

Balancing the benefits and risks of breast cancer radiotherapy

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Benefits and risks of breast cancer RT

1. Main late effects
2. Heart doses modern RT
3. Lung doses modern RT

Benefits and risks of breast cancer RT

- 1. Main late effects**
2. Heart doses modern RT
3. Lung doses modern RT

Benefits of radiotherapy: Breast cancer mortality

Absolute benefit in women treated
according to current guidelines
a few percent

Risks of radiotherapy: Lung cancer and cardiac mortality

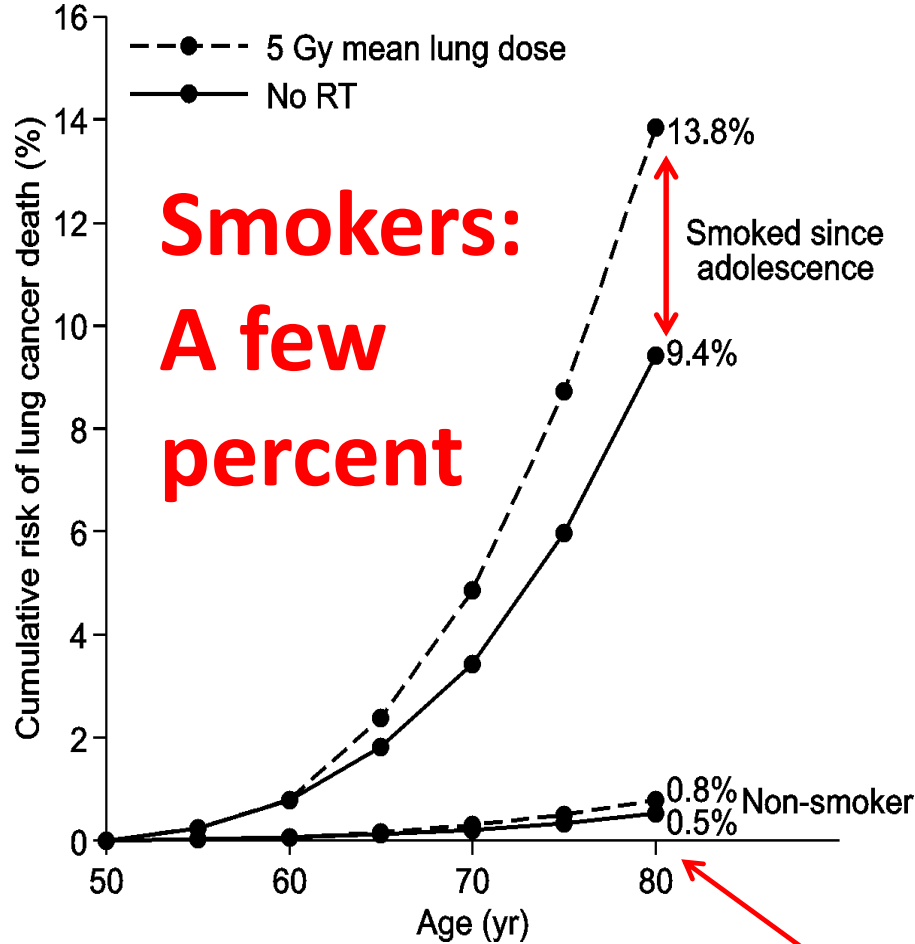
Absolute risk in non-smokers
(or ex-smokers)
less than 1%

Risks of radiotherapy: Lung cancer and cardiac mortality

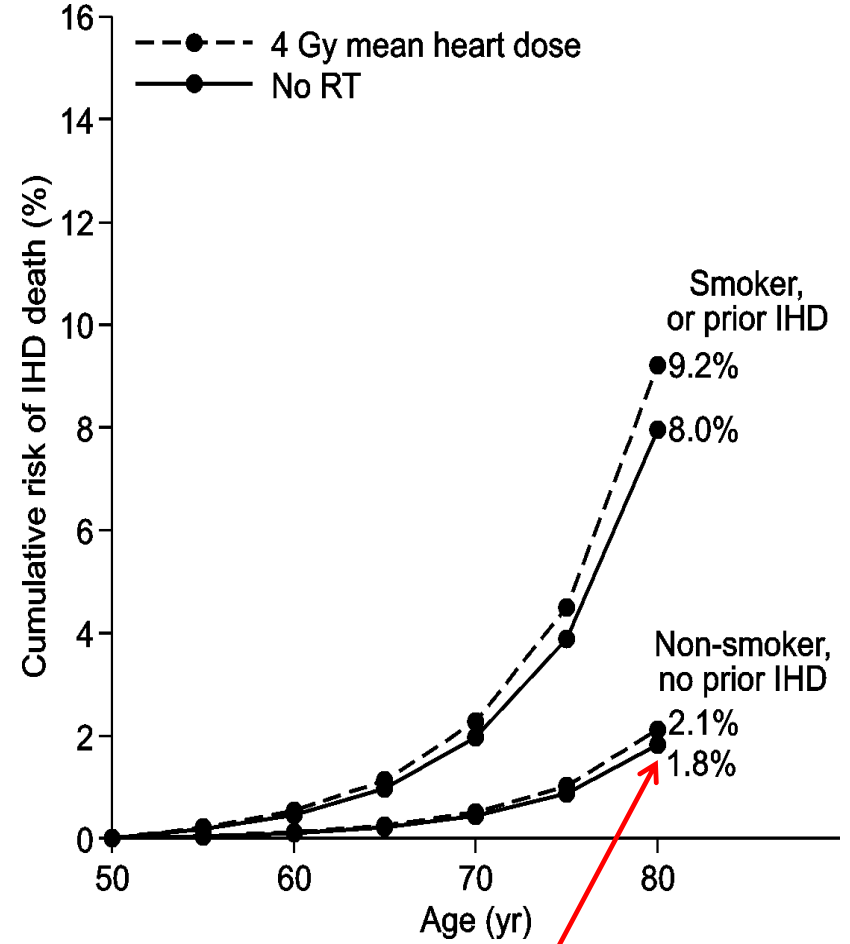
Absolute risk in smokers
a few percent

Risks by age 80 of radiotherapy at age 50

Lung cancer



Ischaemic heart disease



Non-smokers: <1%

Randomised to radiotherapy versus not

75 trials, 40,000 women, median entry 1983

Type of surgery	No. of trials	No. of women	Deaths with no recurrence
Mastectomy (for cancer)	36	16,156	2921
Breast conserving (for ca.)	18	11,655	1270
Various (for cancer)	17	9066	1666
Breast conserving (for DCIS)	4	3904	207
All trials	75	40,781	6064

