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Goiter and Hypothyroidism among Elementary School Children in Lowland Agricultural Area, Brebes District Indonesia

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ABSTRACT

The most common cause of goiter is the lack of iodine intake and usually occurs in many communities in upland areas. Pesticides are widely used in the agricultural area, and it was probably the cause of goiter. This research is aimed to identify goiter and hypothyroidism among elementary school children in lowland agricultural areas. Cross-sectional study recruited sample of 100 children aged 9-12 years old from three elementary schools in Brebes District, Indonesia. Goiter existence determined by palpation of a trained nutritionist; level of thyroid stimulating hormone (TSH) measured with mini vidas test kits; and Urinary Iodine Concentration (UIC) measured with acid digestion method. Univariate and bivariate data analysis (Chi-square test,risk estimate) were applied. Proportion of goiter and hypothyroidism was 53.0% and 17.4% respectively. Median UIC was 346 µg/dL. Proportion of goiter in the children whose fathers were farmer and non-farmer was 80,8% and 43,2% respectively (p=0.002; Prevalence Ratio=1.9; 95% CI=1.3-2.6). The proportion of hypothyroidism in the children whose fathers were farmers (29.4%) tends to be higher than non-farmers (13.5%). However, there was no significance difference proportion of hypothyroidism in both group (p=0.255; Prevalence Ratio=2,2; 95% CI=0.8-6.0).

Keywords: *Goiter, Hypothyroidism, Children, Agricultural Area, Indonesia*

INTRODUCTION

Goiter is an enlargement of thyroid gland located in the neck caused by malfunctioning or changing gland structures or its morphology. The enlargement of the thyroid gland can influence the positions of organs. The negative effects of goiter can be a cosmetic problem and difficulties in swallowing and breathing[1]. Thyroid gland has a function to produce thyroid hormones, thyroxine (T4) and triiodothyronine (T3). Thyroid hormone plays an important role in a process of body growth, brain development, nervous system, and teeth and skeletal development[2]. The lack of thyroid hormone will increase a level of Thyroid Stimulating Hormone (TSH), a type of hormone that increases a synthesis of thyroid hormone and stimulates an enlargement of thyroid gland[3]. Goiter occurred on children is responsible for growth and development disruption such as stunting, low Intelligence Quotient, and mental disorders[4].

Goiter in an endemic area is mainly caused by the lack of iodine intakes as the critical raw material in the process of thyroid hormone synthesis. Endemic goiter, well-known as Iodine Deficiency Disorder (IDD)[5], is generally found in highland areas due to low iodine levels in soil, water, and agricultural products. Goiter rate in lowland areas is also quite high even though the content of iodine levels in soil, water, and agricultural commodities is sufficient[6]. Related to this phenomenon, some theories stated that thyroid dysfunctions occurred due to exposures of heavy metals in the environment such as lead, mercury, cadmium, polychlorinated biphenyl (PCB), and pesticide[7,8].

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Bulakamba, one of the Subdistricts in Brebes District, is the area with high-intensity pesticide use and depends on agricultural products (paddy, shallots, corn, green bean, and chili). Meanhwile, Kluwut Public Health Center located in the Bulakamba Subdistrict was the highest total goiter rate (TGR) among elementary school students in Brebes District (38.5%). The result of the measurement of UIC demonstrated that median UIC ranged from 286-293µg/L (Brebes District Health Offices, unpublished data 2010). These values were not categorized as iodine deficiency[9].

MATERIAL AND METHOD

A cross-sectional study design was conducted in Brebes district, Central Java Indonesia in 2012. Minimum sample size were 97 students calculated using the formula for estimating the population proportion[10]. Notwithstanding, as many as 100 students aged 9-12 years old randomly selected from three elementary schools.

Variables of characteristics were collected using a structured questionnaire by a trained interviewer. Thyroid gland palpation undertaken by trained nutritionists worked at Brebes District Health Office determined the occurrence of goiter. The thyroid size was graded according to the joint criteria of WHO, UNICEF and ICCIDD (non-palpable goiter = grade 0, palpable but not visible goiter = grade 1 and palpable and visible goiter = grade 2)[9].

Thyroid stimulating hormone (TSH) levels collected from sub-samples of 69 subjects were measured with a mini VIDAS® (bioMérieux S.A.), a compact automated immunoassay system based on the Enzyme Linked Fluorescent Assay (ELFA) principles at an accredited clinic laboratory. Non-fasting peripheral venous blood samples were obtained in the morning from 09.00 to 11.00. Subjects were categorized suffering from hypothyroidism when the TSH levels were ≥ 4.5 µIU/L[2]. Meanwhile, UIC levels were measured using a method of acid digestion with persulfate ammonium. Spot urine samples were obtained from sub-samples of 66 subjects.

