Original Article

Anaemia among Egyptian Children between 2000 and 2005: trends and predictors

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Abstract

Anaemia remains the most prevalent nutritional disorder among women and children in the Middle East and North Africa region. We examined anaemia trends using data from the Egyptian Demographic and Health Surveys. Between 2000 and 2005, the prevalence of anaemia (defined as haemoglobin concentrations $<11 \text{ g dL}^{-1}$) increased from 37.04% to over 52% among Egyptian children between 12 months and 36 months of age. We examined the associations of these changes with food consumption, vitamin A administration, recent illness, immunization status, socio-demographic factors and a child's anaemic status. Children under the age of 24 months who had recently been sick and those who resided in Upper Egypt were significantly more likely to be anaemic. Despite significant improvements in water and sanitation facilities, maternal education and asset-based household wealth, there were marked declines in the consumption of nutritive foods and increases in the prevalence of childhood diarrhoea between 2000 and 2005. Placing these analyses in the broader context of Egyptian economic trends suggests that the nutritional basket consumed by Egyptian households between 2000 and 2005 may have shifted towards less nutritive foods with lower costs per calorie, probably in response to economic difficulties and increasing food prices. Shifts in dietary consumption, in conjunction with increases in diarrhoea, are likely contributing to the rapid increase in childhood anaemia in Egypt between 2000 and 2005. National-level fortification efforts may be one way to combat rising levels of anaemia among Egyptian women and children.

Keywords: anaemia, iron fortification, Egypt, child nutrition.

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Introduction

Iron-deficiency anaemia remains the most prevalent nutritional disorder among women and children in the Middle East and North Africa (MENA) region (Aoyama 1999; WHO 2003). Anaemia has been linked to negative consequences for the cognitive and physical development of children, to the economic productivity of adults as well as to increased risk of

maternal and child mortality (Gleason & Scrimshaw 2007; WHO 2008).

At the biological level, iron-deficiency anaemia has been associated with micronutrient deficiencies, infectious disease and inherited disorders (Tolentino & Friedman 2007). Micronutrient deficiencies are often attributable to diets that contain little bioavailable iron, particularly in areas of the world that do not provide iron fortification programmes for food

(Tolentino & Friedman 2007). These deficiencies may be caused or compounded by infectious diseases (Kemmer *et al.* 2003; Tolentino & Friedman 2007). Additionally, anaemia among children has been linked to maternal factors such as poor maternal nutritional status, itself associated with low maternal educational levels (Villamor *et al.* 2000; Subramanian *et al.* 2009). At the household level, childhood anaemia has been linked to poor water and sanitation facilities and low socio-economic status. Economic shocks also adversely affect the nutritional status of children (Villamor *et al.* 2000; Osorio *et al.* 2004; Pongou *et al.* 2006; Tengco *et al.* 2008; Subramanian *et al.* 2009).

The surveillance of anaemia prevalence over time provides a measure of improvements or declines in population-level nutritional status. We examined the trends in the prevalence of anaemia among children in Egypt using nationally representative data. In addition, we explored the biological and socio-demographic factors associated with anaemic status and examined how variations in each of these factors have contributed to changes in anaemia prevalence among Egyptian children between 2000 and 2005.

Methods

We utilized the data collected in the 2000 and 2005 Egyptian Demographic and Health Surveys (EDHS). The 2000 EDHS included direct measurement of haemoglobin (Hb) levels in a subsample of one-half of all EDHS households for three groups: ever-married women aged 15–49 years, children between the ages of 6 months and 59 months and boys and girls aged 11–19 years. Data were collected between February and March of 2000. The 2005 EDHS included direct measurement of Hb levels in a subsample of one-third

of all EDHS households for three groups: ever-married women aged 15–49 years, children aged 6–59 months and never-married young adults and young adults aged 10–19 years. Data were collected between March and July of 2005.

