



# Is Exposure to Ionizing Radiation Resulting from the Chernobyl Fallout Associated with Childhood Cardiac Arrhythmia?

Geraldine Landon, Enora Clero, Jean Rene Jourdain

## ► To cite this version:

Geraldine Landon, Enora Clero, Jean Rene Jourdain. Is Exposure to Ionizing Radiation Resulting from the Chernobyl Fallout Associated with Childhood Cardiac Arrhythmia?. International Conference on Medical Physics, Radiation Protection and Radiobiology., ICMRPR, Mar 2018, LONDRES, United Kingdom. hal-03098808

**HAL Id: hal-03098808**

**<https://hal.science/hal-03098808>**

Submitted on 5 Jan 2021

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Copyright



INSTITUT  
DE RADIOPROTECTION  
ET DE SÛRETÉ NUCLÉAIRE

*Faire avancer la sûreté nucléaire*

# Exposure to Ionizing Radiation Resulting from the Chernobyl Fallout and Childhood Cardiac Arrhythmia:

## A Population Based Study

[Jourdain *et al.*, BMJ Open, 2018, **accepted**]

ICMPRPR – LONDON – March 15<sup>th</sup>, 2018

Geraldine LANDON

Jean-Rene JOURDAIN

Enora CLERO

## Nuclear accident of Chernobyl (Ukraine – April 26<sup>th</sup>, 1986)



■ **Radioactive plume** (~ 5,3 EBq) mainly composed of iodine and caesium radioactive

### ■ **Population radiation exposure**

Mainly through ingestion of contaminated products (vegetables, fish products, meat, milk, etc.)

### ■ **Health effects**

#### ■ Cancerous

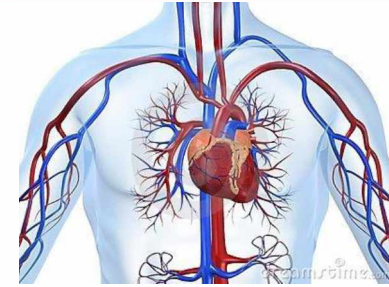
Thyroid cancer especially in children under 5 years old (6 848 cases between 1991 and 2005 in children < 18 years old at the time of the accident) : **link with ionizing radiation exposure proved**

[Unsear 2008]

#### ■ Non cancerous

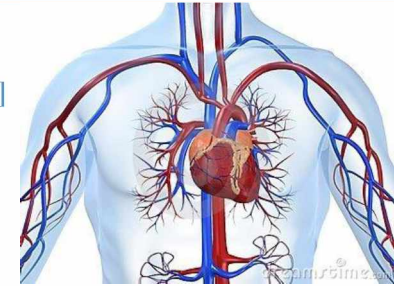
Many diseases or effects reported (chromosomal abnormalities, reproductive effects, psychological effects, peptic ulcers, autoimmune thyroiditis, lens opacities, cardiovascular effects, etc.): **link with ionizing radiation exposure ?**

[Lazjuk *and al.*, Stem Cells, 1997; Little M.P., Radiat Environ Biophys, 2011]



## EXPOSURE TO **LOW DOSES** OF IONIZING RADIATION

- **Nuclear reactor accident (Chernobyl):** ↗ of the risk of mortality due to ischemic heart disease and cerebrovascular disease [Ivanov *et al.*, Health Physics, 2006]
  - **German uranium miners:** No association between cardiovascular mortality and exposure to radiation [Kreuzer, Radiat Environ Biophys, 2006]
  - **Youri Bandazhevski works:** study of non-cancerous diseases presented by children living on the contaminated territories of Belarus according to  $^{137}\text{Cs}$  whole-body burden [Bandazhevski Y. and Bandazhevskaya G., 2004]
    - Cardiac rhythm disorders
    - Other pathologies: cataracts, peptic ulcers, anemia, etc.
- ➔ Correlation between the level of  $^{137}\text{Cs}$  contamination and the occurrence of non-cancerous pathologies according to the authors' conclusions



Studies on low doses ionizing radiation → limitations +++ [Kreuzer *et al.*, Mutation Research, 2015]

- Methodology not thorough (equipment used, statistical tests, etc.)
- Uncertain dosimetry estimates
- Adjustment problems on cofactors (tobacco, alcohol, etc.)
- Limited statistical power
- No consideration of potential biases, etc.

