

DOES STILL EXIST A CORRELATION BETWEEN X-RAYS OCCUPATIONAL EXPOSURE AND BENIGN NODULAR THYROID DISEASE?

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ABSTRACT

Objective: The prevalence of benign nodular thyroid disease in the general population is high, as shown by various studies, and the diagnosis is eased by the improved diagnostic capacity of the instruments used. The aim of the present study is the evaluation of occupational exposure to ionizing radiation as a possible significant risk factor in the determinism of this pathology.

Method: A cross-sectional observational study in “A category” X-ray exposed workers (doctors, nurses, technicians) of the University Hospital of Palermo, compared with a sample of the general population, was carried out from June 2016 to June 2017. We evaluated data obtained from the Personal Health Records, including thyroid sonographic reports, assessed by 10-MHz neck ultrasonography: then were analyzed on the basis of statistical significance (p -value < 0.05 , Odd ratios and 95% confidence interval), in order to identify possible relations with conditions who may become real risk factors, such as: occupational exposure, considering years and accumulated dose, age, gender, smoking habit.

Result: Nodules were detected in 32/85 (37.6%) workers and in 31/90 (34.4%) subjects of the control group. None of the parameters examined in the two groups reached statistical significance as a risk factor, therefore not playing major role in the determinism of thyroid nodularity.

Conclusion: In this study, X-rays work-related exposure does not represent a risk factor of thyroid nodularity, although it would be opportune to know the reasons of the high prevalence of this pathology in general population.

Keywords: benign thyroid nodules, ionizing radiation, X-rays exposed workers, occupational disease.

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Introduction

The correlation between exposure to ionizing radiations and thyroid diseases has been known for decades, especially through studies conducted following the explosion of atomic bombs at the end of the Second World War and after the accidents occurred at the Chernobyl nuclear reactors and more recently in Fukushima⁽¹⁻⁴⁾. Likewise, it is known that other risk factors for thyroid diseases are: female sex, living in geographical areas where iodine is deficient, drinking water full of nitrates, positive familiarity with thyrotoxicosis, the consumption of certain drugs, the advanced age (for example after menopause), cigarette smok-

ing⁽⁵⁻¹⁰⁾. In the workplaces there are various categories exposed to ionizing radiations, particularly in the health sector; often studies have been carried out on the prevalence of thyroid diseases, both benign and non, in exposed workers, but arriving at conflicting results. In Italy, the protection of the workers’ health in this field uses laws, standards and procedures against harmful effects and the Radioprotection legislation comes from the technical regulations issued by the ICRP, (International Commission on Radiological Protection), established scientific body in 1928. The legislative reference text in force in Italy for the radiation protection of exposed workers is Legislative Decree 230/95, supplemented by subsequent legal texts,

based on three fundamental and sequential principles:

- principle of justification of the practice;
- principle of optimization of protection;
- principle of limiting individual doses.

The principle of justification asserts that "no work practice involving exposure to ionizing radiation can be adopted unless it produces a net and demonstrable benefit to exposed persons or to society to offset the damage it causes". For the optimization principle, any exposure to ionizing radiation must be kept as low as reasonably possible, taking into account also the economic and social factors ("ALARA" As Low As Reasonably Achievable). Due to the principle of dose limitation, doses to individuals are only allowed if radiological practice is justified and protection is optimized, but should not exceed certain values. With reference to the principles of justification, optimization and limitation, exposure to ionizing radiation in the workplace, like any other risk factor, must be eliminated if possible, or in any case reduced to the lowest technically achievable level, when elimination is impossible. On the basis of dose limits, Legislative Decree 230/95 identifies three categories of workers: category A, with dose limits $6 \leq 20$ mSv/year; category B ≤ 6 mSv/year; workers equal to the general population up to 1 mSv/year⁽¹¹⁾.

The maximum annual dose limit for exposed workers is 20 mSv (category A) and in companies the attribution to the various categories of radio-exposed is charged to the Qualified Expert, typically a physicist or a nuclear engineer who assesses the dose absorbed by each worker through the use of personal dosimeters. There are a lot of studies related to the correlation between work-exposure to ionizing radiations and the onset of nodular thyroid diseases, but often come to conflicting results⁽¹²⁻¹⁶⁾. The aim of the present study is to evaluate the prevalence of benign nodular thyroidopathies in the population of professionally radio-exposed subjects belonging to category A of the University Hospital of Palermo, in comparison with a sample of the general population, belonging to the same geographical area, not professionally exposed to ionizing radiations, taking into account the variables that may be responsible for the manifestation of thyroid nodular disease.

