Decline in the incidence of neural tube defects after the national fortification of flour (1997-2005)

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ABSTRACT

Objectives: To evaluate the effect of flour fortification with folic acid on the incidence of neural tube defects (NTDs) in babies. We also report the pattern of NTDs, and we compare it with those reported previously.

Methods: All babies who were born with NTDs at King Abdul-Aziz University Hospital (KAUH), Jeddah, Kingdom of Saudi Arabia between 1997 and 2005 were included in the study. The incidence of NTDs was compared between the eras before flour fortification (1997-2000) and the eras after fortification.

Results: We have observed a decline in NTD incidence in the last decade from 1.9/1000 live births (1997-2000) to 0.76/1000 live births (2001-2005). Forty-two babies were born with NTDs with a male to female ratio of 1.1:1. Sixty percent received folic acid during pregnancy, but none pre-conception. Eighty-three percent of the cases had myelomeningocele (MMC), 12% had encephalocele, 2.5% had meningocele, and another 2.5% had anencephaly. Ninety-one percent of MMC patients had severe physical disability. Thirty-two children (91%) had hydrocephalus, which required shunting in the neonatal period and 22 children (63%) had clubfeet.

Conclusion: After folic acid flour fortification, there was an apparent decline in the incidence of NTDs in babies born at KAUH. However, the incidence is still high and associated with serious morbidity. This stresses the need for innovative programs to increase folic acid consumption by women of childbearing age, to reduce NTDs.

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Neural tube defects (NTDs) are among the most common birth defects that contribute to infant mortality and serious disability. It includes defects of the spine (for example, spina bifida) and the brain (for example, anencephaly) that occur during early pregnancy, often before a woman knows she is pregnant; 50-80% of these defects can be prevented if a woman consumes sufficient folic acid daily before conception and throughout the first trimester of her pregnancy.[1,2] It was in 1992 that the first recommendation for all women of childbearing age in the United States, to consume 0.4 mg of folic acid per day for the purpose of reducing their risk of having a pregnancy affected with spina bifida or other NTDs.[3,4] As the previous recommendation and dietary counseling regarding foods rich in folate to all women of childbearing age did not result in the desired reduction in NTDs, the U.S. Food and Drug Administration subsequently proposed a folate fortification scheme for cereal grains.[5] Fortification with folic acid became mandatory in 1998 and resulted in 26% reduction in NTDs in the USA.[6] Furthermore, it was observed to reduce the severity of NTDs and improve survival of affected infants.[7] Folic acid food fortification was adopted by other countries with similar observation of decline in NTDs.[8,9] In the Kingdom of Saudi Arabia (KSA), the national flour mills organization ordered fortification of flour as a mandatory procedure starting from 2001 (1421H) with the minimum requirement of 1.653% (16.53 gram of folic acid for each kilogram of flour).[10] In this study we record the trend of NTDs incidence before (1997-2000) and after (2001-2005) folic acid food fortification at our institution. We also compare the pattern of NTDs in our study from those reported from other parts of KSA.[11,12]

Methods. All babies who were born with NTDs at King Abdul-Aziz University Hospital (KAUH), Jeddah, KSA between 1997 and 2005 were included in the study. The incidence of NTDs was compared between the eras before flour fortification (1997-2000) and the eras after fortification (2001-2005). The clinical notes of the babies and their mothers were reviewed, and the following data were recorded; antenatal diagnosis and

care, history of folic acid intake, history of consanguinity, type of the NTDs and any associated anomalies. The ethical committee has approved the study.

Results. The overall incidence of NTDs was 1.3/1000 live births. Forty-two babies were born with NTDs out of 33,489 births over 9 years duration (1997-2005). Twenty-two were boys and 20 were girls giving a male to female ratio of 1.1:1. They represented 1.7% of neonatal intensive care unit admissions (2409 admissions). We have observed a decline in the incidence in recent years from 1.9/1000 live births (1997-2000) to 0.76/1000 live births (2001-2005). **Figure 1** shows the decline in the incidence of NTDs over the recent years. Ninety-one percent of the mothers were booked, however, only 12 (29%) were reported as diagnosed antenatally. Sixty percent received folic acid during pregnancy, but none before conception. The data of consanguinity between parents were not available for all patients, but for those available it was 50% (13 patients had consanguineous parents out of 26 patients where the history of consanguinity was available). The most common NTD was myelomeningocele (MMC) as it was the lesion in 35 babies (83%). Five patients (12%) had encephalocele, and only one baby (2.5%) had meningocele, and another one (2.5%) had anencephaly. The MMC site was thoracolumbar in 27 patients (77.1%), and the lumbosacral area in 8 patients (22.9%). Thirty-two children (91%) had hydrocephalus requiring shunting in the neonatal period, and 22 children (63%) had clubfeet. Following up these patients for 5.4 ± 2.3 years, revealed that 91% (32 children) with MMC had severe physical disability, as they were paraplegic. They were in wheelchairs or with severe limping and difficulty in walking. Clubfeet were found in 22 patients, scoliosis in 3 patients, and one child was reported to have polydactly. Ninety percent (31 patients with MMC) were diagnosed as neurogenic bladder, and 26 patients were diagnosed to have vesico-ureteral reflux (VUR). Ten children had unilateral VUR and the remaining 16 had bilateral VUR.

