

Quantification and organization of dose uncertainties in IARC thyroid cancer study

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8 May 2009

Study description

- A population-based case-control study of thyroid cancer in young people coordinated by the International Agency for Research on Cancer (Lyon, France)
- 2,239 persons from Belarus (1,704) and from Russia (535), all aged 0-18 at the time of the accident in 1986
- Resided in regions of Belarus (Gomel and Mogilev) and Russia (Bryansk, Kaluga, Orel, and Tula) that were the most contaminated by fallout from the Chernobyl accident

Types of calculated doses

- Thyroid doses from ^{131}I intake via inhalation and ingestion (predominant exposure pathways) in two modes
 - Deterministic, and
 - 10,000 stochastic doses
- Deterministic thyroid doses due to minor exposure pathways:
 - Intakes of short-lived radioiodines (^{132}I , ^{133}I , and ^{135}I) and radiotelluriums ($^{131\text{m}}\text{Te}$, ^{132}Te) via inhalation and ingestion
 - External exposure from gamma-emitting radionuclides deposited on the ground
 - Ingestion of ^{134}Cs and ^{137}Cs

Data used for calculation of doses from ^{131}I intake (1)

- A semi-empirical model based on the relationship obtained between ^{131}I ground deposition and thyroid doses estimated from 130,000 direct thyroid exposure-rate measurements carried out in territories with different contamination levels and on individuals of all ages (infants, children, adolescents, and adults) (Gavrilin et al., 2004)
- Knowledge of the whereabouts, dietary habits and iodine prophylaxis of the subjects, which was obtained by means of personal interview of all subjects or of their parents

Data used for calculation of doses from ^{131}I intake (2)

- Information on ^{137}Cs ground deposition density and ratio of ^{131}I -to- ^{137}Cs activities in deposition which allows to determine the ^{131}I ground deposition for each settlement where the subject resided during the first two months after the accident
- Models of environmental transfer and metabolism taken from the literature. The parameter values used in these models reflected the local situation as much as possible

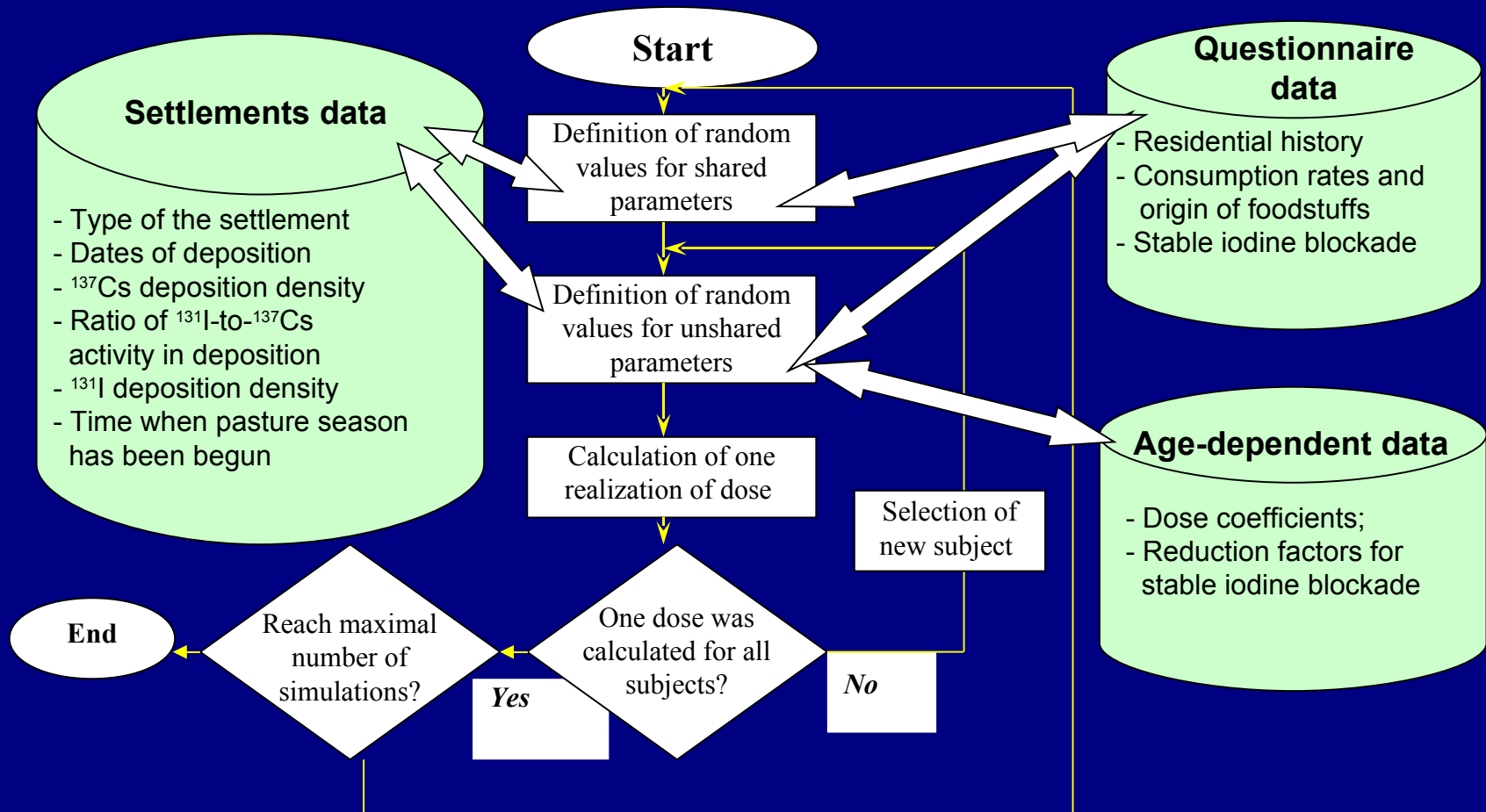
Separation of error types (1)

