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Low Birth Weight and Lung Function in Adulthood: Retrospective Cohort Study in China, 1948–1996

AUTHORS: Lijun Pei, MD, PhD,^a Gong Chen, PhD,^a Jie Mi, MD, PhD,^b Ting Zhang, MD,^b Xinming Song, MD, PhD,^a Jiapeng Chen, PhD,^a Ying Ji, MD, PhD,^c Chengfu Li, MD, PhD,^a and Xiaoying Zheng, MD, PhD^a

^aInstitute of Population Research and ^cPeking University Health Science Center, School of Public Health, Peking University, Beijing, China; and ^bInstitute of Capital Pediatrics, Beijing, China

KEY WORDS

low birth weight, lung function, adult, retrospective cohort study

ABBREVIATIONS

FEV₁—forced expiratory volume in 1 second

FVC—forced vital capacity

PEF—peak expiratory flow

Drs Pei, Chen, and Mi contributed equally to this work.

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Address correspondence to Xiaoying Zheng, MD, PhD, Institute of Population Research, Peking University, Beijing 100871, PR China. E-mail: xzheng@pku.edu.cn

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WHAT'S KNOWN ON THIS SUBJECT: Low birth weight may increase the prevalence of and risk for low lung function in adulthood in the Chinese population. Our study suggested that the development of lung function may be affected by hypogenesis in utero.



WHAT THIS STUDY ADDS: For the high-risk population with low birth weight, close attention should be paid to prevention and treatment of respiratory illnesses in childhood and adulthood, to avoid important public health problems in the future.

abstract

OBJECTIVE: The goal was to determine whether the components of low lung function in adulthood were associated with low birth weight in a Chinese population.

METHODS: A retrospective cohort study was conducted from December 1995 to August 1996. A total of 627 men and women who were born between 1948 and 1954 were recruited; lung function indices were tested and respiratory diseases were examined in the Peking Union Medical College Hospital. Information on variables was recorded, and multivariate analysis of variance was performed to evaluate associations.

RESULTS: Significant associations were observed between birth weight and forced expiratory volume in 1 second (FEV₁), forced vital capacity (FVC), and peak expiratory flow (PEF) in adulthood, after adjustment for maternal age, gestational week, offspring's gender, birth height, history of dyspnea and asthma, lung diseases before 16 years of age, lung diseases after measles and pneumonia before 16 years of age, cough with sputum within 2 years, current asthma, taking medicine for asthma, adult BMI, male alcohol consumption, and male smoking ($P < .001$). Linear trends between birth weight and FEV₁, FVC, and PEF were noted ($P < .001$, 1-way analysis of variance); FEV₁, FVC, and PEF values increased with increasing birth weight. Low birth weight was associated with the FEV₁/FVC predictive value ($P < .05$), but there was no linear trend ($P > .05$).

CONCLUSIONS: Low birth weight may increase the prevalence of and risk for low lung function in adulthood in the Chinese population. The development of lung function may be affected by hypogenesis in utero. *Pediatrics* 2010;125:e899–e905

There is a considerable body of data demonstrating associations between restricted fetal growth and subsequent adult chronic diseases, such as hypertension and type 2 diabetes mellitus.^{1,2} Reduced birth weight is associated with increased risks for the insulin resistance syndrome and heart disease in adult life in the Chinese population.^{3,4} Beginning with ecological studies by Forsdahl⁵ in Norway and later studies by Barker and Osmond⁶ in the United Kingdom, the associations have been confirmed in many historical and cohort studies performed by many different groups of investigators from several countries.^{2,7,8} In view of the long delay between exposure and outcomes in those studies, the reported associations are remarkably robust. A series of retrospective studies suggested that associations exist between low birth weight and fetal growth retardation in early pregnancy^{9,10} and lower respiratory tract infections^{11,12} and lung function in childhood^{13,14} and adulthood.^{11,15–18} The hypothesis of the developmental origins of adult health and disease states that environmental factors, particularly maternal malnutrition, act in early life to program the risks for adverse health outcomes.¹⁹

Epidemiological studies showed that exposure to factors that restrict fetal growth or lead to low birth weight can alter lung development and have later adverse effects on lung function and respiratory health. The major factor was reduced nutrient levels^{17,20–22}; these environmental insults can alter lung structure and thus lung function permanently, increasing the risk of respiratory illness and accelerating the rate of lung aging. Our study was undertaken among people born at a time when the Chinese population was chronically malnourished, between 1948 and 1954. According to detailed obstetric records, the mothers of the

participants in our study were thin and stunted. The study participants lived through a period of nutritional transition.³ Is there an association between reduced birth weight and poor lung function in adulthood in the Chinese population? Our study hypothesized that there would be an association between low birth weight and poor lung function in adulthood and that the increased risk for low lung function in adult life might originate from malnutrition in utero. The purpose of our study was to determine whether the components of low lung function in adulthood in the Chinese population were associated with reduced fetal growth and maternal malnutrition.