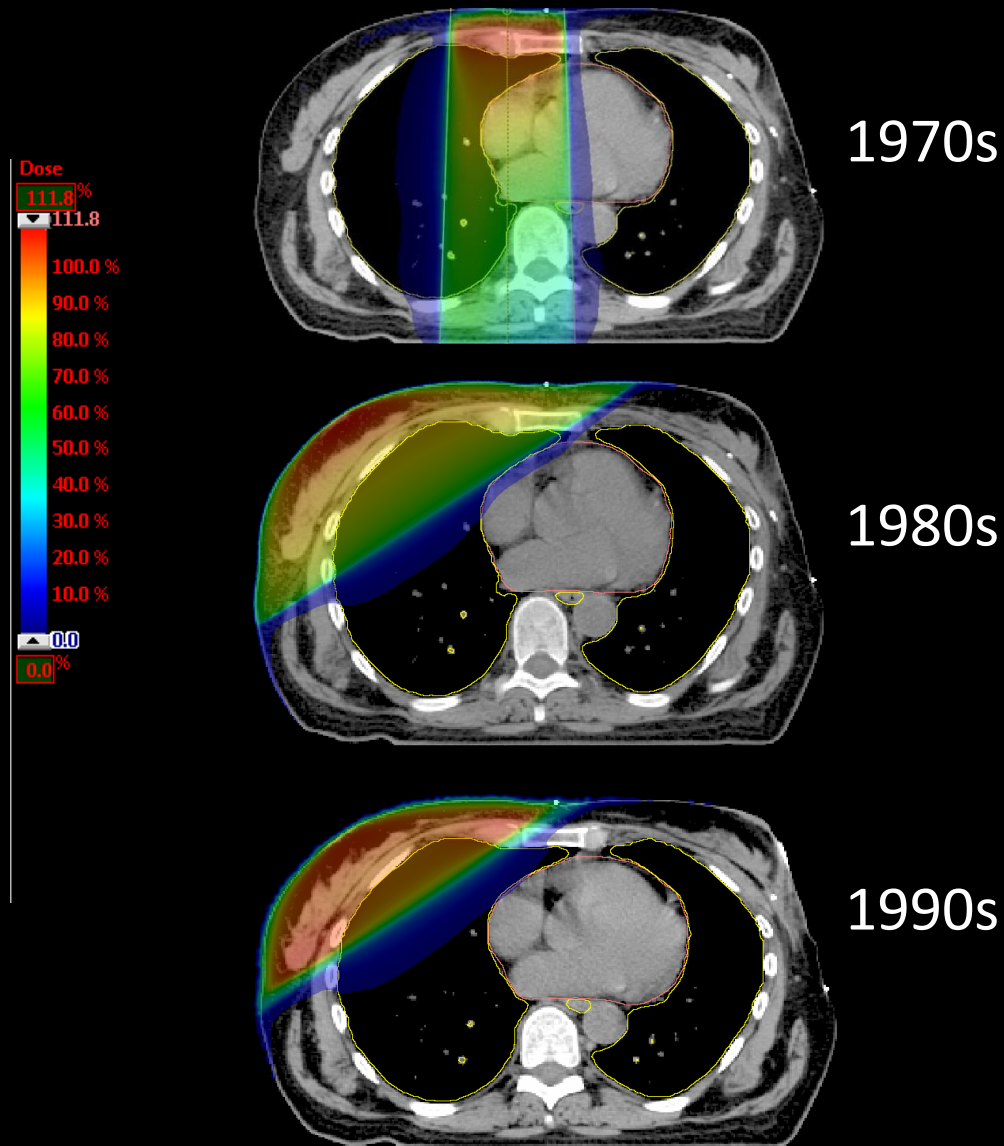
Lung and heart doses, past and present

(different, so use trials to obtain excess RR per Gy)

	Typical dose in RT trials	Typical dose from modern RT*
Two lungs (averaged)	10 Gy	5 Gy
Whole heart (averaged)	6 Gy	4 Gy

*Literature review, **>100** publications in 2010-15

Radiotherapy by decade in trials



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Rate ratio (RR) from trials, and RR per Gy

RR (95% CI) in trials

Lung cancer (10+ years)	2.10 (1.48-2.98)
Cardiac mortality	1.30 (1.15-1.46)

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Average doses in the trials

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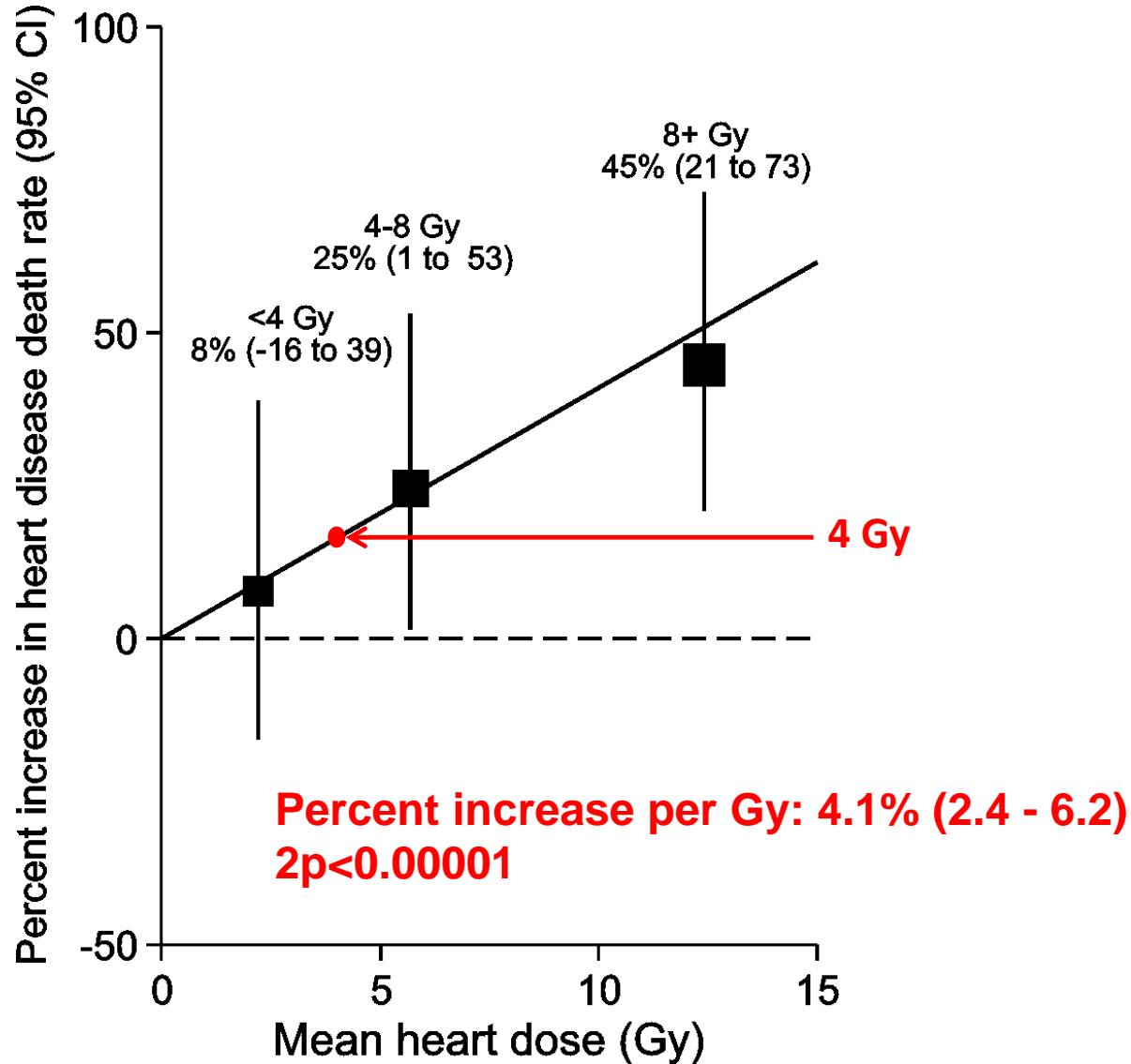
Lung	10 Gy
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Excess RR per Gy in trials

