



# Assessment of $^{137}\text{Cs}$ and $^{90}\text{Sr}$ intake with food by the inhabitants of Warsaw in 2004-2019

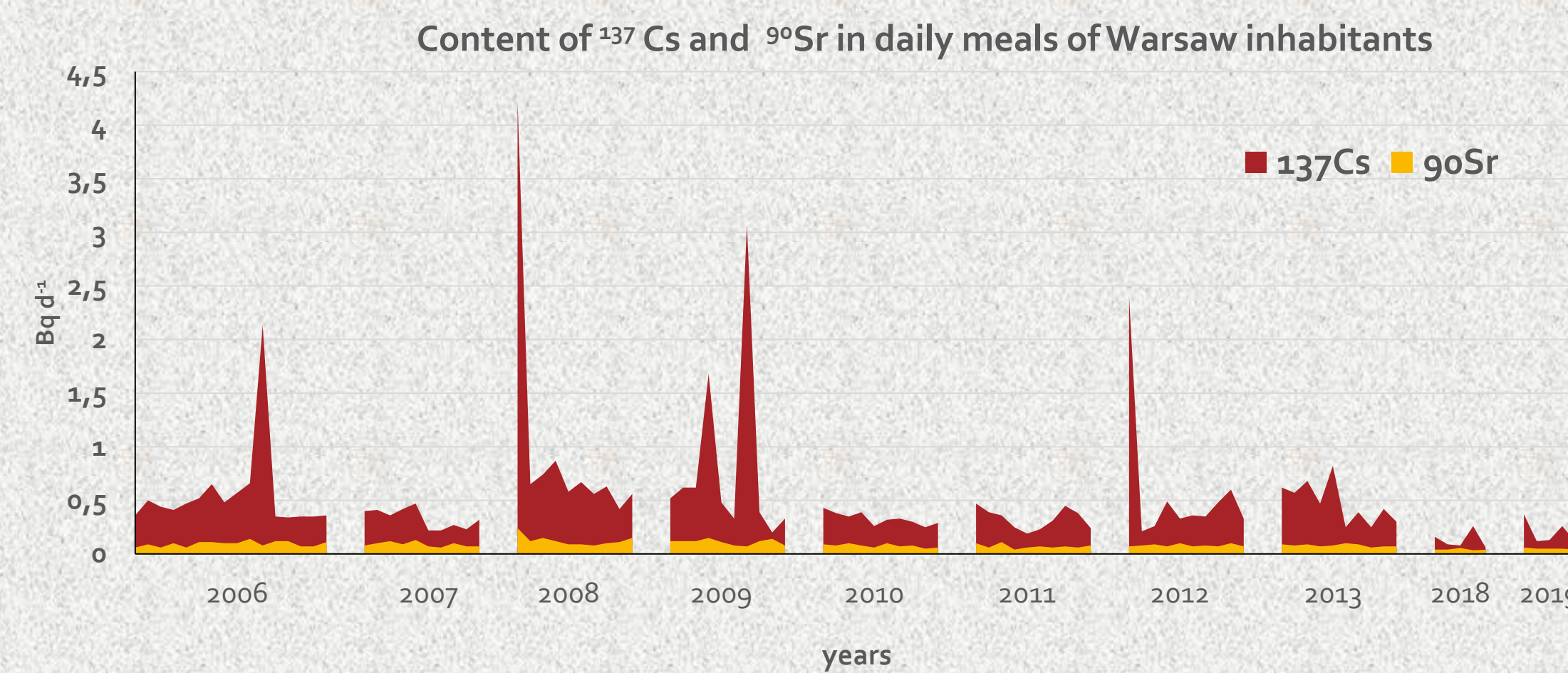
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One of the pathways of radiation exposure in humans is consumption of contaminated food. The composition of an average diet is diversified for various groups within the population and depends on age, sex, habit and performed work. The aim of the study was to assess the intake and to estimate the dose received by the inhabitants of Warsaw from trace quantities of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  isotopes in the consumed food. The assessment of intake has been based on the analysis of main food products available in stores in Warsaw and all-day meals prepared in several canteens during two periods: 2004-2013 and then five years later in 2018-2019. The impact of individual products in dishes, e.g. mushrooms, on the annual intake of  $^{137}\text{Cs}$  was also analysed. In addition, in years 2006-2009 an assessment of the intake of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  isotopes with food by children (8 month -12 y) and teenagers (13-17 y) was conducted. The effect of milk and milk products on the content of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  in 2-3 year old children's daily meals was also examined. Gamma spectrometric and radiochemical methods were used to determine the radioactive concentration of the mentioned isotopes. Based on those results, the annual intake was assessed and the dose received by urban residents could be estimated.

