

Dietary Intake of Manganese in the Japanese Diet and its Association with Cardiometabolic and Cardiovascular Diseases

Naoko Miyagawa

Department of Preventive Medicine and Public Health, Keio University School of Medicine, Tokyo, Japan

See article vol. 29: 1432-1447

Manganese is an essential nutrient found in many plant foods, such as green tea beverages, unrefined cereals, legumes, and vegetables and is involved in various metabolic processes, such as bone formation, amino acid, cholesterol, and carbohydrate metabolism¹⁾. Therefore, a manganese deficiency has been reported to cause impaired growth, interfere with normal skeletal development, and alter lipid metabolism in various animal species¹⁾. Since there were insufficient data to set an Estimated Average Requirement in the Dietary Reference Intakes in North America¹⁾ and the Dietary Reference Intakes for Japanese (2020)²⁾, the Adequate Intake (AI) (adult men and women: 2.3 and 1.8 mg/day in North America¹⁾ and 4.0 and 3.5 mg/day in Japan²⁾, respectively) was set by estimating from the daily intake of people with normal dietary habits. The AI for Japanese people is slightly higher than that for North Americans because the Japanese diet contains more manganese source foods than the North American diet. As for manganese toxicity in humans, occupational exposure to inhaled manganese dust is known to the central nervous pathology. In the Dietary Reference Intakes in North America¹⁾, the Tolerable Upper Limit (UL) 11 mg/day was the amount of intake with no health effects set, based on the dietary intake of Western and vegetarian diets. The UL 11 mg/day was set in the Dietary Reference Intakes for the Japanese (2020)²⁾ as well. Although Manganese is an essential nutrient, it is not assessed in the National Health and Nutrition Examination Survey Japan. Hence, the status of manganese intake in the Japanese population is left to individual research reports.

The manganese intake of 31 adult Japanese men living in 31 prefectures in 1981–82 was 3.4 mg/day,

as measured by inductively coupled plasma atomic emission spectroscopy from dry ash obtained by the duplicate portion method³⁾. In other reports using duplicate portion methods from the early 1960s to the late 1980s, the range of intake for Japanese adults was 2.7–7.5 mg/day⁴⁾. Rice and other cereals accounted for more than 50% of the food intake sources of manganese, followed by legumes, which contributed about 14%⁴⁾. However, these studies had lesser subjects, even if the reports were based on samples drawn from all over Japan. Although the duplicate portion method is useful to accurately assess the amount of dietary and nutrient intake, it is difficult to implement in large epidemiological cohorts. Yamada *et al.*⁵⁾ calculated the dietary intake of manganese in 120 women and 110 men aged 30–69 years using the semiquantitative dietary record method for 4 days of each season from November 2002 to September 2003, using the Standard Tables of Food Composition in Japan. The mean intake of manganese in men and women was 5.1 and 4.9 mg/day. The dietary sources that contributed to manganese intake were refined rice, green tea beverages, and vegetables (32%, 28%, and 13% in men; 24%, 34%, and 14% in women; respectively). The average intake of manganese up to 1990⁴⁾ in the reports and Yamada *et al.*⁵⁾ cannot be compared because of the different assessment methods. Reports up to 1990⁴⁾ and Yamada *et al.*⁵⁾ were in concordance that the principal dietary source of manganese was cereals.

Although there is still a paucity of research reports on the association between manganese and cardiovascular and cardiometabolic diseases, inverse associations with type 2 diabetes^{6, 7)} and metabolic syndrome risk⁸⁾ have recently begun to be reported. Meishuo *et al.*⁹⁾ estimated the manganese intake from the food frequency questionnaire (FFQ) and examined its association with cardiovascular disease mortality using the JACC study cohort data. Resultantly, they

Address for correspondence: Naoko Miyagawa, Department of Preventive Medicine and Public Health, Keio University School of Medicine, 35 Shinanomachi, Shinjuku-ku, Tokyo 160-8582 Japan E-mail address: nmiya@keio.jp