Materials and methods

The epidemiological survey was conducted from June 2016 to June 2017 with the acquisition of data obtained from the Personal Health Records, established, updated and stored by the Authorized Med-

ical Doctor for the radio medical staff of "A category" of the University Hospital of Palermo, including annexed echographic sonographic reports. The study sample included various work tasks: doctors, nurses, technicians, and other paramedical or laboratory staff, exposed to X rays during their routine work. Real-time neck ultrasonography was performed using an ESAOTE mylab and Samsung RS80A devices, with 10 MHz probe. Always, we asked the subjects the informed consent to the processing of data; the Local Ethic Committee approval is not required in Italy for observational retrospective studies without pharmacological experimentation⁽¹⁷⁾. The consent for the consultation of the data to the Hospital Health Directorate has been previously requested and the workers' right to privacy has been respected.

The data were compared to those of a control group consisting of subjects from the general population coming from the province of Palermo, not exposed to ionizing radiations, numerically comparable by age and sex, recruited through a screening campaign for the prevention of thyroid diseases promoted by the Provincial Health Establishment in Palermo, with the execution of the Real-time neck ultrasonography.

The known cases of thyropathy in the control group of the general population were excluded from the study. Also in this case, we asked the subjects the informed consent to the processing of data and, for the consultation of these data, the authorization was requested to the General Direction of the Provincial Health Establishment of Palermo. The privacy of the participants in the screening was guaranteed.

Finally, the data were statistically analyzed on the basis of statistical significance: p-value < 0.05 , Odd ratios and 95% confidence interval, in order to identify possible relations with conditions who may become real risk factors, such as: duration of exposure and accumulated dose for exposed workers, age, gender, smoking habit. Absolute and relative frequencies were calculated for qualitative variables, while quantitative variables were summarized as mean and standard deviation (SD). Categorical variables were analysed using χ^2 test corrected Yates. Statistical analysis was performed with R software version 3.3.2. A p-value < 0.05 was considered to be statistically significant.

Results

The selected sample consists of 85 professional exposed health workers and 90 subjects of the general population. Demographic characteristics and preva-

lence of thyroid nodularities of both groups are shown in table 1.

	Workers	Control group
Number of subjects (M/F)	85 (58/27)	90 (39/51)
Mean age and SD (years)	46.28 (±10.3)	50.41 (±7.3)
Smokers (%)	37/85 (43.5%)	35/90 (38.9%)
Mean duration of exposure (years) and SD	11.2 (±10.2)	/
Thyroid nodules (M/F) % Yes No	32 (18/14) 37.6% 53 (40/13) 62.4%	31 (12/19) 34.4% 59 (27/32) 65.6%

Table 1: General characteristics of subjects (N=175) included in the study.

The subjects of both populations were divided into 4 age groups and for each of them was evaluated the number of subjects presenting nodules (table 2).

Age	Workers	With nodules	Control group	With nodules
	n.	n. (%)	n.	n. (%)
26-35	23	7 (30.4)	13	1 (7.7)
36-45	21	7 (33.3)	16	5 (31.2)
46-56	20	8 (40.0)	24	11 (45.8)
57-65	21	10 (47.6)	37	14 (37.8)
Overall	85	32 (37.6)	90	31 (40)

Table 2: Presence of thyroid nodules in the two groups according to age group.

With increasing age, an increasing number of subjects with multiple nodules in both the examined groups was observed: in 32 radio-exposed workers with nodular tireopathy 14 had only one nodule and 18 multiple nodules and in the general population of 31 only 6 had a single nodule and 25 a multinodular goitre.

Workers were also divided into 8 periods of seniority and for each we evaluated the number of subjects with and without thyroid nodules (Table 3).

Mean duration of exposure (years)	Subjects	With nodules N. (%)	Without nodules N. (%)
0-5	35	10 (28.6)	25 (71.4)
6-10	19	7 (36.9)	12 (63.1)
11-15	7	3 (42.9)	4 (57.1)
16-20	7	3 (42.9)	4 (57.1)
21-25	5	2 (40.0)	3 (60.0)
26-30	5	1 (20.0)	4 (80.0)
31-35	6	5 (83.3)	1 (16.7)
35-40	1	1 (100)	0

Table 3: Nodular thyreopathy trend in the group of radio-exposed subjects based on the age of radio exposure.

