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Secular Trend of Birth Height and Weight in a Population of Iranian Neonates during 1991 and 2011

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Abstract

Background: *The secular trend in growth is a well-documented and recurrent phenomenon in many developed and developing countries. In this study, we examined the secular trends in birth height and weight among Iranian neonates.*

Methods: *This cross-sectional population-based survey was conducted between 1991 and 2011. Using a two-stage stratified cluster sampling, the birth weights and heights of neonates born in Shahroud, Iran were studied using health records from different households. The mean birth weights and heights for neonates were calculated every year. Secular trends were analyzed using linear regression models and joinpoint regression.*

Results: *A random sample of 11,165 neonates was evaluated, and the mean birth weight of neonates during the investigation period was calculated. The mean birth weight changed from 3232.1±444.1 g in 1991 to 3204.1±436.9 g in 2011, and the mean birth height changed from 49.5±2.2 cm to 49.3±1.9 cm. The mean birth weights and heights between 1991 and 2011 were not significantly different; however, the birth weight increased by 6.75 g annually between 2000 and 2011 ($P < 0.021$), and the mean birth height increased by 0.03 cm annually between 2003–2011 and 1991–2003 ($P = 0.009$).*

Conclusions: *The mean birth height and weight of neonates in Shahroud did not change significantly from 1991 to 2011; however, we found a significant improvement after 2000.*

Keywords: Anthropometry, Birth weight, Trends, Iran.
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Introduction

The secular trend in growth is a well-documented and recurrent phenomenon in many developed and developing countries.[1-3] Its evaluation is important because of the following reasons: it is an indicator of public health status over time, it provides an insight into the relation between growth and the environment, and it shows some aspects of intergenerational relationships in growth and body size.[3-5] Furthermore, it reflects the differences in health and welfare levels of the population over time.[6]

A number of studies indicate that variations in the body size of infants at birth are related to the policies in society, socioeconomic status, health status, industrialization, urbanization, war, and economic crisis.[2,5,7] Moreover, other studies showed that the nutritional status of parents and the amount of weight gained during pregnancy usually determine the birth weight and height of infants.[8]

In addition, a secular trend in the mean height and weight of infants at birth has been observed in different studies.[1,2,8-17] For example, studies in China, Queensland, United States, Canada, Norway, Sweden, and Finland have shown an increase in the birth weight of infants.[13,15-18] Furthermore, studies in Denmark, Vietnam, France, and Italy have shown the secular trend of the height of neonates at birth.[8,15-17]

According to the best of our knowledge, insufficient data are available about the secular trend of height and weight of infants at birth in Iran and other Eastern Mediterranean countries.

In this study, we investigated the secular trend of infant birth height and weight in Shahroud, northeast Iran, between 1991 and 2011.

Materials and Methods

We studied the height and weights of 5648 boys and 5515 girls at birth, born between 1991 and 2011 in Shahroud, Iran, from their health records. Shahroud represents the Iranian population. The Shahroud University of Medical Sciences delivers health care services in 79 health houses and health centers. According to previous studies, the standard deviation of birth weight in Iran is 440 g.[4] Consequently, we calculated the desired sample size to be at least 420 neonates for each year, considering a marginal error of 50 g, type I error of 0.05, and design effect of 1.4. Following a two-stage stratified cluster sampling design, we divided the Shahroud district into 13 different geographical areas, which served as the strata, and selected 25 health houses and health centers as clusters. Health records were selected in proportion to the population of each stratum in the clusters.

On the basis of the guidelines of the Iranian Ministry of Health, the weight of neonates was measured in grams and the height was measured in centimeters in the supine position. Height and weight of neonates and other data from the household records was collated using a data collection form. The quality of the height and weight measurement tools was checked according to the national standards and guidelines.

Data were compared for different time intervals between 1991 and 2011. The cluster sampling effect was factored in while calculating confidence intervals and significance level was considered 0.05. The secular trends of infant birth height and weight were evaluated using simple and multiple linear regression models and joinpoint regression for time intervals. Using data obtained from household health records, the role of independent variables, including gender, parent education, type of mother's job, number of prenatal care visits, number of twins, pregnancy

duration, delivery type, and maternal age, was investigated in regression models. STATA and Joinpoint softwares were used for data analysis.

