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Did the Chernobyl atomic plant accident have an influence on the incidence of thyroid carcinoma in the province of Olsztyn?

Czy awaria elektrowni w Czarnobylu miała wpływ na zapadalność na nowotwory złośliwe gruczołu tarczowego w województwie olsztyńskim?

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Abstract

Material and methods: A study of incidence rates of thyroid carcinoma was conducted in Olsztyn province from 1 January 1994 to 31 December 2003 within its former boundaries, in spite of Poland's new administrative division.
The criteria for register entry were as follows: residence in Olsztyn province, newly-diagnosed case of thyroid malignancy in the given calendar year, and histopathological verification in the Department of Anatomical Pathology of the District Specialist Hospital in Olsztyn. The study of selected risk factors comprised patients included in the register of thyroid carcinoma. For that purpose a questionnaire was prepared which covered information about the Chernobyl accident: place of residence, time of carcinoma diagnosis after the accident, and iodine prophylaxis during the accident. The control group consisted of 589 healthy subjects selected based on age and place of residence.
Results: In the years 1993–2003, 462 (395 women and 67 men) cases of thyroid cancer were registered. The questionnaire study comprised 297 patients with thyroid carcinoma and 589 healthy subjects.
Study subjects from both the affected and control groups stayed mainly in their place of residence during the Chernobyl accident (97.28% *v.* 94.24%). Thyroid carcinoma was diagnosed on average 13.58 ± 2.61 years after irradiation. There were no significant differences in iodine prophylaxis during the Chernobyl accident. Lugol's solution was given to 31% of patients and 34% of healthy respondents.
Conclusions:
1. It cannot be stated that the Chernobyl disaster had any influence on the incidence rate of thyroid carcinoma in the province of Olsztyn.
2. Iodine prophylaxis using Lugol's solution could have an influence on lack of significant increase of the thyroid carcinoma incidence rate in the age group 1–18 years.

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Key words: *thyroid carcinoma, incidence Chernobyl accident*

Streszczenie

Materiał i metody: Badanie nad zapadalnością na nowotwory złośliwe tarczycy prowadzono w województwie olsztyńskim od 01.01.1994 do 31.12.2003 roku w jego dawnych granicach pomimo nowego podziału administracyjnego Polski.
Do rejestru włączono chorych spełniających kryteria: zachorowanie nastąpiło w omawianym okresie, dotyczyło stałych mieszkańców województwa, rozpoznanie ustalono na podstawie pooperacyjnego badania histopatologicznego w Zakładzie Patomorfologii Wojewódzkiego Szpitala Specjalistycznego w Olsztynie. Wybrane czynniki ryzyka badano wśród chorych za pomocą specjalnie skonstruowanej ankiety, w której zawarto dane związane z awarią w Czarnobylu: miejsce zamieszkania, czas zachorowania na nowotwory złośliwe gruczołu tarczowego po awarii, stosowanie profilaktyki jodowej podczas awarii. Grupę kontrolną stanowiło 589 zdrowych osób dobranych pod względem wieku oraz miejsca zamieszkania.
Wyniki: W latach 1994–2003 rejestrem objęto 462 chorych na nowotwory złośliwe gruczołu tarczowego: 395 płci żeńskiej i 67 płci męskiej. W badaniach ankietowych wzięło udział 297 osób z grupy chorych oraz 589 osób z grupy kontrolnej. Chorzy, jak i osoby z grupy kontrolnej w czasie awarii w Czarnobylu przebywali głównie w miejscu stałego zamieszkania (97,28% *v.* 94,24%). Chorzy na nowotwory złośliwe zachorowali średnio w 13,58 ± 2,61 lat po ekspozycji na promieniowanie jonizujące. Nie wykazano statystycznie istotnych różnic w zastosowanej podczas awarii profilaktyce jodowej. Płyn Lugola otrzymało 31% chorych i 34% osób z grupy kontrolnej.

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Wnioski
1. Nie udowodniono jednoznacznie wpływu awarii w Czarnobylu na zapadalność na nowotwory złośliwe tarczycy.
2. Zastosowana profilaktyka płynem Lugola mogła mieć wpływ na niewielką zapadalność obserwowaną w grupie wiekowej 0–18 lat.
(Endokrynol Pol 2010; 61 (5): 437–442)

Słowa kluczowe: *nowotwory złośliwe, zapadalność, awaria w Czarnobylu*

Wpływ modeli żywienia kobiet z przebytą cukrzycą ciążową na rozwój zespołu metabolicznego u kobiet oraz nadwagi i otyłości u potomstwa — grant Ministerstwa Nauki i Szkolnictwa Wyższego, zakwalifikowany do finansowania w 38. konkursie

Program badań przesiewowych w kierunku retinopatii cukrzycowej w województwie warmińsko-mazurskim — projekt współfinansowany przez firmy Novo Nordisk Pharma Sp. z o. o. i Roche Diagnostics Polska Sp. z o.o.

