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EPIDEMIOLOGY OF NEURAL TUBE DEFECTS IN THE WORLD AND IRAN

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Abstract

Statistical data from 1966 till 1995, showed that Neural tube defects, in the American continent, Venezuela had the highest prevalence of 38.9 and some Latin American countries showed the low of 7.7. In Europe, Norway had the highest prevalence of 68, and Denmark the lowest, 5.8. In Asia, India had the highest of 181.8 and Japan the lowest of 10. In Africa, Nigeria had the highest of 70 and negroes of South Africa had the lowest of 9.9. In Australia the figure was 20.05.

According to the statistics available of the years 1967 till 1996, anencephaly in China had the highest prevalence of 87. In the American continent, state of Michigan in the USA had the highest of 10.5 and Jamaica, in Central America, had the lowest of 2.6. In Europe, Turkey with 16.4 and Italy with 2.73; in Asia, China with 87 and Iran with 0.8 had the highest and the lowest prevalences, respectively. In Africa, Nigeria with 3.5, and in Oceania, Newzeland with 7.8 in 10000, were reported.

Data available on spina bifida, from the years 1968 till 1991 showed , the highest prevalence in China with 36, and the lowest in the Alps mountains with 0.55 in 10000 individuals. In the American continent, state of Arkansas with 7.8 and California with 3.87 ; in Europe, England with 23.1 and Rhein-Alp with 0.55 in 10000 had the highest and the lowest prevalences. Finally, in China this rate was 36, in Australia 10, in Newzeland 9.4, and in Nigeria 7/10000.

In a study carried out in Tehran, from 1969 till 1978 by the authors, out of 13037 birth, (17.6 in 10000) newborns had neural tube defects, with anencephaly 0.8 and spina bifida 3.8/10000. In a new study on 8585 deliveries (1991-1997) in Hamadan (a north west provience of Iran), Prevalences of total NTDs was 50.1/10000, anencephaly 15.6 and spinabifida 6.98.

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Introduction

Neural tube defects (NTDs) include anencephaly, spina bifida and encephalocele, as well as several other less common forms, and are the most important classes of birth defects, with a newborn prevalence of 1 to 3 per 1000 (12), however, in women with previous affected child, the rate can be 10-20 times higher (4).

Normally, the neural tube closes at about the fourth week of gestation. A defect in closure or a subsequent reopening of the neural tube results NTD. These anomalies are thought to arise from a combination of genetic and environmental factors (12).

In most populations surveyed thus far, empirical recurrence risks for siblings of affected mothers, range from 2% to 5% (12).

Rates appear tobe much higher for certain groups such as the Welsh and Irish (7) and Sikhs (2), for whom the prevalence reach 7-8 per 1000 births, and lower for other groups, such as blacks (16). Hispanic mothers have a higher rate of NTD-affected pregnancies, conpared with blacks and non-Hispanic whites (17).

The most important nutrients in the etiology of NTDs are calories, fat, protein, folate, zinc and vitamins A, C, B6 and B12 (13).

The role of periconceptional folic acid in the prevention of neural tube defects is well established (13). Folate is a B vitamine (B11), which acts as a coenzyme in several single carbon transfer reactions to synthesise components of DNA, RNA and proteins. The term folate describes the group of derivatives exhibiting the biological activity of the parent molecule pteroylmonoglutamic acid. Folate is mainly present as reduced tetrahydrofolate polyglutamate in food. Folic acid is the synthetic fullly oxydised form of pteroylmonoglutamic acid, which is present in supplements and dose not occur naturally in significant quantities (3).

Fluctuations in the bioavailability of folate can affect blood and cellular concentration of compounds associated with this nutrient, including methionine, homocysteine and B12, and thereby exert major effects on metabolism and fetal development. Both vitamin B12 and folic acid are requied for the de novo synthetase and its vitamin B12 cofactor transfer a methyl group from N5-methyltetrahydrofolate to homocysteine, converting homocysteine to methionine. The abnormality in methionine synthase, with a resultant accumulation of homocysteine, results in NTDs affected pregnancies. The cycle of demethylation

and remethylation of methionine dependent on both folate and B12, with generation of the DNA, proteins and polyamines on which fetal growth and develoment depend (11).