Both the 2000 and 2005 EDHS used identical sample collection methods, the HemoCue system for Hb testing. This system uses a battery-operated photometer and a disposable micro-cuvette, coated with a dried reagent that serves as the blood-collection device. A drop of capillary blood was taken from a person's fingertip or heel and was drawn into the micro-cuvette. The blood was analysed using a photometer, which displayed the Hb levels.

For these analyses, data were restricted to children over the age of 12 months, as immunization status was used as a proxy for access to health care services in the final model. A child, according to the World Health Organization (WHO), is considered fully immunized if he/she has received BCG, measles, polio and three doses of DPT vaccines by the age of 12 months. Additionally, the data collection on food consumption for 2005 was limited to last-born, singleton children under the age of 36 months. As the consumption of nutritive foods was used in the final model and is biologically related to Hb levels, the data were restricted so that there would be comparability between survey years. Children who were missing food consumption data were excluded from the analysis. The final sample used in this analysis comprised 1709 children in 2000 and 1425 children in 2005. Our sample was limited to last-born, singleton children aged between 12 months and 36 months who had data on recent food consumption and immunization status, but the anaemia prevalence rates among our sample mirrored the prevalence among all children between the ages of 12 months and 36 months,

Key messages

- Between 2000 and 2005, the prevalence of anaemia (defined as haemoglobin (Hb) concentrations $<11 \text{ g dL}^{-1}$) increased from 37.04% to over 52% among Egyptian children between 12 months and 36 months of age.
- The rise in the prevalence of anaemia occurred in context of shifting food consumption patterns and increases in childhood diarrhoea.
- National-level efforts to fortify the bread that is the staple of the Egyptian diet may lead to increases in population-level iron concentrations.

Table 1. Anaemia prevalence among last-born, singleton, Egyptian children between 12 months and 36 months (2000 and 2005)*

	2000 (<i>n</i> = 1709)			2005 (<i>n</i> = 1425)		
	<i>n</i>	%	% with any anaemia	<i>n</i>	%	% with any anaemia
Severe (Hb levels <7.0 g dL ⁻¹)*	5	0.26		5	0.29	
Moderate (Hb levels 7.0–9.9 g dL ⁻¹)	275	15.26		366	24.41	
Mild (Hb levels 10.0–10.99 g dL ⁻¹)	353	21.55	37.07	407	28.06	52.76
None (Hb levels >11.0 g dL ⁻¹)	1076	62.93		647	47.24	

Hb, haemoglobin. *Anaemia prevalence was assessed using Proc Surveyfreq to adjust for complex survey sample designs, including stratification, clustering, and unequal weighting.

regardless of birth order and the existence of food consumption data. In 2000, the prevalence of anaemia among all 12–23 and 24–35 months old children was 42.6% and 29.5%, respectively (Macro International Inc. 2011). In our sample, the prevalence (adjusted for survey design) of anaemia among last-born singleton children who had food consumption data was 41.5% for children between 12 months and 23 months and 31.2% for children between 24 months and 35 months. Similarly, the prevalence of anaemia among 12–23- and 24–36-month-olds in the 2005 EDHS data was 57.1% and 48.8% (Macro International Inc 2011). In our sample, the prevalence (adjusted for survey design) of anaemia among last-born, singleton children who had food consumption data was 59.1% for the 12–23-month-old children and 49.0% for the 24–35-month-old children.

The wealth index in this analysis was created using the pooled data (2000 and 2005 EDHS) for households with last-born, singleton children between 12 months and 36 months who had been tested for anaemia and adjusted for the distribution of household population. Using variables common across both survey years (ownership of home and domestic animals, number of persons per room, access to electricity, as well as assets including the possession of a television, radio, bicycle or refrigerator), principle component analysis was used to construct an indicator of household wealth that was comparable across the two survey years. The indicator variables were standardized using factor analysis, and coefficient scores were calculated and standardized with a mean of 0 and a standard deviation of 1. The pooled data were divided into three groups: the lowest 40%, the middle

20% and the highest 40%, and then stratified by year. The methodology of this analysis was identical to that of the EDHS; the only difference was the selection of indicator variables and the use of pooled data to determine cut-off points (Rutstein & Johnston 2004).