METHODS

Study Population

Data were collected from a retrospective cohort study during December 1995 and August 1996.³ A total of 725 men and women who were born in Beijing, China, between July 1948 and December 1954 were recruited for the study. The participants for whom we performed follow-up evaluations were invited to attend a physical examination at the Chao Yang Men Hospital (Beijing, China). Of those 725 persons, 627 (86%) agreed to take part in the study. The study protocol was reviewed and approved by the institutional review board of the Peking Union Medical College, and verbal informed consent was obtained from all participants.

Data Collection

Information on Mothers and Infants

The Peking Union Medical College Hospital kept exceptionally detailed obstetric records that included maternal information and each infant's records at birth. The maternal information included gravidity, parity, duration of gestation (calculated from the date of the last menstrual period), pregnant

outcome (fetal death, stillbirth, or live birth), and maternal age during pregnancy. The offspring's information at birth included gender, birth weight, body length, head circumference, biparietal diameter, and placental weight from the medical history of the subjects. Pregnant women who visited the hospital between 1948 and 1954 could be divided into 2 groups. Women in the first group could pay their medical bills and received prenatal and intrapartum care. Women in the second group were poor and were admitted close to the time of delivery. For some women, height and weight were measured during the first half of their pregnancies (5–20 weeks) and subsequently; for other women, these measurements were obtained only during late pregnancy. Therefore, we could not calculate maternal BMI before pregnancy.

Physical Examinations and Questionnaire Interviews

Adult heights and weights of participants were measured by 1 of 2 observers. We inquired about current occupation, average household income per capita, educational level, smoking, alcohol consumption, attacks of shortness of breath, history of dyspnea, history of asthma, current asthma, taking medicine for asthma, pneumonia, bronchitis, pulmonary tuberculosis, lung diseases after measles before 16 years of age, and cough with sputum within 2 years. On the basis of the interviews, a diagnosis of a history of asthma was made if a child had ever met ≥ 2 of the following 3 criteria: reported dyspnea, chest tightness, or wheezing; a diagnosis of asthma by a doctor; and/or reported use of asthma medication (eg, β -adrenergic receptor agonists, cromolyn sodium, corticosteroids, leukotriene antagonists, or aminophylline). Current asthma was defined as a history of asthma plus ≥ 1 of the following: reported dyspnea, chest

tightness, or wheezing during the previous 12 months and/or reported use of asthma medication (eg, β -adrenergic receptor agonists, cromolyn sodium, corticosteroids, leukotriene antagonists, or aminophylline) during the previous 12 months. Smoking was calculated as the total consumption of cigarette packages per week, and alcohol use was calculated as units of consumption per week (1 unit = 75 g of alcohol) and divided into light (<5 units per week), midrange (5–15 units per week), and heavy (≥ 15 units per week) categories. Female participants also were interviewed regarding smoking and alcohol use, but their smoking and alcohol use were not included in analyses because these exposures were very rare among female participants.

Lung Function Tests

The standard lung function test used to measure airway obstruction is the forced expiratory spirogram. This allows assessment of the rate of change in volume that occurs as a function of time. The lung function tests were performed by using a spirometer (Vitalograph SKD26S-980 Alpha-II; Vitalograph, Beijing, China) with an attached printer. The output provided numerical and graphical data. The graphical data enabled detection of any error in subject technique. The spirometer was calibrated every day before use. All assessments were conducted by 1 examiner. The examiner demonstrated to each subject the technique for performing the forced vital capacity (FVC) test. The subjects were given an opportunity to perform a few practice efforts before the forced expiratory volume in 1 second (FEV₁), FVC, peak expiratory flow (PEF), and FEV₁/FVC ratio were tested. The lung function indices were calculated as percentages of predicted values for FEV₁, FVC, and PEF, by using standard reference values. Before testing, respiratory diseases

