Session 2: US and International Variation in Volume and Performance Measures

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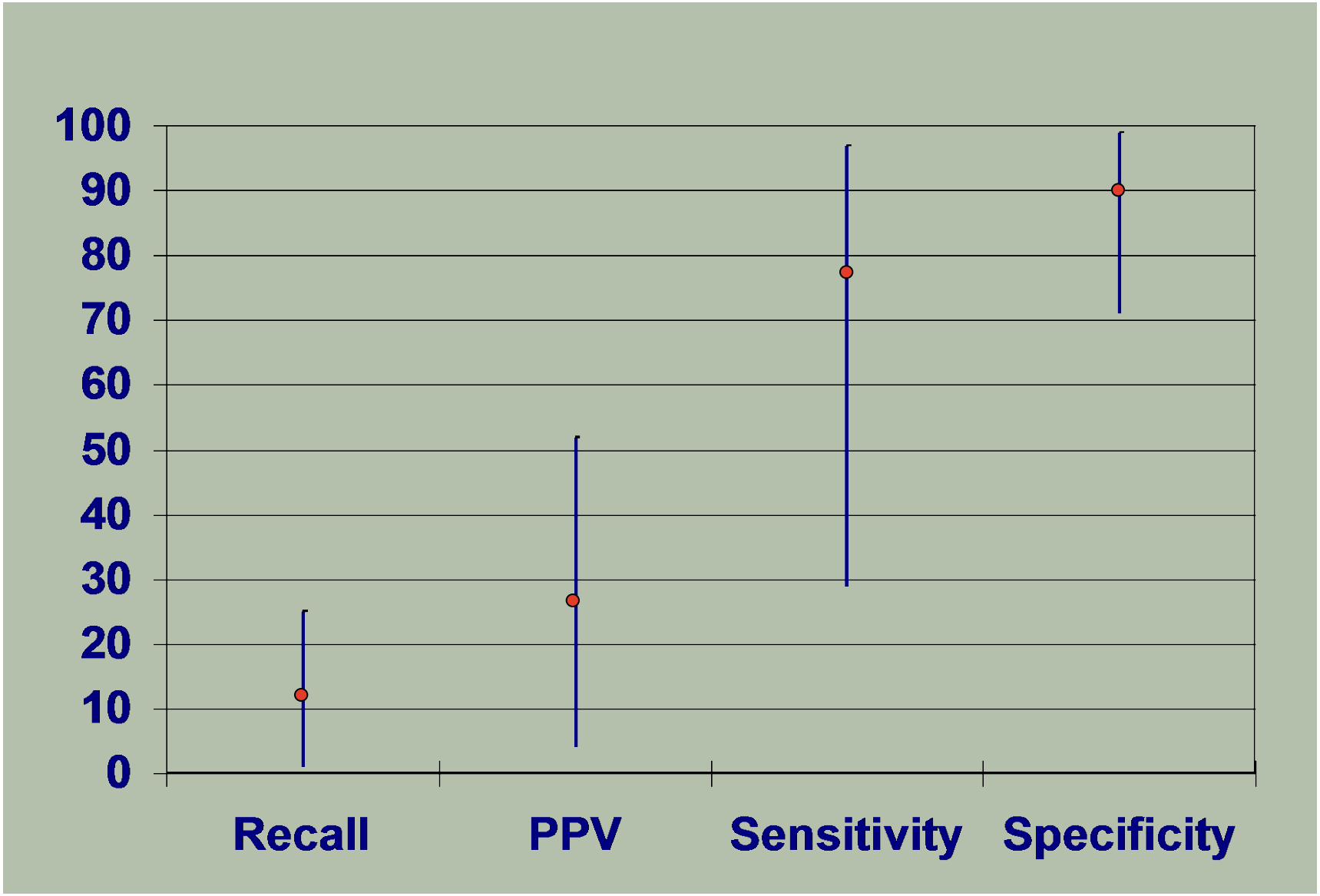
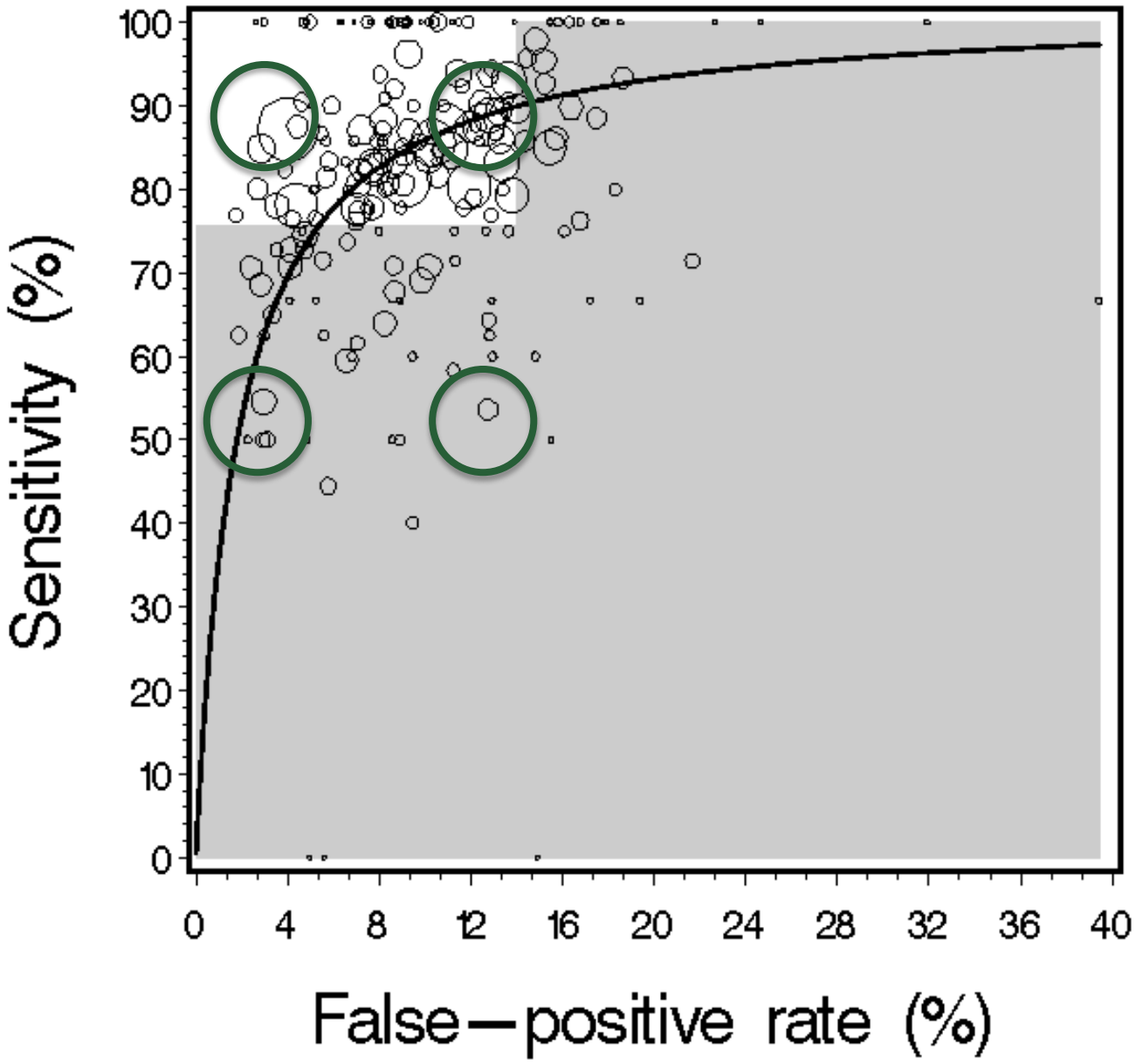
Known: wide interpretive variability in US



Known: high performers on one measure not necessarily high on others



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BCSC
Working together to advance breast cancer research

2005 IOM Report Conclusions:

Extensive variability in mammography interpretation exists among radiologists in the United States.

Interest in understanding reasons for this variability

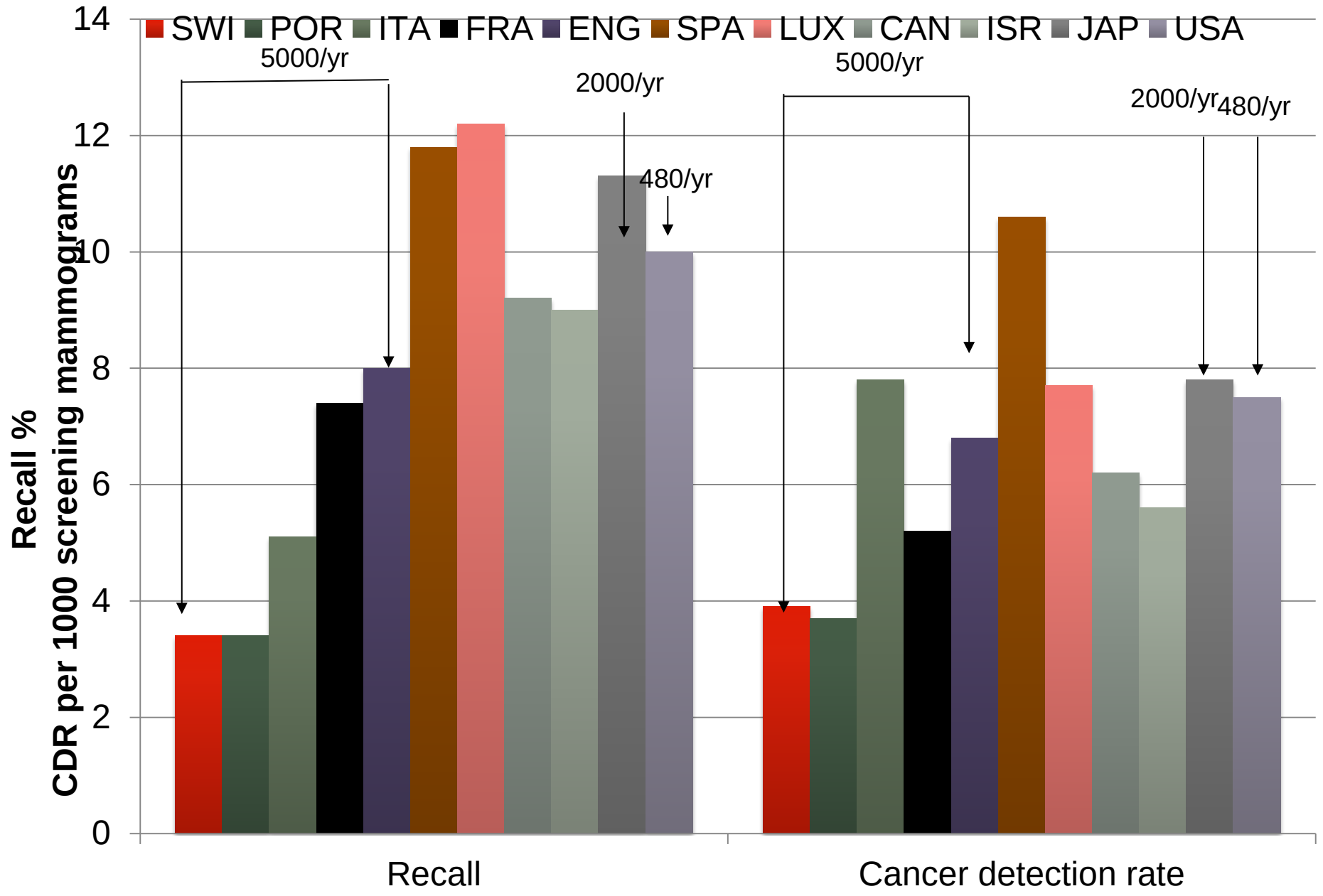
- Patient factors
- Practice and facility characteristics
- Radiologist characteristics
  - Years of experience
  - Training
  - Specialty
  - **Annual interpretive volume**

