia in the baby and could lead to a slowing of psychomotor and intellectual development in the baby [20].

Anemia affects the health and well-being of women and increases the risk of adverse maternal and neonatal outcomes. It affects half a billion women of childbearing age worldwide [21]. In 2011, 29% (496 million) of non-pregnant women and 38% (32.4 million) of pregnant women aged 15-49 years were anemic [21, 22]. The prevalence of anemia in South Asia, Central Africa, and West Africa remains very high [23]. At some places, significant reductions in anemia prevalence were achieved, however, overall progress remained insufficient. Further interventions are needed to achieve the target of a 50% reduction in anemia among women of childbearing age by 2025 [11, 24].

Among many causes of anemia identified worldwide, it is widely accepted that nutritional deficiencies, primarily related to low dietary iron bioavailability, account for more than half of the total number of cases [10]. It contributes to intrauterine growth retardation, low birth weight and increased maternal, infant and child mortality [2]. The etiological diagnosis of anemia is guided by the clinical context: ethnic origin, patient history (hypothyroidism, inflammatory or immune disease), and course of the current pregnancy (infection, pre-eclampsia, and impairment of other blood lines). The erythrocyte constants, blood smear, and reticulocyte count also guide the origin of the anemia [25]. The extent of anemia throughout the country has prompted the Congolese government, in collaboration with certain partners, to implement certain strategies. The purpose of implementing these strategies is to combat iron deficiency anemia while taking into account the nutritional situation of pregnant Congolese women through iron and folic acid supplementation, control of intestinal parasitoids and malaria, and the promotion of adequate nutrition practices [26]. Folic acid deficiency is common among women and it may be due to inadequate intakes, malabsorption, or the use of various medications. Folic acid deficiency results in megaloblastic anemia (indistinguishable from vitamin B12 deficiency) [27, 28]. The deficiency of folic acid in pregnant women increases the risk of neural tube defects. Diagnosis requires confirmation by laboratory tests. Measurement of neutrophil hyper segmentation is sensitive and readily available and the treatment with oral folate is usually effective [29–31].

The current study attempted to answer the questions of whether the strategies to combat iron deficiency anemia, put in place by Congolese government, are effective in combating iron deficiency anemia in pregnant women. Given that, the hemoglobin level of pregnant women depends on their food consumption as well as the integration of iron supplementation by the residential health area. Women who apply these combined strategies would have a better hemoglobin level than those who do not, for instance the consumption of iron-rich foods and provision of minimum amount of iron that contributes globally to the coverage of daily iron-folate needs of

pregnant women. The current study aimed to assess the effectiveness of the strategies involved in controlling iron deficiency anemia in pregnant women in the Democratic Republic of the Congo.

2. MATERIAL AND METHOD

2.1. Study Area

Two peri-urban health facilities were chosen to conduct the current study, namely the Kimbanseke General Referral Hospital for Kimbanseke health zone and Kinkole General Referral Hospital for the Nsele health zone.

2.2. Research Design

The current research was based on a quantitative, cross-sectional and analytical design, followed by conducting interviews with pregnant women. The sample comprised of women who regularly attended the antenatal in each of the selected health facilities.

Laboratory tests focused on parasitological and hematological analyses to determine the presence of intestinal worms and other blood-sucking parasites in the stools and the hemoglobin levels of the study population.

2.3. Sampling and Sample Size

The current study used a simple random sampling technique that was based on the selection of pregnant women. The sample size comprised of 250 pregnant women who responded to the selection criteria. The duration of the study was between January and November 2018 at the General Referral Hospital of Kimbanseke and between January and November 2019 at the General Referral Hospital of Kinkole.

2.4. Data Collection

The data for the current study was collected by employing some laboratory techniques. The level of hemoglobin, the thick drop, and stool analysis helped to assess the hematological and health status of respondents. Direct observation allowed the researcher to perceive the respondents' behaviors and reactions before starting with the questionnaire administration through an interview. A three-stage questionnaire was used to assist the data collection. The first part dealt with the socio-demographic characteristics (age of respondents in years, age of pregnancy in months, level of education, profession, and marital status). Whereas, the second part of this questionnaire was based on the sanitary status of the respondents and the last part included the assessment of respondents' knowledge on the consumption of iron-folates rich foods.

Hem cue 301 was used to ascertain the hemoglobin level which is a photometric analyzer that allows a simple and fast determination of the hemoglobin level. The thick drop test was performed by using a diagnostic rapid test which works by pricking the finger of the respondent to be analyzed. Afterwards, the collected blood is placed on the slide and then observation is performed under the microscope.

