Effects of Rise in Food Costs on Hemoglobin Concentrations of Early School-Age Children, 1972–75

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SCHOOL-AGE CHILDREN from middle- and upper-income families are not likely to be iron deficient (*1–3*). Even in poorer communities, where iron deficiency is common at school age, the iron deficient children are likely to come from families with cultural as well as economic characteristics of poverty (*1–5*). Our objective for this study was to assess changes in hematologic status and somatic growth, during a period of rapidly rising food costs, among children who were iron deficient 3 years previously.

Study Methods

In 1972, a presumptive diagnosis of iron deficiency was made in 68 of 1,210 originally tested inner-city school children. The criterion was microcythemia (mean corpuscular volume (MCV) less than 77 μm^3) in the absence of other identifiable causes for reduced red blood cell volume. All the children lived in an area of Philadelphia that had a sufficient density of impoverished families to qualify the schools for financial aid under Titles I, II, and III of the Elementary and Secondary School Act. The methods for investigating these children and their families, in 1972, have been described (*5*).

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Diet counseling and treatment with ferrous sulfate were provided for all children with evidence of iron deficiency. A representative subpopulation of 23 children responded with a rise in red cell volume from 70 to 79 μm^3 and hemoglobin concentration from 11.4 to 12.0 g/dl (*6*).

In 1975, 38 of the originally investigated iron deficient children attended the same school as in 1972. In this study, conducted in 1975, the hematologic status of all preschool and early school-age children and mothers in these 38 families was evaluated. Permission was received from all parents for the evaluation of their children. Blood for hematologic screening was collected during a 2-week interval in the home by two investigators (Matthews and Fairorth). Red blood cell indices were measured for blood specimens examined in an electronic calculator.

Black children have a small but consistent reduction in hemoglobin concentration when compared to white children, even when socioeconomic variables are considered. However, this finding did not affect the present study because all of the families were black (*7*).

In the original study, children in two age groups were considered: 6 months to 3 years and 3 to 10 years. The range of acceptable hemoglobin concentrations was similar for each study period (*8*). In the 1975 study, we investigated the same age groups.

Measurements of height and weight were taken in the schools in 1972 and 1975 by registered nurses, trained and employed by the Division of Health

Services of the School District of Philadelphia. For each measurement of height and weight a percentile was determined according to the sex and age, in months, of each child at the time of measurement. Reference data were from the National Center for Health Statistics (*9*).

The management of a Philadelphia supermarket chain provided us with sales data for 42 matched weeks of 1972 and 1975 for a store in the impoverished community where the surveys were made. The report was for dollars spent in departments named "grocery," "meat," "dairy," "produce," and "delicatessen." No description of the contents of the departments was provided. However, an inspection of the store revealed that only meat products were sold in the "meat" department.

Results

Among the 38 families that were reevaluated in 1975, there were 9 children 6 months to 3 years of age; these children had mean hemoglobin levels of 10.4 g/dl (SD = 0.97). When measurements for children from families that were not resurveyed in 1975 were excluded from the 1972 data, the measurements were available for 13 children, 6 months to 3 years of age, in the 38 resurveyed families. For these 13 children, the mean hemoglobin level was 11.5 g/dl (SD = 1.38) in 1972. During the interval between testing, the reduction in hemoglobin level was significant for infants in these families ($P<0.005$).

At the time of testing in both 1972 and 1975, 39 children from the 38 resurveyed families were 3 to 10 years of age. The mean hemoglobin level for each child in 1975 was less (10.8 g/dl) than it was in 1972 (12.0 g/dl). The mean difference was 1.2 g/dl, $P<0.001$. (Measurements for children who were younger than 3 years of age in 1972 or who were older than 10 years of age in 1975 were excluded.)

Red blood cell indices were measured for blood specimens from 17 mothers in 1972 and 1975. The mean hemoglobin concentration for 1972 was 12.0 g/dl as compared to 11.5 g/dl in 1975. This difference was not significant. There were no significant changes in mean corpuscular volume for school-age children, infant siblings, or for mothers.

Height and weight measurements were available for 1972 and 1975 for 28 school-age children. For height, the median percentile calculated for measurements in 1972 was the 52d, as compared to a median percentile of the 38th in 1975. For weight, the median percentile calculated for measurements in 1972 was the 47th as compared to a median percentile of the 38th in 1975. During the interval between measurements, the percentile position decreased for 15 of the 28 children, as calculated from measurements of height, and for 16 of 28 children with respect to weight. A binomial test showed these changes to be insignificant.

The survey of supermarket sales showed a significant reduction in the percentage of total sales for "produce," "delicatessen," and "meat" and an increase in "grocery" (table 1). By contrast, in an evaluation of purchasing patterns in a middle- and upper-income neighborhood, supermarket sales (expressed as

a percentage of total sales) did not show changes in "meat" purchases during the interval between 1972 and 1975 (table 2).

Discussion

For the population of inner-city school children originally investigated in 1972, microcythemia in the absence of beta thalassemia trait, hemoglobin C trait, sickle cell trait, chronic bleeding, or lead poisoning was associated with cultural characteristics of chronic poverty, and a presumptive diagnosis of iron deficiency was made. Children who had the alpha thalassemia trait of black Americans were not identified, and it is likely that the original study group contained some children with this condition. The data suggested that iron deficiency in a school-age child was likely to be associated with iron deficiency in other family members (*5*).

