Version 2

FINAL REPORT

Effect of Excess Iodine Intakes onThyroid Function among School Children: Multicenter Study

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Summary
Effect of Excess Iodine Intakes onThyroid Function among School Children: Multicenter Study

At the moment, excessive of iodine intake of school children is defined when in a population the median value of urinary iodine concentration (UIC) 300 µg/L or greater. However, there are few data on the adverse effects of excessive iodine or in what level should be considered as excessive among children. In contrast, there are strong evidence on the adverse effects of iodine deficiency on thyroid function among children. One indicator of the thyroid function that had been widely accepted, especially for neonatal, was thyroid stimulating hormon (TSH). Meanwhile, only recently the level of thyroglobulin (Tg) is considered as biomarker for thyroid function.

Nowadays, there are 29 countries that had median value of UIC category more than adequate or excessive iodine intake. The Iodine Deficiency Disorders (IDD) data from Indonesia showed that the median value of UIC among school age children (SAC) in 2003 and 2007 was 224 µg/L and 229 µg/L where more than 20% of the children in the category of excessive iodine intake (UIC >=300 µg/L). The percentage of household that consume salt with sufficient iodine was around 60% or still far from achieving universal salt iodization (USI).

Thus, the basic question addressed by this study is: Do iodine intake among school age children (SAC) in the category more than adequate (200-300 µg/L) and/or the category excess (300-500 µg/L) impair thyroid function ? If so, should the program managers reduce the level of iodine in salt and keep the median value of UIC < 200 µg/L.

The general objective of this study is to investigate the relationship between iodine intake and thyroid function among school age children (SAC) 8-10 years of age in the area of iodine intake in the category optimal and excessive.

In addition to Indonesia, this collaborative study is also conducted in Tanzania, Croatia, Paraguay, the Philippines, and India. The coordinator of this multicentre study is Prof.Dr.med.Michael B.Zimmermann, from Human Nutrition Laboratory; Institute of Food, Nutrition and Health; Swiss Federal Institute of Technology Zurich, Switzerland.

Subject of the study is Primary School student 8-10 years of age in District of Semarang and District of Grobogan, Province of Central Java and in District of Bantul, Yogyakarta.

Grobogan is to represent area of excessive of iodine intake, Semarang as area of above requirement and Bantul as area of adequate iodine intake. Data collected included UIC from casual urine sample, TSH, tT4, Tg from dry blood spots, thyroid enlargement (goiter) by palpation and using ultrasonography (USG), iodine level in salt and drinking water and body measurements for body surface area (BSA) and nutritional status. Laboratory work for UIC, iodine in water and iodine in salt were done in IDD Laboratory in Semarang in Central Java and for TSH, tT4 and Tg were carried out in Human Nutrition Laboratory, Zurich, Switzerland.

Conclusion of this study is as follow:

i) UIC value in Grobogan was in category 'excesive' of iodine intake, Semarang in category 'above average' of iodine intake and Bantul in category 'adequate' of iodine intake. Urinary iodine concentration value was correlated with iodine content in salt used by households, TSH, tT4 and thyroid gland volume although the degree of correlation was weak. It seems that UIC was in line with enlargement of thyroid gland. Thus, UIC is a good indicator for estimating the true iodine intake.

ii) Only around half of salt used by households in overall 3 districts contained iodine that safisfy the National Standard for Industry. Iodine content in salt used by household correlated with UIC, TSH, tT4 and thyroid gland volume. Results of this study suggest that some parts of iodine in UIC was not come from iodised salt. One of the source of iodine other than iodised salt was water used for daily drinking such as proved in Grobogan.

iii) Palpation as traditional method for determining thyroid gland enlargement resulted in overestimate around 10% on goitre prevalence, even by experinced person, than using USG

iv) No children had TSH level above the normal range (possibly hypothyroidism) but children with TSH level below the normal range (possibly hyperthyroidism) was ranging from 2,8% - 8,5%. However, none of children had tT4 level above the normal range (probably hyperthyroidism) but children with tT4 level below the normal range (probably hypothyroidism) was ranging from 11,3% - 41,5%. It seems that tT4 was in line with the results of measurement of thyroid gland enlargement.

v) Body Surface Area (BSA) value by age was the same for boys and girls but lower than the WHO reference. Stunting was more prevalence than underweight and wasting

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I. Background

WHO/UNICEF/ICCIDD had set that the median value of urinary iodine concentration (UIC) greater than 300 µg/L among school age children as excessive[1)]. Nowdays, it is estimated that more than two-third of 5 billion world population living in countries or areas with iodine deficiency have access to iodized salt[1,2)]. In those countries, excess of iodine is occuring more frequently due to iodine level in salt is too high or is poorly monitored[2)]. For example, median value of UIC among school age children in: Brazil, Algeria, Cöte d'Ivoire, Zimbabwe and Paraguay, the national median value of UIC is greater than 300 µg/L among school age children or in the category of excessive[3,4)].

WHO noted that there are 29 countries had median value of UIC category more than adequate or excess of iodine intake[1)]. In Indonesia, Iodine Deficiency Disorders (IDD) data in 2003 and 2007 showed that the median of UIC among school age children was 244 µg/L and 229 µg/L or in the category more than adequate, where more than 20% of the children with UIC category of excessive. However, more than 10% of the children had UIC less than 100 µg/L or in the category of iodine deficiency[5,6)]. A part from iodised salt, high dietary iodine can also come from foodstuff, for example seaweed in coastal Hokkaido, Japan[7)], drinking water rich in iodine in China[8)] and Indonesia[9)], meat and milk rich in iodine in Iceland because of animal fed with sea fish rich in iodine[10)]. The use of iodine containing agents i.e. iodoform in dairy farming and in bread[11)] and consumption of iodised salt caused the median UIC among school children in the United State of America greater than 300 µg/L[12)].

In an area of iodine sufficiency, where iodine intake is sufficient, healthy individuals are very tolerable to high iodine intake up to 1 mg per day, bacause the thyroid is able to adjust to wide range of intakes to regulate and release of thyroid hormones. However, high dose of iodine i.e. more than 2 mg per day may increase the prevalence of goiter[7)].

Indicator of thyroid function i.e. thyrotropin hormon or thyroid stimulating hormon (TSH), total thyroxine (tT4) and thyroglobulin (Tg). TSH level is low when iodine intake is high. Similarly, thyroglobulin (Tg) is also low when iodine intake is high and increasing when the iodine intake is low or there is an increased in the thyroid cell or thyroid hyperplastic[13)]. In contrast, tT4 level is elevated when iodine intake is high[14)].

In adults, excess of iodine can increase the risk of thyroiditis, hyperthyroidism, hypothyroidism and goitre[15)]. The adminitration of iodine (10-1000 mg/day for several weeks) to euthyroid adults decreases serum thyroxine (T4) and triiodothyronine (T3) concentration[16)]. Smaller dosis of iodine (500-1500 µg/day) may also have a mild inhibitory effect on thyroid hormone secretion in adults with euthyroid. Significant iodine intake among population in area of chronic iodine deficiency causes *iodine induced hipotiroidism* (IIH).

In school age children, exposure of prolong high iodine intake is not clear yet but, iodine excess is associated with goitre and thyroid dysfunction. In Hokkaido, Japan iodine consumption among children with local traditional dietary is more than 23000 µg/day. Visible goitre prevalence of the children can reach above 25%. There is a need of study to investigate the upper level intake of iodine that still tolerable among school children in relation with thyroid function.

II. Objective

General

To study the relationship betwen iodine intake and thyoid function among children 8-10 years of age in area of non-iodine deficiency

Specific

1. To study urinary iodine concentration (UIC)
2. To study body surface area (BSA)
3. To study thyroid gland enlargement (goitre)
4. To study thyroid stimulating hormone (TSH) and thyroglobulin (Tg)
5. To study iodine level in salt used by household
6. To study iodine content in drinking water
7. To study the relationship between UIC, goitre, TSH and Tg

III. Hypothesis

i) Optimal or adequate daily iodine intake 8-10 years of age children is if the urinary iodine concentration 100 – 200 µg/L.

ii) Chronic daily iodine intake 8-10 years of age greater than 200 µg/L will increase the risk of thyroid dysfunction as reflected in abnormal values for TSH and thyroglobulin

IV. Methods

1. Conceptual Framework

Iodine intake into the body mainly comes from foods and drinks in the from of dietary food and drink as well as supplement. Almost all (more than 90%) of iodine excreted from the body is excreted through urine. Thus, urinary iodine concentration (UIC) or urine can be used as *bio-marker* of iodine intake into the body. The curent criteria of iodine intake is adequate or not deficiency if the UIC level 100-200 µg/L and risk of excessive fi the UIC greater than 300 µg/L or among school age children 200 µg/L in the long term period. Excessive iodine in the long term period will disturb thyroid function in the body that is in the TSH and thyroglobulin (Tg) as shown in the following **Figure 1**.

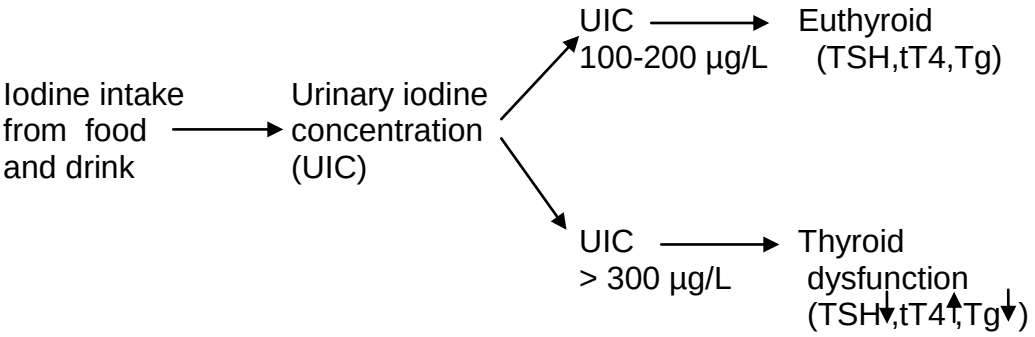

Figure 1
Conceptual Framework

2. Design

Design of this study is cross-sectional study

3. Location

This study was carried out in the District of Semarang and District of Grobogan, Province of Central Java and District of Bantul, Yogyakarta. In the district level 1 subdistrict was selected and in subdistrict level 1 village was selected. To obtain the desired subdistrict i.e. subdistrict with adequate iodine intake (100-199 µg/L), 3 subdistricts were selected, at the beginning, in District of Bantul. Subdistrict and village were selected randomly. The selection was based on the census block of the Basic Health Research (BHR) 2007 in District of Semarang, District of Grobogan and District of Bantul. In each of selected village: 1 Primary School was selected randomly. The number of student (8 – 10 years) in the selected Primary School: grade 3 through grade 5 at least 120 students or at least 40 students in each grade.

The selection of the 3 districts was based on median value of UIC from the BHR 2007 that is District of Bantul represent area of 'adequate' iodine intake, District of Semarang represent area of 'above requirements' iodine intake and District of Grobogan that represent area of 'excessive' iodine intake (**Table 1**). In the District of Semarang, subdistrict of Tuntang of and village of Jombor was selected. In the District of Bantul, subdistricts Sedayu, Pleret and Kretek were selected. Villages of Argorejo, Wonolilo and Trimulyo were selected in the each subdistrict respectively. Meanwhile, in the District of Grobogan, subdistrict of Purwodadi and village of Danyang was selected. The median value of UIC in District of Semarang was 244 µg/L where 71.9% of the household used salt that contained sufficient iodine, meanwhile, the median value of UIC in District of Grobogan was 365 µg/L where 22.2% of household used salt that contained sufficinet iodine. The median of UIC in the District of Bantul was 180 µg/L where 80.3% of the household used salt that contained sufficient iodine (**Table 2**).

The distribution of UIC in the district is showned in **Table 3**. Acording to the results of BHR 2007, 5.8% of children in District of Semarang, 5.0% of children in Bantul and 55.2% of children in District of Grobogan had UIC value greater or equal to 500 µg/L. In contrast, 10.3% of children in District of Semarang, 25.0% of children in Bantul and 6.0% of children in District of Grobogan had UIC value less than 100 µg/L.

Table 1.
Location of District, Subdistrict and Village

Province	District	Subdistrict	Village	Primary School
Central Java	Semarang	Tuntang (239)	Jombor (234)	PS 1
	Grobogan	Purwodadi (757)	Danyang (489)	PS 1
Yogyakarta	Bantul	Sedayu (109)	Argorejo (109)	PS 1
		Pleret (124)	Wonolelo (76)	PS 2
		Kretek (141)	Tirtomulyo (185)	PS 3

Note: number between two brackets is the median value of UIC (μg/L)

Table 2.
Median of UIC and percentage of household with sufficient iodine in salt

Location	n	Median UIC (μg/L)	Mean, standard deviation (μg/L)	HH with sufficient iodine in salt (%)
District of Semarang	225	249	267, 142	71.9
District of Grobogan	330	578	698, 552	22.2
District of Bantul	220	180	216, 144	80.3

Table 3.
Distribution of UIC among school children 6-12 years in Districts of Semarang, Grobogan and Bantul

Location	Distribution of UIC (μg/L) among children (%)							
	< 50	50-	100-	200-	300-	400-	>=500	N
District of Semarang	2,7	7,6	29,3	23,1	18,7	12,9	5,8	225
District of Grobogan	2,4	3,6	10,9	13,3	8,5	7,0	54,2	330
District of Bantul	2,3	22,7	30,9	19,5	11,4	8,2	5,0	220

Source: Basic Health Research 2007

4. Time

The study will be conducted for 4 months started from May-September 2011

5. Population and Subject

Population of this study is student of Primary School in Semarang, Bantul and Grobogan. Subject of this study is children aged 8-10 years old that is student of grade 3 - 5 in the selected Primary School in Semarang, Bantul and Grobogan. Determination of age of the child was based on school records.