The independent variables used in this analysis comprised of the child's age and sex, recent illness (cough, fever or diarrhoea in the 2 weeks preceding the survey), current breastfeeding status and whether or not the child was fully vaccinated, stunted (defined as <−2 standard deviations from the 2006 WHO height/length for age growth curves) or had been given vitamin A in the 6 months preceding the survey. Maternal education was included as well as household-level factors such as urban/rural residence, water and sanitation facilities and governorate of residence.

We used logistic regression models to examine the associations between these independent variables and the primary end point, namely anaemic status among children (defined as Hb <11 g dL⁻¹). Analyses were conducted using SAS version 9.1 (SAS Institute Inc., Cary, NC, USA) and all analyses were adjusted for survey design, sampling errors and uneven weights using the SAS survey procedures (Deaton 1997).

Results

Between 2000 and 2005, anaemia prevalence increased dramatically among children aged 12–36 months in Egypt. The data in Table 1 show that anaemia among last-born, singleton children increased from just over 37% to over 52% in a 5-year period. Between 2000 and 2005, the adjusted sample

Table 2. Spearman correlation coefficients for food consumption variables $n = 3129^*$

	Milk	Meat	Grains	Fruit	Sweet potatoes/tubers	Eggs/fish/poultry
Milk	1	0.08	0.05	0.29	0.06	0.11
Meat		1	0.11	0.15	0.12	-0.05
Grains			1	0.04	0.13	0.15
Fruit				1	0.09	0.06
Sweet potatoes/tubers					1	0.09
Eggs/fish/poultry						1

*Some foods did not have full data so the total n ranged between 3118 and 3129 depending on the food group.

mean Hb levels among last-born Egyptian children between the ages of 12 months and 36 months declined significantly by 0.60 g dL^{-1} from 11.32 g dL^{-1} to 10.72 g dL^{-1} (95% CI: $-0.71, -0.49$).

In the 2000 and 2005 EDHS, participants were asked whether or not their child had consumed each of the following items at any time in the 24-hour preceding the survey: milk, meat, egg/fish or poultry, fruit, sweet potatoes/tubers and grains. There were additional questions asked on consumption, including 'sweetened drinks', 'other drinks', infant formula and water. The first two of these variables were not included in this analysis because of lack of comparability between years. Infant formula was excluded from the analysis as only 5% of the study participants had consumed formula. Water was excluded from this analysis for two reasons: water consumption was fairly universal (>95% in both survey years) and, although vital for life, it provides no nutritive value.

Spearman correlations between all six food consumption variables showed that food consumption patterns were all positively correlated with each other, except for the consumption of eggs/fish/poultry and meat, which was negatively correlated (Table 2). As both the consumption of meat and the consumption of eggs/fish or poultry were significantly protective of anaemia in the univariate analysis (Table 3), a substitution may be occurring; participants were eating either eggs/fish/poultry or meat products. As both variables contain animal proteins, they were collapsed into a single variable to capture the consumption of animal protein from any source (meat, egg, fish or poultry).

In Tables 3–5, we present the unadjusted associations between the consumption of each of the food groups, individual child-level factors, maternal factors and household factors on the probability of a child being anaemic. The consumption of milk, fruit, sweet potatoes, meat, eggs/fish or poultry were all significantly protective of anaemia. Micronutrient deficiencies (in addition to chronic infections that may lower blood Hb) have been shown to increase the rate of anaemia as the consumption of micronutrients improves the synthesis of ingested iron (Neumann & Harrison 1994; Kemmer *et al.* 2003; Tengco *et al.* 2008; WHO 2008). The more food groups a child has consumed, the higher the likelihood that he/she has consumed micronutrients that are iron enhancing. Given the initial findings, together with the literature available and the inability to assess the quantity or type of micronutrients ingested with each food group, a collapsed food consumption variable was created. For the final analyses, children who had consumed all five of the food groups (milk, animal protein, grains, fruit and sweet potatoes) in the 24-hour preceding the survey were coded as '1' and children who had consumed between zero and four of the food groups were coded as '0'. In the collapsed variable, the consumption of all of these food groups, relative to some or none of them, was significantly associated with lower risk of anaemia (Table 3).

