

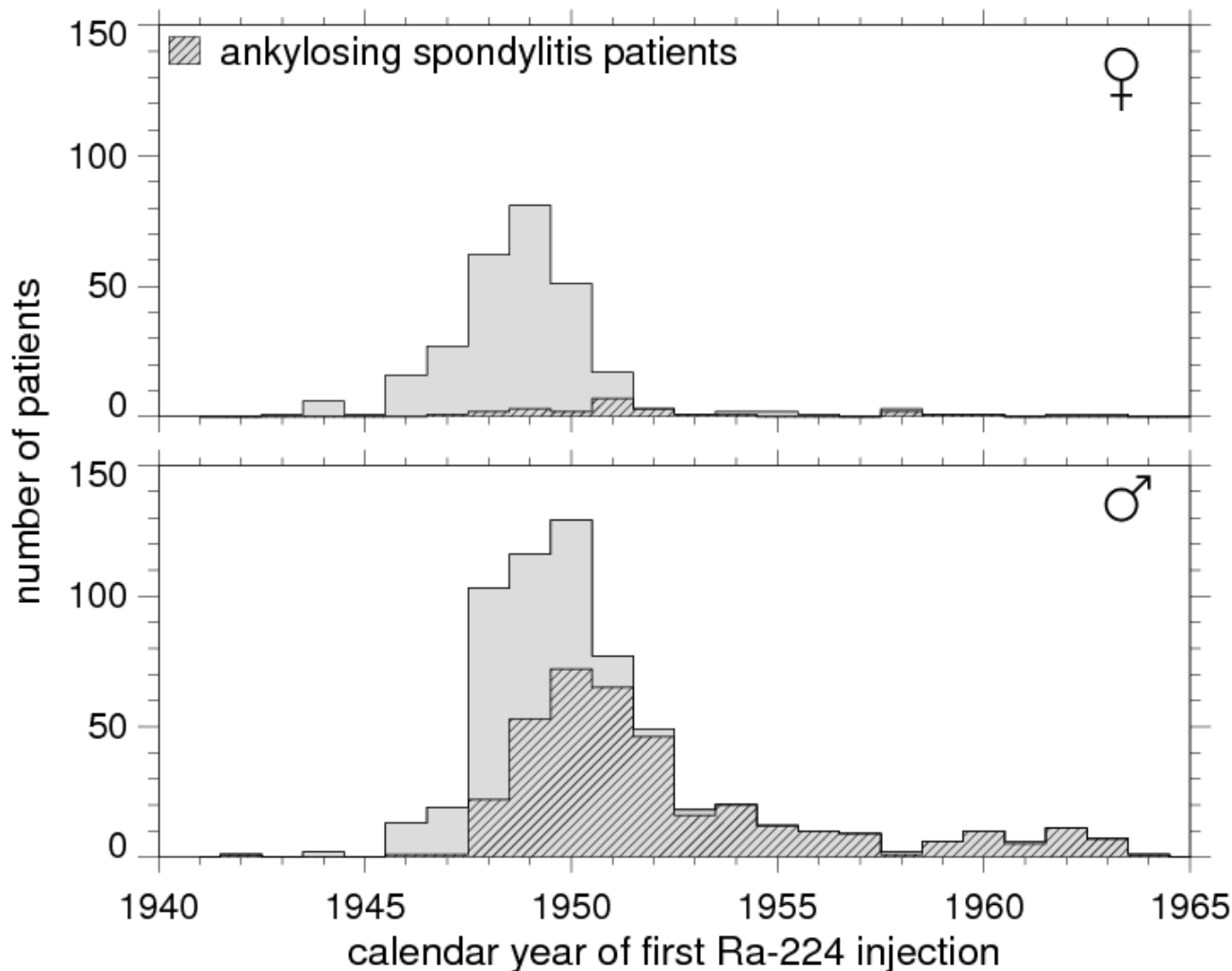
---

# ***Non-skeletal Malignant Diseases in Patients Treated with Radium-224***

**E. A. Nekolla,  
L. Walsh, H. Spiess**

# Radium-224 Study – INTRODUCTION

## Distribution of patients in calendar year of 1st Ra-224 injection



**899**  
patients

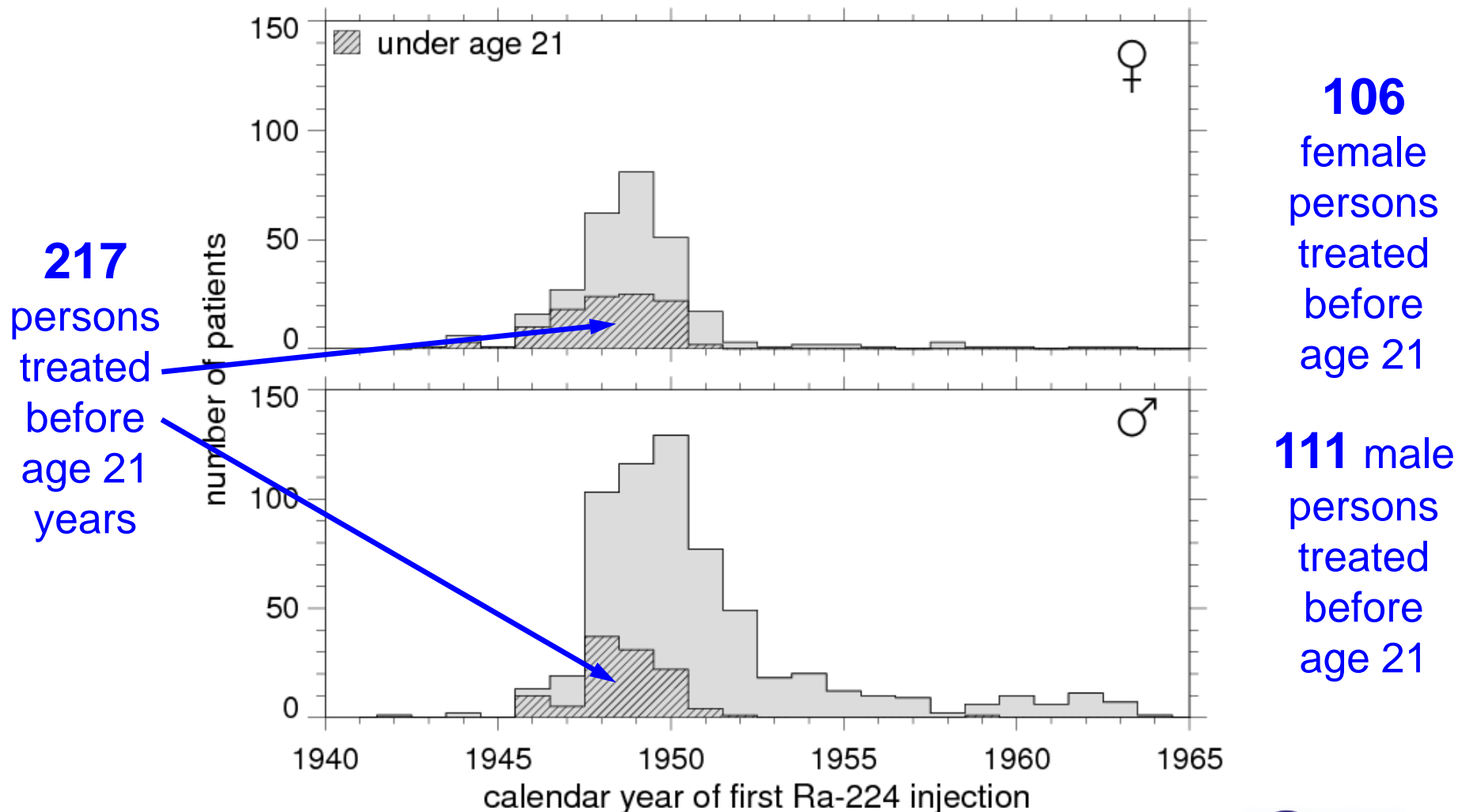
**278**  
female  
patients

**621**  
male  
patients

↓  
**59% AS**  
patients

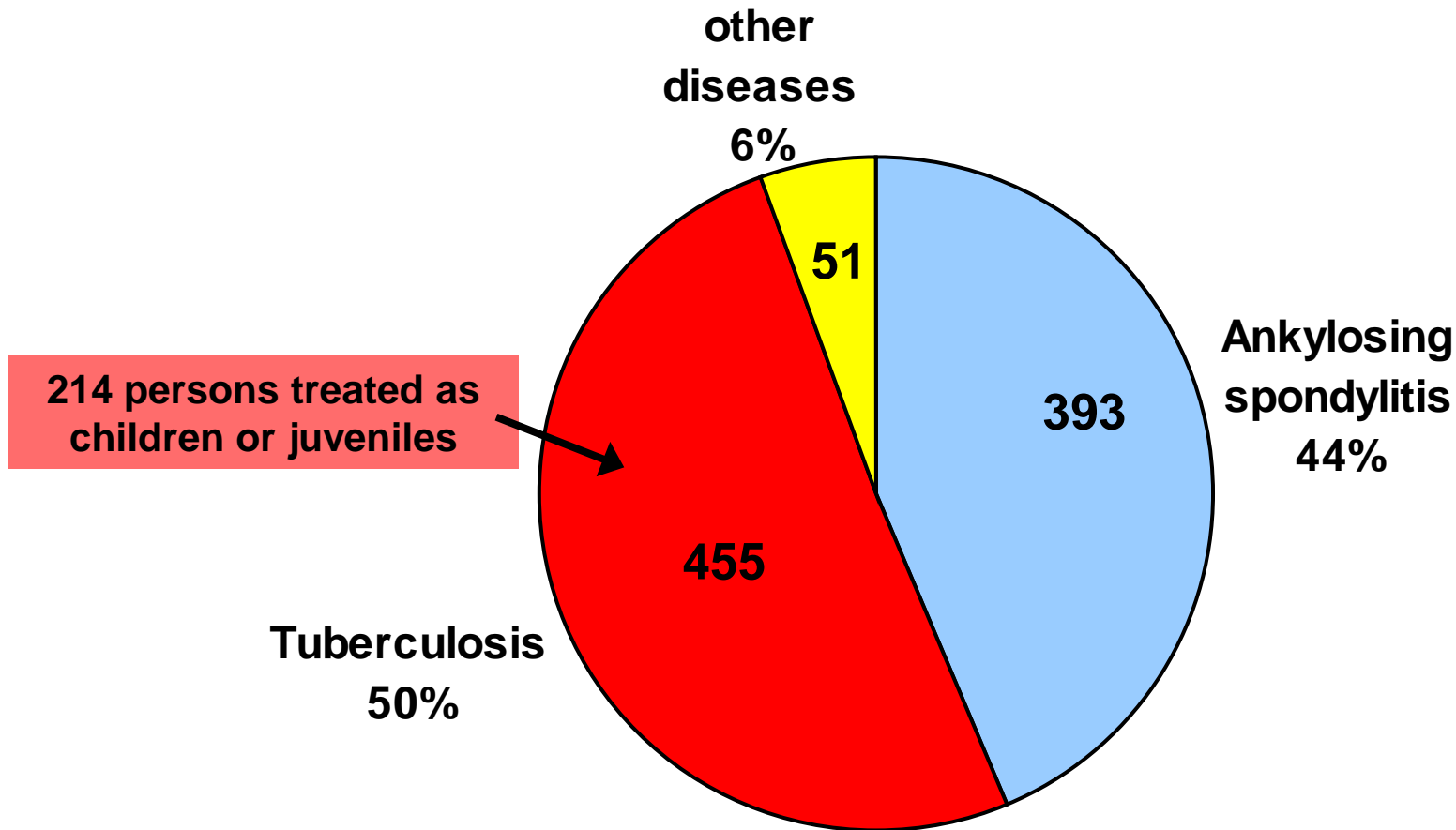