The exclusive criteria of subject of this study are as follow:

i) Aged <8 years or > 10 years
ii) Smoker
iii) Personal or immediate family history of thyroid disease
iv) Recent or current use of iodine supplements or a multiple micronutrient containing iodine
v) Significant medical ilness, including gastrointestinal, hematological, hepatic or renal disease, or medical treatment for any of these conditions

These exclusive criteria should be confirmed by parents of the child which is included in the *Information sheet* or *informed consent*.

6. Sample Size

Calculation of sample size for this study is as follow. Result from earlier studies showed there was a variation in thyroid function variable around 25% from mean value. If the corellation between log UIC and log thyroid volume (r=0.24) from study by Zimmermann et al[16] is taken as an indication of the possible relation between UIC and thyroid function indicators, then the linear regression test of $p=0$ at an $\alpha=0.05$ for a two sided test and a normally distributed covariate, will require a sample size of 80 children in each districts with $1-\beta=90\%$ to detect $p=0.25$.

An additional 25% (=20) children is needed to allow for potential greater variability in the relationship between UIC and thyroid function and potential sampling 'drop-outs'. Thus, sample size in 1 district is 100 children or in 3 districts is 300 children will allow for within-country analyses (**Figure 2**). The data combination from 6 countries (Indonesia,

Tanzania, Croatia, Paraguay, the Philippines, and India) that is 1500 children processed and analysed for global relationship and also country origin as a dependent variable.

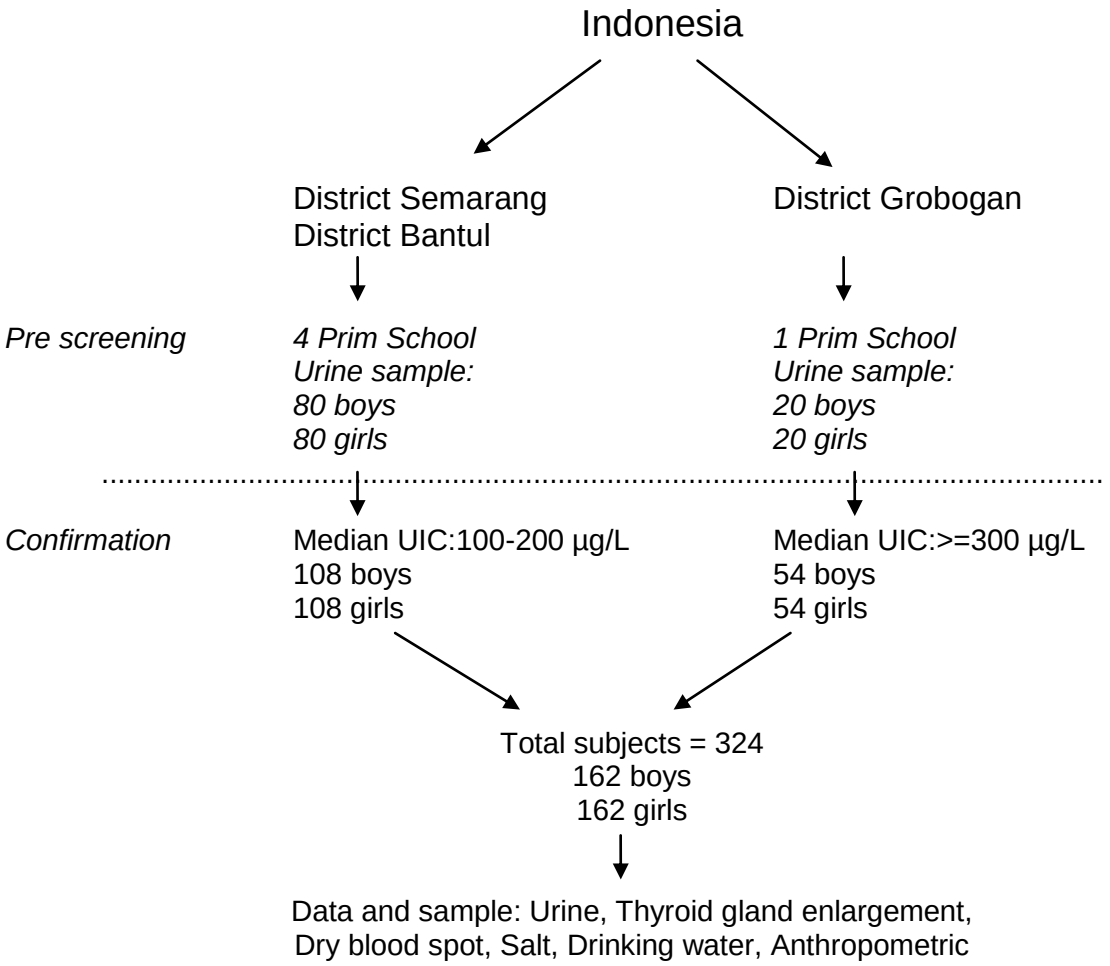

Figure 2
Sample Framework

Pre screening is needed to ensure that the area get together the criteria as excessive iodine intake area or as normal iodine intake area. Total 200 subjects that is 40 subjects in Semarang and 120 subjects (in 3 subdistrict) in Bantul to ensure that the median value of UIC 100-200 µg/L and 80 subjects in Grobogan to ensure that the median value of UIC >=300 µg/L. Those 200 children were asked for casual urine sample (in the morning) for the determination of UIC level.

7. Selection of Subject

Pre-screening

Total subject needed is 200 students that is 40 in Semarang, 120 in Bantul (3 subdistricts) and 40 in Grobogan. The subject was randomly selected as follow.

i) Select 1 Primary School in the selected village. For Bantul, 3 Primary School in 3 selected villages

ii) Make a list of student's name and their age in each grade and make it separate between boys and girls

iii) Only student aged 8 years old (started from 8 years 0 month) through 10 years old (untill 10 years 11 months) were included for selection

iv) Select randomly 7 boys and 7 girls from each group (group of 8 years old, 9 years old and 10 years old)

v) So that in one Primary School selected 42 students (21 boys and 21 girls) and take some students (boys and girls) for replacement.

vi) The total student selected in Semarang (42 students), in Bantul (126 students) and in Grobogan (42 students) is 210 students that is 105 boys and 105 girls

Confirmation

Once the location is eligible then data collection carried out in the Primary School. At the end only 1 Primary School selected in Bantul. Total subject needed is 324 students that is 108 in Semarang, 108 in Bantul and 108 in Grobogan. The subject was randomly selected as follow.

i) Make a list of student's name and their age in each grade and make it separate between boys and girls

ii) Only student aged 8 years old (started from 8 years 0 month) through 10 years old (untill 10 years 11 months) were included for selection

iii) Select randomly 18 boys and 18 girls from each group (group of 8 years old, 9 years old and 10 years old)

iv) So that in one Primary School selected 108 students (54 boys and 54 girls) and take some students (boys and girls) for replacement.

v) The total student selected in Semarang, in Bantul and in Grobogan is 324 students that is 162 boys and 162 girls

8. Collection of Data and Sample

The collection of data and samples were as follows:

i) Casual urine sample from children (8–10 years) : 50 cc and put into plastic bottle

ii) Anthropometric of children that is body weight through weighing and body height through standing height measurement by well-experienced nutritionist i.e have been involved in several studies with standard procedure of the measurements. There was no standardization of anthropometric measurements amongst measurers for this study.

iii) Thyroid gland enlargement (goitre) of children by palpation and using ultrasonography (USG). Palpation was carried out by experienced physician and nutritionist. Experienced mean that they have been trained both in class theoritically and practice in field (community) and they have been involved in several atudies. Measurement of thyroid volume using USG was carried out by radiologist (physician specialist in radiology)

iv) Dry blood spot sample from children that were taken from finger prick put onto filter paper by laboratory analyst and nurse

v) Salt sample that is used for daily cooking in the child's home as much as 30 grams (3 table spoon) and store into plastic bag

vi) Water sample that is used for daily drinking in the child's home: 50 cc and put into plastic bottle. The water can be tap water or well water.

9. Methods of data and sample collection

There will be 2 steps of data and sample collection that is:

i) step for pre-screening, and

ii) ii) step for confirmation.

A. Collection of data and sample for pre-screening:

Data and sample collected for screening were included child's identity and casual urine sample. Identity data and casual urine sample were collected in school. As many as 210 urine sample were collected 42 from Semarang, 126 from Bantul and 42 from Grobogan respectively. These urine samples are sent to the IDD Laboratory at the University of Diponegoro, Semarang, Central Java for its iodine level analysis. The results of analysis on iodine level in the urine or urinary iodine concentration (UIC) are expected to be high or excessive in Grobogan (median >= 300 µg/L), in Semarang and Bantul to be in normal range (median 100-200 µg/L).

Method of casual urine sample collection:

i) Ask child to urinate in the toilet at the school, gives the child drinking water if necessary to stimulate the child to urinate. For boys, urine sample can directly put into the provided plastic bottle, for girls: uine sample, first put urine into plastic bowel with plastic bag then pouring the urine into plastic bottle and thrown the plastic bag.

ii) The need of urine sample is only about half of the plastic bottle or about 50 cc

iii) Close tightly the top of the plastic bottle that contained urine sample

iv) Tighten the top plastic bottle with tape to avoid leaking

v) Stick label on plastic bottle and write child's identity: name, age, sex, grade, name of school and then taped.

vi) Put plastic bottle that had label into sealed plastic bag and make sure that evaporation will not be occured

vii) Store in room temperature, make sure the plastic bottle not be directly expose to heat or sunlight)

viii) Store urine sample in the laboratory in the refregerator but not necessary stored untill frozen

ix) Analysis of iodine level in urine was using enzyme link immuno sorbant assay (ELISA) method and spectrophotometer, Spectroni 20D,

x) The analysis was carried out in the IDD Laboratory in Semarang

B. *Collection of data and sample for confirmation:*

Data and sample for confirmation were collected from selected 324 school children. Collection of data and sample from children were include anthropometric for body surface area, thyroid gland enlargement, casual urine sample, blood spot sample, household's salt sample and sample of drinking water. Detailed of each collected data and sample is as follow:

i) Measurement of body weight (Wt) and body height (Ht) will be using standard technique of anthropometric measurement. For body weight: without shoes, without hat, emptied pocket and wearing cloth as thin as possible and weighing accuration is 0.1 kg. For body height: standing position, without shoes and/or hat and height accuration is 0.1 cm. Reference values for thyroid volume measured by ultrasonography in schoolchildren is presented as a function of age, sex, and body surface area (BSA)[1)]. Unit of BSA is meter square (m^2). The BSA is needed in order to take into account the differences in body development among children of the same age in different countries. The DuBois and DuBois formula for BSA is as follow:
BSA (m^2) = $Weight(kg)^{0.425}$ x $Height(m)^{0.725}$ x 71.84 x 10^{-4}.

ii) Determination of thyroid gland enlargement was by observation as well as by palpation on the thyroid gland

iii) Measurement of the volume of thyroid gland was using ultrasonography (USG) on the thyroid gland

iv) Casual urine sample was ask from children at school in the time of data collection and put into plastic bottle

v) Dry blood spot (DBS) sample was taken from finger prick and put onto filter paper (grade 903, Scheicher & Schuell, Einbeck, German) leave it dry at room temperature (around 20^0C) and then is stored at 4^0C in plastic bag (low-density polyethylene) until analysed.

vi) Salt sample used daily in household was collected from all children

vii) Sampel of drinking water was collected from some children

Method of weighing body weight:

i) Using A4 sized weight watcher digital weighing scale (UC-322, AND, A&D Company Limited) with 0.1 kilogram accuration

ii) Child is asked to free all shoes/sandals, emptied pocket, and only wearing cloth as thin as possible.

iii) All child's feet onto the weighing scale, stand upright and look out forward

iv) Wait until the digital number in the window of weighing scale doesnot change anymore

v) Note the number at the digital window of the weighing scale until 1 decimal, that is the body weight of the child

Method of measuring body height:

i) Using stature meter 200 CM no.26SM body height measurement scale with 0.1 centimetre accuration

ii) Child is asked to free shoes/sandals and hat/cap, stand upright, close foot together and look out forward

iii) Move and stick the right-angled of the stature meter upright above head of the child

iv) Note down the number in the stature meter's window that is height of the child until the nearest millimetre

Method of measuring enlargement of thyroid gland by palpation:

i) Ask the child to stand up in front of and face to the palpation person that observes the front neck of the child whether there is an enlargement of thyroid gland

ii) Ask the child to hold up the head so that it is fully extended. This position will push the thyroid gland appear.

iii) Then palpation person gently rubs the thyroid gland using thumbs along the trachea. To ease the palpation, ask the child to swallow by giving drinking water or candy with sour taste so that thyroid gland will go up while swallowing.

iv) The size of both side of thyroid gland compare with the end part of the child's thumb. If grater than the thumb means that there is an enlargement of thyroid gland.

v) Result of palpation is noted as follow: 0= no thyroid gland enlargement, 1= thyroid gland enlarged but not visible when the neck in normal position (enlargement of thyroid gland not yet visible). Thyroid nodular, although not visible, includes in this category and 2= enlargement at the neck is visible (can be seen from distance) and also when it is palpated.