The originally tested group of iron deficient children came from families with cultural, as well as economic, characteristics of poverty (*5*). In the 1975 survey, 38 of the original families still lived in the impoverished community; 31 families had moved away. The 38 resurveyed families may represent a subpopulation least able to cope with food selection during a period of rising food costs.

Table 1. Purchasing patterns for a supermarket in an inner-city community for 42 matched weeks, 1972 and 1975

	Sales as a percentage of total				
	1972		1975		
Department	Mean	SD	Mean	SD	P [1]
Grocery	56.6	1.2	61.0	2.1	<0.001
Meat	24.2	1.1	20.7	0.95	<0.001
Dairy	8.15	0.42	8.03	0.42	....
Produce	5.88	0.58	5.07	0.64	<0.001
Delicatessen .	5.32	0.23	4.95	0.33	<0.001

[1] From an analysis of dependent variables.

Table 2. Purchasing patterns for a supermarket in a prosperous community for 42 matched weeks of 1972 and 1975

	Sales as a percentage of total				
	1972		1975		
Department	Mean	SD	Mean	SD	P [1]
Grocery	55.8	0.67	57.4	1.5	<0.001
Meat	17.1	0.65	16.9	1.0	....
Dairy	10.3	0.58	10.4	0.67	....
Produce	10.4	0.93	9.4	1.0	<0.001
Delicatessen .	6.4	0.38	5.8	0.35	<0.001

[1] From an analysis of dependent variables.

Persons made deficient by iatrogenic blood loss show reductions in red blood cell volume and mean corpuscular hemoglobin, before they show a reduction in hemoglobin concentration; microcythemia and anemia are associated in the development of iron depletion syndromes (*10–12*).

In this study, children 3 to 10 years of age who had microcythemia and reduced mean corpuscular hemoglobin in 1972 were anemic after a 3-year interval. The mean hemoglobin concentration for the children 3 to 10 years of age was reduced, and for infants 6 months to 3 years of age, born in the interim into resurveyed families, hemoglobin concentration was less than in the previous survey in children of similar age in the same families. There was no significant reduction in the rate of somatic growth.

Somatic growth and hematologic status are affected by the nature of the foods available for purchase and consumption. With an increase in consumption of foods of low iron to energy ratio, the likelihood of iron deficiency occurring is increased (*13*). With iron deficiency, intestinal absorption of iron is increased, but the increase varies with the source of iron. In iron deficiency, the use of iron from either meat products or iron salts is excellent—30 to 40 percent of iron content is absorbed. By contrast, the absorption of iron from grains and legumes, approximately 5 percent when iron stores are adequate, is increased only slightly in iron deficiency (*12–14*).

During the interval between 1972 and 1974, the increase in the cost of food items in the United States was greater than in previous years, with a disproportionate rise in the cost of food staples (*15*). During this interval a shift in purchasing practices occurred, with a decrease in the consumption of meat items of approximately 4 percent. The consumption of vegetable products remained at approximately the same level in 1974 as in 1972 (*16*).

Our evaluation of data provided by the management of a supermarket showed that the changes in national purchasing patterns were identical to the changes in this poor neighborhood. The purchase of "meat" (calculated from the percentage of total sales as "meat") decreased between 1972 and 1975 in the community where this study was conducted.

The children evaluated in 1975 were successfully treated with ferrous sulfate in 1972; diet counseling was provided to the families (*6*). While comparisons were not made between diet histories in 1972 and 1975, the reduction in hemoglobin concentration occurred during a period of increasing food costs and changing patterns of food consumption, both nationally and locally. The decreased intake of meat prod-

ucts would limit iron available for absorption (*12–14*).

A pattern of choosing high-energy, lower-cost foods is characteristic of families in both underdeveloped and rapidly developing countries. If the cost of iron-containing food is excessive, families must choose between iron and energy, and they invariably choose energy. Mothers will purchase foods that satisfy their children's hunger (*17–19*).

In this study, hemoglobin concentration decreased among early school-age children in an inner-city community when food costs increased. The data suggest that the economic characteristics of a community affect the prevalence of iron deficiency at early school age.

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SYNOPSIS

KARP, ROBERT (Thomas Jefferson Medical College, Philadelphia), FAIRORTH, JEANETTE, KANOFSKY, PAUL, MATTHEWS, WARREN, NELSON, MAUDENE, and SOLIMANO, GIORGIO: *Effects of rise in food costs on hemoglobin concentrations of early school-age children, 1972–75. Public Health Reports, Vol. 93, September-October 1978, pp. 456–459.*

In a hematologic survey conducted in 1972, microcythemia in school children was found to be associated with microcythemia in other family members. The association of cultural characteristics of chronic poverty with reduced red cell volume suggested nutritional iron deficiency. A resurvey of families was made in 1975.

For 39 children between the ages of 3 and 10 years at the time of both surveys, mean hemoglobin concentration (HGB) decreased from 21.0 g/dl to 10.8 g/dl. Thirteen infants, 6 months to 3 years of age in 1972, in the resurveyed families had mean HGB of 11.5 g/dl as compared to 10.4 g/dl for 9 similarly aged children newly born into the resurvey families. The rate of somatic growth was unchanged during the interval between survey.

During the interval between 1972 and 1975, food costs rose nationally, and the purchase of meat products decreased both nationally and (as found in this study) locally.

The data suggest that the high cost of foods rich in micronutrients may increase the prevalence of iron deficiency in an impoverished community.