For discussion
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LegCo Panel on Food Safety and Environmental Hygiene

Study of Dietary Exposure to Lead of Secondary School Students

PURPOSE

This paper presents the findings of the study conducted by the Food and Environmental Hygiene Department (FEHD) on dietary exposure of secondary school students to lead.

BACKGROUND

2. The FEHD conducted a study on "Dietary Exposure to Heavy Metals of Secondary School Students" in 2002 to identify the major dietary sources of selected contaminants, namely arsenic, cadmium and mercury, and a follow-up study on "Dietary Exposure to Mercury of Secondary School Students" in 2004. Members were briefed in 2002 and 2004 respectively the findings that both average secondary school students and high consumer students in Hong Kong were unlikely to experience major toxicological effects of the heavy metals studied.

3. Food is regarded as the main source of exposure to lead for the general population. In view of the adverse effect of lead to public health and lack of local exposure data, a study was conducted to assess the risk of lead from food which our population might be exposed to.

Lead

4. Lead is a naturally occurring toxic heavy metal with no known beneficial physiological functions. It is ubiquitous in the environment as a pollutant and may enter the environment at any point during industrial processes including mining, smelting, recycling or disposal. While lead may

cause damages to kidneys, the cardiovascular, immune, haematopoietic, central nervous and reproductive systems, the most concerned effect is its adverse effects on cognitive and intellectual development in children. The International Agency for Research on Cancer (IARC) of the World Health Organization (WHO) has evaluated the carcinogenicity of lead and considered that there was inadequate evidence for carcinogenicity to humans. As for carcinogenicity to experimental animals, IARC considered that there was inadequate evidence for organic lead compounds but sufficient evidence for inorganic lead compounds.

5. The main sources of exposure to lead for human are food and water. Lead in soil is transferred to food crops growing on soil. Lead present in air may also deposit on leafy vegetables. Therefore, cereals and vegetables may contain higher level of lead. Aquatic food animals may also accumulate lead from contaminated waters and sediments. Shellfish was reported to contain a higher level of lead than fish since the chemical tends to bioconcentrate more in shellfish than in fish. For meat and meat products, since lead accumulates more in the offal, higher level of lead would be present in offal than in the meat tissues. Lead can also be present in food as a result of environmental pollution or unintentional contamination during food processing, handling and packaging. Airborne lead may contribute significantly to exposure, depending on various factors such as tobacco smoking, occupation and proximity to sources, which may vary considerably.

INTERNATIONAL REFERENCE ON SAFE INTAKE LEVEL

6. The Joint Food and Agriculture Organization / World Health Organization Expert Committee on Food Additives (JECFA) has established a provisional tolerable weekly intake (PTWI)[1] of 25μg/kg body weight per week for lead.

SCOPE AND METHODOLOGY OF STUDY

[1] PTWI is an estimate of the amount of a contaminant that can be ingested over a lifetime without appreciable risk. Its value represents permissible human weekly exposure to a contaminant unavoidably with the consumption of food. An intake above the PTWI does not automatically mean that health is at risk. Transient excursion above the PTWI would have no health consequences provided that the average intake over long period is not exceeded as the emphasis of PTWI is a lifetime exposure.

7. To estimate the dietary exposure to lead, this study covered six major food groups, namely cereals and cereal products; vegetables; fruits; meat, poultry, egg and their products; seafood; and milk and dairy products. The selection was based on the occurrence of lead in these food groups and the food consumption data extracted from the Food Consumption Survey conducted in local secondary school students in 2000 by FEHD. A total of 345 food samples were taken for analysis by the Food Research Laboratory of FEHD.

8. As leafy vegetable was reported to be more likely to be contaminated with lead than other types of vegetables, and the lead present in air may also adhere to leafy vegetables, the study has explored measures which can be taken at the consumer level to reduce the level of lead.

DIETARY EXPOSURES TO LEAD

9. The dietary exposure to lead for an average secondary school student was estimated to be 1.98 μg/kg bw/week while that for the high consumer was 5.09 μg/kg bw/week. These exposures amount to 8% and 20% of the PTWI respectively and were both well below the PTWI established by JECFA.