Stunted children between the ages of 12 months and 23 months who were not breastfeeding and who had experienced an episode of cough, fever or diarrhoea in the 2 weeks preceding the survey were significantly more likely to be anaemic than older

Table 3. Anaemia status among last-born, singleton Egyptian children between 12 months and 36 months according to food consumption variables*†

Food consumption	<i>n</i>	%Not anaemic	% Anaemic	Chi-square <i>P</i> -value
Milk‡				
Yes	1859	56.86	43.14	0.02
No	1269	52.4	47.6	
Fruit				
Yes	2032	59.74	40.26	<0.0001
No	1087	46	54	
Grains§				
Yes	2779	55.67	44.33	0.24
No	348	50	50	
Meat				
Yes	846	60.76	39.24	0.01
No	2283	52.91	47.09	
Poultry, fish or eggs				
Yes	1946	57.4	42.6	0.0006
No	1183	51.14	48.86	
Sweet potatoes/tubers¶				
Yes	2009	56.55	43.45	0.02
No	1119	52.28	47.72	
Animal protein, milk, fruit, grains, and sweet potatoes/tubers				
Yes	720	64.03	35.97	<0.0001
No	2414	52.28	47.72	

*Pooled data for 2000 and 2005. Proc Surveyfreq was used to adjust for complex survey sample designs, including stratification, clustering and unequal weighting. All *P*-values are Rao–Scott chi-square *P*-values. †Anaemic status is defined as a level of haemoglobin concentration of 10 g dL⁻¹ or less. *n* = 3134. Totals may be <3134 due to missing values. ‡Includes tinned, powdered and fresh milk. §Includes porridge, bread, rice, macaroni or other foods made from local grains. ¶Sweet potatoes and other foods made from tubers for 2000. Includes pumpkin, carrots, squash, sweet potatoes, potatoes or any other food made from tubers in 2005.

children (24–36 months) who were not stunted, who were being breastfed and who had not been sick in the 2 weeks preceding the survey. Gender, vitamin A consumption and immunization status were not significant predictors of a child being anaemic (Table 4).

Children of mothers with no education were significantly more likely to be anaemic than those with mothers with some education. Children residing in upper Egypt in rural households with no water and sanitation facilities were significantly more likely to be anaemic than urban children residing in other governorates with water and sanitation facilities in the home. The prevalence of childhood anaemia declined

Table 4. Anaemia status among last-born, singleton Egyptian children between 12 months and 36 months according to individual factors*†

Child factors	<i>n</i>	% not anaemic	% anaemic	Chi-square <i>P</i> -value
Sex				
Female	1480	53.38	46.62	0.14
Male	1654	56.41	43.59	
Age group				
12–23 months	1368	50.62	49.38	<0.0001
24–36 months	1766	60.6	39.4	
Currently breastfeeding				
Yes	1223	59.34	40.66	<0.0001
No	1911	48.16	51.84	
Fever‡				
Yes	733	57.02	42.98	<0.0001
No	2399	48.29	51.71	
Cough				
Yes	666	57.09	42.91	<0.0001
No	2468	47.15	52.85	
Diarrhoea				
Yes	538	46.65	53.35	<0.0001
No	2596	56.7	43.30	
Vitamin A consumption§				
Yes	487	53.59	46.41	0.34
No	2450	55.14	44.86	
Fully immunized¶				
Yes	2809	55.36	44.64	0.34
No	325	51.69	48.31	
Stunted**				
Yes	895	50.17	49.83	0.01
No	2177	57.01	42.99	