Univariate analysis was used to describe frequencies for categorical data, mean±standard deviation, and range for continuous data. Chi-square test was performed to analyze the association between two variables.

Ethics approval was obtained from the health ethics committee of Faculty of Public Health, Diponegoro University, Semarang, Indonesia. Written permission to conduct this study was obtained from the head of Education Office Brebes District and the head teachers and chiefs of the schools involved. Parents also signed an informed consent form.

FINDINGS

A proportion of female was higher than a proportion of male in three elementary schools. Fathers and mothers educational status were mostly middle or less, respectively 95% and 97%. Meanwhile, as many as 26% of fathers worked as a farmworker and mothers as a farmworker as many as 21%. (Table 1).

Table 1: Characteristics of Subjects

Characteristics	Frequency (%)
Age (years):	
9	6 (6.0)
10	17 (17.0)
11	52 (52.0)
12	25 (25.0)
Sex:	
Male	43 (43.0)
Female	57 (57.0)
Fathers educational status:	
Middle or less	95 (95.0)
High school	5 (5.0)
Fathers occupation:	
Farmworker	26 (26.0)
Non-farmworker	74 (74.0)
Mothers educational status:	
Middle or less	97 (97.0)
High school	3 (3.0)
Mother's occupation:	
Unemployement	33 (33.0)
Farmworker	21 (21.0)
Non-farmworker	46 (46.0)

The overall prevalence of goiter was found to be 53.0%. Prevalence of Grade 1 goiter was 27.0% and that of grade 2 was 26.0%. The results of TSH level measurement on 69 samples demonstrated that as many as 17% of them were categorized suffering from hypothyroidism (TSH > 4.5 µIU/L). Meanwhile, the results of UIC level measurement showed that there was no subject suffering from iodine deficiency (> 100 (mg/L) (Table 2).

Table 2: The occurrence of goiter, hypothyroidism, and median UIC

Characteristics	Frequency (%)
The occurrence of goiter (n = 100):	
Yes	53 (53.0)
No	47 (47.0)
Grade:	
Grade 0	47 (47.0)
Grade 1	27 (27.0)
Grade 2	26 (26.0)

Conted…

Hypothyroidism (n = 69):	
Yes	12 (17.4)
No	57 (82.6)
TSH (mean±SD, range)	3,1±1,87 (0,4-11,4)
UIC (median, range) (mg/L) (n=66)	346 (192-349)

A proportion of goiter among subjects who had fathers working as a farmworker was equal to 80.8%, two times higher than that of subjects who had fathers working as non-farmworker (43.2%) (Table 3).

Table 3: The occurrence of goiter based on fathers' occupation

Fathers' occupation	The occurrence of goiter		P	Prevalence Ratio (95% CI)
	Yes	No		
Farmworker	21 (80.8)	5 (19.2)	0.002*	1.9 (1.3-2.6)
Non-farmworker	32 (43.2)	42 (56.8)		

Significant <0.05

A proportion of hypothyroidism among subjects who had fathers working as a farmworker was equal to 29.4%, two times higher than that of subjects who had fathers working as non-farmworker (13.5%) (Table 4).

Table 4: The occurrence of hypothyroidism based on fathers' occupation

Fathers' occupation	The occurrence of hypothyroidism		P	Prevalence Ratio (95% CI)
	Yes	No		
Farmworker	5 (29.4)	12 (70.6)	0.255	2.2 (0.8-6.0)
Non-farmworker	7 (13.5)	45 (86.5)		

DISCUSSION

This study found as many as 53% of elementary school students located in lowland areas suffered from goiter. Brebes is an agricultural area producer of shallot in Central Java province, Indonesia. The farmers usually spray pesticides 2-3 times per week, even every day in the rainy season. The yield rate of shallot in Brebes in 2014 as much as 121.46 quintals/hectare[11].

Goiter, a manifestation of thyroid hyperplasia and increased thyroid vascularity, results from a compensatory increase in the release of thyroid-stimulating hormone (TSH) as a result of lower triiodothyronine (T_4) levels and is traditionally detected and evaluated using inspection and palpation[12]. We used palpation in our study because ultrasonography is cumbersome and costly to carry out[13], and palpation is regarded as an acceptable and simple alternative. Palpation of the thyroid is important in assessing goiter prevalence, which is relatively easy to conduct, and training of personnel to do it[14].