10. The main dietary source of lead identified in the study was "vegetables" which contributed to about 58% of the total dietary exposure. This was followed by the food groups "meat, poultry, egg and their products" and "seafood" which contributed 21% and 15% of the total exposure respectively. "Fruits" and "cereal and cereal products" accounted for 4% and 2% of total exposure respectively while milk and dairy products only accounted for less than 1 % of total dietary exposure.

11. Further analysis on the food group "meat, poultry, egg and their products" indicated that lime preserved eggs were found to have the highest level of lead which alone accounts for 79% of the contribution by this food group or 17% of total dietary exposure. Traditionally, lead compounds have been used for processing lime preserved egg, and therefore resulting in a high lead level in these products. However, alternate methods which use copper or zinc compounds to replace the lead compounds are available and lime preserved eggs produced by these newer methods would contain lower level of

lead. Excluding lime preserved egg, dietary exposure to lead from other foods in the group was only 0.09 μg/kg bw/week, or 5% of total dietary exposure.

12. Oysters were found to have the second highest level of lead in our study, after lime preserved eggs. Exposure to lead from oysters accounts for 8% of total dietary exposure, or half of the contribution by the food group of seafood.

Reduction of lead level in leafy vegetables

13. We have also conducted a study to examine the effects of soaking, boiling and cooking leafy vegetables on the lead level. Our findings showed that a significant portion (more than half) of lead could be removed from the leafy vegetables by soaking and washing in water. Cooking in boiling water alone is not as effective in reducing the level of lead as compared with soaking and washing, since the process of soaking and washing in water could remove the surface contamination of leafy vegetables.

LIMITATIONS OF THE STUDY

14. The dietary consumption pattern was obtained through a food frequency questionnaire. Although the food frequency questionnaire was very comprehensive, it was not possible to cover every single food item, some of which might be relevant to lead exposure. Furthermore, only the data of consumption pattern for secondary school students was available. To produce more accurate estimates, FEHD has commenced a population-based food consumption survey so that more comprehensive exposure studies can be conducted in the future.

15. Lead exposures from individual sources may vary greatly, depending on the life-style of the people and socioeconomic status. This study mainly focused on lead exposure from food while sources like cigarette smoking, water and air were briefly touched upon. For smokers who smoke 20 cigarettes daily, an additional exposure of lead from cigarette smoking was estimated to be 0.28 μg/kg bw/week, and this accounts to an extra of about 15% of our current dietary exposure. Exposures from air and water together are estimated to be less than 30% of total exposure in our local situation. However, other

sources of exposures, such as those from dust and soil, were not covered in the present study.

CONCLUSIONS AND RECOMMENDATIONS

16. The dietary exposures to lead were 1.98 and 5.09 µg/kg bw/week for average secondary school students and high consumers respectively which are all well below the PTWI established by JECFA. It can be concluded that both the average and high consumers among secondary school students are unlikely to experience major toxicological effects of lead from food.

17. Food is recognised as the major source of lead exposure. Because of the ubiquitous nature of lead in the modern industrial world, low levels of lead in foods may be unavoidable[2]. The food trade is nevertheless advised to observe good agricultural and manufacturing practices to minimise lead contamination of foods, such as avoid using lead compounds as pesticides or for food production.

18. The food group "vegetables" was identified as the main dietary source of lead and leafy vegetables is particularly important. The public is advised to soak and wash vegetables thoroughly to remove dust and soil and to reduce the level of lead. Before preparing food, washing hands would also help remove any lead-contaminated dust or soil from hands. Lime preserved eggs and oysters were found to contain high concentration of lead and they may be significant dietary sources of lead if they are consumed in large amount. Last but not least, a balanced diet is essential to avoid excessive exposure to contaminants including lead from a small range of food items.

PUBLICITY

19. FEHD will publicise the findings of the study through various channels to advise the public of the risk factors concerned and the ways to reduce the possible risk through dietary intake. The reports of the study will be uploaded onto the FEHD Website (http://www.fehd.gov.hk), sent to relevant academic

[2] Under the Food Adulteration (Metallic Contamination) Regulations, the maximum concentration of lead cannot exceed 6 parts per million (ppm) in solid food and 1 ppm in liquid food.

departments of universities and will be available at major libraries and FEHD Communication Resource Unit and Health Education Exhibition and Resource Centre.

Health, Welfare and Food Bureau
Food and Environmental Hygiene Department
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