*Pooled 2000 and 2005 data. Proc Surveyfreq was used to adjust for complex survey sample designs, including stratification, clustering, and unequal weighting all *P*-values are Rao–Scott chi-square *P*-values. †Anaemia status is defined as a level of haemoglobin concentration of 10–10.9 g dL⁻¹ or less. *n* = 3,134. Totals may be <3134 due to missing values. ‡Fever, cough or diarrhoea in the 2 weeks preceding the survey. §Administered in the 6 months preceding the survey. ¶A child, according to the World Health Organization (WHO) is considered fully immunized if he/she has received BCG, Measles, Polio and three doses of DPT vaccines by the age of 12 months. **A child is considered stunted if he is <2 standard deviations away from the 2006 WHO height/length for age growth curves.

with increases in household wealth (Cochran–Armitage trend test *P*-value <0.0001) (Table 5).

The consumption of all of the food groups was significantly protective in the adjusted model. Younger age and an episode of cough in the 2 weeks preceding the survey were all significant predictors of a child being anaemic. Overall, the year 2005 relative

Table 5. Anaemia status among last-born, singleton Egyptian children between 12 months and 36 months according to maternal and household factors*†

Factors	<i>n</i>	% not anaemic	% anaemic	Chi-square <i>P</i> -value
Maternal education				
None	1999	48.99	51.01	<0.0001
Any	1135	58.38	41.62	
Urban/rural				
Urban	1279	61.85	38.15	<0.0001
Rural	1855	50.24	49.76	
Residence				
Frontier governorates	192	57.81	42.19	<0.0001
Upper Egypt	1361	46.8	53.2	
Lower Egypt	1056	59.38	40.63	
Urban governorates	525	66.29	33.71	
Water and sanitation‡				
Yes	2141	57.73	42.27	<0.0001
No	852	47.54	52.46	
Household wealth index, §				
Lowest	1248	49.92	50.08	0.0002
Medium	636	53.3	46.70	
Highest	1237	60.95	39.05	

*Pooled 2000 and 2005 data. Proc Surveyfreq was used to adjust for complex survey sample designs, including stratification, clustering, and unequal weighting all *P*-values are Rao–Scott chi-square *P*-values. †Anaemia status is defined as a level of haemoglobin concentration of 10–10.9 g dL⁻¹ or less. *n* = 3,134. Totals may be <3134 due to missing values. ‡Defined as households with piped drinking water, a flush toilet and a finished floor. §*P*-value of the Cochran–Armitage Trend Test *P* < 0.0001.

to 2000 is significantly associated with declines in a child's Hb levels, after adjustment for food consumption, individual child characteristics and maternal and household factors (Table 6).

Between 2000 and 2005, the number of children who consumed animal proteins, milk, grains, fruit and sweet potatoes/tubers declined significantly from over 30% in 2000 to 14% in 2005. The number of children who had experienced an episode of diarrhoea or fever in the 2 weeks preceding the survey increased significantly from 9.3% to 26% and from 21% to 25%, respectively, and the prevalence of child stunting increased from 25.6% to 33%. There were significant improvements in water and sanitation facilities between 2000 and 2005 as well as an increase in the number of mothers with some education. There

Table 6. Multivariate analysis of the predictors of anaemia among Egyptian children between the ages of 12 months and 36 months*† (*n* = 2 733)

Variable	OR	95% CI	
		Lower	Upper
Consumption of nutritive foods‡	0.78	0.63	0.97
Currently breastfeeding	1.17	0.94	1.47
Cough§	1.34	1.04	1.73
Diarrhoea	1.16	0.89	1.52
Fever	1.03	0.80	1.33
Received vitamin A¶	1.05	0.82	1.35
Fully immunized**	1.21	0.88	1.67
Female Sex	1.19	0.99	1.42
Child's age (12–23 vs. 24–35 months)	1.48	1.19	1.86
Water and sanitation available††	0.81	0.64	1.03
Governorate			
Frontier governorates	1.37	0.85	2.20
Upper Egypt	1.68	1.20	2.36
Lower Egypt	1.16	0.82	1.63
Urban governorates (ref)			
Urban residence vs. rural	0.84	0.65	1.07
Household wealth category			
Lowest	1.11	0.86	1.42
Medium	1.07	0.83	1.38
Highest (ref)			
No maternal education vs. any education	0.89	0.72	1.09
Child stunted**	0.92	0.76	1.11
Year 2000 vs. 2005	0.53	0.44	0.65