# Radium-224 Study – INTRODUCTION

## Distribution of patients in calendar year of 1st Ra-224 injection



# Radium-224 Study – INTRODUCTION

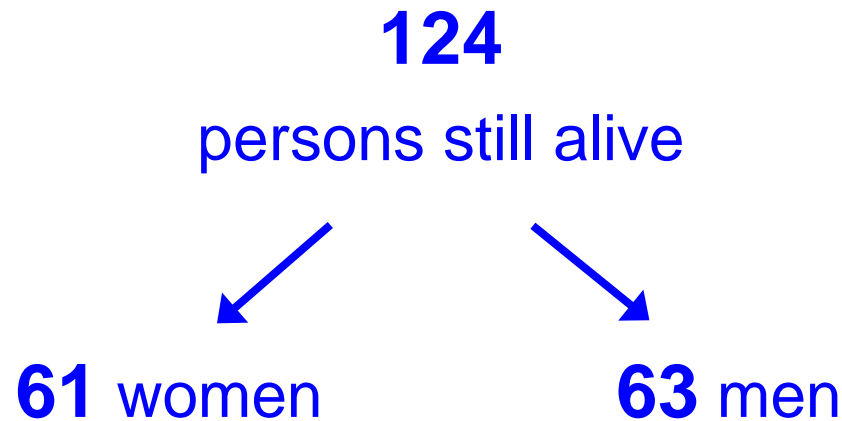
## Distribution of original diseases



# Radium-224 Study – INTRODUCTION

---

## Last Follow-up: December 2007



mean attained age of those still alive:

**71.5 years**

# Radium-224 Study – METHODS

---

- Expected number of cases:

computed from the age, gender and calendar year distribution of person years at risk

and the age, gender and calendar year specific incidence rates from the German Saarland Cancer Registry.

- Expected number of cases were compared with the observed number of cases. To test for statistical significance Poisson statistics were applied.



# Radium-224 Study – RESULTS

---

## December 2007

Number of malignant diseases in the Ra-224 cohort:

**327** cases versus 193 ( $p < 0.001$ )

- **57** malignant bone tumors
- **248** malignant non-skeletal solid and soft tissue tumors
- **22** other malignant diseases:
  - 8 cases of leukemia vs. 4.1,  $p = 0.05$ ,
  - 5 multiple myelomas vs. 1.5,  $p = 0.02$ ,
  - 3 Non Hodgkin lymphomas,
  - 6 malignant neoplasms without specification of site

# Radium-224 Study – RESULTS

---

**December 2007**

**248** malignant non-skeletal solid and soft tissue tumors

Minimum latency period of 5 years: ***excluding 4 cases***

&

***excluding 13 cases***

of non-melanoma skin cancer (mainly basaliomas)