TABLE 1 Participants' Measurements at Birth and in Adulthood

Variable	Mean $\pm$ SD	
	Men (N = 309)	Women (N = 318)
Adult measurements		
Age, y (N = 627)	45.1 $\pm$ 1.4	45.2 $\pm$ 1.3
Height, cm (N = 627)	172.5 $\pm$ 6.1	160.5 $\pm$ 5.3
Weight, kg (N = 627)	73.4 $\pm$ 10.5	60.1 $\pm$ 8.5
BMI, kg/m ² (N = 627)	24.7 $\pm$ 3.1	23.3 $\pm$ 3.1
Measurements at birth		
Birth weight, g (N = 627)	3196 $\pm$ 438	3094 $\pm$ 442
Crown-heel length, cm (N = 626)	49.7 $\pm$ 2.0	49.1 $\pm$ 1.9
Ponderal Index, kg/m ³ (N = 626)	26.0 $\pm$ 2.0	26.1 $\pm$ 2.4
Head circumference, cm (N = 623)	32.1 $\pm$ 1.4	31.7 $\pm$ 1.4
Placental weight, g (N = 608)	524 $\pm$ 102	518 $\pm$ 93
Fetal age, wk (N = 611)	39.8 $\pm$ 2.0	40.1 $\pm$ 2.0
Maternal measurements		
Age, y (N = 627)	28.3 $\pm$ 5.0	28.2 $\pm$ 5.4
Height, cm (N = 591)	155.3 $\pm$ 6.0	155.9 $\pm$ 5.9
Weight at 15 GW, kg (N = 232)	50.2 $\pm$ 6.2	50.8 $\pm$ 6.1
Weight at 38 GW, kg (N = 599)	60.1 $\pm$ 6.7	60.2 $\pm$ 6.2
BMI at 15 GW, kg/m ² (N = 226)	20.8 $\pm$ 2.6	21.0 $\pm$ 2.6
BMI at 38 GW, kg/m ² (N = 584)	24.9 $\pm$ 2.5	24.7 $\pm$ 2.3
Average GW (N = 611)	39.9 $\pm$ 2.0	

GW indicates gestational weeks.

were assessed in the Peking Union Medical College Hospital, to exclude contraindications for FVC testing (eg, recent hemoptysis, diaphragmatic angina, myocardial infarction, severe heart function disorder, heart rate of >120 beats per minute, aeropleura, bunamiodyl treatment, hypertension, or history of epilepsy). The subjects were required to remove their shoes and heavier clothes during measurements of adult height and weight, to ensure accuracy.

Statistical Analyses

Descriptive analyses were performed for all subjects. Natural logarithmic transformations of FEV₁, FVC, and PEF values were used to normalize distributions, and results are given as mean values with 95% confidence intervals. Levene's test of equality of error variance was performed before multivariate analyses. Multivariate analyses of variance were conducted to compare mean adult lung function values (FEV₁, FVC, PEF, and FEV₁/FVC predictive value) according to birth weight, after adjustment for confounding factors.

Tests for linear trends between birth weight and FEV₁, FVC, and PEF were performed with 1-way analysis of variance. We classified the participants into 4 groups according to birth weight (ie, <2.5, ≥ 2.5 to 3.0, ≥ 3.0 to 3.5, and ≥ 3.5 kg) and 3 groups according to BMI (<24, ≥ 24 to 28, and ≥ 28 kg/m²). The data were analyzed with SPSS 11.0 (SPSS Inc, Chicago, IL). All *P* values were 2-sided, and a significance level of .05 was used to define statistical significance.

RESULTS

Participants' Measurements at Birth and in Adulthood

The 627 participants ranged in age from 41 to 47 years (mean: 45 years). Anthropometric data and other descriptive data for participants as adults and at birth and maternal measurements during pregnancy are shown in Table 1. Of the 627 subjects, 627 (100%) underwent lung function testing at 41 to 47 years of age. The mean maternal gestation was 39.9 weeks.

TABLE 2 Distribution of Lung Diseases Before 16 Years of Age and Adult Lung Diseases According to Lung Function

