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Trends in Wheat-Flour Fortification with Folic Acid and Iron --- Worldwide, 2004 and 2007

Consumption of adequate amounts of folic acid by women before pregnancy and during early pregnancy decreases their risk for having a pregnancy affected by neural tube defects (NTDs) (*1*), the most common preventable type of birth defects worldwide. Consumption of iron ameliorates iron deficiency, the most prevalent nutritional deficiency in the world, affecting approximately 2 billion persons (*2*). Although certain populations consume substantial amounts of rice and corn, worldwide, the consumption of wheat flour is greater than that of any other cereal grain. Fortification of wheat flour is an effective, simple, and inexpensive strategy for supplying folic acid, iron, and other vitamins and minerals to large segments of the world population. To assess the global change from 2004 to 2007 in 1) the percentage of wheat flour being fortified with folic acid and iron; 2) the total number of persons overall and women in particular with access to fortified wheat flour; and 3) the total number of newborns whose mothers had access to fortified wheat flour during pregnancy, CDC analyzed data from the Flour Fortification Initiative (FFI).* This report summarizes the results of that assessment, which indicated that the worldwide percentage of wheat-flour fortification increased from 18% in 2004 to 27% in 2007. The estimated number of persons with access to fortified wheat flour increased by approximately 540 million, and the annual number of newborns whose mothers had access to fortified wheat flour during pregnancy increased by approximately 14 million. Nonetheless, approximately two thirds of the world population lacks access to fortified wheat flour. Programs should continue to expand coverage of wheat-flour fortification as a strategy to increase folic acid and iron consumption.

FFI maintains a surveillance system that monitors national fortification practices and policies related to wheat flour processed in roller mills worldwide. FFI staff members use information from food balance sheets from the Food and Agriculture Organization of the United Nations to compile data on the amount (in metric tons) of wheat flour used at the country level.† FFI consultants and staff members visit or communicate with governmental, nongovernmental, or industry representatives involved in wheat production or milling in the various countries to collect country-level data on laws and regulations regarding wheat-flour fortification, annual production of fortified wheat flour, and the type and level of vitamins and minerals used in fortification. Data are collected continuously as laws and regulations change, and the database is updated annually. For this report, CDC used the FFI surveillance system database to document the number of countries with mandatory wheat-flour fortification (i.e., countries with laws or regulations requiring fortification of wheat flour with specific vitamins or minerals and penalties for lack of compliance) and calculated the percentage of wheat flour that is fortified as the amount of fortified wheat flour divided by the total amount of wheat flour used in each country. The results are presented by World Health Organization (WHO) region§ and worldwide. The percentage of persons in each country with access to fortified wheat flour was assumed to be equal to the percentage of wheat flour that is fortified. Multiplying this

percentage by data on country population size obtained from the U.S. Central Intelligence Agency and by data on country-level birth rates from the United Nations International Children's Emergency Fund (UNICEF), CDC estimated the total number of persons and the total number of women with access to fortified wheat flour, and the number of newborns whose mothers had access to fortified wheat flour during pregnancy by country. Data were analyzed for 2004 (the year in which FFI was launched) and for November 2007 (the most recent data available).

From 2004 to 2007, the number of countries with documented national regulations for mandatory wheat-flour fortification increased from 33 to 54. Fifty of the 54 countries with mandatory fortification in 2007 required fortification with both iron and folic acid, two with folic acid but not iron, and two with iron but not folic acid. Twenty-four of those countries also mandated wheat-flour fortification with thiamin, riboflavin, and niacin; two with thiamin and riboflavin; and two with thiamin. The percentage of wheat flour processed in roller mills that was fortified increased from 18% in 2004 to 27% in 2007. Nearly 540 million additional persons, including 167 million additional women aged 15--60 years, had access to fortified wheat flour in 2007 compared with 2004, and the annual number of newborns whose mothers had access to fortified wheat flour during pregnancy increased by approximately 14 million (Table). By region, the greatest increase in the percentage of wheat flour being fortified was in the Eastern Mediterranean Region: from 5% in 2004 to 44% in 2007 (Figure). The portion of wheat flour being fortified increased from 90% to 97% in the Americas Region (the region with the highest percentage of wheat flour being fortified), from 26% to 31% in the African Region, from 16% to 21% in the South-East Asia Region, from 3% to 6% in the European Region, and from 2% to 4% in the Western Pacific Region.

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Editorial Note:

Previous studies in the United States have established that fortification of wheat flour is cost effective (*3*). The cost of fortification with folic acid and iron is approximately $1.50 U.S. dollars per metric ton of wheat flour, which is pennies per person per year. NTDs affect approximately 200,000 births each year, resulting in the death of fetuses or newborns or in lifelong disabilities that result in tens to hundreds of thousands of dollars per year in direct costs per person. In the United States, folic acid fortification has an estimated economic benefit of $312--$425 million annually. The estimated benefit-cost ratio of U.S. folic acid fortification is 40:1 (*3*). Worldwide, iron deficiency is associated with approximately 861,000 deaths, approximately 35 million disability-adjusted life years lost, and billions of dollars in indirect costs annually (*4*). The benefit-cost ratio for iron fortification is approximately 36:1 (*5*).

Ecological studies from the United States (*6*), Canada (*7*), and Chile (*8*) have documented decreases of 26%, 42%, and 40%, respectively, in the rate of NTD-affected births after implementation of national regulations mandating wheat-flour fortification with folic acid. Investigators in Ireland documented that small increases in red blood cell folate levels reduce the risk for NTDs, indicating that small increases in folic acid consumption might result in substantial reductions in NTD incidence in the population (*9*). No adequate ecological studies have examined the health impact of fortifying wheat flour with iron; however, research trials have demonstrated an association between the

consumption of wheat flour fortified with iron and increased hemoglobin levels and decreased prevalence of anemia (*10*).