This study (No. 9147) was approved by the Shahroud University of Medical Sciences and was conducted in agreement with the Declaration of Helsinki. The study design was approved by the ethics committee of the Shahroud University of Medical Sciences.

Results

Tables 1 and 2 show the mean birth weight and height of 11,165 neonates born between 1991 and 2011. The mean birth weight and height of neonates during the total study period was 3186.8±468.4 g and 49.2±2.2 cm, respectively.

The birth weights increased by 0.4 g every year between 1991 and 2011; however, these annual changes were not statistically significant in the linear regression model. (Coefficient = 0.40, 95% CI= −1.04 to 1.85, P = 0.584). The regression coefficients were 0.09 (95% CI = −1.95 to 2.12, P = 0.934) for boys and 0.60 (95% CI = −1.44 to 2.64, P = 0.663) for girls (Figure 1).

Table 1.The birth weight mean of neonates in Shahroud, Iran, 1991-2011.

Birth year	Total			Boys			Girls		
	Number	Mean (SD)	95% Confidence Interval	Number	Mean (SD)	95% Confidence Interval	Number	Mean (SD)	95% Confidence Interval
1991	455	3232.1 (444.1)	3191.2-3273.0	229	3272.1 (474.6)	3210.3-3333.9	226	3191.6 (408.0)	3138.1-3245.1
1992	417	3241.1 (461.4)	3196.7-3285.5	219	3256.5 (474.2)	3319.7–3193.4	197	3227.5 (446.0)	3164.8-3290.2
1993	417	3164.8 (486.2)	3118.0-3211.6	202	3213.1 (500.9)	3282.6-3143.6	215	3119.4 (468.6)	3056.4-3182.4
1994	470	3180.5 (464.1)	3138.4-3222.6	220	3216.7 (465.1)	3154.9-3278.5	250	3148.6 (461.9)	3091.1-3206.1
1995	408	3209.9 (482.4)	3162.9-3256.9	199	3187.7 (474.1)	3121.4-3254.0	209	3231.1 (490.5)	3164.2-3297.9
1996	417	3225.8 (445.1)	3183.0-3268.7	214	3260.9 (458.4)	3199.1-3322.7	203	3188.9 (428.7)	3129.5-3248.2
1997	482	3185.4 (464.9)	3143.8-3227.1	223	3163.5 (463.5)	3102.3-3224.4	259	3204.4 (466.2)	3147.3-3261.4
1998	450	3169.5 (496.1)	3123.5-3215.5	229	3244.6 (462.9)	3184.6-3305.1	221	3091.4 (518.0)	3022.8-3160.1
1999	534	3124.9 (467.4)	3085.1-3164.6	283	3202.7 (418.4)	3153.7-3251.6	251	3037.2 (503.8)	2974.6-3099.8
2000	557	3129.7 (485.7)	3089.3-3170.1	278	3178.8 (528.8)	3116.3-3241.2	278	3080.8 (434.6)	3029.5-3132.2
2001	591	3139.4 (501.6)	3098.9-3180.0	311	3150.3 (525.0)	3091.7-3208.8	280	3127.4 (474.9)	3071.5-3183.3
2002	612	3148.3 (486.0)	3109.7-3186.9	314	3167.3 (485.4)	3113.4-3221.2	298	3128.2 (486.7)	3072.8-3183.7
2003	589	3159.4 (479.7)	3120.6-3198.3	317	3145.8 (483.1)	3092.4-3199.2	272	3175.3 (476.2)	3118.4-3232.1
2004	578	3207.1 (465.9)	3169.1-3245.2	283	3257.6 (461.5)	3203.6-3311.6	295	3158.7 (465.6)	3105.4-3212.1
2005	604	3207.0 (453.4)	3170.8-3243-2	308	3212.2 (421.2)	3164.9-3259.4	296	3202.6 (485.2)	3146.1-3257.1
2006	522	3199.7 (466.2)	3159.6-3239.8	259	3266.9 (459.7)	3210.6-3323.1	263	3133.6 (464.0)	3077.3-3190.0
2007	464	3212.8 (444.5)	3172.2-3253.3	242	3227.5 (426.6)	3173.5-3281.5	222	3196.8 (463.7)	3135.4-3258.1
2008	547	3174.5 (483.6)	3133.9-3215.2	256	3199.8 (480.1)	3140.7-3258.9	291	3152.3 (486.4)	3096.2-3208.5
2009	617	3259.4 (436.3)	3224.9-3293.9	321	3319.8 (428.9)	3272.2-3366.9	296	3193.9 (435.6)	3144.0-3243.7
2010	667	3172.7 (466.1)	3137.2-3208.1	357	3178.9 (477.6)	3129.2-3228	310	3165.5 (453.0)	3114.9-3216.2
2011	768	3204.1 (436.9)	3173.1-3235.0	384	3219.3 (438.4)	3175.3-3263.3	383	3188.8 (435.5)	3145.1-3232.6
Total	11165	3186.8 (468.4)	3178.2-3195.5	5648	3214.5 (468.8)	3202.3-3226.8	5515	3158.6 (466.3)	3146.3-3170.9

