

# Impact of a positive deviance approach to improve the effectiveness of an iron-supplementation program to control nutritional anemia among rural Senegalese pregnant women

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## Abstract

**Background.** Iron supplementation through prenatal care remains the most widespread strategy to control anemia during pregnancy, but its effectiveness is only partial, showing the need to address other approaches.

**Objective.** This study was conducted to measure the impact of a positive deviance approach to improve an iron-supplementation program among pregnant women in a rural Senegalese area.

**Methods.** A positive deviance approach (PD Micah) was compared with an ongoing integrated nutrition and health program intervention (Micah) in a rural Senegalese area. A pre-post evaluation was conducted using independent cross-sectional samples with a total of 371 pregnant women. A sociodemographic questionnaire was administered, and biologic and anthropometric measurements were performed.

**Results.** After 9 months of activities, the mean hemoglobin level rose from 93.9 to 100.7 g/L in the PD Micah group. Distribution of iron supplements through community volunteers and implementation of healthy pregnancy promotion sessions on a monthly basis improved the accessibility to 23.3% in the PD Micah group. No significant change was observed in the Micah group. Logistic regression analysis showed a significantly reduced risk of anemia in the PD Micah area (adjusted odds ratio, 0.25; 95% confidence interval, 0.12 to 0.53).

**Conclusions.** This intervention shows that a community-based strategy, such as the positive deviance approach, can contribute to improving the effectiveness of iron supplementation during pregnancy.

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**Key words:** Anemia, community-based program, effectiveness, iron supplementation, positive deviance, pregnancy

## Introduction

Sub-Saharan Africa remains one of the regions worldwide with the highest prevalence of iron-deficiency anemia. Children, adolescents, and pregnant women are particularly at risk for iron-deficiency anemia. Even though national data on iron-deficiency anemia are still lacking in most African countries, several studies conducted in urban and rural areas among pregnant women showed a prevalence ranging between 50% and 65% [1–3]. Etiologic factors include low intake and bioavailability of dietary iron and secondary effects of malaria, intestinal parasites, and HIV infection [4–7]. During pregnancy, anemia is associated with increased risks of premature delivery and low birthweight, and severe anemia with increased risks of maternal and perinatal death [8–10].

Ongoing strategies to control iron-deficiency anemia include supplementation and, to a lesser extent, dietary diversification and food fortification. Iron supplementation through antenatal care programs is the most widespread intervention to prevent and control anemia among pregnant women. The World Health Organization (WHO) recommends a universal supplemental dose of 60 mg of iron, usually combined with folic acid, starting in the second trimester of pregnancy until at least 3 months postpartum [11]. In Senegal, as in many developing countries, iron supplementation is included in the national strategy to control iron-deficiency anemia among pregnant women [12]. This approach is based on the expectation that pregnant women will visit health centers for antenatal care on a regular and timely basis. After more than a decade of intervention, little progress has been made in reducing anemia levels, and the effectiveness of this approach is not evident. Reasons given by studies conducted in various countries have highlighted the difficult access to health

facilities, lack of motivation of health service providers, and poor compliance with the recommended timing and frequency of taking iron supplements during pregnancy [13–16].

The purpose of the present study was to evaluate the impact of a positive deviance approach as a community-based intervention to improve the effectiveness of an iron-supplementation program to reduce anemia among pregnant women in rural Senegal.

## Methods

### Intervention strategy

The MICronutrient And Health (Micah) program was a multistrategy, community-based intervention to reduce micronutrient deficiencies among children, adolescents, and women of childbearing age. It was implemented in the administrative district of Velingara, located in southern Senegal, one of the poorest regions of the country. The district is made up of one urban area (the commune of Velingara) and villages gathered in 11 rural communes, accounting for nearly 90% of the district population. The majority of the population belongs to the Peulh ethnic group, but the Manding, Sarakhole, and Bassari groups are also represented. The inhabitants are mostly subsistence farmers and livestock breeders with little education and poor access to health facilities.

The Micah program was implemented by World Vision in three geographic areas, consisting of two rural communes (Sinthian Koundara and Kounkane) and one district (Pakour). In view of the deleterious consequences of anemia among rural pregnant women, interventions focused on increasing iron intake and bioavailability through promotion of iron supplementation during pregnancy, nutrition education to increase intake of iron-rich foods, and promotion of small-animal raising to increase access to and consumption of animal-source foods. Despite the fact that the Peulh are renowned for livestock production, few animals are used for household consumption. Micah also sought to reduce the prevalence of diseases that contribute to anemia. Malaria prevention and control were promoted by distribution of subsidized insecticide-treated bednets through health facilities and education on the importance of proper treatment for malaria. Prevention of intestinal parasitic infections was promoted through education on hygiene practices and support for communities in improving water and sanitation. Community Integrated Management of Childhood Illness (IMCI) training was conducted for both government health staff and community health volunteers. In the framework of this program, the control of anemia among pregnant women included a community-based education program (videos, local

radio station messages, and a mass media campaign) to disseminate information on anemia as well as technical and financial support to the district health team for medical supplies and distribution of iron supplements in the health center, health posts, and health huts.

