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Original Article

Thyroid Diseases in Populations Residing Near the Semipalatinsk Nuclear Test Site, Kazakhstan: Results from an 11 Years Series of Medical Examinations

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Keywords Thyroid diseases; Nuclear bomb testing; Kazakhstan

Abbreviations Gy: Gray; SNTS: Semipalatinsk Nuclear Test Site; SRIRME: Kazakh Scientific Research Institute for Radiation Medicine and Ecology; T3: Triiodthyronine; T4: Tetraiodthyronine; TSH: Thyroid-Stimulating Hormone; 95%CI: 95% Confidence Interval

Abstract

Background: Some above ground nuclear tests conducted from 1949 to 1962 at the Semipalatinsk Nuclear Test Site led to radiation exposure of the public. We conducted medical examinations for hypothyroidism, thyroid cancer, and thyroid nodules with the purpose of providing documentation that might be used in determining whether these exposures had an impact on public health.

Methods: A series of medical field studies were carried out from 1999 – 2009 among volunteers living either in settlements which were potentially affected or which were not affected by the nuclear testing. Risk ratios were estimated between exposed and unexposed individuals.

Results: 1,287 examinations were carried out among 1,067 study participants. 456 were believed to have been exposed and 577 were not. For 34 participants, the exposure situation could not be determined. Risks for hypothyroidism and for thyroid cancer were lower in the exposed compared to the unexposed, i.e., the risk ratios were 0.22 (95%CI, 0.11-0.47) and 0.75 (95%CI, 0.37-1.54), respectively. Looking at affected settlements only did not change the result. For thyroid nodules the risk ratio was 0.99 (95%CI, 0.73-1.35), in affected settlements it was 1.26 (95%CI, 0.81-1.95).

Conclusion: There was no indication for an elevated risk of hypothyroidism or thyroid cancer among those who were believed to have been exposed compared to those who were likely unexposed. However, an elevated risk for thyroid nodules could not be ruled out among those living in affected settlements. The strength of these findings is limited by the absence of individual radiation dose estimates.

Introduction

Health effects from nuclear bomb testing amongst both military veterans and affected civil populations have been a research topic over many decades, and it is anticipated that careful investigation of possible health effects in the general population will contribute to our understanding of radiation effects [1]. In the area around the former Soviet Union's Semipalatinsk Nuclear Test Site (SNTS), a considerable number of persons from the general public (a few 10,000s) were exposed to low and medium doses of ionizing radiation [2,3].

The SNTS is in the present Pavlodar and East Kazakhstan oblasts (regions) of Kazakhstan. The test site is named after the city of Semipalatinsk (in Kazakh: Semey) 150 kilometers to the east. The site covers 18,500 square kilometers. In comparison, the United States' Nevada nuclear test site was about 3,522 square kilometers.

The SNTS was a major site for nuclear weapons testing by the USSR and where the country conducted its first nuclear bomb test on 29 August 1949. That test replicated the first U.S. nuclear device, Trinity, because of design information leaked from the U.S. Manhattan Project. During the following 40 years, 456 nuclear tests were conducted there, including 111 atmospheric tests (eighty-six events in the atmosphere and twenty-five surface events) between 1949 and 1962 [2,4].

After the Limited Test Ban Treaty was signed in 1963, detonations at SNTS were restricted to underground shafts and tunnels; and with a few exceptions little or no off-site environmental contamination resulted from these tests [5].

Settlements affected by the 1949 test were located north-east of the test site (e.g., Dolon and Cheremushka), but traces from this test have also been documented in residents living further away

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in the Altai Region in Russia [6]. The tests of 1951, 1953, and 1956 affected settlements located south and south-east of the test site (e.g. Kainar, Karaul, Kaskabulak, Sarzhal or Znamenka).

The fact that a relatively large number of the general population was potentially exposed by the nuclear testing resulted in numerous studies on possible biological or health effects. A detailed overview on the epidemiological studies is given elsewhere [7,8].

It is well known that radiation exposure can cause thyroid cancer [9,10], and that the risk per unit dose generally decreases with increasing age at exposure and that females usually have a higher risk per unit dose than males. The fact that those being exposed as children have a high risk became particularly evident after the Chernobyl accident [11], but a radiation related risk was also observed among Chernobyl clean-up workers [12]. Studies of the general population affected by the Chernobyl accident suggested a radiation related increase in subclinical hypothyroidism [13], but not for hyperthyroidism [14]. Thyroid disorders, either malignant or non-malignant, have also been investigated among the population affected by the United States' nuclear bomb testing at the Bikini Atoll of the Marshall Islands, in particular, from the1954 BRAVO test. There was no evidence for an association between benign nodules and radiation exposure [15], but there was suggestive evidence that the prevalence of thyroid cancer increased with estimated doses to the thyroid [16].

