Are Current ‘Acceptable’ Blood Lead Levels Safe for Female Workers of Reproductive Age?

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Although occupational exposure to lead has declined dramatically since the establishment of better occupational hygiene and the improvement of standards, chronic exposure at a low level has remained a public health problem in many societies. Because many adverse pregnancy outcomes have been reported at ‘acceptable’ blood lead levels (≤ 5 μg/dl), occupational health policymakers should improve the industrial standard of lead exposure for female workers of reproductive age. To achieve this goal, there is a need to carry out more studies on pregnant female workers in lead–related industries to find a safe level for them. In addition, blood lead screening programs for female workers should be considered on regular bases during reproductive age.

Key words: lead, pregnancy, female worker

Introduction

Lead has been widely used in many industries and hundreds of products, such as paints, pipes, cables, ceramics, stained glass, and batteries. However, this very useful metal is a well-known poison for human. The most deleterious toxic effects of lead is mediated by hemopoietic, reproduction, blood pressure, and central/peripheral nervous system, with various range of symptoms from subclinical to symptomatic poisoning, clinically obvious toxicity, and acute poisoning1) 2). Despite awareness of these adverse health effects, lead exposure have been continued, at low to moderate levels, in many societies. On the other word, although acute lead poisoning has become rare, chronically exposure to low-level have remained a public health issue due to people of all ages encounter lead in their workplaces and environment (i.e., air, dust, soil, and drinking water).

Occupational exposure declined dramatically by the establishment of better occupational health and improve the exposure limits. The environmental exposure have been also decreased by the introduction of legislation to remove lead from petrol, and paint in the past decades, with a substantial variation among different countries. For instance, a Japanese study showed that blood lead concentrations in women reduced from 3.17 μg/dl in 1977–1981 to 2.02 μg/dl in 1991–19973) and a more recent report on women showed declined further to 1.9 μg/dl, from both urban and rural areas in Japan4). However, researchers have reported that low–level of lead exposure can induce many adverse effects on human health, especially at levels that may induce subclinical disorders. The present paper outlines prenatal lead exposure effects on pregnancy (i.e., effects on pregnancy outcomes and early children mental development) as a sensitive and at high risk population, at relatively low–level of blood lead to answer this question: Is current ‘acceptable’ blood lead level ‘safe’ for female workers of reproductive age?
Low-level lead and pregnancy outcomes

Reproductive toxicity of high-level lead exposure have known for several decades\(^5\). On the other hand, some adverse pregnancy outcomes have been reported at blood lead levels lower than supposedly be ‘safe’ (\(<=5 \mu\text{g/dl}\)), which adopted by the US Centers for Disease Control and Prevention indicates a screening action guideline in pregnant women and children few years ago\(^6\). Similarly, our recent studies have revealed several pregnancy complications induced by lower than the ‘acceptable’ blood lead level, such as preterm birth\(^7\), preterm rupture of the membrane\(^8\), pregnancy hypertension\(^9\), and low birth weight\(^10\). In addition, not only pregnant women but also people of general population can be effected by blood lead at relatively very low-level (\(~2 \mu\text{g/dl}\)), such as myocardial infarction and stroke mortality\(^11\).

During pregnancy, in addition to occupational exposure, stored lead in bone from previous exposure can be released to blood stream and becomes a potential endogenous source to raise gestational blood lead concentrations. Furthermore, because clearance of lead from the body is less efficient during prenatal life, this can cause much more increase in blood lead\(^12\). Such increased maternal blood lead can freely cross the placenta and accumulate in the fetus body. As a result, long-term fetal exposed to lead via the mother causes accumulation in fetal tissues and may lead to toxicities, because of high sensitive nature of the fetus to toxic substances. Thus, not only current occupational exposure to lead is important, but also previous exposure can be a critical health problem for young female workers and their fetuses.

Prenatal lead exposure and mental development

The fetal brain is in a state of rapid growth and impairment of later cognitive function can be induced by relatively minor prenatal exposed to lead. Therefore, what prenatal blood lead levels should be considered as ‘safe’ for fetal mental development has been a topic of concern. Our recent study\(^13\) showed relatively low-level gestational lead exposure can increase the risk of early childhood mental development delay. Similarly, in the recent years, many studies have revealed that low-level lead exposure during prenatal life can induce adverse effect on mental/behavioral development, such as deterioration in recognition, concentration, and learning\(^14\)\(^15\).

The Figure-1 summarized prenatal lead expo-

![Figure-1](image-url)
sured effects on pregnancy outcomes and early childhood mental development using schematic format. The pathophysiology and molecular mechanisms involving in lead toxicant on pregnancy outcomes, such as preterm labor, preterm rupture of the membrane, pregnancy hypertension, and subsequence delay in early childhood mental development have yet to be clearly understood. However, we included some of high probably molecular pathways, which lead can induce adverse pregnancy outcomes in the Figure-1.

Conclusion

Although the acceptable level of blood lead for pregnant women have been decreased to lower concentrations (<5 μg/dL) recently, findings of our longitudinal study and many other studies have supported a need for a reappraisal to a new lower blood lead level, i.e., no more than 1–2 μg/dl. On the other hand, since no lead concentration has been proven safe during gestation, the gold standard can be at near to zero concentration of blood lead for pregnant women. Unfortunately, many of Japanese female workers continuously exposed to lead in workplaces and significant number of them have blood lead higher than this standard level. Thus, health effects of low-level lead exposure on female workers must be concerned and addressed appropriately by health policy makers and argues for an improvement of occupational exposure standards for female workers at reproductive age and pregnant workers.

In short, we should consider many factors to improve protection of pregnant women and their fetuses against lead toxicities. First, more studies are needed on female workers in lead-related industries to have much more evidences about lead toxicity at low-level exposure and perhaps, to find a safe blood lead threshold for pregnancy. Second, to achieve any new lower exposure goals, in additional to revise occupational exposure standard, other relevant environmental (air, dust, soil and water) standards must also be revised downwards. Third, health surveillance including the assessment of blood lead levels (lead exposure screening programs) in female workers of reproductive age in lead-related industries should always be recommended previous to get pregnant or, no later than the first trimester of pregnancy.

References