

Determining median urinary iodine concentration that indicates adequate iodine intake at population level

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Objective Urinary iodine concentration is the prime indicator of nutritional iodine status and is used to evaluate population-based iodine supplementation. In 1994, WHO, UNICEF and ICCIDD recommended median urinary iodine concentrations for populations of 100–200 µg/l, assuming the 100 µg/l threshold would limit concentrations <50 µg/l to ≤20% of people. Some scientists felt this proportion was unacceptably high and wanted to increase the threshold above 100 µg/l. The study was carried out to determine the frequency distribution of urinary iodine in iodine-replete populations (schoolchildren and adults) and the proportion of concentrations <50 µg/l.

Method A questionnaire on frequency distribution of urinary iodine in iodine-replete populations was circulated to 29 scientific groups.

Findings Nineteen groups reported data from 48 populations with median urinary iodine concentrations >100 µg/l. The total population was 55 892, including 35 661 (64%) schoolchildren. Median urinary iodine concentrations were 111–540 (median 201) µg/l for all populations, 100–199 µg/l in 23 (48%) populations and ≥200 µg/l in 25 (52%). The frequencies of values <50 µg/l were 0–20.8 (mean 4.8%) overall and 7.2% and 2.5% in populations with medians of 100–199 µg/l and >200 µg/l, respectively. The frequency reached 20% only in two places where iodine had been supplemented for <2 years.

Conclusion The frequency of urinary iodine concentrations <50 µg/l in populations with median urinary iodine concentrations ≥100 µg/l has been overestimated. The threshold of 100 µg/l does not need to be increased. In populations, median urinary iodine concentrations of 100–200 µg/l indicate adequate iodine intake and optimal iodine nutrition.

Keywords Iodine/urine/deficiency; Urine/chemistry; Nutritional status; Reference values; Epidemiologic studies; Child; Adult (*source: MeSH, NLM*).

Mots clés Iode/urine/déficit; Urine/composition chimique; Etat nutritionnel; Valeur référence; Etude analytique (Epidémiologie); Enfant; Adulte (*source: MeSH, INSERM*).

Palabras clave Yodo/orina/deficiencia; Orina/química; Estado nutricional; Valores de referencia; Estudios epidemiológicos; Niño; Adulto (*fuentes: DeCS, BIREME*).

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Introduction

In 1990, 1572 million people suffered from iodine deficiency, which meant it was the leading cause of preventable mental retardation. Universal salt iodization (USI) — a policy in which all salt used in agriculture, food processing, catering and households is iodized — is the agreed strategy for achieving iodine sufficiency (1). The last decade saw enormous efforts and investments towards achieving this goal, which is now within reach, and the achievements are an unprecedented public health success in the field of noncommunicable diseases (2).

The concentration of iodine in the urine (urinary iodine concentration) is the prime indicator of a person's nutritional iodine status; it is the primary variable used to measure the success of iodine supplementation in a population (1). According to current recommendations produced by the World Health Organization (WHO), United Nations Children's Fund

(UNICEF) and International Council for Control of Iodine Deficiency Disorders (ICCIDD), median urinary iodine concentrations of 100–199 µg/l in samples from schoolchildren or adults indicate adequate iodine intake and optimal iodine nutrition (Table 1) (3). This recommendation was made on the basis of the assumption that the threshold of 100 µg/l would allow values <50 µg/l (concentrations that indicates persistent, at least moderate iodine deficiency in the population) in no more than 20% of the population. Some participants at a meeting in 1999 convened by WHO to revise the indicators felt that 20% represented an unacceptably high number of people, and the group considered raising the threshold for the median above the current value of 100 µg/l (3).

It appeared, however, that this concern was not scientifically based, because no hard data were available on the frequency of concentrations of urinary iodine <50 µg/l in populations where the median urinary is >100 µg/l. Such

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Table 1. **Epidemiological criteria for assessing iodine nutrition based on median urinary iodine concentrations in school-age children**

Median urinary iodine ($\mu\text{g/l}$)	Iodine intake	Iodine nutrition
< 20	Insufficient	Severe iodine deficiency
20–49	Insufficient	Moderate iodine deficiency
50–99	Insufficient	Mild iodine deficiency
100–199	Adequate	Optimal
200–299	More than adequate	Risk of iodine-induced hyperthyroidism in susceptible groups
>300	Excessive	Risk of adverse health consequences (IH, autoimmune thyroid diseases)

Adapted from: WHO/UNICEF/ICCIDD (2).

iodine-replete populations could be found in areas where iodine deficiency has never existed, because of adequate food habits — such as Japan or coastal populations in Latin America, for example — or in areas previously affected by iodine deficiency disorders (IDD), where programmes of USI have been implemented successfully.