A study among children who were exposed to fallout from the US Nevada Test Site, Utah, showed that the risk for both thyroid cancer and autoimmune thyroiditis is increased for up to 30 years after exposure to radioiodine in fallout [17].

Thyroid nodules are associated with thyroid cancer [9] and an association with external radiation has been shown [18,19]. A study among 2994 people who were exposed to Iodine-131 from nuclear testing in Kazakhstan found a significantly elevated prevalence of ultrasound-detected thyroid nodules which was independently associated with both external and internal doses [20,21].

In this paper, we report on the findings of a medical thyroid examinations program for people residing in the East Kazakhstan oblast (region), Kazakhstan, which was part of the Hiroshima-Semipalatinsk Project [22]. This series of medical thyroid examinations was carried out over 11 years from 1999 – 2009 among persons living either in settlements which were highly affected by the atomic bomb testing or which were less or not affected. The aim of the study was to determine the thyroid status of the population.

Table 1: Year of examination by sex.

Year of examination	sex			Sum
	male	female	n.a.*	
1999	73	108	4	85
2000	26	57	0	83
2001	79	151	1	231
2002	16	53	0	69
2003	7	90	0	97
2004	17	127	1	145
2005	27	71	0	98
2006	6	111	0	117
2007	2	93	1	96
2008	28	90	0	118
2009	4	44	0	48
sum	285	995	7	1287

*: n.a.: not available.

Material and Methods

Study population

The study population comprised voluntarily participating persons who lived either in one of four affected settlements (Dolon, Kainar, Karaul, Sarzhal) or in one of 65 settlements considered as being not affected. This is based on the knowledge about the trajectories (see e.g. [23]) and on current dose estimates. It has been shown that the historical dose estimates, as they were used for example in the first analysis of the so-called historical cohort [24], tend to overestimate the actual exposure (see [25]).

We targeted those seeking medical examination in the various rayons (districts) of the East Kazakhstan oblast. All participants provided informed consent, in accordance with the Code of Ethics of the Republic of Kazakhstan. Though participation was voluntarily, the focus of the program was on females since thyroid disorders are more common among females than among males. Overall, 1287 examinations were conducted over the years 1999 to 2009 (Table 1). It has to be noted that in 1999, East Kazakhstan had a population of almost 1.4 million, with about 320,000 living in Ust-Kamenogorsk and 300,000 living in Semipalatinsk. The population of the four affected settlements summed up to 11,139.

The study design was a series of cross-sectional studies. Interviews were conducted and questionnaires administered to ascertain information on date of birth, height, weight, family structure, exposure status of family members, place of residence at the time of exposure, the number of deliveries for females, etc. In a second step, urine samples were taken for determining stable iodine concentrations, blood samples were taken to determine the thyroid hormone status, palpations were done to investigate the physical status of the thyroid gland, and finally ultrasound examinations were conducted to better determine the presence and size of physical abnormalities. When indicated, nodule punctures were taken. In the first years (1999-2003), medical examinations were conducted at the study participants' places of residence; later (2004-2009) the participants were invited to the Kazakh Scientific Research Institute for Radiation Medicine and Ecology (SRIRME) in Semey, which is responsible for medical follow-up of the population around SNTS, and examinations took place at the Institute's hospital. All examinations were conducted by physicians of the study team. The equipment was donated from Japan and didn't change over the years. The process from selecting settlements to analyzing the blood samples is shown in Figure 1.

For 711 of the examinations, the study subjects were listed in the SRIRME population registry of the East Kazakhstan oblast [26]. For another 576 examinations, the study subjects were not included in this registry.

