



**Use of organ dose approach versus  
effective dose approach in risk  
assessment for the common  
radiographic X-ray examinations  
of children**

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# Materials

29 specialized pediatric hospitals:  
(St. Petersburg, Belgorod, Bryansk, Tyumen regions)

33 X-ray units

10  
radiographic  
procedures:

- Skull, chest, thoracic spine, lumbar spine - all in two projections,
- Abdomen and pelvis - in one projection.

# Algorithm

Primary technical data of procedures parameters

PCXMC  
(mathematical phantoms for 5 children's age groups)

Typical organ and effective doses for each X-ray unit

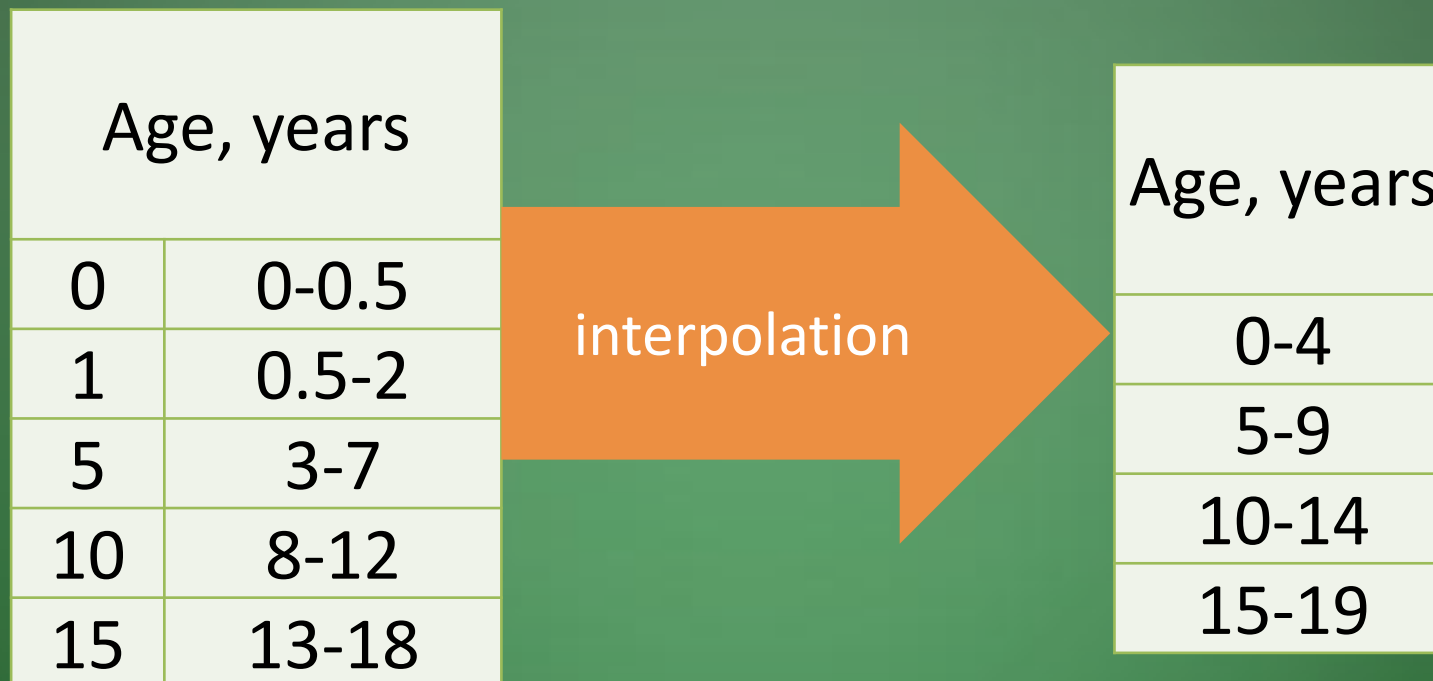
Mean organ and effective doses for procedure (for 4 children's age groups)

Lifetime radiation risks for procedure

Age and gender risk factors



# Age groups



# Lifetime detriment-weighted radiation risks calculation

$${}^{det}R_p(A, G) = \sum_o D_p(A, O) \cdot r(A, G, O) \cdot (D/I)_o$$

where:  ${}^{det}R_p(A, G)$  – lifetime detriment-weighted radiation risk for a patient of gender G at the age A (years) from an X-ray procedure P, relative unit;

$D_p(A, O)$  – absorbed dose in the organ O for a patient of any gender at the age A (years) from an X-ray procedure P, mGy;

$r(A, G, O)$  – nominal coefficient of radiation risk from organ O irradiation of a person of gender G at the age A (years),  $10^{-4} \text{ mGy}^{-1}$ .