The positive deviance approach (PD Micah) was initiated as an additional component only in the rural community of Sinthian Koundara to test its effectiveness as an anemia control strategy. Positive deviance refers to the finding that in many poor communities, there are some individuals who employ beneficial practices that allow them to have better health than their neighbors, despite the fact that they are equally impoverished. These behaviors are usually affordable, acceptable, and sustainable by the wider community, because their peers are already practicing them [17]. Positive deviance interventions have traditionally addressed child malnutrition, but in this case the positive deviance approach was applied to the problem of anemia among pregnant women.

A positive deviance inquiry was conducted between July and August 2003 to identify facilitators and barriers associated with iron supplementation and to learn about positive-deviant women's strategies to prevent iron deficiency and anemia during pregnancy. From the database of 204 women who participated in the baseline survey, 110 women with measured hemoglobin levels were identified and questioned on their reproductive history; knowledge, attitudes, and practices related to anemia and iron supplements; history of malaria and helminth infections; and dietary habits during their last pregnancy. The socioeconomic status of the households was determined on the basis of local criteria defined by heads of villages and community health workers. According to the level of hemoglobin measured during the baseline survey, women were assigned to anemic and nonanemic groups with a cutoff point of 11 g/dL. Nonanemic women (hemoglobin  $\geq$  11 g/dL) living in impoverished families who were compliant with iron supplementation and who had attended at least two antenatal visits during their pregnancy were considered positive deviant. Women with hemoglobin levels below 11 g/dL were classified as non-positive-deviant, regardless of their socioeconomic status. We did not identify negative-deviant women because there were no anemic women in nonpoor households. Five focus groups were held with 22 positive-deviant and 16 non-positive-deviant women to explore dietary behavior related to pregnancy, perceptions and practices about anemia, compliance with iron tablet supplementation, awareness of parasitic diseases related to anemia, and perceptions of health services. The discussions were conducted by two trained women with six or eight women in a session.

Data obtained from focus group discussions revealed that positive-deviant women, in addition to being compliant with iron supplementation, had a better

knowledge of the role of iron supplementation and were well aware of the link between anemia and malaria or helminth infection. These women were also more likely to attend health centers for antenatal consultation and to deliver in health facilities. They had a better perception of health services and were more willing to take iron supplements. The main constraint on attendance at health facilities reported by positive-deviant women as well as non-positive-deviant women was the accessibility of the facilities.

The coordinating team designed an intervention to involve community health volunteers to distribute iron supplements to pregnant women in their own communities, follow them up regularly to improve compliance, promote good practices identified among positive-deviant women, and provide education to all women on the causes and prevention of anemia. The community health volunteers were women of child-bearing age and elderly women who were willing to share their knowledge and to support pregnant women in their villages. The inclusion of elderly women was based on the finding of the positive deviance inquiry that these women play an important role in influencing younger women's practices during pregnancy.

In PD Micah only, the volunteers were trained to identify all pregnant women in each village, encourage them to attend antenatal care, and distribute iron supplements at a subsidized price during the sessions for promotion of healthy pregnancy. In these sessions, which were organized on a monthly basis, knowledge and practices from the findings of the positive deviance inquiry were used to develop key messages on antenatal care, anemia, iron supplementation, and nutrition during pregnancy. The volunteers also verified the availability of iron supplements for each woman, reminded them of antenatal care appointments, and conducted food demonstrations to promote consumption of animal foods and good nutrition for pregnant women. The volunteers followed up defaulters at home to identify reasons for nonparticipation and provide support and encourage their return to the following session. These activities were under the supervision of one Micah agent who was in charge of initiating a participatory discussion among women to enable sharing of knowledge and experiences regarding healthy pregnancy issues. The PD Micah activities were implemented for 9 months (March to November 2005). Their impact was evaluated by comparison with the impact of the Micah program conducted in the rural community of Kounkane over the same period of time. The program in Kounkane also included educational activities (but with less frequency and no involvement of trained volunteers) and supplying the health centers with antiparasitic medications, insecticide-treated bednets, and iron supplements. The two rural communities, Sinthian Koundara (PD Micah) and Kounkane (Micah), were randomly assigned to positive-deviant and non-

positive-deviant activities. These areas were similar in terms of socioeconomic and geographic characteristics and far enough from each other to avoid contamination between these two types of interventions.