For our data analyses, we only used the result of one examination per study subject. If one individual was examined more than once, only the most recent information was used. From the 711 examinations

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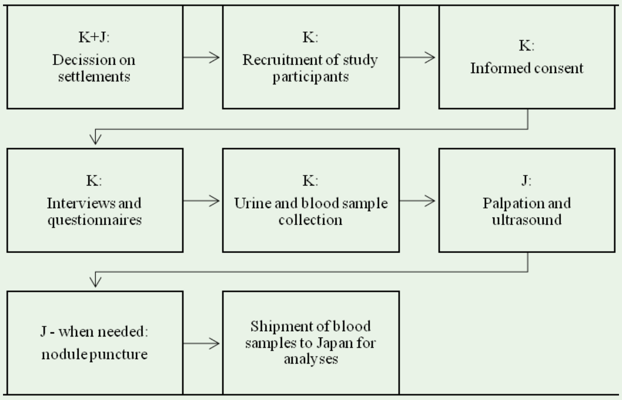

Figure 1: Process for the thyroid screening (K – Kazakh team; J – Japanese team).

that included the ID of the SRIRME registry, 557 different individuals were identified (21.7% of the examinations were excluded). For those 576 individual examinations with no ID in the SRIRME registry, plausibility was checked manually based upon date of birth, gender, ethnicity, and sometimes height and weight. From this analysis, 510 individuals were left in the data set (11.3% of the examinations were excluded). Among those excluded were 56 individuals for whom none of the relevant information was available. The maximum number of examinations per study subject was 6.

For seven study participants, no information on sex was available, of which two had an unknown place of residence; two lived in unaffected and three in affected settlements, respectively. Finally, 1067 individuals are included in the study, while for 2 of these, the information on sex and for 5 the information on sex and age was missing (Table 2). Table 3 gives an overview on the age at the time of examination and the sex distribution of the study participants. The clear majority was either Kazakh (61%) or Russian (15%). Other ethnic groups were Bashkir, Bulgarian, Byelorussian, Georgian, German, Tartar, or Ukrainian. For 229 (22%) individuals, the respective information is missing.

Exposure data

No data on the magnitude of individual radiation dose are available. Thus, we grouped the individuals in two different ways. The first grouping was by the place of residence, i.e., affected or not affected. Accordingly, 715 of the 1067 study subjects (67%) came from affected settlements.

Table 2: Participants from affected and unaffected places of residence at time of recruitment, stratified by sex.

Place of residence		Sex			Sum
		male	female	n.a.*	
affected	Dolon	64	204	1	269
	Kainar	43	99	1	143
	Karaul	8	35	0	43
	Sarzhal	62	197	1	260
not affected		56	288	2	346
n.a.*		0	4	2	6
sum		233	827	7	1067

*: n.a.: information not available.

Table 3: Age group at time of examination by sex.

Age group	Sex			sum
	male	female	n.a.*	
0-14	10	13	0	23
15-24	3	5	0	8
25-34	3	25	0	28
35-44	9	76	0	85
45-54	69	253	1	323
55-64	104	337	1	442
65-74	32	110	0	142
75+	3	8	0	11
n.a.[a]	0	0	5	5
sum	233	827	7	1067

*: n.a.: not available.

In a second step, we grouped individuals according to whether they were living in an affected settlement at the time of the relevant bomb testing (see [24]) or not. It has to be noted, that the doses given in [24] are not compatible with dose estimates derived from to-dates most evolved dosimetry system [5,27,28], but allow the definition of affected settlements. Based on this definition, we found that 244 of those living in an affected settlement were actually not exposed, and 6 living in an unaffected settlement were actually exposed. Finally, the study population comprised 1031 individuals, 455 exposed and 576 unexposed, respectively. For 34, either the exposure status or whether the place of residence was affected could not be determined (Table 4).

Statistical analyses

The data set is considered as a random sample taken from the entire population. Thus, Chi^2 tests were applied to clarify differences between the exposed and the unexposed. For comparing the risks between the exposed and the unexposed, data were stratified by age group and sex. Risk ratios were calculated by using the Mantel-Haenszel estimate for the odds ratio.

Results

Descriptive results

There were two sets of medical information collected: one on thyroid function, the other on cytology. Figures 2 to 4 give the prevalence of the most interesting diagnosis by age and sex,

Table 4: Study subjects by exposure status from affected and unaffected settlements at time of recruitment.

Study subjects	Settlement			sum
	affected	not affected	n.a*	
exposed	449	6	1	456
not exposed	244	332	1	577
n.a.*	22	8	4	34
sum	715	346	6	1067

*: n.a.: relevant information not available.