- Shared errors associated with
 - Dose-to-fallout linear regression coefficients of the semi-empirical model
 - Parameters used to determine the ^{131}I deposition in settlements
 - kinetics of fallout
 - ^{137}Cs ground deposition density
 - ratio of ^{131}I -to- ^{137}Cs activities in deposition
 - Ecological parameters:
 - time when pasture season began
 - effective loss rate of ^{131}I by vegetation

Separation of error types (2)

- **Unshared errors** associated with ecological (effective rate of ^{131}I decrease in cow's milk), anatomical (thyroid mass), and biological (breathing rate) parameters
- **Unshared errors** associated with variability, reliability and ability of information from the personal interviews:
 - Consumption rates of milk and other foodstuffs
 - Dates of residence in given settlement
 - Date of changing of food consumption habits
 - Date of application of thyroid blockade
 - Unreliable answers of subject, i.e. “Beginning of May”, “Don't remember”, etc.
 - Information missed in personal questionnaire about consumption rates, frequency of foodstuffs consumption, dates of residence, etc.

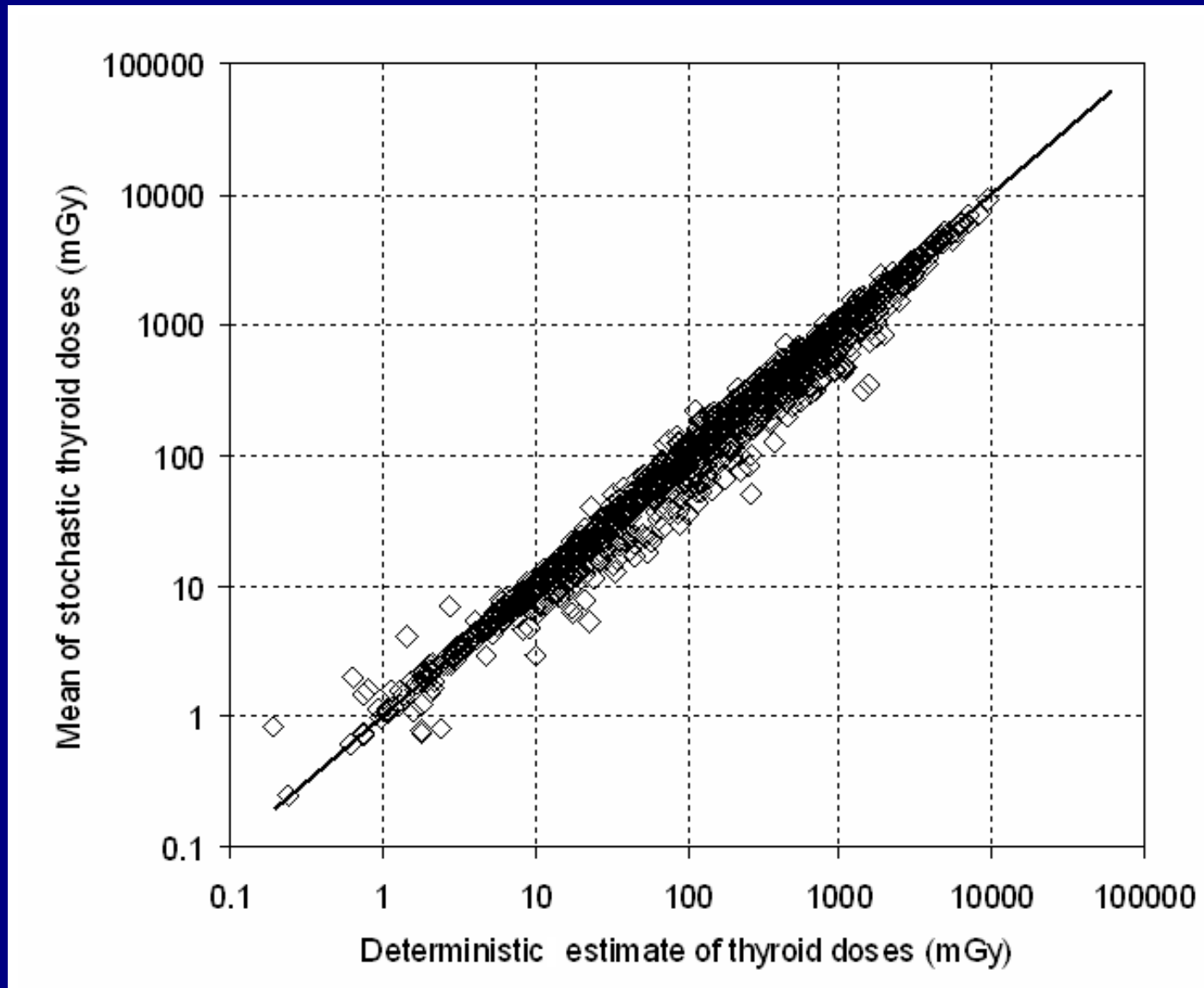
Scheme of the stochastic dose calculation