## Assessment of the impact

### Subjects and enrollment

The impact of the intervention was assessed by two cross-sectional surveys conducted pre- and postintervention. On the basis of an estimated 80% prevalence of anemia among pregnant women in the area, as found in the baseline survey conducted by World Vision [18], and the assumption that activities would lead to decreases of 30% and 10%, respectively, in the PD Micah and Micah areas, a minimum sample size of 94 women was calculated, with a confidence level of 95% and 80% power. The sample size was increased to 100 women for each survey and each rural commune.

For the baseline and postintervention surveys, all pregnant women were identified by house-to-house visits by the community health volunteers. On the basis of these lists, participants were randomly selected with the use of EpiInfo 6.04dfr. A total of 205 pregnant women were included in the baseline survey and 218 in the final survey, divided between the study (PD Micah) and the control (Micah) areas.

### Data collection procedures

Each selected woman received a visit from a field-worker who administered a questionnaire documenting socioeconomic and demographic characteristics as well as knowledge, attitudes, and practices regarding anemia, iron supplements, malaria and helminth infections, use of prenatal care, and dietary practices during pregnancy. Age in years was self-reported. The women were asked to provide a stool sample in a plastic bottle that was provided for this purpose.

Within 3 days of the household interview, anthropometric measurements were obtained and laboratory work was performed. Mid-upper-arm circumference (MUAC) was measured as a proxy for the woman's nutritional status; values below 25.0 cm were taken to indicate inadequate nutritional status [19]. Hemoglobin was assessed by fingertip capillary-blood samples analyzed with a HemoCue, which was checked daily with a control cuvette supplied with the photometer. Measurements were performed in duplicate. Analyses were repeated when the difference between duplicate measurements exceeded 0.5 g/dL. Anemia was defined as hemoglobin below 110 g/L, in accordance with WHO guidelines [11], and the mean value of two measurements was used for statistical analysis. During the same visit, thick blood smears were stained in 4% Giemsa's solution on glass slides for qualitative determination of malaria parasites and read with a light microscope. Collected stool samples were used to check the level

of compliance with iron supplementation and the presence of helminths. Intake of iron supplements was confirmed the day after stool collection by a qualitative test using the method described by Afifi et al. [20]. Approximately 10 g of each sample was immediately fixed in 10% formalin and refrigerated at 4°C until it was analyzed for parasites. Examinations for intestinal parasites were performed by the modified Kato-Katz method [21]. The intensity of infection was based on the number of eggs per gram of feces. Determination of malaria and analysis of stool samples were performed only among the postintervention participants.

#### Statistical analysis

Data were entered and analyzed with the use of the statistical software SPSS for Windows, version 11.0.1. The socioeconomic and demographic characteristics and other variables were compared among the baseline and the postintervention participants (PD Micah and Micah groups). Continuous variables were compared by Student's *t*-test and categorical variables by the chi-squared test, with  $p < .05$  considered to indicate statistical significance. Logistic regression analysis was used to assess the impact of PD Micah and Micah activities on the prevalence of anemia among pregnant women in the study area. Prior to constructing the logistic models, bivariate analysis was performed to identify potential confounding factors, and variables with a *p*-value less than .15 were included in the final models.

#### Ethical considerations

Permission to carry out the study was obtained from each village chief as well as the head of each household or the husband. Informed consent was also obtained

from each woman after she received a detailed explanation of all procedures. The project was approved by the ethical committees of the Senegal Ministry of Health and the Faculty of Medicine at the Université de Montréal. Women with a hemoglobin level below 110 g/L were given 30 iron supplement tablets free of charge.

## Results

#### Characteristics of participants

Among the 423 pregnant women initially enrolled in the study, 371 had complete information; the remaining 52 were excluded from the analysis. The main reason for exclusion was the lack of records on gestational age. The baseline socioeconomic characteristics of women with complete information were similar to those of women excluded from the analysis. No significant differences were observed in age, parity, occupation, level of education, family size, and main source of family income. The only difference between women included in the analysis and those who were excluded was in the proportion of women who attended antenatal care (57.4% vs. 23.1%,  $p < .0001$ ). The prevalence of anemia did not differ significantly between these groups.