Also, 667C→T mutation in the 5,10 methylenetetrahydrofolate reductase (MTHFR) gene results in accumulation of homocysteine (6,19). This mutation occurs in about 11% of most white populations and probably slightly less commonly among the Dutch population, and that it confers an enhanced risk of NTDs and signals a need for an above-average folate intake, especially preconceptionally (20).

Materials and methods

The data of medical record in a general hospital in Hamadan (a north west province of Iran), of pregnancies during 1991-97 , carried out. A statistical analisis shows in this retrospective study, the prevalence of the Neural tube defects (anencephalia and spinabifida) in this region of Iran.

Results and Discussion

In this study on 8585 deliveries (1991-1997) in a general hospital in Hamadan (a north west province of Iran), prevalence of total NTDs, was 50.1/10000, anencephaly 15.6 and spina bifida 6.98. In Figure 1,2 and 3 it can be see the average prevalence of total NTDs, anencephaly and spina bifida in the continents and Iran.

The epidemiological data of NTD, anencephaly and spina bifida, available from 1990 to 1998 (34 paper and 383 abstract) were reviewed (9), and compared with those from Iran.

The highest prevalence of total Neural tube defects, anencephaly and spina bifida in the world, were observed in India with 181.8 and China with 8 and 36/10000 births, respectively. The lowest prevalence were in Denmark for NTDs and Alp mountains 0.55/10000 for spina bifida (9).

In Africa, the highest prevalence of NTDs on the whole, anecephaly and spina bifida were in Nigeria with 70, 3.5 and 7/10000, respectively. The lowest prevalence was observed among negroes of South Africa (9.9/10000), congo (1.2) and for spina bifida no data were available so far (9).

In America, Venezuela with 38.9 for total NTDs, Michigan with 10.5 anencephaly and Arkansas with 7.8 for spina bifida showed the highest prevalences of these defects. The lowest rate was reported from Latin America with 7.7,

Jamaica in Central America with 2.6 , and the state of California with 3.87/10000(9).

The highest prevalences of these three defects, in Asia, were reported from India with 181.8, China with 87 and 36/10000. The lowest rates for these malformation were seen in Japan with less than 10/10000, in Iran with 0.8 and 3.8, respectively (9).

Limited information was available from Oceania indicating that the prevalence of total NTDs and spina bifida was in Autralia 20.05 and 10, in Newzeland was 7 and 9.4 in 10000, respectively (9).

In a study carried out in Tehran, Iran, from 1969 to 1978 by the authors, 23 out of 13037 births, 17.6 in 10000 newborns had total neural tube defects, anencephaly 0.8, spina bifida 3.8 in 10000 (10).

The prevalence of NTDs in countries with high population growth rates, in lower socioeconomic groups, was higher than that of others (4). It can be see that India and China with high population growth rates are top on the prevalence list of these malformations. On the other side, a greater prevalence at birth has been shown for rural areas compared with urban areas (5,7,18).

A report from China (1998-1991) indicated that the prevalence of NTD in rural areas (44.3 per 10000) was 3 times higher than urban areas (14.4 per 10000) (21).

Mediterranean diets with high vegetable and fruit consumption that contains folic acid in high amounts, results in reducing certain disease such as NTDs (14).

Among the nutrients important for prevention of NTDs, folic acid had the key role, Iron supplement and multivitamins containing folic acid are more affective.

United kingdom Report of an Expert Advisory Group recommended that all women with SB or with a previos pregnancy affected with a NTD, should be advised to take a supplement of 5 mg/day of folic acid if they wish to become pregnant or at risk of pregnancy. All other women planing a pregnancy or who suspect they may be pregnant, should take 0.4 mg/day as a medical supplement and should eat more folate rich food (15).

The human neural tube closes about the 4th post-conception week, therefore intake of folic acid supplement prior to and during this time, plays very important role in prevention of NTDs (8).

The safest time to begin the intake of folic acid supplements in women who are planing for pregnancy is three month prior to pregnancy unitll delivery (a conclusion of all available investigations)(9).

The best time to begin Iron supplementation is from initiation of pregnancy untill several mounths after delivery (9).

The best recommended time to begin multivitamin supplements is three months before pregnancy until delivery, to prevent the occurrence of NTD.