$(D/I)_o$  – ratio of detriment D to the radiogenic incidence  ${}^{inc}R_p(A, G)$  of organ O

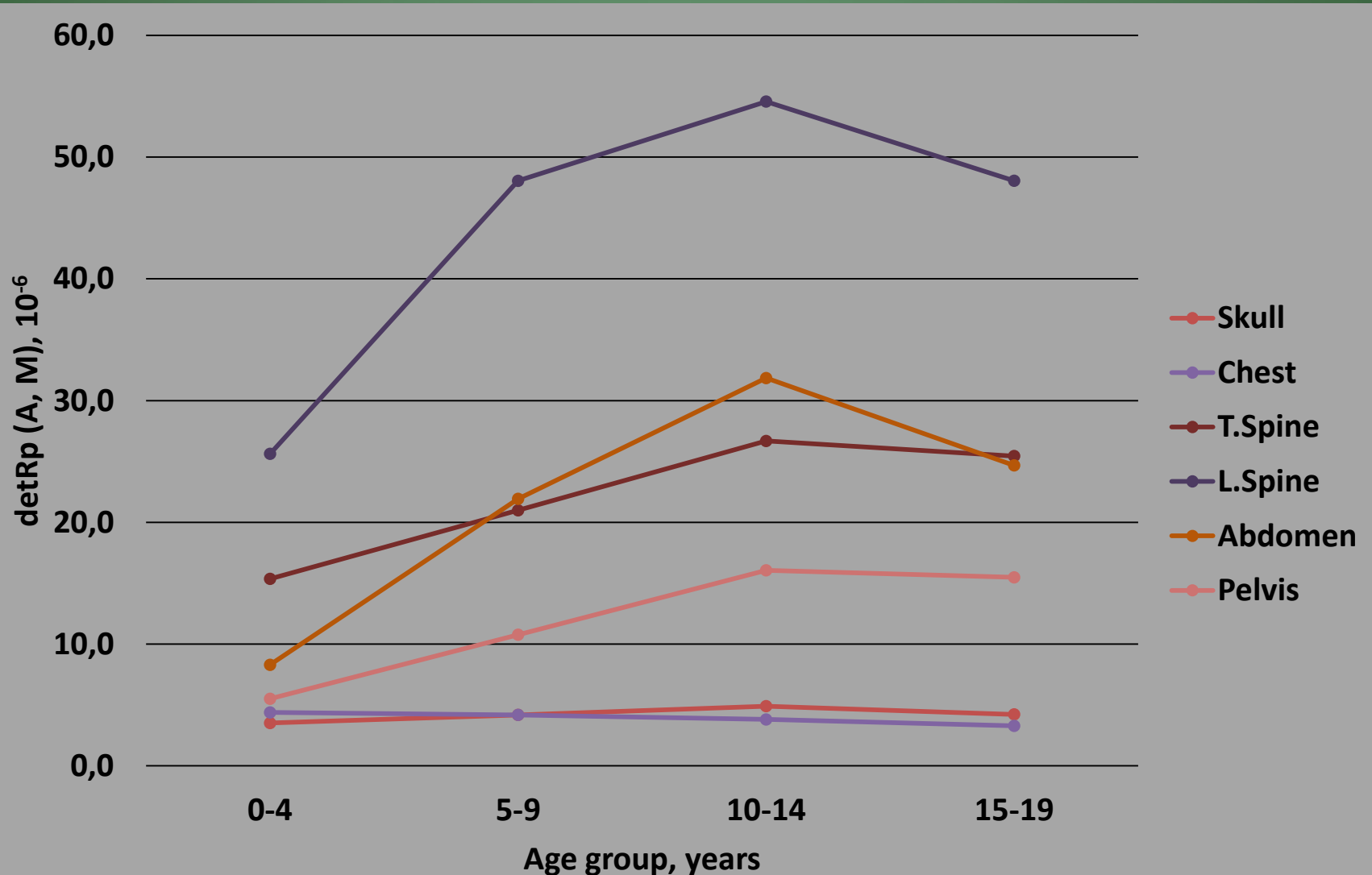


# The coefficients of lifetime radiation risk

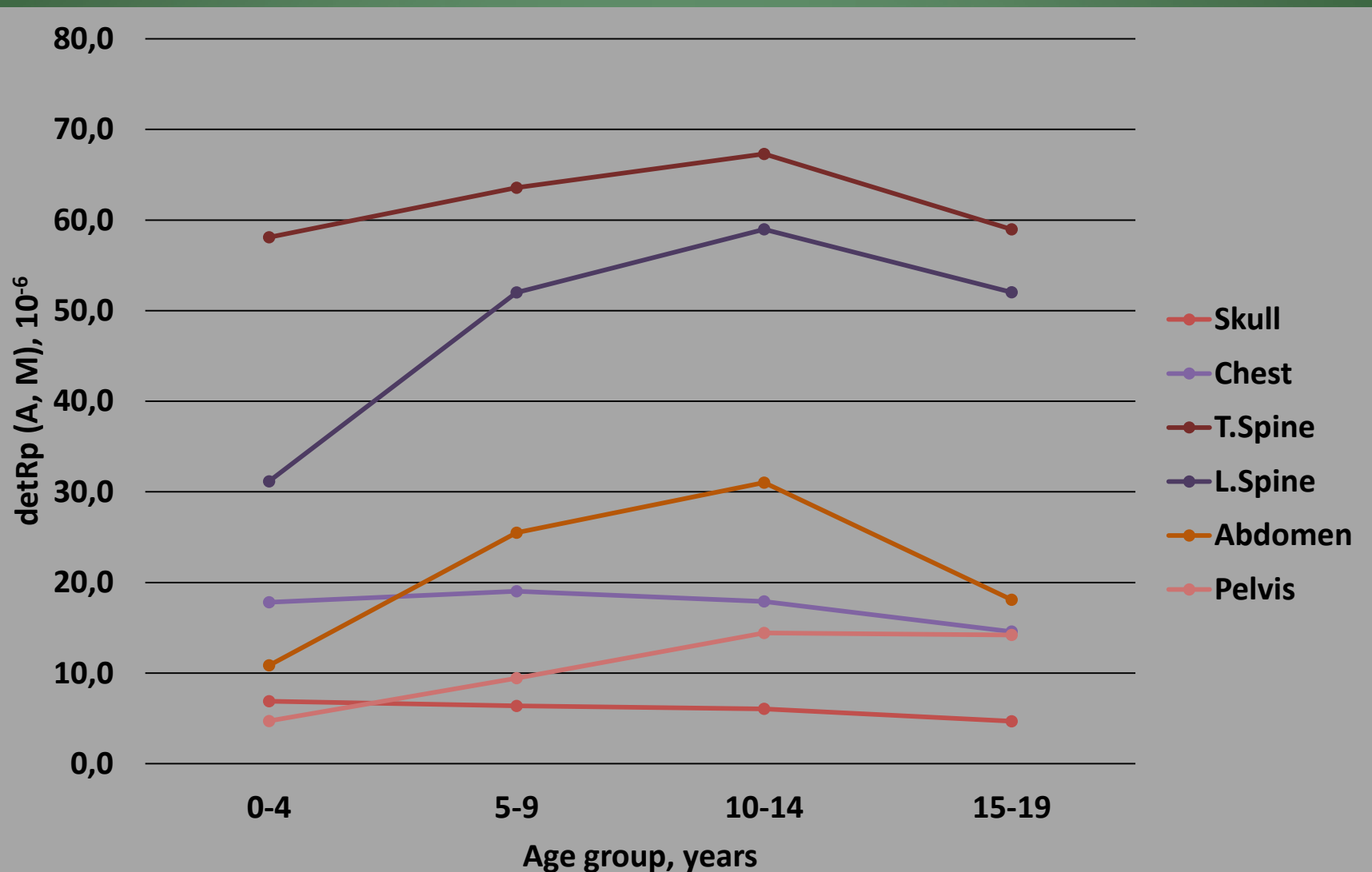
- The sex-age risk coefficients for eight organs (esophagus, stomach, colon, liver, lung, breast, bladder, thyroid) are explicitly given in “Methodology for estimating cancer risks of diagnostic medical exposure: with an example of the risks associated with computed tomography” Ivanov V. et al. (2012).
- Age dependence of the risk coefficient for cancers of bone, skin, ovaries, red bone marrow, and "other tissues", in the absence of detailed data, was considered similar to that for all solid cancers.
- The risk factors for the hereditary effects were simplified to be constant from birth to the period of fertility decline without considering the duration of the forthcoming life.



