

# The relationship between occupational radiation exposure and thyroid nodules

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**Background:** Considering that thyroid nodules and thyroid cancer occur more frequently in people chronically exposed to radiation, the aim of this study was to evaluate the prevalence of thyroid nodules in a population occupationally exposed to radiation in hospitals of Isfahan, Iran. **Materials and Methods:** In this case-control study, the prevalence of thyroid nodules in staff members occupationally exposed to radiation was determined by ultrasonography. The results were compared with the results of another study among the adult population of Isfahan which selected by cluster random sampling method. The 2 studied groups were matched according to sex and age. **Results:** The case and control groups included 124 and 471 persons, respectively. The prevalence of thyroid nodules in the case and control groups was 22.6% and 24.6%, respectively ( $p > 0.05$ ). Although thyroid nodules were significantly more prevalent in females in the control group, no such difference was observed between females and males of the case group ( $p > 0.05$ ). The number of thyroid nodules (single or multiple) and calcification were not different between the two groups ( $p > 0.05$ ). In addition, hypoechogenicity of thyroid nodules was not different between the two groups for ( $p > 0.05$ ). **Conclusion:** In our study, there was not any correlation between chronic occupational exposure to low dose of radiation and the risk of developing thyroid nodules. Further studies with larger sample sizes, at different doses of radiation, and considering iodine status and thyroid function are thus required.

**Key words:** Thyroid Nodule, Radiation, Occupational Exposure, Ultrasonography.

## INTRODUCTION

Many studies have indicated the effects of ionizing radiation on the thyroid gland especially as a prime cause of thyroid cancer and nodules.<sup>[1]</sup> Analysis of the risk of mentioned pathologies in relation to radiation dose have suggested that acute exposure is more harmful than chronic exposure. High doses of ionizing radiation clearly produce deleterious consequences including cancer induction. At very low radiation doses, the situation is much less clear, but the risk of low-dose radiation is important because of its relation to issues as varied as screening tests for cancer and occupational radiation exposure.<sup>[2,3]</sup>

There is no clear evidence of an association between occupational radiation exposure and thyroid cancer and nodule. According to some previous reports, there is a high prevalence of thyroid cancer and nodules formation in workers who are occupationally exposed to radiation, whereas others have claimed that it is difficult to consider radiation as the cause of nodules or other non-malignant pathologies.<sup>[4-8]</sup>

Thyroid nodules are common and are usually

benign. However, their diagnosis, treatment and follow up are essential to rule out thyroid cancer. The reported prevalence of nodular thyroid disease depends on the population studied and the methods used to detect nodules.<sup>[9]</sup> Nodule incidence increases with age and is higher in women, in people with iodine deficiency, and after radiation exposure. Ultrasonography is the most accurate, cost-effective, relatively inexpensive and sensitive method for diagnosing thyroid nodules.<sup>[10]</sup>

Numerous studies have suggested a prevalence of 2-6% with palpation and 19-35% with ultrasound.<sup>[11]</sup> In a population-based study, Jafary et al. reported the prevalence of thyroid incidentaloma in Isfahan, Iran as 13.2%.<sup>[12]</sup>

Therefore considering the utility of ultrasound examination in the initial evaluation of a patient with known or suspected thyroid nodule and the high occurrence of thyroid nodules and thyroid cancer in people exposed chronically to radiation, the aim of this study was to evaluate the prevalence of thyroid nodules in a population occupationally exposed to

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radiation, in hospitals of Isfahan, Iran.

## MATERIALS AND METHODS

In this case-control study from February to July 2008, the prevalence of thyroid nodules in radiation-exposed staff members in hospitals of Isfahan was determined by ultrasonography. Isfahan is considered as an iodine sufficient area as reported in previous studied.<sup>[13]</sup> The results of current study regarding the prevalence of nodules among radiation-exposed staff members were compared with the results of another study among adult population of Isfahan as a control group (without exposure) which selected by cluster random sampling method<sup>[12]</sup> The Medical Ethics Committee of Isfahan University of Medical Sciences (Isfahan, Iran) approved the study protocol and all subjects gave their written consent. The 2 studied groups were matched according to sex and age.

Demographic data and history of thyroid disorders and medications were obtained for each person by a questionnaire. Subjects with a past history of thyroidectomy (partial or complete) or thyroid agenesis (congenital) were excluded from the study. The use of frequent radio-diagnostic procedures (no more than two chest radiographs a year) or radio-therapeutic procedures in the past, type of work and radiation exposure, and the use of radio-protective devices were also recorded.