SD, Standard Deviation

Table 2. The birth height mean of neonates in Shahroud, Iran, 1991-2011

Birth Year	Total			Boys			Girls		
	Number	Mean (SD)	95%Confidence Interval	Number	Mean (SD)	95%Confidence Interval	Number	Mean (SD)	95%Confidence Interval
1991	435	49.5 (2.2)	49.3-49.7	217	49.6 (2.3)	49.3-49.9	218	49.3 (2.0)	49.0-49.6
1992	397	49.4 (2.1)	49.2-49.7	207	49.6 (2.1)	49.3-49.9	189	49.3 (2.0)	49.0-49.6
1993	394	49.2 (2.5)	48.9-49.4	191	49.6 (2.1)	49.3-49.9	201	48.7 (2.8)	48.4-49.1
1994	429	49.6 (2.1)	49.4-49.8	203	49.8 (1.9)	49.6-50.1	236	49.3 (2.3)	49.0-49.6
1995	391	49.4 (2.4)	49.2-49.7	192	49.5 (2.4)	49.1-49.8	199	49.4 (2.3)	49.0-49.7
1996	367	49.4 (2.4)	49.1-49.6	190	49.5 (2.8)	49.1-49.9	177	49.3 (2.0)	49.0-49.6
1997	361	49.0 (2.6)	48.7-49.2	158	48.7 (2.7)	48.1-49.1	203	49.2 (2.5)	48.9-49.6
1998	425	49.1 (2.3)	48.9-49.3	216	49.4 (2.2)	49.1-49.7	219	48.8 (2.4)	48.9-49.1
1999	498	49.1 (2.2)	48.9-49.3	264	49.2 (2.2)	48.9-49.5	234	48.9 (2.3)	48.6-49.2
2000	517	49.2 (2.2)	49.0-49.4	261	49.3 (2.2)	49.1-49.6	256	49.1 (2.1)	48.9-49.4
2001	572	49.3 (2.5)	49.0-49.5	299	49.4 (2.5)	49.1-49.7	273	49.1 (2.6)	48.8-49.4
2002	594	49.2 (2.1)	49.4– 49.0	304	49.5 (2.0)	49.2-49.7	290	48.9 (2.2)	48.6-49.1
2003	575	49.1 (2.3)	48.9-49.3	313	48.9 (2.5))	48.7-49.2	262	49.3 (2.0)	49.0-49.5
2004	551	49.2 (2.1)	49.0-49.4	266	49.4 (2.1)	49.1-49.6	211	49.1 (2.0)	48.8-49.3
2005	574	49.1 (1.9)	49.0-49.3	294	49.4 (1.7)	49.2-49.6	280	48.8 (2.0)	48.6-49.1
2006	490	49.2 (2.2)	49.0-49.4	244	49.5 (2.1)	49.2-49.8	246	48.8 (2.1)	48.6-49.1
2007	441	49.2 (1.9)	49.0-49.3	230	49.3 (1.9)	49.0-49.5	211	49.0 (2.0)	48.7-49.3
2008	526	49.1 (2.2)	48.9-49.3	246	49.4 (2.0)	49.2-49.7	280	48.8 (2.3)	48.5-49.1
2009	590	49.5 (2.0))	49.3-49.6	309	49.6 (1.9)	49.4-49.8	281	49.3 (2.1)	49.0-49.5
2010	646	49.2 (2.2)	49.1-49.4	346	49.5 (2.4)	48.7-49.7	300	49.0 (2.0)	48.7-49.2
2011	756	49.3 (1.9)	49.2-49.5	378	49.5 (1.9)	49.3-49.7	378	49.2 (1.9)	49.0-49.4
Total	10539	49.2 (2.2)	49.2- 49.3	5328	49.4 (2.2)	49.3-49.5	5210	49.1 (2.2)	49.0-49.1