UIC levels greater than 100 µg/L (Table 2) mean that there was no case of iodine deficiency on all research participants. Iodine deficiency early in life impairs cognition and growth, but iodine status is also a key determinant of thyroid disorders in adults. Dietary iodine intake is required for the production of thyroid hormone. Consequences of iodine deficiency include goiter, intellectual impairments, growth retardation, neonatal hypothyroidism, and increased pregnancy loss and infant mortality[15,16]. A main cause of goiter commonly is due to lack of iodine intakes. Iodine is the critical raw material for a process of thyroid hormone biosynthesis. Iodine plays an important role in growth and development, and brain function[17].

There are several accepted methods for the monitoring of population iodine status[18]. Because 90% of ingested iodine is renal excreted, median spot urinary iodine concentrations (UIC) serve as a biomarker for recent dietary iodine intake. Population iodine sufficiency is defined by median UIC of 100–299 µg/L in school-aged children[9]. A source of iodine in the environment depends on a location/geographical factor. Generally, sufferers of goiter are commonly found in highland areas (mountainous regions) because there is a lack of iodine levels in water and soil, where iodine has been washed away by glaciation and flooding[15]. On the other hand, oceans are the world's main repositories of iodine and very little of earth iodine is actually found in the soil. The deposition of iodine in the soil occurs due to volatilization from ocean water, a process aided by ultraviolet radiation. The coastal regions of the world are much richer in iodine content than the soils further inland[19].

IDD has a strong relationship with a geographical factor because it is generally found in highland areas among school age children. This age group is very susceptible to iodine intakes obtained from the environment. School-age children are considered as an appropriate target group for determining iodine deficiency due to their susceptibility to iodine deficiency, easily accessibility as a study group and representativeness of their community society as a whole[20]. Some studies demonstrated that the occurrence of goiter was due to a lack of iodine intake and generally found in highland areas. A study conducted at Kayseri, Turkey, where the goiter is endemic, goiter prevalence was 54.8% and median urinary iodine level was 9.54 µg/dl indicating mild iodine deficiency[21]. The prevalence of goiter among children 6-12 years old in Lay Armachiho Northwest Ethiopia was found to be 37.6%, whereas 70,3% of the subjects had inadequate iodine content (<15 ppm)[20]. A study in high altitude areas of Saudi Arabia revealed the goiter prevalence was 7.4% and about 71% of the participants had UIC less than 100µg/L[22]. Other studies demonstrated that goiter cases were found in areas with sufficient iodine intakes (non-endemic areas) such as coastal or lowland areas. Study at adult more than 18 years old in an iodine-sufficient area in Chengdu China revealed prevalences of goiter was 8.1%[23]. A study by Suhartono in District of Brebes found pesticide exposure as a risk factor for hypothyroidism among women at childbearing age living in an agricultural area, Brebes District, Indonesia[24].

The proportion of goiter and hypothyroidism was higher among farmworkers' children than among non-farmworker's children (Table 4). However, Iodine intakes in all research participants were sufficient. Pesticides might be a risk factor for goiter. A pesticide is a chemical widely used to increase agricultural products and to decrease food-borne or vector-borne diseases[25]. The use of a synthetic pesticide can contaminate soil, water, grass, and other vegetation. In addition to killing the insects or weeds, pesticides can be toxic to a number of other organisms, including birds, fish, beneficial insects, and non-target plants. Insecticides are generally the most acute toxic class of pesticides, herbicides but can also pose a risk to non-target organisms[26]. Pesticide residues leftover from agriculture not only contaminated crops but also the environment, such as ambient air, surface water, and soil. These findings reinforce the concern about pollution by organophosphates in areas surrounding agriculture areas of pesticide use[27]. Ideally, toxic effects of pesticide are on target organisms (pests) but in fact, the toxicity of most of the active ingredients of pesticide is not specific. Therefore, it is very harmful to human health[28].

Pesticides are categorized as endocrine disrupting chemicals (EDCs)[29]. Exposure by EDCs can disrupt thyroid function that is well-known as thyroid disrupting chemicals (TDCs)[30]. Thyroid dysfunction has an impact on growth and development of children[2]. EDCs can bind and activate a variety of hormone receptors and then mimics the action of natural hormones (agonist action). EDCs also can bind to the receptors without activating them. Antagonist action would block and inhibit the action of the receptors. In addition, EDCs also can interfere with the synthesis, transport, metabolism and elimination of hormones, thus reducing the concentrations of natural hormones[31].

CONCLUSIONS

The proportion of goiter and hypothyroidism among children was two times higher in subjects whose fathers as farmworkers than non-farmworkers although the iodine intake was adequate.

Conflict of Interest: The authors declare that they have no conflict of interest.

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6