Received: February 1, 2022 Accepted for publication: February 2, 2022

Copyright©2022 Japan Atherosclerosis Society

This article is distributed under the terms of the latest version of CC BY-NC-SA defined by the Creative Commons Attribution License.

reported that higher manganese intake was associated with a significantly lower risk of cardiovascular disease. This is the first report in Japan that has challenged the study of the association between manganese intake and cardiovascular disease mortality. In this study, the estimated manganese intake from FFQ was 5.3 mg/day, and the mean intake from the dietary record method for validation was 4.8 mg/day. Although it cannot be simply compared with previous reports because of the different estimation methods, the mean values suggest that the estimation of manganese intake from FFQ is relatively successful in this study. On the contrary, according to previous reports^{4, 5)}, the principal dietary source of manganese was cereals. However, in this study, it was green tea beverages, rice, and oolong tea beverages (84%, 7%, and 4%, respectively). Plant-based foods, a major dietary source of manganese, have already been reported to be inversely associated with cardiovascular disease¹⁰⁾. Therefore, it remains possible that the results of this study are a proxy for plant-food intake rather than manganese intake. However, Meishuo *et al.*⁹⁾ stratified by the amount of green tea beverage, which was the principal source of manganese in this cohort, and found inverse associations between manganese and cardiovascular disease mortality in both groups, indicating that at least manganese intake is associated with cardiovascular mortality independently of green tea beverage intake.

Thus, the amount and source of manganese intake vary according to dietary habits and are expected to change due to increased consumption of refined foods. Further findings are needed on the association between manganese intake and cardiometabolic and cardiovascular diseases.

Funding

None.

Conflict of Interest

None.

References

- 1) Medicine Io: Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc, The National Academies Press, Washington, DC, 2001
- 2) Ministry of Health, Labour and Welfare of Japan. Dietary Reference Intakes for Japanese (2020). <https://www.mhlw.go.jp/content/10904750/000586553.pdf> (in Japanese).
- 3) Shiraishi K, Yoshimizu K, Tanaka G and Kawamura H: Daily intake of 11 elements in relation to reference Japanese man. *Health Phys*, 1989; 57: 551-557
- 4) Shiraishi K: Intake of trace minerals. *Rinsho Eiyu*, 1994; 84: 381-389. (in Japanese)
- 5) Yamada M, Asakura K, Sasaki S, Hirota N, Notsu A, Todoriki H, Miura A, Fukui M and Date C: Estimation of intakes of copper, zinc, and manganese in Japanese adults using 16-day semi-weighed diet records. *Asia Pac J Clin Nutr*, 2014; 23: 465-472
- 6) Du S, Wu X, Han T, Duan W, Liu L, Qi J, Niu Y, Na L and Sun C: Dietary manganese and type 2 diabetes mellitus: two prospective cohort studies in China. *Diabetologia*, 2018; 61: 1985-1995
- 7) Eshak ES, Muraki I, Imano H, Yamagishi K, Tamakoshi A and Iso H: Manganese intake from foods and beverages is associated with a reduced risk of type 2 diabetes. *Maturitas*, 2021; 143: 127-131
- 8) Choi MK and Bae YJ: Relationship between dietary magnesium, manganese, and copper and metabolic syndrome risk in Korean adults: the Korea National Health and Nutrition Examination Survey (2007-2008). *Biol Trace Elem Res*, 2013; 156: 56-66
- 9) Meishuo O, Eshak ES, Muraki I, Cui R, Shirai K, Iso H and Tamakoshi A: The association between dietary manganese intake and mortality from cardiovascular disease among Japanese population: the Japan Collaborative Cohort Study (JACC) Study. *J Atheroscler Thromb*, 2022; 29: 1432-1447
- 10) Quek J, Lim G, Lim WH, Ng CH, So WZ, Toh J, Pan XH, Chin YH, Muthiah MD, Chan SP, Foo RSY, Yip J, Neelakantan N, Chong MFF, Loh PH and Chew NWS: The Association of Plant-Based Diet With Cardiovascular Disease and Mortality: A Meta-Analysis and Systematic Review of Prospect Cohort Studies. *Front Cardiovasc Med*, 2021; 8: 756810