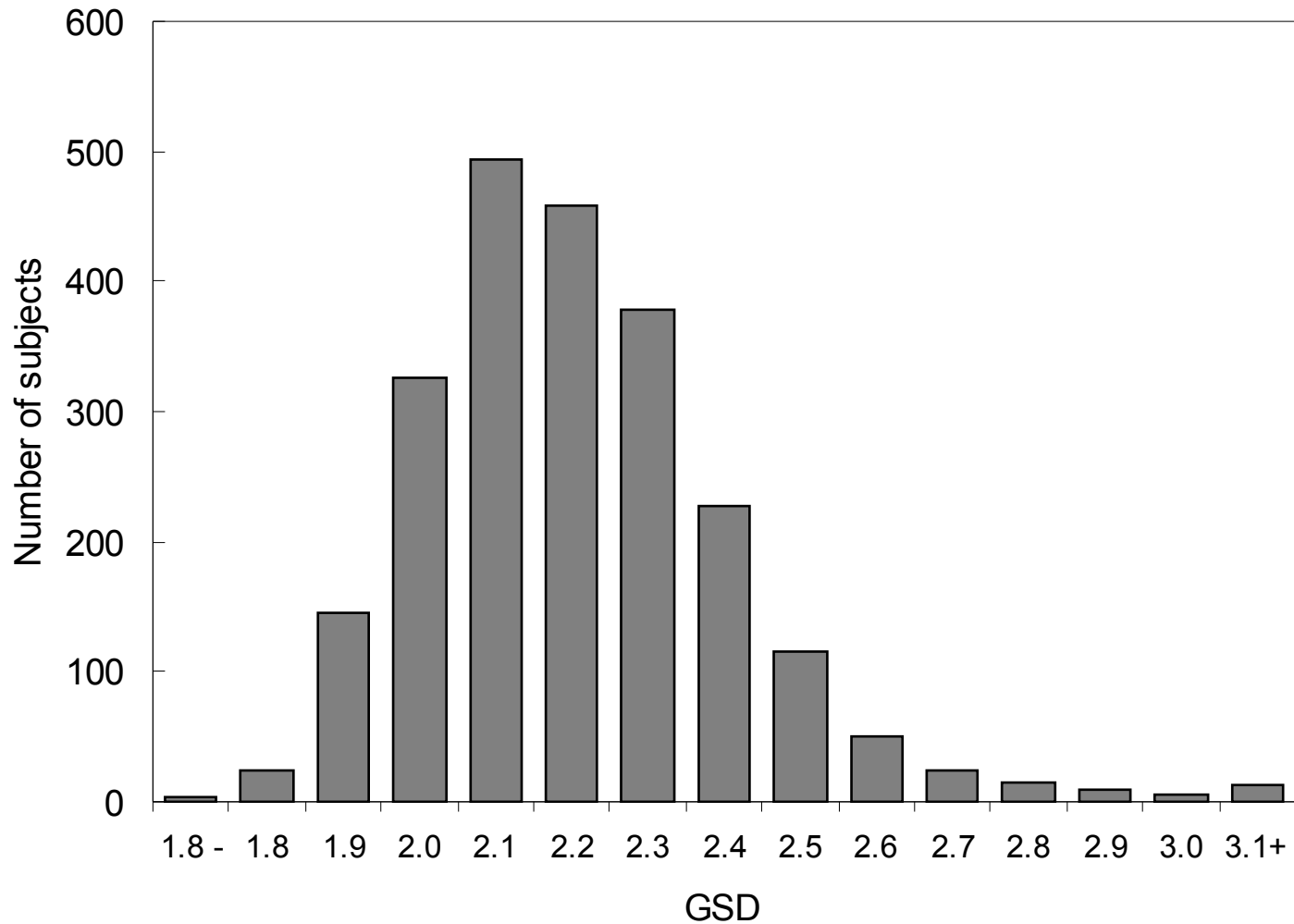
Presentation of stochastic dose estimates

- During one realization of Monte Carlo calculations, one value of thyroid dose was calculated for each of 2,239 study subjects
- By repeating this process 10,000 times, 10,000 realizations of the doses were recorded for all study subjects
- As a result, a matrix of doses with 2,239 columns (representing the number of subjects) and 10,000 rows (representing the number of stochastic doses) was obtained

Deterministic vs mean stochastic doses



Distribution of uncertainties



How to incorporate the dose uncertainties in the dose response analysis?