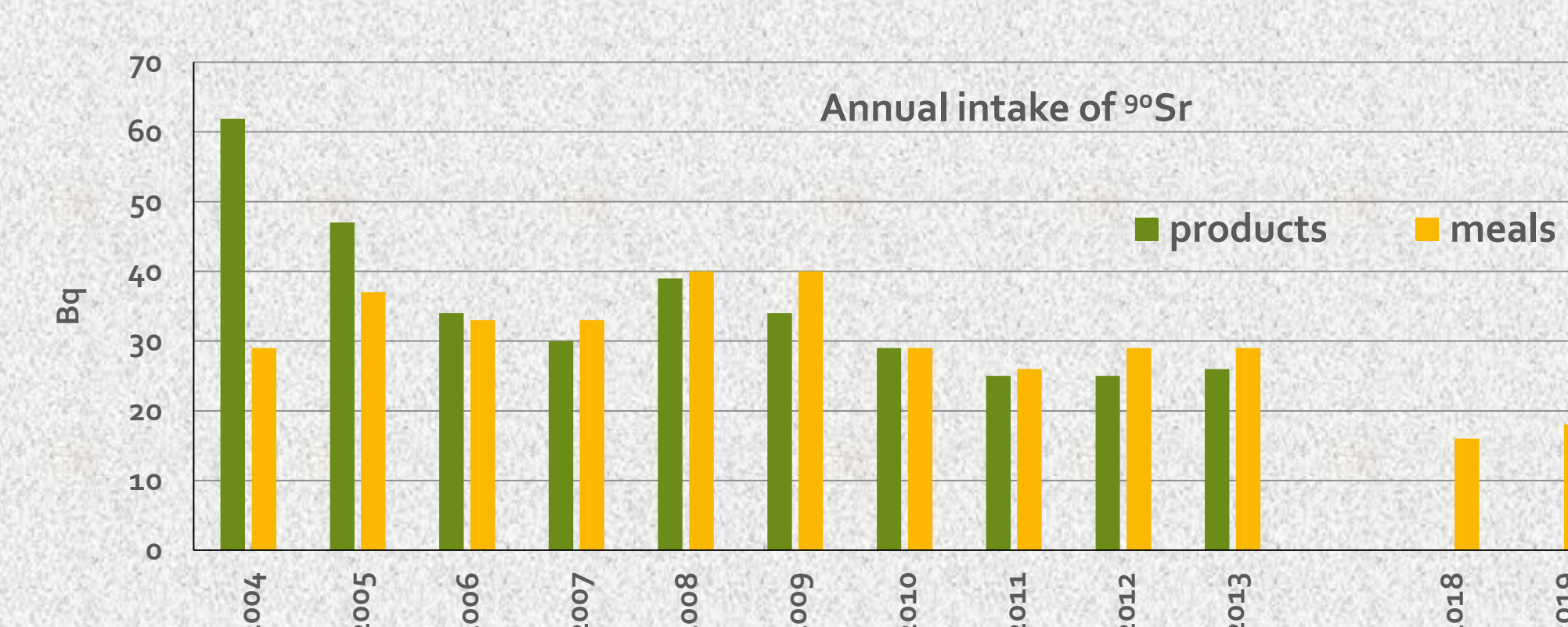
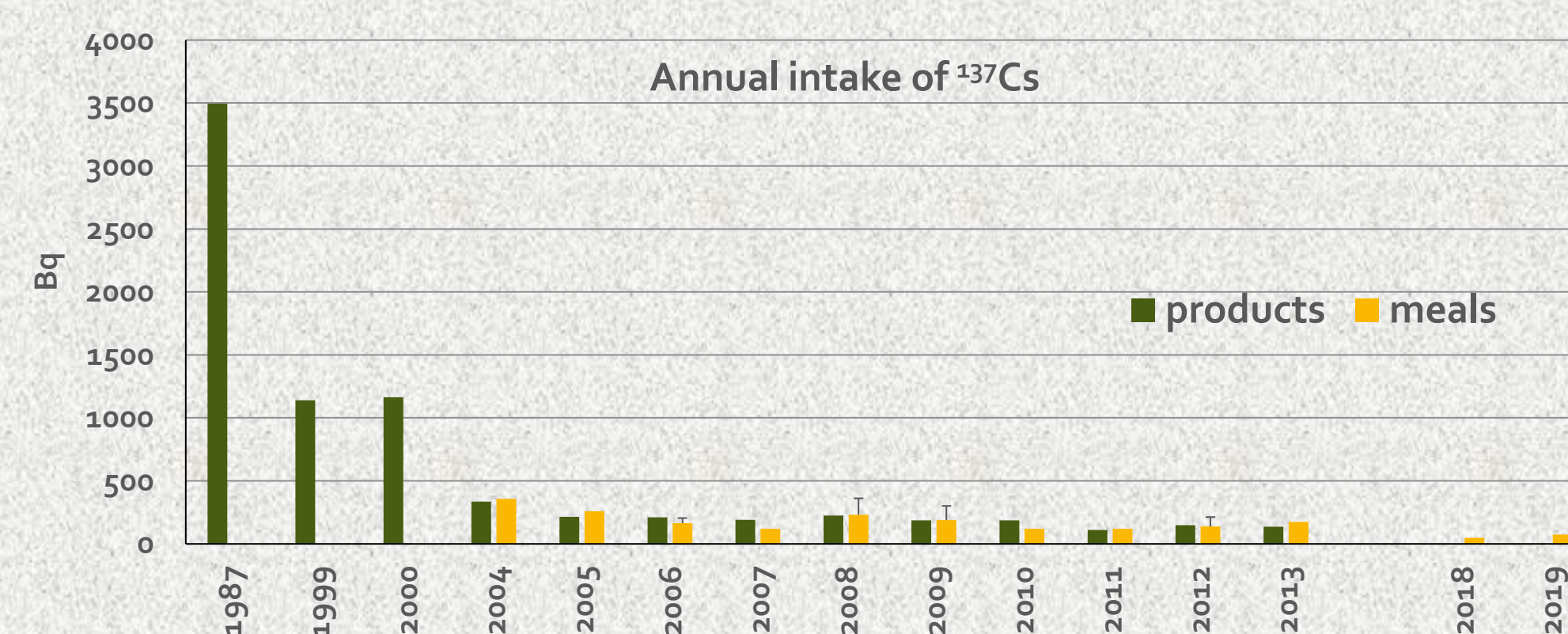
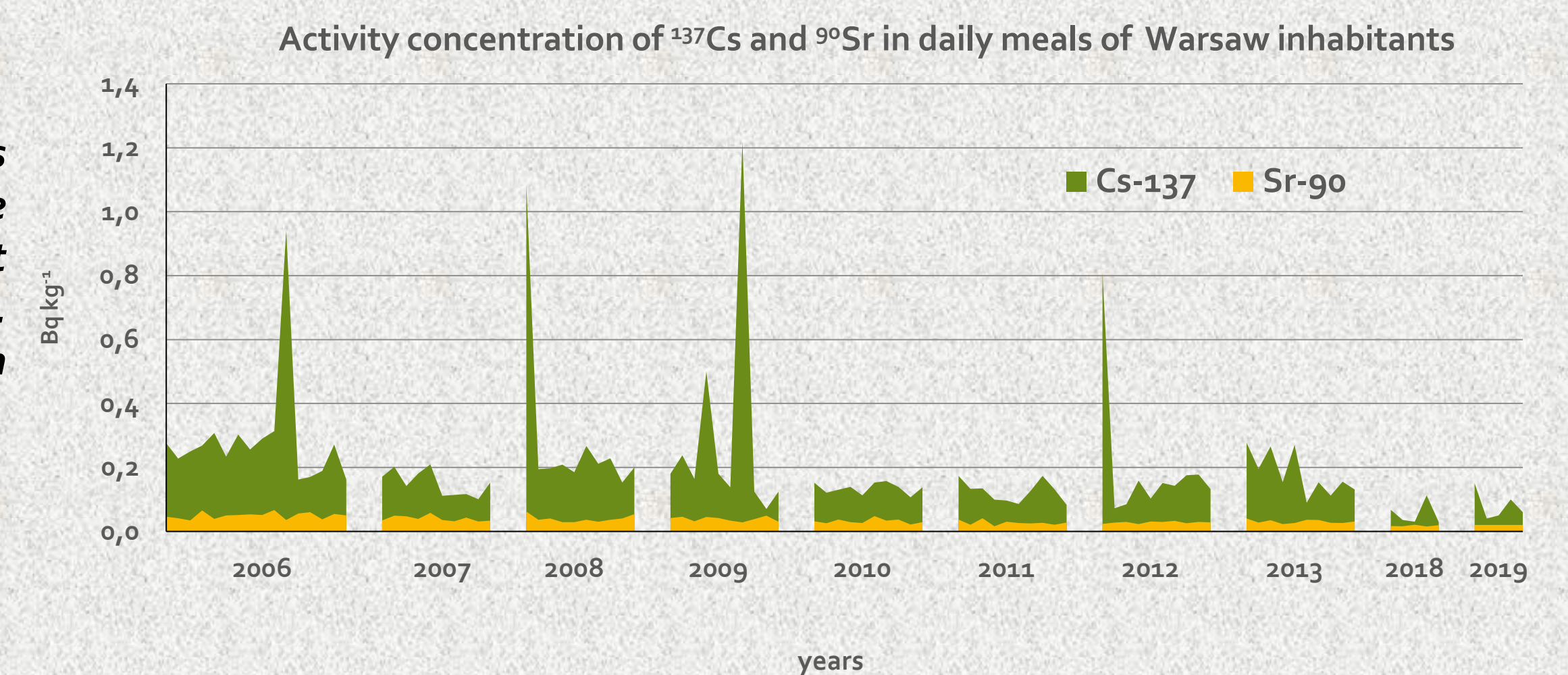
	$^{137}\text{Cs}$ [Bq d <sup>-1</sup> ]	$^{90}\text{Sr}$ [Bq d <sup>-1</sup> ]
2004	0,28 – 2,48	0,03 – 0,17
2005	0,36 – 0,51	0,13 – 0,22
2006	0,34 – 0,66 (2.13)*	0,06 – 0,14
2007	0,22 – 0,41	0,06 – 0,13
2008	0,42 – 0,87 (4.22)*	0,08 – 0,24*
2009	0,20 – 1.68 (3.07)*	0,07 – 0,15
2010	0,25 – 0,43	0,05 – 0,10
2011	0,19 – 0,47	0,06 – 0,11
2012	0,21 – 0,60 (2.41)*	0,07 – 0,10
2013	0,25 – 0,82	0,07 – 0,09
2018	0,06 – 0,26	0,01 – 0,03
2019	0,12 – 0,37	0,04 – 0,06