SD, Standard Deviation

Notably, a slight annual decrease in birth height was observed between 1991 and 2011, and this decrease was more marked for girls. This change was not statistically significant in the linear regression model. (Coefficient = −0.006, 95% CI= −0.013 to 0.002, P = 0.129). Subgroup analysis revealed that neonatal height in girls decreased more than boys at birth, although both were not statistically significant (coefficient = −0.003, 95% CI = −0.01 to 0.007, P = 0.556 for boys; Coefficient = −0.009, 95% CI = −0.02 to 0.001, P = 0.088 for girls) (Figure 2).

Furthermore, an analysis by joinpoint regression revealed that birth weight decreased by 9.26 g annually between 1991 and 2000 (P = 0.041) and then increased by 6.75 g every year till 2011 (P = 0.021) (Figure 3). A similar analysis for infant birth height shows that birth height decreased by 0.03 cm between 1991 and 2003 (P = 0.018) and then increased by the same amount annually till 2011 (P = 0.093) (Figure 4). The increase in birth height of infants between 2003–2011 and 1991–2003 was statistically significant (P = 0.009).

Table 3. The relationship between birth weight and other variables in Shahroud, Iran, 1991-2011

Independent variables		Simple linear regression Coefficient	95% Confidence Interval	P.V	Multiple linear regression Coefficient	95% Confidence Interval	P.V
Year of birth		0.4	-1.1, 2.0	0.608	1.1	-1.4 ,3.6	0.366
Gender							
-	Boy	Reference	-	-	-	-	-
-	Girl	-55.9	-83.2 , -28.6	<0.001	-58.0	-30.8 , -85.1	<0.001
Mother's education		0.3	-3.1 , 3.8	0.840	2.1	-1.9 , 6.2	0.290
Father's education		1.2	-2.4 , 4.9	0.489	2.5	-2.8, 7.9	0.343
Mother's Job							
-	Housekeeper	Reference	-	-	-	-	-
-	Employed	-1.2	-32.3 , 29.9	0.937	-13.3	-44.0, 17.2	0.377
Number of prenatal care		0.5	-4.5 , 5.7	0.818	1.1	-4.5, 6.8	0.677
Number of twin		-713.3	-816.7 , -610.0	<0.001	-699.6	-793.1 , -606.1	<0.001
Pregnancy duration							
-	≥37 week	Reference	-	-	-	-	-
-	<37 week	-680.5	-1079.2 , -281.8	0.002	-643.0	-1021.3 , -264.7	0.002
Type of delivery							
-	Normal delivery	Reference	-	-	-	-	-
-	Caesarean	21.2	-3.5 , 46.0	0.09	33.8	8.6 , 59.1	0.011
Maternal age		4.0	1.8 , 6.1	<0.001	0.1	-3.1, 3.4	0.922
Birth order	1	Reference	-	-	-	-	-
	2	55.0	45.4 , 64.6	<0.001	58.0	36.3 , 79.7	<0.001
	3	71.2	50.3 , 92.1	<0.001	94.9	57.0 , 132.8	<0.001
	4	115.6	80.1 , 151.1	<0.001	142.7	90.9 , 194.5	<0.001

Table 4. The relationship between birth height and other variables in Shahroud, Iran,1991-2011