The socioeconomic and demographic characteristics of the 371 women with complete data are compared at baseline and after 9 months of activity in Sinthian Koundara (PD Micah) and Kounkane (Micah) in **table 1**. Among these 371 participants, only 302 were willing to provide their age, which ranged from 14 to 45 years, with a mean age of 23 years. Most of the women were married (at least 97%), multiparous, and had no

TABLE 1. Socioeconomic and demographic characteristics of participants at baseline and postintervention in Micah and PD Micah areas<sup>a</sup>

Characteristic	Micah		PD Micah		<i>p</i> <sup>b</sup>
	Preintervention ( <i>n</i> = 82)	Postintervention ( <i>n</i> = 100)	Preintervention ( <i>n</i> = 89)	Postintervention ( <i>n</i> = 100)	
Age (yr)					.860
< 20	( <i>n</i> = 70) 20.0	( <i>n</i> = 87) 35.6	( <i>n</i> = 57) 38.6	( <i>n</i> = 88) 38.6	
20–30	68.6	57.5	54.4	53.4	
> 30	11.4	6.9	7.0	8.0	
	<i>p</i> ≤ .083		<i>p</i> ≤ .977		
Parity					.326
0	13.4	20.0	21.3	24.0	
1	15.9	14.0	13.5	20.0	
≥ 2	70.7	66.0	65.2	56.0	
	<i>p</i> ≤ .497		<i>p</i> ≤ .371		
Trimester of pregnancy					.901
1	20.7	14.0	12.4	14.0	
2	51.2	40.0	57.3	43.0	
3	28.0	46.0	30.3	43.0	

TABLE 1. Socioeconomic and demographic characteristics of participants at baseline and postintervention in Micah and PD Micah areas<sup>a</sup> (continued)

Characteristic	Micah		PD Micah		<i>p</i> <sup>b</sup>
	Preintervention ( <i>n</i> = 82)	Postintervention ( <i>n</i> = 100)	Preintervention ( <i>n</i> = 89)	Postintervention ( <i>n</i> = 100)	
	<i>p</i> ≤ .043		<i>p</i> ≤ .131		
MUAC < 250 mm	41.5	55.0	33.7	46.0	.203
	<i>p</i> ≤ .69		<i>p</i> ≤ .085		
Ethnic group					.004
Peulh	85.4	91.0	96.6	76.0	
Other <sup>c</sup>	14.6	9.0	3.4	24.0	
	<i>p</i> ≤ .237		<i>p</i> ≤ .0001		
Marital status					1.000
Married	100.0	97.0	100.0	97.0	
Single or widowed	0.0	3.0	0.0	3.0	
	<i>p</i> ≤ .114		<i>p</i> ≤ .100		
Level of education					.398
No education	82.9	71.0	77.5	76.0	
Functional literacy	13.4	9.0	11.2	13.0	
Primary school	3.7	16.0	10.1	9.0	
Secondary school	0.0	4.0	1.1	2.0	
	<i>p</i> ≤ .022		<i>p</i> ≤ .935		
Family size (no.)	( <i>n</i> = 79) 7.2 ± 4.2	( <i>n</i> = 100) 11.8 ± 7.0	( <i>n</i> = 88) 6.2 ± 3.3	( <i>n</i> = 99) 14.9 ± 10.2	.015
	<i>p</i> ≤ .0001		<i>p</i> ≤ .0001		
Main source of family income					.005
Agriculture	96.3	81.0	91.0	63.0	
Other <sup>d</sup>	3.7	19.0	9.0	37.0	
	<i>p</i> ≤ .002		<i>p</i> ≤ .0001		
Family ownership of a field	81.7	63.0	80.9	61.0	.771
	<i>p</i> ≤ .005		<i>p</i> ≤ .003		
Distance from nearest health center (km)					.001
≤ 5	23.2	25.0	28.1	11.0	
5–10	67.1	57.0	15.7	30.0	
> 10	9.8	18.0	56.2	59.0	
	<i>p</i> ≤ .229		<i>p</i> ≤ .003		

MUAC, mid-upper-arm circumference

a. All values are expressed as percentages except for family size, which is expressed as mean ± SD.

b. Chi-square test for differences between Micah postintervention and PD Micah postintervention.

c. Bassari, Maure, Manding, Soninke.

d. Salary, trade, or craft industry.

formal education (at least 71%). In the Micah group, the proportion of women who were in the second trimester of pregnancy was higher among those interviewed at baseline than among those interviewed in the postintervention survey (51.2% vs. 40.0%, *p* ≤ .043). These findings were not seen in the PD Micah group.

The proportion of women with MUAC below 25.0 cm before and after intervention showed a tendency to increase over the 9-month period in both groups.

As was expected in rural areas, agriculture was the main source of family income for the overwhelming majority of participants, even though a significant

difference was observed between the baseline and the postintervention period in both groups. Other sources of family income were salaries and self-employment. The mean household size was significantly lower among the baseline participants compared to the post-intervention participants in both Micah and PD Micah areas.