Any woman who wishes to take a multivitamin supplement should ensure that it contains 0.4 - 1.0 mg folic acid and not more than 5000 IU vitamin A and not with out medical advice (1).

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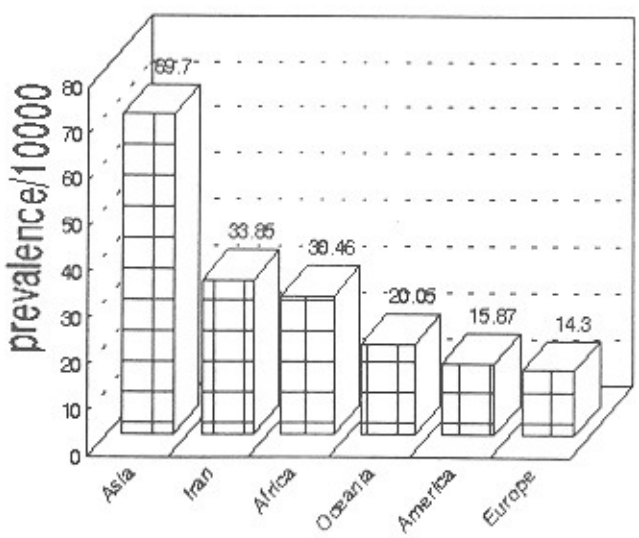

Fig. 1- Prevalence of NTD in the continents compared with Iran

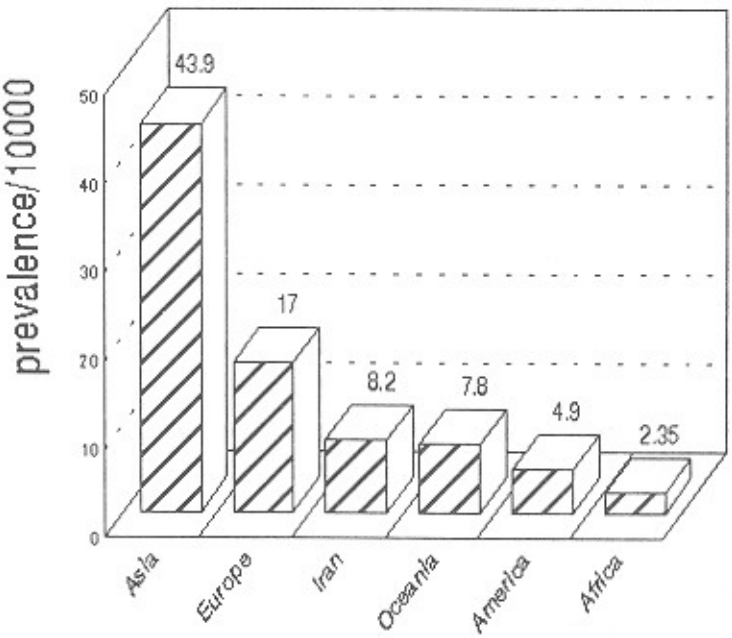

Fig. 2- Prevalence of Anencephaly in the continents compared with Iran

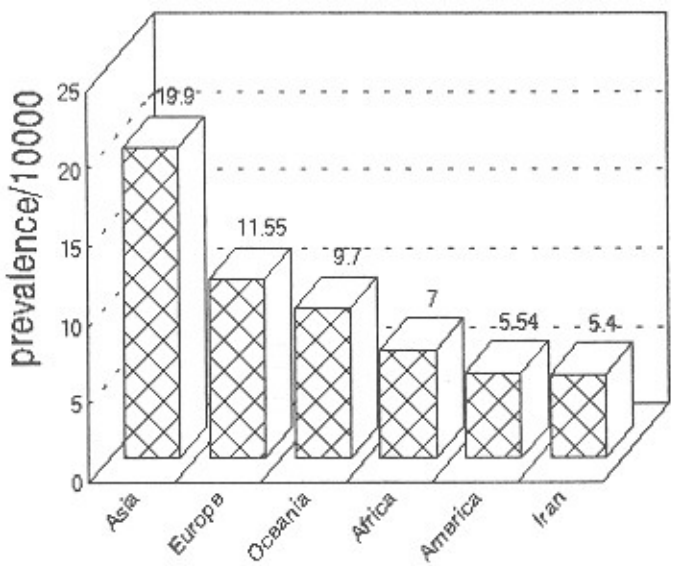

Fig. 3- Prevalence of Spina bifida in the continents compared with Iran

References

1- American College of Obstetrics and Gynecology (1993) : Vitamin A supplementation during pregnancy. ACOG Opinion : Committee on Obstetrics: maternal and fetal medicines. *Int J Gyn Obst,* **40**: 175.