MQSA interpretation requirements

960 mammograms in last 24 months

What can we learn from other countries?

International mammography performance variability by minimum annual volume



Possible reasons for international variation

- US:
  - Generalized not organized screening programs
  - Shorter screening interval
  - Screening starts younger & goes to older ages
  - Legal differences
  - Radiologist's incentives
    - >66% of radiologists do some breast imaging
    - Not most lucrative
- Different reading/interpretation practices
  - Double reading
  - Centralized reading
  - Higher volume – more specialized
- Different volume requirements and quality standards
  - Under-performing programs and MDs reviewed
  - Physicians take biennial exams – voluntary

Interpretive volume and sensitivity

Study	Country	Years	Volume categories (min, max)	
			Total Volume	Screening Volume
Théberge 2014	Canada	2000-2006	< 250, ≥ 2 500	500-999, ≥ 4 000
Buist 2011	USA	2002-2006	< 480, ≥ 5 000	< 480 , ≥ 3 000
Duncan 2011	Scotland	2006-2009		< 5 000, > 8 333
Elmore 2009	USA	1998-2005	≤ 1 000, > 2 000	
Woodard 2007	USA	1996-2001	≤ 1 000, > 2 000	
Smith-Bindman 2005	USA	1995-2000	480-750, > 4 000	
Barlow 2004	USA	1996-2001		≤ 1 000, > 2 000

Statistical significant association
Not statistical significant association

Interpretive volume and false-positive rates

Study	Country	Years	Volume Categories (min, max)	
			Total Volume	Screening Volume
Théberge 2014	Canada	2000-2006	< 250, ≥ 2 500	500-999, ≥ 4 000
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Cornford 2011	UK	2005-2008		< 5 000, ≥ 8 333
Duncan 2011	Scotland	2006-2009		< 5 000, > 8 333
Elmore 2009	USA	1998-2005	≤ 1 000, > 2 000	
Woodard 2007	USA	1996-2001	≤ 1 000, > 2 000	
Coldman 2006	Canada	1998-2000		480-699, ≥ 5 000
Tan 2006	USA	1998-1999	≤ 200, ≥ 560	
Smith-Bindman 2005	USA	1995-2000	480-750, > 4 000	
Théberge 2005	Canada	1998-2000		< 250, ≥ 1 500
Barlow 2004	USA	1996-2001		≤ 1 000, > 2 000
Kan 2000	Canada	1994-1997		< 2 000, 4 000-5 199

Statistical significant association: lower volume = higher FPR
Other statistical significant association
Not statistical significant association

5 / 12 | 2 / 12 | 5 / 12

Why conflicting study findings across countries & within?

- Volume measurements – self-report vs. comprehensive volume pooled across facilities
- Outcomes – what is optimal accuracy?
  - Carney *Radiology* 2013, Miglioretti *AJR* 2015
- Statistical modeling Miglioretti *Academic Radiology* 2009
  - Conditional/cluster-specific
  - Marginal/population-averaged

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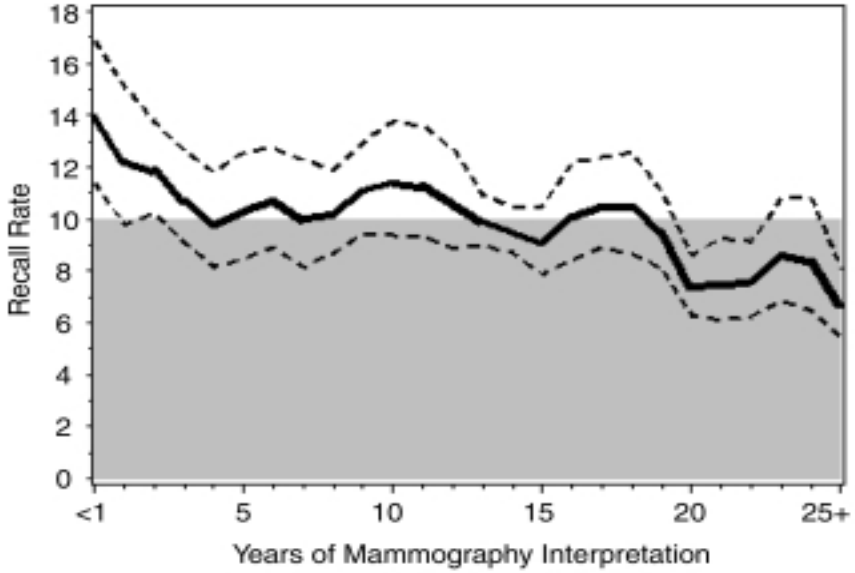
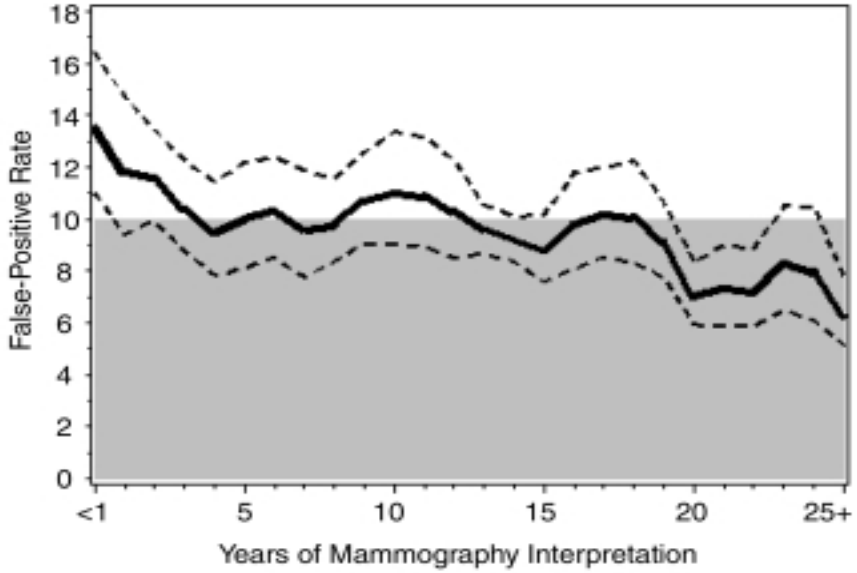
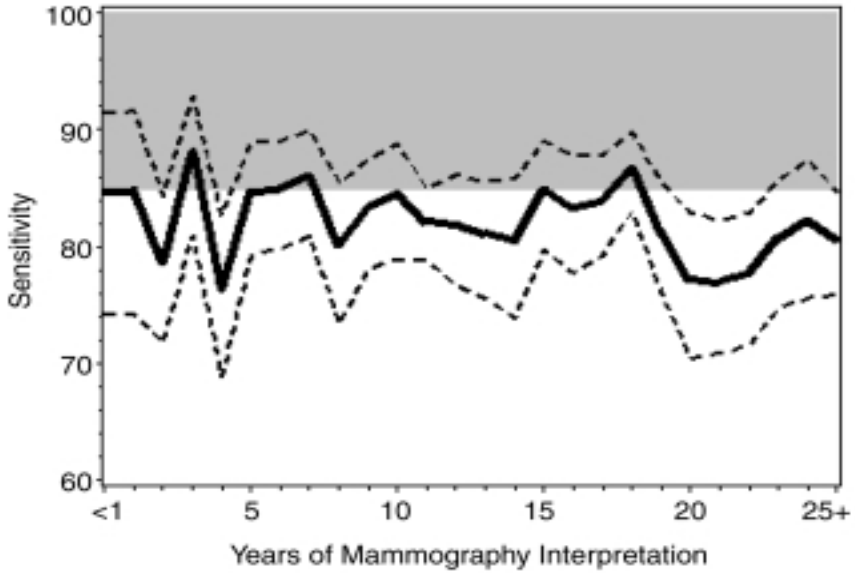
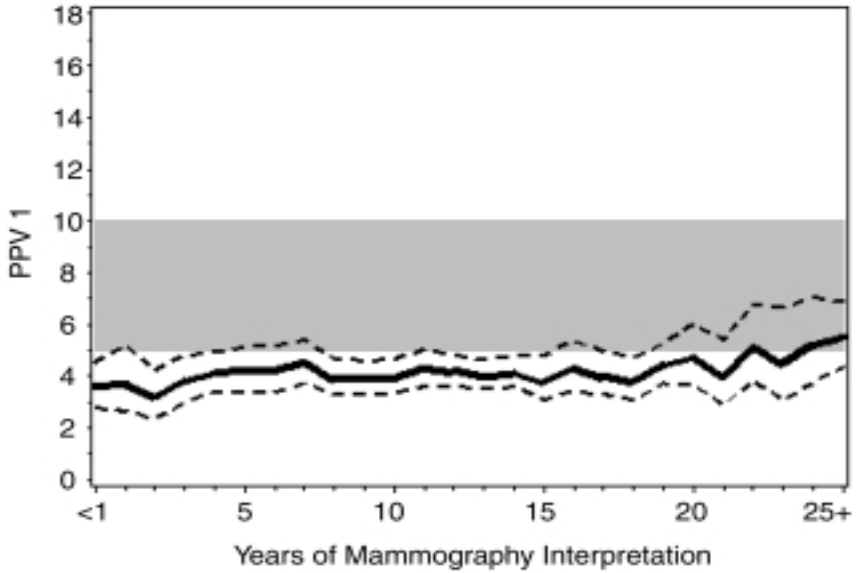
  - Training
  - Specialty
  - Annual interpretive volume