Age-dependent detriment-adjusted lifetime risk  ${}^{det}R_p(A, M)$ ,  $10^{-6}$  per examination, for males based on organ doses

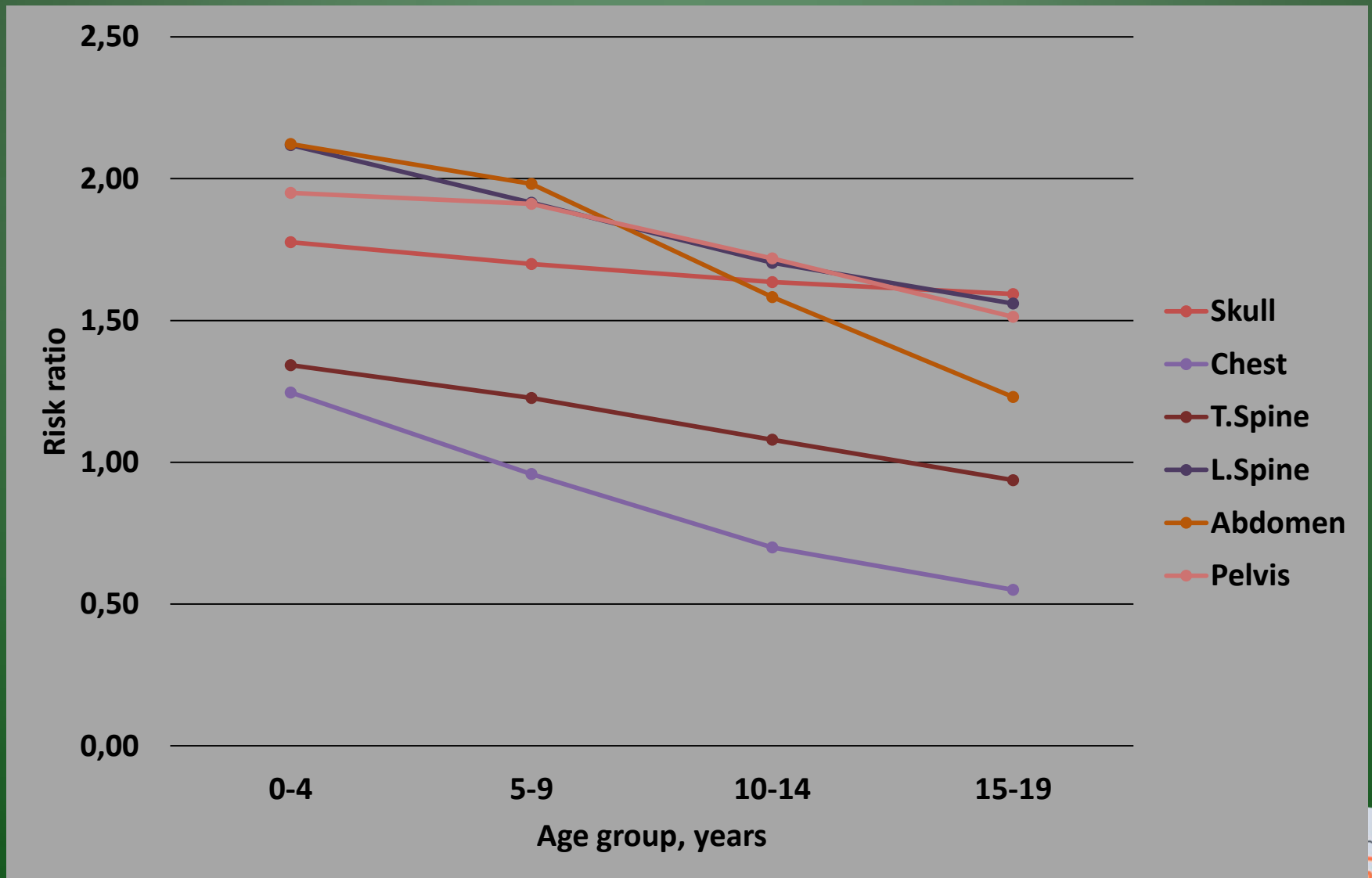


Age-dependent detriment-adjusted lifetime risk  ${}^{det}R_p(A, F)$ ,  $10^{-6}$  per examination, for females based on organ doses