Method of measuring volume of thyroid gland by ultrasonography:

i) Equipment used to measure the volume of thyroid gland is ultrasonography (USG) 2 dimension portable ExaGo 1006ex14 made in France and printer Sony model UP897MD.

ii) Measurement was conducted by radiologist

iii) Thyroid gland enlargement is measured by ultrasonography that yield the thyroid volume: length (l), width (w) and depth (d)

iv) Volume of thyroid gland (mililiter) is multiplication of l (cm) x w (cm) x d (cm) with correction factor of 0.479

v) It is a goitre if the thyroid volume greater than 97 percentile adjusted for both age and body surface area (BSA)

Method of taking blood spot sample

i) The blood sample taker wearing gloves

ii) Prepare filter paper, write child's identity: name, age, sex, grade and name of school using ballpoint/pencil

iii) The inner side of the circle outline in the filter paper for the blood spot, do not touch with hand although wearing gloves, avoid struck from antiseptic solution, chemical substance or other solution

iv) Hold the child's ring-finger, clean the finger tip with alcohol 70%, wipe off with dry cotton

v) Use the disposible sterile lancet, wipe off the first blood drop with dry cotton (not to be taken), to obtain sufficient blood, gently massage the finger

vi) The drop of blood is put onto the middle of the circle outline and fulfill the entire area within the circle with blood

vii) One drop of blood is only for one circle outline and should go through the back of the filter paper

viii) Do not repeat to drop the blood to the same circle outline

ix) Perform through the fifth circle outline in the filter paper so that all circle fulfill with blood

x) Do not touch the blood sample with hands or put in unsafe place and do not expose to sunlight or to direct heat

xi) Put the paper in the horizontal position and avoid the paper into touch with other unless it is dry

xii) Dry at cool and dry room (not humid), ideally in air conditioned room (around 20^0C) all night long (around 8-10 hours)

xiii) Put it into sealed plastic bag and stored in cool and dry room until ready to be sent

xiv) When the *material transfer agreement* (MTA) is ready then the dry blood spot samples will be sent using FedEx service to the Human Nutrition Laboratory of the Swiss Federal Institute of Technology (ETH) Zürich, Switzerland for analysis.

Method of collecting salt sample

i) Ask for 3 table spoon of household salt sample from children (subject of this study)

ii) If salt stored in a bowl, ask the child to stir up first then take the middle part, if in the form of bricket then crush first and stir up and lastly take 3 table spoon of the salt.

iii) Put the salt into sealed plastic bag

iv) Stick label on plastic bag and write child's identity: name, age, sex, grade and name of school

v) Store in dry place/room until ready for analysis

vi) Analysis of iodine level in salt was carried out in the Laboratory in Semarang

Method of collecting sample of drinking water:

i) Ask the child to bring water used for drink at home 50 cc or ½ of provided plastic bottle
ii) Close the top of plastic bottle and tighten with tape
iii) Stick label and write area identity: district, subdistrict, village, name of primary school
iv) Store in dry place/room until ready for analysis
v) Analysis of iodine level in drinking water was using enzyme link immuno sorbant assay (ELISA) method and spectrophotometer, Spectroni 20D,
vi) The analysis was carried out in the IDD Laboratory in Semarang

10. Variables and operational definition

Variables collected, method of collection and its definition are shown in **Table 4**.

Table 4
Variable, operational definition and method of its measurement

No.	Variable	Operational definition	Method of measurement	Criteria	Scale
1.	Household salt	Iodine level in household (HH) salt	Rapid test kit & titration from sample of salt	Iodine level in salt -Qualitative: sufficient, not sufficient and no iodine Quantitative: < 20 ppm low >20 ppm adequate	Numeric
2.	Iodine in drinking water	Iodine level in child's drinking water	Water sample from HH's drinking water using spectrophotometer, Spectroni 20D	Iodine level in drinking water	Ratio
3.	Height for age	Measurement of Ht based on Age Ht (cm), age (yrs,mo)	Using standard WHO 2007	Normal: z-score $\geq$ - 2.0 Stunting: z-score < - 2.0	Categorical
4.	Body Mass Index (BMI) for age	Measurement of BMI based on Age BMI (kg/m^2), age (yrs,mo)	Using standard WHO 2007	Wasting:z-score $\leq$ - 2.0 Normal: z-score $\geq$ - 2.0 and $\leq$ 2.0 Overweight:z-score	Categorical
5.	Body Surface Area	Body Surface Area (BSA) value based on Wt and Ht	Measurement of weight (kg) & height (cm)	BSA in square meter (m^2): multiplication of Ht & Wt	Categorical
6.	Thyroid size	Thyroid enlargement or goitre	Palpation of thyroid gland by physician or nutritionist	1= Normal, 2= thyroid enlargement, 3= enlargement visible	Categorical
7.	Thyroid volume	Thyroid enlargement or goitre	Ultrasonography (USG) by radiologist	Using 97 percentile and as a function of age and BSA	Numeric
8.	Urinary iodine concentration (UIC)	Iodine concentration in urine of child	Casual urine sample of children using spectrophotometer	UIC: <100 µg/L risk of iodine deficiency, 100-299 µg/L optimal, >300 µg/L risk of excessive iodine	Numeric/ Categorical
9	Thyroid Stimulating Hormone (TSH)	TSH level of child from dry blood spot	Dry blood spot sample of children by laboratory analyst or nurse	High: > 6.0 µIU/mL Risk of hypothyroidism Low: < 0.4 µIU/mL Risk of hyperthyroidism	Numeric/ Categorical
10	Thyroglobulin (Tg)	Thyroglobulin level of child from dry blood spot	Dry blood spot sample of children	High: > 40.0 µg/L Riks of hypothyroidism Low: <4.0 µg/L Risk of hyperthyroidism	Numeric/ Categorical
11	Thyroxine Hormon (T4)	Thyroxine level of child from dry blood spot	Dry blood spot sample of children	High: > 165 nmol/L Risk of hyperthyroidism Low: < 65 nmol/L Risk of hypothyroidism	Numeric/ Categorical

11. Laboratory work

Laboratory work is carried out in Semarang, Indonesia and in Zürich, Switzerland. Here is the explanation.

i) Iodine level in urine sample and drinking water were analysed using method that recommended by WHO/UNICEF/ICCIDD[1)] that is enzym link immuno sorbant assay (ELISA) method and spectrophotometer, Spectroni 20D, in the IDD Laboratory in the University of Diponegoro, Semarang, Indonesia which is currently internationally recognize.

ii) Iodine level in salt samples was analysed using titration method that recommended by WHO/UNICEF/ICCIDD[1)] in the IDD Laboratory in the University of Diponegoro, Semarang, Indonesia which is currently internationally recognized.

iii) For the reason of developing reference standard, so sample of dry blood spot from all countries involved in this collaborative study will be analysed for thyroglobulin (Tg) and thyrotropin (TSH) using 'dissociation enhance lanthanide fluorescent immunoassy' (DELFIA Neo TSH) method that has been adopted for dry blood spot and total thyroxine (tT4) using DELFIA Neonatal T4 Kit in the Human Nutrition Laboratory Institute of Food, Nutrition and Health, the Swiss Federal Institute of Technology (ETH) Zürich, Switzerland.

V. Results

a. Data collection for screening

Data collection for screening included identity and sample of urine from children aged 8-10 years old.

Province of Central Java

District of Grobogan, subdistrict of Purwodadi, village of Danyang, SDN 2 Danyang

District of Semarang, subdistrict of Tuntang, village of Jombor, SDN Jombor dan MI Jombor.

Province of Yogyakarta

District of Bantul, subdistrict of Sedayu (village of Argorejo), SDN Krapyak; subdistrict of Pleret (village of Wonolelo), SDN Wonolelo and MI Al Khoiro; and subdistrict of Kretek (village of Trimulyo), SDN Tirtomulyo.

District	Sub-district	Village	Median, Mean, Std.Dev. (µg/L)	No subject
Grobogan	Purwodadi	Danyang	593, 546, 95	42
Semarang	Tuntang	Jombor	211, 214, 107	42
Bantul			208, 195, 48	126
	Sedayu	Argorejo	214, 200, 51	41
	Pleret	Wonolelo	184, 178, 47	42
	Kretek	Tirtomulyo	220, 213, 26	42

b. Data collection for analysis

Data collection was carried out from Grobogan, Semarang and Bantul respectively.

Province of Central Java

Data collection of this study was started from District of Grobogan, subdistrict of Purwodadi, village of Danyang, SDN 2 Danyang. The expected or planned number of subject to be examined was 100-110 children. Due to the request from school, the number increased to 119. However, determination the number of subject was based on both USG and DBS. In this case, although 119 subjects were examined by USG but only 112 subjects were asked for DBS. Thus that the number of subject that was planned for analysis was 112. At the end, only 111 subjects were included in the data analysis after completing laboratory data.

District of Semarang, subdistrict of Tuntang, village of Jombor, SDN Jombor dan MI Jombor, SDN Candirejo, SDN Sidorejo, SDN Salatiga. All children are lived in village of Jombor. The number of subject was 108 when field data collection finished and also after completing laboratory data.

Province of Yogyakarta

District of Bantul, subdistrict of Pleret (village of Wonolelo), SDN Wonolelo and MI Al Khoiro. The number of subjects examined by USG were 109 but only 108 subjects were asked for DBS. Thus that only 108 subjects were planned in the data analysis. The number remained 108 subjects after completing laboratory data.

Location	Number of samples					
	USG	DBS	Urine	HHs Salt	Water*)	Total final
Grobogan	113	112	120	120	8	111
Semarang	108	108	108	108	7	108
Bantul	109	108	108	108	5	108
T o t a l	330	328	336	336	20	127

Note: *) from piped-water as well as from well-water

Laboratory works for iodine in urine from all urine samples in Semarang were finished. However, titration for iodine in salt from all households salt samples in Semarang were not finished yet. Overall, data entry is in progress and almost finished.

Table 1 shows the distribution of age of school children by district. In Grobogan, the school children were equally distributed by age. However, in Semarang, the proportion of children aged 10 years was higher than children aged 8 and 9 years and similarly in Bantul, the proportion of children aged 9 years was higher than children aged 8 and 10 years.

Table 1.

Age distribution of school children by district

District	Age (years)			
	8	9	10	T o t a l
Grobogan	39 (33.6%)	39 (33.6%)	38 (32.8%	116 (100%)
Semarang	33 (30.8%)	34 (31.8%)	40 (37.4%)	107 (100%)
Bantul	35 (33.0%)	43 (40.6%)	28 (26.4%)	106 (100%)

There are more girls than boys in Grobogan as shown in **Table 2**. In contrast, there are more boys than girls in Semarang. However, the number of boys and gilrs in Bantul are almolst the same. The total number of school children for this study was more than 300 school children as the study requirement i.e. 116, 107 and 106 in Grobogan, Semarang and Bantul respectively.

Table 2.

Gender distribution of school children by district

District	Gender		
	Boys	Girls	T o t a l
Grobogan	51 (44.0%)	65 (56.0%)	116 (100%)
Semarang	60 (56.1%)	47 (43.9%)	107 (100%)
Bantul	51 (48.1%)	55 (51.9%)	10600%)

c. Urinary Iodine Concentration (UIC)

Collection of urine sample in this study was casual or one spot collection. Analysis of iodine level in the urine sample was using enzym link immuno sorbant assay (ELISA) method. Results of analysis are shown in Table 3, Table 4 and Table 5 respectively.

Table 3 showed that the mean and standard deviation values of UIC of all chilren was 232 µg/L and 81 µg/L respectively. Mean value was highest (305 µg/L) in Grobogan and the lowest (173 µg/L) was in Bantul. Median and 5th and 95th percentile values of all children were 235 µg/L, 90 µg/L and 350 µg/L respectively . The highest (312 µg/L) median value was in Grobogan and the lowest (186 µg/L) was in Bantul.

Based on age of children, the mean value of UIC was similar at all age and so the median value (**Tabel 4**). The UIC of children based on age and district is shown in **Table 5**. It is shown that there was a constant trend in the mean as well as in the median values. The trend was that Grobogan the highest and Bantul the lowest.

Table 3.
Mean dan median values of urinary iodine concentration (UIC) by districts

District	N	UIC (µg/L)	
		Mean (SD)	Median (P5 ; P95)
Grobogan	111	305 (60)	312 (174 ; 391)
Semarang	106	215 (60)	225 (80 ; 293)
Bantul	107	173 (58)	186 (67 ; 249)
Total	324	232 (81)	235 (90 ; 350)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

Table 4.
Mean dan median values of urinary iodine concentration (UIC) by age

Age (yrs)	N	UIC (µg/L)	
		Mean (SD)	Median (P5 ; P95)
8	108	233 (81)	236 (67 ; 349)
9	112	233 (71)	221 (86 ; 317)
10	104	241 (90)	239 (95 ; 392)
Total	324	232 (81)	235 (90 ; 350)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

Table 5.
Mean dan median values of urinary iodine concentration (UIC) by age and district

Age (yrs) / District	N	UIC (µg/L)	
		Mean (SD)	Median (P5 ; P95)
8	108		
Grobogan	40	294 (67)	315 (154 ; 350)
Semarang	32	218 (57)	234 (86 ; 284)
Bantul	36	179 (70)	194 (35 ; 287)
9 years	112		
Grobogan	35	292 (44)	306 (183 ; 343)
Semarang	34	206 (70)	194 (35 ; 287)
Bantul	43	180 (45)	189 (86 ; 252)
10 years	104		
Grobogan	36	330 (59)	344 (175 ; 394)
Semarang	40	221 (55)	221 (124 ; 293)
Bantul	28	156 (56)	161 (67 ; 240)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

Using epidemiological criteria for assessing iodine nutrition of the World Health Organization (WHO) of school age children, for overall children, only 29% of children categorized as having adequate intake of iodine. There was 6.8% of children with insufficient iodine intake and 23.8% of children with ecessive iodine intake. In Grobogan, there was 67.6% of children categorized as having excessive iodine intake, while in Semarang and Bantul only 0.9% (**Tabel 6**). Based on age of children, the percentage as having insufficient iodine intake was similar in all age and so the percentage of children with excessive iodine intake (**Table 7**).