Variable	N	FEV ₁ , Mean (95% CI), L	P	FVC, Mean (95% CI), L	P	PEF, Mean (95% CI), mL/s	P
History of dyspnea							
No	601	2.87 (2.83–2.92)		3.54 (3.48–3.61)		438.63 (430.63–446.68)	
Yes	26	2.51 (2.29–2.76)	.001	3.71 (3.36–4.11)	.282	379.75 (338.07–426.58)	.002
History of asthma							
No	603	2.87 (2.83–2.92)		3.55 (3.48–3.61)		438.73 (430.82–446.89)	
Yes	24	2.46 (2.24–2.70)	.0001	3.67 (3.31–4.07)	.447	371.79 (329.08–419.95)	.001
Current asthma							
No	614	2.87 (2.82–2.91)		3.55 (3.48–3.61)		438.03 (430.03–446.07)	
Yes	13	2.29 (1.99–2.63)	.0001	3.72 (3.30–4.19)	.446	350.27 (292.48–419.56)	.001
Medicine for asthma							
No	604	2.87 (2.83–2.92)		3.55 (3.48–3.61)		438.83 (430.92–446.99)	
Yes	23	2.44 (2.22–2.69)	.0001	3.65 (3.28–4.06)	.529	366.52 (323.74–414.86)	.0001
Lung diseases before 16 y of age							
No	458	2.90 (2.85–2.95)		3.58 (3.51–3.65)		443.81 (434.61–453.32)	
Yes	169	2.74 (2.65–2.83)	.001	3.47 (3.36–3.59)	.137	415.34 (400.59–430.53)	.002
Lung diseases after measles before 16 y of age							
No	610	2.86 (2.82–2.91)		3.56 (3.49–3.62)		437.62 (429.64–445.76)	
Yes	17	2.55 (2.32–2.81)	.020	3.32 (3.03–3.64)	.208	380.19 (329.69–438.33)	.014
Pneumonia before 16 y of age							
No	549	2.87 (2.83–2.92)		3.56 (3.49–3.62)		438.73 (430.33–447.20)	
Yes	78	2.72 (2.58–2.86)	.021	3.49 (3.31–3.68)	.455	417.16 (393.46–442.18)	.074
Bronchitis before 16 y of age							
No	539	2.87 (2.82–2.92)		3.55 (3.48–3.61)		438.63 (429.93–447.40)	
Yes	88	2.77 (2.64–2.90)	.110	3.57 (3.39–3.75)	.849	420.24 (401.51–439.85)	.112
Cough with sputum within 2 y							
No	592	2.84 (2.80–2.89)		3.53 (3.47–3.59)		434.11 (425.99–442.28)	
Yes	35	3.06 (2.88–3.24)	.038	3.91 (3.65–4.19)	.007	469.46 (433.01–508.98)	.054
Adult BMI							
<24 kg/m ²	332	2.87 (2.81–2.93)		3.60 (3.51–3.68)		425.50 (414.86–436.31)	
≥24 kg/m ²	228	2.86 (2.79–2.94)		3.55 (3.45–3.65)		448.23 (434.81–462.06)	
≥28 kg/m ²	67	2.75 (2.62–2.89)	.0001	3.32 (3.16–3.50)	.0001	447.61 (423.94–472.72)	.0001
Male alcohol use							
No	177	3.17 (3.09–3.25)		4.03 (3.93–4.13)		511.56 (498.88–524.57)	
Yes	132	3.34 (3.24–3.43)	.007	4.26 (4.14–4.39)	.003	513.57 (497.62–530.03)	.845
Male smoking							
No	446	2.72 (2.67–2.77)		3.35 (3.29–3.42)		410.49 (401.98–419.18)	
Yes	181	3.22 (3.14–3.29)	.0001	4.09 (3.99–4.20)	.0001	505.83 (492.38–519.64)	.0001

Values are geometric means. CI indicates confidence interval.

Distributions of Lung Diseases Before 16 Years of Age and in Adulthood According to Lung Function

FEV₁ and PEF were associated with history of dyspnea and asthma, current asthma, receiving medicine for asthma, lung diseases before 16 years of age, lung diseases after measles before 16 years of age, and smoking ($P < .01$ or $P < .05$). FEV₁ was associated with pneumonia before 16 years of age ($P < .01$), and FEV₁ and FVC were associated with cough with sputum within 2 years, male use of alcohol, and male smoking ($P < .01$ or $P < .05$). FEV₁, FVC, and PEF were statistically associated

with adult BMI. The results presented in Table 2 are from the univariate analyses.

Associations Between Birth Weight and Adult Lung Function

Significant associations were observed between birth weight and FEV₁, FVC, and PEF, after adjustment for confounding factors including maternal age, gestational week, offspring's gender, birth height, history of dyspnea and asthma, lung diseases before 16 years of age, lung diseases after measles and pneumonia before 16 years of age, cough with sputum within 2 years, current asthma, taking medicine for

asthma, adult BMI, male use of alcohol, and male smoking ($P < .01$). The findings also indicated that there were linear trends between birth weight and FEV₁, FVC, and PEF (test for linear trend, $P < .01$); the FEV₁, FVC, and PEF values increased with increasing birth weight. Birth weight also was associated with the FEV₁/FVC predictive value ($P < .05$), but there was no linear trend (test for linear trend, $P > .05$) (Table 3).

