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Estimation of the cranial capacity and brain weight of Iranian female newborns

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SUMMARY

Anthropological measurements such as brain weight and cranial capacity are of practical use for the evaluation the health of newborns and also as a basis for the cranium alterations in future years of life. The present research was carried out to determine brain weight and cranial capacity and the effect of the ethnic factor on them in female newborns in northern Iran.

In this study, 423 normal female newborns in Turkman (n=211) and Native Fars (n=212) groups were evaluated by classic cephalometry.

The means and SD of the cranial capacity in the native Fars and Turkman groups were 438.16 ± 63.5 and 418.84 ± 33.19 milliliters, respectively ($p<0.05$). The means and SD of brain weight in Fars and Turkman newborns were 453.50 ± 65.72 and 433.50 ± 34.35 grams respectively ($p<0.05$).

The results of this investigation show that the ethnic factor could influence brain weight and cranial capacity in Iranian female newborns.

Key words: Anthropometry – Brain weight – Cranial capacity – Ethnicity – Iran

INTRODUCTION

The evaluation and measurement of human body dimensions and diameters are achieved by physical anthropometry (Chamella, 1997; Williams et al., 1995).

The dimensions of newborns bodies can be the basis for all changes in anthropometric indices. Therefore, these dimensions are important in this field, because this is one of the health evaluation indices of newborns (Golalipour et al., 2000; Afak and Turgut, 1998). The common method for evaluating of craniofacial forms includes cephalometry, photogrametry, ultrasound, computed tomography (CT) scanning and magnetic resonance imaging (MRI) (McIntyre et al., 2003).

Cephalometry is one of the important parts of anthropometry, in which the dimensions of the head and face are measured (Grau et al., 2001; El-Feghi et al., 2004).

The cephalometric results are used in pediatric, forensic medicine, plastic surgery, oral surgery, orthodentistry and diagnostic comprehension between patient and normal populations (Williams et al., 1995; Gale et al., 2003).

The dimensions of the human body are affected by geographical, racial, ethnic, gender and age factors (Golalipour et al., 2003;

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Williams et al., 1995; Okupe et al., 1984; Irmak et al., 2004).

Cranial capacity, which is in close correlation with brain volume, reflects racial characteristics and thus has been thought to be one of the commonest items in physical anthropological studies (Von Bonin, 1934; Hwang et al., 1995).

A few investigations have also been made on living subjects (Oliver, 1932; Verdun and Bourdiol, 1962; Dekaban, 1997).

By noticing the importance of acquiring information on brain weight and cranial capacity, this study was implemented in living subjects as a baseline study for determining cranial capacity and brain weight in normal female newborns and the effect of ethnic factor on them in northern Iran.

Material and Methods

This investigation was performed on 423 normal female newborns, that were comprised of the native Fars group (n=212) and the Turkman group (n=211) at the Dezyani teaching hospital in Gorgan (Southeast Caspian Sea Shore – northern Iran).

Turkman group: The Turkman population has been living for more than two centuries in this area, who immigrating there from central Asia. Due to both religious and racial beliefs, these people do not marry into other ethnic cultures. Thus, they, and therefore the newborns chosen for the study, are nearly a pure ethnic group.

Native Fars group: These are the main and original inhabitants. The population of native Fars was selected from among the last three generations living in the area.

All newborns were evaluated at 12-24 hours after birth. They were single normal healthy newborns from healthy mothers (i.e., who did not have pre-eclampsia, diabetes mellitus or hypertension). This study was performed with the prior consent and understanding of either parents or legal guardian.

Body weight, head length (L), head width (B) and auricular length (H) were determined by a classic cephalometry method, using a Martin spreading caliper and determining the average of at least three measurements (Williams et al., 1995; Manjunath 2002a; Karatza et al., 2003).

Cranial capacity (CC) was determined by the following formula (Williams et al., 1995; Manjunath, 2002b):

$$CC = 0.0004\ (L-11)\ (B-11)\ (H-11) + 206.06$$

Also Brain weight (BW) and cerebral index (CI) were determined by the following formulas:

- Brain weight = cranial capacity x 1.035 where 1.035 is the mass density of brain (Courchesne et al., 2000; Frontera, 1958)
- Cerebral index = Brain weight/Body weight

The data for each newborn were recorded on a special form and analyzed by the EPI6 software. For comparisons of the means of the anthropometric measurements, a t-test (α=0.05) was used.

Results

The means and SD of body weight, head length, head width and auricular height in Turkman and native Fars are shown in Table 1.

The means and SD of cranial volume in the Fars and Turkman groups were 438.16 ± 63.5 and 418.84 ± 33.19 milliliters, respectively. There was a significant difference between two groups ($p<0.05$).

The means and SD of brain weight in the Fars and Turkman groups were 453.50±65.72 and 433.50 ± 34.35 g, respectively ($p<0.05$).

Also, the means and SD of cerebral index in the Fars and Turkman groups were 14.36 ± 2.32 and 13.43 ± 1.51, respectively, and there was a significant difference between the two groups ($p<0.05$).

Table 1. Means ± SD of body weight, head length, head width and auricular height in female newborns in the native Fars groups and Turkman

Different parameters	*Native Fars Mean ± SD*	*Turkman Mean ± SD*
Body weight (g)	3189 ± 384	3262 ± 4.3
Head length (mm)	113 ± 5.6	113.46 ± 6.8
Head width (mm)	88.5 ± 5.6	87.9 ± 6.4
Auricular height (mm)	78 ± 7.2	78.2 ± 6.2

g = grams; mm = millimeters

Discussion

In this research, cranial capacity in the Fars group (438.16 ± 63.5 ml) was higher than that reported in Imami's study in the northwest of Iran (Mibodi and Farahani, 1996), with 409 ± 61.3 ml.

Also, cranial capacity in the Turkman group (418.84 ± 33.19 ml) in comparison with the Fars group was lower, although higher in comparison with Imami's report (Mibodi and Farahani, 1996).

Here, brain weight in the two groups (Fars and Turkman) was higher than in the Imami study, with 424 ± 64.5 g.

The cerebral indices in the two groups were higher than in Imami report (Mibodi and Farahani, 1996), with 12.4 ± 2.2 and lower than a report on male newborns (Golalipour and Heidari, 2005).

Two factors can affect in brain weight and cranial capacity:

(1) Genetic and racial/ethnic characteristics and (2) Environmental factors.

Regarding the first factor, anthropometric parameters such as brain weight and cranial capacity have been shown depend on gene expression (Okupe et al., 1984). Since gene expression can change in different racial and ethnic groups, it can be considered a determining factor. According to Hooton (1926), racial characters are best defined in the skull. Cranial capacity is one of the most important characters for determining racial difference. It is also an indirect approach to evaluating the size of the brain. More recently, Okupe et al. (1984) reported a higher fetal biparietal diameter in Nigerian women than in Europeans. A racial/ethnic variation in the cranium is also recorded in Gray's Anatomy (Williams et al., 1995).

Also, environmental factors and variant ecological conditions can cause changes in head dimensions, such as cranial capacity and head shape. Nakashima's investigations (Nakashima, 1986) on the diameters of the heads and craniums of Japanese immigrant children in Hawaii reported that the dimensions of the head and cranium were changed after the passage of 30 years. The fact that environmental pressures produce noticeable differences between people with respect to the cranial capacity is an important factor in enabling man to adapt to life in diverse environmental conditions (Irmak et al., 2004).

This investigation has determined the dimensions of cranial capacity and brain weight in female Iranian newborns and also shows the role of ethnic factor on brain weight and cranial capacity in northern Iran.

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