Table 6.
Adequacy of urinary iodine concentration (UIC) of children by district

District	N	UIC (µg/L)			
		<100	100-199	200-299	300-399
Grobogan	111	0,9	8,1	23,4	67,6
Semarang	106	5,7	31,1	62,3	0,9
Bantul	107	14,0	48,6	36,4	0,9
Total	324	6,8	29,0	40,4	23,8

Note: < 100 µg/L=insufficient iodine intake, 100-199 µg/L = adequate, 200-299 µg/L = above requirement, >=300 µg/L= excessive

Table 7.
Adequacy of urinary iodine concentration of children by age

Age (years)	N	UIC (µg/L)			
		<100	100-199	200-299	300-399
8	108	7,4	28,7	38,9	25,0
9	112	6,3	33,9	39,3	20,5
10	104	6,7	24,0	43,3	26,0
Total	324	6,8	29,0	40,4	23,8

Note: < 100 µg/L=insufficient iodine intake, 100-199 µg/L = adequate, 200-299 µg/L = above requirement, >=300 µg/L= excessive

d. Anthropometric

Collection of anthropometric data included body weight using “UC-322, AND, A&D Company Limited digital weighing scale” and body height using “Stature Meter 200 CM no.26SM”. The number of children that had complete data to calculate the nutritional status was 321 children (160 boys and 161 girls).

Body Weight (Wt)

Result from measurements of the children body weight showed that the overall mean and standard deviation of body weight were 25,0 ± 5,3 kg and 26,1± 6,7 kg for boys and girls respectively. Mean and standard deviation of body weight for boys was lower than for girls in Grobogan and Semarang but not in Bantul. The overall median, 5th and 95th percentiles were 23,9; 18,4 and 37,7 kg respectively among boys and 23,9; 18,2 and 40,6 kg repectively among girls (**Table 8a**). Mean and median of body weight for both boys and girls is shown in **Table 8b**. The overall mean and standard deviation of body weight was 25,5 ± 6,1 kg. In Grobogan, the mean and standard deviation of body weight was 25,7± 5,9 kg, in Semarang was 25,9± 7,1 and in Bantul was 25,0± 5,1 kg. Median value, 5^{th} and 95^{th} percentiles were 23,9; 18,4 and 37,8 kg respectively. In Grobogan, median value of body height was 24,4 kg, in Semarang was 23,9 kg and in Bantul was 23,7 kg.

Based on the age of children, the mean of body weight increased with age where girls was hevier than boys. Median value of body weight increase with age both among boys and girls (**Table 9**). Mean body weight increased with age in every district in both boys and girls. Similarly, the median value of body weight also increased with age in both boys and girls (**Tabel 10**).

Table 8a.
Mean and median of body weight of boys and girls by district

District	N		Body weight (kg)			
			Mean (SD)		Median (P5 ; P95)	
	Boys	Girls	Boys	Girls	Boys	Girls
Grobogan	51	58	24,6 (5,3)	26,6 (6,4)	23,9 (17,5 : 36,5)	25,3 (18,2 : 41,2)
Semarang	57	48	24,8 (5,1)	27,4 (8,7)	23,5 (17,6 : 34,3)	24,7 (18,2 : 50,6)
Bantul	52	55	25,7 (5,4)	24,4 (4,5)	24,2 (19,3 : 39,0)	23,4 (17,9 : 35,0)
Total	160	161	25,0 (5,3)	26,1 (6,7)	23,9 (18,4 : 37,7)	23,9 (18,2 : 40,6)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

Table 8b.
Mean and median of body weight of children by district

District	n	Body weight (kg)	
		Mean (SD)	Median (P5 ; P95)
Grobogan	109	25,7 (5,9)	24,4 (18,2 ; 38,8)
Semarang	105	25,9 (7,1)	23,9 (18,1 ; 44,1)
Bantul	107	25,0 (5,0)	23,7 (18,7 ; 35,6)
Total	321	25,5 (6,1)	23,9 (18,4 ; 37,8)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

Table 9.
Mean and median of body weight of children by age

Age (yrs)	N		Body weight (kg)			
			Mean (SD)		Median (P5 ; P95)	
	Boys	Girls	Boys	Girls	Boys	Girls
8	54	52	22,5 (5,0)	23,4 (5,9)	21,4 (16,9 : 34,9)	22,4 (17,3 : 38,9)
9	56	56	25,4 (3,9)	25,8 (6,7)	24,6 (20,0 : 32,6)	23,4 (18,5 : 45,5)
10	50	53	27,3 (5,8)	29,0 (6,5)	26,2 (19,9 : 42,9)	27,9 (20,8 : 43,2)
Total	160	161	25,0 (5,3)	26,1 (6,7)	23,9 (18,4 : 37,7)	23,9 (18,2 : 40,6)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

Table 10.
Mean and median of body weight of children by age and district

Age / Dsitrict	N		Body weight (kg)			
			Mean (SD)		Median (P5 ; P95)	
	Boys	Girls	Boys	Girls	Boys	Girls
8						
Grobogan	17	21	20,8 (2,7)	23,8 (5,2)	20,6 (16,7 : -)	22,8 (17,8 : -)
Semarang	16	15	22,2 (4,8)	24,4 (8,6)	22,0 (16,5 : -)	21,9 (17,3 : -)
Bantul	21	16	24,1 (6,1)	22,0 (3,2)	22,6 (17,6 : 44,0)	22,2 (17,2 : -)
9						
Grobogan	17	18	25,3 (3,0)	27,2 (8,1)	24,9 (19,6 : -)	24,3 (18,2 : -)
Semarang	19	15	24,6 (3,8)	27,8 (8,2)	23,9 (19,7 : 38,5)	25,8 (19,1 : -)
Bantul	20	23	26,4 (4,6)	23,3 (3,0)	24,9 (21,7 : -)	23,2 (18,2 : -)
10						
Grobogan	17	19	27,8 (6,8)	29,1 (4,6)	26,2 (18,5 : -)	28,3 (22,9 : -)
Semarang	22	18	26,8 (5,5)	29,5 (9,1)	26,4 (17,6 : 42,9)	27,4 (20,3 : -)
Bantul	11	16	27,5 (5,1)	28,3 (5,1)	25,1 (22,8 : -)	28,0 (19,5 : -)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

Body height (Ht)

Result from measurements of the children body height showed that the overall mean and standard deviation of body height were 126.1 ± 6,3 cm and 127,3 ± 8,2 cm for boys and girls respectively (**Table 11a**). Among boys, mean of body height was similar in all district. Mean and standard deviation of body height for boys was lower than for girls in Grobogan and Semarang but not in Bantul. The overall median values of body height were 125,8 cm and 127,0 for boys and girls respectively. There was no clear pattern beween median value and mean value of body height in all district. Mean and median of body height for both boys and girls is shown in **Table 11b**. The overall mean and standard deviation of body height was 126,7 ± 7,4 cm. In Grobogan, the mean and standard deviation of body height was 126,5± 7,1 cm, in Semarang was 127,3± 7,9 cm and in Bantul was 126,3± 7,1 cm. The overall median value, 5^{th} and 95^{th} percentiles

were 126,5; 115,5 and 139,5 cm respectively. In Grobogan, median value of body height was 127,5 cm, in Semarang was 126,9 cm and in Bantul was 125,3 cm.

Based on age of children, the mean of body height increased with age in both boys and girls and so the median. Mean value of body height was similar to the median value of body height (**Table 12**). Mean and median values of body height for 10 years old girls was higher than boys (**Tabel 13**)

Table 11a.
Mean and median of body height of boys and girls by district

District	N		Body height (cm)			
			Mean (SD)		Median (P5 ; P95)	
	Boys	Girls	Boys	Girls	Boys	Girls
Grobogan	51	58	126,1 (6,6)	126,9 (7,6)	127,0 (115,3:138,8)	127,5 (114,4:140,0)
Semarang	57	48	125,6 (6,5)	129,2 (8,9)	125,0 (115,9:138,4)	128,1 (113,3:144,1)
Bantul	52	55	126,7 (6,0)	125,9 (8,0)	125,6 (117,0:135,7)	124,6 (115,2:140,6)
Total	160	161	126,1 (6,3)	127,3 (8,2)	125,8 (116,0:137,0)	127,0 (114,6:140,5)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

Table 11b.
Mean and median of body height of children by district

District	N	Body height (cm)	
		Mean (SD)	Median (P5 ; P95)
Grobogan	109	126,5 (7,1)	127,5 (115,0 ; 139,7)
Semarang	105	127,3 (7,9)	126,9 (114,9 ; 140,2)
Bantul	107	126,3 (7,1)	125,2 (116,4 ; 139,1)
Total	321	126,7 (7,4)	126,5 (115,5 ; 139,5)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

Table 12.
Mean and median of body height of children by age

Age (yrs)	N		Body height (cm)			
			Mean (SD)		Median (P5 ; P95)	
	Boys	Girls	Boys	Girls	Boys	Girls
8	54	52	121,6 (4,9)	122,3 (8,3)	121,0 (113,4:132,1)	122,2 (112,2:137,5)
9	56	56	126,5 (4,9)	126,6 (6,5)	126,6 (118,9:134,9)	125,3 (117,4:140,1)
10	50	53	130,7 (5,7)	132,8 (6,2)	130,5 (121,2:141,6)	131,6 (122,0:143,0)
Total	160	161	126,1 (6,3)	127,3 (8,2)	125,8 (116,1:137,0)	127,0 (114,6:140,5)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

Table 13.
Mean and median of body height of children by age and district

Age / Dsitrict	N		Body height (cm)			
			Mean (SD)		Median (P5 ; P95)	
	Boys	Girls	Boys	Girls	Boys	Girls
8						
Grobogan	17	21	121,4 (5,6)	122,3 (6,3)	120,0 (114,0: -)	123,0 (111,6: 132,9)
Semarang	16	15	120,5 (4,9)	124,1 (11,7)	120,7 (111,0: -)	123,5 (106,5: -)
Bantul	21	16	122,4 (4,4)	120,5 (6,6)	122,9 (112,2: 132,0)	118,1 (112,5: -)
9						
Grobogan	17	18	126,1 (4,4)	126,7 (7,3)	128,5 (118,0: -)	125,8 (117,0: -)
Semarang	19	15	124,8 (4,9)	129,9 (7,1)	123,4 (117,9: -)	127,9 (119,9: -)
Bantul	20	23	128,3 (4,9)	124,3 (4,4)	128,9 (120,9: 136,5)	123,5 (116,6: 132,8)
10						
Grobogan	17	19	130,7 (6,2)	132,2 (5,7)	130,0 (119,5: -)	131,0 (122,6: -)
Semarang	22	18	130,1 (5,8)	132,9 (5,4)	130,5 (117,1: 139,9)	132,7 (125,0: -)
Bantul	11	16	131,8 (5,3)	133,5 (7,7)	132,4 (124,6: -)	133,8 (118,1: -)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

Nutritional status

Distribution of nutritional status among boys and girls by district is shown in **Tabel 14a**. Overall, the percentage of children with stunted was 11,9% for boys and 14,9% for girls; under-weight was 13,7% for boys and 14,4% for girls; and wasted was 6,8% for boys and 9,4% for girls. The highest (15,7%) of stunted was among boys in Grobogan and the lowest (5,8%) was among boys in Bantul. The highest (17,5%) of underweight was among boys in Semarang and the lowest (5,8%) in Bantul. The highest (15,7%) of wasted was among boys in Grobogan and the lowest (3,8%) was among boys in Bantul. Nutritional status combined boys and girls by district si shown in **Table 14b**. Overall, the percentage of children with stunted was 13,4%; under-weight was 14,0%; and wasted was 8,1%. The highest (16,5%) of stunted was among children in Grobogan and the lowest (10,2%) was among children in Bantul. The highest (17,1%) of underweight was among children in Semarang and the lowest (9,3%) in Bantul. The highest (10,1%) of wasted was among children in Grobogan and the lowest (5,6%) was among children in Bantul.

