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## Original Research

# Growth disparity of motherless children might be attributed to a deficient intake of high-quality nutrients

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## ABSTRACT

We hypothesized that single-parent children (SPC) are retarded in growth compared with both-parent children (BPC), and that motherless children (MC) are affected differently from fatherless children. Moreover, the growth disparity between SPC and BPC might be attributed to a deficient nutrient intake. Data from 2967 children between the ages of 2 and 18 years were extracted from 4 recent waves (2004, 2006, 2009, and 2011) of the China Health and Nutrition Survey to compare the growth status of SPC and BPC and to investigate the association between growth indicators and nutrition status. Anthropometric measures and 24-hour recall of 3 consecutive days of dietary intake were collected. The discrepancy of growth status and nutrition between BPC and SPC was analyzed by multivariable regression models with adjustments for socioeconomic status. Results indicated that MC were significantly lighter in weight than BPC ( $P = .03$ ); the same trend was observed for height ( $P = .08$ ). This might be attributed to the lower intake of animal-source protein ( $P = .02$ ), such as meat ( $P = .04$ ) and fish ( $P = .04$ ). Further analysis showed that intake of animal-source iron and zinc was also significantly lower in MC compared with BPC ( $P = .01$ ,  $P = .03$ ). No difference was detected in fatherless children in comparison with BPC. Our study indicated that the loss of the mother adversely affected children's growth status and that a lower intake of animal-source protein, iron, and zinc might be a reason for the retarded growth status of MC.

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Abbreviations: BMI, body mass index; BPC, both-parent children; CHNS, China Health and Nutrition Survey; FC, fatherless children; GLS, generalized least square regression; LM, Lagrange multiplier; MC, motherless children; SPC, single-parent children.

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## 1. Introduction

Rapid socioeconomic development in the past 3 decades has greatly reshaped various aspects of China's society. The improved economic status shifted the traditional Chinese dietary style toward a Western diet, but although undernutrition was reduced, there was an increase in indicators of overnutrition, such as overweight and obesity [1]. At the same time, attitudes to marriage appear to have changed significantly. For instance, the Ministry of Civil Affairs claimed that 3.5 million pairs divorced in 2013, representing an increase in the crude divorce rate of 12.8% in comparison with the previous year [2]. Moreover, the unmarried birth rate has also increased in recent years. The sixth national population census data (2010) showed that single-parent families accounted for 5.25% and 6.28% in urban and rural areas, respectively, with the number of single-parent children (SPC) exceeding 20 million [3].

Families in which one or both parents are absent are associated with disadvantages in relation to children's health, education, and psychosocial development [4-9]. Published studies have mainly focused on the psychological and mental health of SPC, only a few shed light on the nutritional status of children from one-parent families [10,11]. Malnutrition in early childhood is one major reason for growth failure and it is connected with adverse consequences, such as retarded growth, negatively affected neurologic development, lower education, and failure in the marriage market [12]. However, few studies have compared the nutritional status of children from different family structures and further link dietary intake to stunted physical growth. Moreover, SPC in China were unfortunately overlooked in current studies. In light of the great improvement China achieved in eliminating undernutrition and promoting physical growth in recent decades, it is particularly important to reveal whether SPC benefited equally from this progress compared with both-parent children (BPC). In addition, whether children from families with a single mother might be affected differently from their counterparts from families with a single father should be investigated.

Thus, the aim of our study was to test the following hypotheses: (1) SPC are shorter and lighter than their BPC counterparts; (2) height, weight, and nutritional status are different between motherless children (MC) and fatherless children (FC); and (3) retarded growth might be associated with relatively poor dietary intake. To test these hypotheses, data from 2967 children aged 2 to 18 years were extracted from the China Health and Nutrition Survey (CHNS), which was conducted between 2004 and 2011. The children were divided into 2 major groups: BPC and SPC; furthermore, the SPC group was subdivided into motherless and fatherless groups. Data from anthropometric measures and 24-hour recall of 3 consecutive days of dietary intake were collected. We specifically investigated 2 research objectives: first, to compare the growth indicators and nutritional status of children from various family structures (MC, FC, and BPC), and second, to analyze the relationship between lower weight and dietary intake for SPC. Both mean comparison tests (t tests) and parametric and semiparametric multivariable regression models were adopted in our analysis.

## 2. Methods and materials

### 2.1. Study participants

In this study, SPC were defined as "children under the age of 18 years, where only the maternal mother or paternal father lived in the home." We adopted the CHNS data (from 2004, 2006, 2009, and 2011). This survey was approved by the institutional review board of the University of North Carolina at Chapel Hill and the National Institute for Nutrition and Food Safety, China Center for Disease Control and Prevention. All participants provided written, informed consent. Additional details about the CHNS data are provided elsewhere [13]. Single-parent children were defined by 2 questions that inquired whether the children's father or mother was still a member of the family: (1) "Does your father live in this household" and (2) "Does your mother live in this household?" If children responded to 1 of these 2 questions with "no," they were classified as SPC. Children with no parents (orphans) were not included in our analysis. The data set contained 3015 children who have both parents and 528 children with a single parent.

### 2.2. Study design

We extracted data from 4 survey years (2004, 2006, 2009, and 2011) of the CHNS data set. The sample consisted of data obtained from more than 4000 households in each survey year through the use of a multistage, random-cluster strategy for 9 provinces (Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shandong) and 3 municipalities (Beijing, Chongqing, and Shanghai). Only children between 2 and 18 years of age with complete anthropometric and dietary data for at least 1 wave were included in our analysis ( $n = 3253$ ). In addition, to avoid the distortion due to outliers, we excluded observations with values of energy intake greater than mean + 3 SD. Observations with daily energy intake less than 2146.6 KJ (the minimum energy required for an infant to survive) were also excluded. In addition, one improbable weight value of 521.2 kg was excluded. Thus, in total, 286 children with improbable energy and food intake values were excluded; 2967 children remained in our analysis. Furthermore, because children without fathers might differ from those without mothers, we divided children into 3 groups: both-parents (2510), fatherless (318), and motherless (139).

### 2.3. Assessment of anthropometric data

The weight and height of each child were measured by trained health workers, using regularly calibrated equipment and according to the manufacturer's instructions (SECA880 scales and SECA 206 wall-mounted metal tapes). Body mass index (BMI) was calculated by dividing the weight (in kg) by the square of the height (in  $m^2$ ). Because these indicators were strongly correlated with age and sex, we used the Chinese Children Growth Standards, a growth reference for various ages and sexes proposed by Li et al [14] that is based on a 9-city pilot study to remove the impact of age and sex.

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