World Health Organization

Goitre as a determinant of the prevalence and severity of iodine deficiency disorders in populations

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VMNIS | Vitamin and Mineral Nutrition Information System

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Background

Iodine deficiency is the most common cause of goitre, a condition defined when "each of the lateral lobes of the thyroid gland is larger than the terminal phalanges of the thumb of the person examined" *(1)*. Iodine is a trace element in the human body and is absorbed through the gut as iodide, the chemically bound form of iodine. The iodine content of food depends on the iodine content of the soil in which it is grown. Iodine in soil is often leached out by repeated flooding and glacial activity and carried to the sea, thereby making seawater, seaweed and marine fish rich sources of iodine *(2)*. Because iodine is an essential constituent of the thyroid hormones thyroxine (T_3) and triiodothyronine (T_4), iodine deficiency can have a profound effect on their production. Goitre, a manifestation of thyroid hyperplasia and increased thyroid vascularity, results from a compensatory increase in the release of thyroid-stimulating hormone (TSH) as a result of lower T_4 levels and is traditionally detected and evaluated using inspection and palpation. The prevalence of goitre increases with the severity of iodine deficiency and becomes endemic in populations where the intake of iodine is less than 10 µg per day *(3)*. Persistent iodine deficiency can eventually affect growth and mental development in all age groups *(4)*.

Goitre is a reflection of chronic iodine deficiency and can be used as a baseline assessment of a region's iodine status and as a sensitive long-term indicator for the success of an iodine programme *(5)*. Since 1960, inspection and palpation methods have been used for assessment of the severity of endemic goitre in populations *(1)*. Currently, the prevalence of goitre is quantified using the total goitre rate (TGR), which is equivalent to the number of goitres of grades 1 and 2 detected in a population divided by the total number of individuals examined. In addition to inspection and palpation, goitre can also be detected by using ultrasonography and is most often measured in school-age children (6–12 years of age) because of this population's accessibility and high physiologic vulnerability *(6)*. A TGR of 5% or more in school-age children is used to signal a public health problem *(6)*.

Scope and purpose

This document aims to provide users of the Vitamin and Mineral Nutrition Information System (VMNIS) with guidance about the use of goitre for assessing the prevalence and severity of iodine deficiency in populations. It is a compilation of the current World Health Organization (WHO) recommendations on the topic and summarizes existing information on the assessment of goitre, epidemiological criteria for defining the severity of iodine deficiency at the population level, and the chronology of their establishment.

The methods and criteria included in this summary permit the identification of populations at greatest risk of iodine deficiency and priority areas for action, especially when resources are limited. They also facilitate the monitoring and assessment of progress towards international goals of preventing and controlling iodine deficiency disorders.

Description of technical consultations

This document compiles the current WHO recommendations, previously published in the following documents:

Endemic goiter (7). This document was published in 1960 and contains 12 chapters, covering all aspects of goitre in one volume. It covers the history, physiology, pathology and etiology of endemic goitre; experimental studies on goitre; practical aspects of endemic goitre control; and legislation on iodine prophylaxis. This monograph was developed to serve as a work of reference for all those interested in the control of endemic goitre and to encourage the adoption of active measures in those countries where endemic goitre is a considerable public health problem but has not yet received the attention it deserves.

Report of the PAHO Scientific Group on Research in Endemic Goiter, Caracas, 22–26 April 1963 (8). This is a report of the first meeting of the Pan American Health Organization (PAHO) Scientific Group on Research in Endemic Goiter. Participants described the disease as they had observed it in various parts of the world and demonstrated the kinds of studies that had proved profitable. A research agenda was also developed for new questions raised. Many aspects of endemic goitre remained under investigation. Resources in Latin America, in terms of patients and scientific personnel, were considered to be particularly well suited for research on the nature of the disease and alternative programmes for its treatment and prevention. The meeting concluded with an assignment of research programmes and responsibilities to each of the Latin American participants.

Report of the PAHO Scientific Group on Research in Endemic Goiter. Second meeting, Cuernavaca, Mexico, 5–9 October 1965 (9). The purpose of this meeting was to review progress made since the meeting in 1963 and to explore needs and programmes for future studies on endemic goitre in Latin America.