OR, odds ratio; CI, confidence interval. L-R-test: *P* < 0.0001; *c* = 0.66 *n* = 2733. *Anaemia status is defined as a level of haemoglobin concentration of 11 g dL⁻¹ or less. †Analysis was conducted using the SURVEYLOGISTIC procedure in SAS V9 to obtain the adjusted parameter estimates. ‡Defined as consuming egg/fish/poultry, meat, sweet potatoes or tubers, fruit and grains in the 24 h preceding the survey. §Cough, fever or diarrhoea in the 2 weeks preceding the survey. ¶In the past 6 months as recorded on health card or reported by mother. **A child is considered fully immunized if he/she has received BCG, three doses of DPT, three doses of oral polio vaccine and anti-measles vaccines before turning 1-year-old. ††Child's house has a finished floor, flush toilet and piped drinking water. **Defined as <2 standard deviation from the 2006 World Health Organization Height for Age Growth Curve Standards.

was an overall improvement in assets-based household wealth between the survey years (Table 7).

Discussion

One of the main causes of anaemia in the MENA region is attributed to low intakes of iron (Bagchi 2004). Of the iron that is consumed, the majority is

Table 7. Comparison of child and household characteristics between the two survey years (2000 and 2005) $n = 3134$ singleton Egyptian children between 12 months and 36 months*

Variable	2000	2005	Chi-sq <i>P</i> -value
	<i>n</i> = 1709 %	<i>n</i> = 1425 %	
Consumption of nutritive foods [‡]	30.19	14.32	<0.0001
Currently breastfeeding	38.74	39.37	0.45
Cough [‡]	21.65	20.77	0.85
Diarrhoea	9.30	26.60	<0.0001
Fever	21.36	25.86	0.007
Received vitamin A [§]	16.86	16.22	0.74
Fully immunized [¶]	93.27	85.26	<0.0001
Female sex	47.34	47.09	0.99
Child's between 12 months and 23 months	56.99	55.58	0.72
Water and sanitation available **	67.86	76.02	<0.0001
Governorate			
Frontier governorates	6.90	5.10	0.47
Upper Egypt	37.10	50.95	
Lower Egypt	38.44	28.00	
Urban governorates	17.50	15.86	
Urban residence	42.42	38.88	0.62
Household wealth category			
Lowest	46.30	32.39	<0.0001
Medium	18.54	22.58	
Highest	35.15	45.02	
No maternal education	38.39	33.61	0.01
Child stunted ^{††}	25.69	33.29	<0.0001

*Totals may not add up to <3134 due to missing values for some variables. [‡]Defined as consuming animal proteins (eggs, fish, meat, milk or poultry), sweet potatoes or tubers, fruit and grains in the 24 h preceding the survey. [§]Cough, fever or diarrhoea in the 2 weeks preceding the survey. [¶]In the past 6 months as recorded on health card or reported by mother. [§]A child is considered fully immunized if he/she has received BCG, three doses of DPT, three doses of oral polio vaccine and anti-measles vaccines before turning 1-year-old. **Child's house has a finished floor, flush toilet and piped drinking water. ^{††}Defined as <-2 standard deviation from the 2006 World Health Organization Height for Age Growth Curves.

non-haem iron. This type of iron has low bioavailability. Poor uptake is exacerbated by the low intake of enhancers such as fresh fruit and meat and by the high consumption of inhibitors such as tea (Al-Othaimen *et al.* 1999; Zijp *et al.* 2000; WHO 2003; Faber 2007; Baig-Ansari *et al.* 2008). Egypt is a country with relatively high caloric availability with widespread adult obesity (FAO 2007; El-Zanaty & Way 2009). Estimates of food consumption (kcal/person/day) remained well over 3200 calories between 2000 and

2005 (FAO 2007). In spite of this, the prevalence of childhood anaemia in Egypt increased significantly between 2000 and 2005 and the prevalence of child stunting increased by almost 30%.