Table 14a.
Nutrirional status of boys and girls by district

Index Status	District						Total	
	Grobogan		Semarang		Bantul			
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Grils
Ht/A								
Stunted	8(15,7)	14(7,2)	8(14,0)	6(12,5)	3(5,8)	8(14,5)	19(11,9)	24(14,9)
Normal	43(84,3)	48(82,8)	49(86,0)	42(87,5)	49(94,2)	47(85,5)	141(88,1)	137(85,1)
Wt/A								
Under wt	10 (9,0)	7(12,1)	10 (17,5)	8(16,7)	3(5,8)	7(12,7)	23(14,4)	22(13,7)
Normal	42(81,0)	48(82,8)	44(77,2)	34(70,8)	48(92,3)	45(81,8)	133(83,1)	127(78,9)
Over wt	0	3 (5,2)	3 (5,3)	6(12,5)	1(1,9)	3(5,5)	4(2,5)	12(7,4)
BMI/A								
Wasted	8(15,7)	3(5,2)	5(8,8)	4(8,3)	2(3,8)	4(7,3)	15(9,4)	11(6,8)
Normal	41(80,4)	50(86,2)	50(87,7)	39(81,3)	44(84,6)	51(92,7)	135(84,4)	140(87,0)
Over wt	2(3,9)	5(8,6)	2(3,5)	5(10,4)	6(11,5)	0	10(6,3)	10(6,2)

Note: Wt=weight, Ht=height, number between parentheses is percentage

Table 14b.
Nutrirional status of children by district

Index	Status	District			Total
		Grobogan	Semarang	Bantul	
Ht/A					
	Stunted	18 (16,5)	14 (13,3)	11 (10,2)	43 (13,4)
	Normal	91 (83,5)	91 (86,7)	96 (89,7)	278 (86,6)
Wt/A					
	Under wt	17 (15,6)	18 (17,1)	10 (9,3)	45 (14,0)
	Normal	89 (81,7)	78 (74,3)	93 (87,0)	260 (81,0)
	Over wt	3 (2,8)	9 (8,6)	4 (3,7)	14 (4,9)
BMI/A					
	Wasted	11 (10,1)	9 (8,5)	6 (5,6)	26 (8,1)
	Normal	91 (83,5)	89 (84,8)	95 (88,8)	275 (85,7)
	Over wt	7 (6,4)	7 (6,7)	6 (5,6)	20 (6,2)

Note: Wt=weight, Ht=height, number between parentheses is percentage

Distribution of nutritional status among children by age is shown in **Tabel 15**. Percentage of stunted was highest (17,3%) among girls at the age of 8 years old and the lowsest (8,9%) among boys at theage of 9 years old. The highest (20%) of underweight was among boys at the age of 10 years old and the lowest (7,1%) was among boys at the age of 9 years old. The highest (14,0%) of wasted was among boys at the age 0f 10 years old and the lowest (1,8%) was among boys at the age of 9 years old.

Table 15.
Nutrirional status of children by age

Index Status	Age (yrs)						Total	
	8		9		10			
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Grils
Ht/A								
Stunted	6(11.1)	9(17,3)	5(8,9)	9(16,1)	8(16,0)	6(11,3)	19(11,9)	24(14,9)
Normal	48(88,9)	43(82,7)	51(91,1)	47(83,9)	42(84,0)	47(88,7)	141(88,1)	137(85,1)
Wt/A								
Under wt	9(16,7)	7(12,1)	4(7,1)	8(16,7)	10(20,0)	7(12,7)	23(14,4)	22(13,7)
Normal	43(79,6)	48(81,8)	51(91,1)	34(70,8)	39(78,0)	45(81,8)	133(83,1)	127(78,9)
Over wt	2(3,7)	3(5,2)	1(1,8)	6(12,5)	1(2,0)	3(5,5)	4(2,5)	12(7,4)
BMI/A								
Wasted	7(13,0)	3(5,8)	1(1,8)	4(7,1)	7(14,0)	4(7,5)	15(9,4)	11(6,8)
Normal	43(79,6)	44(84,6)	53(94,6)	49(87,5)	39(78,0)	47(88,7)	135(84,4)	140(87,0)
Over wt	4(7,4)	5(9,6)	2(3,6)	3(5,4)	4(8,0)	2(3,8)	10(6,2)	10(6,2)

Note: Wt=weight, Ht=height, number between parentheses is percentage

Body Surface Area (BSA)

The body surface area (BSA) is needed in order to take into account the differences in body development among children of the same age in different countries. BSA is useful in population with a high prevalence of child growth retardation due to malnutrition with both stunting (Ht/A) and underweight (Wt/A).

Result from measurements of BSA among children 8-10 years old showed that the same among boys and girls for overall mean and standard deviation of BSA that is 0,6 and 0.1 m^2 respectively (**Table 16a**). Mean of BSA was the same among boys and girls in all districts. The overall median and 5th and 95th percentile values of BSA were 0,6 m^2, 0,4 m^2 and 0.8 m^2 respectively among boys and 0,6 m^2, 0,4 m^2 and 0,9 m^2 respectively among girls. The median value of BSA was the same with the mean of BSA in all districts except among girls in Bantul (0,5 m^2). Mean and median of BSA combined boys and girls age 8-10 years is shown in **Table 16b**. The overall mean and standard deviation of BSA that is 0,6 and 0.1 m^2 respectively. Mean of BSA was also the same in all districts that is 0,6 and 0,1 m^2. The overall median and 5th and 95th

percentile values of BSA were 0,6 m^2, 0,4 m^2 and 0.8 m^2 respectively. The median value of BSA was the same with the mean of BSA in all districts.

Based on age of children, the mean of BSA tend to increase with age and so the median (**Table 17**). Mean BSA for children in Grobogan clearly increased with age but not so in Semarang and Bantul. The median value of BSA was similar in all age (**Tabel 18**).

Table 16a.
Mean and median of body surface area of boys and girls by district

District	N		Body surface area (m^2)			
			Mean (SD)		Median (P5 ; P95)	
	Boys	Girls	Boys	Girls	Boys	Girls
Grobogan	51	58	0,6 (0,1)	0,6 (0,1)	0,6 (0,4 : 0,8)	0,6 (0,4: 0,9)
Semarang	57	48	0,6 (0,1)	0,6 (0,2)	0,6 (0,4 : 0,8)	0,6 (0,4: 1,1)
Bantul	52	55	0,6 (0,1)	0,6 (0,1)	0,6 (0,5 : 0,8)	0,5 (0,4: 0,8)
Total	160	161	0,6 (0,1)	0,6 (0,1)	0,6 (0,5 : 0,8)	0,6 (0,4: 0,9)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

Table 16b.
Mean and median of body surface area of children by district

District	n	Body surface area (m^2)	
		Mean (SD)	Median (P5 ; P95)
Grobogan	109	0,6 (0,1)	0,6 (0,4 ; 0,9)
Semarang	105	0,6 (0,1)	0,6 (0,4 ; 0,9)
Bantul	107	0,6 (0,1)	0,6 (0,5 ; 0,8)
Total	321	0,6 (0,1)	0,6 (0,4 ; 0,8)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

Table 17.
Mean and median of body surface area of children by age

Age (yrs)	N		Body surface area (m^2)			
			Mean (SD)		Median (P5 ; P95)	
	Boys	Girls	Boys	Girls	Boys	Girls
8	54	52	0,5 (0,1)	0,5 (0,1)	0,5 (0,4: 0,7)	0,5 (0,4: 0,8)
9	56	56	0,6 (0,1)	0,6 (0,1)	0,6 (0,5: 0,7)	0,6 (0,5: 0,9)
10	50	53	0,6 (0,1)	0,7 (0,1)	0,6 (0,5: 0,9)	0,6 (0,5: 0,9)
Total	160	161	0,6 (0,1)	0,6 (0,1)	0,6 (0,5: 0,8)	0,6 (0,4: 0,9)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

Table 18.
Mean and median of body surface area of children by age and district

Age / Dsitrict	N		Body surface area (m^2)			
			Mean (SD)		Median (P5 ; P95)	
	Boys	Girls	Boys	Girls	Boys	Girls
8						
Grobogan	17	21	0,5 (0,1)	0,5 (0,1)	0,5 (0,4: -)	0,5 (0,4:0,8)
Semarang	16	15	0,5 (0,1)	0,6 (0,2)	0,5 (0,4: -)	0,5 (0,4: -)
Bantul	21	16	0,6 (0,1)	0,5 (0,1)	0,5 (0,4: 0,9)	0,5 (0,4: -)
9						
Grobogan	17	18	0,6 (0,1)	0,6 (0,1)	0,6 (0,5: -)	0,6 (04: -)
Semarang	19	15	0,6 (0,1)	0,6 (0,2)	0,6 (0,5: -)	0,6 (0,5: -)
Bantul	20	23	0,6 (0,1)	0,5 (0,1)	0,6 (0,5: 0,8)	0,5 (0,4: 0,7)
10						
Grobogan	17	19	0,6 (0,1)	0,7 (0,1)	0,6 (0,5: -)	0,7 (0,5: -)
Semarang	22	18	0,6 (0,1)	0,7 (0,2)	0,6 (0,4: -)	0,6 (0,5: -)
Bantul	11	16	0,6 (0,1)	0,7 (0,1)	0,6 (0,5: 0,9)	0,6 (0,5: -)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

e. Palpation and ultrasonography of thyroid gland

In this study, examination of thyroid gland enlargement was conducted in two methods: i) by palpation and ii) using ultrasonography (USG). Palpation of thyroid gland was carried out by general physician from Station for Research nd Development in Iodine Deficiency Disorders, Magelang, Central Java, while examination of thyroid gland using ultrasonography was carried out by a group of physician (radiologist) from Dr.Sardjito Hospital, Yogyakarta.

Palpation

Result of analysis on palpation of thyroid gland enlargement among boys and girls by district is shown in **Table 19a**. Percentage of children with palpable thyroid enlargement was 26,7% and 24,5% among boys and girls respectively. Children with visible goitre was 1,9% and 0,6% for boys and girls respectively. Palpable goitre was highest (41,2%) among boys in Grobogan and lowest (18,6%) among boys in Semarang.

Result of analysis on palpation of thyroid gland enlargement among children by district is shown in **Table 19b**. Percentage of children with palpable thyroid enlargement was 25,6% while children with visible goitre was 1,2%. Palpable goitre was highest (33,3%) in Grobogan and lowest (20,6%) in Bantul.

Table 19a.
Thyroid gland enlargement by palpation among boys and girls by district

District	N		Thyroid gland					
			Normal		TGR		VGR	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Grobogan	51	60	28 (54.9)	43(71,7)	21 (41,2)	16(26,7)	2(3,9)	1(1,7)
Semarang	59	47	48 (81,4)	34(72,3)	11(18,6)	13(27,7)	0	0
Bantul	51	56	39 (76,5)	45(80,4)	11(21,6)	11(19,6)	1(2,0)	0
Total	161	163	115(71,4)	122 (74,8)	43(26,7)	40(24,5)	3(1,9)	1(0,6)

Note: TGR= total goitre rate; VGR= visible goitre rate

Table 19b.
Thyroid gland enlargement by palpation among children by district

District	N	Thyroid gland		
		normal	TGR	VGR
Grobogan	111	64,0	33,3	2,7
Semarang	106	77,4	22,6	0,0
Bantul	107	78,5	20,6	0,9
Total	324	73,1	25,6	1,2

Note: TGR= total goitre rate; VGR= visible goitre rate

Result of palpation on thyroid gland enlargement among children by age and district is shown in **Table 20**. Percentage of children with thyroid gland enlargement athe age of 8 years was highest (35,3%) among boys in Grobogan and lowest (10,0%) among boys in Bantul. At the age of 9 years, palpable goitre was highest (47,1%) among boys in Grobogan and lowest (21,0%) among boys in Semarang. At the age of 10 years, the highest (47,4%) of palpable goitre was amgong boys and girls in Grobogan.

Table 20.
Thyroid gland enlargement by palpation among children by age and district

Age (yrs) District	N		Thyroid gland					
			Normal		TGR		VGR	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
8								
Grobogan	17	23	11(64,7)	21(91,3)	6(35,3)	2(8,7)	0	0
Semarang	18	14	16(88,9)	12(85,7)	2(11,1)	2(14,3)	0	0
Bantul	20	16	18(90,0)	14(87,5)	2(10,0)	2(12,5)	0	0
9								
Grobogan	17	18	9(52,9)	13(72,2)	7(41,2)	5(27,8)	1(5,9)	0
Semarang	19	15	15(78,9)	9(47,4)	4(21,1)	6(40,0)	0	0
Bantul	20	23	12(60,0)	17(73,9)	7(35,0)	6(26,1)	1(5,0)	0
10								
Grobogan	17	19	8(47,1)	9(47,4)	8(47,1)	9(47,4)	1(5,9)	1(5,3)
Semarang	22	18	17(77,3)	13(72,2)	5(22,7)	5(27,8)	0	0
Bantul	11	17	9(81,8)	14(82,4)	2(18,2)	3(17,6)	0	0

Note: TGR= total goitre rate; VGR= visible goitre rate

Ultrasonography (USG)

Examination of thyroid gland among children using ultrasonography included volume of total thyroid gland, volume of right and left thyroid gland. Value of thyroid volume measured by ultrasonography in schoolchildren is recommended to be presented with other parameter that is as a function of age, sex, and body surface area (BSA).

Mean and median volume of total thyroid gland among boys and girls is shown in **Table 21a**. Overall mean and standard deviation volume of total thyroid gland were 3,04 ± 1,08 and 3,21 ± 1,51 mm among boys and girls respectively. The mean was biggest in Grobogan both for boys and girls. The median volume of total thyroid gland was also biggest in Grobogan and smallest in Bantul.