Endemic goiter. Report of the meeting of the PAHO Scientific Group on Research in Endemic Goiter held in Puebla, Mexico, 27 to 29 June 1968 *(10)*. This document was published in 1969 and consists of papers presented at the third meeting of the PAHO Scientific Group on Research in Endemic Goiter. The document is a compilation of communications of the work that was in progress on endemic goitre in Latin America, with relevant studies from Africa and the Far East as indicators of what the disease is like elsewhere and what may be expected of prophylactic programmes under other circumstances. In this meeting, interest focused primarily on the prophylactic use of iodized oil. As a result of the work presented, it was concluded that prophylaxis of endemic goitre with iodized oil was economically and technically feasible and was also safe and effective.

Endemic goiter and cretinism: continuing threats to world health. Report of the IV Meeting of the PAHO Technical Group on Endemic Goiter (11). This document was published in 1974 following the fourth meeting of the PAHO Technical Group on Endemic Goiter held in Guarujá, São Paulo, Brazil, 14–18 October 1973, to review current knowledge of the subject, evaluate the current state of prophylaxis, and make concrete recommendations for future action in each of these areas. The meeting emphasized both scientific and public health aspects of endemic goitre and cretinism. The document consists of six main chapters, including those on the importance of endemic goitre and cretinism; hormone production and goitrogenesis; etiologic factors in endemic goitre; special problems associated with endemic goitre; programmes for goitre control and prevention; and results of supplementation programmes.

The control of endemic goitre (12). This document was published in 1979 to address the significance of endemic goitre as a public health problem and to give a detailed account of the means available to control it. The techniques described in the document are simple and affordable. They do not involve sophisticated technology and can be used anywhere in the world.

Towards the eradication of endemic goiter, cretinism, and iodine deficiency (13). PAHO/WHO convened the 5th meeting of its Technical Group on Endemic Goiter in Lima in November 1983, to explore the present status of the campaign against endemic goitre, cretinism and iodine deficiency. The objectives were: (i) to review recent advances in the pathogenesis of endemic goitre, cretinism and iodine deficiency; (ii) to assess available methods for their diagnosis, treatment and prevention; (iii) to document the current status of iodine deficiency by geographical area, with particular emphasis on the western hemisphere; and (iv) to make recommendations for future approaches to the problem. Participants included public health officials from individual countries, representatives of international agencies, particularly PAHO/WHO and the United Nations Children's Fund (UNICEF), and academic specialists in endocrinology and public health.

Indicators for assessing iodine deficiency disorders and their control through salt iodization (6). This document was published in 1994 following a technical consultation on indicators of iodine deficiency held in Geneva, Switzerland, 3–5 November 1992, to provide guidance concerning the use of surveillance indicators for iodine deficiency disorders. Indicators are presented as a tool for monitoring the progress towards eliminating iodine deficiency disorders as a significant public health problem by the year 2000.

The document also presents a modified three-grade goitre grading system, criteria for determining the severity of endemic iodine deficiency disorders, and recommendations for levels of salt iodization that are appropriate for varying geographical regions.

Assessment of iodine deficiency disorders and monitoring their elimination: a guide for programme managers, 2nd edition *(14)*. In 1999, experts in the field of iodine were commissioned to review and update the 1994 publication, *Indicators for assessing iodine deficiency disorders and their control through salt iodization (6)*. The updated sections were used as the background document for an expert technical consultation held in Geneva, Switzerland, 4–6 May 1999, with the objective of conducting a critical analysis of the revised sections and of subsequently developing a new document.

Assessment of iodine deficiency disorders and monitoring their elimination: a guide for programme managers, 3rd edition *(5)*. This document was published in 2007 for use as a background document for a technical consultation held in Geneva, Switzerland, 22–23 January 2007, and is an updated version of the document published in 2000 *(14)*. It contains new indicators of thyroid function, adjusted iodine requirements for pregnant and lactating women, and innovative programmatic criteria to assess progress towards the elimination of iodine deficiency.