In the wider context of Egyptian economic trends, the significant decline in the consumption of nutritive foods between 2000 and 2005 occurred during a period of rising food prices and worsening indicators of economic performance. Between 2000 and 2005, wholesale price indices (based on 1986/87 = 100) increased from 381.4 to 548.90. In the context of overall inflation, wholesale food price indices increased even more, from 504.6 to 734.20 in the same time period (CAPMAS 2006). Between 2000 and 2005, unemployment in Egypt increased by 14% from 9.0% to 11.2%. The dollar value of the Egyptian pound remained fairly constant between 1995 and 2000, but declined by over 66% between 2001 and 2005 (CAPMAS 2006; EIU 2008; IMF 2009). In an analysis of the welfare loss as a result of exchange rate-induced price increases, Kraay (2007), found that the price for food items increased significantly more than the price of other goods. This resulted in increases in the total expenditures on food, particularly among poorer Egyptian households (Kraay 2007).

The increase in child anaemia between 2000 and 2005 have occurred in a high-calorie context where the consumption of animal proteins, dairy products, fruits, grains and sweet potatoes/tubers has declined significantly. Overall, these products are significantly more expensive per calorie than other, less nutritive foods (Asfaw 2007a,b). Asfaw attributes this disparity to the Egyptian subsidy system that disproportionately makes the price of high-calorie, non-nutritive foods (unfortified bread, sugar and cooking oil) cheaper (Asfaw 2007b). When overall caloric intake seems to have remained constant, one factor that may be leading to the increase in anaemia may be a shift in the contents of the 'nutritional basket' available to the Egyptian population.

The National Nutrition Institute in Egypt has found that the intake of dietary iron in the Egyptian population was 75% below the recommended daily allowance (WHO 2003) and it is estimated that national-level fortification efforts would result in a 28%

decline in the prevalence of anaemia in Egypt (GAIN 2008). 'Aish' or 'life' is the Egyptian Arabic word for bread, emphasizing the central importance of bread in the Egyptian diet. In 2002, daily bread consumption among Egyptian men and women was estimated at 354 g and 357 g, respectively, and the majority of Egypt's poor population subsists on unfortified, subsidized bread (Karamanos *et al.* 2002; WHO 2003). The Egyptian government has been committed to national fortification efforts since 2001, although no national-level fortification efforts have been fully implemented to date (WHO 2003; GAIN 2008). Several small-scale fortification efforts have been undertaken, including the fortification of biscuits for school children and private sector production of fortified baby formula and pasta.

This study has shown that the rapid decline in Hb concentrations among Egyptian children has occurred in a context of a decline in the variety of foods consumed by Egyptian children. In a context where food consumption patterns are shifting towards a less varied diet, the nutritional quality of cheaper dietary staples becomes increasingly important. The successful implementation of a national-level flour fortification effort in Egypt would serve to improve the nutritional quality of the mainstay of the Egyptian diet, and perhaps ameliorate some of the recent, population level increases among Egyptian children.

