P-2a-76

The Frequency of Down's Syndrome in the City of Ozyorsk Located Near the Nuclear Complex "Mayak"

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INTRODUCTION

For many years possible genetic effects of exposure to ionizing radiation has been a subject of interest and concern but data from studies of the risk of radiation-induced hereditary effects in humans are limited. Several studies showed association between maternal radiation exposure and Down's syndrome (1-4), but others did not show such an association (5-8).

The most interest is that the occurrence of congenital malformation might be associated with occupational ionizing radiation exposure of the parents. In a case-control study of the association of parental occupational exposure and risk of congenital malformation (including Down's syndrome) in their offspring there was no evidence of such an associated (9, 10). It is preferable to carry out such studies on the basis of population registries, since long follow-up in large populations allows to reveal increased frequency of even very rare forms of congenital abnormalities.

MATERIALS AND METHODS

The aim of the study is to assess the frequency of Down's syndrome among newborns in the city of Ozyorsk located near the nuclear complex "Mayak". The study has been conducted on the basis of the Childhood Registry, which includes 18,047 children born in Ozyorsk in 1974-1988. The frequency of Down's syndrome among children whose parents were occupationally exposed to radiation has been studied. The cohort has been divided into two subcohorts based on whether or not parents worked at Mayak. In 5,273 children either one or both parents were occupationally exposed to radiation radiation at Mayak. The characteristics of the main group were presented in table 1. The doses of occupational external γ-radiation of the mothers before conception were from 0.01 to 82.86 cGy, the doses of occupational exposure of the fathers were from 0.01 to 486.27 cGy.

Table 1

Characteristic of parental occupational exposure in main subcohort

Parents	N	Doses before conception, cGy		Distribution cohort by doses (cGy) of occupational exposure			
		min	max	≤5.0	5.01-50.0	50.01-100.0	>100.01
Exposed mother	267	0.01	82.86	247	19	1	0
Exposed father	4,664	0.01	486.27	3,340	1,269	42	13
Exposed both parents							
mother	342	0.01	23.95	298	44	0	0
father	342	0.02	189.76	215	121	5	1

The comparison group includes 12,774 children whose parents never worked at Mayak. Mothers of children of both groups were observed during pregnancy and delivered at the same obstetric clinic. Information on cases of Down's syndrome has been abstracted from newborn records at the city maternity hospital. One of the purposes of the study was to assess the role of maternal age in the occurrence of Down's syndrome.

Table 2

Age distribution of the parents of the children

Parents	Age subgroups									
	19 years and less		20-30 years		31 years and more		unknown age		Total	
	n	%	n	%	n	%	n	%	n	%
Mothers	2,023	11.2	13,588	75.3	2,326	12.9	110	0.6	18,047	100.0
Fathers	638	3.5	13,307	73.7	3,285	18.2	817	4.6	18,047	100.0

The frequency of Down's syndrome among children has been studied in 3 groups: 1)children whose parents were less 20 years old, 2) from 20 to 30 years old, 3) 31 years and older (table 2). The prevalence of Down's syndrome was calculated in cases per 1000 livebirth.

RESULTS AND DISCUSSION

In the period 1974-1988 26 children with Down's syndrome were born in Ozyorsk. The frequency of Down's syndrome was 1.44 cases per 1,000 newborns (table 3). According to some published data, the population frequency of this syndrome is 1.25-1.42 cases per 1,000 newborns (11, 12). Investigation of Down's syndrome in children of high background radiation area demonstrated that the frequency was 0.87 per 1000 (13). No association was shown between Down's syndrome and gonad dose equivalent rate of natural background radiation (14).The results are less consistent in showing an association of Down's syndrome with Chernobyl accident (15-18). Moreover, the rate of Down's syndrome was 1.26 before and 0.91 after the accident (15).

Table 3

The frequency of Down's syndrome in children of the observed cohort

Groups	Number of the children	Down's syndrome	
		n	per 1000 newborn
All children	18,047	26	1.44
Children of the main group	5,273	7	1.33
Children of the exposed mothers[1] (Range of the doses 0.23-0.65cGy)	609	2	3.28
Children of the exposed fathers[2] (Range of the doses 1.19-10.31cGy)	5,006	5	1.00
Children of the control group	12,774	19	1.49

[1] - including mothers from the group in which both parents were exposed

[2] - including fathers from the group in which both parents were exposed

The study of parental occupational exposure as the risk factor for Down's syndrome was conducted. No association between parental occupational exposure and occurrence of Down's syndrome was demonstrated. In the children, whose parents worked at Mayak, the frequency of Down's syndrome was 1.33 cases per 1000, and in the comparison group – 1.49 cases per 1000 - the difference is not statistically significant ($p>0.05$). Parental radiation doses by the time of conception of children with Down's syndrome were in the range from 0.23 to 10.31 cGy. These data are consistent with the results presented by Sever et al. Eleven defects including Down's syndrome for which an association with radiation was considered most likely, showed no evidence of such an association (9, 10). Among children born to medical radiographers, overall risks of chromosomal anomaly were as expected based on general population rates (19).

It is known that parental age is the most important aetiological factor in Down's syndrome formation in humans. The role of parental age was a subject of our study. The frequency of Down's syndrome in children born to mother whose the age was 20-30 years was 1.05 per 1,000 and in children born to mothers older than 30 years – 2.74 per 1,000 ($p<0.05$) (table 3). Our data are consistent with the results of other studies which demonstrate the effect of maternal age (13, 16, 20-22), and no effect of paternal age (3, 23).

Table 4

The frequency of the births children with Down's syndrome in different age group of the parents

Parents	Age groups[1], number of the children with Down's syndrome					
	before 20 years		20-30 years		31 years and older	
	n	on 1000	n	on 1000	n	on 1000
Mothers	3	1.48	14	1.03	9	3.87[2]
Fathers	2	3.13	15	1.13	9	2.74

[1] – only for parents whose age is known

[2]- the difference between age groups "20-30 years" and "31 years and older" is statistically significant

CONCLUSION

The frequency of Down's syndrome among children born in the city located near the nuclear complex does not exceed the spontaneous level. No association has been detected between the frequency of Down's syndrome and preconception parental radiation exposure. The effect of maternal age has been confirmed.

ACKNOWLEDGMENT

This work was supported by contract between Branch #1 of the State Research Center "Biophysics Institute" and ELECTRICITE DE FRANCE "ETUDE DES MALFORMATIONS OBSERVEES A LA

NAIISSANCE CHEZ LES ENFANTS NES DANS LE DISTRICT D'OZYORSK ENTRE 1974 et 1988"

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