\*) dish with mushrooms

Range of content of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  in daily meals of Warsaw inhabitants



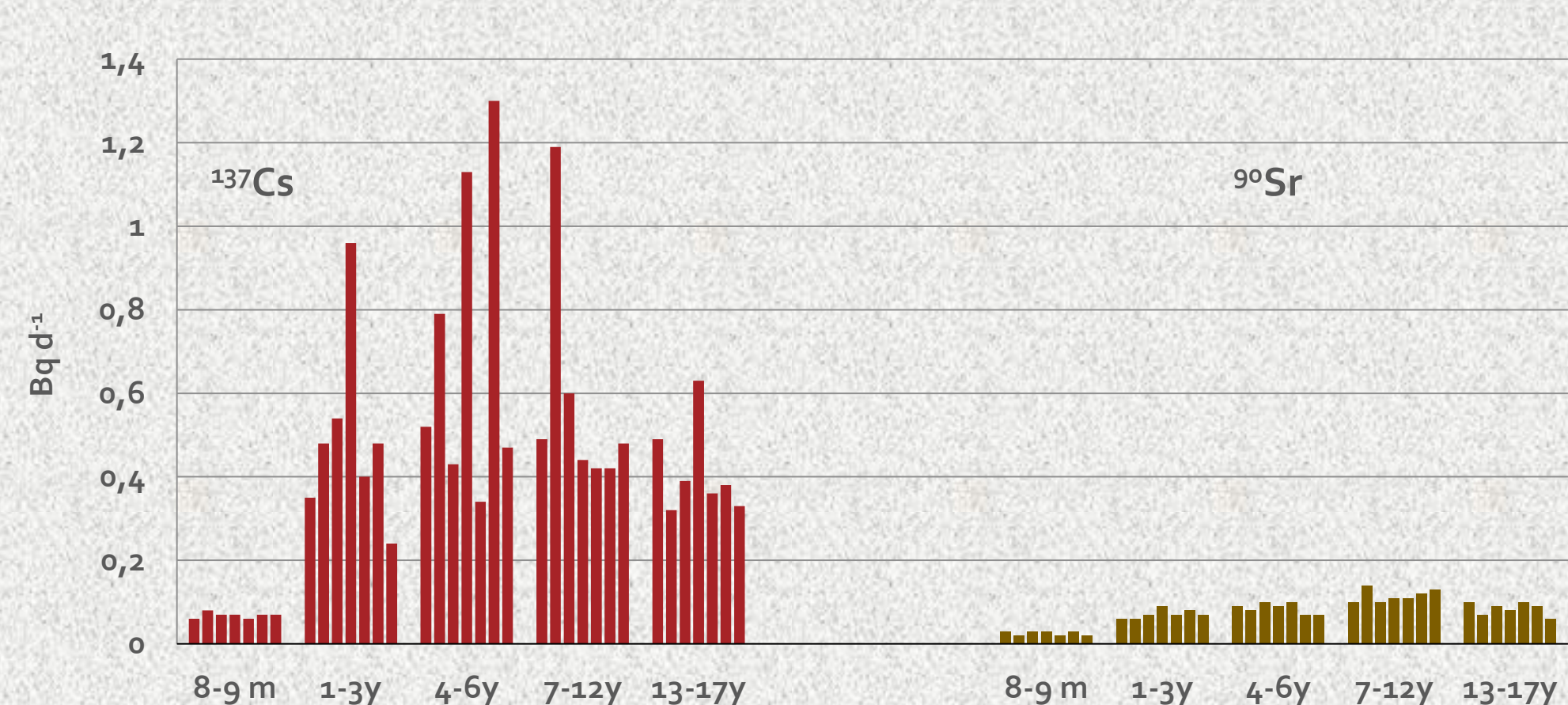
The highest values of  $^{137}\text{Cs}$  content in daily meals are connected with serving forest mushrooms for lunch e.g. mushrooms soup or mushroom sauce as a side dish to meat