This study aimed to describe the frequency distribution of urinary iodine concentrations in iodine-sufficient populations (schoolchildren and adults). More specifically, we aimed to evaluate in such populations the proportion of people with concentrations of urinary iodine $<50 \mu\text{g/l}$.

Methods

We sent a questionnaire to 29 groups of scientists around the world who we thought might have access to the appropriate data. The questionnaire asked each investigator to give a detailed description of the iodine-sufficient area that they had investigated:

- possible past history of iodine deficiency and endemic goitre;
- possible programmes of iodine supplementation and present evidence for normal concentrations; or
- normalized iodine nutrition of the population (prevalence of goitre by palpation, by ultrasounds, blood tests, results of neonatal thyroid screening).

The questionnaire also asked for a description of the populations being studied (characteristics such as number of subjects, age and sex), the mean and median urinary iodine concentrations in the population and the frequency of values below the cut-off values of 100, 50 and $20 \mu\text{g/l}$, respectively. These cut-off values correspond to degrees of iodine deficiency defined as moderate, mild and severe (1, 3).

Nineteen groups sent replies with adequate data. These groups constitute the ICCIDD Working Group and are coauthors of this study.

Results

We received responses about 48 populations in 17 countries across four continents. The populations covered a total of

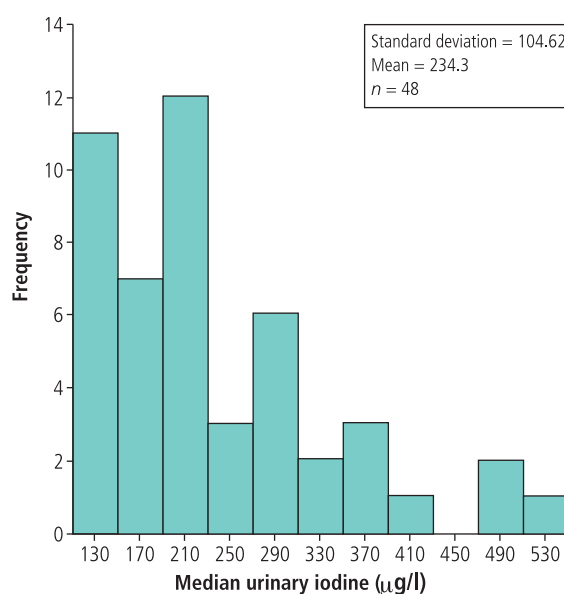
55 892 people, with population sizes varying from 50 to 16 660 people. Most (64%) participants were schoolchildren aged 6–14 years, 3% were adults, and the last 33% represented samples of the whole population (aged 2–74 years)

In all population groups (and by definition), median urinary iodine concentrations were $>100 \mu\text{g/l}$. Median urinary iodine concentrations varied from 111 to 540 (mean \pm SD 234 ± 104 , median 201) $\mu\text{g/l}$ (Fig. 1). The concentration was $100\text{--}199 \mu\text{g/l}$ in 48% of the populations and $>200 \mu\text{g/l}$ in the remaining 52%. In all groups, iodine sufficiency was confirmed by additional data — most often by a normal prevalence of goitre. In some places, iodine deficiency had never existed — for example in Japan, Iceland and coastal Peru. In others, iodine deficiency had been corrected by the implementation of USI for between one year (one survey each in Indonesia and Bulgaria) and almost 60 years (in the United States of America). By definition, the frequency of values in each group $<100 \mu\text{g/l}$ was $<50\%$ (mean \pm SD 15.6 ± 11.1).

For all groups taken together, the frequency of values $<50 \mu\text{g/l}$ varied from 0 to 20.8 (mean \pm SD 4.8 ± 4.6)%. Frequencies were $\leq 12\%$ in all but two populations, for which they were 19.7 and 20.8%. These two populations were from the same Chinese province, in which median urinary iodine concentrations were 128 and 137 $\mu\text{g/l}$, respectively, only one and two years after correction of IDD. The frequency of values $<50 \mu\text{g/l}$ was inversely related to the median urinary iodine (Fig. 2). The frequency was $7.2 \pm 5.4\%$ in samples with median concentrations of $100\text{--}200 \mu\text{g/l}$ and only $2.5 \pm 1.7\%$ in samples with medians >200 (mean 307) $\mu\text{g/l}$. In all populations, the frequency of values $<20 \mu\text{g/l}$ varied from 0 to 6 (mean \pm SD 1.0 ± 1.5)%.