Lung cancer	12% per Gy
Cardiac mortality	4% per Gy

Heart dose-response relationship

1253 cardiac deaths



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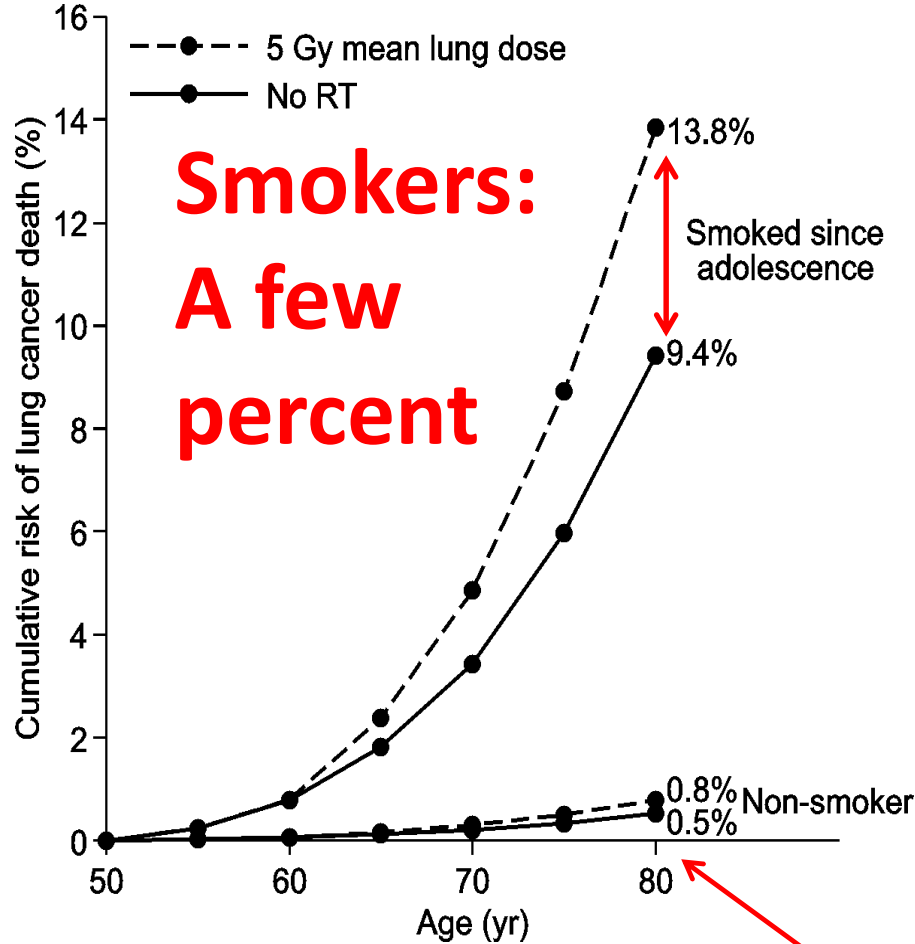
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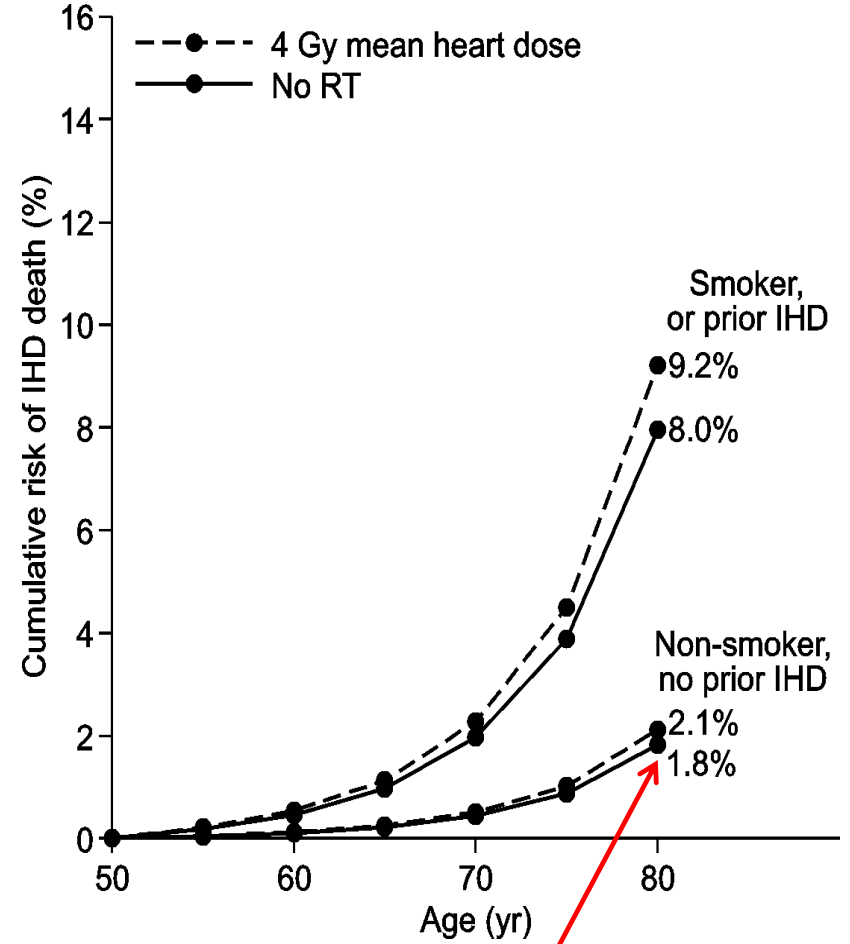
Lung cancer	12% per Gy
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Risks by age 80 of radiotherapy at age 50

Lung cancer



Ischaemic heart disease



Non-smokers: <1%

Conclusions

Smoking status can determine the net long-term effect of breast cancer radiotherapy on mortality.

Smoking cessation at the time of radiotherapy may avoid most of the risk.