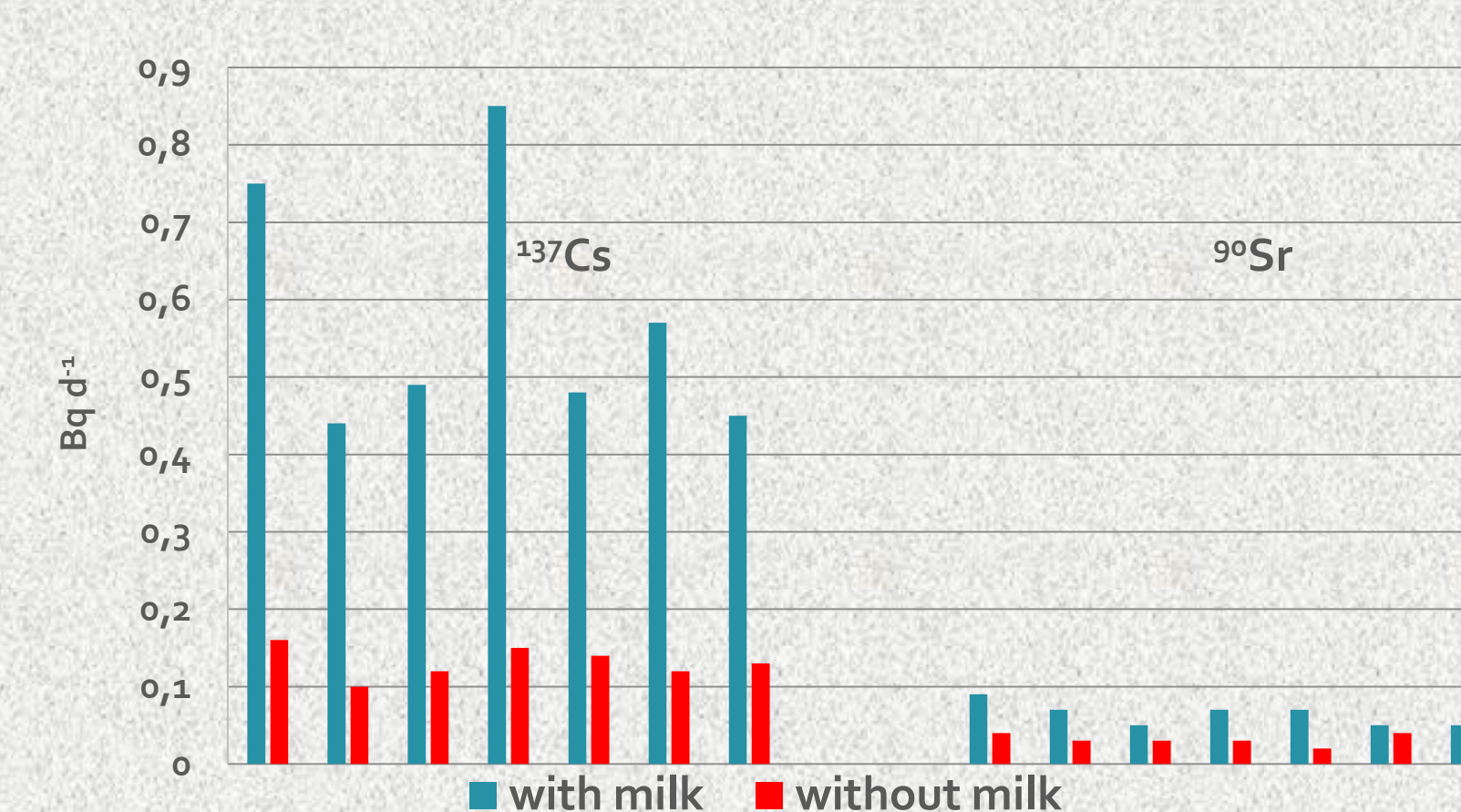
Annual intake of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  based on analyses of daily meals and food products analysis and consumption [Bq]