Introduction

April 26 is the date of the anniversary of the Chernobyl atomic plant accident. On that day the world's media discuss the issue of the effect of the disaster on the health of the residents of the radiocontaminated area. Olsztyn province, in the north-east of Poland, was within the affected area.

Iodine was a major fallout element, which, by being deposited in the thyroid gland, caused a marked increase in thyroid cancer incidence within the area of contamination. Proof of this can be found in observations of the growing number of cases of malignant thyroid cancer among children in Belarus as soon as four years after the accident [1, 2].

The aim of the study was to investigate if the Chernobyl atomic plant disaster had an influence on thyroid cancer incidence in Olsztyn province.

Material and methods

The prospective study on thyroid cancer incidence was conducted in Olsztyn province from 1 January 1994 to 31 December 2003 within its former administrative boundaries in spite of the new administrative division of Poland which became effective as of 1 January 1999. In the years 1999–2002 the register of thyroid cancer cases in Olsztyn province (presently part of Varmia and Masuria province) was conducted under the National Programme for the Elimination of Iodine Deficiency [3].

The area of Olsztyn province is 12,327 km^2, which constitutes 3.9% of Poland's total area. The province population in 1994 was 769,200 (2% of Poland's population); in 2003 the area was inhabited by 760,737 people (still 2% of the total population) [4–6].

The register of thyroid gland malignant cancer comprised subjects meeting the following criteria:
— disease onset occurred between 1 January 1994 and 31 December 2003;
— subjects were permanent residents of Olsztyn province, for all age groups;
— diagnosis of thyroid gland carcinoma was based on post-operational histopathological investigation according to ICD-9 and ICD-10 classification done in the Anatomical Pathology Department of Olsztyn District Specialist Hospital, and verification in the Pathomorphology Department of the Medical University in Warsaw or Maria Sklodowska-Curie Oncology Centre in Gliwice, and from 1997 also in the Oncology Institute in Warsaw [7, 8].

Table I. ***Characteristics of patients with thyroid cancer comprised by questionnaire***

Tabela I. ***Charakterystyka badanej grupy chorych na nowotwory złośliwe gruczołu tarczowego objętych badaniami ankietowymi***

Characteristics of patients with thyroid cancer in the years 1994–2003	n (%)
Patients comprised by standardised register	462 (100.00)
Death cases among patients in the register	77 (16.66)
Patients answering questionnaires	
In person	139 (30.08)
By mail	151 (32.68)
By phone	4 (0.86)
From close family	3 (0.64)
In total	297 (64.28)

The study of selected risk factors affecting changes in thyroid cancer incidence was conducted among patients entered in the standardized register in the years 1994–2003. For that purpose, a special form was prepared named the „questionnaire for patients with thyroid gland carcinoma". Patients completed the questionnaires during follow-up outpatient clinic visits in the Endocrinology Outpatient Clinic in Olsztyn. In cases of severe disability or change of place of residence answers were obtained by mail or, in some cases, by phone (Table I). As well as personal data, the questionnaire covered medical history (date of thyroid carcinoma diagnosis, methods of diagnosis and treatment, including surgical procedures and complementary pharmacological therapy as well as occurrence of thyroid cancer in the course of other endocrinopathies), physical examination (body height in cm, body weight in kg, body mass index expressed at the ratio of height to body weight^2 in kg/m^2, accepting appropriate BMI $\geq$ 18.5 kg/m^2 and $\leq$ 25 kg/m^2) [9]. Also included was information

Table II. *Characteristics of subjects from control group comprised by the study*

Tabela II. *Charakterystyka osób z grupy kontrolnej objętych badaniami ankietowymi*