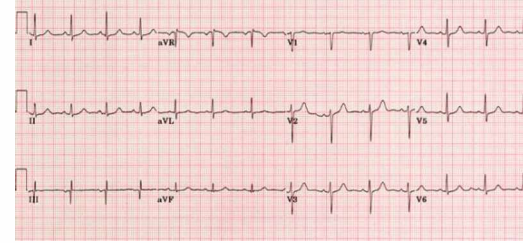
Little evidence of an association between exposure to ionizing radiation ( $<0.5$  Gy) and the presence of circulatory diseases



## IMPLEMENTATION OF EPIDEMIOLOGICAL STUDY

- **Scientific community** → to collect scientific information about the non-cancerous effects induced by chronic exposure to low doses of ionizing radiation
- **Population** → to answer societal issue relating to health consequences Chernobyl nuclear accident in a sensitive population (children)





**Study period:** May 2009 – May 2013

**Cross-sectional study with a design *exposed – unexposed***

**Location** → Bryansk oblast (Russian Federation)

## Objectives

- What is the prevalence of cardiac arrhythmias in Bryansk oblast (CT vs NCT)?
- Is caesium 137 associated factor in the occurrence of cardiac arrhythmias?

**Study population:** 17 697 children aged from 5 to 18 years old

## Medical examinations for all children

- $^{137}\text{Cs}$  whole-body activity measurement during 10 min
- EKG during 10 min
- Cardiac ultrasound

## Further medical examinations for some children

- Holter (21%)
- Blood test (6%)
  - ✓ Enzymatic profile (transaminases, PAL, LDH,  $\gamma$ -GT, CK)
  - ✓ Biochemical profile (Na, K, Ca, P, albumin)
  - ✓ Inflammatory profile (CRP)
  - ✓ Renal profile (urea, creatinine)
  - ✓ Thyroid profile (TSH, FT4)
  - ✓ Cardiac profile (troponin T, CK-MB)

**Data collection in schools** by a multidisciplinary team from the Clinical Diagnostic Centre, Bryansk (Russian Federation)

# Cardiac arrhythmia study- Population characteristics (1/3)

	CONTAMINATED TERRITORIES (EXPOSED POPULATION)		CONTROLLED TERRITORIES (UNEXPOSED POPULATION)	
CHARACTERISTICS	N = 8 816	(%)	N = 8 881	(%)
<b>GENDER</b>				
Male	<b>4 436</b>	(50.3)	<b>4 534</b>	(51.1)
Female	<b>4 380</b>	(49.7)	<b>4 347</b>	(48.9)
<b>AGE</b>				
< 10	<b>3 412</b>	(38.7)	<b>3 057</b>	(34.4)
10 - 13	<b>2 598</b>	(29.5)	<b>3 109</b>	(35.0)
≥ 14	<b>2 806</b>	(31.8)	<b>2 715</b>	(30.6)
<b>DRUG INTAKE</b>				
No	<b>3 933</b>	(44.6)	<b>8 335</b>	(93.9)
Yes	<b>108</b>	(1.2)	<b>257</b>	(2.9)
Do not know	<b>4 775</b>	(54.2)	<b>289</b>	(3.3)