	$^{137}\text{Cs}$ [Bq d <sup>-1</sup> ]	$^{90}\text{Sr}$ [Bq d <sup>-1</sup> ]
8-9 m	0,06-0,08	0,02-0,03
2-3 y	0,30-0,84	0,06-0,13
4-6 y	0,43-1,13	0,07-0,10
7-12 y	0,41-1,19	0,10-0,14
13-17 y	0,32-0,63	0,06-0,10

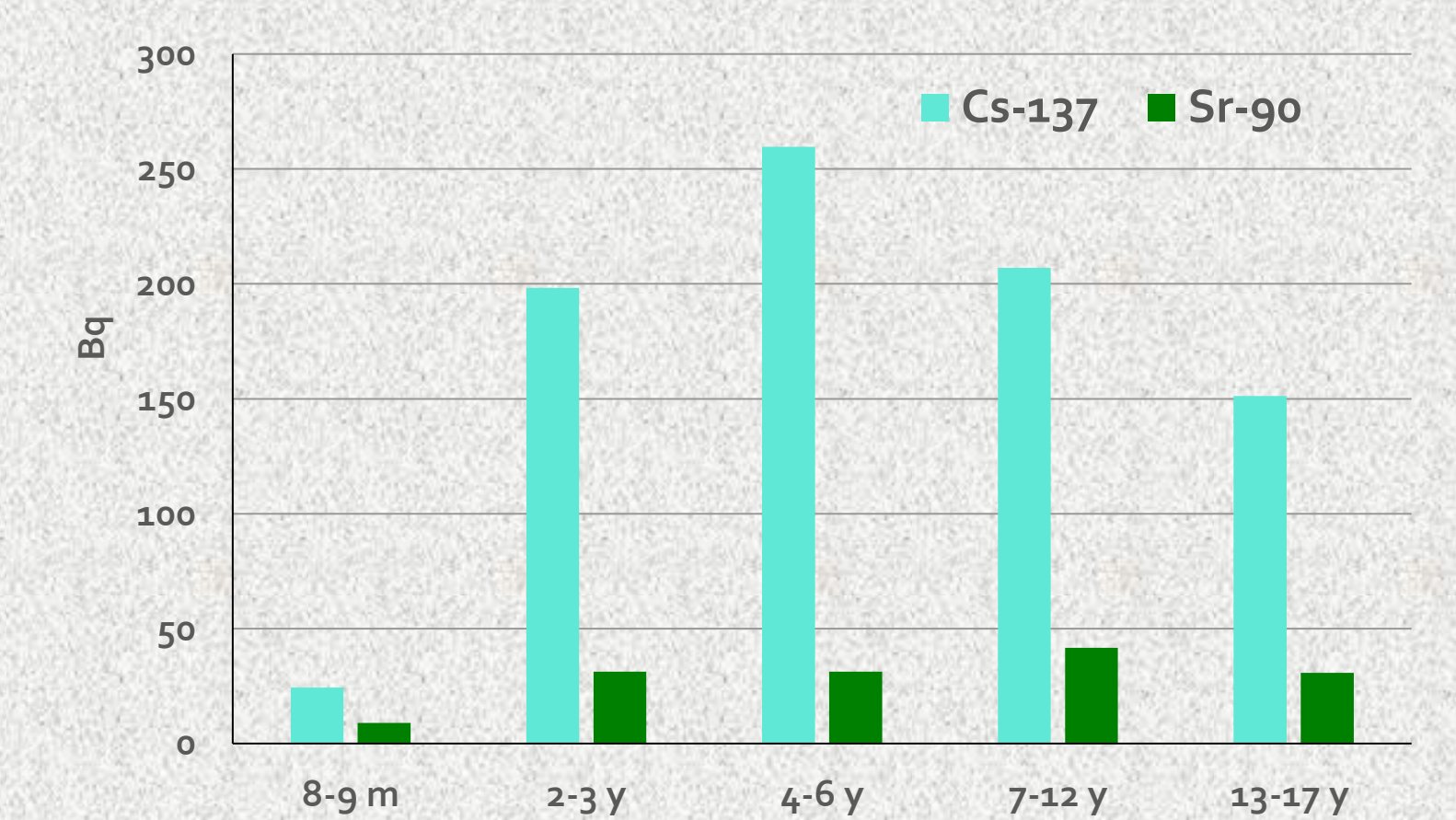
Range of content of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  in daily meals for children



