Marked Reduction of Anemia during Pregnancy over a 10-Year Period in Montserrat[1]

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Anemia during pregnancy is associated with adverse outcomes including maternal and perinatal mortality. However, health education and other public health strategies seeking to reduce its prevalence have usually met with only limited success. The study reported here surveyed anemia of pregnancy on the island of Montserrat in 1980, 1985, and 1990. This involved examination of clinic and hospital records for over 90% of all women giving birth on Montserrat in 1980 and 1985, as well as 80% of those giving birth in 1990.

This examination showed a dramatic reduction in the prevalence of anemia at the time of the first prenatal visit (a drop from 82% of the study women in 1980 to 23% in 1985 and 19% in 1990) and also a marked drop at three days postpartum (from 91% in 1980 to 41% in 1985 and 39% in 1990). Logistic regression analyses indicated that after controlling for three possible confounding factors (maternal age, parity, and weeks of gestation at first prenatal visit) the difference between the risk of developing anemia during pregnancy in 1980 as compared to 1985 or 1990 was still highly significant.

The reasons for the observed drop in anemia's prevalence during the survey period are not entirely clear, partly because of the retrospective nature of the study. However, better nutrition resulting from improvement in the standard of living on Montserrat during the survey period could have been important, as could changes in health education and food supplementation activities.

Anemia, a key nutritional disease, has many adverse consequences—including reduction of adult work output (*1, 2*), increased susceptibility of anemic children to infection (*3*), and cognitive development deficits (*4*). More directly, severe anemia in pregnancy increases the risk of maternal mortality, and even mild anemia in this period is associated with premature delivery, low birth weight, placental hypertrophy, and reduced maternal estriol excretion (*3*). Not surprisingly, a recent national survey in Jamaica associated anemia of pregnancy with increased perinatal mortality (*5*).

As the foregoing suggests, anemia during pregnancy continues to pose a significant public health problem in the English-speaking Caribbean (*5–7*). Available information shows the most common cause to be an iron deficiency, probably due to inadequate intake and/or low absorption. A deficiency of folate is sometimes noted, and a small number of cases appear due to parasitic infections and hemoglobinopathies such as sickle cell disease (*8*).

Efforts to control anemia have commonly included fortification of various

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foods, provision of supplements to high-risk groups, and nutrition education (*9*). However, the positive results attained by such measures have generally been limited. This article presents data indicating a remarkable drop in the prevalence of anemia of pregnancy on the island of Montserrat between 1980 and 1990 and examines the possible causes of this change.

METHODS

Montserrat is a small Caribbean island, 39 square miles in area, with a population of 10 500. Over 95% of the population is of African-Caribbean descent, and 96% of the adult population is literate. The country has an efficient public health system that offers complete prenatal coverage. Hemoglobin levels are routinely assessed upon enrollment at the prenatal clinic and at three days postpartum.

The study reported here encompassed all women giving birth on Montserrat in 1980, 1985, and 1990. Data on these women's hemoglobin status, as well as their age, parity, and weeks of gestation at first visit, were obtained from clinic and hospital records.

Hemoglobin levels were determined at the same laboratory throughout the 10-year period using the cyan-methemoglobin method (*10*). To determine reliability, a number of blood samples with known hemoglobin values were analyzed at this laboratory during the period in collaboration with the University of the West Indies in Jamaica. The results indicated that the laboratory measurements never differed significantly from the reference values.

For purposes of this study, anemia was defined in accordance with WHO recommendations as a hemoglobin level less than 11 g/dL during pregnancy or less than 12 g/dL postpartum (*11*, *12*).

To assess differences between the study subjects in each of the three years covered, chi-square tests were used to compare the prevalence of anemia, while analyses of variance were used to compare mean maternal ages, gestational ages at the time of the first clinic visit, and parity. To identify differences in the characteristics of anemic and nonanemic women, their ages, parity, and weeks of gestation at first visit were compared using *t*-tests. Parity was transformed into logarithmic values before the assessment to allow for use of parametric statistical analyses.

Odds ratios were calculated to assess differences in the risk of anemia over the period, and logistic regression analyses were performed to determine whether the higher risk of anemia in 1980 remained after controlling for the confounding effects of maternal age, parity, and gestational age at first prenatal visit.

RESULTS

One hundred and fifty-eight women gave birth in 1980, 194 in 1985, and 175 in 1990. Hemoglobin data from the first prenatal visit were available for 100%, 97%, and 86% of the women giving birth in 1980, 1985, and 1990, respectively, while postpartum hemoglobin data were available for 91%, 92%, and 74% of the women giving birth in 1980, 1985, and 1990, respectively. The main cause of missing data was failure to record the indicated hemoglobin values. Such failure was most significant in 1990, when record-keeping was still being adversely affected by a hurricane that had devastated the island the previous year.