#### Changes observed in the prevalence of anemia and intermediate outcomes in the Micah and PD Micah areas

Differences between the Micah and PD Micah areas in the prevalence of anemia, access and adherence to iron supplementation, attendance at antenatal care, and other intermediate outcomes are presented in **table 2**. After 9 months of activity, the mean hemoglobin concentration in the PD Micah group was 100.7 g/L, as compared with 93.9 g/L at baseline ( $p = .011$ ). In contrast, the mean hemoglobin concentration in the Micah group was similar at baseline (100.8 g/L) and after 9 months (103.4 g/L) ( $p = .312$ ). When the WHO cutoff point for pregnant women (hemoglobin  $\leq 110$  g/L) was used to estimate the prevalence of anemia, 85.4% of women in the PD Micah group were anemic at baseline, as compared with 55.0% in the postintervention evaluation. In the Micah group, the percentage of women with hemoglobin below 110 g/L decreased from 70.7% to 66.0%, but this change was not statistically significant (**table 2**). Most of the participants had mild to moderate anemia. Severe anemia was evident

in 4.0% of women assessed during the postintervention evaluation in the Micah and PD Micah groups. The proportion of women who had iron supplements at home showed no significant change in the PD Micah area but fell dramatically from 52.4% to 26.0% in the Micah area. Self-reported intake of iron supplements also decreased significantly in the Micah area from 72.0% to 52.0%, whereas it increased in the PD Micah area from 43.0% to 60.0%. A check for iron in the stool to confirm subjects' statements about compliance showed that a higher proportion of women in the PD Micah than in the Micah area had recently taken iron supplements (55.4% vs. 40.0%) (data not shown). Regarding the source of the iron supplements, no difference was observed between the baseline and the postintervention groups in the Micah area. However, in the PD Micah area, the distribution of supplements at the community level increased significantly from 2.6% to 23.3%. Furthermore, the proportion of women who attended health facilities for antenatal care increased significantly in the PD Micah area and remained unchanged in the Micah area.

Among other results, we found that a significantly higher proportion of women reported using bednets and eating animal products in the postintervention PD Micah area. Analyses for malaria and helminth infections were performed only among women in the postintervention study. The prevalence of malaria parasitemia was higher among women in the Micah group than among those in the PD Micah group (52.0% vs. 32.0%,  $p < .05$ ). Malaria infection was associated with

TABLE 2. Changes among pregnant women in prevalence of anemia and intermediate outcomes in Micah and PD Micah areas<sup>a</sup>

Outcome	Micah		PD Micah		$p^b$
	Preintervention ( $n = 82$ )	Postintervention ( $n = 100$ )	Preintervention ( $n = 89$ )	Postintervention ( $n = 100$ )	
Prevalence of anemia	70.7	66.0	85.4	55.0	.003
	$p \leq .098$		$p \leq .0001$		
Had iron supplement at home	52.4	26.0	31.5	43.0	.001
	$p \leq .0001$		$p \leq .091$		
Reported having taken iron supplement	72.0	52.0	43.3	60.0	.254
	$p \leq .006$		$p \leq .026$		
Reported community health structures as sources of iron	3.4	7.7	2.6	23.3	.025
	$p \leq .317$		$p \leq .005$		
Had health card for prenatal care	61.0	56.0	21.3	52.0	.570
	$p \leq .498$		$p \leq .0001$		
Reported having bednets	58.5	68.0	44.9	74.0	.350
	$p \leq .186$		$p \leq .0001$		
Reported eating animal products (meat or fish) at least once a week	41.5	32.0	49.4	70.7	.0001
	$p \leq .019$		$p \leq .003$		

a. All values are expressed as percentages.

b. Chi-square test for difference between Micah postintervention and PD Micah postintervention values.

a higher prevalence of anemia in the Micah area only. Because most participants were not willing to provide a stool sample, only 158 samples (83 in the PD Micah group and 75 in the Micah group) were obtained. Of the 158 stool samples submitted, 4 were insufficient for identification of intestinal parasites and were used only for determination of stool iron. Among the remaining 154 samples, 27.0% in the PD Micah area and 41.0% in the Micah area tested positive for intestinal parasite infections. Hookworms were present in 7.4% and 43.9% of stool samples in the PD Micah and Micah groups, respectively (data not shown).