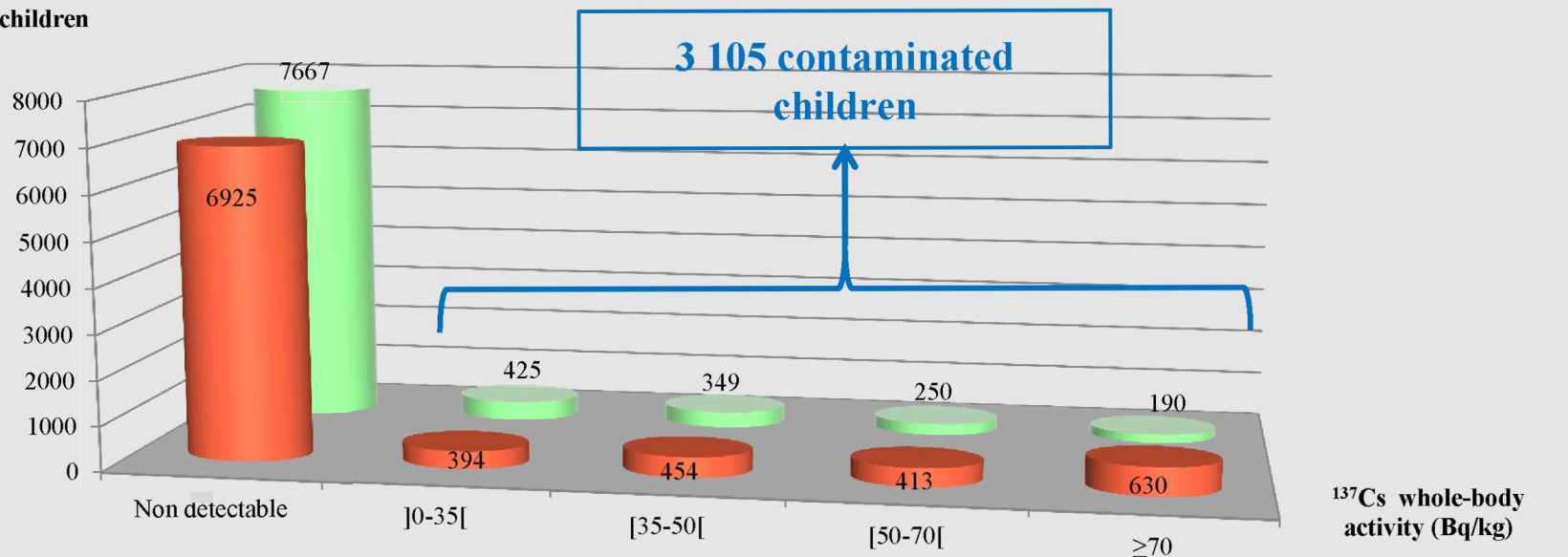


# Cardiac arrhythmia study- Population characteristics (2/3)

	CONTAMINATED TERRITORIES (EXPOSED POPULATION)		CONTROLLED TERRITORIES (UNEXPOSED POPULATION)	
CHARACTERISTICS	N = 8 816	(%)	N = 8 881	(%)
<b>BMI (WHO CLASSIFICATION)</b>				
Underweight	<b>179</b>	(2.0)	<b>204</b>	(2.3)
Normal weight	<b>6 565</b>	(74.5)	<b>6 550</b>	(73.8)
Overweight	<b>1 219</b>	(13.8)	<b>1 218</b>	(13.7)
Obesity	<b>853</b>	(9.7)	<b>909</b>	(10.2)
<b>PLACE OF RESIDENCE</b>				
Rural	<b>2 833</b>	(32.1)	<b>3 165</b>	(35.6)
Urban	<b>5 983</b>	(67.9)	<b>5 716</b>	(64.4)
<b>DIETARY HABITS</b>				
Shop	<b>8 128</b>	(92.2)	<b>7 676</b>	(86.4)
Personal farm (milk, meat, vegetables)	<b>6 448</b>	(73.1)	<b>6 722</b>	(75.7)
Forest (mushrooms, berries, meat)	<b>5 486</b>	(62.2)	<b>7 171</b>	(80.7)
Rivers (fish, crayfish)	<b>3 862</b>	(43.8)	<b>4 237</b>	(47.7)

## Children distribution according to $^{137}\text{Cs}$ whole-body activity (Bq/kg)

Number of children



### COMMITTED EFFECTIVE DOSE

3 081 children  $< 1$  mSv/y

24 children  $\geq 1$  mSv/y (max = 5,77 mSv/y)



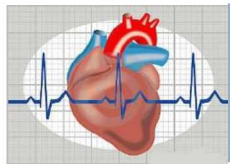
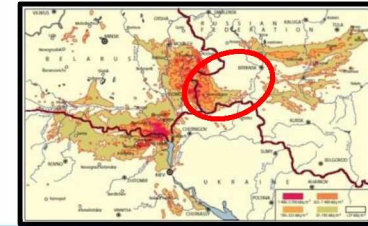
(WHO - ICD – 10<sup>th</sup> edition) ➔ 54 in total

- D15 - Benign neoplasm of other and unspecified intrathoracic organs
- I08 - Multiple valve diseases except endocarditis
- I34 - Nonrheumatic mitral valve disorders
- I35 - Nonrheumatic aortic valve disorders
- I36 - Nonrheumatic tricuspid valve disorders
- I37 - Pulmonary valve disorders
- I42 – Cardiomyopathy
- I43 - Cardiomyopathy in diseases classified elsewhere
- I44 - Atrioventricular and left bundle-branch block
- I45 - Other conduction disorders
- I47 - Paroxysmal tachycardia
- I49 - Other cardiac arrhythmias
- Q20 - Congenital malformations of cardiac chambers and connections
- Q21 - Congenital malformations of cardiac septa
- Q22 - Congenital malformations of pulmonary and tricuspid valves
- Q23 - Congenital malformations of aortic and mitral valves
- Q24 - Other congenital malformations of heart
- Q25 - Congenital malformations of great arteries
- R00 - Abnormalities of heart beat

**2 526 children with  
cardiac arrhythmia**

# Cardiac arrhythmia study - Objective n°1: prevalence estimation

## Health status of the study population according to the territory (CT vs NCT)



### HEALTH STATUS

HEALTH STATUS	CONTAMINATED	CONTROLLED
Healthy	7 644	7 527
With cardiac arrhythmia	1 172	1 354