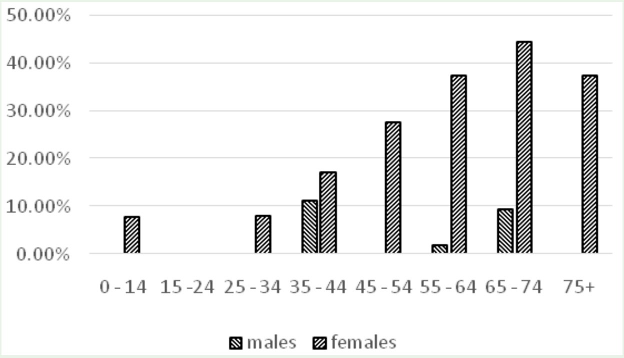

Figure 2: Prevalence of hypothyroidism by age group and sex, 1999-2009, based on diagnostic findings among 1062 persons.

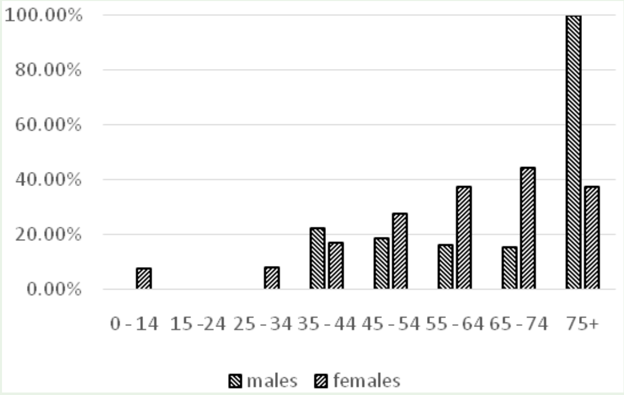

Figure 3: Prevalence of nodules by age group and sex, 1999-2009, based on diagnostic findings among 1062 persons.

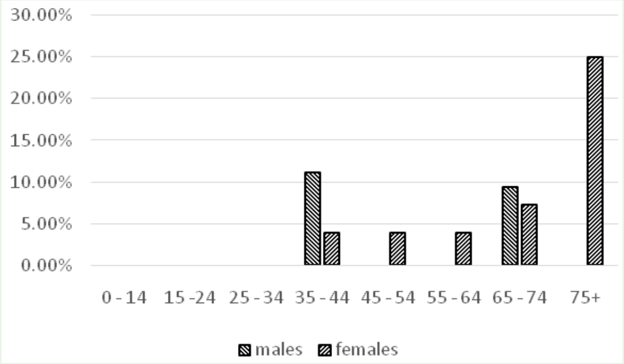

Figure 4: Prevalence of thyroid cancer by age group and sex, 1999-2009, based on diagnostic findings among 1062 persons.

i.e., hypothyroidism, thyroid cancer, and thyroid nodules. In the following some details are given on thyroid function and cytological findings followed by risk comparisons for hypothyroidism, thyroid cancer, and thyroid nodules by exposure status.

Table 5: Findings on thyroid function.

Diagnosis	Frequency	Percent
sub-clinical hypothyroidism	45	4.2
hypothyroidism	18	1.7
normal	990	92.8
slight hyperthyroidism	1	0.1
hyperthyroidism	13	1.2
sum	1067	100.0

Table 6: Findings on cytological diagnoses.

Diagnoses	Frequency	Percent
NAD*	675	63.3
colloid nodule	291	27.3
follicular adenoma	6	0.6
follicular cancer	14	1.3
papillary cancer	16	1.5
struma	1	0.1
thyroiditis	55	5.2
class II / III	8	0.7
metastasis	1	0.1
sum	1067	100.0

*: NAD: no abnormality detected.

Table 7: Cytological diagnoses, allowing for more than one diagnosis per individual.

Diagnoses	Frequency	Percent
NAD*	675	63.3
thyroiditis	55	5.2
nodule	255	23.9
thyroditis and nodule	42	3.9
cancer	33	3.1
nodule and cancer	7	0.7
sum	1067	100.0

*: NAD: no abnormality detected.

Thyroid function: Important for the diagnosis of hyper- or hypothyroidism are the values of T3, T4 and TSH. If the measured value is more than twice of the standard rate in the study population, it is considered as being abnormal. Mean values (minimum and maximum given in brackets) for T3, T4 and TSH were: 3.35 (0.20-27.43), 1.17 (0.26-6.49), and 3.55 (0.01-195.50), respectively. These values are based on 1028, 1027 and 997 measurements, respectively. In general, the decision whether an individual had hyper- or hypothyroidism was based on the values of T3, T4 and TSH; but medication that might have an effect on the measured values was also considered.