Independent variables		Simple linear regression Coefficient	95% Confidence Interval	P.V	Multiple linear regression Coefficient	95%Confidence Interval	P.V
Year of birth		-0.005	-0.02 , 0.01	0.474	-0.0004	-0.01 , 0.01	0.954
Gender							
-	Boy	Reference	-	-	-	-	-
-	Girl	-0.3	-0.4 , -0.1	<0.001	-0.3	-0.4 , -0.2	<0.001
Mother's education		-0.009	-0.03 , 0.01	0.403	-0.01	-.03 , 0.01	0.382
Father's education		-0.0008	-0.02 , 0.01	0.932	0.02	0.005 , 0.03	0.01
Mother's Job							
-	Housekeeper	Reference	-	-	-	-	-
-	Employed	0.1	-0.1 , 0.4	0.425	0.1	-0.2 , 0.6	0.356
Number of prenatal care		0.01	-0.006 , 0.03	0.176	0.01	-0.002 , 0.03	0.093
Number of twin		-2.5	-2.8 , -2.1	<0.001	-2.2	-2.6 , -1.9	<0.001
Pregnancy duration							
-	≥37 week	Reference					
-	<37 week	-3.1	-4.6 , -1.7	<0.001	-3.1	-4.4 , -1.8	<0.001
Type of delivery							
-	Normal delivery	Reference	-	-	-	-	-
-	Caesarean	-0.1	-0.2 , 0.0002	0.05	-0.08	-0.1 , -0.02	0.118
Maternal age		0.008	-0.001 , 0.01	0.086	0.003	-0.01 , 0.01	.617
Birth order	1	Reference	-	-	-	-	-
	2	0.1	0.03 , 0.2	0.009	0.1	-0.04 , 0. 2	0.153
	3	0.1	-0.006 , 0.2	0.060	0.1	0.01 , 0.3	0.038
	4	0.3	0.06 , 0.5	0.017	0.2	-0.002 , 0.5	0.052

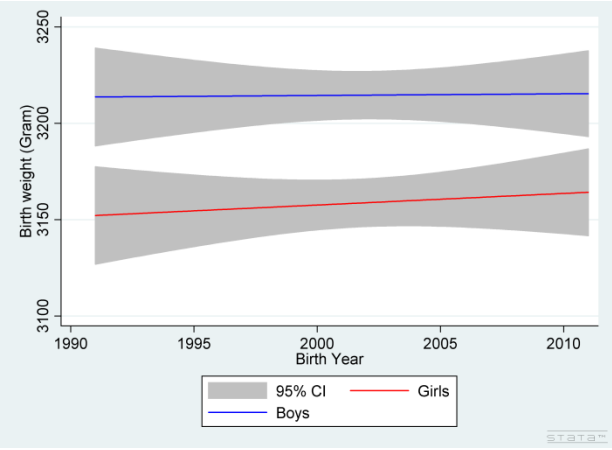

Figure 1: The predicted mean for birth weight according to gender and birth year, Shahroud, Iran

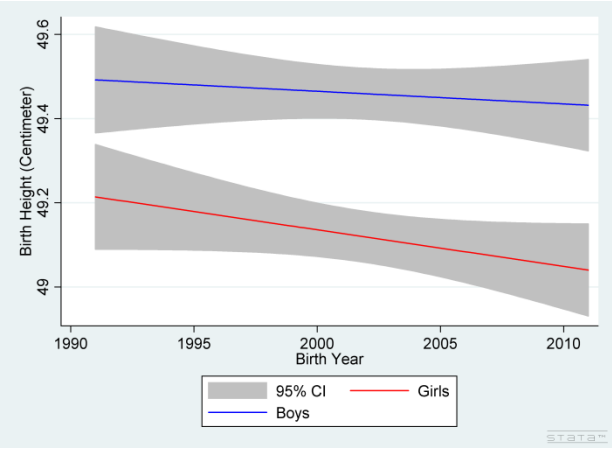

Figure 2: The predicted mean for birth height according to gender and birth year, Shahroud, Iran

As shown in Table 3, the mean weight of girls at birth was 58 g lower than that of boys (P < 0.001). The mean birth weight of premature neonates was 643 g lower than (P = 0.002) that of term neonates. The second, third, fourth, and subsequent children of families were respectively 58, 94.9, and 142.7 g heavier than the first born child (P < 0.001). It was also observed that during each pregnancy pertaining to twins, the average birth weight decreased by 699.6 g (P < 0.001).

As shown in Table 4, the average birth height of girls was 0.3 cm lower than that of boys (P < 0.001). Preterm neonates were 3.1 cm shorter on average than term infants (P < 0.001). The mean height of neonates decreased by 2.2 cm for each pair of twins (P < 0.001).

Discussion

Our findings revealed the mean birth weight and height of Iranian neonates in the 1991–2011 period was 3186.8 g and 49.2 cm, respectively. While investigating the secular trends from 1991 to 2011, we found no significant differences. When compared to the 1991–2000/2003 period, the average weight and height of infants at birth in the 2000/2003–2011 period increased annually by 6.75 g and 0.03 cm, respectively.