Experience matters: average performance by years of experience
AHRQ desirable goals for screening mammography (shaded)









Miglioretti *Radiology* 2009

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Volume-Performance relationships within the Breast Cancer Surveillance Consortium

Volume measures:

- screening
- diagnostic
- total
- % screening/total

BCSC Radiologists

- 6 BCSC registries (San Francisco, North Carolina, New Hampshire, Vermont, Washington State, New Mexico)
- Radiologists who interpreted screening mammograms between 2005-2006 (N=214)
- Collected comprehensive volume measures from all facilities interpreted in between 2001-2005
- Final sample: 120 Radiologists (average 4 years of volume measures) for a total of 481 reader-years
  - 91% radiologists only interpreted in BCSC facilities

Volume definitions

Annual volume for each volume measure

Primary reader only

Screening volume

- Routine views only
- Screening + diagnostic views on same day by same reader

Diagnostic volume (SIFU, additional evaluation & symptomatic)

- Diagnostic views only
- Screening + diagnostic views on same day by same reader

Total

- Routine views
- Diagnostic view
- Screening + diagnostic views on same day by same reader

% screening/total

Outcomes measures

Linked annual volume measures to performance in the following year

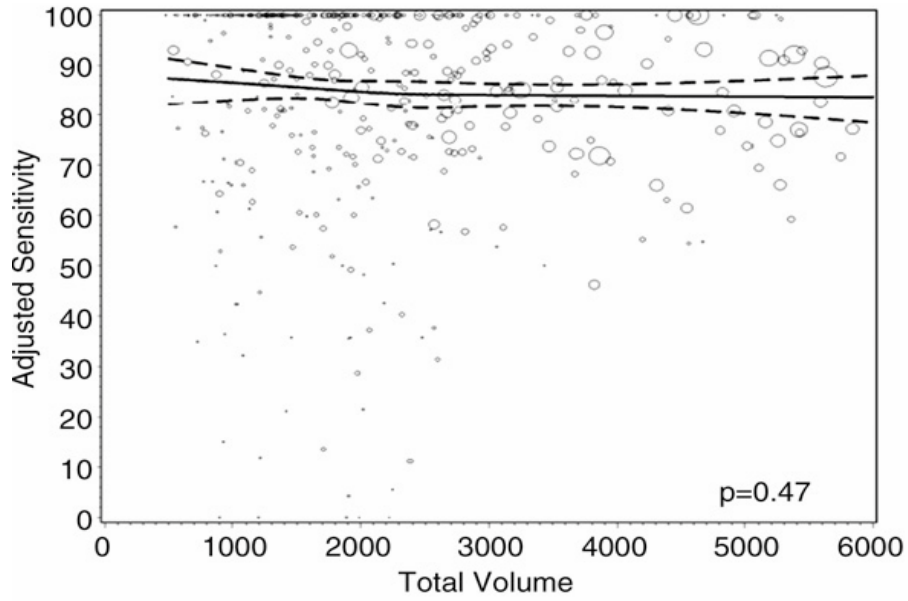
Performance measures:

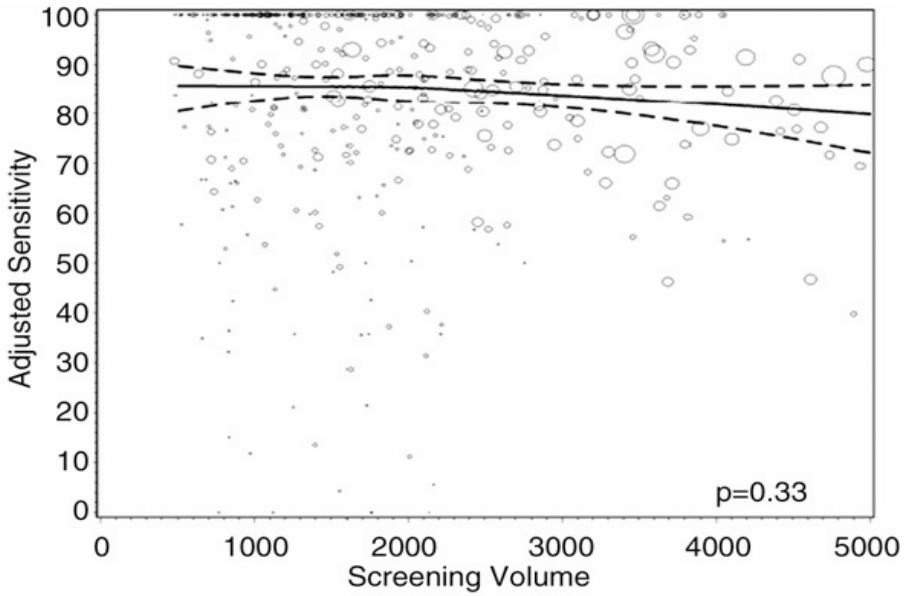
- Sensitivity
- False positive rate
- Cancer detection rate per 1000 screening mammograms
- Number of women recalled per cancer detected

All data shown adjusted for: age, time since last mammogram,

Buist *Radiology* 2011

Sensitivity





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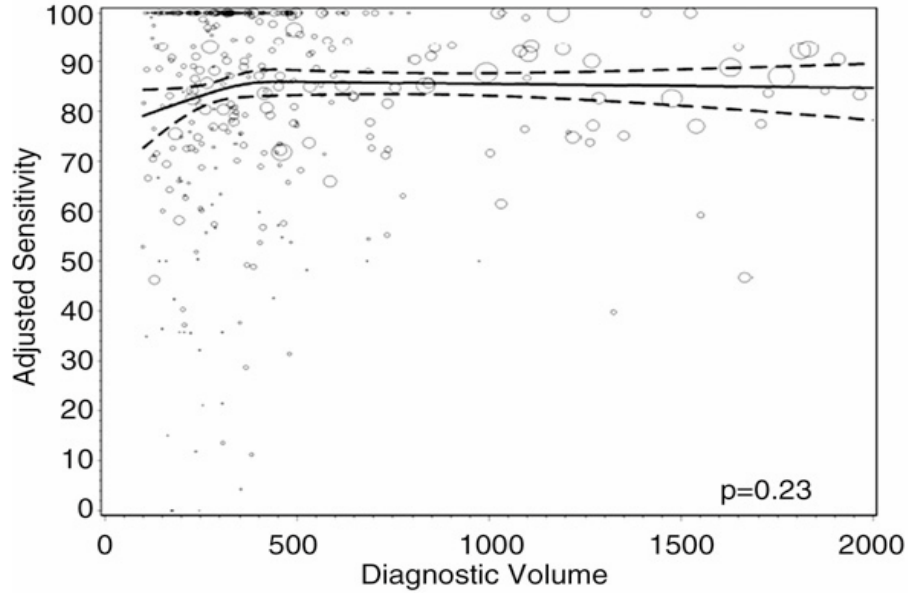

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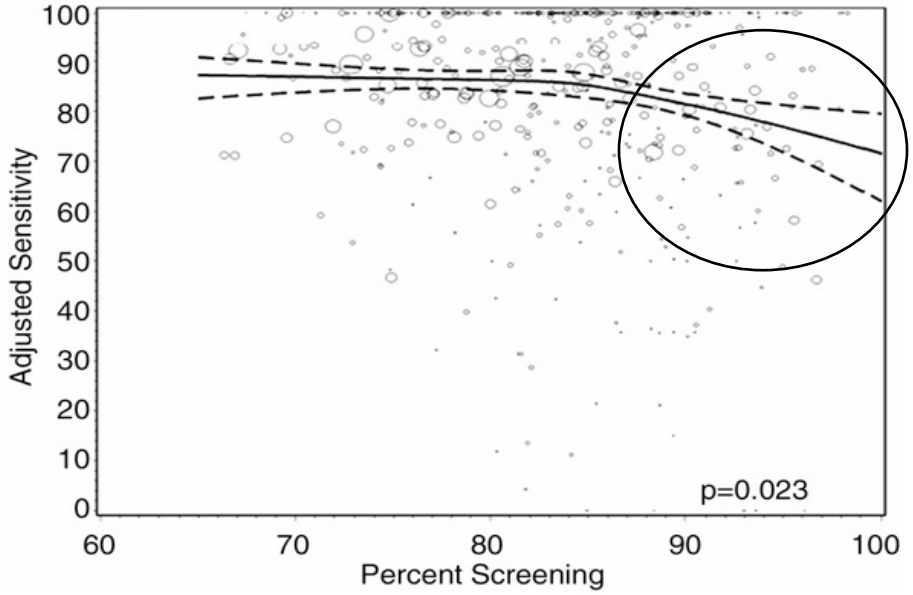
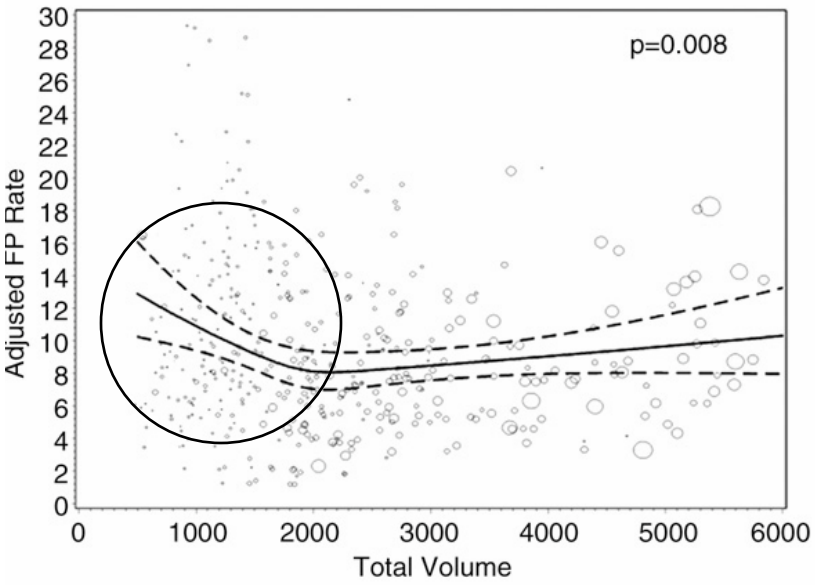
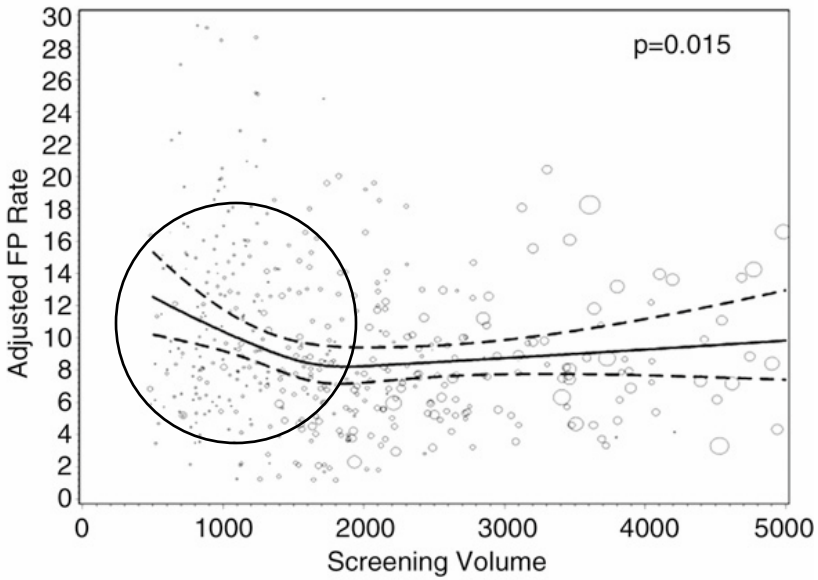