Benefits and risks of breast cancer RT

1. Risks

2. Heart doses modern RT

3. Lung doses modern RT

**Systematic review of heart dose
in breast cancer radiotherapy
2003-2013**

Carolyn Taylor

Zhe Wang

Elisabeth Macaulay

Reshma Jagsi

Sarah Darby

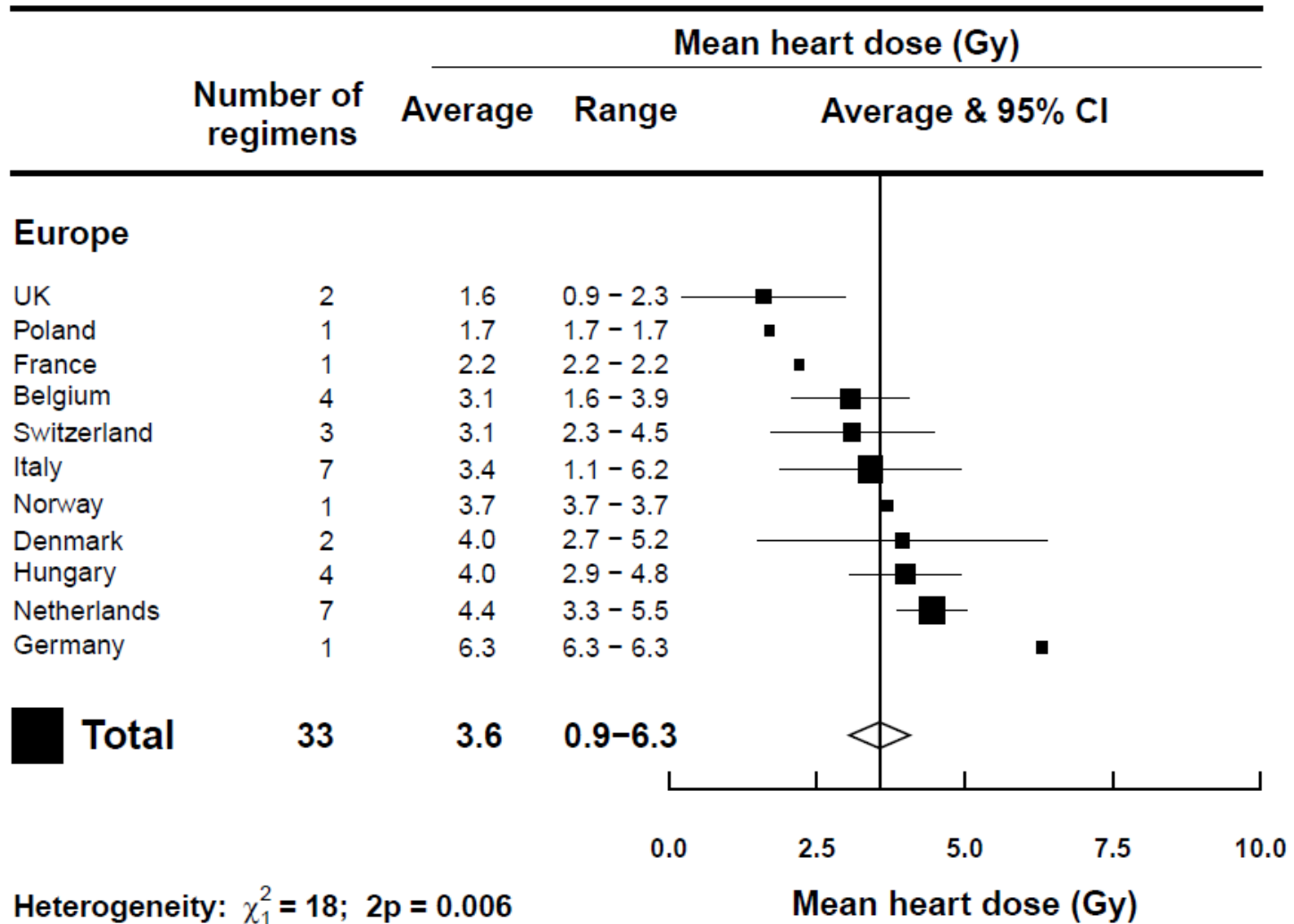
Whole **heart dose**

Breast cancer radiotherapy 2003-2013

Laterality	No. studies	No. regimens	Mean heart dose (Gy)	
			Average	Range
Left	149	398	5.4	<0.1-28.6
Right	23	45	3.3	0.4-21.6

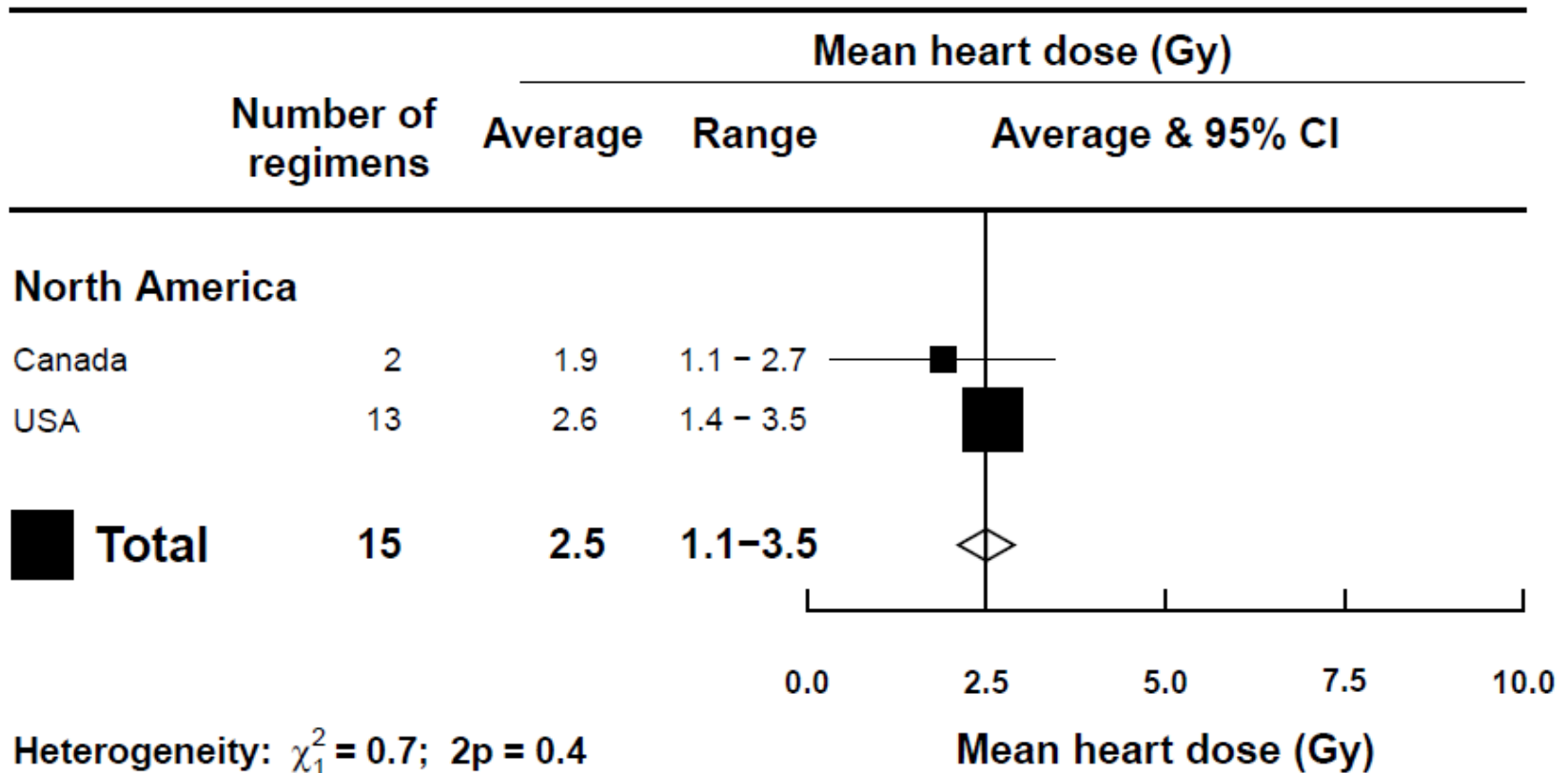
Left tangential breast radiotherapy:

Heart dose Europe



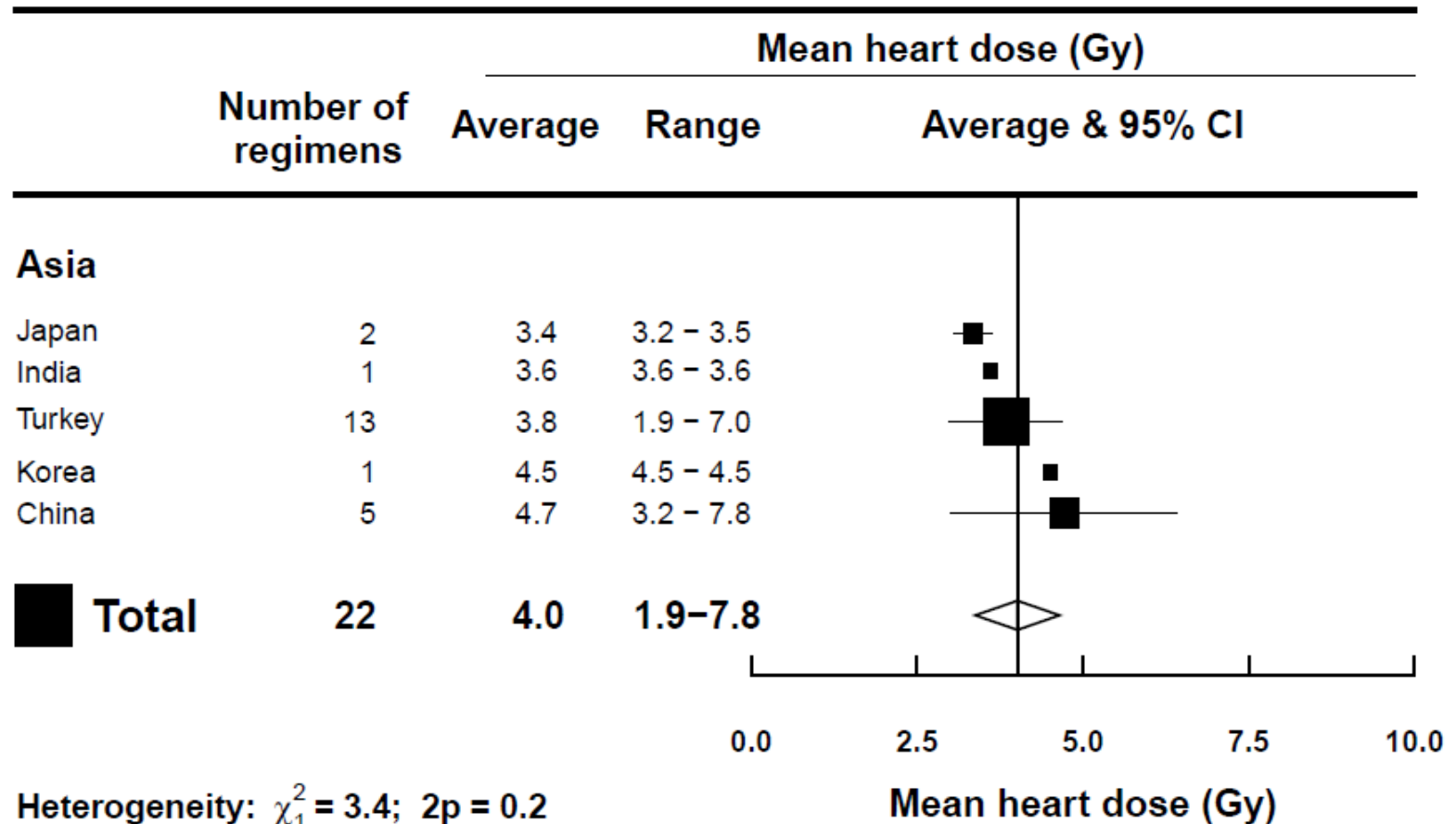
Left tangential breast radiotherapy:

Heart dose North America

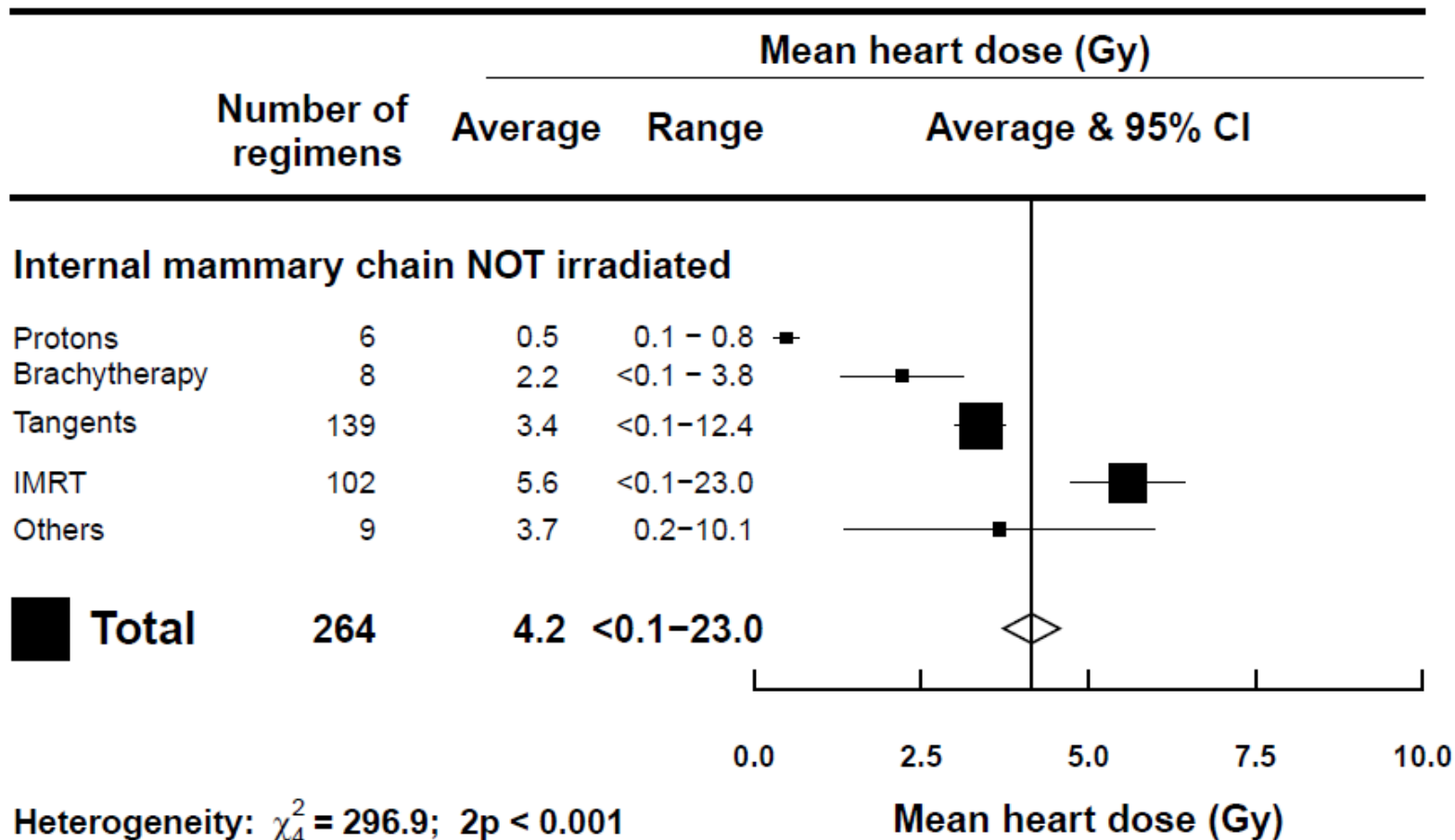


Left tangential breast radiotherapy:

Heart dose Asia

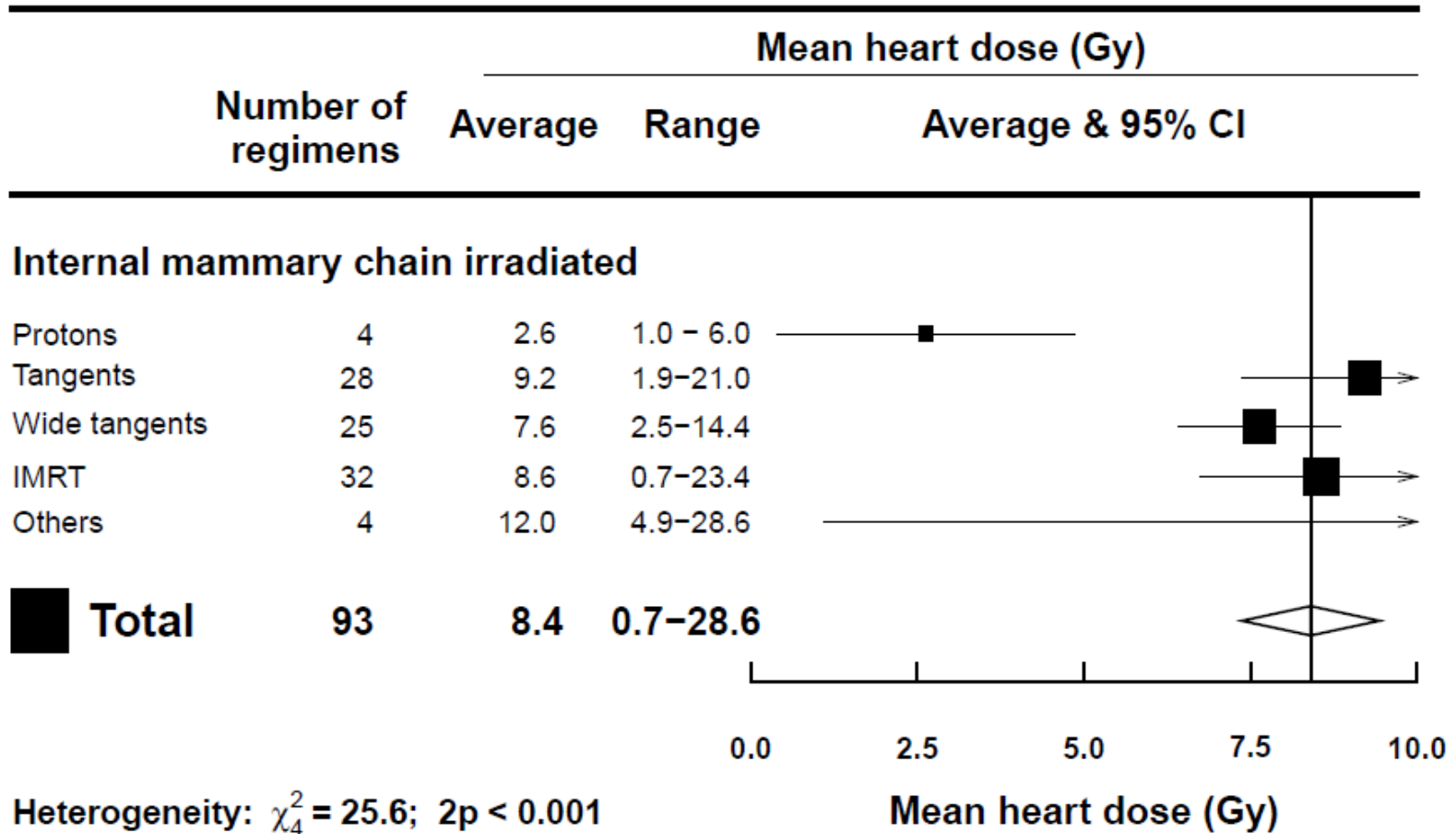


Internal mammary chain NOT irradiated (left) **Heart dose**



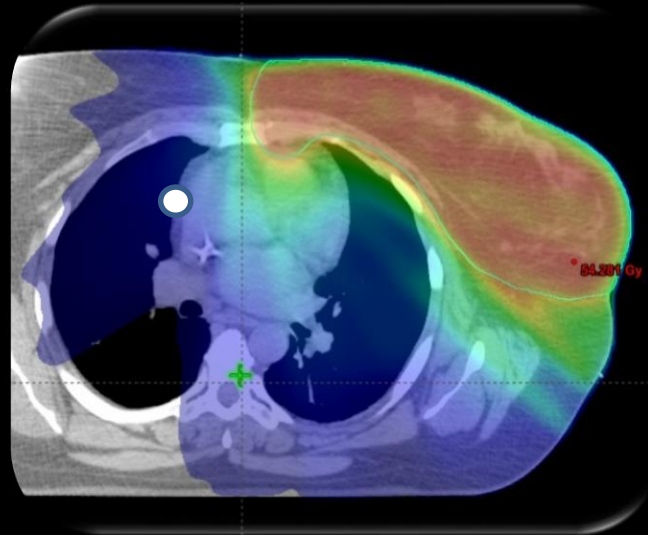
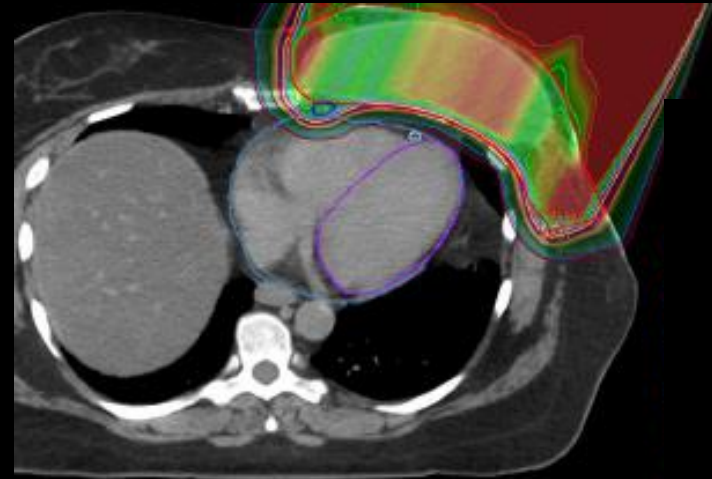
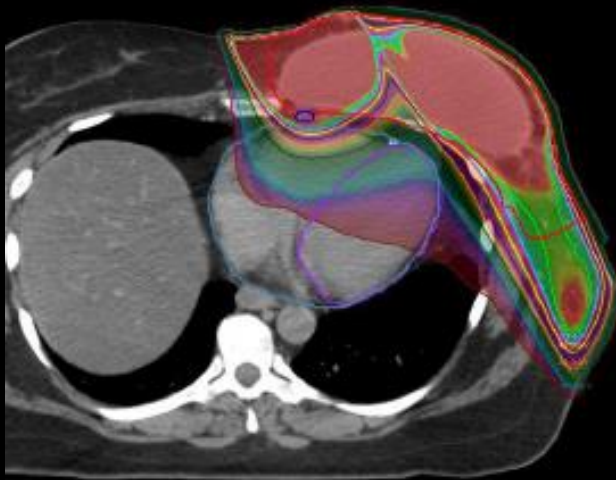
Mean heart dose ~4 Gy

Internal mammary chain irradiated (left) Heart dose



Mean heart dose ~8 Gy

Breast cancer radiotherapy 2010-2015



Whole **heart dose**

Left breast cancer radiotherapy

Year	No. studies	No. regimens	Mean heart dose (Gy)	
			Average	Range
2003-2013	149	398	5.4	<0.1-28.6
2014-2015	71	217	4.9	<0.1-26.0

