Letter to the Editor

Using an Alternative Method to Estimate the Status of Iodine Nutrition in Pregnant Women*

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Iodine is an element that is essential for the synthesis of thyroid hormones. Adequate intake of dietary iodine has been recognized as a critical factor for maintaining health[1]. It is a well-known fact that iodine deficiency can impede the production of thyroid hormones in both the mother and fetus, which increases the risk of brain damage in the fetal stage. Excess iodine can also result in a series of thyroid dysfunction symptoms such as goiter and hypothyroidism. Since approximately 90% of dietary iodine intake is excreted in the urine, the concentration of urinary iodine (UIC) primarily reflects the iodine status. However, a high variability in UIC exists in the day-to-day dietary iodine intake and the large daily flux[2]. Currently, the World Health Organization (WHO) recommends using median spot UIC, but without a specified time, to describe the iodine status[3]. Spot UIC can exhibit fluctuations due to several external factors, including personal habits, environmental conditions, and internal factors. Therefore, the urinary iodine/creatinine (UIC/Cr) ratio in spot urine specimens is often used to describe the iodine status by adjusting the differences in urine volume and sample dilution.

The 24-h urinary iodine excretion (24-h UIE) has been recognized as the gold standard for assessing the iodine status[4]. Obtaining a complete collection of 24-h urine specimens is impractical due to the considerable burden. Consequently, a concise, alternative method for estimating the iodine status in the population based on spot urine and 24-h urine specimens has been increasingly considered. The method for estimating 24-h UIE (est_24-UIE) is obtained using the UIC/Cr ratio in spot urine, multiplied by the estimated 24-h urinary creatinine excretion (est_24-h UCrE)[5]. In fact, the formula for calculating the est_24-h UCrE has already been established in the Japanese and the USA populations, but its applicability to the Chinese population remains unclear. More remarkably, the formula for calculating the est_24-h UCrE has not yet been established in the Chinese population.

Pregnant women comprise a susceptible group of population exhibiting the greatest variations in their physiological metabolism. The status of iodine nutrition is pivotal to maintain the fitness of pregnant women and their fetus during the gestation period. Therefore, the aim of the present study was to develop a more reliable and widely practical method for assessing the iodine status among pregnant women.

This study was performed in Peking Union Medical College Hospital in China from March to November in 2016. All the study subjects were required to have no previous history of thyroid diseases and medication intake (including iodine supplements). A total of 118 pregnant women were finally recruited in this study. The study protocol was approved by the Medical Ethics Committee of the National Institute of Nutrition and Health of the Chinese Center for Disease Control and Prevention. Written informed consent was obtained from every subject. Body height and weight were measured in duplicate using a calibrated stadiometer and a beam scale, respectively. Height was measured to the nearest 0.1 cm, and weight was measured to the nearest 0.1 kg. All subjects were asked to collect their morning spot urine (8:00-12:00 am) and the following 24-h urine specimens. The 24-h urine specimens were measured, and two 10-mL aliquots were obtained and stored at −10 °C until analysis.

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The UIC was determined using the Sandell-Kolthoff method in the National Reference Laboratory for Iodine Deficiency Disorders[6]. Three levels of certified reference human urine (GBW09108, GBW09110, and GBW0911; National Reference Laboratory for Iodine Deficiency Disorders, Beijing) were applied to ensure the accuracy of the method. The CVs were calculated as 0.3%-4.0% in this study. Urinary creatinine concentration (Cr) was measured using the kinetic Jaffé procedure[7]. Since previous research[8] postulates a suite of hypotheses that the measured 24-h UCrE is relatively proportional to the estimated 24-h UCrE according to the formula and the spot UIC/Cr ratio is positively associated with the 24-h urine UIC/Cr ratio, the estimated 24-h UIE can be calculated using the spot UIC/Cr ratio, multiplied by the estimated 24-h UCrE.