The study subjects' mean ages, parity, and weeks of gestation at first clinic visit, by year, are shown in Table 1. Significant differences were found between the years examined for all three variables. Specifically, the mean age of the 1980 mothers was lower than the mean ages of the 1985 and 1990 mothers (post-ANOVA contrasts, $P = 0.004$ and $P < 0.001$, respec-

Table 1. Background data and anemia-related data obtained for women giving birth on Montserrat in 1980, 1985, and 1990 (SD = standard deviation, Hb = hemoglobin).

	1980	1985	1990	*P*
Age in years (mean ± 1SD)	22.2 ± 5.4	24.0 ± 6.1	24.7 ± 6.2	<0.001
Parity (mean ± 1SD)	2.5 ± 1.7	2.3 ± 1.5	2.8 ± 1.8	0.01
Gestational age at first visit in weeks (mean ± 1SD)	18.8 ± 7.1	17.8 ± 7.3	15.8 ± 7.0	<0.001
Hemoglobin at first visit in g/dL (mean ± 1SD)	9.9 ± 1.1	11.8 ± 1.3	12.0 ± 1.3	<0.001
% with anemia at first visit (Hb < 11 g/dL)	82.3%	23.2%	18.5%	<0.001
Hemoglobin at 3 days postpartum in g/dL (mean ± 1SD)	10.5 ± 1.2	12.2 ± 1.3	12.3 ± 1.6	<0.001
% with anemia at 3 days postpartum (Hb < 12 g/dL)	91.0%	40.6%	38.6%	<0.001

tively); however, there was no significant difference between the mean ages of study women giving birth in 1985 and 1990. Similarly, the 1990 mothers were found to make their first prenatal clinic visit earlier in gestation, on the average, than the 1980 or 1985 mothers (post-ANOVA contrasts, $P < 0.001$ and $P = 0.01$, respectively). Although 1985 women made their first visit a week earlier, on the average, than 1980 women, this difference was not statistically significant. (In 1990, 45% of the study women made their first visit in the first trimester of pregnancy, as compared to 27% in 1980 and 31% in 1985.) The only significant difference found with respect to parity was that the 1990 women had a higher average parity (2.8) than either the 1980 or 1985 women (post-ANOVA contrasts, $P = 0.04$ and $P = 0.004$, respectively).

When the anemic and nonanemic women were compared, no significant differences were found between the mean ages or mean parities of women who were anemic as compared to nonanemic at their first clinic visits in 1980, 1985, or 1990. However, in all three years the anemic women made their first clinic visit later, on the average, than the nonanemic women (at 21.5 versus 16.2 weeks of gestation, $P < 0.001$, in 1980; at 25.6 versus 17.3 weeks, $P < 0.001$, in 1985; and at 20.2 versus 15.2 weeks, $P = 0.02$, in 1990). Among the study women examined at three days postpartum, no significant differences were found between the anemic and nonanemic women with respect to their mean ages or mean gestational ages at the time of the first prenatal visit. Similarly, no significant difference was observed between the mean parities of these anemic and nonanemic women in the 1980 and 1990 groups. However, the mean parity (plus or minus one standard deviation) of the anemic women in 1985 was found to be significantly lower than that of their nonanemic counterparts

(2.0 ± 1.4 versus 2.5 ± 1.6, $P = 0.04$).

Overall, as Table 1 shows, there were significant differences between the study women in the three survey years with respect to mean hemoglobin values at the time of the first prenatal visit and at three days postpartum, and also with respect to the prevalence of anemia at the first prenatal visit and at three days postpartum. Between 1980 and 1985, there was a shift in the distribution of hemoglobin values, the mean hemoglobin value at the first prenatal visit being 1.9 g/dL greater in 1985, and the mean hemoglobin value at three days postpartum being 1.7 g/dL greater in 1985. This shift produced a dramatic drop in the prevalence of anemia between 1980 and 1985, a drop also reflected in the 1990 data. This was so for both anemia at the time of the first prenatal visit and anemia at three days postpartum.

As Table 2 shows, the odds ratios for the risk of anemia at the first visit and three days postpartum indicated a reduced risk of anemia among pregnant women in 1985 and 1990 compared to 1980. There was no significant difference between 1985 and 1990 in either case. The results of logistic regression analysis indicated that after controlling for maternal age, parity, and weeks of gestation at first prenatal visit, the reduced anemia risk observed in the 1985 and 1990 groups remained significant. Weeks of gestation at first prenatal visit was the only independent predictor of anemia other than survey year at the time of the first visit, and there were no other independent predictors of anemia at three days postpartum.