DISCUSSION

A higher prevalence rate of intrauterine growth retardation was noted in China, with an average level of 6.39%.²³

TABLE 3 Association Between Birth Weight and Adult Lung Function

Birth Weight	N	Adult Lung Function			FEV ₁ /FVC Predictive Value, Mean (95% CI), %
		FEV ₁ , Mean (95% CI), L	FVC, Mean (95% CI), L	PEF, Mean (95% CI), mL/s	
<2.5 kg	38	2.62 (2.45–2.79)	3.30 (3.08–3.53)	399.48 (371.88–4290.04)	79.60 (77.36–81.85)
≥2.5 kg	190	2.70 (2.63–2.77)	3.31 (3.21–3.41)	418.31 (405.51–431.42)	82.07 (80.98–83.17)
≥3.0 kg	284	2.93 (2.87–3.00)	3.66 (3.57–3.76)	444.32 (432.31–456.67)	80.59 (79.61–81.58)
≥3.5 kg	115	3.00 (2.89–3.11)	3.79 (3.64–3.94)	458.56 (437.93–480.18)	79.56 (78.18–80.95)
Total	627	2.85 (2.81–2.90)	3.55 (3.49–3.61)	436.01 (428.06–444.02)	80.79 (80.17–81.42)
F		12.00	13.95	6.34	3.23
P		.0001	.0001	.0001	.020
Linear trend, F		19.82	18.03	13.06	0.13
Linear trend, P		.0001	.0001	.0001	>.05

CI indicates confidence interval.

To our knowledge, this is the first study to investigate the association between fetal growth and adult lung function with a retrospective cohort study in China. We proposed the hypothesis that there would be positive associations between birth weight and adult lung function in an urban Chinese population 41 to 47 years of age. The findings indicated that neonates with low birth weight had reduced levels of the components of lung function in adult life. They had low FEV₁, FVC, and PEF values after adjustment for confounding factors influencing birth weight and lung function (Table 3). Our current results are in line with other retrospective cohort studies in some countries,^{11,12,15,16} which found that impaired fetal growth and lower respiratory tract infections in early childhood were associated with lower lung function levels in adult life. Follow-up studies in Britain showed that low rates of fetal growth were followed by reduced lung function in adult life.¹⁰ The authors suggested that fetal adaptations to malnutrition in utero resulted in permanent changes in lung structure, which in turn led to chronic airflow obstruction. This is additional evidence supporting the idea that adult lung function is “programmed” in fetal life.²¹ These relationships were investigated in some similar studies. Birth weight was associated continuously and independently with adult respiratory function.

FEV₁, FVC, and PEF values decreased with decreasing birth weight, and there were positive linear trends between birth weight and FEV₁, FVC, and PEF, after adjustment for confounding factors in this study. An 8-study meta-analysis of data for 2257 women in England who were 60 to 79 years of age indicated that there were positive linear associations between birth weight and all 3 measures of lung function.¹⁷ Further adjustment for lifetime socioeconomic status, adult BMI, and smoking did not alter these associations. Therefore, that study also suggested that intrauterine factors might have a role in lung development. The strength of these associations supports the fetal origins hypothesis that impairment of fetal growth has a significant influence on adult lung function.^{19,21} These considerations are critical to an understanding of the biological features and timing of programming, the direction of future research, and future public health interventions.^{24–26} Programming stimuli may be generated endogenously; for instance, they may be environmental.¹⁹ One important type of environmental programming is that induced by early nutrition. Numerous studies have shown that nutrition in infancy or fetal life can produce lifetime effects on metabolism, growth, and neurodevelopment and on major disease processes such as hypertension, diabetes mellitus, atherosclerosis, obesity, and respiratory dis-

eases.^{17,24,26–28} These studies, when applied to prevention and treatment of respiratory illnesses in childhood and adulthood, suggested a major public health concern with great clinical importance.