The SAS statistical software (version 9.2, SAS Inc., Cary, NC) was used for data analysis in this study. Age, height, weight, and BMI were expressed as mean ± SD. Since the UIC and Cr/I ratio were not normally distributed, these data were expressed as median values with the 25th and 75th percentiles. Differences in age, height, and 24-h urinary volume among the trimesters of gestation were evaluated using one-way analysis of variance. Differences in the UIC and UIC/Cr ratio between morning spot urine and 24-h urine specimens were analyzed by Mann-Whitney U tests, and the differences among the three trimesters were evaluated using Kruskal-Wallis H tests. A linear regression formula for calculating the est_24-h UCrE, including age, gestation period, height, weight, and BMI, was further developed to calculate the 24-h UIE. The measured values and the estimated values calculated by the formulas were compared[5,8,9]. All the values with $P < 0.05$ were considered to be statistically significant.

The characteristics of the pregnant women are shown in Table 1. During pregnancy, there was a physiological increase in the weight and BMI of the women. However, there were no significant differences in age, height, and 24-h urinary volume between the trimesters of gestation ($P > 0.05$). The 24-h UIC was significantly lower than spot UIC ($P < 0.05$), whereas the UIC/Cr ratio in the 24-h urine specimens was significantly higher ($P < 0.05$). The 24-h UCrE was about 1.10 g/day, ranging from 1.07 to 1.13 g/day, but there was no significant difference during pregnancy ($P > 0.05$). Similarly, the 24-h UIE was 237 μg/day, ranging from 218 to 245 μg/day, with no significant difference ($P > 0.05$).

A formula to predict 24-h UCrE was also established in this study. The correlation coefficient (R) of the UIC/Cr ratio between the 24-h urine and the spot urine specimens was calculated as 0.553, which is depicted in Figure 1. As independent variables, we sequentially included age, gestation period, height, weight, and BMI in the model. However, significance was observed when only weight was included in the model ($P < 0.05$). The formula is listed as follows: est_24-h UcrE (g) = 0.011 × weight (kg) + 0.377.

Table 1. Characteristics of Pregnant Women during the Gestation Period

Variables	First Trimester	Second Trimester	Third Trimester	All
Number (*n*)	23	51	44	118
Age (years)	31.2 ± 4.3	33.1 ± 4.3	33.6 ± 4.1	33.3 ± 4.2
Height (cm)	164 ± 5	164 ± 4	162 ± 4	163 ± 4
Weight (kg)	59.0 ± 8.8	63.6 ± 8.8	67.8 ± 8.6	64.3 ± 9.2
BMI (kg/m^2)	21.8 ± 3.4	23.8 ± 3.2	25.8 ± 3.4	24.2 ± 3.6
Urinary volume (L/24 h)	2.0 (1.3-2.3)	1.7 (1.4-2.4)	1.7 (1.3-2.8)	1.8 (1.3-2.2)
24-h UIC (μg/L)	112 (96-146)	113 (91-149)	131 (100-180)	118 (92-158)
Spot UIC (μg/L)	124 (112-157)	141 (93-202)	135 (84-192)	137 (93-193)
24-h UIC/Cr (μg/g)	181 (145-245)	194 (154-295)	204 (145-246)	194 (148-272)
Spot UIC/Cr (μg/g)	144 (85-185)	150 (109-221)	149 (116-235)	148 (109-208)
24-h UCrE (g/d)	1.07 (0.95-1.23)	1.04 (0.85-1.22)	1.06 (0.92-1.37)	1.06 (0.88-1.25)
24-h UIE (μg/d)	186 (153-245)	221 (148-299)	212 (153-279)	207 (150-286)

Note. Age, Height, Weight, and BMI are expressed as mean ± SD, and urinary volume, 24-h UIC, spot UIC, 24-h UIC/Cr, spot UIC/Cr, 24-h UcrE, and 24-h UIE are expressed as median (25th-75th). Differences in the overall UIC and UIC/Cr ratio or each trimester between the 24-h urine and the spot urine specimens were analyzed using Mann-Whitney U tests. Differences in the UIC and UIC/Cr ratio in the 24-h urine and spot urine specimens among the three trimesters were evaluated using Kruskal-Wallis H tests.