#### Effect of the interventions on the risk of anemia

The adjusted odds ratio for the risk of anemia among the two types of intervention was calculated by binary logistic regression (**table 3**). Bivariate analysis was performed first to identify potential confounding factors. Only factors associated with anemia that affected women in the Micah and the PD Micah groups differently at  $p < .15$  were included in the logistic regression analysis. Gestational age and parity were forced in the logistic model to take account of their effect on the risk of anemia during pregnancy. MUAC was not included in the model because there was no significant difference between anemic and nonanemic women in both groups. The results (**table 3**) show that the risk of anemia was reduced only in the PD Micah group after all confounding factors had been controlled for. Women coming from communities where the positive deviance strategy was implemented had a lower risk of being anemic (adjusted odds ratio [AOR], 0.25;  $p < .05$ ) at the end of the intervention period. In contrast, the protective effect of the Micah intervention on anemia was weaker and not significant (AOR, 0.88;  $p > .05$ ).

TABLE 3. Impact of Micah and PD Micah interventions on the risk of anemia

Impact	AOR (95% CI) <sup>a</sup>
Impact of PD Micah intervention PD Micah postintervention/PD Micah baseline	0.25 (0.12–0.53) <sup>b</sup>
PD Micah compared with Micah PD Micah postintervention/Micah postintervention	0.59 (0.31–1.13)
Impact of Micah intervention Micah postintervention/Micah baseline	0.88 (0.20–6.36)
Baseline comparison Baseline PD Micah/baseline Micah	2.07 (0.41–10.56)

AOR, adjusted odds ratio

a. Odds ratio (95% confidence interval) adjusted for gestational age, parity, family ownership of a field, main source of family income, and distance from the nearest health center.

b.  $p < .05$ .

The effect associated with PD Micah compared with Micah overall tended to be positive (AOR, 0.59) but not quite significant.

## Discussion

The present study took place in a rural area of Senegal where iron supplementation through antenatal care has been shown to be less effective, mainly because of poor access to health facilities. We believe that it is the first study comparing two types of community-based interventions using independent samples assessed before and after the interventions. This approach may reflect the possible changes within a population more realistically than the usual prospective study design that follows the same subjects and is likely to overestimate the effect as compared with the whole population [22].

The additional PD Micah intervention aimed to improve the availability of and compliance with iron supplements during pregnancy as well as to increase knowledge of the risk factors of anemia through community health volunteer channels. This approach contributed to a significant decrease in the prevalence of anemia among pregnant women. The baseline prevalence of anemia (85.4%) fell to 55.0% in the PD Micah group, corresponding to a statistically significant mean increase in hemoglobin of 6.8 g/L. These results are in agreement with a longitudinal study conducted in Abidjan, Côte d'Ivoire, where an increase of 5 g/L (from 104 to 109 g/L) after supplementation decreased the prevalence of anemia in the study population from 62.8% to 49.4% [1]. A randomized, controlled trial among pregnant women in rural Malawi showed that an increase of 1.6 g/L in the hemoglobin level was also associated with a decline of 10.2% (from 62.0% to 51.8%) in the prevalence of anemia [23], suggesting that the impact of an intervention is in part a function of the distribution of hemoglobin values in the population.

In the logistic regression, comparison of the overall impacts of the two types of intervention on the risk of anemia showed a tendency toward a protective effect of PD Micah but no statistically significant difference. The lack of difference between the impacts of Micah and PD Micah may be due in part to the lower level of anemia at baseline in the Micah area rather than to an equal effect of activities in both areas. Among other explanations is the difference of the two groups on some baseline intermediate outcomes which limits comparison without post hoc contrast models. Using independent samples leads to more reliable results but at a cost of increased sample size. Our sample size was barely sufficient.

Nevertheless, in the PD Micah area, we found a significant protective effect of the intervention after controlling for all confounding factors, whereas no such

effect was observed in the Micah area. Furthermore, the monthly sessions increased attendance at antenatal care, the use of insecticide-treated bednets, and the use of chloroquine for malaria prophylaxis. The coverage of the target population as well as compliance with iron supplements was also increased in the PD Micah area, and measurements of stool iron confirmed that compliance was higher in PD Micah after 9 months. The decrease in accessibility of iron supplements over time in the Micah area cannot be explained and could be related to interventions of other agencies, but no data were available on the availability of iron supplements from other sources (such as district hospitals). Nevertheless, these data demonstrate that distribution of iron supplements by community volunteers may be an effective complement to health systems in the effort to control anemia during pregnancy, confirming results from a randomized, double-blind, placebo-controlled, community-based trial among Gambian pregnant women [24]. The distribution of iron supplements by traditional birth attendants in that study led to a significant reduction in the prevalence of anemia in the treatment group compared with the placebo group.