Buist *Radiology* 2011

False positive rate





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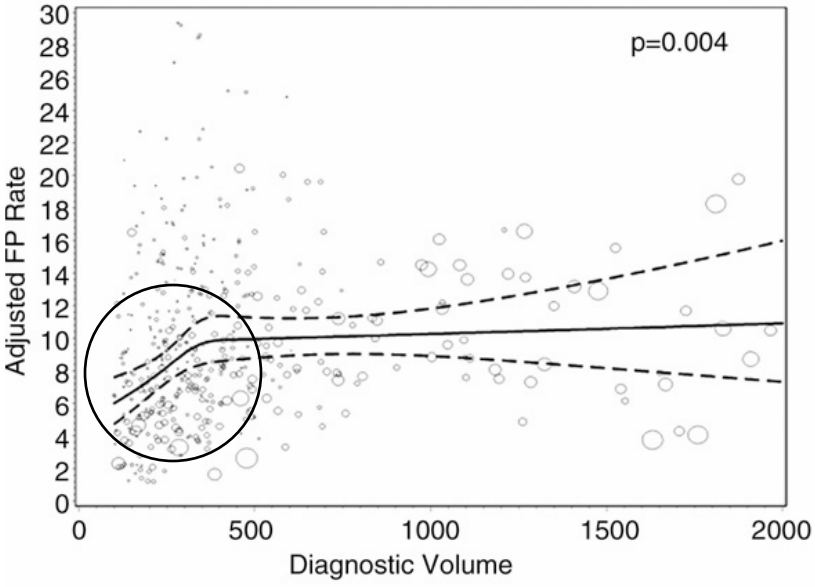

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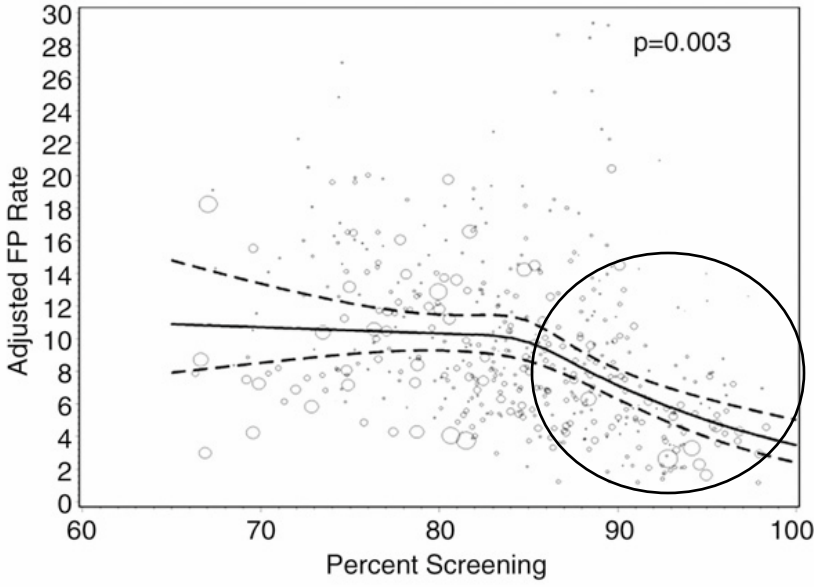
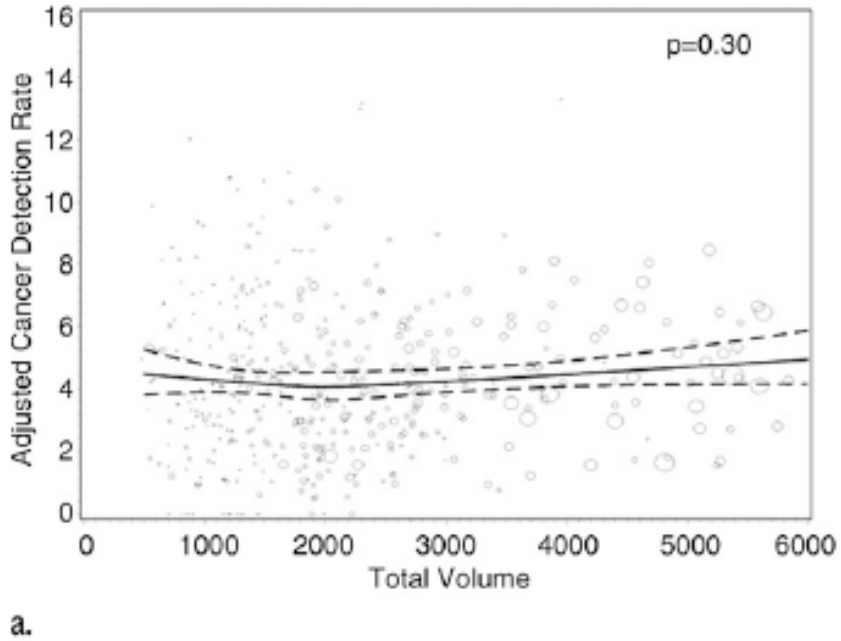


Buist *Radiology* 2011

Cancer detection rate



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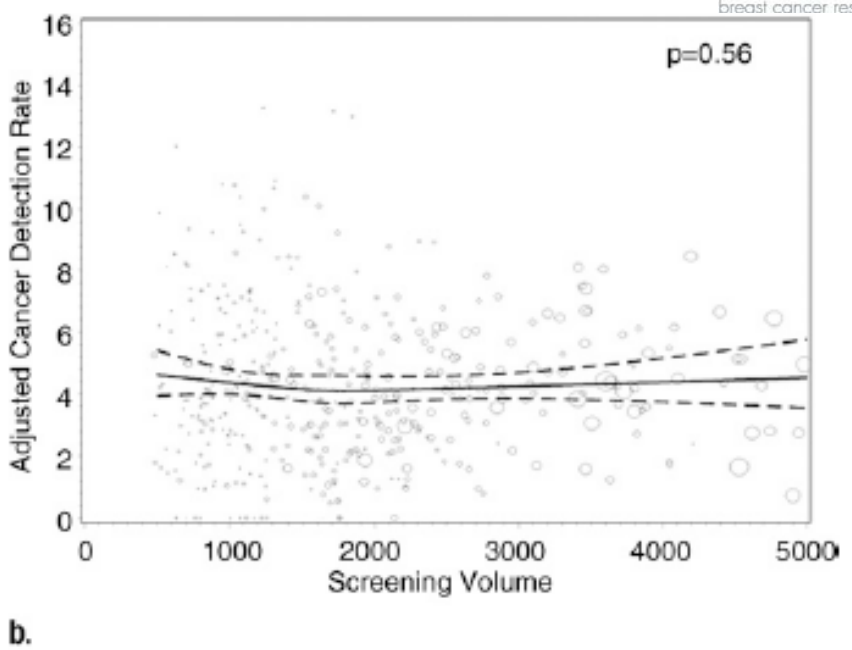

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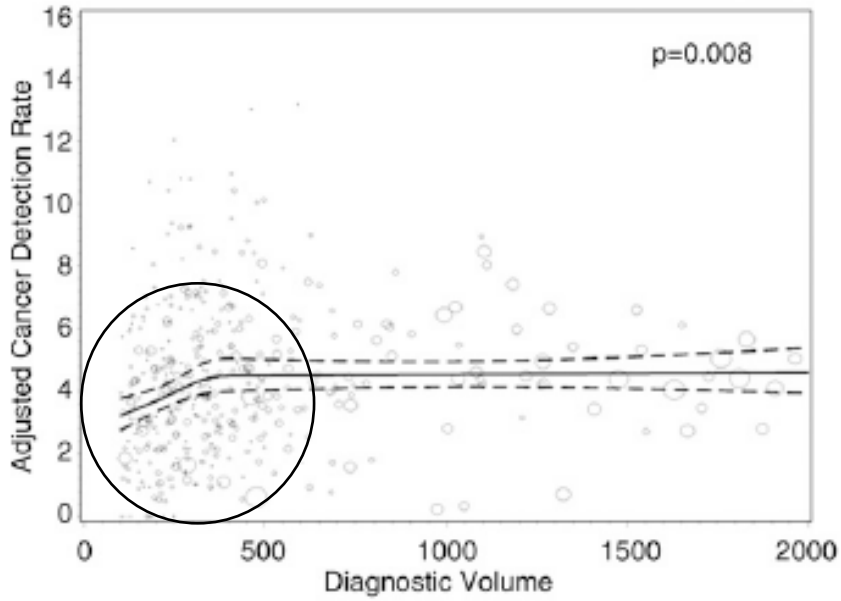