Discussions and recommendations

The WHO definition of goitre has been maintained since it was first proposed in 1960, as "a thyroid gland whose lateral lobes have a volume greater than the terminal phalanges of the thumbs of the person being examined" *(1)*. The diagnosis of goitre depends not only on the visibility of the thyroid gland but also on the degree of enlargement of the gland or on the presence of nodules in the gland. Therefore, in 1979, use of the palpation method was recommended as the most accurate and reliable way of diagnosing endemic goitre and estimating its severity *(12)*. The normal size of the thyroid gland varies with age and a person's build. In adults, the lobes of the thyroid gland are about the size of a lima bean, with the isthmus appearing as a thick connecting strand *(12)*. On palpation, the lateral lobes can be felt beneath the muscles on both sides of the trachea, while the isthmus is either not palpable or just barely palpable.

Guidance on the technique for examination was presented in 1979 *(12)*. Children and adults should be examined while standing with the head and neck first in a vertical position, and then in an extended position, with the examiner sitting or standing directly in front of the subject, according to the height of the subject. The examiner should inspect the thyroid area and, without delay, use both thumbs to palpate very gently the full extent of the lobes and the isthmus. It is advisable to ask the subject to relax the neck muscles by throwing the head slightly downwards, and it may be helpful to get him or her to swallow several times. When an infant is examined, the child should be lying on his or her back, with the examiner's left hand under the shoulder blades, lifting the body slightly so that the child's head remains in touch with the surface of the table on which he or she is lying. The child can be held securely if the examiner places his left thumb in the child's right armpit. The region of the thyroid is then palpated with the right forefinger. The gland should not be palpable at all, and the isthmus should be palpable only as a thin strand no more than 1–2 mm thick.

The first system for classifying goitre was suggested in 1960, using four grades *(1)*. Subsequent consultations held in 1963 *(8)* and 1983 *(13, 15)*, suggested a five-grade system, modifying group 0 and group 1, respectively. This five-grade classification system for goitre was further modified to develop a simpler three-grade classification system that would be more practical in the field, by combining grades 1A and 1B into one group and grades 2 and 3 into another group *(6)*. The severity of goitre is currently graded according to the classification system displayed in Table 1.

Table 1

Classification of goitre by palpation[a]

Grade	Characteristics
0	>No palpable or visible goitre.
1	A goitre that is palpable but not visible when the neck is in the normal position (i.e. the thyroid gland is not visibly enlarged). Nodules in a thyroid that is otherwise not enlarged fall into this category.
2	A swelling in the neck that is clearly visible when the neck is in a normal position and is consistent with an enlarged thyroid gland when the neck is palpated.

[a] *Source:* reference *(16)*.

School-age children remain the preferred group for inspection and palpation, although the small size of the thyroid gland in young children can present as a significant challenge and the highest prevalence of goitre occurs during puberty and childbearing age *(5)*.

Pregnant women are a particularly vulnerable group because of the susceptibility of the fetus to iodine deficiency. However, access to, and utilization of, health-care services by women at high risk for iodine deficiencies can be highly variable and no criteria for assessing the severity of iodine deficiency based on prevalence have been recommended for pregnant women *(6)*. Other limitations of palpation include reduced sensitivity and specificity in evaluating goitres of grades 0 and 1, owing to high interobserver variation and the significant lag time that is required for the goitre rate to normalize after iodine repletion *(5, 16, 17)*. Despite these concerns regarding the precision and applicability of the technique to broader age groups, palpation can be used to measure the baseline severity of iodine deficiency and to evaluate the long-term impact of control programmes (*5*).

The first recommendations for defining endemic goitre were made during the 1973 consultation *(11)*. It was agreed that an area would be arbitrarily defined as endemic with respect to goitre if more than 10% of its population was found to be goitrous on appropriate survey *(11)*. The figure 10% was chosen because a higher prevalence usually implies an environmental factor, while a prevalence of several per cent is common, even when all known environmental factors are controlled. In addition to the frequency of goitre, it was further recommended that endemic goitre should be described by the severity of iodine deficiency, based on the average urinary iodine excretion per gram of creatinine *(11)*. In 1994, this recommendation was revised and it was recommended that a TGR (sum of goitre grades 1 and 2) of 5% or more in primary school children (age range approximately 6–12 years) should be used to signal the presence of a public health problem *(6)*. This cut-off value was based on the observation that, in iodine-replete populations, the prevalence of goitre is low. The cut-off value of 5% allows for some margin of error in the assessment of goitre and the possibility that goitre may occur in iodine-replete populations because of the presence of goitrogens in the diet and autoimmune thyroid diseases. Additionally, it had been shown that goitre prevalence rates between 5% and 10% may be associated with a range of abnormalities, including inadequate urinary iodine excretion and/or subnormal levels of TSH among adults, children and neonates *(6)*. Guidance on the use of goitre prevalence in school-age populations for assessing the severity of iodine deficiency as a public health problem was developed in 1994, and is summarized in Table 2.