Despite the decline in the prevalence of anemia, 55% of women in the study population remained anemic. These results may be explained in large part by the level of compliance with iron supplementation, the impact of malaria infection, and the duration of the intervention. Side effects, which are usually cited as a source of noncompliance, were not often self-reported by women who claimed to have taken supplements. Such findings are in accordance with other reports that a dose of 60 mg of iron seems to have an acceptable level of side effects [25]. Adherence to iron supplementation, however, seems to be insufficient to drive the prevalence of anemia to low levels. Studies conducted in Côte d'Ivoire, India, and the Gambia with similar rates of adherence to those of our study reported a comparable reduction in anemia [1, 24, 26]. The investigators of the Gambian study reported that the dose of 60 mg of elemental iron was probably insufficient to fully correct iron deficiency. The results of a randomized trial in Australia, however, reported a reduction in the prevalence of anemia from 11.5% to 3.0% with 20 mg per day of elemental iron [27]. In this survey, the rate of compliance with iron treatment was 86%, confirming Yip's assertion that a compliance rate of at least 80% is required to significantly reduce anemia worldwide [28]. In our intervention, coverage and intake of iron supplementation rather than the dose appears to be the determining factor for the limited decrease in anemia. If coverage must be improved, communication for behavior change is a key element to enhance the knowledge and awareness of beneficiaries. Considering the infrequent contact between pregnant women and health staff in this area, the health sector alone, even though useful, is still unable to address this public

health problem. Effective education strategies using different groups within the community, such as peers, mothers-in-law, and older women, may be useful to address local beliefs and behavioral barriers that limit iron-supplementation programs. In an environment where iron supplements are taken without supervision, as in many intervention programs, motivating factors that improve utilization must be identified and emphasized. The positive deviance approach, which promotes healthy behaviors and practices already existing within a community, could be expanded. Such an approach implemented over a longer period of time than the few months of this study and adequately sustained might produce a greater impact.

Several studies have demonstrated that malaria is a key contributing factor to anemia in subtropical areas [2, 4, 6, 7, 29–31]. In this study, 35% and 52% of women in the PD Micah and the Micah groups, respectively, were infected by the malaria parasite. Such results call for more attention to effective malaria prevention activities when implementing anemia control programs in similar areas.

Although activities were not exactly implemented as planned in both intervention areas, the PD Micah, nevertheless, added a marginal improvement in its implementation area that was sufficient to lead to a statistically significant reduction in the risk of anemia. This result demonstrates that iron supplementation strategies might be improved by involving community volunteers. Such an approach, when combined with effective messages, may also contribute to improving the awareness and motivation of women to better manage their pregnancies. Nevertheless, the high prevalence of anemia even after intervention emphasizes the need for additional strategies if anemia is to be adequately controlled during pregnancy.

The main limitations of the study were the missing data on malaria and intestinal parasites at baseline. The lack of such data led to a cautious interpretation of the impact of the intervention, since we were not able to attribute changes in the prevalence of anemia in PD Micah to any specific aspect of the interventions.