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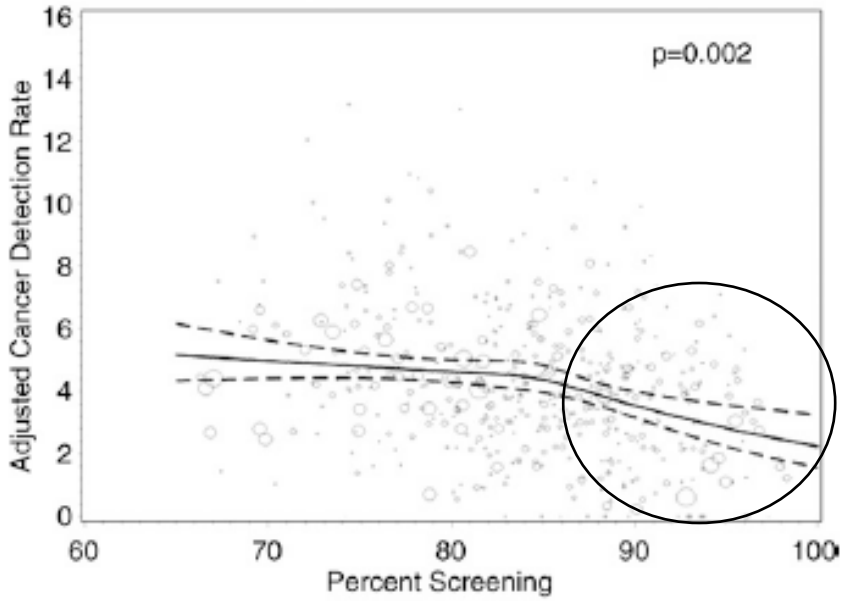

d.

Buist *Radiology* 2011

Screening performance advances in knowledge

- Higher false positives with lower volumes (screening, diagnostic and total)
- Significantly lower cancer detection with low diagnostic volume and high % screening
- Significantly lower sensitivity with high % screening focus

Policy implications: Screening performance unlikely to be affected by volume alone balance in the interpreted examination composition

Diagnostic performance

Much less research on diagnostic performance

Want to weigh screening and diagnostic performance

- Subset of prior BCSC study
- 107 radiologists; 117,136 diagnostic mammograms (98,677 women)
  - 46,269 additional imaging
  - 70,767 symptomatic evaluation
- All analyses evaluated by exam indication

Diagnostic performance advances in knowledge

- No consistent association between total, screening and diagnostic volume and diagnostic performance
- False-positive rates were highest among radiologists who did interpreted <20% as diagnostic
- **Policy implications**: Diagnostic volume is a key determinant in developing thresholds for considering a diagnostic mammogram to be abnormal

Further exploration of composition of interpretive volume

- Volume did not explain much of the observed inter-radiologist variability in screening or diagnostic performance
- ***Composition of interpretive volume*** was the most important factor influencing screening and diagnostic performance

Does performance improve from working up your own recalled screening exams or just any diagnostic exams?

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Working together to advance breast cancer research

What type of diagnostic work-up matters more?

Own

of radiologists' own recalled screening exams with diagnostic work up within 60 days

	annual ave	% distribution
Low	<25	38%
Med	26-50	24%
High	>50	39%

Any

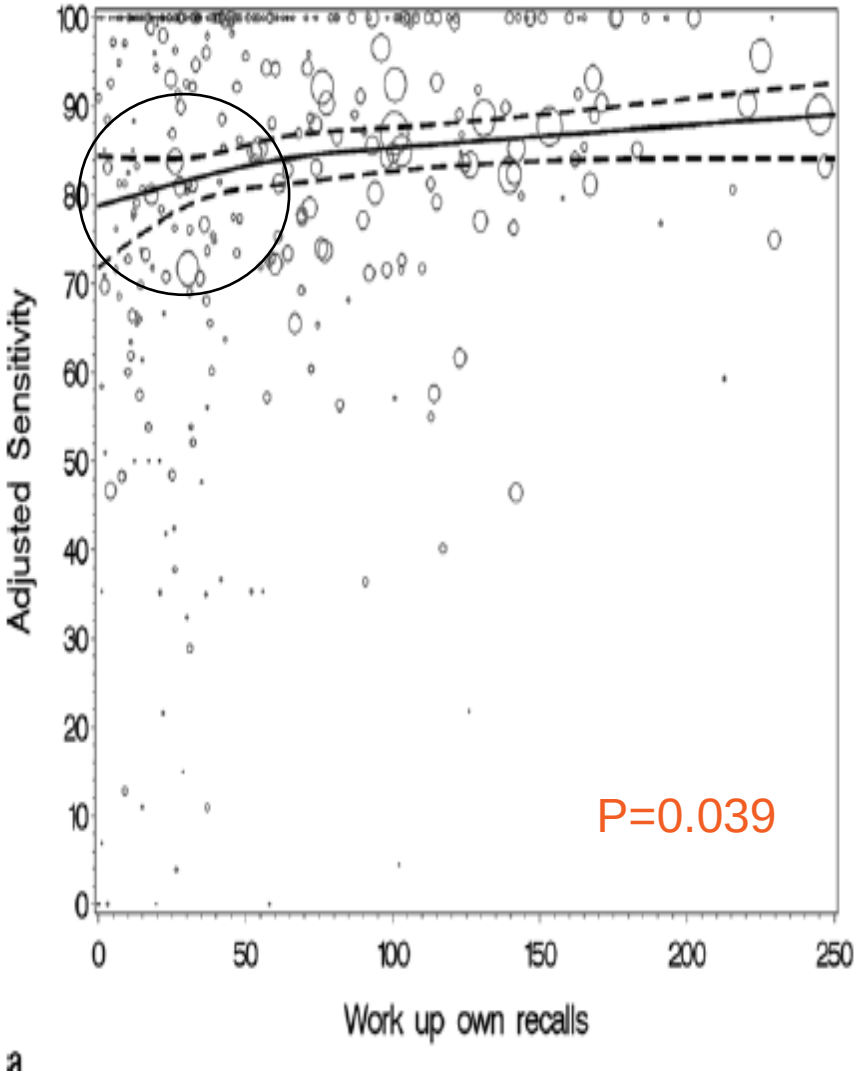
of any recalled screening exam regardless of who recalled

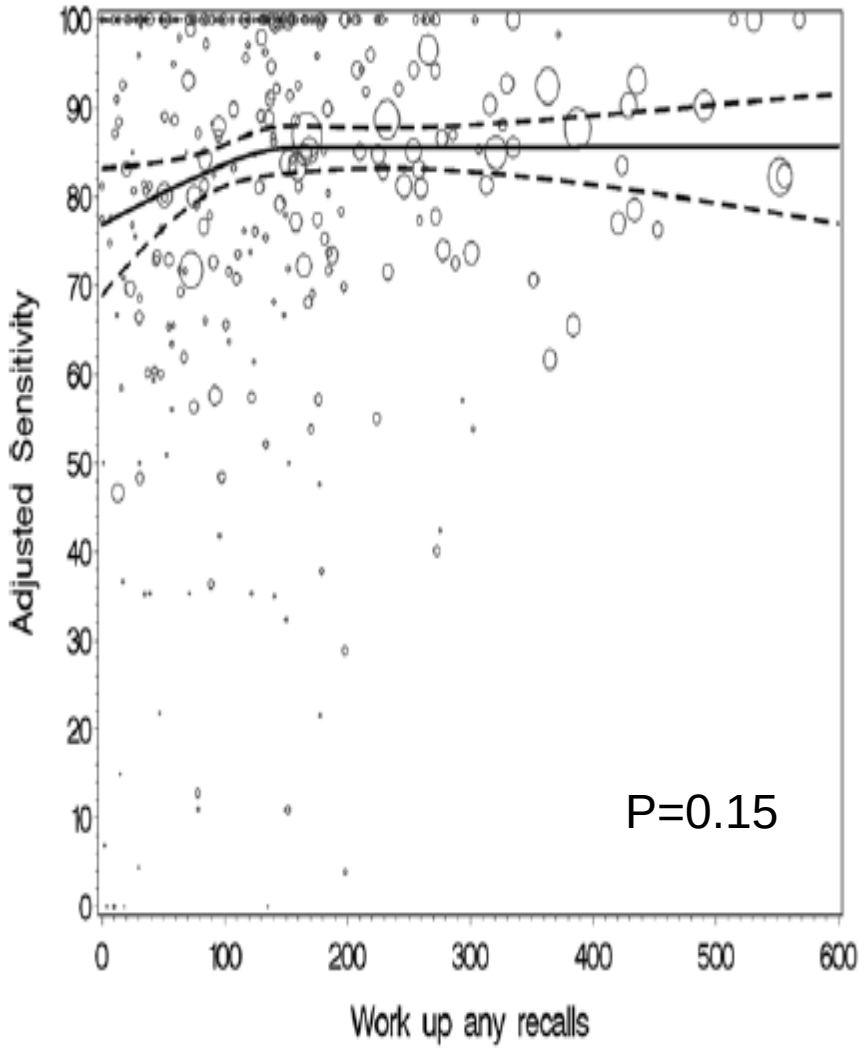
	annual ave	% distribution
Low	<50	24%
Med	51-125	32%
High	>125	44%