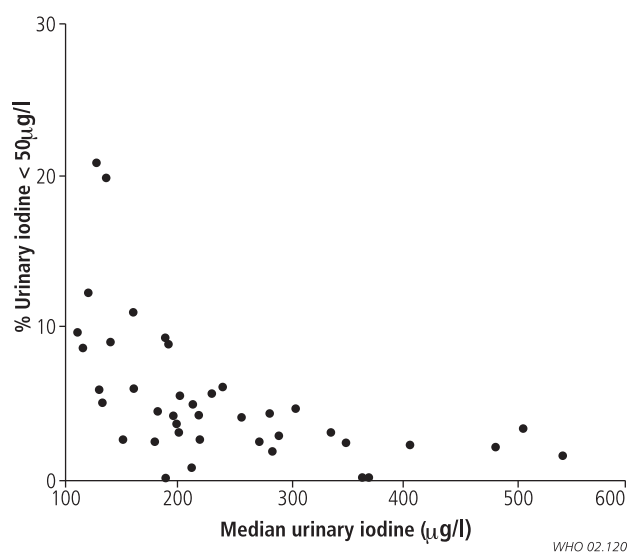
When the 39 906 schoolchildren in the 48 population samples were considered separately from the adults, the results were very similar to those observed in the total population under investigation. The mean urinary iodine concentration was $297 \pm 147 \mu\text{g/l}$ and the median 240 $\mu\text{g/l}$. The frequencies of values below 100, 50 and $20 \mu\text{g/l}$ were 16.2, 4.9 and 1.0,

Fig. 1. **Frequency distribution of median urinary iodine concentrations in 48 groups of subjects**



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Fig. 2. Relation between median urinary iodine concentrations and frequencies of concentrations $<50\mu\text{g/l}$



respectively. When the schoolchildren with median urinary iodine concentrations of 100–200 $\mu\text{g/l}$ (26 270 children; median 157 $\mu\text{g/l}$) were considered separately, the frequency of values $<50\mu\text{g/l}$ was 7.8%. The latter frequency was only 2.6% in the 13 636 schoolchildren with a median urinary iodine concentration >200 (mean 307) $\mu\text{g/l}$.

Discussion

The results show that the risk of persistent iodine deficiency in iodine-sufficient populations with median urinary iodine concentrations $\geq 100\mu\text{g/l}$ is much lower than the 20% assumed by WHO, UNICEF and ICCIDD in 1994 (1).

The frequency of urinary iodine concentrations $<50\mu\text{g/l}$ is 2.5% and 2.6% in global populations and schoolchildren, respectively, when the median concentration of urinary iodine is about 300 $\mu\text{g/l}$. In such conditions, which are reported from many parts of the world after implementation of USI (4), the risk of persistent iodine deficiency is very low. The problem with such iodine concentrations is the

increased risk of iodine-induced hyperthyroidism (5–7); this is especially so when they are achieved suddenly in populations previously exposed to long-standing, severe iodine deficiency (8–10).

A series of investigations showed that urinary iodine concentrations vary considerably from day to day and during a single day in one individual (11–13). During successive sampling of the same groups of individuals, problematic values of $<50\mu\text{g/l}$ were not found every time a sample was taken from one individual. Thus, a single urinary iodine measurement is not representative of an individual's nutritional iodine status. Urinary iodine concentrations are useful, however, when used in cross-sectional, epidemiological surveys in population samples of appropriate size.

Conclusions

The frequency of urinary iodine concentrations $<50\mu\text{g/l}$ in populations with median urinary iodine concentrations $\geq 100\mu\text{g/l}$ is 4.8% — much lower than the value of 20% assumed previously. Moreover, the intra- and inter-day variability of urinary iodine suggests that values below the critical level of 50 $\mu\text{g/l}$ may not be present permanently in one member of a given population.

The critical threshold of 100 $\mu\text{g/l}$ as an indicator of iodine sufficiency does not need to be increased. This study, which used hard data, further supports the statement that, at a population level, a median urinary iodine level between 100 and 200 $\mu\text{g/l}$ indicates adequate iodine intake and optimal iodine nutrition (3). ■

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Conflicts of interest: none declared.