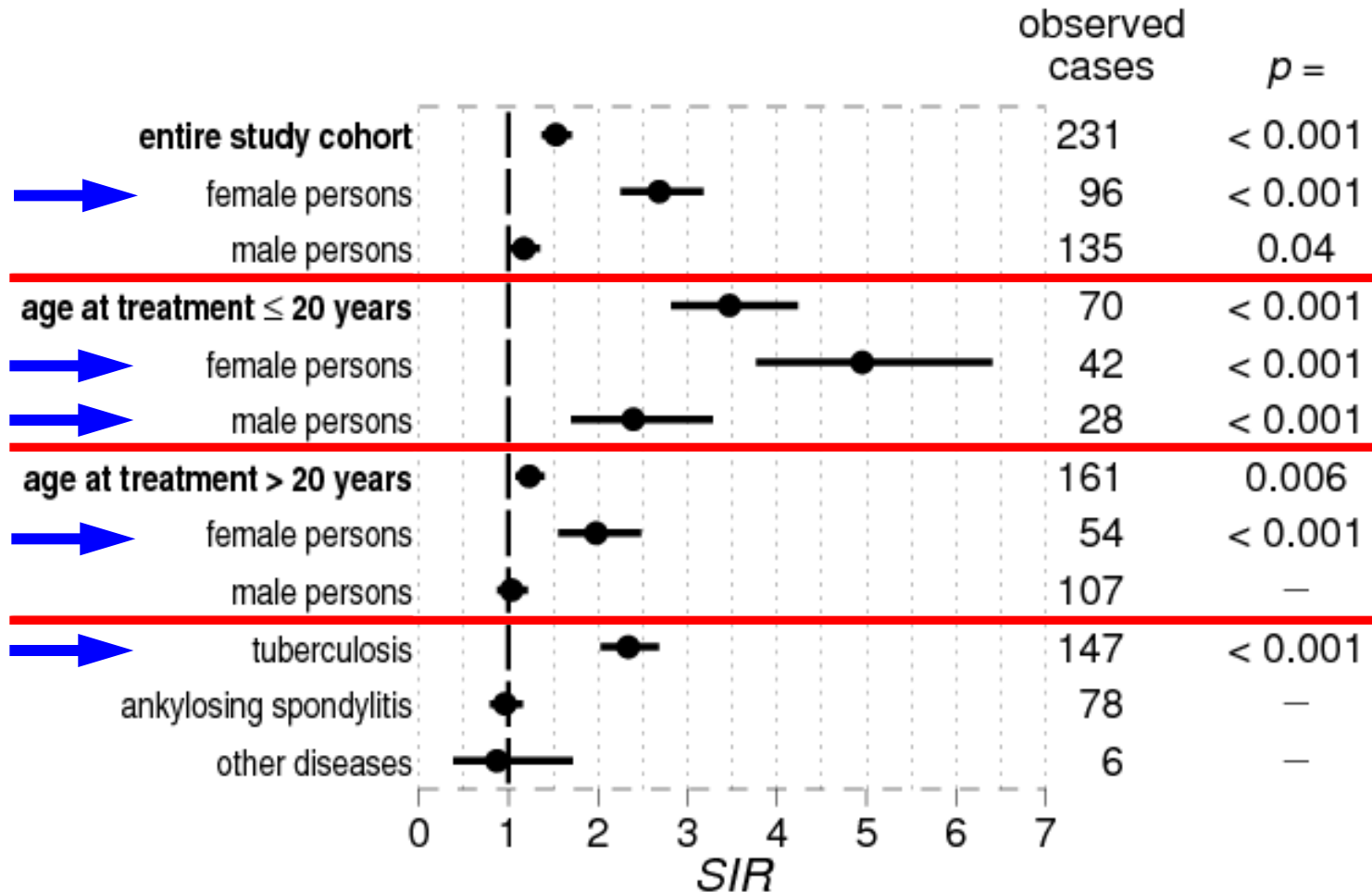


**231 cases** versus 151 ( $p < 0.001$ )



# Radium-224 Study – RESULTS

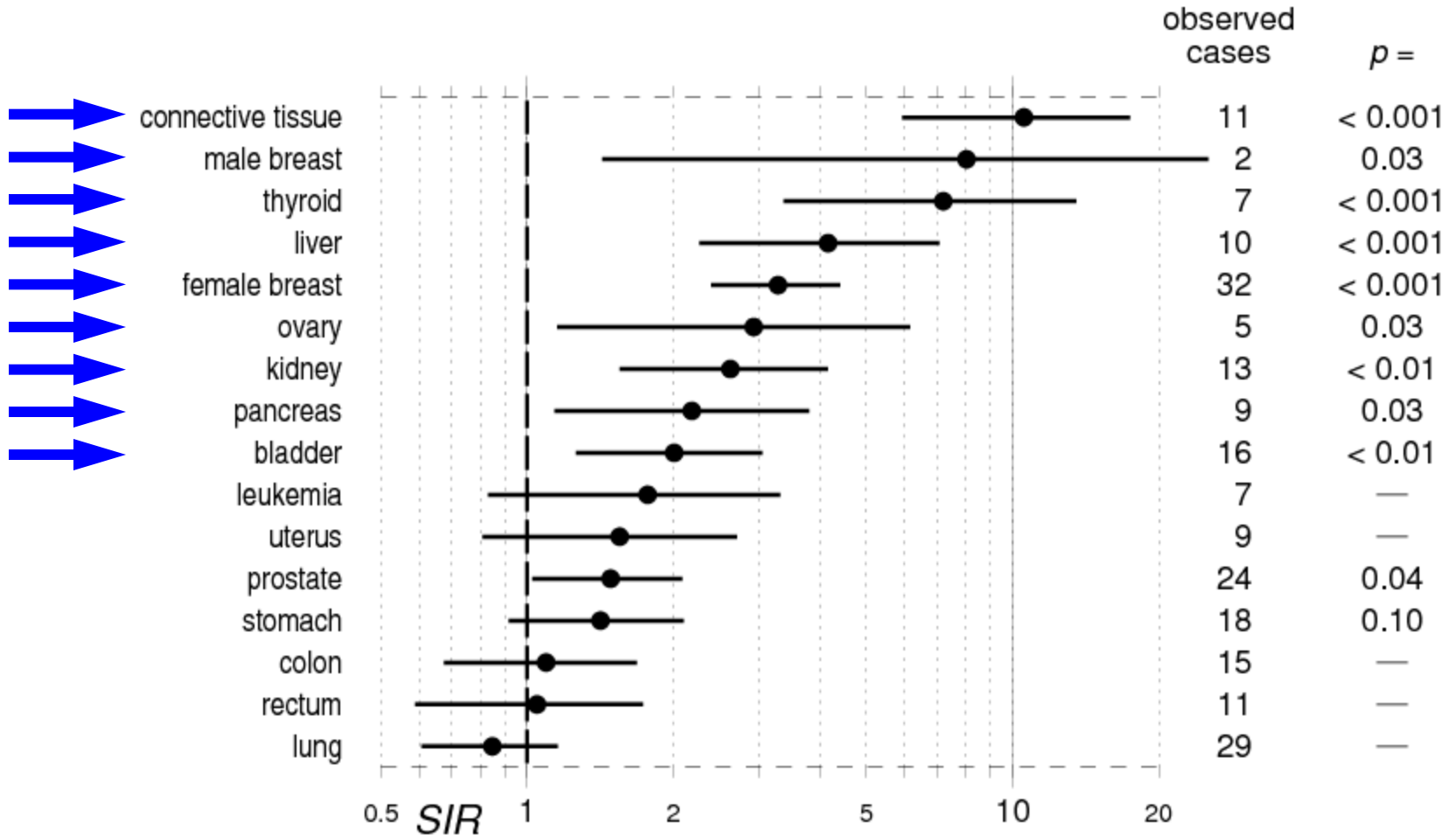
## Rate Ratios (*SIR*) for different groups of patients



*malignant non-skeletal solid and soft tissue tumors, excl. non-melanoma skin cancer, lag = 5 years*