Successful wheat-flour fortification worldwide requires adoption and enforcement of legislation for mandatory fortification at the national level, and industry and public-sector commitment for such legislation. Mandatory fortification places the same requirements on all flour producers and is more likely to succeed if the milling industry is well organized and supports fortification (*2*). Concomitant consumer education and social-marketing programs are important to ensure consumer acceptance of fortified flour products. The development and implementation of consumer education and communication strategies that include evidence of the health benefits of fortification require commitment from the public sector and is strengthened by the support of civic organizations. Through public, private, and civic collaboration, advocates and public health agencies are promoting wheat-flour fortification and the fortification of other food items (e.g., other cereal grains, soy and fish sauces, sugar, margarine, and cooking oil) to increase worldwide consumption of vitamins and minerals.

The findings in this report are subject to at least three limitations. First, flour-use data are based on Food and Agriculture Organization estimates, which, in certain instances, can be subject to substantial margins of error and do not account for differing levels of flour use among various subpopulations. However, these are the only standardized data that permit international comparisons. Second, the FFI surveillance system only monitors wheat flour processed in roller mills. The system accounts for the known production of substantial amounts of wheat flour in stone-grinder mills in Pakistan and India and assumes that the amount of flour produced in such mills in other countries is not substantial (V. Tyler, CDC, personal communication, 2008). Finally, the percentage of persons with access to fortified flour was considered to be equal to the percentage of flour that is fortified. The extent to which mandatory fortification regulations are implemented and enforced in each country is not known. In addition, several countries have terminology in their fortification laws that allows certain types of flour (e.g., "not enriched" or "brown" flour) to remain unfortified. These factors might have resulted in overestimates of persons with access to fortified flour and the percentage of flour that is fortified.

Although increases occurred from 2004 to 2007 in the number of newborns whose mothers had access to fortified wheat flour, the total number of women aged 15--60 years who had access, and the total number of persons overall who had access, the majority of the world population still lacks access to fortified wheat flour and to the folic acid, iron, and other vitamins and minerals this flour provides. Wheat-flour fortification remains an important strategy for decreasing vitamin and mineral deficiencies, along with targeted supplementation, mass fortification of other food products, in-home fortification strategies, and integrated health and economic-development programs.

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* FFI is a network of public, private, and civic organizations with the goal of making fortification of wheat flour a standard practice. The FFI goal is for 70% of the wheat flour processed in roller mills (i.e., industrial mills in which flour or meal is produced by crushing grain between rollers) to be fortified with at least folic acid and iron by the end of 2008. Additional information is available at http://www.sph.emory.edu/wheatflour.

† Additional information on food balance sheets is available from the Food and Agriculture Organization of the United Nations at http://www.fao.org/docrep/003/x9892e/x9892e00.htm.

§ A list of countries in each WHO region is available at http://www.who.int/about/structure/en/index.html.

Table

TABLE. Estimated number and percentage of persons and women who had access to fortified wheat flour and of newborns whose mothers had access to fortified wheat flour during pregnancy — worldwide, 2004 and 2007

Category	Total population	2004 No.*	2004 (%)	2007 No.*	2007 (%)	Change from 2004 to 2007 No.	Change from 2004 to 2007 (%)
Total persons	**6,512,822†**	**1,271,363**	**(19.5)**	**1,810,659**	**(27.8)**	**539,297**	**(8.3)**
Women aged 15–60 yrs	**2,142,225†**	410,091	(19.1)	577,461	(27.0)	167,370	(7.8)
Newborns whose mothers had access	**133,804§**	27,052	(20.2)	41,060	(30.7)	14,007	(10.5)

* In thousands. Calculated from data from the Flour Fortification Initiative, available at http://www.sph.emory.edu/wheatflour.
† In thousands, mid-2006 estimate. From U.S. Central Intelligence Agency, available at http://www.cia.gov.
§ In thousands. From United Nations International Children's Emergency Fund (UNICEF) birth rate estimates, available at http://www.unicef.org.

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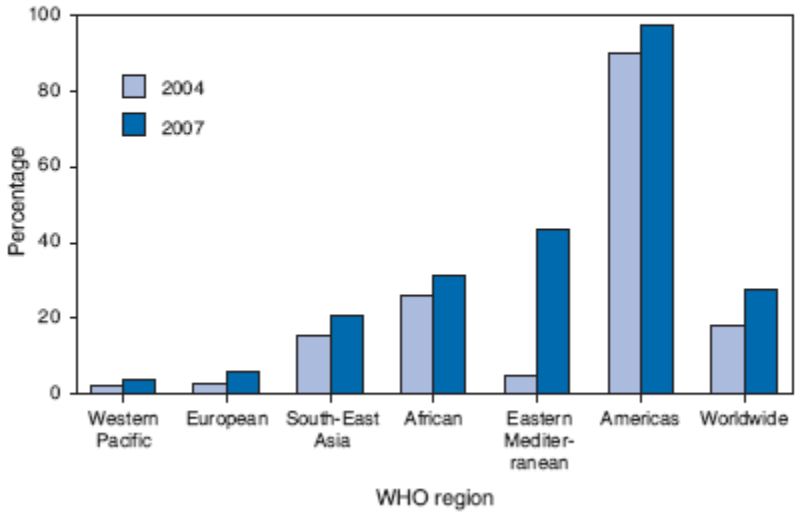
Figure

FIGURE. Percentage of wheat flour processed in roller mills that was fortified — worldwide and by World Health Organization (WHO) region, 2004 and 2007



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