Résumé

Détermination de la concentration médiane d'iode urinaire indicative d'un apport d'iode suffisant dans une population

Objectif La concentration d'iode urinaire est le principal indicateur de l'état nutritionnel en ce qui concerne l'iode et elle est utilisée pour évaluer la supplémentation en iode au niveau d'une population. En 1994, l'OMS, l'UNICEF et l'ICCIDD ont recommandé des concentrations médianes d'iode urinaire de 100–200 $\mu\text{g/l}$, en admettant que le seuil de 100 $\mu\text{g/l}$ limiterait les concentrations $<50\mu\text{g/l}$ à $\leq 20\%$ de la population. Certains auteurs ont estimé cette proportion beaucoup trop élevée et ont souhaité relever le seuil au-dessus de 100 $\mu\text{g/l}$. La présente étude avait pour but de déterminer la distribution de fréquence de la concentration d'iode urinaire dans des populations ayant un apport d'iode suffisant (écoliers et adultes) et la proportion de concentrations $<50\mu\text{g/l}$.

Méthodes Un questionnaire sur la distribution de fréquence de l'iode urinaire dans des populations ayant un apport d'iode suffisant a été remis à 29 groupes scientifiques.

Résultats Dix-neuf groupes ont rapporté des données issues de 48 populations ayant des concentrations médianes d'iode urinaire $>100\mu\text{g/l}$. L'effectif total de ces populations était de 55 892 personnes, dont 35 661 (64 %) écoliers. Les concentrations médianes d'iode urinaire étaient de 111–540 (médiane 201) $\mu\text{g/l}$ dans toutes les populations, de 100–199 $\mu\text{g/l}$ dans 23 (48 %) populations et $\geq 200\mu\text{g/l}$ dans 25 (52 %) populations. La fréquence des valeurs $<50\mu\text{g/l}$ était globalement de 0–20,8 % (moyenne 4,8 %); elle était de 7,2 % dans les populations où la valeur médiane était de 100–199 $\mu\text{g/l}$ et de 2,5 % dans celles où la médiane était $>200\mu\text{g/l}$.

Elle n'atteignait 20 % que dans deux endroits où la supplémentation en iode était appliquée depuis moins de deux ans.

Conclusion La fréquence des concentraciones d'iode urinaire <50 µg/l dans les poblaciones où la valeur médiane des

concentraciones d'iode urinaire est ≥ 100 µg/l a été surestimée. Le seuil de 100 µg/l n'a pas besoin d'être relevé. Des concentraciones médianes d'iode urinaire de 100-200 µg/l dans une población indiquent un apport d'iode suffisant et un bilan iodé optimal.

Resumen

Concentraciones medianas de yodo urinario indicativas de una ingesta suficiente de yodo por la población

Objetivo La concentración urinaria de yodo es el principal indicador del estado nutricional en cuanto a ese elemento y se utiliza para evaluar la administración de suplementos de yodo a nivel poblacional. En 1994, la OMS, el UNICEF y el CILTCY recomendaron concentraciones medianas de yodo urinario en poblaciones del orden de 100–200 µg/l, suponiendo que el umbral de 100 µg/l limitaría las concentraciones < 50 µg/l a $\leq 20\%$ de las personas. Algunos científicos consideraron esta proporción inadmisiblemente alta y propusieron aumentar el umbral por encima de los 100 µg/l. El presente estudio se llevó a cabo para determinar la distribución de frecuencias de las concentraciones urinarias de yodo en poblaciones (escolares y adultos) que tenían las necesidades de yodo satisfechas, así como la proporción correspondiente de concentraciones < 50 µg/l.

Métodos Se difundió entre 29 grupos científicos un cuestionario sobre la distribución de frecuencias del yodo urinario en poblaciones cubiertas en cuanto a las necesidades de yodo.

Resultados Diecinueve grupos notificaron datos de 48 poblaciones con concentraciones medianas de yodo urinario > 100 µg/l. La población total ascendía a 55 892 personas, incluidos 35 661 (64%) escolares. Las concentraciones medianas de yodo urinario fueron de 111–540 (mediana 201) µg/l para todas las poblaciones, de 100–199 µg/l en 23 (48%) poblaciones y ≥ 200 µg/l en 25 (52%) poblaciones. Las frecuencias de valores < 50 µg/l fueron de 0–20,8 (media 4,8%) a nivel general y de 7,2% y 2,5% en poblaciones con medianas de 100–199 µg/l y de más de 200 µg/l, respectivamente. La frecuencia sólo alcanzaba el 20% en dos lugares donde los suplementos de yodo se habían administrado durante menos de 2 años.

Conclusión Se ha sobreestimado la frecuencia de las concentraciones de yodo urinario < 50 µg/l en las poblaciones con niveles ≥ 100 µg/l. No es necesario aumentar el umbral de 100 µg/l. A nivel poblacional, unas concentraciones medianas de yodo urinario de 100–200 µg/l son indicativas de una ingesta suficiente de yodo y de un aporte nutricional óptimo de este elemento.

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