Control group n = 589			
Age (years)	**Sex**	**n (%)**	**Average age (years) ± SD**
0–18	Girls	7 (58.33)	16.71 ± 1.38
	Boys	5 (41.67)	13.80 ± 2.17
> 18	Women	507 (87.87)	50.92 ± 13.01
	Men	70 (12.13)	46.33 ± 13.71
0–85+	Women	514 (87.27)	50.46 ± 13.52
	Men	75 (12.73)	44.16 ± 15.56
Total		589 (100.00)	49.66 ± 13.46

about investigated risk factors for thyroid gland cancer apart from specified individual factors, socio-economic factors related to lifestyle, environmental factors related to the Chernobyl accident such as place of residence during the accident, time of thyroid cancer onset after the accident, and iodine prophylaxis during the breakdown. The control group comprised 589 healthy subjects chosen according to age and place of residence, who completed the „Questionnaire for patients with thyroid gland carcinoma" apart from the questions concerning the basic disease. The characteristics of the control group are presented in Table II. Personal data obtained based on questionnaire answers, medical histories, and physical examinations in the group of patients with thyroid cancer and in the control group of healthy patients were anonymously entered into a computer database. Statistical analysis was made using Statistica 7PL software. Standardisation of coefficients was made for the world population. Logistical analysis with determining odds ratio for individual changes within a 95% confidence range was applied to analyse the influence of factors on thyroid carcinoma incidence. Hypotheses on the existence or lack of a relation between variables with nominal or ordinal scale were verified using Pearson's test χ^2 and Maximum Likelihood Estimation χ^2. Poisson distribution was used for analysis of disease incidence. Using normal proximity from Poisson's distribution, test Z was applied to compare two frequencies of thyroid cancer incidence [10–12].

Results

In total, in the years 1994-2003, the register comprised 462 patients with thyroid cancer, 395 females and 67 males. Questionnaires were completed by 297 patients with thyroid carcinoma and 589 healthy subjects from

Table III. *Place of residence during the Chernobyl atomic plant accident in 1986 — study group vs. control group*

Tabela III. *Miejsce zamieszkania badanej grupy chorych na nowotwory złośliwe gruczołu tarczowego i grupy kontrolnej podczas awarii elektrowni atomowej w Czarnobylu w 1986 roku*

Residence place during the Chernobyl accident	**Group of patients**	**Control group**
Barczewo	4 (1.34)	16 (2.71)
Bartoszyce	15 (5.01)	28 (4.75)
Biskupiec Reszelski	3 (1.02)	8 (1.35)
Bisztynek	1 (0.34)	2 (0.33)
Dobre miasto	7 (2.38)	6 (1.01)
Dywity	3 (1.02)	1 (0.16)
Działdowo	0 (0.00)	3 (0.50)
Górowo Iławeckie	2 (0.68)	6 (1.01)
Iława	14 (4.76)	32 (5.43)
Janowo	1 (0.34)	3 (0.50)
Jedwabno	1 (0.34)	2 (0.33)
Jeziorany	5 (1.70)	11 (1.86)
Jonkowo	3 (1.02)	11 (1.86)
Kętrzyn	14 (4.76)	26 (4.41)
Kolno	1 (0.34)	0 (0.00)
Korsze	6 (2.04)	13 (2.20)
Kozłowo	2 (0.68)	2 (0.33)
Lidzbark Warmiński	18 (6.12)	37 (6.28)
Lubawa	6 (2.04)	9 (1.52)
Łukta	1 (0.34)	2 (0.33)
Miłakowo	2 (0.64)	4 (0.68)
Morąg	7 (2.38)	14 (2.37)
Mrągowo	15 (5.10)	29 (4.92)
Nidzica	5 (1.70)	11 (1.86)
Olsztyn	96 (32.65)	174 (29.54)
Olsztynek	5 (1.70)	11 (1.86)
Ostroda	10 (3.40)	22 (3.73)
Pasym	1 (0.34)	0 (0.00)
Purda	1 (0.34)	2 (0.33)
Reszel	7 (2.38)	11 (1.86)
Rozogi	1 (0.34)	2 (0.33)
Sępopol	1 (0.34)	2 (0.33)
Sorkwity	1 (0.34)	2 (0.33)
Stawiguda	1 (0.34)	0 (0.00)
Szczytno	16 (5.44)	36 (6.11)
Świątki	3 (1.02)	6 (1.01)
Świętajno	1 (0.34)	1 (0.16)
Wielbark	4 (1.34)	8 (1.35)
Zalewo	2 (0.68)	2 (0.33)
Other provinces and countries (not marked on the map)	6 (2.04)	17 (2.88)
I don't know	2 (0.68)	17 (2.88)
Total	294 (100.00)	589 (100.00)