Diagnoses on hypo- and hyperthyroidism, respectively, were classified as sub-clinical, manifest (hypo- or hyperthyroidism in Table 5), and slight. Almost 93% of all individuals had normal diagnoses, while hypothyroidism was more frequent than hyperthyroidism amongst the remainder.

Cytology: Cytological information comprised several diagnoses, which are listed in Table 6 for the entire study population. Cases with diagnoses specified as “possibly” were handled as if the diagnosis was confirmed. In case more than one diagnosis was given for an

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Table 8: Age and sex adjusted risk ratios for hypothyroidism, thyroid cancer, and thyroid nodules; comparing study participants from affected with unaffected settlements.

Diagnoses		Males	Females	Sum	Persons	Risk ratio	95%-CI
hypothyroidism	Yes	6	57	63	1030	0.22	0.11-0.47
	No	220	747	967			
thyroid cancer	Yes	3	36	39	1018	0.75	0.37-1.54
	No	221	758	979			
thyroid nodules	Yes	39	254	293	1018	0.99	0.73-1.35
	No	185	540	725			

individual, the following ranking of importance was used: thyroiditis (low), nodule (medium), cancer (high). In a second step, this led to eight possible groups of diagnoses: No Abnormality Detected (NAD); thyroiditis; nodule; thyroiditis and nodule; cancer; thyroiditis and cancer; nodule and cancer; thyroiditis, nodule and cancer. The actual numbers of cases are given in Table 7.

Risk ratios

Hypothyroidism: To test whether the prevalence of hypothyroidism differed among the exposed compared to unexposed, we regrouped the data from Table 5 into two categories: hypothyroidism and no hypothyroidism. Accordingly, 63 cases and 1004 non-cases were used for the analysis.

Table 8 shows the number of cases of hypothyroidism and of non-cases by sex. When comparing the prevalence among the exposed with the unexposed, the risk ratio stratified by age and sex was 0.22 (95%CI, 0.11-0.47).

The diagnosis of hypothyroidism might be affected by previous medications. As can be seen from Table 9, information on medical treatment for thyroid malfunctions was available for 271 subjects with a statistically significant higher proportion among females than among males. We analyzed whether this information altered the previous finding by introducing medication as a further level of stratification. The resulting risk ratio point estimate was 0.25 with a wide 95%-CI (0.03-1.91).

Further it is known from previous studies that the overall health situation in the area around the SNTS is worse than in other parts of the East Kazakhstan oblast, in particular with respect to mortality from all causes, from solid cancer [24] and from cardio-vascular diseases [29]. Thus, we restricted the analyses for hypothyroidism to the affected settlements (see Table 1). Based upon information from 667 subjects, the risk ratio was 0.15 (95%CI, 0.06-0.36). Introducing medication as a further stratifying variable did not give any meaningful result, because the number of subjects was reduced to only 168 of which 8 had the disease.

Thyroid cancer: To test whether the prevalence of thyroid cancer differed among the exposed compared to the unexposed, we regrouped the data from Table 7 into two categories: thyroid cancer and no thyroid cancer giving 40 cases and 1027 non-cases. The risk ratio stratified by age and gender was 0.75 (95%CI, 0.37-1.54).

Table 9: Medication by sex.

Medication	Sex		Sum
	male	female	
yes	12 (13.0%)	78 (43.6%)	90 (35.3%)
no	80 (87.0%)	101 (56.4%)	181 (64.7%)
sum	92(100%)	179(100%)	271 (100%)

Similar to the case for hypothyroidism, we restricted the analysis of thyroid cancer to the population from affected settlements. Based upon information from 691 subjects, the risk ratio was 0.84 (95%CI; 0.32-2.20), i.e., there was no indication for an increased risk of thyroid cancer in those having been exposed compared to the unexposed.

Thyroid nodules: To test whether the prevalence of thyroid nodules differed among the exposed from the unexposed, we re-categorized the diagnoses as given in Table 7 to nodules (i.e. nodules only plus thyroiditis and nodules) and no nodules. Thus, 297 subjects were defined as having nodules of which 293 could be included in the analysis. As can be seen from Table 8, the risk ratio stratified by age and gender was 0.99 (95%CI, 0.73-1.35). When restricting the analysis to affected settlements only, the risk ratio was not statistically significant elevated: 1.26 (95%CI, 0.81-1.95), based upon 685 study subjects.