Table 2

Epidemiological criteria for assessing the severity of iodine deficiency based on the prevalence of goitre in school-age children[a, b]

	Degree of iodine deficiency, expressed as a percentage of the total number of children surveyed, %			
Indicator	**None**	**Mild**	**Moderate**	**Severe**
Total goitre rate (TGR)	0–4.9	5–19.9	20–29.9	30 or more
Thyroid volume >97th percentile by ultrasonography[c]	0–4.9	5–19.9	20–29.9	30 or more

[a] Source: references *(5, 6)*.
[b] Goitre prevalence responds slowly to changes in iodine intake.
[c] Normative thyroid volume size values as described in references *(5, 12)*.

Thyroid ultrasonography, an imaging method used to visualize the thyroid, is preferred in areas with mild to moderate iodine deficiency because it measures thyroid volume more precisely and objectively than palpation does *(5, 6)*. The thyroid is visualized transversely and longitudinally, to determine the gland's dimensions, and these are used to calculate thyroid volume. The 1973 consultation recommended the procedure of MacLennan and Gaitán for the measurement of thyroid surfaces, in order to standardize the technique among different examiners and to allow for comparison of surveys in different

areas and at different times *(11, 18)*. International reference values for thyroid volume for screening of goitre have been established in school-age children, as a function of age, sex and body surface area *(5, 19)*. As a result, ultrasonography has become an effective tool to monitor iodine control programmes, where the size of the thyroid is expected to decrease slowly over time *(5)*.

The preferred strategy for the control of iodine deficiency disorders remains universal salt iodization. However, iodine supplementation is also an option in high-risk communities that are unlikely to have access to iodized salt *(5, 20)*. The effectiveness of iodine prophylaxis in preventing endemic goitre has shown that iodine deficiency is a necessary cause of the disorder. However, it has been pointed out that other causes act in unison with iodine deficiency to generate the clinical phenomena *(11)* and it is now well known that components of the diet can interfere with thyroid metabolism. Since 1991, data on the prevalence of goitre in populations have been collected and imputed into the Micronutrients Database within the WHO VMNIS, in order to strengthen surveillance of iodine deficiency disorders at the global level.

Summary of statement development

This summary has primarily used information from WHO publications released between 1960 and 2007 *(5–14)*. The first, *Endemic goiter (7)*, was published in 1960 and covered all aspects of goitre known at that time in one volume. The next five documents *(8–11, 13)* were valuable meeting reports of the PAHO Scientific/Technical Group on Endemic Goiter that took place between 1963 and 1983, detailing advances in the state of knowledge of goitre and urgent research needs. The control of endemic goitre *(12)* was published in 1979 to help address the significance of endemic goitre as a public health problem and to give a detailed account of the means available to control it. *Indicators for assessing iodine deficiency disorders and their control through salt iodization (6)* was published in 1994 and identified useful indicators for assessing iodine deficiency in a population, including a newly defined method of classifying goitre. The document was a response to a 1992 technical consultation, which first proposed the prevalence criterion of 5% or more for goitre in school-age children as an indicator for determining the public health significance of iodine deficiency in a population. The 2007 publication, *Assessment of iodine deficiency disorders and monitoring their elimination: a guide for programme managers (5)* was an updated version of the document published in 2000 *(14)* and analysed the utility of four indicators of iodine deficiency. Furthermore, it reinforced the use of goitre to establish a baseline prevalence of iodine deficiency disorders and to monitor long-term responses to iodine control programmes.

Plans for update

The WHO Evidence and Programme Guidance Unit, Department of Nutrition for Health and Development, is responsible for reviewing this document and, if needed, will update it by 2017, following the procedures of the *WHO handbook for guideline development (21)*.

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