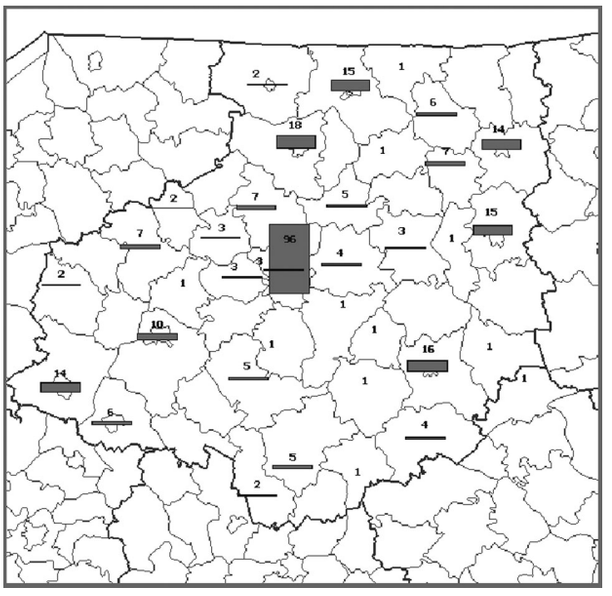

Figure 1. *Place of residence during the Chernobyl atomic plant accident in 1986 — study group*

Rycina 1. *Miejsce zamieszkania osób badanej grupy chorych na nowotwory złośliwe gruczołu tarczowego podczas awarii elektrowni atomowej w Czarnobylu w 1986 roku*

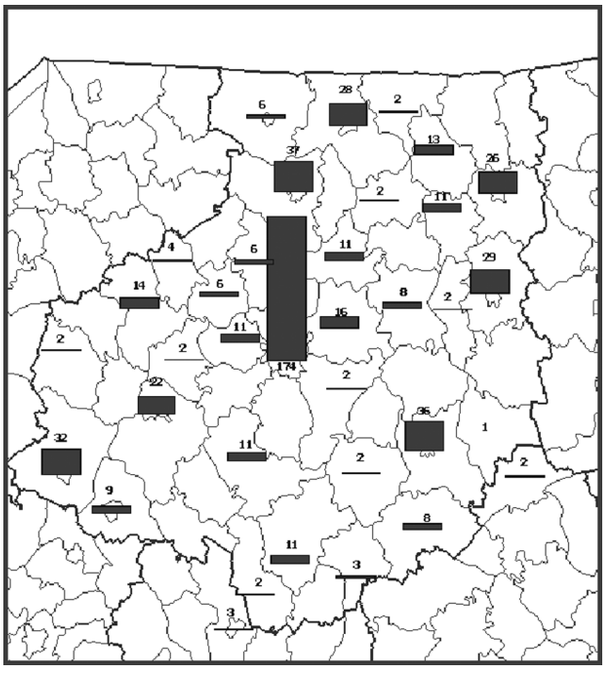

Figure 2. *Place of residence during the Chernobyl atomic plant accident in 1986 — control group*

Rycina 2. *Miejsce zamieszkania osób z grupy kontrolnej podczas awarii elektrowni atomowej w Czarnobylu w 1986 roku*

the control group. As Table III and Figures 1 and 2 show, both patients with malignant carcinoma of the thyroid gland and subjects from the control group predominantly stayed in their place of residence during the Chernobyl atomic plant disaster (97.28% *v.* 94.24%). As Table IV demonstrates, patients with thyroid carcinoma fell sick on average 13.58 ± 2.61 years following exposure to ionizing irradiation caused by the Chernobyl accident.

Table IV. *Time of carcinoma diagnosis after the Chernobyl atomic plant accident in the study group*

Tabela IV. *Czas zachorowania na nowotwory złośliwe gruczołu tarczowego w badanej grupie chorych po awarii elektrowni atomowej w Czarnobylu w województwie olsztyńskim w latach 1994–2003*

Age (years)	Sex	n (%)	Average time of cancer onset after the Chernobyl accident (years) ± SD
0–18	Girls	3 (42.86)	13.00 ± 1.63
	Boys	4 (57.14)	11.75 ± 2.64
> 18	Women	258 (89.90)	13.90 ± 2.58
	Men	29 (10.10)	13.83 ± 2.57
0–85+	Women	261 (88.78)	13.89 ± 2.57
	Men	33 (11.22)	13.58 ± 2.61
Total		294 (100.00)	13.67 ± 2.58

No statistically significant differences were observed in the applied iodine prophylaxis during the Chernobyl accident. Lugol's solution was administered to 31% of patients with thyroid cancer and 34% of subjects from the control group (Fig. 3). No univocal proof was found for the effect of the Chernobyl accident on the incidence of thyroid cancer; the applied prophylaxis with Lugol's solution might have brought about the low thyroid cancer incidence observed in the age group 0–18.

