



## Association between Serum Free Thyroxine and Anemia in Euthyroid Adults: A Nationwide Study (*Endocrinol Metab* 2020;35:106-14, Mijin Kim et al.)

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We thank Dr. Ma for the careful review and insightful comments regarding our recent publication, titled “Association between serum free thyroxine and anemia in euthyroid adults: a nationwide study” [1]. Although several studies have explored the association between thyroid dysfunction and anemia, data on the association between thyroid function and anemia in the euthyroid range are scarce. In this study, we evaluated the associations of serum free thyroxine (fT<sub>4</sub>) and thyrotropin (TSH) with anemia in euthyroid adults. Data collected from a nationally representative cross-sectional survey suggested that a low-normal serum fT<sub>4</sub> level was associated with a lower serum hemoglobin concentration and a higher risk of anemia in euthyroid adults, especially in younger adults.

With the increased use of data not originally recorded for research, measurement error is a key challenge to making valid interferences in medical research. We agree with Dr. Ma’s comment that repeated measurements can help avoid underestimating the observed relationship between the studied exposure results. However, the possibility of underestimation is presumed to be low because all biochemical parameters measured by the Korea National Health and Nutrition Examination Survey (KNHANES) met the standards of the quality control and assurance program of the College of American Pathologists [2].

As Dr. Ma pointed out, there were differences in the reference

ranges of TSH and fT<sub>4</sub> levels according to age and sex [3]. However, the regional differences associated with iodine intake contributed significantly more to differences in the reference intervals of TSH and fT<sub>4</sub> than age and sex [3]. The reference interval of serum TSH was 0.45 to 4.12 mIU/L in the United States and the corresponding value was 0.62 to 6.86 mIU/L in Korea [2]. In addition, there is evidence that age-related differences in iodine intake affect serum TSH levels [3]. In this regard, we defined a euthyroid state as serum TSH and fT<sub>4</sub> levels within the reference range of the Korean population from the KNHANES VI data, and adjusted for age, sex, and iodine intake.

In accordance with Dr. Ma’s comment, determination of the etiology of anemia and an appropriate choice of treatment are important. Iron deficiency anemia, hemolytic anemia, and anemia of chronic disease seem to be associated with thyroid dysfunction [4]. As described in the Discussion section, we did not additionally measure ferritin and transferrin to distinguish between iron deficiency and anemia of chronic disease due to the retrospective design. Further studies are required to determine the association between thyroid dysfunction and the cause of anemia.

Dr. Ma’s valuable comments enable a more thorough understanding of our article. We deeply appreciate Dr. Ma’s comments, which have enriched our study.

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## CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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