For the direct stool analysis, a drop of a saline solution was placed on one side of the slide and a drop of Lugol on the other side of the slide. By using an applicator, a small quantity of stool was collected which was mixed with the saline. Afterwards, the preparation was observed under the microscope at 10X and 40X of magnitude.

2.5. Statistical Analysis

The data was stored in Excel spreadsheet and cleaned by using SPSS 25.0. Descriptive statistics (frequency, mean and standard deviation) was applied to socio-demographic data. Afterwards, for the comparison of proportions, chi-square

test was performed and logistic regression was used to set the effectiveness of applied strategies.

2.6. Ethical Considerations

A consent form was provided to each respondent in the current study. Interviewees were told that they didn't have to answer questions and that they could end the interview at any time. They were also assured about the confidentiality of their responses. Interviews were conducted in a secluded setting for the sake of confidentiality of their responses.

3. Results

3.1. Socio-demographic characteristics

The socio-demographic characteristics of respondents is presented in the table below.

Table 1. Socio-Demographic Characteristics of Respondents

Variables	Frequency (*n*=250)	Percentage (%)
Age (years)		
15-19	42	16.8
20-24	85	34.0
25-29	55	22.0
30-34	27	10.8
35-40	34	13.6
41-45	7	2.8
Age of pregnancy (months)		
1-3	19	7.6
4-6	124	49.6
7-9	107	42.8
Level of education		
Primary	7	2.8
Secondary	173	69.2
Professional	41	16.4
University	29	11.6
Profession		
Housewife	53	21.2
Seller	118	47.2
Public civil servant	16	6.4
Private civil servant	50	20.0
Student	13	5.2
Marital status		
Married	210	84.0
Single	40	14.0

It was observed that the predominant age group was of 20-24 (34.0%), while most respondents were in the second semester of pregnancy (49.6%). Furthermore, most respondents had a secondary education (69.2%), the main activity of respondents was selling (47.2%) and most respondents were married (84.0%).

3.2. Evaluation of Biological Parameters

Table 2 presents different clinical parameters of respondents.

Table 2. Clinical Parameters of Respondents

Variables	Frequency (*n*=250)	Percentage (%)
Hemoglobin Level (g/dl of blood)		
≤ 11	139	55.6
≥ 11	111	44.4
Degree of Gestation		
Primigravida	55	22.0
Multigravidae	165	66.0
Highly multigravidae	30	12.0
Space Between Pregnancies (months)		
≤ 12	67	34.4
12-24	101	57.8
≥ 24	27	7.8
Stool Analysis (Pathogens Identified)		
Amoeba	38	15.2
Yeasts	60	24.0
Roundworms	40	16.0

Variables	Frequency (*n*=250)	Percentage (%)
Hookworms	46	18.4
Enterobius vermicularis	47	18.8
Pinworms	19	7.6
Thick Drop		
Presence of parasite	194	77.6
Absence of parasite	56	22.4

It was observed that the level of hemoglobin was less than 11 g/dl in most of the respondents (55.6%), while 66% of respondents were multigravida with the space between pregnancy of 12-24 months (57.8%). The stool analysis showed that most respondents had yeasts (24%), though the presence of some parasites was also observed. For the thick drop, most respondents were diagnosed with malaria (77.6%). Biological parameters of respondents are presented in the table below.

Table 3. Biological Parameters of Respondents

Variables	Frequency (*n*=250)	Percentage (%)
Presence of a Disease		
Yes	132	52.8
No	118	47.2
Type of Disease (n=132)		
Diabetes	21	15.9
Low/High blood pressure	27	20.4
Tuberculosis	32	24.2
HIV	33	25
Rheumatism	19	14.5
Iron-Folate Supplementation		
Yes	219	87.6
No	31	12.4
Period of Supplementation Start (months) (*n* = 219)		
4	89	40.6
5	121	55.2
6	9	4.2
Number of Tablets (*n*=219)		
One tablet	112	51.1
Two tablets	107	48.9
Status of Drug Intake		
Fasting	49	23.4
During the meal	116	53
After the meal	54	23.6

The majority of respondents had a disease (52.8%) and HIV (25%) and tuberculosis (24.2%) were predominant among the diseases listed. Most respondents accepted that they have a supplementation in iron-folate (87.6%) and the starting period was 5 months for the majority (55.2%). Most of respondents (51.1%) took one tablet of iron-folate as supplement and the majority of respondents (53%) took that tablet during a meal.

Table 4 displays the para-clinical parameters of respondents.