Table 21a.
Mean and median volume of total thyroid gland among boys and girls by distric

District	N		Volume of total thyroid gland (mm)			
			Mean (SD)		Median (P5 ; P95)	
	Boys	Girls	Boys	Girls	Boys	Girls
Grobogan	51	60	3,60(1,40)	3,76(2,06)	3,53(1,82: 6,66)	3,50(1,70: 6,05)
Semarang	59	47	3,04(0.80)	3,38(1,10)	2,90(1,60: 3,71)	3,50(1,66: 5,02)
Bantul	51	56	2,49(0,62)	2,47(0,52)	2,30(1,61: 3,71)	2,45(1,63: 3,38)
Total	161	163	3,04(1,08)	3,21(1,51)	2,88(1,65: 4,68)	2,93(1,68: 4,93)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

Mean and median volume of total thyroid gland among children is shown in **Table 21b**. Overall mean and standard deviation volume of total thyroid gland were 3,1 ± 1,3 mm. The mean was biggest in Grobogan (3,7 mm) and the smallest was in Bantul 2,5 mm. The median volume of total thyroid gland was also biggest in Grobogan (3,5 mm) and smallest in Bantul (2,4 mm).

Table 21b.
Mean and median volume of total thyroid gland among children by distric

District	n	Volume of total thyroid (mm)	
		Mean (SD)	Median (P5 ; P25 ; P75 ; P95)
Grobogan	111	3,7 (1,8)	3,5 (1,8 ; 2,8 ; 4,2 ; 6,2)
Semarang	106	3,2 (0,9)	3,1 (1,7 ; 2,5 ; 3,9 ; 4,8)
Bantul	107	2,5 (0,6)	2,4 (1,6 ; 2,1 ; 2,8 ; 3,6)
Total	324	3,1 (1,3)	2,9 (1,7 ; 2,3 ; 3,7 ; 4,8)

Note: n=number of children SD= standard deviation, P5=5th percentile, P95=95th percentile

Mean and median volume of left thyroid gland is shown in **Table 22**. The mean and standard deviation volume of left thyroid gland was 1,5 ± 0,6 mm. The mean was biggest (1.7 mm) in Grobogan and was smallest (1.1 mm) in Bantul. The median volume of left thyroid gland in Grobogan and Semarang was bigger than in Bantul.

Mean and median volume of right thyroid gland is shown in **Table 23**. The mean and standard deviation volume of right thyroid gland was 1,7 ± 0,8 mm. The mean was bigest (1.9 mm) in Grobogan and was smallest (1.4 mm) in Bantul. The median volume of right thyroid gland was also biggest (1.8 mm) in Grobogan and smallest (1.4 mm) in Bantul.

Table 22.
Mean and median volume of left thyroid gland by distric

District	n	Volume of left thyroid gland (mm)	
		Mean (SD)	Median (P5 ; P25 ; P75 ; P95)
Grobogan	111	1,7 (0,8)	1,6 (0,8 ; 1,3 ; 1,9 ; 2,6)
Semarang	106	1,6 (0,5)	1,6 (0,8 ; 1,2 ; 1,9 ; 2,6)
Bantul	107	1,1 (0,3)	1,1 (0,7 ; 0,9 ; 1,3 ; 1,6)
Total	324	1,5 (0,6)	1,4 (0,7 ; 1,1 ; 1,8 ; 2,5)

Note: n=number of children SD= standard deviation, P5=5th percentile, P25=25th percentile, P75=75th percentile, P95=95th percentile

Table 23.
Mean and median volume of right thyroid gland volume by distric

District	n	Volume of right thyroid gland (mm)	
		Mean (SD)	Median (P5 ; P25 ; P75 ; P95)
Grobogan	111	1,9 (1,1)	1,8 (0,9 ; 1,4 ; 2,2 ; 3,3)
Semarang	106	1,6 (0,5)	1,5 (0,9 ; 1,2 ; 1,9 ; 2,5)
Bantul	107	1,4 (0,4)	1,4 (0,8 ; 1,1 ; 1,6 ; 2,1)
Total	324	1,7 (0,8)	1,6 (0,9 ; 1,2 ; 1,9 ; 2,6)

Note: n=number of children SD= standard deviation, P5=5th percentile, P25=25th percentile, P75=75th percentile, P95=95th percentile

Percentage of boys and girls experiencing from thyroid hypertrophy based on examination using USG on thyroid gland by district is shown in **Table 24a**. Overall, hypertrophy of thyroid gland among boys and girls were 9,9% and 10,4% respectively. In Grobogan, hypertrophy of thyroid gland was 25,5% for boys and 16,7% for girls. In Semarang, the hypertrophy was 3,4% and 14,9% for boys and girls respectively. Meanwhile, in Bantul, the hypertrophy was 2,0% for boys and no hypertrophy among girls.

Table 24a.
Percentage of boys and girls experiencing from hypertrophy by district

District	N		Thyroid gland (%)			
			Normal		Hypertrophy	
	Boys	Girls	Boys	Girls	Boys	Girls
Grobogan	51	60	38(74,5)	50(83,3)	13(25,5)	10(16,7)
Semarang	59	47	57(96,6)	40(85,1)	2(3,4)	7(14,9)
Bantul	51	56	50(98,0)	56(100.0)	1(2,0)	0
Total	161	163	145(90,1)	146(89,6)	16(9,9)	17(10,4)

Note: hypertrophy is enlargement of thyroid gland

Percentage of children experiencing from thyroid hypertrophy based on examination using USG on thyroid gland by district is shown in **Table 24b**. Overall, hypertrophy of thyroid gland among children was 10,2%. In Grobogan, hypertrophy of thyroid gland was 20,7%. In Semarang, the hypertrophy was 8,5%. Meanwhile, in Bantul, the hypertrophy was 0,9%.

Table 24b.
Percentage of children experiencing from hypertrophy by district

District	N	Thyroid gland (%)	
		Normal	Hypertrophy
Grobogan	111	79,3	20,7
Semarang	106	91,5	8,5
Bantul	107	99.1	0,9
Total	324	89,8	10,2

Note: hypertrophy is enlargement of thyroid gland

f. Dry blood spots

In this multicentre study, dry blood spot (DBS) specimens from every children were collected using filter papers. The specimens were sent to and analysed in the Hormon Protein Laboratory in Zurich, Switzerland for thyrotrophin hormon (TSH), total thyroxine (tT4), and thyroglobulin (Tg) using radio immuno assay (RIA) method. The reason is to have only one laboratory for analysis of specimens. At this stage, thyroglobulin data are not available yet.

Thyroid Stimulating Hormon (TSH)

Mean and median value of TSH by district is shown in **Table 25**. Overall, mean and standard deviation values of TSH were 0,8 ± 0,4 µU/ml. The mean value of TSH in Bantul (0.7 µU/ml) was lower than in Grobogan and Semarang. The overall median

value was 0.7 µU/ml. It is the same for all district. Mean and median value of TSH by age is shown in **Table 26**. The mean and standard deviation values at the age 8 years (0,7 ± 0,3 µU/ml) was lower than at the age 9 and 10 years children. The median value was the same for all district. Mean and median of TSH among children by age and district is shown in **Table 27**. The mean and standard deviation values were very similar in all age and in all district and so the median value.

Table 25.
Mean and median of thyroid stimulating hormon (TSH) by district

District	n	TSH (µU/ml)	
		Mean (SD)	Median (P5 ; P25 ; P75 ; P95)
Grobogan	111	0,8 (0,4)	0,7 (0,3 ; 0,6 ; 1,0 ; 1,5)
Semarang	106	0,8 (0,4)	0,7 (0,3 ; 0,5 ; 0,8 ; 1,7)
Bantul	107	0,7 (0,3)	0,7 (0,4 ; 0,5 ; 0,9 ; 1,4)
Total	324	0,8 (0,4)	0,7 (0,3 ; 0,5 ; 0,9 ; 1,5)

Note: n=number of children SD= standard deviation, P5=5th percentile, P25=25th percentile, P75=75th percentile, P95=95th percentile

Table 26.
Mean and median of thyroid stimulating hormon (TSH) by age

Age (yrs)	n	TSH (µU/ml)	
		Mean (SD)	Median (P5 ; P25 ; P75 ; P95)
8	108	0,7 (0,3)	0,7 (0,3 ; 0,5 ; 0,8 ; 1,5)
9	112	0,8 (0,4)	0,7 (0,3 ; 0,5 ; 0,9 ; 1,3)
10	104	0,8 (0,4)	0,7 (0,4 ; 0,6 ; 1,0 ; 1,6)
Total	324	0,8 (0,4)	0,7 (0,3 ; 0,5 ; 0,9 ; 1,5)

Note: n=number of children SD= standard deviation, P5=5th percentile, P25=25th percentile, P75=75th percentile, P95=95th percentile

Table 27.
Mean and median of thyroid stimulating hormon (TSH) by age and district

Age (yrs) District	n	TSH (µU/ml)	
		Mean (SD)	Median (P5 ; P25 ; P75 ; P95)
8			
Grobogan	40	0,7 (0,3)	0,6 (0,3 ; 0,5 ; 0,8 ; 1,5)
Semarang	32	0,8 (0,4)	0,7 (0,3 ; 0,5 ; 0,9 ; 1,8)
Bantul	36	0,7 (0,3)	0,7 (0,4 ; 0,5 ; 0,8 ; 1,4)
9			
Grobogan	35	0,8 (0,5)	0,7 (0,3 ; 0,5 ; 1,0 ; 1,5)
Semarang	34	0,7 (0,4)	0,7 (0,2 ; 0,5 ; 0,8 ; 1,6)
Bantul	43	0,8 (0,3)	0,7 (0,4 ; 0,5 ; 1,0 ; 1,6)
10			
Grobogan	36	0,9 (0,4)	0,9 (0,5 ; 0,6 ; 1,2 ; 1,6)
Semarang	40	0,8 (0,4)	0,7 (0,4 ; 0,6 ; 0,9 ; 1,7)
Bantul	28	0,7 (0,3)	0,6 (0,3 ; 0,5 ; 0,9 ; 1,4)

Note: n=number of children SD= standard deviation, P5=5th percentile, P25=25th percentile, P75=75th percentile, P95=95th percentile

Category of thyroid stimulating hormon (TSH) value by district is shown in **Table 28**. Overall, there was no children with TSH greater than 6.0 µU/ml or in category hypothyroid. However, there were children with TSH less than 0.4 µU/ml or in category hyperthyroid. In overall 3 districts, percentage of children with risk of hyperthyroidism was 5,6%. Percentage of children with risk of hyperthyroid was 5,4% in Grobogan, 8,5% in Semarang and 2,8% in Bantul.

Table 28.
Category of thyroid stimulating hormon (TSH) value by district

Category of TSH	District			Total
	Grobogan	Semarang	Bantul	
Risk of hyperthyroid (< 4,0 µU/ml)	6(5,4)	9(8,5)	3(2,8)	18(5,6)
Normal (0,4 – 6,0 µU/ml)	105(94,6)	97(91,5)	104(97,2)	306 (94,4)
Risk of hypothyroid (> 6,0 µU/ml)	0	0	0	0

Note: number in the parentheses is percentage

Total Thyroxine (tT4)

Mean and median of total thyroxine (tT4)value by district is shown in **Table 29**. Overall mean and standard deviation values of thyroxine among children were 80,8 ± 23,1 nmol/L. The mean value was highest (90.4 nmol/L) in Bantul and lowest in Grobogan (69.9 nmol/L). Overall median value of total thyroxine was 78.1 nmol/L. The median value was highest (89.4 pmol/L) in Bantul and lowest in Grobogan (67.4 pmol/L). Based on the age of children, mean value of total thyroxine among children age 8 years was lower than children at the age 9 and 10 years and so the median value (**Table 30**).

Mean and median of total thyroxine (tT4)value by age and district is shown in **Table 31**. The mean value was highest in Bantul in all age and lowest in Grobogan in all age and so the median value.

Category of total thyroxine (tT4) value by district is shown in **Table 32**. Overall, there was no children with tT4 greater than 165.0 nmol/L or in category high level. However, there were children with tT4 less than 65 nmol/L or in category low level.