These are different measures
Pearson's correlation= 0.49

Buist *Radiology* 2014

Sensitivity by number of work-ups



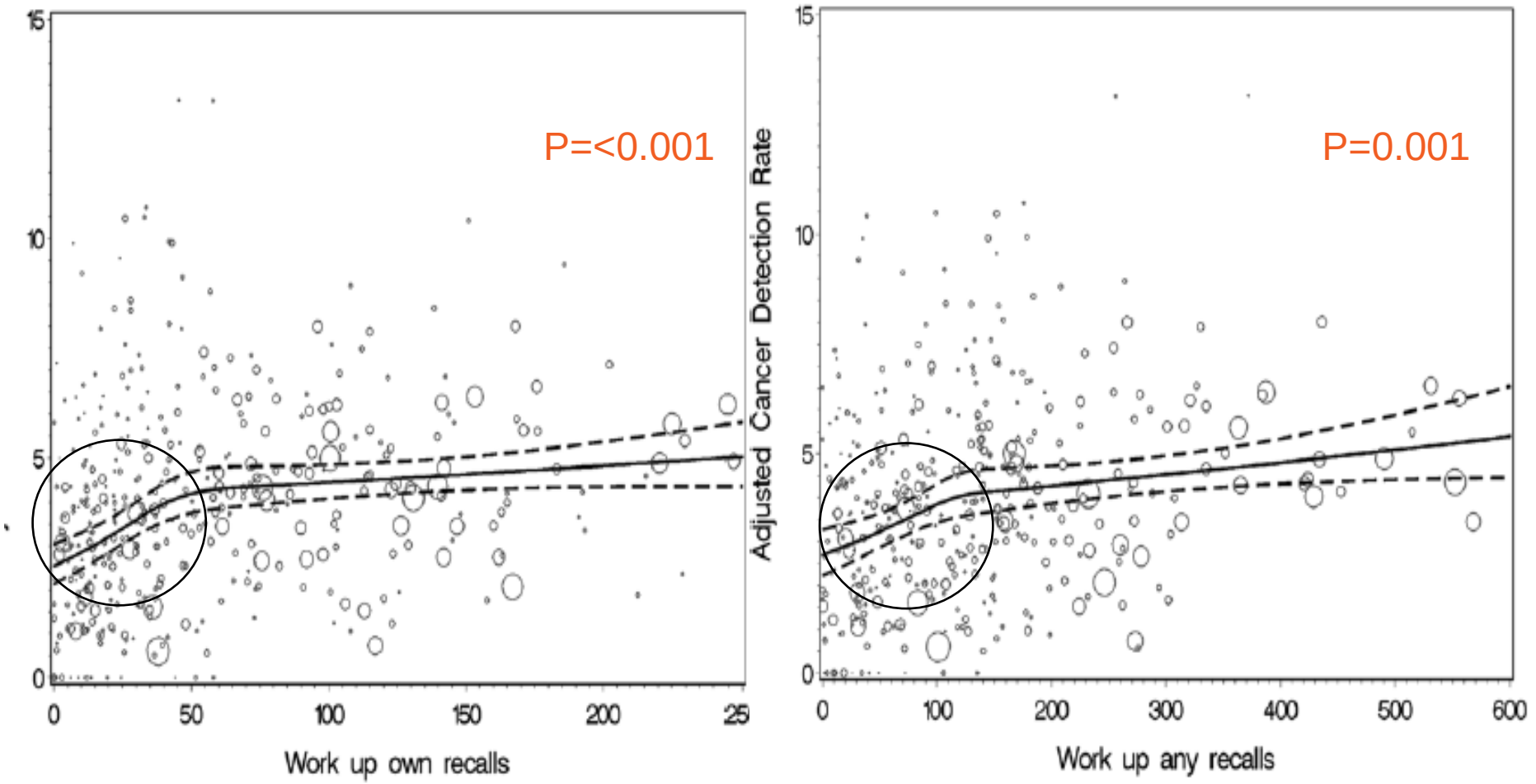


OWN

ANY

Buist *Radiology* 2014

Cancer detection rate by number of work-ups



OWN

ANY

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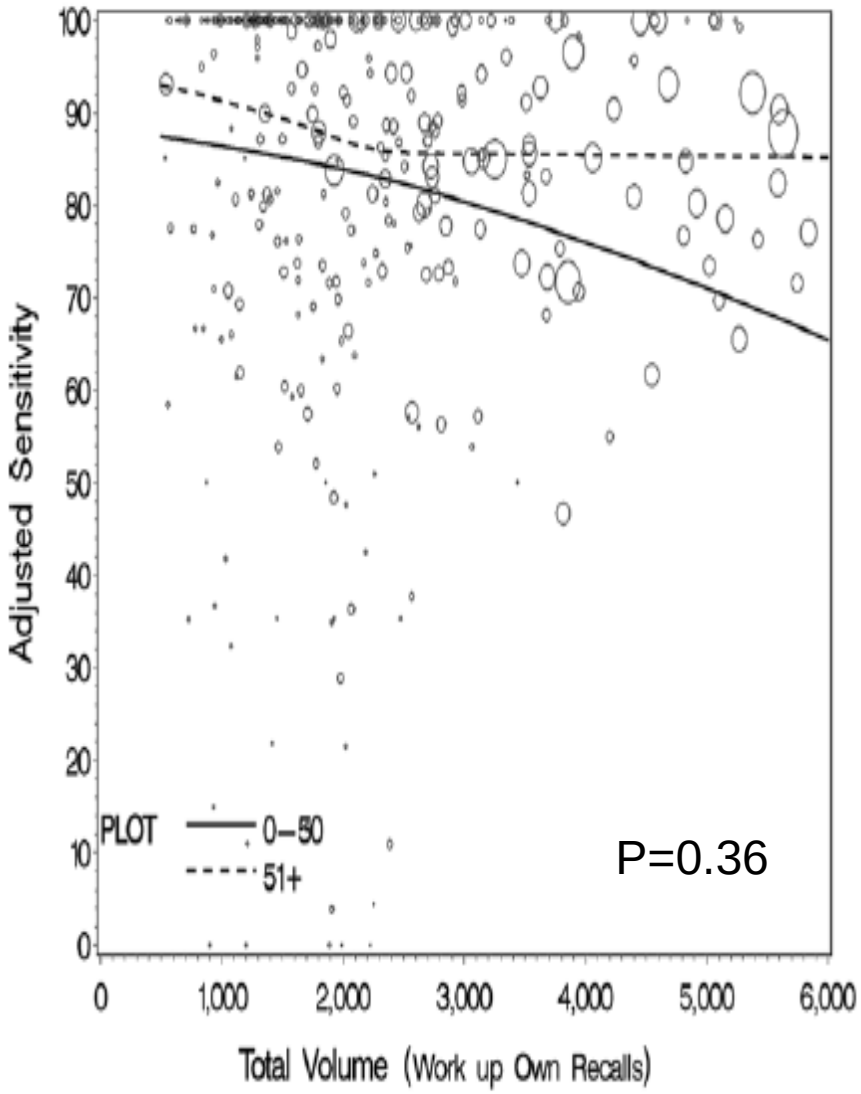
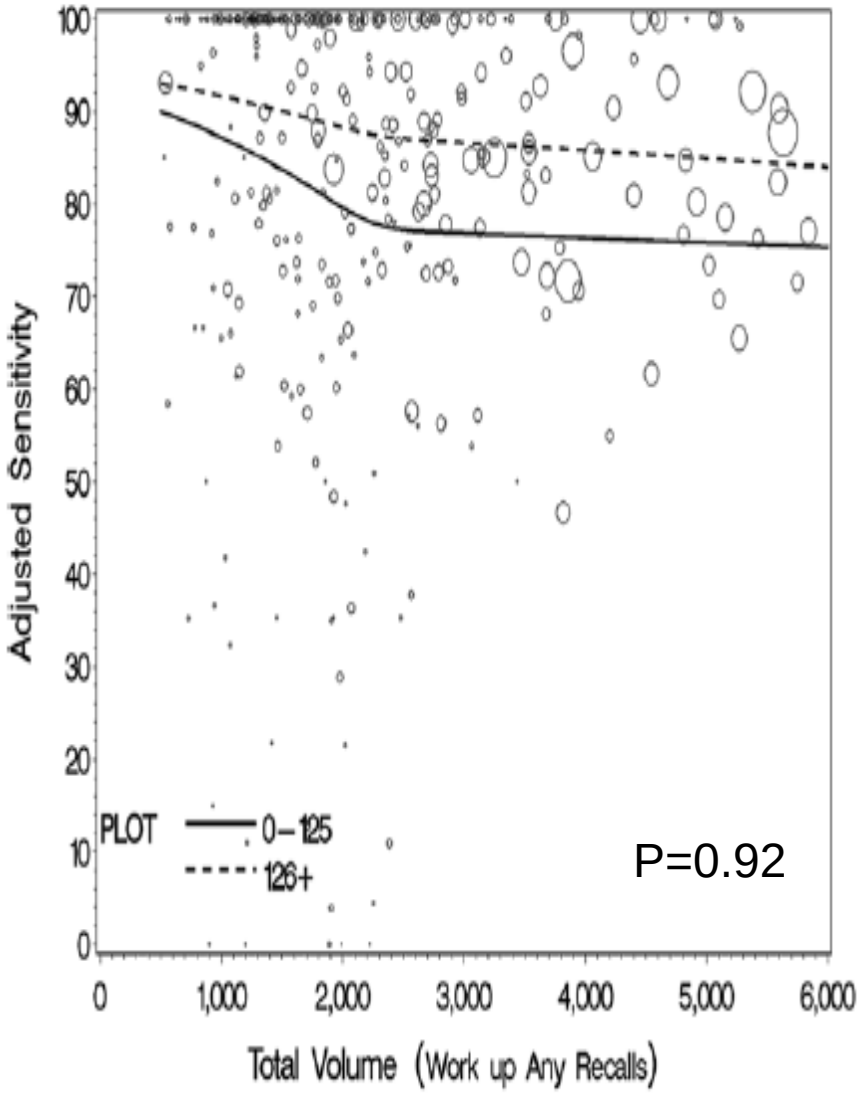
Sensitivity by total volume stratified by number of work-ups – low (solid), high (dashed)