Table 4. Para-Clinical Parameters of Respondents

Variables	Frequency (*n*=250)	Percentage (%)
Received a Presumptive Malaria Treatment		
Yes	174	69.6
No	76	30.4
Sleep Under the Insecticide-Treated Net		
Yes	101	40.4
No	149	59.6
Have Been Dewormed		
Yes	211	84.4

Variables	Frequency (*n*=250)	Percentage (%)
No	39	15.6
Have an Iron-Rich Food		
Yes	69	27.6
No	181	72.4
Food Listed (n=69)		
Wheat flour	32	46.4
Cube maggy	37	53.6
Eating Wheat Flour		
Yes	250	100
No	0	0
Eating the Cube Maggi		
Yes	158	63.2
No	92	36.8
Most Consumed Foods from Animal Origin		
Meat	104	41.6
Fish	86	34.4
Poultry	60	24.0
Weekly Consumption Frequency		
One to two times	47	18.8
Three to four times	86	34.4
More than four times	117	46.8

The table above shows that 69.6% of respondents received a presumptive treatment against malaria, while 40.4% of respondents slept under the net, 84.4% were dewormed, and 27.6% had a knowledge on iron rich-food.

Table 5 shows the diet for the respondents.

Table 5. Diet to Be Adopted for Respondents

Variables	Frequency (*n*=250)	Percentage (%)
Regularly Eaten Fruits		
Orange	51	20.4
Avocado	52	20.8
Papaya	16	6.4
Mango	108	43.2
Pineapple	19	7.6
Banana	4	1.6
Previously Suffered from Anemia		
Yes	94	37.6
No	156	62.4
Treatment Method Followed (*n*=94)		
Drugs	73	73.7
Iron-rich foods	21	22.3
Respect the Antenatal Appointment		
Yes	239	95.6
No	11	4.4
Have Received Advice on the Consumption of Fruits, Vegetables, and Iron-Rich Food		
Yes	212	84.8
No	38	15.2

Majority of respondents consumed fruits in abundance and the most consumed fruit was mango (43.2%), followed by avocado (20.8%) and orange (20.4%). The majority of these respondents did not suffer from anemia (62.4%). Furthermore, most respondents took common drugs than iron-rich foods (73.7%), the majority of them respected the antenatal appointments and received advices on the importance of consuming fruits, vegetables, and iron-rich foods.

The comparison and estimated risk of the level of hemoglobin related to the current strategies against iron deficiency anemia are presented in the table below.

Table 6. Estimated Risk of Hemoglobin Level to the Adopted Strategies

Strategies	Level of hemoglobin							
Supplementation in Iron-Folate								
	≤ 11g	≥11g	Total	X^2	*p*-value	Sig.	OR	CI 95%
Yes	92	127	219	4.090	0.043	S	2.186	1.528-7.096
No	19	12	31					
Have Received Presumptive Treatment for Malaria								
Yes	80	94	174	0.577	0.448	NS	0.809	0.324-1.467
No	31	45	76					
Sleeping under the Insecticide-Treated Net								
Yes	50	51	101	1.789	0.181	NS	0.707	0.978-1.004
No	61	88	149					
Have been Dewormed								
Yes	83	128	211	14.048	0.000	S	3.926	0.487-2.141
No	28	11	39					
Consumption of Iron-Rich Food								
Yes	77	81	158	3.267	0.072	NS	0.617	0.380-1.504
No	34	58	92					
Have Received Advice on the Consumption of Iron-Rich Foods During ANC								
Yes	87	125	212	6.387	0.11	S	2.463	0.269-1.125
No	24	14	38					

Note. S: Significance, NS: Non-significant, S: Significant, OR : Odd ratio, CI: Confidence Interval, X^2: chi-squared test

A significant difference was observed between iron supplementation, having been dewormed and having received advice on the consumption of iron-rich foods and the hemoglobin level, that is, these parameters have a positive influence on the hemoglobin level of respondents.

The effectiveness to adopt current strategies against iron-deficiency anemia have been displayed in the table below.

Table 7. Effectiveness of Current Strategies Against Iron-Deficiency Anemia of Respondents

Strategies	Odd ratio	Sig.	CI (95%)
Supplement iron-folate*	2.5	0.028	[1.100 – 5.42]
Treatment against malaria	0.357	0.753	[0.412 - 1.376]
Deworming*	3.632	0.001	[1.667 – 7.916]
Sleeping under the insecticide-treated net	0.846	0.566	[0.479 – 1.496]
Consumption of fortified and iron-rich foods	0.776	0.405	[0.428 – 1.408]
Tips on eating iron-rich foods *	2.223	0.038	[1.045 – 4.728]
R^2= ,122 ; F= (df : 4)= 3,111; *p<0.05			

The iron supplementation, deworming, and counseling during the antenatal sessions are effective against iron deficiency anemia of respondents. Moreover, a woman who is not supplemented with iron has a 2.5-fold risk of developing iron deficiency anemia, 3.6-fold for the non-dewormed woman, and 2.2-fold for the woman who has not received any advice on the consumption of fortified and iron-rich foods.