All volunteers were physically examined and thyroid ultrasonography was performed. Thyroid ultrasonography was performed by SIEMENS-G40 ultrasound equipment with a 7-10 megahertz (MHZ) linear probe. Ultrasonography was performed by one particular physician. Subjects were examined in a supine position with hyper-extended neck by one of the two radiologists. Transverse (X), sagittal (Y), and anteroposterior (Z) diameters of right and left lobes were measured and volumes (V) were calculated by three-dimensional ellipsoid formula ( $V = p/6 \times X \times Y \times Z$ ) and expressed in  $\text{cm}^3$ . The sum of the volumes of both lobes was taken

as the thyroid volume. The isthmus was not taken into account in thyroid volume calculation. Thyroid volume, number of nodules (if any), the greatest diameter and echogenicity of the nodule, as well as its calcification, were reported.<sup>[13]</sup> Thyroid nodularity was defined as the presence of at least one nodular lesion (liquid, solid, or mixed structure) with a minimum diameter of 4 mm. Patients with thyroid nodules > 1 cm in diameter were submitted to ultrasound examination and guided fine-needle aspiration (FNA).

The obtained data was analyzed using chi-square test and independent sample t-test in SPSS<sub>13</sub> (SPSS Inc., Chicago, IL, USA). P values less than 0.05 were considered as significant.

## RESULTS

The case and control groups included 124 and 471 persons, respectively. Demographic findings of the two studied groups are presented in Table 1. The prevalence of thyroid nodule in the case and control groups was 22.6% (n = 28) and 24.6% (n = 115), respectively ( $p > 0.05$ ). Thyroid nodules were significantly more prevalent in females in the control group (30.1% in females vs. 19.6% in males;  $p < 0.05$ ). However, no such difference was observed between females and males of the case group (19.7% vs. 25.4%;  $p > 0.05$ ). The characteristics of thyroid nodules, i.e. numbers, echogenicity, and calcification, in the case and control groups are presented in Table 2.

Mean duration of occupational exposure in individuals with and without nodules was 13.4 and 13 years, respectively ( $p > 0.05$ ). The mean hours of exposure per week in occupationally exposed population with and without nodules were 44.7 and 41.8 hours, respectively ( $p > 0.05$ ).

The prevalence of thyroid nodules among the staff members of different parts of radiology department was 23.3% in radiology, 14.3% in fluoroscopy, and 19.4% in computed tomography (CT) scan fields.

**Table 1. Baseline characteristics of the occupationally exposed population (case group) and the control group**

	Case Group n = 124	Control Group n = 470	P
Age (years)	36.9 ± 8.9	37.2 ± 11.2	NS
Female/male	61/63	226/245	NS
Body mass index (kg/m <sup>2</sup> )	29.2 ± 2.4	28.9 ± 2.2	NS
History of radio-diagnostic procedures	49 (39.5%)	191 (40.6%)	NS
Thyroid volume (cm <sup>3</sup> )	9.0 ± 5.6	10.4 ± 5.1	NS

The results are expressed as mean ± SD or number (%) where appropriate.  
NS: Not significant

**Table 2. Characteristics of thyroid nodules in the case and control groups with thyroid nodules**

	Case Group n = 28	Control Group n = 115	p
Number			
Single	18 (63%)	64 (56%)	NS
Multiple	10 (37%)	51 (44%)	NS
Echogenicity			
Isoechoic	7 (25%)	6 (5.6%)	P < 0.001
Hypoechoic	17 (60.7%)	78 (68.2%)	NS
Hyperechoic	0 (0%)	27 (23%)	P < 0.001
Mixed echo	4 (14.3%)	4 (3.2%)	P < 0.001
Calcification	4 (14.3%)	7 (6%)	NS

NS: Not significant

FNA was performed in 14 occupationally exposed persons with thyroid nodules. The results of FNA indicated that in all studied cases, the nodules were benign.

## DISCUSSION

Radiation exposure and its potential complications are considered as one of the most important issues in occupational health. Implementation of proper occupational health may have an important bearing not only on the health of the population occupationally exposed to radiation but also on the health and prosperity of the community.<sup>[1]</sup> In order to achieve this goal, basic knowledge about the effects of ionizing radiation on function of certain organs and its consequences is needed. Therefore, this study determined the prevalence of thyroid nodules in a population occupationally exposed to radiation in hospitals of Isfahan, Iran. Our findings indicated that the prevalence of thyroid nodules among the staff members of radiology departments who were occupationally exposed to radiation was not significantly higher than the general population without radiation exposure. While the prevalence of thyroid nodules was higher in females in the control group, females and males of the case group were not different in this regard.