Discussion. Our results demonstrate a decline in the incidence of NTDs after the mandatory fortification of nationally produced flour. This observation is similar to reports from other countries where fortification is taking place.[5,6,8,9,13] However, the incidence is still high, and it is similar to those reported from Asir region before fortification between 1995-1998 of 0.78/1000.[10] Similarly, Murshid et al[11] reported a high incidence of spina bifida in the Al-Madinah Al-Munawarah region of 1.09/1000 live births. Those incidences are still much higher than those reported from western countries.[14,15] However, the observed decline (60%) in our study after fortification was more than that observed in the USA.[6] The high incidence of NTDs in KSA could be explained by absence of peri conceptional use of folic acid supplements among women of childbearing age. Furthermore, antenatal diagnosis does not seem widely available and obviously termination of pregnancy is not practiced for affected cases because of religious beliefs.

In western countries, the decline in the incidence in NTDs was observed before the folic acid supplementation and fortification policy.[14,16] That decline was explained by antenatal screening and termination of pregnancy of affected babies, as well the improvement of the general health and nutritional status of the community. Such decline was not observed in KSA, as Al-Awad et al[17] reported the incidence of NTDs of 0.82/1000 live births in the Asir region between 1987 and 1990, with no significant decline in a later study between 1995-1998.[11] There are no other studies demonstrating the trend in

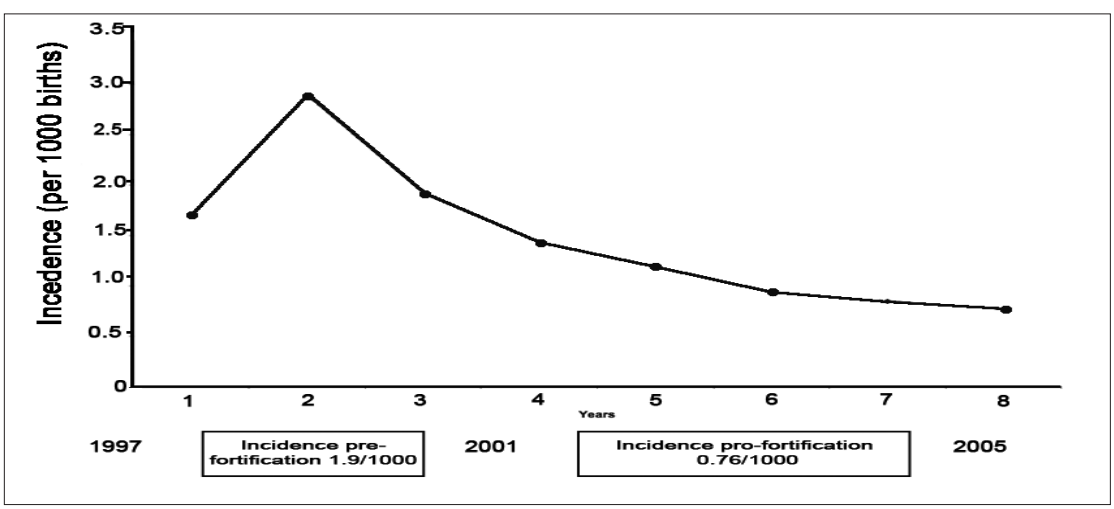

Figure 1 - Incidence of neural tube defects from 1997-2005.

the incidence in KSA. We have observed a decline in the incidence of NTDs after the national policy of folic acid fortification. However, there are several limitations to our study as it was carried out in a referral center and we did not include spontaneous abortion caused by NTDs as it was difficult to obtain the data. The high incidence after fortification compared to other countries could be explained by the fact that fortification was carried out only in flour, while it included all cereals and grains in the USA.[18] Another, important point is that most of the pregnancies in KSA are unplanned, and none of the women in our study were receiving folic acid before conception. As the dietary supplementations are often inadequate, the American Academy of Pediatrics endorses the US Public Health Service (USPHS) recommendation that all women capable of becoming pregnant consume 400 microgram of folic acid daily to prevent NTDs.[19] We need to educate the public about the importance of folic acid intake in women of childbearing age. Continuous innovative programs to increase folic acid consumption are important as the USA observed a decrease in the proportion of childbearing-aged women who reported taking folic acid in dietary supplements daily, from 40% in 2004 to 33% in 2005, returning to a level consistent with that reported during 1995-2003.[6] Consanguinity was reported as risk factor in previous studies.[11,20] Eighty-nine percent of the patients in the study of Murshid et al,[11] were born to consanguineous parents compared to 50% in Asindi's study.[12] Similarly, it was 50% in our cohort; however, 50% is the normal consanguinity rate in KSA. Genetic factors are believed to play a role, and variants of several genes have been found to be significantly associated with the risk of NTDs in recent studies.[21] Similar to previous studies, MMC was the most common lesion,[12,22] and the thoracolumbar site was the most common site with the majority having hydrocephalus and Chiari II malformation.[22] Similarly, talipes equinovarus was common in patients of previous reports.

The majority of our patients had significant physical disability later in life, reflecting the lack of a multidisciplinary approach, and early intervention with orthopedic and occupational therapists. In conclusion, there was an apparent decline in the incidence of NTDs after folic acid flour fortification. However, the incidence is still high and associated with serious morbidity. This highlights the need for innovative programs to increase folic acid consumption by women of childbearing age, to further reduce NTDs.

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