Study of Uranium Toxicity due to Protracted Ingestion of Groundwater in Bathinda District of Punjab, India

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Abhishek, Dr. Rohit Mehra
Radiation Monitoring and Assessment Lab
Department of Physics
Dr. B R Ambedkar NIT Jalandhar, Punjab-144008

OUTLINE

- Introduction
- Research objective and significance
- Instrumentation
- Methodology
- Results
- Conclusion

URANIUM IN GROUND WATER

- Amount of Uranium in aquifer rocks
- Water-Rock interactions
- Interaction of Uranium with other compounds like bicarbonates
- Ground water decline, Nitrate pollution
- Anthropogenic activities, Nuclear waste

Impacts of uranium on health

Low level of radioactivity of Natural Uranium

- Radiological toxicity due oral ingestion, inhalation

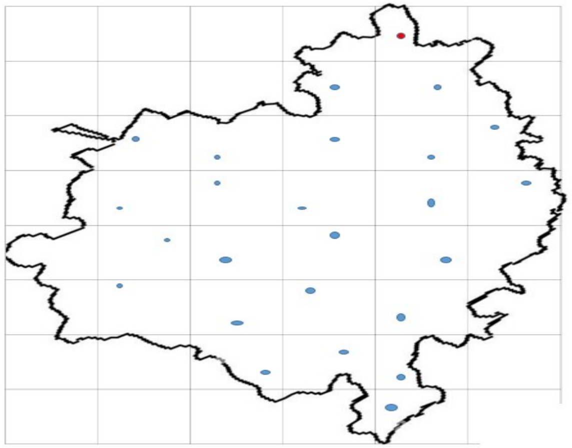
Uranyl compounds form stable complexes with proteins and nucleotides targeting skeleton, kidney and liver as primary sites

- Nephritis, bone cancer, respiratory diseases etc.

RESEARCH OBJECTIVES

- To estimate the concentration of Uranium in groundwater samples collected from Bathinda district of Punjab.
- To calculate the health risks associated with uranium via drinking water pathway.
- To compute the dose received by different body organs/tissues in human body using Hair Compartment Model.

SIGNIFICANCE OF STUDY



Bathinda District

Baseline mapping and worldwide comparisons

Significance with respect to experimental techniques

Significance with respect to area and geology

INSTRUMENTATION

LED-FLUORIMETER

Analytical Technique Fluorescence of uranium salt

Element Analysed Uranium in aqueous medium

Excitation Source Pulsed UV LED (Light Emitting Diodes)

Detector Photomultiplier tube

Cuvette Made from Ultra low fluorescence Fused Silica

Minimum Detection Limit 0.5 ppb.

Dynamic range 0.5 – 1000 ppb with deviation10%

Modes of operation

Standard Addition Mode (Spike Mode)

Calibrated Fluorescence Mode

Uncalibrated Fluorescence Mode (Count Mode)

Measurement time

1 second (averages the fluorescence for 256 pulses

METHODOLOGY

Radiological toxicity

$$Uranium\ Activity = 0.025 \times U\ concentration$$

$$Cancer\ risk = A_c \times R$$

$$A_c\ is\ activity\ concentration\ of\ Uranium$$

$$R\ is\ risk\ factor\ R = r \times I$$

$$r\ is\ risk\ co-efficient$$

$$I\ is\ per\ capita\ intake$$

$$I = life\ expectancy \times daily\ consumption\ of\ water$$

Risk coefficients for various Uranium isotopes		
Isotope	**Mortality (Bq^{-1})**	**Morbidity(Bq^{-1})**
$^{92}U_{234}$	$6.2 X10^{-11}$	$9.5 X 10^{-11}$
$^{92}U_{235}$	$6.32 X 10^{-11}$	$9.8 X 10^{-11}$
$^{92}U_{238}$	$7.5 X 10^{-11}$	$7.5 X 10^{-10}$