4. DISCUSSION

The iron deficiency anemia is associated with the socioeconomic level of respondents. It is now necessary to educate women on food quality for a healthy pregnancy and the health of fetus [32, 33]. Iron deficiency anemia is the most common nutritional difference observed during pregnancy and mainly occurs in the third trimester [34, 35].

The most affected age group was 20-24 years (34.0%). These respondents were mostly married (84.0%) and had a secondary education (69.2%); with a pregnancy in the second trimester (49.6%); working in small trade (47.2%). In the current study, the prevalence of anemia recorded (55.6%) implies that it is a public health problem in Kinshasa and that, at the population level, the group studied was classified by WHO as having severe anemia. The prevalence of anemia in pregnant women remains high and a better management of chronic diseases in pregnant women and their postnatal follow-up should be emphasized in order to relieve anemia before the subsequent pregnancy [36].

However, living in an endemic area where malaria is high, it is necessary to take measures in order to protect pregnant women. Thus, the prevalence of malaria is very high (77.6%). However, with such a high prevalence, these findings suggest that the risk of iron deficiency anemia is almost permanent among these pregnant women. In South Kivu, Bahizire et al. [37] reported malaria as more prevalent than iron deficiency in pregnant women, that is, the decreased prevalence of malaria in this area led to a decrease in anemia prevalence. This can be explained by the fact that the use of the insecticide-treated net is very low (40.4%), coupled with the almost total presence of intestinal parasites in the stools of these pregnant women. The correct use of the insecticide-treated net helps in the management of malaria in pregnant women to reduce the risk of anemia [38].

It was observed that the prevalence of anemia in multigravida was higher than (57.1%) to pupiparous women (40.9%). Some studies reported that the risk of getting anemia becomes higher when number of pregnancies increase, that is, the parity [39]. This might be due to the lack of compensation of losses, normally hemorrhage and the depletion of reserves recorded during previous pregnancies and breastfeeding [39, 40]. The increased risk of anemia in women in the third trimester of pregnancy was observed to be (56.9%). The literature reported that the blood volume tends to increase during pregnancy which may lead to a decrease in iron storage. The demand for iron increases in pregnant woman as the number of trimesters increases. Therefore, there is a great chance for those who are in the third trimester to develop anemia as compared to those in the first trimester by considering the increased hem dilution which occurs in the second trimester [41, 42].

The prevalence of anemia in pregnant women with a chronic pathology was found to be 60% (p=0.02). Thus, it can be considered, as in some studies, that anemia is aggravated by the presence of chronic diseases, such as diabetes, tuberculosis [43, 44]. In malaria endemic regions, malaria can cause acute hemolytic anemia among women during pregnancy. Furthermore, the prevalence of anemia in HIV-immunocompromised women was found to be 64.7%. HIV causes several hematological manifestations including immune thrombocytopenia, coagulation, and anemia. Anemia here is a consequence of inflammation, bone marrow alteration

microenvironment, hemolysis or antiretroviral therapy [11, 18, 45, 46].

The iron-folate supplementation during the gestational period (p=0.043), having been dewormed (p=0.000) and receiving advices on the consumption of iron-rich food during the antenatal sessions, positively influenced the hemoglobin level of the pregnant women. On the other hand, presumptive malaria treatment (0.448), sleeping under insecticide-treated net, (p=0.181) and consumption of iron-fortified food did not influence the hemoglobin of the pregnant women. Based on the logistic regression results, pertaining to the relationship with the strategies in place to combat iron deficiency anemia, three of them were found to be effective, namely: iron-folate supplementation (p=0.028), deworming (p=0.001), and advice on the consumption of iron-rich food (p=0.038). However, women who did not apply these strategies were more than eight times prone to develop iron deficiency anemia. This means that these women would have a 2.5-fold risk of developing anemia if they were not supplemented with iron, a 3.632-fold risk if they were not dewormed, and a 2.223-fold risk if they were not advised to eat iron-rich foods.

4.1. Conclusion

Seeing the situation of anemia in the world, it is necessary to adopt new strategies which may decrease the prevalence of anemia in pregnant women. The current study raised three strategies which may be implemented, namely iron-folate supplementation, deworming, and advice on the consumption of iron-rich foods.

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