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Review

The national trend of blood lead levels among Chinese children aged 0–18 years old, 1990–2012

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ABSTRACT

We analyzed the epidemiological data during 1990–2012 that investigated the blood lead level (BLL) in the population aged 0–18 years old in China mainland and provided evidence of the benefits of implementing policies to prevent lead pollution based on the dynamic changes of BLL. Data were collected through databases including China Knowledge Resource Integrated Database (CNKI), CBM disc, Wanfang Data, Pubmed and Medline. The inclusion criteria were: 1. Epidemiological study in healthy population not included studies limited to specific patient; 2. Study subject was not the specific lead exposure population; 3. Sample size should be no less than 100 (for neonatal, no less than 50); 4. BLL detection was under strict quality control; and 5. Results should be presented as BLL (arithmetic mean level or geometric mean level). 62 articles were included in this study. All the surveys in these articles contained 189,352 subjects in 19 provinces, autonomous regions and municipalities. Linear regression analysis showed a significant decrease between 1990 and 2012 with an estimated regression coefficient of 3.05/year (SE = 0.01, $p < 0.001$). BLL gradually declined since early 21st century. Median levels of BLL among the three economic zones were 51.4 μg/L in the eastern zone, 52.72 μg/L in the central zone and 46.2 μg/L in the western zone respectively. Median BLLs in male and female population aged 0–18 years old of China were 48.8 μg/L and 46.1 μg/L. Median levels of BLL among the different age ranges were 74.9 μg/L in newborn, 46.4 μg/L in 0 to 3 years old, 57.6 μg/L in 3 to 7 years old and 55.6 μg/L in above 7 years old respectively. In conclusion, the BLL in the Chinese population of 0–18 years old has gradually dropped in the past 10 years. The decline in temporal trend still remains under potential impacts of several factors such as economical level, gender and age difference. Although, China has made significant achievements in the control prevention of lead pollution, concerted efforts are still warranted to reduce children lead poisoning.

Contents

Abbreviations: AAP, American Academy of Pediatrics; AAS, atomic absorption spectrometry; AM, arithmetic mean; BLL, blood lead level; CNKI, China Knowledge Resource Integrated Database; CBM disc, Chinese Biomedical Literature Database; CDC, Center of Disease Control and Prevention; GM, geometric mean; ICP-MS, inductively coupled plasma mass spectrometry; NHANES, National Health and Nutrition Examination Survey; AHRQ, Agency for Healthcare Research and Quality.

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1. Introduction

Childhood lead poisoning has emerged as a global concern. In 1991 the US Center for Disease Control and Prevention (CDC) suggested that children under 72 months of age, should be screened for lead, unless sufficient evidence was available to prove the absence of lead exposure (Roper et al., 1991). In 1993 American Academy of Pediatrics (AAP), suggested that lead screening should be mandatory as a routine health examination for children aged 9–72 months, repeated tests should be performed at 24 months if necessary (AAP, 1993). In 1997 the US CDC proposed that all children with high risk of lead exposure should have a blood lead level test (CDC, 1997).

The Chinese government began to pay attention to childhood lead poisoning in the 1990s (Shen et al., 1996). Chinese researchers conducted a couple of epidemiological studies to investigate childhood lead poisoning. In 1999, China's State Council issued an act to implement the unleaded gasoline policy from 2000 (Yang, 2000). Meanwhile, childhood lead poisoning outpatient services were established, which contained examinations of BLL and nutritional interventions. In February 2006, the Ministry of Health issued the guidelines for the prevention of childhood lead poisoning as well as principles for grading and treatment of childhood lead poisoning (Ministry of Health, 2006).

Local epidemiological studies have been performed in most areas of China since 2000. However, national data on BLL and percent of elevated BLL of children in China are still unknown.

In the early 1990s, the Chinese government gradually phased out automobile lead gasoline and took several measurements for preventing environmental pollution. For evaluating effect of these efforts, this study investigated the temporal trend of blood lead levels in the 0–18 year old Chinese population during 1990–2012 by the data published.

2. Materials and methods

2.1. Literature search strategy

We searched epidemiologic studies on BLL in China mainland between January 1990 and October 2012 in electronic databases: CNKI, CBM disc, Wanfang Data, Pubmed and Medline. The searching strategy was “blood lead level” OR “lead poisoning” in Chinese and in English. Limitations of the searching conditions included: epidemiologic studies, age (0–18 years old), China, January 1990 to October 2012.

Two authors screened the title and abstract and then reviewed the full-text of eligible publications.

2.2. Literature quality assessment

We used a standard containing 11 items for evaluating literature quality, which was recommended by the Agency for Healthcare Research and Quality (AHRQ) (Kane et al., 2007). The principal is described in Table 1.

Two authors evaluated the score of each eligible article independently. The discrepancy between two authors was solved through discussion.

2.3. Inclusion criteria

1. Epidemiological study in healthy population not included studies limited to specific patient; 2. Study subject was not the specific lead exposure population; 3. Sample size should be no less than 100 (for neonatal, no less than 50); 4. BLL detection was under strict quality control; 5. Results should be presented as BLL (arithmetic mean level or geometric mean level).

2.4. Data extraction

Standard data form was designed to input relevant information and data extracted from included literatures. Two authors entered the data independently and cross-checked it. We recorded the following details: authors, title, study year, study site, sample type, testing method, sample size, age range, gender, and blood lead level by unit of μg/L.

2.5. Data analytic method

2.5.1. Unit conversion of BLL

Uniform unit in this study was μg/L. Other units should be converted to μg/L, e.g. 1 μmol/L = 207.04 μg/L, 1 μg/dL = 10 μg/L.

2.5.2. Calculation of geometric mean of BLL

Many studies reported an arithmetic mean of BLL. As we all know, BLL distributes log-normally and geometric mean should be a better indicator to present BLL distribution than arithmetic mean. The relationship between arithmetic mean (AM) and geometric mean (GM) is exact: $1 + GM = (1 + AM) \times [1 + SD\,(1 + AM)^{-2}]^{-1/2}$ (de La Grandville et al., 2002). SD means standard deviation of BLL and is estimated by a formula when unavailable from articles. The estimating formula is SD = range / 4 (range means the gap between maximum and minimum) (Hozo, et al. 2005).

2.5.3. Statistical analysis

Geometric mean of BLL was analyzed with linear regression weighted by sample size of individual publications. Analysis of covariance with fixed factors such as economic zone, gender and age range was used to

Table 1
Assessment of observing study quality based on the standard recommended by AHRQ.

Assessing principal[a]
Study question clearly focused
multi-site study
Sampling of study population (random, convenient, self-selected)
Clear definition of including or excluding criteria
Clear definition of research time
Clear description of data distribution
Assessment of confounding effects of various factors (for example, age of the patients, patient sex)
Appropriate measure of precision
Clear description of response rate
Clear description of dealing with missing data
Conclusions supported by results with possible bias and limitations taken into consideration

[a] Scoring method: yes = 1; no or not mentioned = 0.