In the radio-exposed group, the prevalence of nodular thyroid disease was also assessed based on whole-body dose distribution (mSV) (Table 4).

Therefore, we evaluated some parameters, work-related and not, as possible risk factors correlated with the occurrence of the pathology under study.

mSv/year	6-10	10-20
With nodularity n. (%)	29 (36.2)	3 (60)
Without nodularity n. (%)	51 (63.8)	2 (40)
All (%)	80 (100)	5 (100)

Table 4: Thyroid nodularity rates in workers with respect to total accumulated doses of ionizing radiations.

The data in Table 5 show that none of the characteristics considered reached statistical significance, in order to be considered a predictor of pathology in the two groups considered.

Variable	Adjusted OR	p-value	95% CI
Work exposure	1.15	0.776	0.62-2.13
Gender (male)	1.01	0.844	0.42-2.43
Gender (female)	1.81	0.317	0.71-4.66
Smokers	1.21	0.533	0.66-2.21
Age 26-45	1.79	0.438	0.60-5.37
Age 46-65	1.13	0.929	0.51-2.51
Duration work exposure >20 years	0.45	0.145	0.15-1.33
Dose > 10 msv/year	2.64	0.287	0.42-16.72

Table 5: Statistical analysis with Odds ratios (OR), p-value and 95% CI for presence of thyroid nodularity between two groups and in relation to duration of work exposure.

Discussion

The analysis of the obtained data did not reveal statistically significant differences in the two groups under examination, regarding benign nodular thyroid pathologies. Multinodular thyroid diseases represent, with respect to uninodulars, the most frequent sonographic finding both in the radio-exposed subjects and in the general population of the examined sample. Furthermore, we found that nodular thyroid disease, both in radio-exposed workers and in the general population, seems to correlate with increasing age. In exposed workers a positive correlation was not observed between nodular thyroid diseases, neither with the increasing doses of distribution of the whole body dose (mSV), or with the increasing years of seniority at radio-exposure. Surely the limit of the study is to be found in the small sample of enrolled subjects in this project, in which none of the considered parameters represented a statistically significant risk factor in the determinism of the pathology between the two groups. It would be advisable to compare the data obtained with the data of another geographical area of the Country, to verify if the territorial origin is a risk factor for the determinism of thyroid nodular pathology.

Studies affirming a positive correlation between thyroid nodules and occupational radio-exposure are few and dated⁽¹²⁻¹³⁾.

Other authors, on the contrary, in subsequent years came to other conclusions, finding a percentage of nodular thyroid diseases in the radio-exposed workers in line with the general population, stating therefore that low-dose radio-exposed health workers do not appear to incur any excess risk of nodular thyroid disease, while the association with age and female gender was significant⁽¹⁴⁻¹⁶⁾. Therefore the results of these studies are not univocal, but the prevailing idea in literature is currently to exclude that exposure to ionizing radiations causes the development of thyroid nodules. Benign nodular pathology is widespread in the general population, reaching up to 70% in asymptomatic subjects, randomly selected, with occasional echographic findings, thanks also to the technological improvement of diagnostic tools⁽¹⁸⁻²⁰⁾. Higher frequencies are found in women and the elderly. If the most recent studies have not indicated a significant correlation between subjects professionally exposed to ionizing radiations and the general population, it may be due to the reduced exposure of workers, compared to the past, thanks to the most advanced technology of radiant instruments which at the present time we can find in companies and in hospitals.

Undoubtedly, another reason is the existence of laws which provide the mandatory existence of the Risk Prevention and Protection Service, with the involvement of all the professional figures provided for by the Legislative Decrees 81/08 and 230/95: the Workers' Safety Representative, the Authorized Medical Doctor, the Qualified Expert, who collaborate with the Employer efficiently.

It should also be considered that the current technology allows to detect even very small lesions, accidentally diagnosed in the general asymptomatic population.

In radio-exposed workers with nodular thyroid disease a periodic follow-up is however desirable, to observe the possible evolution of the pathology. However, it would be desirable to understand which factors contribute to the determinism of such a high prevalence of nodular thyroid disease in the general population, investigating genetic, environmental, food, pharmacological, lifestyle, hormonal and other possible associated factors.

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