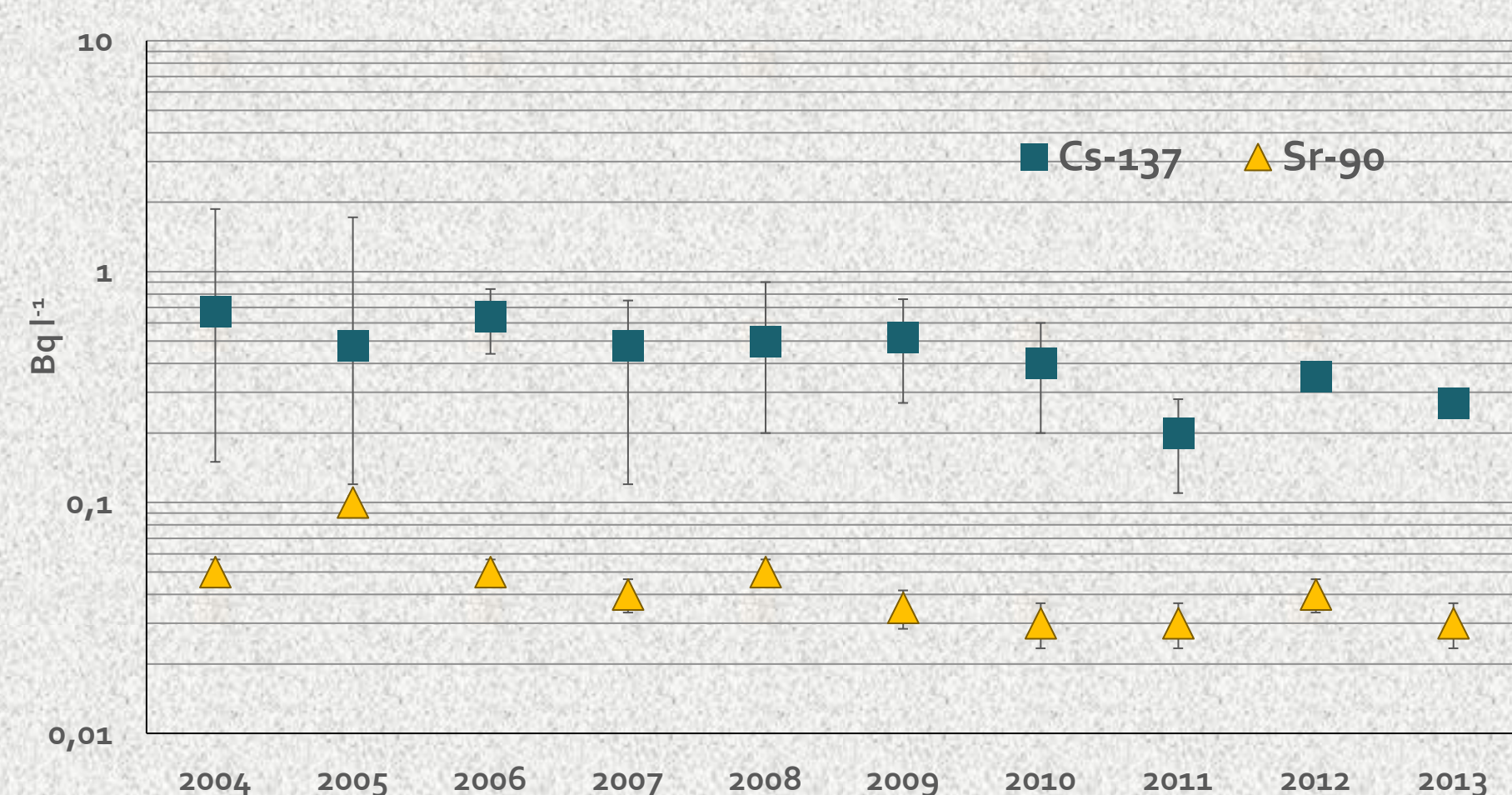
The content of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  in daily meals for children and youths