# Radium-224 Study – RESULTS

## Rate Ratios (*SIR*) for different types of cancer



# Radium-224 Study – RESULTS

---

## Female breast cancer

**32 versus 9.75 ( $p < 0.001$ )**

**age at Ra-224 treatment**

**$\leq 20$  years**

**20 versus 2.7 ( $p < 0.001$ )**

**age at Ra-224 treatment**

**$> 20$  years**

**12 versus 7.1 ( $p = 0.06$ )**



# Radium-224 Study – RESULTS

---

**Female breast cancer**

**Estimated *ERR* per Sv:**

**0.8**

**age at Ra-224 treatment**

**≤ 20 years**

**Estimated *ERR* per Sv:**

**2.1**

**age at Ra-224 treatment**

**> 20 years**

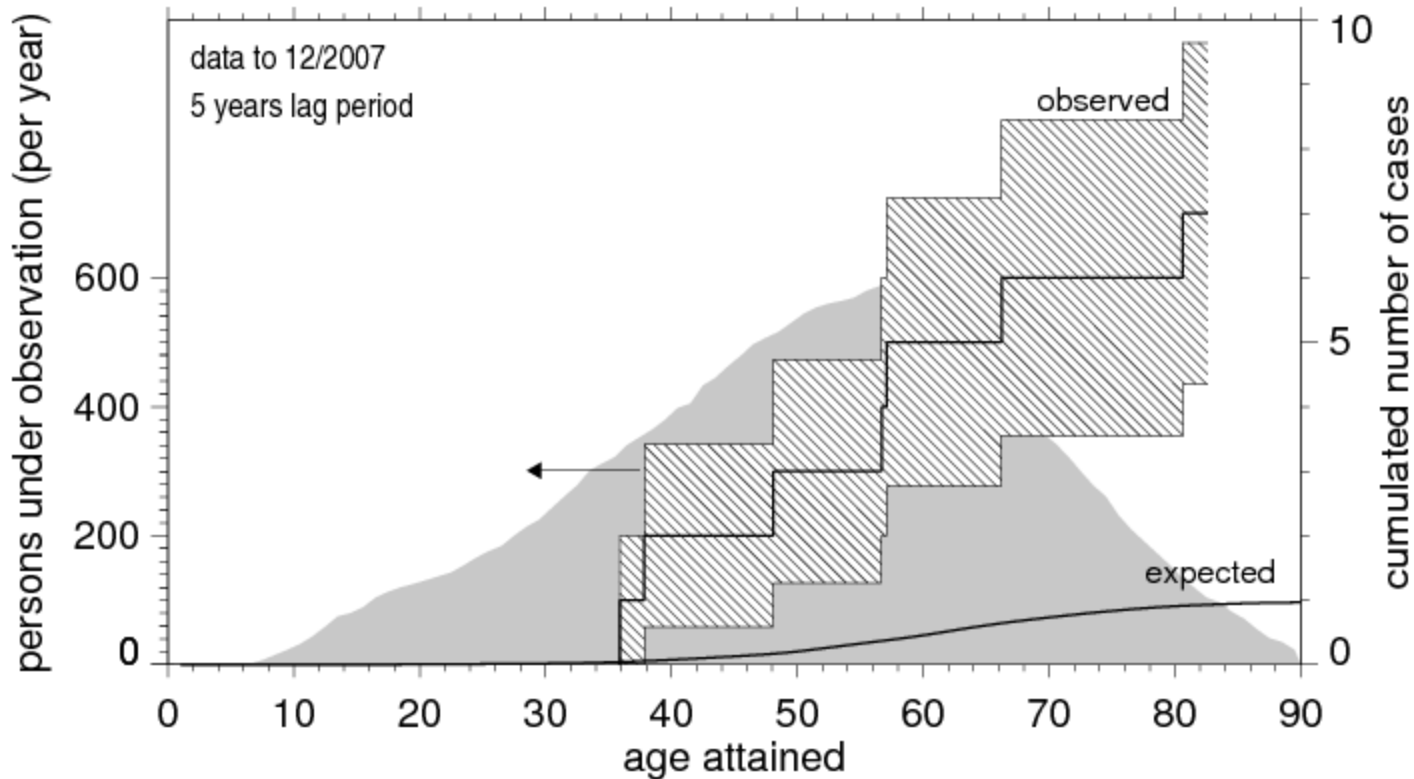
**Estimated *ERR* per Sv:**

**0.2**

# Radium-224 Study – RESULTS

## Thyroid cancer

7 versus 1.0 ( $p < 0.001$ )



young age at treatment of cases (yr):  
11, 11, 12, 14, 21, 22, 31 (17 on average)