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## References

- Carre N, Eono P, Kouakou K, Duponchel JL, Marquis M, Zahui KH. Traitement martial associé à la prophylaxie du paludisme chez la femme enceinte à Abidjan. *Rev Epidemiol Sante Publique* 2003;51:31–8.
- Huddle JM, Gibson RS, Cullinan TR. The impact of malarial infection and diet on the anaemia status of rural pregnant Malawian women. *Eur J Clin Nutr* 1999;53:792–801.
- Sall G, Ndiaye B, Siekmans K. Combined primary health care interventions for controlling iron deficiency anemia in Senegal. INACG Report: Integrating program to move iron deficiency and anemia control forward. Marrakesh, Morocco: International Anemia Consultative Group, 2003.
- Asobayire FS, Adou P, Davidsson L, Cook JD, Hurrell RF. Prevalence of iron deficiency with or without concurrent anemia in population groups with high prevalences of malaria and other infections: A study in Côte d'Ivoire. *Am J Clin Nutr* 2001;74:776–82.
- Meda N, Mandelbrot L, Cartoux M, Dao B, Ouangné A, Davis F for the DITRAME Study Group. Anaemia during pregnancy in Burkina-Faso, West Africa. *Bull World Health Organ* 1999;77(11):916–22.
- Van den Broek NR. The aetiology of anaemia in pregnancy in West Africa. *Trop Doct* 1996;26:5–7.
- Van den Broek NR, Letsky EA. Etiology of anemia in pregnancy in south Malawi. *Am J Clin Nutr* 2000;72:247S–56S.
- Allen LH. Anemia and iron deficiency: Effects on pregnancy outcome. *Am J Clin Nutr* 2000;71:1280S–4S.
- Viteri FE. The consequences of iron deficiency and anemia in pregnancy. *Adv Exp Med Biol* 1994;352:127–39.
- Zhou L-M, Yang W-W, Hua J-Z, Deng C-Q, Tao X, Stoltzfus RJ. Relation of hemoglobin measured at different times in pregnancy to preterm birth and low birth weight in Shanghai, China. *Am J Epidemiol* 1998;148:998–1006.
- World Health Organization/UNICEF/United Nations University. Iron deficiency anemia, assessment, prevention and control: A guide for programme managers. Geneva: WHO, 2001.
- Service National de l'Alimentation et de la Nutrition. Document de normes et protocoles en nutrition—Sénégal. Dakar: Service National de l'Alimentation et de la Nutrition, Ministère de la Santé et de la Prévention, 2001:98.
- Bondarianzadeh D, Siassi F, Omidvar N. Low compliance with the iron supplementation program among pregnant women in the rural areas of Kerman district I. *R. Iran. Nutr Res* 1998;18:945–52.
- Galloway R, Dusch E, Elder L, Achadi E, Grajeda R, Hurtado E, Favin M, Kanani S, Marsaban J, Meda N, Moore KM, Morison L, Raina N, Rajaratnam J, Rodriguez J, Stephen C. Women's perceptions of iron deficiency and anemia prevention and control in eight developing countries. *Soc Sci Med* 2002;55:529–44.
- Galloway R, McGuirre J. Determinants of compliance with iron supplementation: Supplies, side effects, or psychology? *Soc Sci Med* 1994;39:381–90.
- Schultink W, Van Der Ree M, Matulessi P, Gross R. Low compliance with an iron-supplementation program: A study among pregnant women in Jakarta, Indonesia. *Am J Clin Nutr* 1993;57:135–9.
- Marsh DR, Schroeder DG. The positive deviance approach to improve health outcomes: Experience and evidence from the field. Introduction. *Food Nutr Bull* 2002;23(4 suppl):5–8.
- World Vision. Rapport enquête de base du Micah 2 dans les districts sanitaires de Velingara. Dakar, World Vision Sénégal, Dakkar, 2002.
- Liljestrand J, Bergstrom S. Antenatal nutritional assessment. The value of upper arm circumference. *Gynecol Obstet Invest* 1991;32:81–3.
- Afifi AM, Banwell GS, Bennison RJ, Boothby K. Simple test for ingested iron in hospital and domiciliary practice. *Br Med J* 1966;1:1021–2.
- World Health Organization. Basic laboratory methods in medical parasitology. Geneva: WHO, 1991.
- Sellers DE, Crawford SL, Bullock K, McKinley B. Understanding the variability in the effectiveness of community heart health programs: A meta analysis. *Soc Sci Med* 1997;44:1325–39.
- Young MW, Lupafya E, Kapenda E, Bobrow EA. The effectiveness of weekly iron supplementation in pregnant women of rural northern Malawi. *Trop Doct* 2000;30:84–8.
- Menendez C, Todd J, Alonso PL, Francis N, Lulat S, Ceesay S, M'Boge B, Greenwood BM. The effects of iron supplementation during pregnancy, given by traditional birth attendants, on the prevalence of anaemia and malaria. *Trans R Soc Trop Med Hyg* 1994;88:590–3.
- Hyder SM, Persson LA, Chowdhury AM, Ekstrom EC. Do side-effects reduce compliance to iron supplementation? A study of daily- and weekly-dose regimens in pregnancy. *J Health Popul Nutr* 2002;20:175–9.
- Nair MK, Bhaskaram P, Balakrishna N, Ravinder P, Sesikera B. Response of hemoglobin, serum ferritin, and serum transferrin receptor during iron supplementation in pregnancy: A prospective study. *Nutrition* 2004;20:896–9.
- Makrides M, Crowther CA, Gibson RA, Gibson RS, Skeaff MC. Efficacy and tolerability of low-dose iron supplements during pregnancy: A randomized controlled trial. *Am J Clin Nutr* 2003;78:145–53.
- Yip R. Iron supplementation: Country level experiences and lessons learned. *J Nutr* 2002;132:859S–61S.
- Antelman G, Msamanga GI, Spiegelman D, Urassa E, Narh R, Hunter DJ, Fawzi WW. Nutritional factors and infectious disease contribute to anemia among pregnant women with human immunodeficiency virus in Tanzania. *J Nutr* 2000;130:1950–7.
- Njagi Kiambo J, Magnussen P, Estambale B, Ouma J, Mugo B. Prevention of anemia in pregnancy using insecticide-treated bednets and sulfadoxine-pyrimethamine in high malarious area of Kenya: A randomized controlled trial. *Trans R Soc Trop Med Hyg* 2003;97:277–82.
- Torlesse H, Hodges M. Albendazole therapy and reduced decline in haemoglobin concentration during pregnancy (Sierra Leone). *Trans R Soc Trop Med Hyg* 2001;95:195–201.