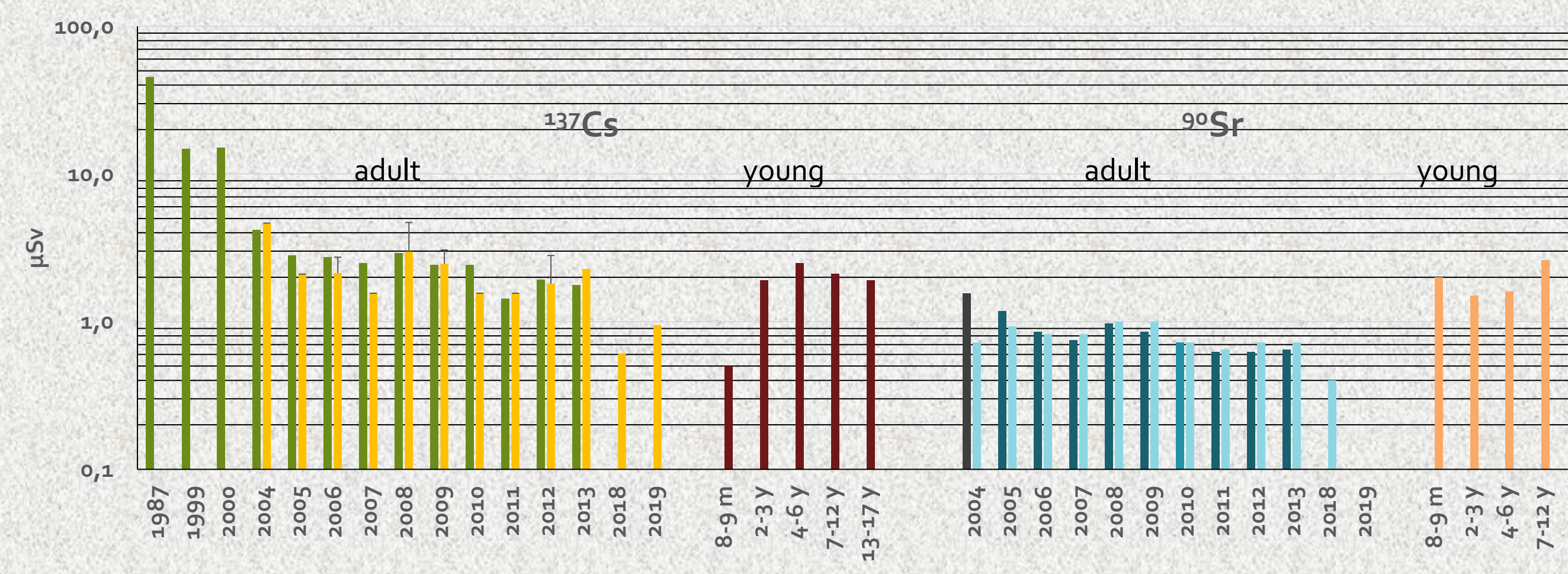
Impact of milk on content of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  in daily meals for 2-3 old children



Annual intake of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  with daily meals by children in different age group



Activity concentration of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  in milk from Warsaw stores



Annual effective doses received by Warsaw adult and young inhabitants due to consumption of food with  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$ . Doses for adults were assessed on analysis of daily meals and based on analysis on products derived from Warsaw market and their consumption. Doses received by children and youth were assessed on analysis of daily meals. [μSv]

Annual doses received in period 2005-2013 by the adult inhabitants of Warsaw from  $^{137}\text{Cs}$  ranged from 1.6 μSv to 3.0 μSv excluding dishes with mushrooms while the dose related to dishes with forest mushrooms reached 5.0 μSv. Doses from  $^{90}\text{Sr}$  ranged from 0.6 μSv to 1.2 μSv. In 2018-2019, the dose received from  $^{137}\text{Cs}$  was below 1 μSv. The dose from  $^{137}\text{Cs}$  is connected with the consumption of products like: milk, meat (mainly beef and veal) and some fish species. The dose from  $^{90}\text{Sr}$  is related to eating milk, cereal and vegetables.

Doses received by children ranged from 0.5 to 2.5 μSv depending on age and those received by teenagers were on the level of 2.0 μSv from  $^{137}\text{Cs}$ . For these two groups, the values from  $^{90}\text{Sr}$  were 1.5-2.1 μSv and 2.5 μSv, respectively.

## Conclusions:

- ✓ Doses due to consumption of contaminated food received by Warsaw residents, both adults and children are a fraction of a percentage of the annual permissible dose limit of 1 mSv.
- ✓ Annual intake of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  with food depends on mass of meals, products used to prepare the dishes e.g. milk, meat and also mushrooms.
- ✓ Doses received by Warsaw inhabitants do not differ from doses received by inhabitants of other Polish towns.