In a next step, we excluded all subjects with thyroid cancer, because there is a strong epidemiologic evidence of a relationship between thyroid nodules and subsequent thyroid cancer [9]. This left 979 subjects in the analysis. Stratifying the data by age and sex revealed a risk ratio of 0.95 (95%CI, 0.69-1.30), again indicating no higher risk in the exposed compared to the unexposed. When looking at those in affected settlements only, the risk ratio was 1.17 (95%CI, 0.75-1.83), based upon 661 subjects.

Discussion

We report on a series of field studies conducted during the years 1999 – 2009 in several areas of the East Kazakhstan oblast including the vicinity of the Semipalatinsk Nuclear Test Site. The aim was to determine the thyroid status of the population. When taking possible radiation exposure as an influencing factor into account, we found a lower prevalence of hypothyroidism in the exposed population compared to the unexposed population, and no difference in the prevalence of thyroid cancer and thyroid nodules. There is a slight but insignificant indication that the prevalence of thyroid nodules among the exposed might be higher than among the unexposed when restricting the analysis to the population from the affected settlements, i.e. the closer vicinity of the test site.

From 1999 through 2002, 571 residents from four exposed and one control village near SNTS were screened for thyroid nodules [30]. The individuals were all below 20 years of age at the time of major radiation fallout. The author concluded that it would probably be more informative for thyroid dosimetry studies to distinguish

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between specific morphological types of thyroid nodules; however, the number of nodules in our study is too small to follow this suggestion.

A case review of 7271 patients aged 15 to 90 who underwent surgery for thyroid diseases between 1966 and 1996 examined the variation of diagnoses over time [31]. It was shown that the percentage of thyroid cancer among all diagnoses increased over time, starting low in the first years 1966-1971 (1.3%), peaking in the years 1987-1991 (16.3%), and probably decreasing again in the last study period 1992-1996 (11.2%). During the period of our studies (1999-2009), which follows the last study period of the case review, the proportion of thyroid cancer was 10.2% based upon 40 cases. The proportion is in line with the findings from the large case review, but the number of cases is too small to look at possible trends over time.

The strength of our field study is the careful examination of the thyroid and the hormonal status in a population residing in the East Kazakhstan oblast. It gives a very good impression on several clinical parameters. This is particularly true for a mid-aged female population, because 65% of the entire study population are females aged between 25 and 64.The values of TSH, T3, and T4 found in this population can be compared to those from other populations. This might be of interest for the discussion on what the appropriate reference values are. The same accounts for the information on the prevalence of the thyroid disorders in this population.

With respect to the analysis of a possible influence of the radiation exposure from the nuclear bomb testing at the SNTS, the data include some limitations. The most important one is the fact that the information on individual doses is not available, and the range of doses might be broad. In the study of Land et al., the authors estimated the dose range for external doses between 0 and 0.65 Gy (mean 0.042 Gy) and for internal doses between 0 and 9.6 Gy (mean 0.31 Gy) [21]. In our study, the available information only allowed to define the exposure status at a level of Yes or No. A further weakness is the fact that the study population is not representative but has an uneven distribution of the sexes in the study population, i.e., 87% females. This might reflect the case that females are more concerned about their health than males.

The biased sex distribution might be an explanation that we did not find convincing indication for an increased risk for thyroid nodules in our study population. As found by Land et al.[20], the excess relative risk for nodules by unit dose is 30 times higher among males than among females. When restricting the analysis of our data set to males only, there was no indication for an increased risk for thyroid nodules among the exposed (age stratified risk ratio = 0.72; 95%CI, 0.33-1.56), based upon 233 study subjects. Looking at affected settlements only gave a risk ratio of 1.36 (95%CI, 0.42-4.37) based upon 177 study subjects. It has to be noted, that one major difference between our examinations and the study by Land et al. [21] is the fact that the examinations of the latter were conducted within one year and ours were conducted over 11 years. It is known from the study among the Marshall islanders that examinations of the same person in different years might lead to different results because of a possibility of intra-personal variation in diagnoses [15]. We used most recent information for individuals who underwent more than one examination, but results of the previous examinations were likely to influence the attitude for participating into the study. Thus people who underwent more than one examination might have different characteristics from those who underwent only one examination. Indeed, a look at the diagnoses among those persons from our study with more than one examination showed that the diagnoses sometimes changed over time. We suspect that multiple diagnoses were done among those participants who had greater concern about the status of their thyroid. Other risk factors for the diseases of interest have not been taken into account or they are directly related, e.g. thyroid cancer and nodules or thyroid cancer and TSH values (see [9]).

