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Short communication

Changes in weight, length, head circumference, and ponderal index at birth of healthy term newborns in nine cities in China during the period of rapid social development 1985–2005

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ABSTRACT

The changes in the anthropometric parameters at birth of healthy singleton term newborns in nine cities in China were analyzed by means of the data collected in three large-scale cross-sectional physical growth surveys in 1985, 1995, and 2005 ($n = 6660$, 7109 and 6144). Between 1985 and 2005, average increases in body weight (BW), body length (BL), ponderal index (PI), and head circumference (HC) of newborns were statistically significant: 107 g, 0.2 cm, 0.6 kg/m^3 and 0.4 cm, respectively. The relative increase in BW was more than that in BL (3.4% vs 0.4%) in the last two decades, leading to an increase in PI. The distribution of birth size shifted slightly to the right, and the proportion of macrosomia increased from 3.2% in 1985 to 3.4% in 1995 and to 4.3% in 2005. The increases in BW and PI and the increase in rate of macrosomia are concerns from public health perspectives.

1. Introduction

Anthropometric parameters at birth, including body weight (BW), body length (BL), and head circumference (HC) are widely used as indirect measures of the intrauterine environment and maternal nutrition as well as predictors of newborns' short- and long-term health outcomes (Falkner, 2002; Boulet et al., 2003; Rogers, 2003). Therefore, it has important significance to explore the time trends of birth size in population for perinatal health care. Analyses of this trend worldwide reveal relatively high variability over time.

In some developed countries, BW had been trending upward over the past three or four decades (Bell, 2008; Skjaerven et al., 2000; Odlind et al., 2003; Schack-Nielsen et al., 2006; Tretyak et al., 2005; Ananth and Wen, 2002; Wen et al., 2003; Dober et al., 1993; Lahmann et al., 2009; Oishi et al., 2004), however, more recent data suggested a reversal in this trend in the United States (Donahue et al., 2010), France (Diouf et al., 2011), and Germany (Schiessl et al., 2009). Furthermore, the changes of BL in different populations were different (Hop, 2003; Oishi et al., 2004; Tretyak et al., 2005; Schack-Nielsen et al., 2006; Davidson et al., 2007; Lahmann et al., 2009; Mirmiran et al., 2013). For example, the BL had shown no significant change from the 1970–2000s in Iran (Mirmiran et al., 2013) and a minor increase from 1973 to 2003 in Denmark (0.2 cm) (Schack-Nielsen et al., 2006), while there was a significance increase in BL from 1980 to 2000 in Vietnam (1.3 cm) (Hop, 2003).

Ponderal index (PI) is one of the most commonly used indicators of neonatal body proportionality. Change in PI could provide more information on change in weight-to-length ratio, while there are few population-based studies of such change. An increase in PI during 1973–2003 was

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observed in Denmark (Schack-Nielsen et al., 2006), whereas there was no trend in PI from 2001 to 2005 in Australia (Lahmann et al., 2009).

In China, a significant upward trend in BW was observed in Hong Kong from 1982–1986 to 1998–2000 (Fok et al., 2003). Zong et al. had described the means of BW and BL from 1975 to 2005 in nine cities (Zong et al., 2011). However, a comprehensive analysis of the time trends in birth size simultaneously including BW, BL, PI and HC is limited. In order to understand the significance of the time trends in birth size, and thereby provide more data on human physical-growth trends from different populations, we analyze the changes in BW, BL, HC, and PI among healthy term newborns in nine cities of China from 1985 to 2005 on the basis of three cross-sectional surveys in which identical sampling procedures and measurement standards were applied.