Using high resolution ultrasonography, which is considered the most sensitive method for diagnosing thyroid nodules, has revealed the prevalence of thyroid nodules, as a common clinical problem, as 19-67% among randomly selected individuals. According to different epidemiologic studies, the clinical importance of thyroid nodules is its diagnosis and exclusion of thyroid cancer which occurs in 5-10% of the population.<sup>[14]</sup> Similar to previous studies,<sup>[14]</sup> the prevalence of thyroid nodule in our case and control groups was 22.6% and 24.6%, respectively.

The findings of several studies that have examined the relationship between occupational radiation exposure and thyroid nodule formation are considerably different<sup>[4-8]</sup> due to various methods of study, doses of radiation, and duration of exposure. The results of the current study on individuals chronically exposed to low doses of radiation were concordant with some prior studies which have demonstrated that it is difficult to point to radiation as the cause of nodules or other non-malignant pathologies.<sup>[4,7,8,15]</sup> Other studies however, were in contrast with ours.<sup>[5,6]</sup>

In line with our results, an Italian study by Violante et al. investigated the presence of thyroid nodularity in healthcare workers routinely exposed to low-level ionizing radiation. It could not establish a significant association between mildly occupational radiation exposure and thyroid nodules in healthcare personnel. Moreover, while the duration of occupational exposure did not affect the prevalence of thyroid nodularity, female gender and age were significant risk factors.<sup>[4]</sup> In another study in Estonia, following the Chernobyl Power Station accident, the risk of thyroid nodularity was determined in nearly 2,000 Chernobyl cleanup workers with protracted exposure to ionizing radiation. According to their results, the risk of nodular thyroid disease was not associated with exposure to external radiation. The lack of association was explained by low doses of radiation, the protracted exposure, errors in dose measurement, low sensitivity of the adult thyroid gland, or insufficient course of time for expression of radiation effect.<sup>[8]</sup> On the contrary, in 2 other Italian studies, Antonelli et al. reported occupational exposure to radiation as a possible risk factor for thyroid nodules.<sup>[5,6]</sup> Considering that recent studies have not indicated a significant association between low-dose radiation exposure and thyroid nodularity,<sup>[4,7,8]</sup> differences between our results and those reported by Antonelli et al.<sup>[5,6]</sup> might have been due to

low doses of radiation, the protracted exposure, or low sensitivity of the adult thyroid gland. However, the role of genetic or ethnic factors and the greater predisposition to thyroid disease in people with familial thyroid disease should also be considered.<sup>[16]</sup>

Several studies have suggested that the chance of malignancy of a thyroid nodule depends on all of its ultrasonographic features and characteristics. Solid nodules, hypoechoic nodules, and those with calcifications are more likely to be malignant.<sup>[17-22]</sup> In this study, there was not any correlation between the mentioned nodule characteristics in the case and control groups which might have been caused by the benign nature of most detected thyroid nodules.

In vivo studies have shown that thyroid cells are influenced both by irradiation and iodine intake. However, there is controversy about the effects of iodine deficiency in combination with radiation exposure on the risk of thyroid nodules.<sup>[23]</sup> Some authors have suggested that elimination of iodine deficiency may be important in reducing the effects of radiation exposure on the thyroid.<sup>[24]</sup> Other authors have reported that it is not possible to demonstrate the effect of radiation in iodine deficiency, because iodine intake is the most effective risk factor.<sup>[24,25]</sup>

Although according to Azizi et al. Iran had reached a sustainable control program for iodine deficiency,<sup>[26]</sup> and the prevalence of nodules was in the reported range, it seems that this study would have been more conclusive if it had evaluated iodine status and thyroid function among the studied population. Like our study, Trerotoli et al. reported that occupational exposure to radiation accompanied by mild iodine deficiency did not increase the risk of thyroid nodularity.<sup>[7]</sup> In sum, we could not establish any correlation between chronic occupational exposure to low dose of radiation and the risk of developing thyroid nodules. Further studies with larger sample sizes, at different doses of radiation, and considering iodine status and thyroid function are required.

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