DISCUSSION AND CONCLUSIONS

Between 1980 and 1985, the observed prevalence of anemia fell from 82% to 23% at the time of the first prenatal visit and from 91% to 41% at three days postpartum, comparably low prevalences (19% at first visit, 39% at three days postpartum) also being observed in 1990. Something that further dramatizes these findings are the results of a previous study indicating that virtually all pregnant women were anemic in 1975 and 1976 (V. Horsham, personal communication).

As noted above, the average woman in both the 1985 and the 1990 study group was older than the average woman in the 1980 group, while the average 1990 woman made her first prenatal visit earlier than

Table 2. The risk of anemia among the study women at the time of the first prenatal visit and at three days postpartum in 1985 and 1990 compared to 1980, before and after controlling for confounding variables.

	Unadjusted data		Data adjusted for maternal age, parity, and gestational age at first prenatal visit	
	Odds ratio	(95% CI)	Odds ratio	(95% CI)
At first visit:				
1980	1		1	
1985	0.06	(0.04–0.11)*	0.06	(0.03–0.11)*
1990	0.05	(0.03–0.09)*	0.05	(0.03–0.10)*
At 3 days postpartum:				
1980	1		1	
1985	0.07	(0.04–0.13)*	0.07	(0.04–0.14)*
1990	0.06	(0.03–0.12)*	0.08	(0.04–0.15)*

*$P < 0.001$.

her 1980 and 1985 counterparts. However, after controlling for the confounding effects of maternal age and weeks of gestation at the first prenatal visit, as well as the possible effects of parity, the risk of anemia in 1985 and 1990 was still significantly lower than in 1980.

There has been some debate about the suitability of the WHO cutoff points used to define anemia—it having been suggested, among other things, that lower values should be used to identify anemia among black women (*13*). However, it appears unlikely that use of the WHO reference values in this study introduced a bias in the results, since there was no change in the ethnic composition of Montserrat women (over 95% black) during the study period. It is also unlikely that the relatively greater extent of missing data in 1990 introduced a bias because of the nature of its cause—record-keeping problems associated with hurricane damage the preceding year.

It also seems unlikely that bias could have been introduced by incomplete coverage, since Montserrat provided complete public health coverage for pregnant women throughout the study period. Nor are variations in methodology likely to have had a significant impact, since all of the participants' blood samples were analyzed using the same methodology in the same laboratory over the 10-year period, during which time a quality control system operating through the University of the West Indies periodically validated the laboratory's determinations. Therefore, it appears unlikely that measurement error was responsible for the observed decline.

Since this was a retrospective observational study, it is difficult to determine the cause of the reduced anemia prevalence on the basis of study data. Many factors could have been responsible. One such factor was an increase in the country's GDP from US$ 2 738 per capita in 1983 to US$ 6 133 in 1990 (*14, 15*). This seems likely to have prompted improvement in the standard of living and better nutrition. There may have also been an increase in health consciousness among pregnant women in 1985 and 1990 due to public health education programs, which may have been instrumental in encouraging them to make their first prenatal visit at an earlier stage of pregnancy.

Before 1980 there were shortages of iron and folate tablets on Montserrat, and the dosage given to pregnant women was six tablets. Starting in 1980, a slow-release iron/folate tablet was used for a period of two years, after which supplementation with regular iron/folate tablets was introduced. The changes in procedure that were involved here could have improved pregnant women's compliance; and this, together with improved availability of appropriate supplements, seems likely to have contributed to the observed decline in anemia at three days postpartum. These developments may also have affected the prevalence of anemia at the first prenatal visit among multiparous women—who comprised 65% of the pregnant women studied in 1985 and 73% of those studied in 1990.

Other factors potentially responsible for the decline in anemia include food fortification and a reduction in the prevalence of intestinal parasites. No food fortification program was implemented in Montserrat during the study period. However, most of the food consumed on the island was imported, and it is not known whether there was an increase in the availability of fortified foods among these imported products. The possible role of reduced parasitism is also unclear. Although a national program to reduce the prevalence of intestinal parasites was implemented, it was only carried out between 1986 and 1989, which is after the observed decrease in 1985. This leaves open the possibility that the program could have been important in maintaining the

lower prevalence of anemia observed in 1990.

Overall, the findings presented here point up the potential for reducing the prevalence of anemia among pregnant women at the national level. However, the actual mechanism by which this reduction was achieved in Montserrat is not clear. It could have resulted mainly from an improvement in the nation's standard of living, though it is also possible that implementation of public health/education programs which included regular provision of supplements to clinics were important.

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