2. Data and methods

2.1. Data source and subjects

China initiated the National Survey on the Physical Growth and Development of Children in the Nine Cities of China (NSPGDC) in 1975 (Zhang, 1977); the subsequent three surveys, using the same study designs in the same nine cities, were undertaken in 1985, 1995, and 2005 (Zong et al., 2011). The nine major cities are located in the northern, southern, eastern, and western regions of China. Two of the nine, Beijing and Shanghai, are municipalities, and the other seven—Harbin, Xi'an, Nanjing, Wuhan, Guangzhou, Fuzhou, and Kunming – are provincial capitals (Zong et al., 2011). The NSPGDC, the earliest nationwide and, at the time, the largest cross-sectional study on the physical growth of healthy infants and preschool children, provided a large quantity of population-based data on changes in physical growth. In this paper, the data of newborns were used to analyze the trends of birth size. Because the raw data collected in 1975 have not been preserved and the pertinent statistics for the period that have been published are inadequate for our purposes, we have limited our analysis of birth-size trends to the years 1985–2005. In the three surveys spanning this period, healthy singleton term live births of Han nationality within 72 h of delivery (gestational age (GA) $\geq$37 complete weeks) without serious illness or congenital malformations were included; pre-term births (GA $<$ 37weeks) or BW $<$ 2500 g, and multiple births were excluded. Stratified cluster sampling was applied according to urban/suburban areas in each city and governmental hospital was considered as cluster unit where the mother of newborns included not only higher but also lower socioeconomic background in each city. The sample sizes were 6660 in 1985, 7109 in 1995, and 6144 in 2005.

2.2. Measurements and ethics statement

BW was measured to the nearest 10 g by means of a newborn scale. BL and HC were measured to the nearest 0.1 cm by means of a baby board and flexible, non-stretchable plastic tape. All of the field sites were equipped with identical measuring tools. All of the measurements were carried out in delivery rooms or neonatal rooms from May to the following October by specially trained technicians or nurses in accordance with standardized methods; measurement errors were not more than 0.05 kg or 0.5 cm among measurement groups and between two repeated measurements in the three surveys (Zhang, 1977; Zong et al., 2011). PI was calculated as BW (kilograms) divided by BL cubed (meters cubed).

The NSPGDC was approved by the Ethics Committee of the Capital Institute of Pediatrics, and informed consent was verbal. Members of each survey's staff explained to the parents of newborns the purpose of the survey and how it would proceed. The participation of parent was voluntary (Zong and Li, 2013).

2.3. Data analysis

The average levels of measurements were expressed by Mean $\pm$ Standard Deviation (SD). The significance of average differences in each decade was calculated by means of the independent-samples t test method, and their 95% Confidence Intervals (CI) from 1985 to 2005 were calculated. The sex difference was analyzed by the independent-samples t test and their 95% CI were also calculated for each of the three surveys. The differences among the northern (Beijing, Harbin, Xi'an), central (Shanghai, Nanjing, Wuhan), and southern (Guangzhou, Fuzhou, Kunming) regions were tested by means of the Analysis of Variance (ANOVA) and the Student–Newman–Keuls method of multiple comparison in each of the three surveys. The proportions of measurements were calculated to illustrate the distribution and their differences among the three surveys were analyzed by χ^2 test. Macrosomia was defined as BW $\geq$ 4000 g. All statistical analyses were carried out by means of SPSS 13.0 for Windows. A value of $P < 0.05$ was considered statistically significant.

3. Results

3.1. Positive changes in birth size during the last two decades

The average BW, BL, PI, and HC of healthy term newborns born in 2005 increased by 107 g, 0.2 cm, 0.6 kg/m^2 and 0.4 cm, respectively, compared with those born in 1985. The relative increases of these measures were 3.4%, 0.4%, 2.2% and 1.2%, respectively. These specific increments of boys and girls were shown in Table 1.

The distribution of anthropometric measurements shifted slightly to the right (Table 2). The proportion of macrosomia was 3.2% in 1985 and increased to 3.4% in 1995 and 4.3% in 2005.

3.2. The sex and region difference and their changes over time

BW, BL, and HC of boys were greater than those of girls and this difference remained unchanged over time (Table 3). Conversely, the PI of girls was larger than that of boys.

The region difference was shown in Fig. 1. BW, BL and HC of northern and central newborns were significantly