Chemical toxicity risk assessment

$$Lifetime\ Average\ Daily\ Dose(LADD) = \frac{EPC \times IR \times IF \times D}{AT \times W}$$

$$EPC = exposure\ point\ concentration\ of\ U\ in\ water(\mu g\ L^{-1})$$

$$IR = ingestion\ rate$$

$$IF = ingestion\ frequency$$

$$D = duration$$

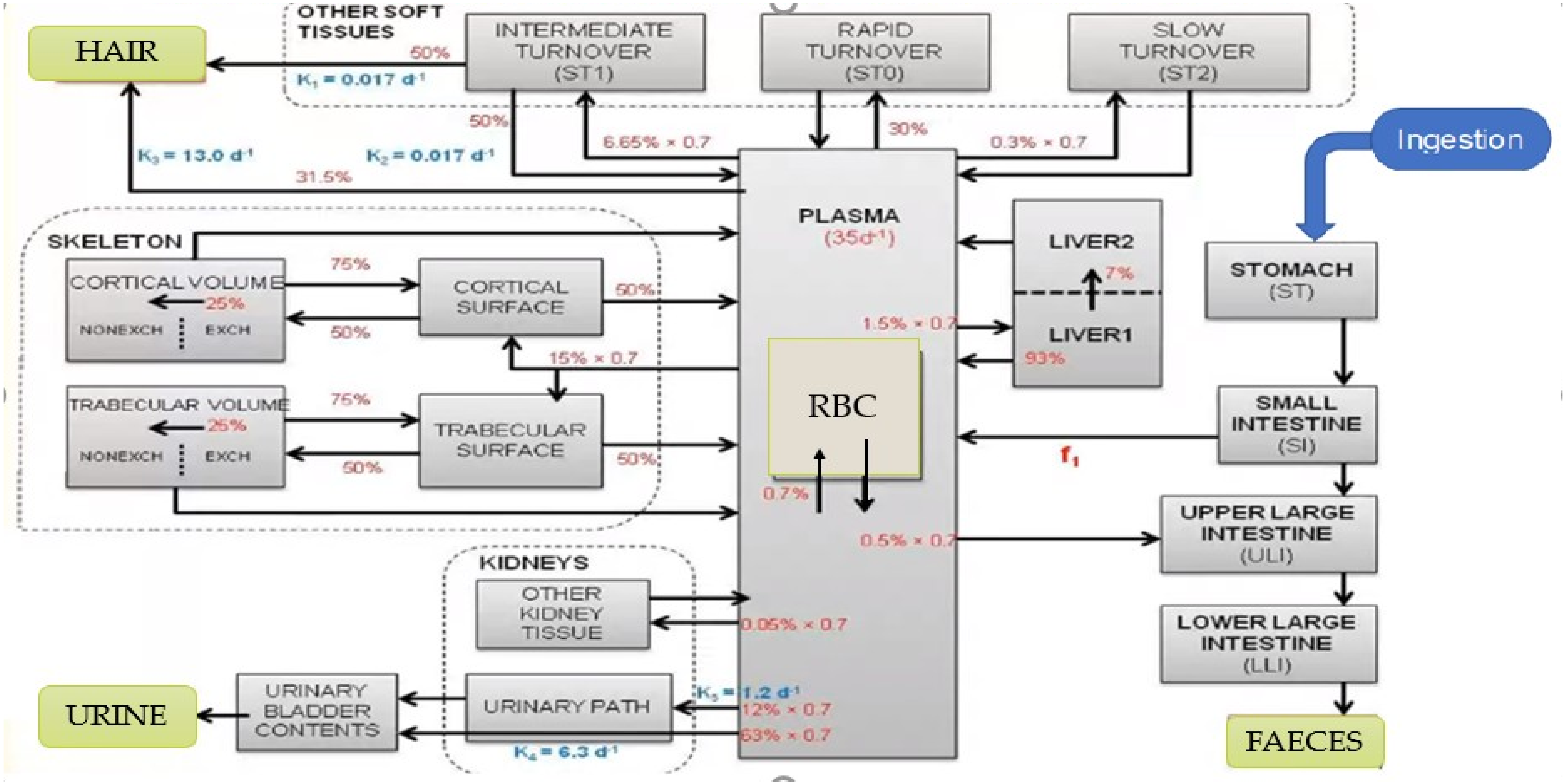
$$AT = average\ lifetime$$

$$W = ideal\ body\ weight$$

$$Hazard\ Quotient = \frac{LADD}{reference\ dose}$$

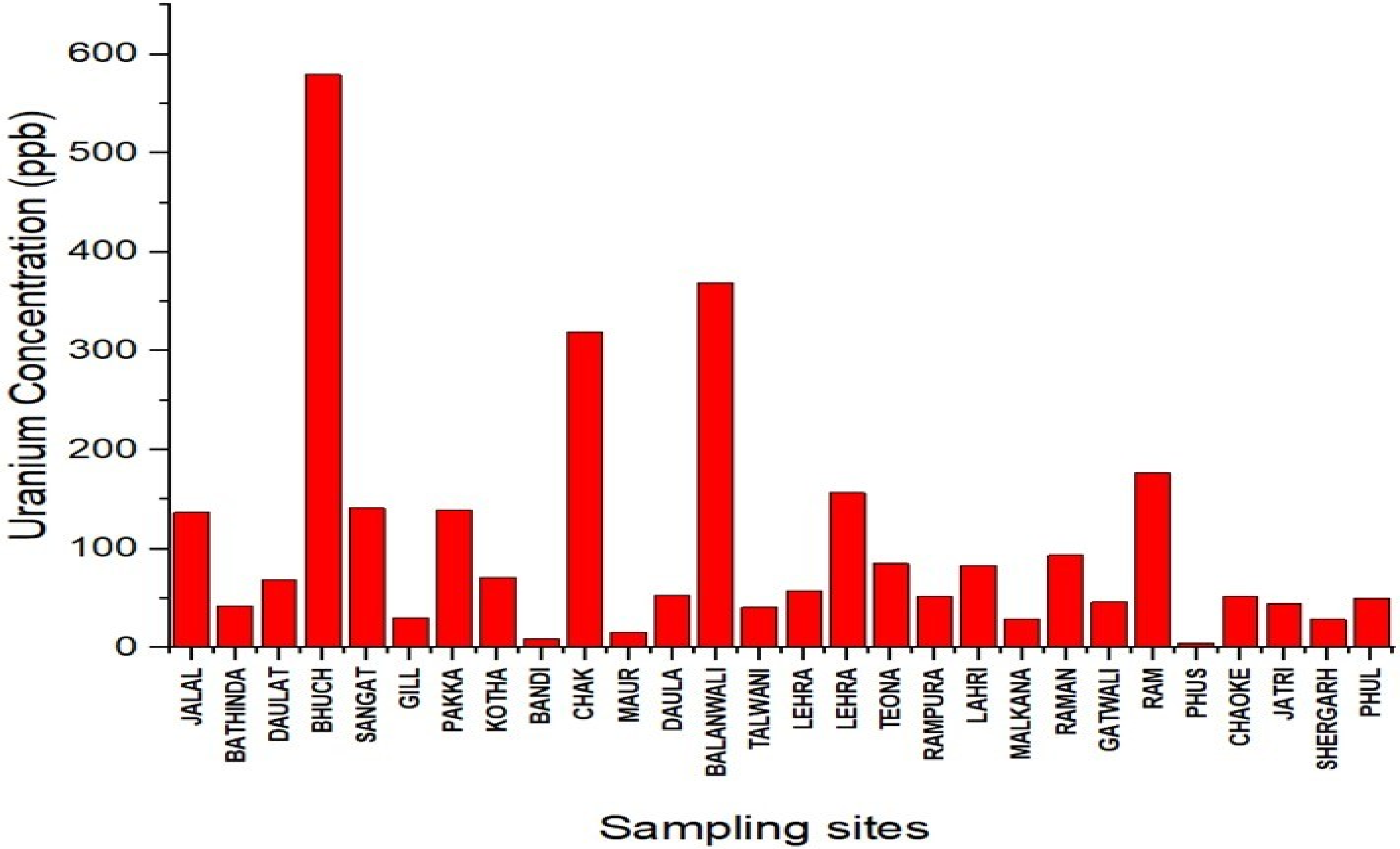
$reference\ dose = 1.2\ \mu g\ kg^{-1}\ day^{-1}$ **WHO (2011)**