Table 29.
Mean and median of total thyroxine (tT4)value by district

District	n	tT4 (nmol/L)	
		Mean (SD)	Median (P5 ; P25 ; P75 ; P95)
Grobogan	111	69,9 (18,8)	67,4 (43,9 ; 55,8 ; 79,2 ; 103,6)
Semarang	106	82,6 (22,9)	79,7 (46,2 ; 69,1 ; 97,9 ; 118,6)
Bantul	107	90,4 (23,2)	89,4 (49,7 ; 74,7 ; 105,0 ; 131,6)
Total	324	80,8 (23,2)	78,1 (46,2 ; 65,0 ; 95,5 ; 122,7)

Note: n=number of children SD= standard deviation, P5=5th percentile, P25=25th percentile, P75=75th percentile, P95=95th percentile

Table 30.
Mean and median of total thyroxine (tT4)value by age

Age (yrs)	n	tT4 (nmol/L)	
		Mean (SD)	Median (P5 ; P25 ; P75 ; P95)
8	108	77,8 (19,5)	76,2 (41,1 ; 68,0 ; 91,1 ; 113,9)
9	112	82,6 (22,8)	81,8 (44,3 ; 64,6 ; 100,9 ; 124,7)
10	104	81,9 (22,1)	77,6 (47,8 ; 65,3 ; 98,3 ;126,6)
Total	324	80,8 (21,4)	78,5 (44,4 ; 66,0 ; 96,8 ; 121,8)

Note: n=number of children SD= standard deviation, P5=5th percentile, P25=25th percentile, P75=75th percentile, P95=95th percentile

Table 31.
Mean and median of total thyroxine (tT4)value by age and district

Age (yrs) District	n	tT4 (nmol/L)	
		Mean (SD)	Median (P5 ; P25 ; P75 ; P95)
8			
Grobogan	40	66,9 (15,2)	64,7 (41,6 ; 55,9 ; 77,9 ; 101,9)
Semarang	32	83,1 (22,0)	78,3 (37,9 ; 73,1 ; 97,3 ; 123,1)
Bantul	36	83,5 (21,2)	85,6 (43,7 ; 75,1 ; 98,1 ; 116,7)
9			
Grobogan	35	74,3 (22,1)	72,1 (41,8 ; 58,2 ; 89,1 ; 125,6)
Semarang	34	76,7 (25,3)	75,6 (25,8 ; 54,7 ; 101,5 ; 114,5)
Bantul	43	96,7 (20,9)	97,7 (65,3 ; 80,8 ; 112,0 ; 134,0)
10			
Grobogan	36	69,0 (18,6)	66,7 (43,8 ; 54,1 ; 82,0 ; 108,6)
Semarang	40	87,1 (20,8)	80,6 (52,7 ; 74,7 ; 98,4 ; 130,9)
Bantul	28	89,6 (26,8)	85,5 (46,7 ; 67,2 ; 114,5 ; 140,3)

Note: n=number of children SD= standard deviation, P5=5th percentile, P25=25th percentile, P75=75th percentile, P95=95th percentile

Table 32.
Category of total thyroxine (tT4)value by district

Category tT4	District			Total
	Grobogan	Semarang	Bantul	
Low (< 65,0 nmol/L)	44 (41.5)	18 (17,0)	12 (11,3)	74 (23,3)
Normal (65,0 – 165,0 nmol/L)	62 (58,5)	88 (83,0)	94 (88,7)	244 (76,7)
High (>165,0 nmol/L)	0 (0,0)	0 (0,0)	0 (0,0)	0 (0,0)

Note: number in the parentheses is percentage

g. Iodine in salt

In this study, every child was asked to bring salt sample used at home for cooking. The national standard for industry or standar nasional industri (SNI) requires that iodised salt containt 30–80 ppm of potassium iodate. Analysis of iodine content in salt was carried out using titraion method. Three hundreds twenty one salt samples were analysed. Iodine content in salt from titration of salt sample by district is shown in **Table 33**. Overall mean and standard deviation values were 19,9 ± 17,5 mg/kg salt or part per million (ppm). Mean value of iodine content in salt was highest (26.2 ppm) in Semarang and the lowest (16.2 ppm) in Banrtul. Overall median value was 14 ppm. The median value was highest (24.9 ppm) in Semarang and the lowest (7.4 ppm) in Bantul.

Table 33.
Iodine content in salt from titration of salt sample by district

District	n	Iodine in salt (ppm)	
		Mean (SD)	Median (P5 ; P95)
Grobogan	108	17,4 (15,0)	12,6 (2,1 ; 43,6)
Semarang	106	26,2 (13,1)	24,9 (5,7 ; 51,2)
Bantul	107	16,2 (21,7)	7,4 (2,5 ; 79,1)
Total	321	19,9 (17,5)	14,0 (3,2 ; 49,9)

Note: n=number of children SD= standard deviation, P5=5th percentile, P25=25th percentile, P75=75th percentile, P95=95th percentile

Iodine content in salt sample from household by district is shown in **Table 34**. Overall, only 47.2% of salt used by household contained iodine greater than 17.8 ppm or 30 ppm of potassium iodate. Proportion of salt that safisfy SNI was highest (75.4%) in Semarang and lowest (24.9%) in Bantul.

Table 34.
Iodine content in salt sample from household by district

Iodine content (ppm)	District			Total
	Grobogan	Semarang	Bantul	
< 5	24 (21,6)	2 (1,9)	25 (23,4)	51 (15,7)
5,0 – 9,9	24 (21,6)	11 (10,4)	44 (41,1)	79 (24,4)
10,0 – 14,9	12 (10,8)	11 (10,4)	10 (9,3)	33 (10,2)
15,0 – 17,8	2 (1,8)	2 (1,9)	1 (0,9)	5 (1,5)
17,9 – 19,9	6 (5,4)	3 (2,8)	5 (4,7)	14 (4,3)
20,0 – 24,9	11 (9,9)	24 (22,6)	4 (3,7)	39 (12,0)
25,0 – 29,9	11 (9,9)	17 (16,0)	3 (2,8)	31 (9,6)
>=30,0	18 (16,2)	36 (34,0)	15 (14,0)	69 (21,3)

Note: number in the parentheses is percentage

h. Iodine in water

The iodine content and other trace elements in soil and plant is influenced by various factors such as soil type, local geology and type of fertilizers used. Iodine is present in the soil and absorb through foods grown on that soil where water is involved. Everyone needs water daily. Thus that water should be considered as a source of iodine.

Iodine content in water sample from household by district is shown in **Table 35**. In this study, purposive sample of water from households were examined for iodine content using enzym link immuno sorbant assay (ELISA) method. In Grobogan, mean and standard deviation values of iodine content in water were 201 µg/L and 127 µg/L respectively. In Semarang and Bantul, iodine content in water was very low that is less than 5 µg/L.

Table 35.
Iodine content in water sample from household by district

District	N	Iodine in water (µg/L)	
		Mean (SD)	Median (min – max)
Grobogan	8	201,5 (127,2)	244,0 (5,0 – 305,0)
Semarang	6	0,3 (0,8)	0,0 (0,0 – 2,0)
Bantul	5	2,2 (2,8)	2,0 (0,0 – 7,0)
Total	19	85,5 (128,9)	2,0 (0,0 – 305,0)

Note: n=number of children SD= standard deviation, min=minimum, max=maximum

i. Relationship between variables

Test for normality

Test for normality was carried out using analitical method, to know the form of data dissemination and to determine the type of test

Result of Kolmogorov-Smirnov test show that iodine content in salt, iodine in urine (UIC), TSH level, and total T4 level have not normal distribution data ($p<0,05$), meanwhile thyroid volume (left, right, and total thyroid volume) have normal distribution data ($p>0,05$) after a logarithmic transformation (**Table 36**).

Relationship between iodine content in salt and urinary iodine concentration (UIC) value

Result of Spearman test 2-sides with 95% (**Table 37**) showed a correlation between iodine content in salt used by households (result from titration) with UIC value ($p< 0,05$; $r = 0,115$). Coefficient of correlation value (rho)= 0,115 indicated the direction of correlation is positive, and the degree of correlation is weak. The positive correlation indicated that the higher the iodine content in salt used by household the higher the adequacy of iodine among chidren as that expressed by UIC value from casual urine sample.

Tabel 36.
Results of statistical test for normality

Variable	Kolmogorov-Smirnov		Sig	Distribution of data
	Statistics	Df		
Iodine in salt (titration)	0,155	321	0,000	not normal
	0,100	321	0,000*)	
UIC	0,050	324	0,047	not normal
	0,102	324	0,000*)	
TSH	0,192	324	0,000	not normal
	0,104	324	0,000*)	
tT4	0,062	324	0,004	not normal
	0,050	324	0,050*)	
Left thyroid volume	0,118	324	0,000	
	0,031	324	0,200*)	Normal
Right thyroid volume	0,081	324	0,000	
	0,037	324	0,200*)	Normal
Total thyroid volume	0,109	324	0,000	
	0,031	324	0,200*)	Normal

Note: *) logarithmic transformation

Table 37.
Correlation between variables*)

Variable	Correlation	UIC	TSH	tT4	USG
Titration salt iodine	- coeff	0,115	-0,008	0,030	0,036
	- sig	0,040	0,884	0,597	0,526
	- n	321	321	321	321
UIC	- coeff		0,180	-0,254	0,280
	- sig		0,001	0,000	0,000
	- n		324	324	324

Note: *) Spearman test

Relationship between iodine content in salt and thyroid stimulating hormon (TSH) level

Result of Spearman test 2-sides (**Table 37**) showed no correlation between iodine content in salt used by households from result of titration and TSH level from dry blood spot ($p>0,05$; $r = -0,008$).

Relationship between iodine content in salt and total thyroxine (tT4) level

Result of Spearman test 2-sides (**Table 37**) showed no correlation between iodine content in salt used by households and tT4 level from dry blood spot sample ($p>0,05$; $r = 0,597$).

Relationship between iodine content in salt and thyroid volume

Result of Spearman test 2-sides (**Table 37**) showed no correlation between iodine content in salt used by households and enlargement of thyroid volume using ultrasonography (USG) ($p>0,05$; $r = 0,526$).

Relationship between urinary iodine concentration (UIC) value and thyroid stimulating hormon (TSH) level

Result of Spearman test 2-sides (**Table 37**) showed a correlation between UIC value and TSH level from dry blood spot sample ($p< 0,01$; $r = 0,180$). Coefficient of correlation (rho) value 0,180 indicated the direction of correlation is positive, and the degree of correlation is weak. The positive correlation indicated that the higher the UIC value the higher the TSH level from dry blood spot.

Relationship between urinary iodine concentration (UIC) value and total thyroxine (tT4) level

Result of Spearman test 2-sides (**Table 37**) showed a correlation between UIC value and tT4 level ($p< 0,01$; $r = -0,254$). Coefficient of correlation (rho) value -0,254 indicated the direction of correlation is negative, and the degree of correlation is weak. The negative correlation indicated that the higher the UIC value the lower the tT4 level from dry blood spot.

Relationship between urinary iodine concentration (UIC) and total thyroid volume

Result of Spearman test 2-sides (**Table 37**) showed a correlation between UIC value and total thyroid volume ($p< 0,01$; $r = 0,280$). Coefficient of correlation (rho) value 0,280 indicated the direction of correlation is positive, and the degree of correlation is weak. The positive coreelation indicated that the higher the UIC value the bigger the total thyroid volume.

Relationship between enlargement of thyroid gland by palpation and using ultrasonography (USG)

Result of t-test 2-sides enlargement of thyroid gland by palpation and using USG showed a significant difference ($p=0,000$, confidence limit 95%= -0.3, -0.2). It is concluded that there is a difference in the mean value of thyroid volume among children with normal (no enlargement) thyroid gland (by palpation) and children with enlargement of thyroid gland (by palpation). Children with enlargement of thyroid gland or goitre (by palpation) had mean value of total thyroid gland volume bigger than children with normal thyroid gland (by palpation).

VI. Discussion

a) IUC

Almost all iodine absorbed in the body is excreted in the urine. For that reason, urinary iodine concentration (UIC) is a good marker of the current iodine intake. Many studies have demonstrated that UIC in morning or other casual urine specimens (child or adult) provides an adequate assessment of iodine nutrition for population if the number of specimens collected are sufficient. UIC is presented as median instead of mean value as the curve is not a normal distribution.

Result of this study showed that the overall (Grobogan, Semarang and Bantul) median value of UIC among children 8-10 years old was 235 µg/L with the 5th and 95th percentiles were 90 µg/L and 350 µg/L respecively. Clearly, there were children with UIC below 100 µg/L or insufficient iodine intake or riks of iodine deficiency. Meanwhile,

some other children already had UIC above requirement (> 200 µg/L) or may pose risk of more than adequate intake and adverse health consequences.

Result of this study also indicated that Grobogan can represent an area of high iodine intake as the median value of UIC was 312 µg/L. Meanwhile, Semarang and Bantul may represent area of above requirement (200-299 µg/L) and adequate intake of iodine (> 300 µg/L) respectively.

b) Anthropometric

The ultimate goal of anthropometric measurement was to know the nrtritional status. In this study anthropometric measurement included body weight and body height.

Median values of body weight (wt) by age were 21,4 kg, 24,6 kg and 26,2 at age 8, 9 and 10 years respectively for boys and 22,4 kg, 23,4 kg and 27,9 kg at age 8, 9 and 10 years respectively for girls. They are all (both boys and girls) at around minus 1 standard deviation (-1 SD) of the WHO 2007 standard reference.

Meanwhile, median value of body height (ht) by age were 121,0 cm, 126,6 cm and 130,5 cm at age 8, 9 and 10 years respectively for boys and 122,2 cm, 125,3 cm and 131,6 cm at age 8, 9 and 10 years respectively for girls. They are all (both boys and girls) at between minus 1 and minus 2 standard deviation (> -1 and <-2 SD) of the WHO 2007 standard reference.

The overall stunted was 11,9% among boys and 14,9% among girls. Percentage of stunted were 11.1% and 17,3% among boys and girls respectively at age 8 years, at age 9 years were 8,9% and 16,1% among boys and girls respectively, and at age 10 years were 16,0% and 11,3% among boys and girls respectively.

Overall underweight was 14,4% and 13,7% among boys and girls respectively. Percentage of underweight were 16,7% and 12,1% among boys and girls respectively at age 8 years, at age 9 years were 7,1% and 16,7% among boys and girls respectively, at age 10 years were 20,0% and 12,7% among boys and girls respectively.

Overall wasted was 9,4% and 6,8% among boys and girls respectively. Percentage of underweight were 13,0% and 5,8% among boys and girls respectively at age 8 years, at age 9 years were 1,8% and 7,1% among boys and girls respectively, at age 10 years were 14,0% and 7,5% among boys and girls respectively.

Results of this study showed that the median BSA at age 8 years was 0,5 m^2 in both boys and girls, at age 9 years 0,6 m^2 in both boys ans girls andat age 10 years also 0,6 m^2 in both boys and girls. These sizes are lower than that WHO reference.