The participants could be affected by various selection biases about outcomes (i.e., they had target disorders or not) and exposure (i.e., they lived in polluted areas or not). This doesn't seem to be the case, but it cannot be ruled out. The results do not support the assumption that participation depended on previously known target disorders or the area a participant lived in. It might be that people with an unknown thyroid status participated more likely than those with an already known status. In addition, proportion of participants among the potentially screened population is quite small, and the information about the whole residential population from which the participants derived can't be given.

In summary, this series of examinations did not indicate that the risk for hypothyroidism, thyroid cancer or thyroid nodules is higher among those who were believed to have been exposed compared to those who were likely unexposed by the nuclear bomb testing. Nevertheless, an elevated risk for thyroid nodules could not be ruled out, but confidence intervals were broad. The strength of these findings is limited by the absence of individual radiation dose estimates.

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References

1. Gilbert ES, Land CE, Simon SL. Health effects from fallout. Health Phys. 2002; 82: 726-735.
2. Grosche B. Semipalatinsk test site: introduction. Radiat Environ Biophys. 2002; 41: 53-55.
3. Grosche B. Risk to Populations Exposed from Atmospheric Testing and Those Residing Near Nuclear Facilities. In: Encyclopedia of Environmental Health. Burlington: Elsevier. Nriagu JO, editor. 2011; 887-891.
4. Mikhailov VN. Nuclear weapons tests and peaceful nuclear explosions in the USSR 1949-1990. Moscow: Ministry of the Russian Federation on Atomic Energy and Ministry of Defense of the Russian Federation. 1996.
5. Gordeev K, Shinkarev S, Ilyin L, Bouville A, Hoshi M, Luckyanov N, et al. Retrospective dose assessment for the population living in areas of local fallout from the Semipalatinsk Nuclear Test Site Part II: Internal exposure to thyroid. J Radiat Res. 2006; 47: A137-141.