HAIR COMPARTMENT MODEL



RESULTS

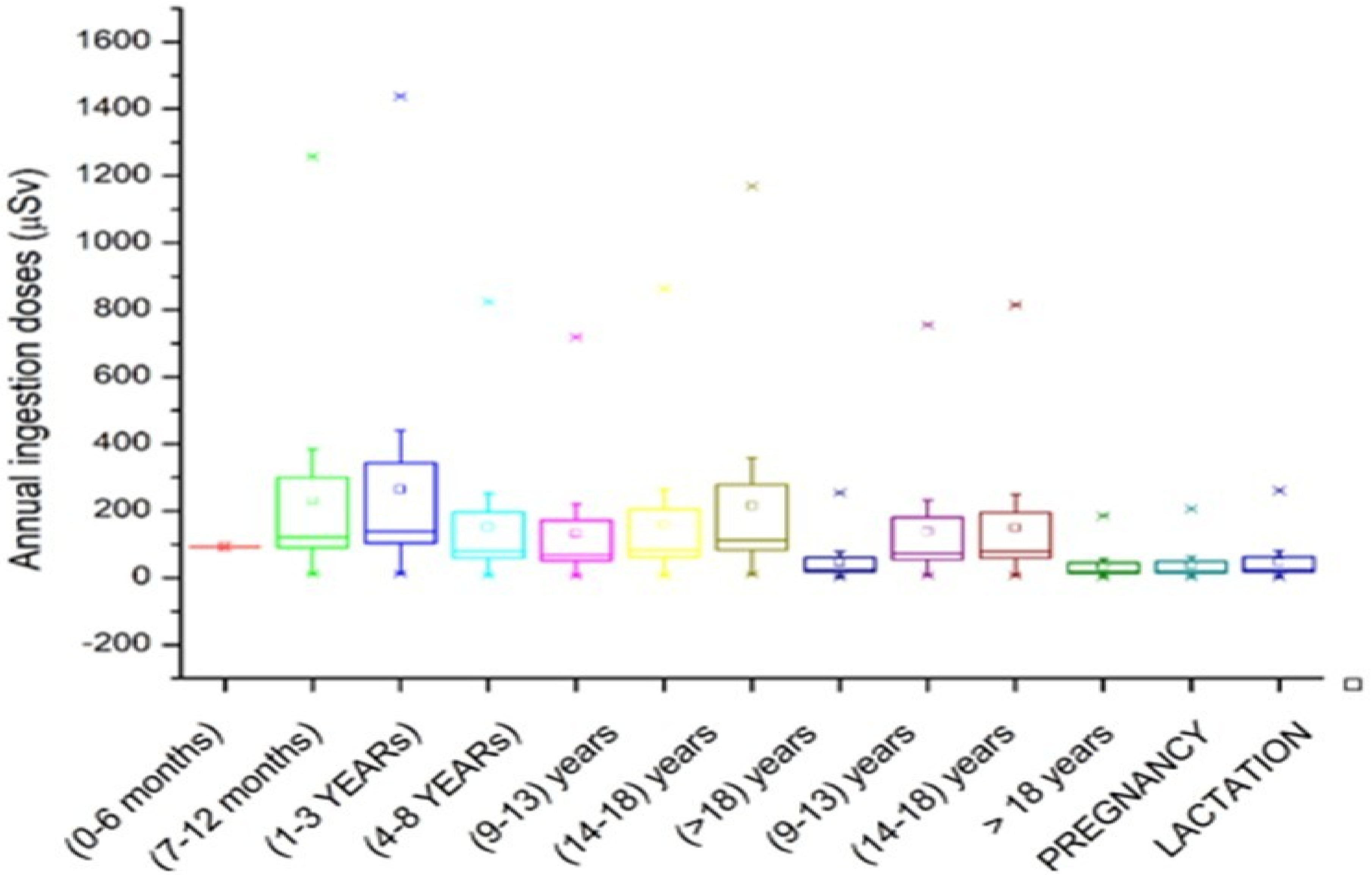
Graph showing concentration of Uranium



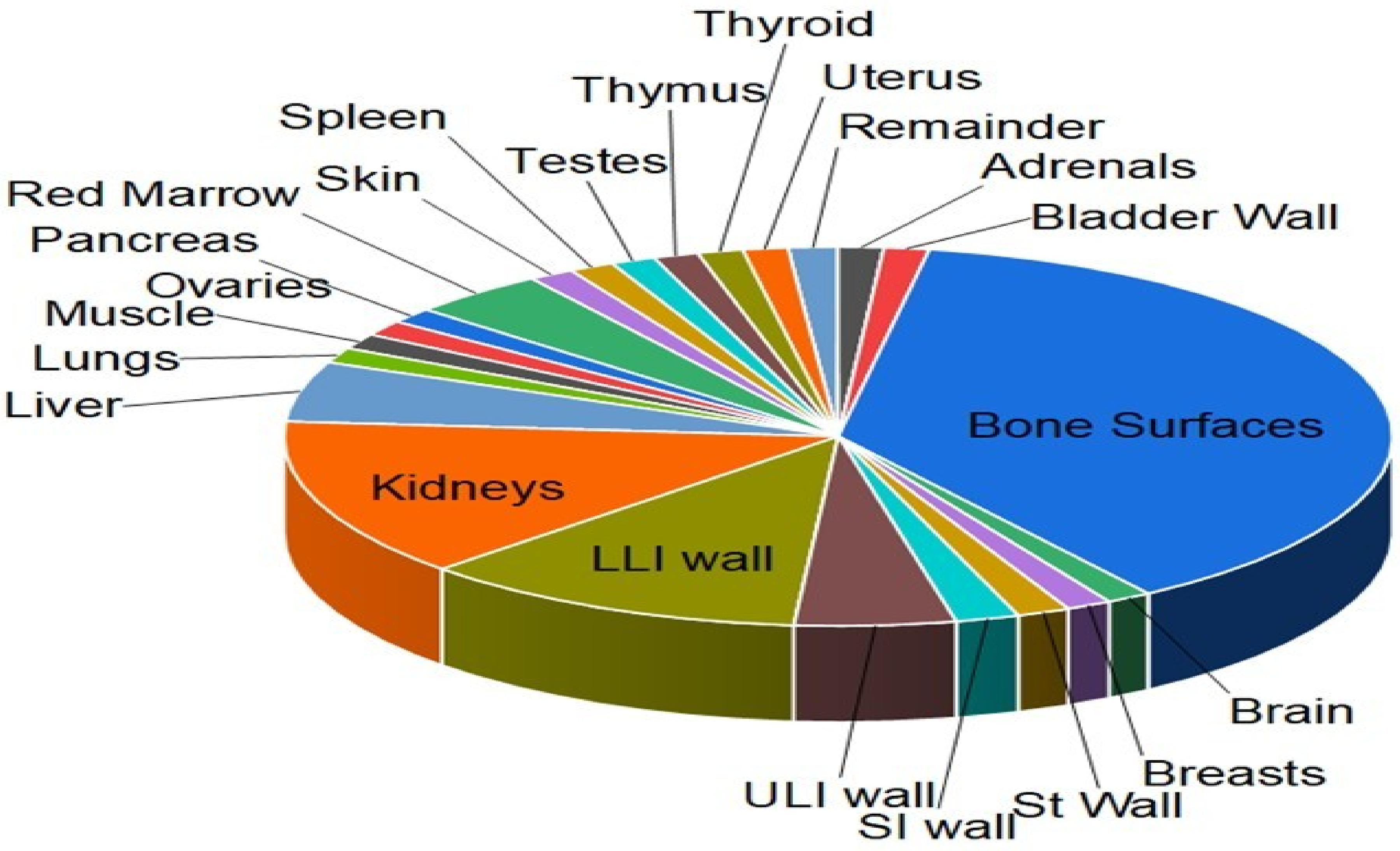
RADIOLOGICAL AND CHEMICAL TOXICITY

		Minimum	Maximum	Mean
Uranium concentration (μg L^{-1})		5.19	579.28	106.41
Uranium Activity (Bq L^{-1})		0.13	14.48	2.66
Excess Cancer Risk (Mortality)	U-234	1.39×10^{-11}	1.55×10^{-09}	2.86×10^{-10}
	U-235	2.04×10^{-09}	2.28×10^{-07}	4.18×10^{-08}
	U-238	3.40×10^{-07}	3.80×10^{-05}	6.97×10^{-06}
Excess cancer risk (Morbidity)	U-234	2.17×10^{-11}	2.42×10^{-09}	4.45×10^{-10}
	U-235	3.22×10^{-09}	3.60×10^{-07}	6.61×10^{-08}
	U-238	3.40×10^{-07}	3.80×10^{-05}	6.97×10^{-06}
LADD (μg kg^{-1} day^{-1})		0.10	11.61	2.13
HQ		0.09	9.68	1.78

AGE DEPENDENT ANNUAL INGESTION DOSES (µS/year)



ORGAN SPECIFIC DOSES FOR DIFFERENT ORGANS



Conclusions

- ✓ The high concentration of uranium in the study region may be due to geology of the region and presence of radioactive Tosham Hills nearby the study region, heavy use of fertilizers.
- ✓ In region of high concentration, ingestion of groundwater poses significant radiological and chemical toxicity risk.
- ✓ Study highlights that infants and children are more vulnerable towards exposure due to uranium ingestion.
- ✓ Bone surface is the most stable repository for uranium in human body followed by LLI wall and Kidney

Thankyou

Email: abhishek.ph.22@nitj.ac.in