Late side-effects of breast cancer radiotherapy

1. Main late effects
2. Heart doses modern RT
- 3. Lung doses modern RT**

Systematic review of **lung dose** in breast cancer radiotherapy 2010-2015

Marianne Aznar*

Fran Duane*

Zhe Wang

Sarah Darby

Carolyn Taylor

* Joint first authors

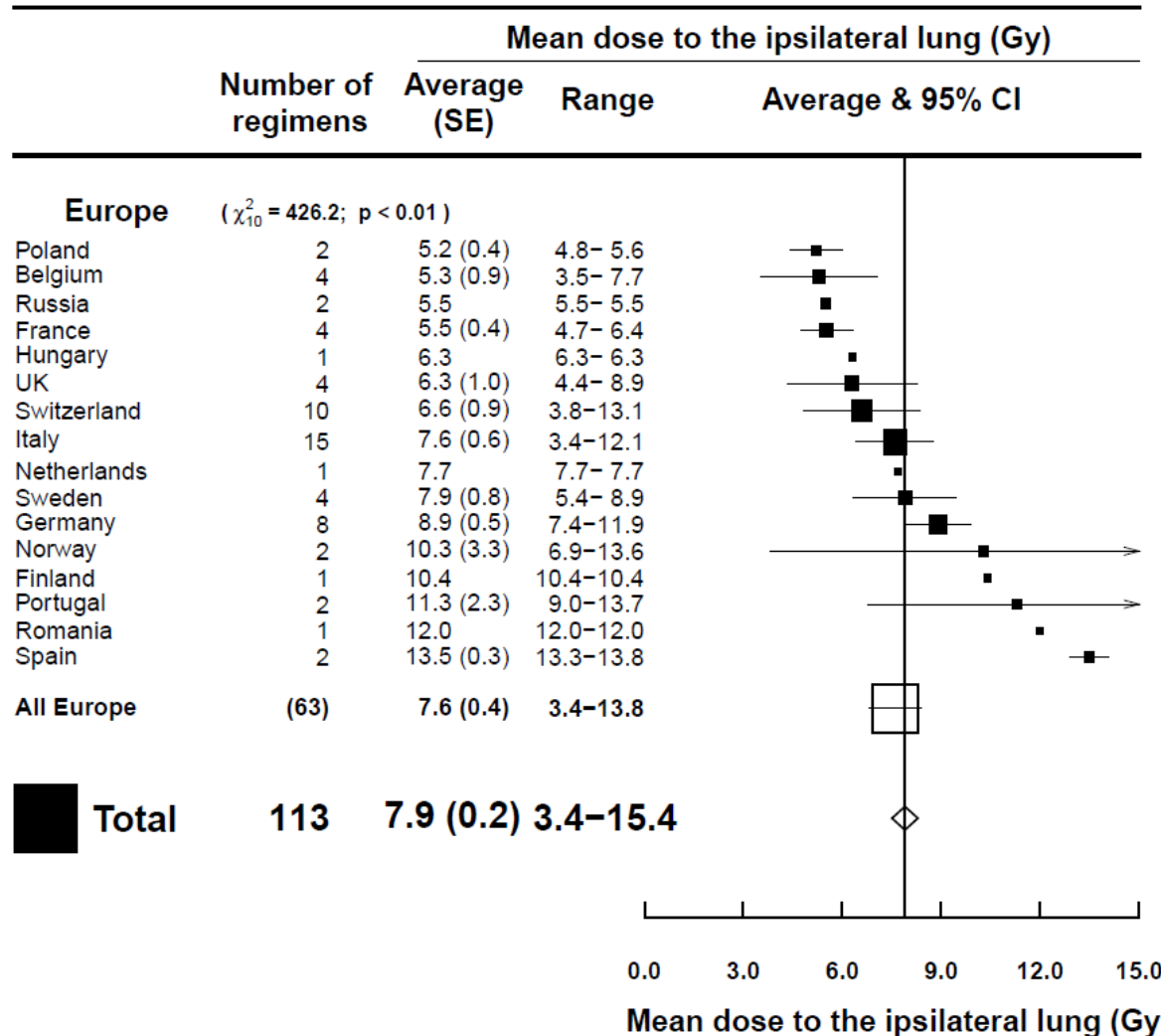
Mean lung dose

Breast cancer radiotherapy 2010-2015

	No. studies	No. regimens	Mean lung dose (Gy)	
			Average	Range
Ipsilateral	153	471	9.0	0.3-27.5
Contralateral	62	218	2.3	0.0-15.0

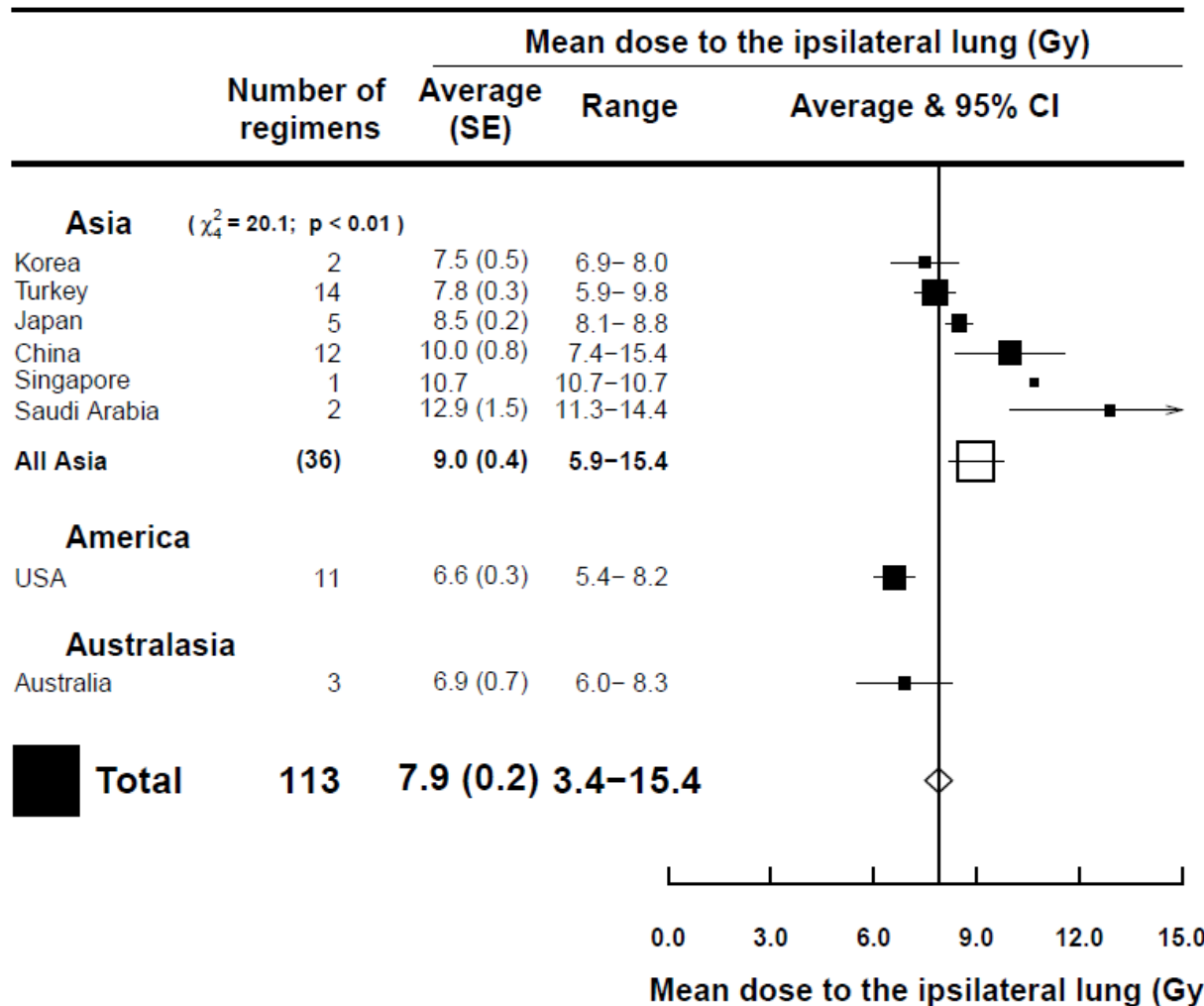
Left tangential breast radiotherapy:

Lung dose Europe

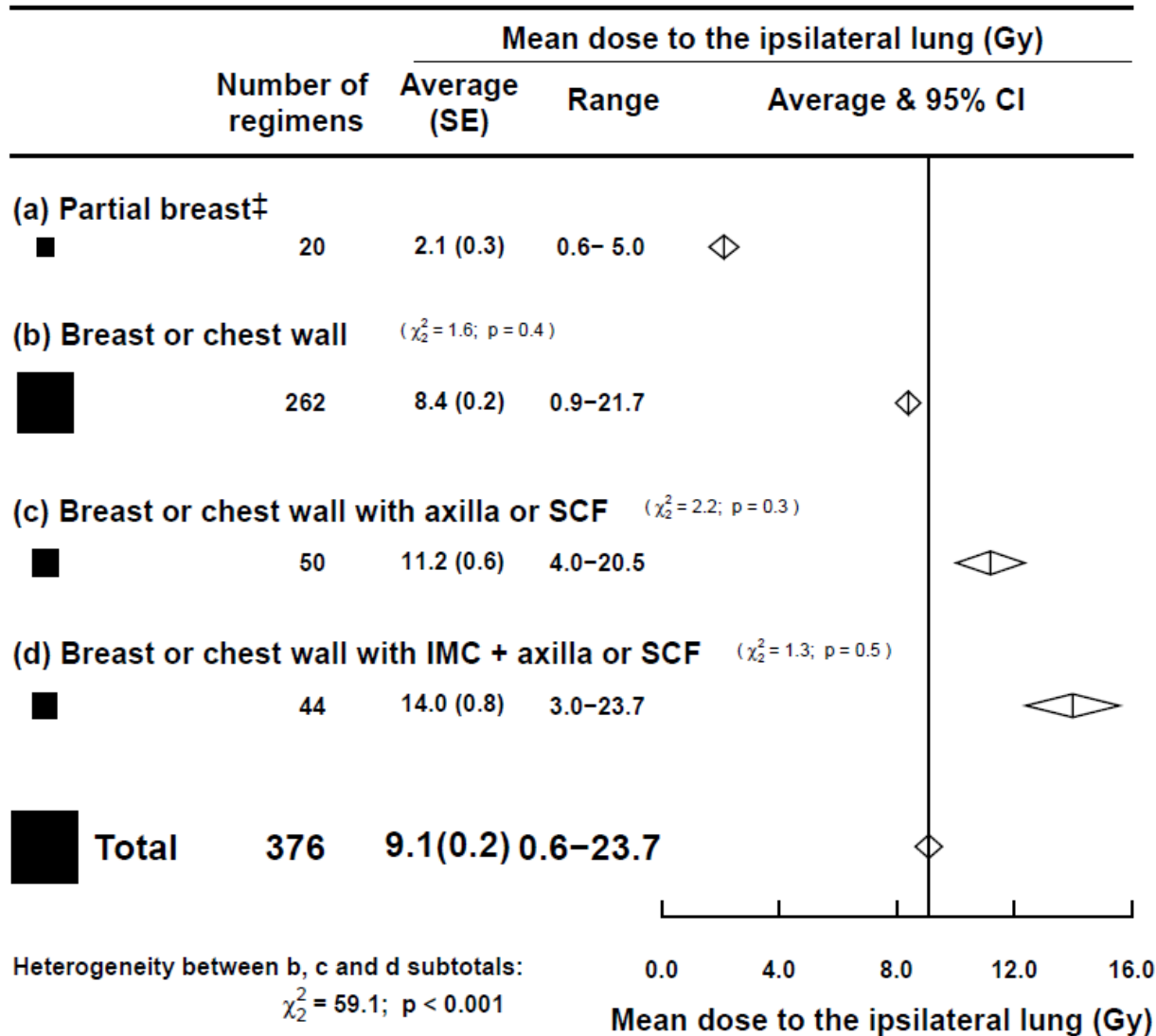


Left tangential breast radiotherapy:

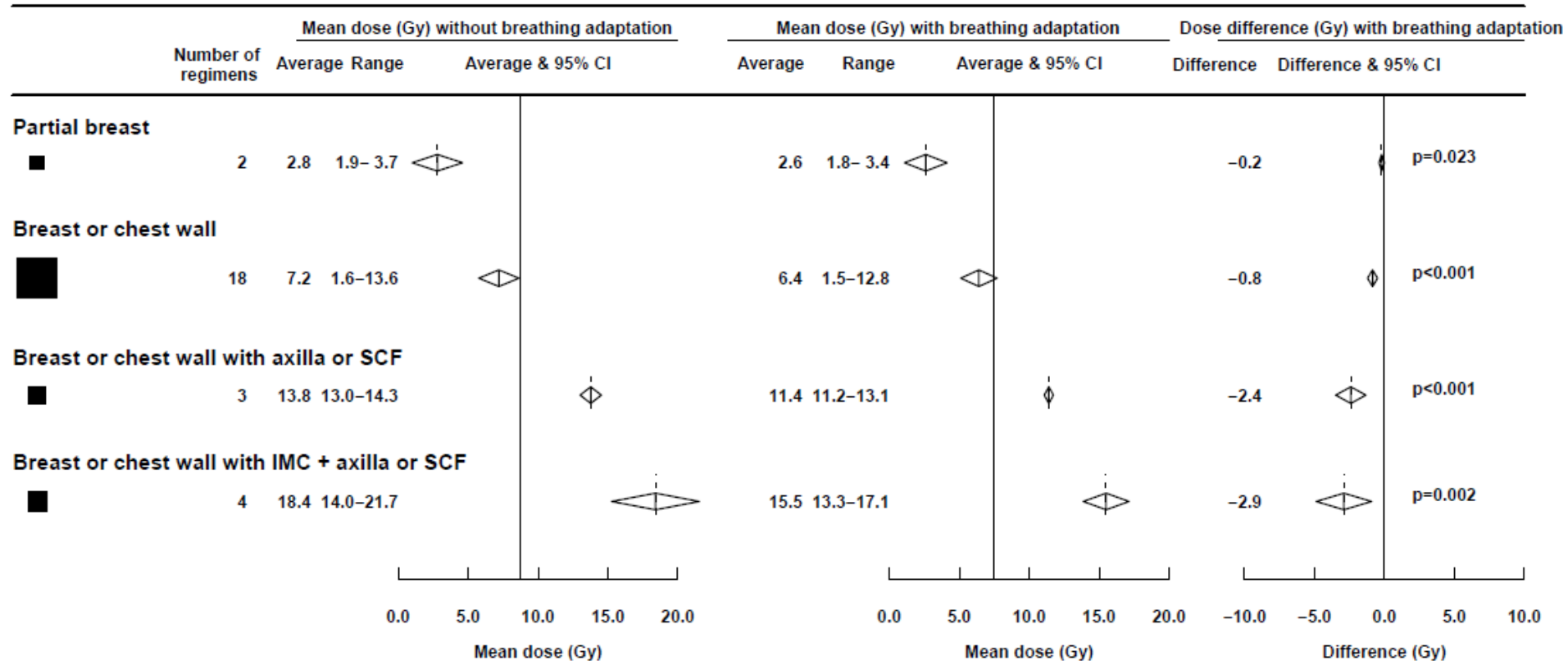
Lung dose Asia, USA, Australasia



Breast cancer radiotherapy, different targets **Lung dose**



Breast cancer radiotherapy, breathing control Lung dose



Benefits and risks of breast cancer radiotherapy

Absolute risks:

Heart disease
Second cancers



Absolute benefit:

Breast cancer
recurrence

Benefits of radiotherapy: Breast cancer mortality

Absolute benefit in women treated
according to current guidelines
a few percent

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Absolute risk in smokers
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The end