Discussion

The first reports on the relation between ionizing radiation and the occurrence of malignant carcinoma of the thyroid gland were published in 1950 [13]. After the atomic attacks on Hiroshima and Nagasaki in 1945 an increase in the incidence of thyroid cancer in the Japanese population was observed. In subsequent years, a similar increase was observed among the inhabitants of the Marshall Islands following American nuclear trials there [14–16].These reports were the first to point out a significant rise in thyroid cancer incidence, especially in children and adolescents. The observations were univocally confirmed by the studies carried out after the Chernobyl accident [17–20]. In the Belorussian population in the first years after the Chernobyl disaster the highest growth in thyroid cancer incidence was

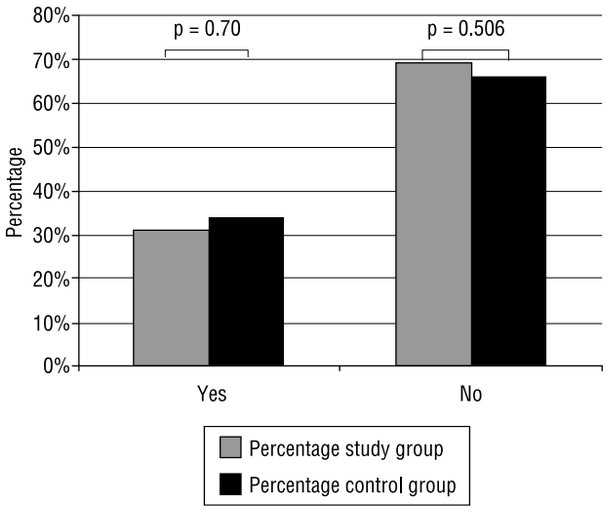

Figure 3. *Iodine prophylaxis during the Chernobyl atomic plant accident in 1986 — study group vs. control group*

Rycina 3. *Stosowana profilaktyka jodowa w badanej grupie chorych na nowotwory złośliwe gruczołu tarczowego i grupie kontrolnej podczas awarii elektrowni atomowej w Czarnobylu w 1986 roku*

reported mainly among children [17–23]. It is generally thought that within the whole population the risk of developing malignant thyroid cancer grows on average from 5 to 9 years after exposure, and incidence peak is observed after 15–19 years. Then, incidence starts to decrease, which lasts for 40 more years [15, 21].

Olsztyn province, due to its geographical location and relatively short distance from the nuclear accident in Chernobyl, was one of the most heavily contaminated areas in the period from 28 April 1986 to 5 May 1986 when winds and fallout carried the radioactive cloud twice over its territory [24–26]. All patients with thyroid cancer comprised in the register were born before 26 April 1986, so they were exposed to irradiation. Only a few individuals from the register stayed in other provinces during the period (5 patients and 14 subjects from the control group) or in other European countries (1 patient and 3 subjects from the control group). Since the majority of researchers consider ionizing radiation to be a risk factor for thyroid carcinoma, it should be assumed that the Chernobyl accident might be a factor that affected the increase in malignant carcinoma of thyroid in Olsztyn province in the years 1994–2003, especially because the first observed growth in thyroid cancer incidence was observed in 1997 and another in 2002, i.e. 11 and 16 years following irradiation.

On the other hand, it cannot be excluded that there was a cause-effect relation with the social unrest caused by the Chernobyl accident, which resulted in increased concern about health among many residents of the area. The development of modern diagnostic methods, more precise instruments used for examinations, and better availability of specialist outpatient clinics have all had a significant effect on the increase of diagnosing thyroid cancers.

Soviet authorities wanted to keep the news of the Chernobyl disaster on 26 April 1986 secret, but just a few hours after the explosion screening instruments in Europe, including those in Poland, observed a rapid rise in ionizing irradiation in the atmosphere. Polish authorities, having consulted scientists, reacted promptly by issuing a resolution about common application of Lugol's solution to children and youths under 16 years of age. Thank to this action the youngest group of our society was protected against the negative effects of the following wave of radiation on 3 May 1986 [27].

In the present study, both in the study group and in the control group, a third of patients and subjects were given iodine prophylaxis. Since only 11.04% of them were children in 1986, it means that 22% of the adult population were also given Lugol's solution. From a time perspective, it should be said that it was the best organized iodinating prophylaxis in Europe [26, 27]. The incontrovertible evidence for this came from our observations as well as other studies conducted in other parts of Poland, which did not reveal a significant rise in thyroid cancer incidence among children and adolescents [24].

Conclusions

1. There is no proof for the effect of the Chernobyl accident on the incidence of malignant carcinoma of the thyroid gland.
2. The applied iodinating prophylaxis with Lugol's solution might have had effect on the low thyroid cancer incidence observed in the age group 1–18 years.

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