BSA is defined as the total area of human body. It is used in measurements in medicine such as for calculation of the amount of fluids to be given intravenously. Reference values for thyroid volume measured by ultrasonography are presented as a function of age, sex, and body surface area (BSA). The advantage of the thyroid volume-for-BSA is that the age of the child is not required. The limitation of the thyroid volume-for-BSA is that in severely malnourished populations of schoolchildren, 10% or more may have a BSA below the lowest BSA cut-off of 0.7.

c) Palpation and USG

Using palpation method, there were 45,1% and 28,4% of boys and girls suffering from palpable goitre or in sex-combined was 36% in Grobogan. In Semarang there were 18,6% and 27,7% of boys and girls or in sex-combined was 22,6% suffering from thyroid gland enlargement and in Bantul there were 23,6% and 19,6% of boys and girls or in sex-combined was 21,5% had thyroid enlargment. In Hokkaido, Japan visible goitre rate (VGR) among children is 25% where iodine consumption with local traditional dietary is more than 23000 µg/day. Refering to the WHO criteria, Grobogan was categorized as severe endemic goitre (TGR: >= 30%), meanwhile District of Semarang and Bantul were categorized as moderate endemic goitre (TGR: 20,0 – 29,9%).

Using USG, percentage of thyroid enlargement in Grobogan was 25,5% and 16,7% among boys and girls respectively, and in sex-combined was 20,7%. In Semarang was 3,4% and 14,9% among boys and girls respectively, and in sex-combined was 8,5%. In Bantul was only 2.0% among boys and in sex-combined was 0,9%. Thus with this finding, Grobogan is categorized as moderate endemic area, Semarang as mild endemic area and Bantul as non-endemik area.

Examination of thyroid gland among children using USG included volume of total thyroid gland, volume of right and left thyroid gland. Value of thyroid volume measured by USG in children is recommended to be presented with other parameter that is as a function of age, sex, and body surface area (BSA).

d) Dry blood spots

TSH

Thyroid hormone levels in the blood are regulated by a feedback mechanism that involve thyrotropin or thyroid stimulating hormone (TSH). TSH stimulate the uptake of iodine by thyroid gland, and the synthesis and release of thyroid hormon. When thyroid hormone levels in blood is high than less TSH is released. In contrary, when thyroid hormone levels in blood is low than more TSH is released.

Overall, mean value of TSH were 0,8 µU/ml is on normal range (if using normal value of TSH: 0,4 – 6,0 µU/ml). None of children had TSH value greater than 6,0 µU/ml. In Grobogan, 5,4% children had TSH level less than 0,4 µU/ml or risk of hyperthyroidism, in Semarang 8,5% and in Bantul 2,8% had TSH level less than 0,4 µU/ml. This study showed that children was facing from risk of hyperthyroidism.

tT4

There are 2 thyroid hormones in the human body: thyroxine (T4) with 4 iodine atoms per molecule, thri iodothyronine (T3) with 3 iodine atoms. More than 99% of T4 and T3 in the blood are bound to carrier proteins, and only very small amount of free hormone (fT4 and fT3) has metabolic activity. (*Note: carrier proteins is a protein that transports specific substance through intracellular compartments, into the extracellular fluid, or across the cell membrane*). T4 is broken down in the tissues to T3, and it is T3 that is active hormone. If T4 is normal, thyroid dysfunction is unlikely. The problem with total T4 (tT4) is that it may be abnormal as a result of changes in the level of proteins that bind thyroxine in the blood, and not thyroid dysfunction. If tT4 is low, hypothyroidism may be confirmed by a high TSH level. If tT4 is high, a check should be made that does not have one of the conditions known to raise the levels of carrier proteins.

The normal range of tT4 value is 65 - 165 nmol/L. Total thyroxine (tT4) level below that range indicated that thyroid function is less active or risk of (probably) hypothyroidism and above that range is very active or probably hyperthyroidism. Result of this study showed that children with tT4 value less than 65,0 nmol/L or probably hypothyroidism was 41,5% in Grobogan, 17,0% in Semarang and 11,3% in Bantul. There was no children with tT4 greater than 165 nmol/L or probably hyperthyroidism.

The link between TSH and tT4 levels of this study is as follow.
There was no TSH and tT4 categorized as high. Thus, no children had low TSH and high tT4 or probably hyperthyroidism. Similarly, no children had high TSH and low tT4 or probably hypothyroidism.

e) Iodine in salt and water

The National Standard for Industry requires iodized salt be fortified at 30–80 ppm of potassium iodate (KIO_3). Thirty part per million of potassium iodate (30 ppm KIO_3) is equal to 17,8 ppm of iodine. The WHO, recommended that iodine content in salt at production level should be within the range of 20 – 40 ppm iodine to provide 150 µg of iodine per person per day.

This study found that mean value of iodine in salt in Grobogan was 17,4 ppm of iodine, in Semarang was 26,2 ppm and in Bantul 16,2 ppm. So the salt sample from Semarang was already satisfy the requirement while in Grobogan and Bantul was nearly satisfy the requirement. The proportion of salt that satisfy the requirement of National Standard for Industry, in Semarang was the highest (75.4%). Meanwhile, in Grobogan and in Bantul were 41,4% and 24,4% respectively.

Concerning iodine in water, this study found that in Grobogan, mean and standard deviation values of iodine content in water were 201$\pm$ 127 µg/L. In Semarang and Bantul, iodine content in water was very low that is less than 5 µg/L. There is no concensus yet on the threshold values of iodine in water. For comparison, here are some example. The iodine content in sea water is 50 µg/L; in rain water, range: 1.8 – 8.5 µg/L; in water of severely iodine deficient areas, range: 0.1 – 0.2 µg/L; and in mildly deficient areas 9 µg/L. Thus that water iodine content in Grobogan might be considered very high.

f) Relationship among indicators

To know the relationship between variables several test of relationship were carried out. Not all of variables had correlation, and if there was a correlation, the degree of

correlation was weak. There was correlation between iodine content in salt used by household with variables: UIC, and volume of thyroid gland. There was also correlation between UIC with variables: TSH level, tT4 level, and volume of thyroid gland. Thus that, iodine content in salt used by households and UIC are two important indicators.

UIC:
Median value was highest in Grobogan (235 µg/L) and lowest in Bantul (186 µg/L). Percentage of 100 – 199 µg/L as the basis of adequacy was highest in Bantul (48,6%) and lowest in Grobogan (8,1%).
Thyroid measurements:
Prevalence of goiter with palpation was 36% in Grobogan, 22,6 in Semarang and in Bantul 21,5%. Percentage of goiter using USG, in Grobogan was 20,7%, in Semarang 8,5% and in Bantul was 0,9%. The size of thyroid gland was biggest in Grobogan (3,7 mm) and smallest in Bantul (2,5 mm).
Iodine source:
Mean of iodine content in salt in Semarang was 26,2 ppm of iodine, in Grobogan was 17,4 ppm and in Bantul was 16,2 ppm of iodine. Percentage of salt > 17,8 ppm of iodine was highest in Semarang (75,4%) and in Grobogan (41,4%) and lowest in Bantul (24,4%). Mean value of iodine content in water was very high in Grobogan (201,5 µg/L) and lowest in Semarang (0,3 µg/L).
In summary:
i) in Bantul, despite the mean iodine content in salt was still < 17,8 ppm and percentage of salt that contained 17,8 ppm of iodine was still 24,4%, the UIC was in category of 'adequate'. There must be iodine source other than just from iodised salt. Percentage of thyroid enlargement was also low, proved that intake of iodine was in adequate iodine nutrition;
ii) in Grobogan, despite the mean iodine content in salt was still < 17,8 ppm and percentage of salt that contained 17,8 ppm of iodine was still 41,4% but iodine content in water was very high, the intake of iodine was in category 'excessive'. Water must be the contributor on iodine intake other than iodised salt. Percentage of thyroid enlargement was high, proved that intake of iodine was in excessive that risk of adverse health consequences included goitre; and
iii) in Semarang, despite the mean iodine content in salt was still < 17,8 ppm and percentage of salt that contained 17,8 ppm of iodine was 75,4%, the UIC was in category of 'above requirements'. There must be iodine source other than just from iodised salt. Percentage of thyroid enlargement has appeard, proved that intake of iodine was just in above requirements.

Thyroid Stimulating Hormone:
None of children had TSH value > 6,0 µU/ml or possibly hypothyroidism. In Grobogan, 5,4% children had TSH level < 0,4 µU/ml or possibly hyperthyroidism, in Semarang 8,5% and in Bantul was 2,8%.

Total Thyroxine:
There was no children with tT4 > 165 nmol/L or probably hyperthyroidism. Percentage of children with tT4 value < 65,0 nmol/L or probably hypothyroidism was 41,5% in Grobogan, 17,0% in Semarang and 11,3% in Bantul.
Thyroid measurements:
Prevalence of goiter with palpation was highest in Grobogan (36%) and lowest in Bantul (21,5%). Percentage of goiter using USG, in Grobogan was 20,7%, in Semarang 8,5% and in Bantul was 0,9%. The size of thyroid gland was biggest in Grobogan (3,7 mm) and smallest in Bantul (2,5 mm).
In summary:
i) in Bantul, despite no possibility of hypothyroidism based on TSH, there was a little probability of hypothyroidism (11,3%) based on tT4, thyroid enlargement was not appeared yet;
ii) in Semarang, despite no possibility of hypothyroidism based on TSH, there was a little probability of hypothyroidism (17,0%) based on tT4, thyroid enlargement was appeared, it seems that at this stage tT4 is more sensitive than TSH;
iii) in Grobogan, despite no possibility of hypothyroidism based on TSH, there was a high probability of hypothyroidism (41,5%) based on tT4; thyroid enlargement was appeared in quite high proportion, it seems that tT4 is more sensitive than TSH;

Status of indicators results from this study are summarized as follow.

Indicator	**District**			
	Grobogan	**Semarang**	**Bantul**	**3 districts**
Median UIC (µg/L)	312	225	186	235
UIC 100-199 µg/L (%)	8,1	31,1	48,6	29,0
Thyroid enlarged (%)	36,0	22,6	21,5	26,8
Total thyroid gland volume (mm)	3,7	3,2	2,5	3,1
Mean TSH (µU/mL)	0.8	0.8	0.7	0,8
Low TSH (%)	5,4	8,5	2,8	5,6
Mean tT4 (nmol/L)	69,9	82,6	90,4	80,8
Low tT4 (%)	41,5	17,0	11,3	23,3
Iodine in salt >= 17,9 ppm (%)	41,4	75,4	24,4	47,2
Mean iodine in water (µg/L)	201,5	0,3	2,2	85,5

VII. Conclusions

1. The following conclusions is made on the basis of results and discussion:

2. UIC value in Grobogan was in category ‘excesive’ of iodine intake, Semarang in category ‘above average’ of iodine intake and Bantul in category ‘adequate’ of iodine intake. Urinary iodine concentration value was correlated with iodine content in salt used by households, TSH, tT4 and thyroid gland volume although the degree of correlation was weak. It seems that UIC was in line with enlargement of thyroid gland. Thus, UIC is a good indicator for estimating the true iodine intake.

3. Only around half of salt used by households in overall 3 districts contained iodine that safisfy the National Standard for Industry. Iodine content in salt used by household correlated with UIC, TSH, tT4 and thyroid gland volume. Results of this study suggest that some parts of iodine in UIC was not come from iodised salt. One of the source of iodine other than iodised salt was water used for daily drinking such as proved in Grobogan.

4. Palpation as traditional method for determining thyroid gland enlargement resulted in overestimate around 10% on goitre prevalence, even by experinced person, than using USG

5. No children had TSH level above the normal range (possibly hypothyroidism) but children with TSH level below the normal range (possibly hyperthyroidism) was ranging from 2,8% - 8,5%. However, none of children had tT4 level above the normal range (probably hyperthyroidism) but children with tT4 level below the normal range (probably hypothyroidism) was ranging from 11,3% - 41,5%. It seems that tT4 was in line with the results of measurement of thyroid gland enlargement.

6. Body Surface Area (BSA) value by age was the same for boys and girls but lower than the WHO reference. Stunting was more prevalence than underweight and wasting

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X. STUDY TEAM

No	N a m e	Position	Expertise	Job discription
1	Djoko Kartono, MSc., PhD	Principle Investigator	Ph.D in Community Nutrition	Responsible in preparation, implementation and reporting study
2	Dr.Suryati Kumorowulan, Mbiotek	Researcher	MD, Biotechnologist, and palpation	Responsible in laboratory work and palpation
3	M.Samsudin, M.Kes	Researcher	Comm Nutritionist and palpation	Responsible in data management, palpation
4	Yusi Dwi Nurcahyani, SKM	Researcher	Comm Nutritionist	Responsible in anthrop. measurement
5.	Drs.Suhartato	Finance Administration	Nutrition Education	Responsible in administration of finance
6	Ina Kusrini, SKM	Research Assistant	Nutritionist	Assist in data management
7	Ernani Budi Prihatin, AMAK	Research Assistant	Lab. Analyst	Assist in collection of urine and blood sample & lab work
8	Sudarinah, AMAK	Research Assistant	Lab. Analyst	Assist in collection of urine and blood sample & lab work
9	Dr.Siswanto, MHP	Consultant	MD, Health Planning	Direction and suggestion in preparation, implementation and reporting