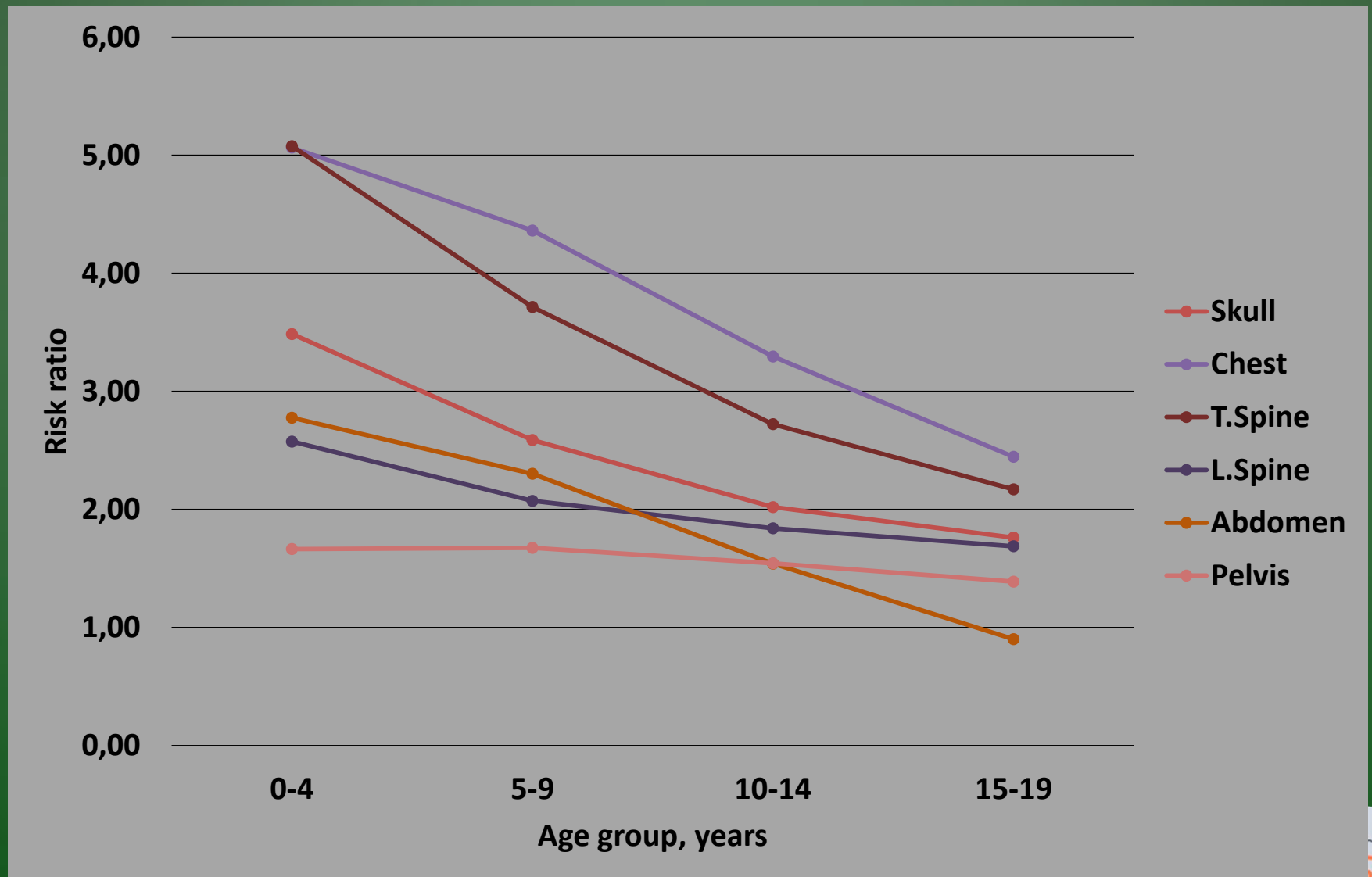




# Age-dependent ratio (dimensionless) of organ-dose-based radiation risk due to X-ray examination to risk based on effective dose for males



# Age-dependent ratio (dimensionless) of organ-dose-based radiation risk due to X-ray examination to risk based on effective dose for females



# Conclusions

- The results of assessments indicate significant dependence of radiation risk on the X-ray examination type and examination parameters as well as on the age and gender of patients.
- Detriment-adjusted risk of radiation-induced cancer and hereditary effects for the middle age groups of children (10-14 years) is significantly higher (by up to a factor of four) compared to younger and older groups.
- Risk from medical exposure of the thorax for females is higher compared to males by a factor of 3.
- The simplified risk assessment based on effective dose for some X-ray examinations lead to an underestimation of risk for children by a factor up to 4-5 and for adolescents by a factor up to 2-3.



THANK YOU!