Entire Ra-224 cohort:  
Age at treatment  
= 32 yr on average

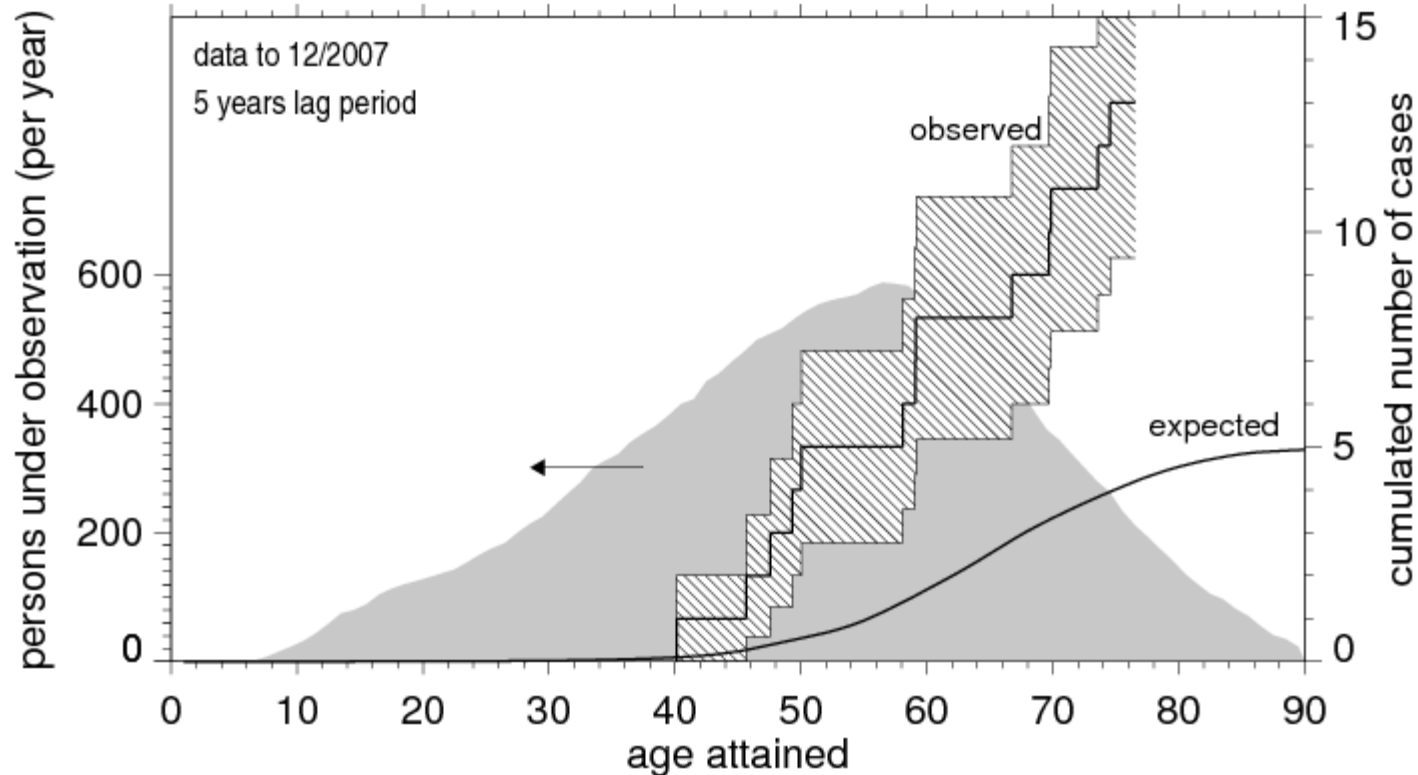
**Estimated ERR per Sv = 5.5  
for those treated as children/juveniles**

# Radium-224 Study – RESULTS

## Kidney cancer

13 versus 5.0 ( $p = 0.002$ )

**Estimated  
*ERR* per Sv = 0.7**



young ages at  
diagnosis:  
59 years  
on average !

age at Ra-224 treatment  $\leq 20$  years

6 versus 0.8 ( $p < 0.001$ )

**Estimated *ERR* per Sv = 2.0**

age at Ra-224 treatment  $> 20$  years

7 versus 4.2

**(Estimated *ERR* per Sv = 0.3)**

# Radium-224 Study – SUMMARY

---

Completion of last follow-up in December 2007:

→ a total of 124 persons still alive

Most striking **early** effect following Ra-224 injections:

→ 57 malignant **bone tumors**

During the two most recent observation decades, a **significant excess of *non-skeletal* malignant diseases** has become evident:

→ Increased cancer rates most prominent in women and in those treated at young ages

→ Increased rates especially of breast cancer, cancer of soft and connective tissue, thyroid cancer, kidney cancer, pancreas cancer, bladder cancer

---

This study is supported  
by the Bavarian State Ministry for State  
Development and Environmental Affairs