6. Shoikhet Y, Loborev V, Sudakov V, Kiselev VI, Zelenov V, Azarov L. Fallout from nuclear tests: Dosimetry in the Altai region. Radiat Environ Biophys. 2002; 41: 57-60.
7. Grosche B, Simon SL, Apsalikov KN, Kesminiene A. Radiation health risk studies associated with nuclear testing in Kazakhstan. In: Freedman E, Neuzil M, editors. Environmental Crisis in Central Asia. London New York: Routledge. 2016; 117-126.
8. Grosche B, Zhunussova T, Apsalikov K, Kesminiene A. Studies of Health Effects from Nuclear Testing near the Semipalatinsk Nuclear Test Site, Kazakhstan. CAJGH. 2015; 1-7.
9. Ron E, Schneider AB. Thyroid Cancer. In: Schottenfeld D, Fraumeni JF, editors. Cancer Epidemiology and Prevention. 3rd edn. New York: Oxford University Press. 2006; 975-994.
10. UNSCEAR. Effects of ionizing radiation: UNSCEAR 2006 Report to the General Assembly, with scientific annexes: United Nations Publications. 2008.
11. Jacob P, Bogdanova TI, Buglova E, Chepurniy M, Demidchik Y, Gavrilin Y, et al. Thyroid cancer among Ukrainians and Belarusians who were children or adolescents at the time of the Chernobyl accident. J Radiol Prot. 2006; 26: 51-67.
12. Kesminiene A, Evrard AS, Ivanov VK, Malakhova IV, Kurtinaitise J, Stengrevics A, et al. Risk of thyroid cancer among chernobyl liquidators. Radiat Res. 2012; 178: 425-436.
13. Ostroumova E, Brenner A, Oliynyk V, McConnell R, Robbins J, Terekhova G, et al. Subclinical hypothyroidism after radioiodine exposure: Ukrainian-American cohort study of thyroid cancer and other thyroid diseases after the Chornobyl accident (1998-2000). Environ Health Perspect. 2009; 117: 745-750.
14. Hatch M, Furukawa K, Brenner A, Olinjyk V, Ron E, Zablotska L, et al. Prevalence of hyperthyroidism after exposure during childhood or adolescence to radioiodines from the chornobyl nuclear accident: dose-response results from the Ukrainian-American Cohort Study. Radiat Res. 2010; 174: 763-772.
15. Takahashi T, Trott K, Fujimori K, Nakashima N, Ohtomo H, Schoemaker M, et al. Thyroid disease in the Marshall Islands. Findings from 10 years of study. Sendai: Tohoku University Press. 2001.
16. Takahashi T, Schoemaker MJ, Trott KR, Simon SL, Fujimori K, Nakashima N, et al. The Relationship of Thyroid Cancer with Radiation Exposure from Nuclear Weapon Testing in the Marshall Islands. Journal of epidemiology / Japan Epidemiological Association. 2003; 13: 99-107.
17. Lyon JL, Alder SC, Stone MB, Scholl A, Reading JC, Holubkov R, et al. Thyroid disease associated with exposure to the Nevada nuclear weapons test site radiation: a reevaluation based on corrected dosimetry and examination data. Epidemiology. 2006; 17: 604-614.
18. Imaizumi M, Usa T, Tominaga T, Neriishi K, Akahoshi M, Nakashima E, et al. Radiation dose-response relationships for thyroid nodules and autoimmune thyroid diseases in hiroshima and nagasaki atomic bomb survivors 55-58 years after radiation exposure. JAMA. 2006; 295: 1011-1022.
19. Schneider AB, Ron E, Lubin J, Stovall M, Gierlowski TC. Dose-response relationships for radiation-induced thyroid cancer and thyroid nodules: evidence for the prolonged effects of radiation on the thyroid. The Journal of Clinical Endocrinology & Metabolism. 1993; 77: 362-369.
20. Land CE, Kwon D, Hoffman FO, Moroz B, Drozdovitch V, Bouville A, et al. Accounting for shared and unshared dosimetric uncertainties in the dose response for ultrasound-detected thyroid nodules after exposure to radioactive fallout. Radiat Res. 2015; 183: 159-173.
21. Land CE, Zhumadilov Z, Gusev BI, Hartshorne MH, Wiest PW, Woodward PW, et al. Ultrasound-detected thyroid nodule prevalence and radiation dose from fallout. Radiat Res. 2008; 169: 373-383.
22. Kawano N, Taooka Y, Takeichi N, Kobatake C, Noso Y, Hoshi M. International Medical Cooperation for the Radiation Exposed Population (Hibakusha) in Semipalatinsk, Kazakhstan: A Challenge from Hiroshima, the City of the World's First Atomic Bombing. Journal of International Development and Cooperation. 2003; 9: 89-100.
23. Gordeev K, Vasilenko I, Lebedev A, Bouville A, Luckyanov N, Simon SL, et al. Fallout from nuclear tests: dosimetry in Kazakhstan. Radiat Environ Biophys. 2002; 41: 61-67.
24. Bauer S, Gusev BI, Pivina LM, Apsalikov KN, Grosche B. Radiation exposure due to local fallout from Soviet atmospheric nuclear weapons testing in Kazakhstan: solid cancer mortality in the Semipalatinsk historical cohort, 1960-1999. Radiat Res. 2005; 164: 409-419.
25. Gordeev K, Shinkarev S, Ilyin L, Bouville A, Hoshi M, Luckyanov N, et al. Retrospective dose assessment for the population living in areas of local fallout from the Semipalatinsk nuclear test site Part I: External exposure. J Radiat Res. 2006; 47: A129-136.
26. Katayama H, Apsalikov KN, Gusev BI, Galich B, Madieva M, Koshpessova G, et al. An attempt to develop a database for epidemiological research in Semipalatinsk. J Radiat Res. 2006; 47: A189-197.
27. Beck HL, Anspaugh LR, Bouville A, Simon SL. Review of methods of dose estimation for epidemiological studies of the radiological impact of nevada test site and global fallout. Radiat Res. 2006; 166: 209-218.
28. Simon SL, Beck HL, Gordeev K, Bouville A, Anspaugh LR, Land CE, et al. External dose estimates for Dolon village: application of the U.S./Russian joint methodology. J Radiat Res (Tokyo). 2006; 47: A143-147.
29. Grosche B, Lackland DT, Land CE, Simon SL, Apsalikov KN, Pivina LM, et al. Mortality from cardiovascular diseases in the Semipalatinsk historical cohort, 1960-1999, and its relationship to radiation exposure. Radiat Res. 2011; 176: 660-669.
30. Zhumadilov Z. Thyroid nodules in the population living around Semipalatinsk nuclear test site: possible implications for dose-response relationships study. J Radiat Res. 2006; 47: A183-187.
31. Zhumadilov Z, Gusev BI, Takada J, Hoshi M, Kimura A, Hayakawa N, et al. Thyroid abnormality trend over time in northeastern regions of Kazakstan, adjacent to the Semipalatinsk nuclear test site: a case review of pathological findings for 7271 patients. J Radiat Res. 2000; 41: 35-44.

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