### TERRITORIES

## Prevalence estimation over the period 2009 – 2013

- $P_{\text{exposed}} = 13.3\%$
- $P_{\text{unexposed}} = 15.2\%$


Prevalence ratio (PR) =  $P_{\text{exp}}/P_{\text{unexp}} = 0.87$  [95%IC= 0.84 – 0.90]

Over the period 2009 - 2013, the estimated prevalence of cardiac arrhythmias in CT was significantly lower than in the NCT

# Cardiac arrhythmia study - Objective n°1: prevalence estimation

## Health status of the study population according to $^{137}\text{Cs}$ whole-body burden



		$^{137}\text{Cs}$ whole-body burden	
		POSITIVE	NOT DETECTABLE
 HEALTH STATUS	Healthy	2 656	12 515
	With cardiac arrhythmia	449	2 077

## Prevalence estimation over the period 2009 – 2013

- $P_{\text{exposed}} = 14.5\%$
- $P_{\text{unexposed}} = 14.2\%$

Prevalence ratio (PR) =  $P_{\text{exp}}/P_{\text{unexp}} = 1.02$  [95%IC= 0.97 – 1.07]

Over the period 2009 - 2013, the estimated prevalence of cardiac arrhythmia among contaminated children does not differ significantly from the estimated prevalence among children with  $^{137}\text{Cs}$  contamination not detectable



# Cardiac arrhythmia study - Objective n°2: $^{137}\text{Cs}$ = associated factor?

## Multivariate analysis (SAS software)

Explanatory variables	OR <sup>¥</sup>	[95%CI]	P-value
<b>Territory</b>			
Controlled	1		
Contaminated	0.90	[0.81 – 1.00]	<b>0.06</b>

¥ adjustment for gender, age, drug intake, BMI and  $^{137}\text{Cs}$  whole-body burden

Explanatory variables	OR <sup>¥</sup>	[95%CI]	P-value
<b><math>^{137}\text{Cs}</math> whole-body activity</b> (Bq/kg)			
Not detectable	1		
]0 – 35[	1.07	[0.89 – 1.29]	
[35 – 50[	1.00	[0.81 – 1.23]	
[50 – 70[	1.04	[0.82 – 1.31]	
≥ 70	0.96	[0.77 – 1.20]	<b>0.97</b>

¥ adjustment for gender, age, drug intake, BMI and territory

No evidence of an association between the presence of cardiac arrhythmia and the territory or  $^{137}\text{Cs}$  whole-body burden

➔  **$^{137}\text{Cs}$  is not an associated factor in the frame of the study**



# Cardiac arrhythmia study – Strengths/ limitations

## Strengths

- Study population: 17 697 children
- High participation rate: 91%
- Little missing data (37 for holter and 69 for blood test)
  - ➔ justifications provided
- Conditions gathered to bring out an effect if this one exists



## Limitations

- Selection bias
- Memory bias (drug intake)
- Classification bias (no Holter for all children and DL)
- Some factors not considered (blood pressure measurement, alcohol/drug/tobacco consumption, genetic tests, blood test, etc.)

## CONCLUSIONS

■ Estimated prevalence over the period 2009-2013

- Statistically significant **differences according to the territory** (lower prevalence in the contaminated territories)
- **No** statistically significant **differences according to  $^{137}\text{Cs}$  whole-body burden** (contaminated children vs children with  $^{137}\text{Cs}$  contamination not detectable)

■  **$^{137}\text{Cs}$  is not a factor associated to the presence of cardiac arrhythmia** (main hypothesis) in the frame of the study

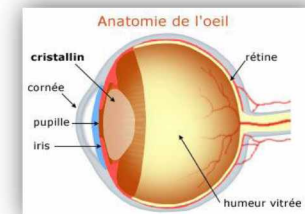
■ Children (with cardiac arrhythmia) care

- Followed up and outpatient care by cardiologists, pediatricians
- 6 children were operated in emergency (2 with the pose of pacemaker)

## PERSPECTIVES

■ Results communication to Bryansk oblast population

■ Lens opacities study (2013 – 2017)





INSTITUT  
DE RADIOPROTECTION  
ET DE SÛRETÉ NUCLÉAIRE

*Faire avancer la sûreté nucléaire*

# Exposure to Ionizing Radiation Resulting from the Chernobyl Fallout and Childhood Cardiac Arrhythmia:

## A Population Based Study

[Jourdain *et al.*, BMJ Open, 2018, **accepted**]

ICMPRPR – LONDON – March 15<sup>th</sup>, 2018

Geraldine LANDON

Jean-Rene JOURDAIN

Enora CLERO