2- Baird PA (1983): Neural tube defects in the Sickhs, *Am J Med Genet,* **16**: 49-56.

3- Bree A, Dusseldrop M, Brouwer IA and van der Hof KH (1997): Review, Folate intake in Europe: recommended, actual and desired intake. *Eur J Clin Nutr,* **51**: 643-50.

4- Butterworth CEJr (1996) : Folic acid and the prevention of birth defects. *Annu Rev Nutr,* **16**: 73-97.

5- Carter Co (1974): Clues to the aetiology of neural tube malformations. *Dev Med Child Neurol,* **16**:(suppl. 32): 3-15.

6- Davis RE (1996): Abnormal folate metabolism and neural tube defects. *Med J Aust,* Apr, **164**(8): 509-10.

7- Elwood JH (1972): Major central nervous system malformations notified in Northern Irland 1964-1968. *Dev Med Child Neurol,* **14**: 731-9.

8- Eskes KAB (1997): Folates and the fetus. *Eur J Obst Gyn Rep Biol,* **71**:105-11.

9- Farhud DD, Hadavi V and Sadighi H (1999): Study of nerual tubel defects in Iran with a review of the world wide epidemiology. 2nd Intr. Conference on Population & Molecular Genetics Update. Nov. 30-Dec.2, Cairo-Egypt.

10- Farhud DD, Walizadeh GhR and Kamali MS (1986): Congenital malformation and genetic disease in Iranian infants. *Hum Genet,* **74**:382-85.

11- Gaull GE, Testa CA, Thomas PR and Weinreich DA (1996): Fortification of the food supply with folic acid to prevent neural tube defects is not yet warranted. *J Nurt,* **126**:773s-80s.

12- Jorde LB, Carey JC and White RL (1997): Medical Genetics, USA, Mosby.

13- Khoury MJ, Show GM, Moore CA, Lammer EJ and Mulinare J (1996): Does periconceptional multivitamin use reduce the risk of nerual tube defects associated with other births defects? Data from two population - based case-control studies. *Am J Med Genet,* **61**: 30-6.

14- Kushi LH , Lenart EB and Willett WC (1995): Health implications of Mediterrannean diets in light of contemporary knowledge 1. Plant foods and dairy products. *Am J Clin Nutr,* **61**: 1407s-15s.

15- Picciano MF, Green T and Connor DL (1994): The folate status of women and health. *Nutr Today,* **29**(6): 20-30.

16- Roeper PJ, Harris JA, Croen LA and et al (1988): Congenital malformation prevalence and racial variation (Abstract) *Teratology,* 37: 485.

17- Shaw GM , Schaffer D , Velie EM , Morland K and Harris JA (1996): Periconceptional vitamin use, dietary folate, and the occurrence of neural tube defects. *Epidemiology,* **6**: 219-26.

18- Slattery ML and Janerich DT (1991): The epidemiology of neural tube defects: A review of dietary intake and related factors as etiologic agents. Am J Epidemiol, **133**(6): 526-40.

19- Vand der Put NMJ, Steegers - Theunissen RPM, Frlosst P and et al (1995): Mutated methylenetetrahydrofolate reductase as a risk - factor for spina bifida. *Lancet,* **346**: 1070-71.

20- Wilcken D EL (1997): MTHFK 677C→T mutation, folate intake, neural tube defect and risk of cardiovascular disease. *Lancet, August,* **350**: 603.

21- Wu Y, Zeng M, Xu C and et al (1995): Analyses of the prevalences for nerual tube defects and cleft lip and palate in china from 1988 to 1991. *Hua Hsi I Ko Ta Hsueh Hsueh Pao,* Jun, **26**(2): 215-9.