Our study has several limitations. First, our sample of last-born, singleton children between the ages of 12 months and 36 months showed slightly higher rates of anaemia when compared with the nationally representative EDHS data that were not restricted by food consumption, immunization and last-born status selection criteria. The overall national sample proportion of children between the ages of 6 months and 59 months who were anaemic in 2000 was 0.30 and its standard error was 0.009 (El-Zanaty & Way 2001). The overall national sample proportion of children between the ages of 6 months and 59 months who were anaemic in 2005 was 0.49 and its standard error was 0.009 (El-Zanaty & Way 2006). The higher rates of anaemia found in our study sample may be due to the fact that younger age groups (in both the EDHS national sample and our sample) have higher rates of

anaemia than older age groups. Second, the food consumption variable used in this analysis is crude, and it is impossible to assess the quantity or frequency of foods consumed in each food group. Additionally, some key variables are absent including details on vegetable consumption, the consumption of pulses (a staple in the Egyptian diet) and the type of grains consumed (fortified vs. unfortified). Third, while there were data on recent cough, fever or diarrhoea for the study participants, it was impossible to determine whether these were due to chronic infections, parasitic infection or acute illnesses. In the MENA region, the high prevalence of parasites has been shown to contribute to elevated anaemia prevalence (Astal 2004). The extent to which parasitic infections contribute to the national-level increases in childhood anaemia in Egypt is impossible to determine from current data. The most recent estimates suggest the prevalence of hookworm and Schistosomiasis to be about 10% nationally (Raso 2007; Hotez 2008). Third, the sharp increase in diarrhoea and fever between 2000 and 2005 may be attributable to seasonality. The 2005 EDHS data were collected between March and July of 2005, whereas the 2000 EDHS data were collected between February and March of 2000. The diarrhoea season in upper Egypt occurs later in the year between August and September, during the hot season (Serdula *et al.* 1986). Although neither survey occurred during August and September, the 2005 survey was conducted during warmer months than the 2000 survey. Fifth, child immunization is free in Egypt and is covered under the national primary health care plan. UNICEF and other international organizations have promoted National Immunization Days (NID) to promote child vaccinations. A 1998 study by Reichler *et al.* found that children who resided households farther than a 10-min walk from the NID distribution sites, who did not have information on the NID programmes and who resided in a household that did not watch TV were significantly less likely to receive vaccinations (Imam 1985; Reichler *et al.* 1998). A UNICEF evaluation of the 2005 January, February and March NID programmes found that children who resided in rural areas were more likely to miss immunization during NID programmes (Hegazi *et al.* 2005). Children in the 2005

sample were more likely to reside in rural areas than children in the 2000 sample. This may be one reason that immunization coverage declined between 2000 and 2005. Finally, fertility and birth intervals were not included in this analysis. It has been shown that the MENA region's high prevalence of anaemia is partially attributable to sustained high levels of fertility, relatively short birth intervals and the high prevalence of parasitic infections (Darwish *et al.* 1979; Al-Sibai *et al.* 1987; Abdel-razik 1991; Azab 1995; Musaiger 2002; WHO 2003; Astal 2004; Hotez 2008). Fertility was not considered in this analysis for two reasons: between 2000 and 2005, fertility actually declined from a total fertility rate of 3.5 to 3.1, while birth intervals remained fairly constant, increasing slightly from 34.3 months and 35.4 months (El-Zanaty & Way 2006).

In conclusion, although trends in anaemia among Egyptian children are occurring in a context of declines in the Egyptian economy, data limitations make it impossible to infer causality. The wealth index used in this analysis was asset based, rather than a true reflection of household consumption. Although macro-economic indicators show that consumption and disposable income appear to decrease between 2000 and 2005, it is impossible to assess how clearly they parallel food consumption patterns in the EDHS data. Although the authors have been unable to access the data, there are national-level data on household consumption that were collected in 1999 and 2005. More longitudinal or panel studies are needed to explore further the role of economic declines on children's food consumption patterns and the extent to which appropriately targeted food subsidies (both in distribution of subsidies and the quality of subsidized foods) can ameliorate nutritional decline.

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Conflicts of interest

The authors declare that they have no conflict of interest.

Contributions

AMA designed and conducted the research, analysed the data and wrote the paper. WF and AGH assisted in writing the paper, selecting the variables and advising during the research development. All authors read and approved the final manuscript.

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