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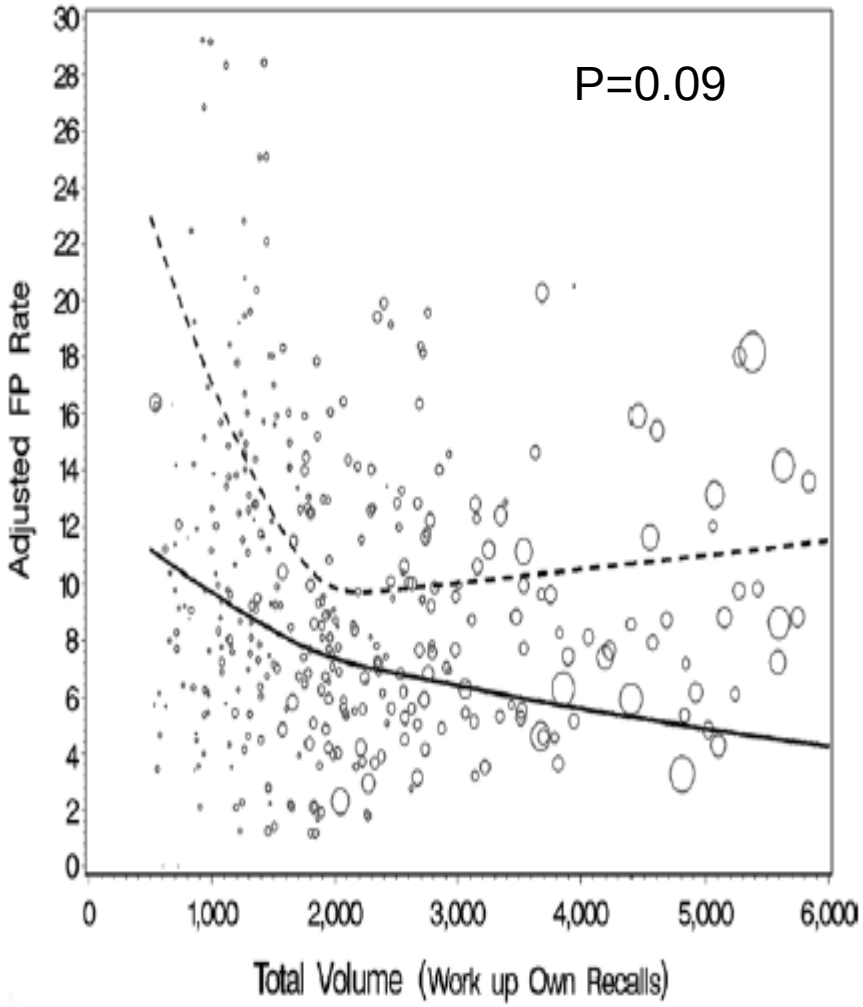
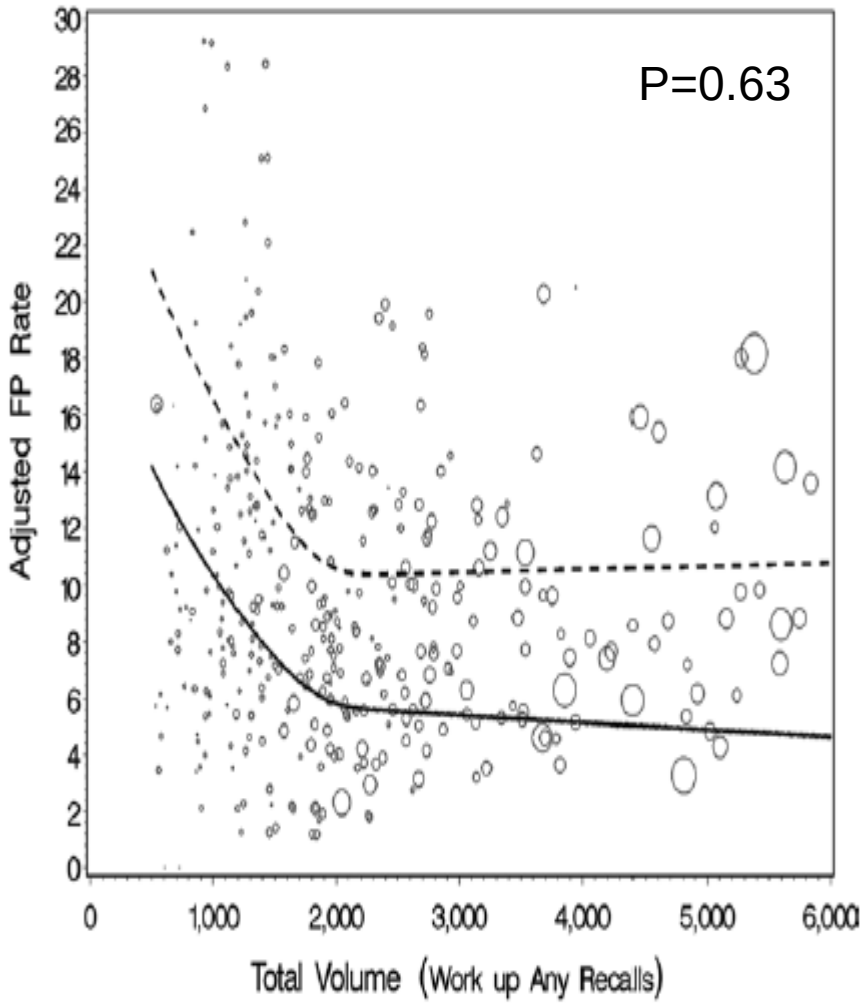
False-positive rate by total volume stratified by number of work-ups – low (solid), high (dashed)





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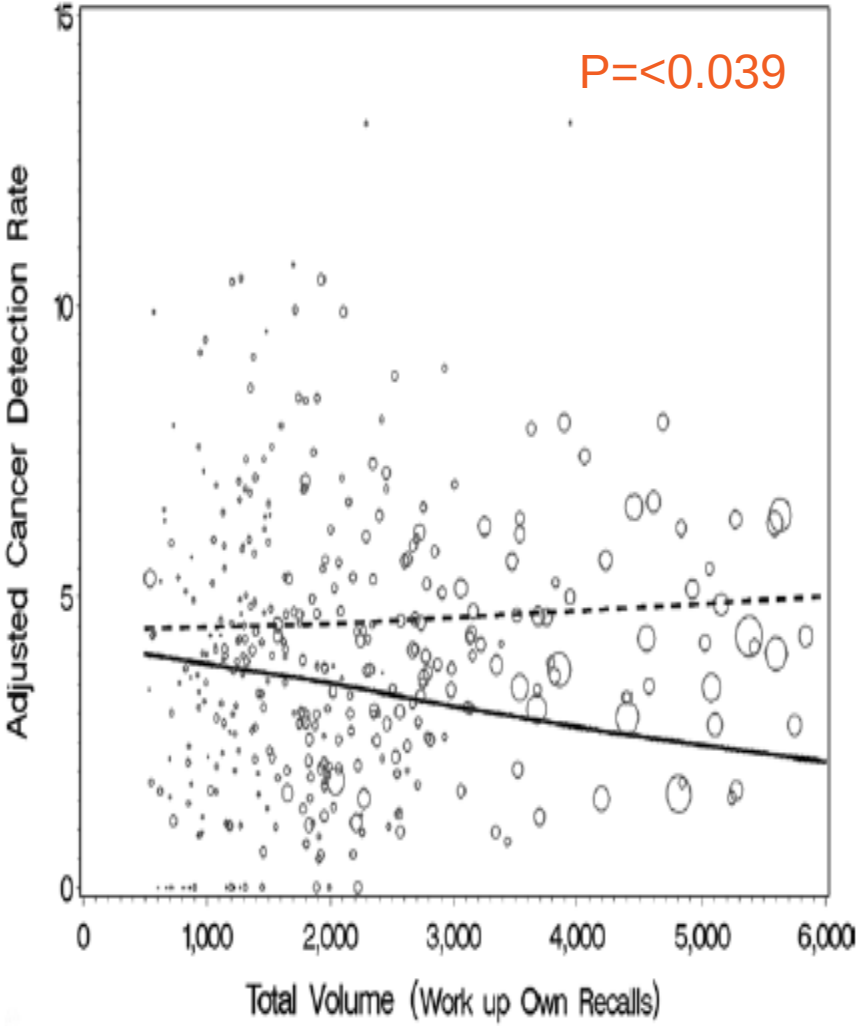