The cohort spanned 6 years, from 1948 to 1954, and the homogeneity of the cohort might have been affected by the changes resulting from Chinese liberation in 1949. This event inevitably had a major influence on the health system, but the change could not have affected greatly the growth and development of infants or children or even the nutritional status of the Chinese population in 1948 and 1954, because the study participants were living through an initial period of the nutritional transition.³ Some evidence showed the similarity of characteristics of cohorts born in 1948 and 1954; the selected measurements could represent children's growth and development in the period of 1948–1954. The results indicated that there were no significant differences in the height and weight of 7- to 14-year-old children between 1948 and 1954.^{29–33} Therefore, the cohort was homogeneous although it spanned 6 years from 1948 to 1954. Study of the vitamin C metabolism of Chinese primary school students indicated that 68% of students had plasma vitamin C deficiencies, which reflected indirectly the general nutritional status of the Chinese population.³⁴ The av-

erage monthly living expenses per primary school student were only 11.03 yuan (renminbi) in the urban center of Shanghai in 1954,²⁹ which included food, clothes, lodging, school, and amusements. The average expenses could represent the economic status of residents of the city in 1954. The aforementioned evidence suggested that there were malnutritional conditions for the Chinese population in the period of the nutritional transition.

The study sample is the same as in the report by Mi et al.³ The participants were all born in Beijing, China, between 1948 and 1954, when a large proportion of the population was chronically malnourished. The participants born in the Peking Union Medical College Hospital were not representative of the whole population born in the city. However, the short stature and thinness of the mothers in this sample (Table 1) and the small sizes of their infants are in accord with the results of contemporary anthropometric surveys performed in China.^{29–34} In addition, these characteristics are typical for populations in chronically malnourished communities.³ In general, the sizes of newborns at birth basically reflect their nutritional status in utero.²⁸ Reduced developmental index values, such as birth weight, height, head circumference, and Ponderal Index, can indicate indirectly the effective time of malnutrition in utero. The outcome of fetal malnutrition may be developmental retardation or adaptation to the malnutritional environment, in which growth velocity is not reduced but persistent transformation of the metabolic environment occurs. The 2 outcomes may be associated with increased risks for adult diseases, such as heart diseases or respiratory diseases. In this study, we could not provide direct data to support the hypothesis that the increased risk of low lung function in adult life originated from

malnutrition in utero; however, the malnutritional condition of the Chinese population suggests fetal exposure to maternal malnutrition in the period of 1948–1954. This suggests that the development of lung function may be affected by hypogenesis in utero. Low birth weight measurements, representing fetal growth retardation, may contribute to the presence of biological risk factors for low lung function or pulmonary disease in the adult Chinese population. It is plausible that poor growth early in life restricts normal lung growth and development, which could have long-term consequences for lung function later in life.¹⁰

In this study, we failed to collect data on maternal exposure to smoking in early pregnancy; therefore, we were not able to estimate the exposure level for maternal smoking and its effect on lung development in early life. Although accurate data on intrauterine exposure to smoking were not available, we collected information on the long-term smoking exposure of adult male offspring. The results in the univariate analysis indicated that male smoking exposure in adulthood was associated with reduced lung function, which was regarded as a confounding factor to be controlled in the multivariate analyses of variance. Although adult smoking exposure was a confounding factor in this study, this could provide further insight regarding low birth weight and smoking exposure in adulthood. Many studies showed that maternal smoking during early pregnancy and environmental tobacco smoke exposure may be particularly detrimental to the lung function of populations already disadvantaged by poor rates of fetal growth.^{35,36} This study suggested that lung function might deteriorate more rapidly for subjects with low birth weight and long-term adult

smoking exposure. Ultimately, a major goal should be to prevent exposure to hazardous environmental factors not only through early pregnancy but also throughout adulthood, thereby ensuring that each fetus has the best possible environment in which to develop²¹ and avoids further functional alterations in adulthood.

Future research should focus on the interactions of low birth weight with multiple factors, such as maternal nutritional status, maternal metabolism, epigenetic and environmental exposures in early pregnancy, respiratory diseases in childhood, and smoking and alcohol exposure in adulthood. These are important to describe fundamental aspects of reduced lung function, especially when malnutrition-responsive hypogenesis in utero, fetal growth retardation, and low lung function are being considered. Special respiratory health care throughout the life course may be needed for infants with a history of low birth weight. For the high-risk population with low birth weight, close attention should be paid to prevention and treatment of respiratory illnesses in childhood and adulthood, to avoid important public health problems in the future.

CONCLUSIONS

Low birth weight may increase the prevalence of and risk for low lung function in adulthood in the Chinese population. This suggests that the development of lung function may be affected by fetal exposure to maternal malnutrition that leads to hypogenesis in utero.

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