The absence of a linear trend over the 21-year study period (1991–2011) may be explained by the decrease in birth weight during the 1991–2000 period with that compared to the 2000–2011 period (Figure 3). In the case of length, the observed decrease in trend within the interval 1991–2003, compensate the increase in birth length till 2011 (Figure 4).

Several studies from different parts of the world reveal that neonatal birth weight continually changes over time. Average birth weight in Montreal, Canada, decreased by 400 g during the 1850–1900 period,[19] whereas in Vietnam, the height and weight at birth increased to 1.3 cm and 190 g, respectively, from early 1980 to 1997/1998.[2,8]

In Denmark, from 1970 to 2000, the infant body size at birth increased; weight and height at birth increased by 5 g and 2.4 mm every year, respectively. Similarly, an increase in birth height and weight was also observed in Sweden, Canada, and Norway.[17,20,21]

A meta-analysis conducted in Iran in 2012 showed that birth height did not change significantly during the 1971–2010 period, but birth weight decreased by 8.1 g.[22] Considering that this meta-analysis included several studies in which birth heights and weights were estimated in different areas over a short time period, the possibility that various factors may influence its results should be taken into consideration.

The weight and height of boys at birth exceeded those of girls by 58 g and 0.3 cm, respectively. Studies in Europe, Iran, Japan, Canada, Africa, Australia, China, and Russia showed that weight, length, head circumference, and chest circumference of boys are generally higher than those of girls.[1,2,7,11,12,18]

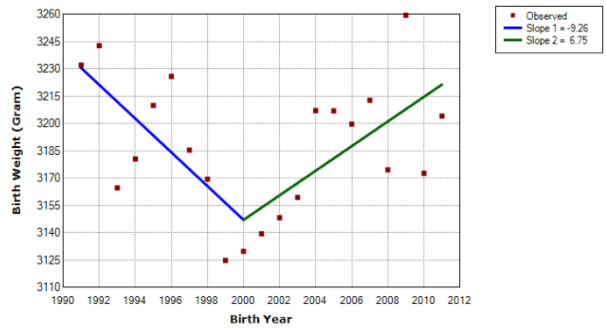

Figure 3: The trend of birth weight in different time intervals, Shahroud, Iran

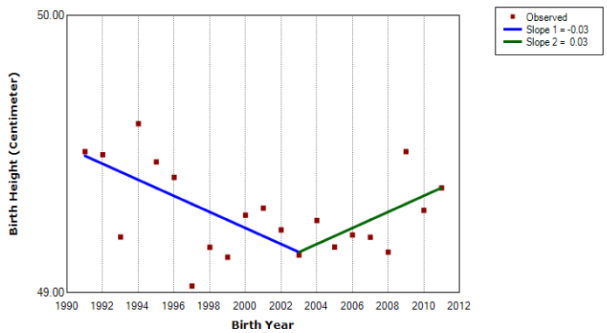

Figure 4: The trend of birth height in different time intervals, Shahroud, Iran

Notably, the parameters of population growth may change positively or negatively over generations. In some populations the secular trend stops, or no trend is observed.[5,7] Therefore, to explore the causes leading to any change, it is essential to collect sufficient data on the environmental, health, and welfare conditions of the communities.

This study has some limitations. First, in the time period covered by this study, nurses and midwives measured birth heights and weights of neonates using different tools, which may have affected the results. Second, some information is missing as it was not recorded in the household health records.

Despite these limitations, our study offers advantages such as a high sample size, high power, and appropriate duration of investigation. In addition, because Shahroud district can be considered as a representative for the Iranian population, the results of this study can be generalized to the whole country; however, further studies may be necessary.

In this study, we did not observe a linear trend for infant birth height and weight between 1991 and 2011. Nevertheless, we observed some changes while comparing the time intervals, indicating improvement in birth weight and height after 2000. To determine the associated factors responsible for the decrease and increase in birth height and weight and to find out obvious reasons and reasonable conclusions, factors such as nutrition, socioeconomic status of the family and society, mother's body mass index, and weight gain during pregnancy should also be considered.

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Conflict of Interest

The authors declare that they have no conflict of interests.

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