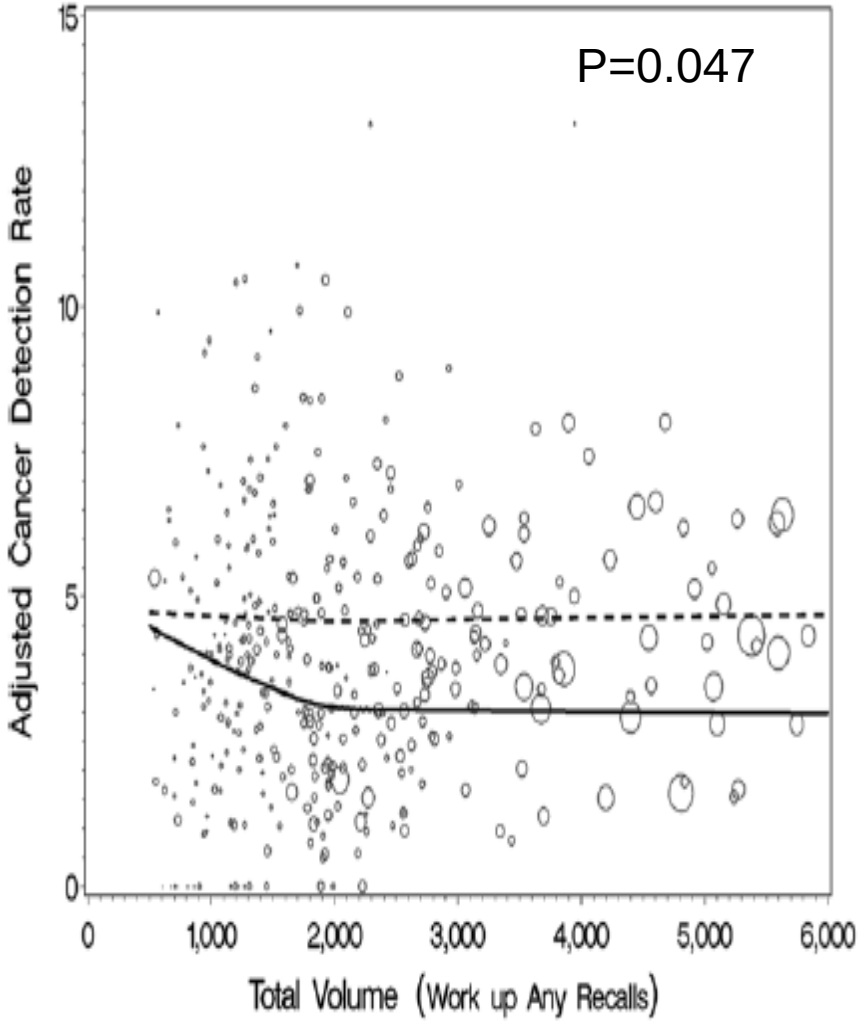

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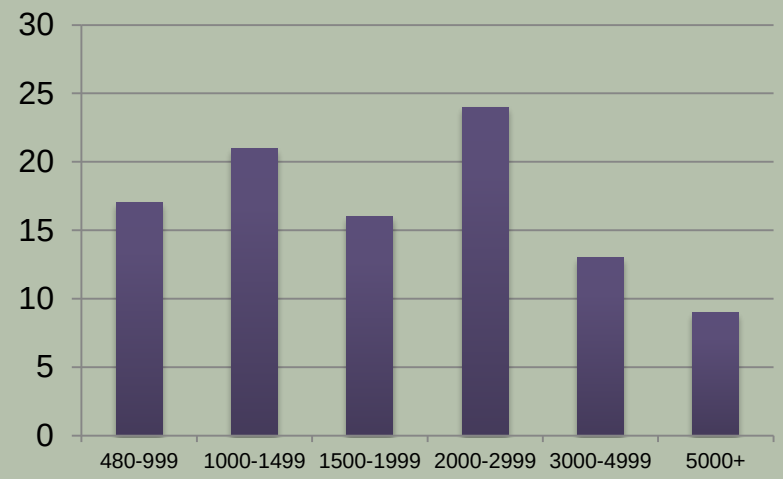
Bringing it all together – Volume & Performance in the US

- Suggest consideration for increasing minimum interpretation volume requirements in the US
- Include a minimal diagnostic interpretation requirement – better to be some proportion of total volume
- Consider requiring a minimum number of diagnostic work-ups that resulted from radiologists' own recall

Impact



Own recalled exams

	annual ave	% distribution
Low	<25	38%
Med	26-50	24%
High	>50	39%

National Impact:

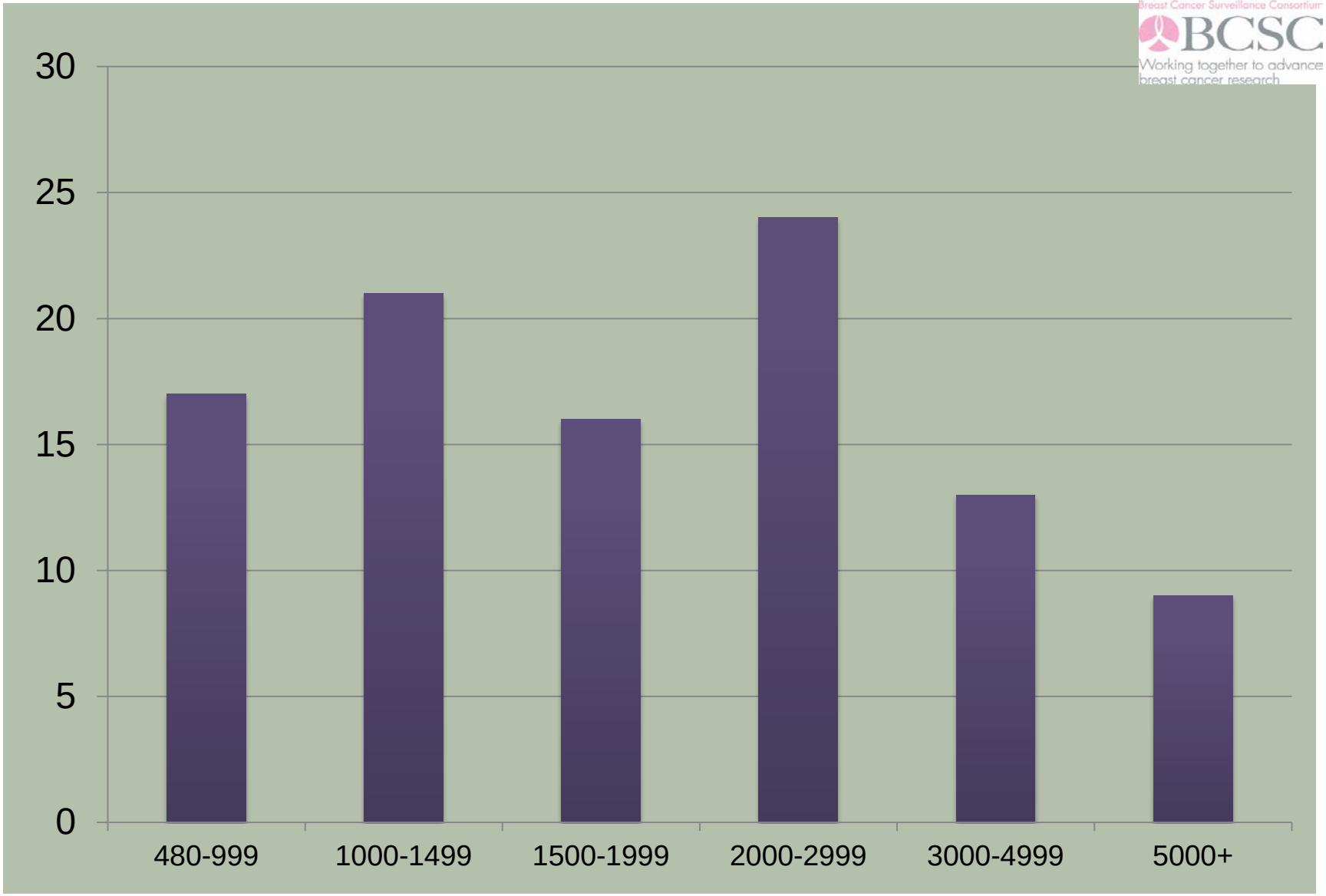
- Breast cancer screening costs >$3.6 billion annually in the United States
- ~$1.6 billion/year for costs of false positives (~$1.6 billion per year, or avoid time, trouble, and anxiety for women)
- Increasing annual screening increase would lower FP work-ups by
  - >1000: $35.6 million/year
  - >1500: $58.6 million/year

Have not updated simulation based on any joint criteria of total volume and composition of volume

*based on $107 US/screening mammogram

Thank you!

Distribution of annual screening volume interpretation in BCSC radiologists, US



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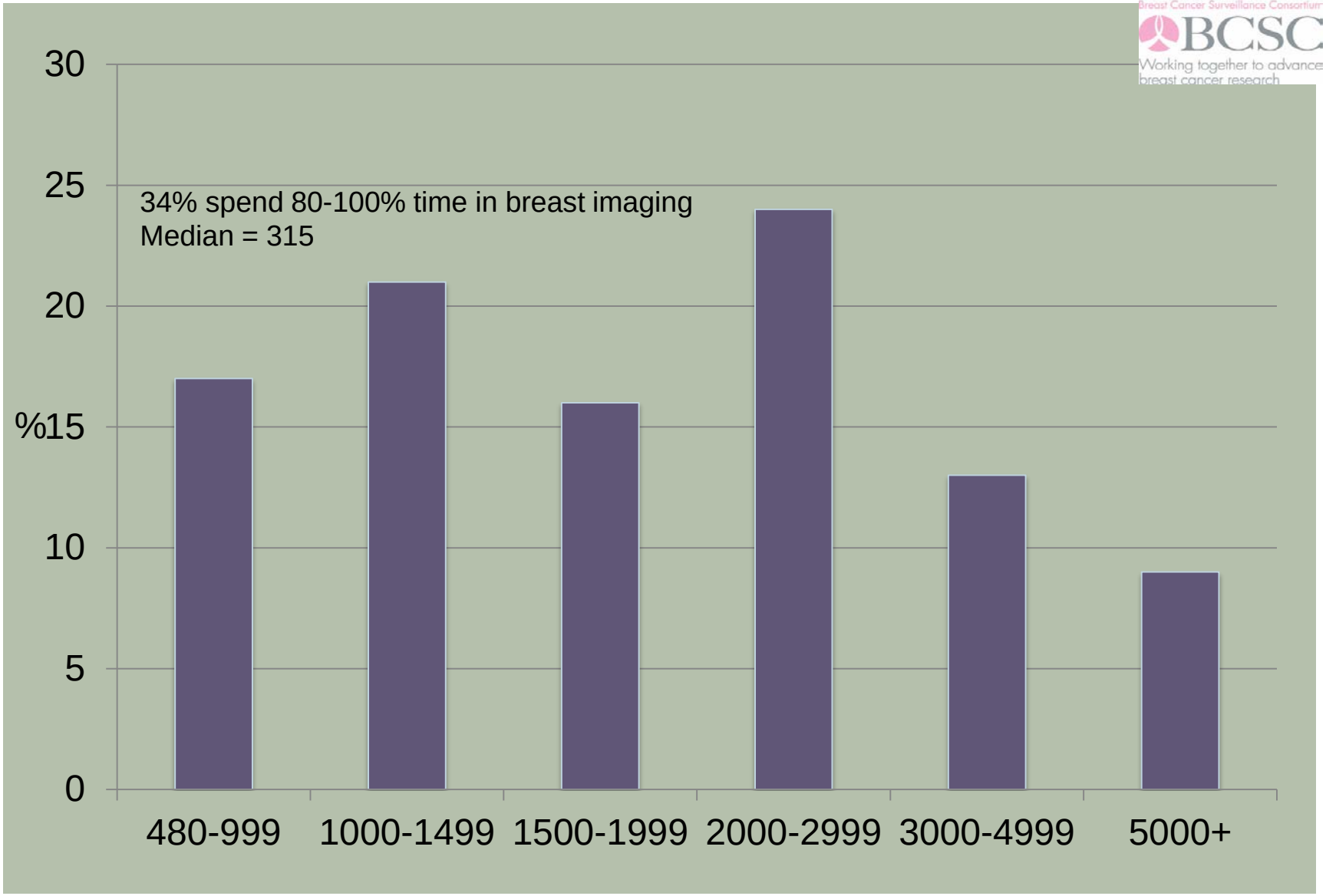
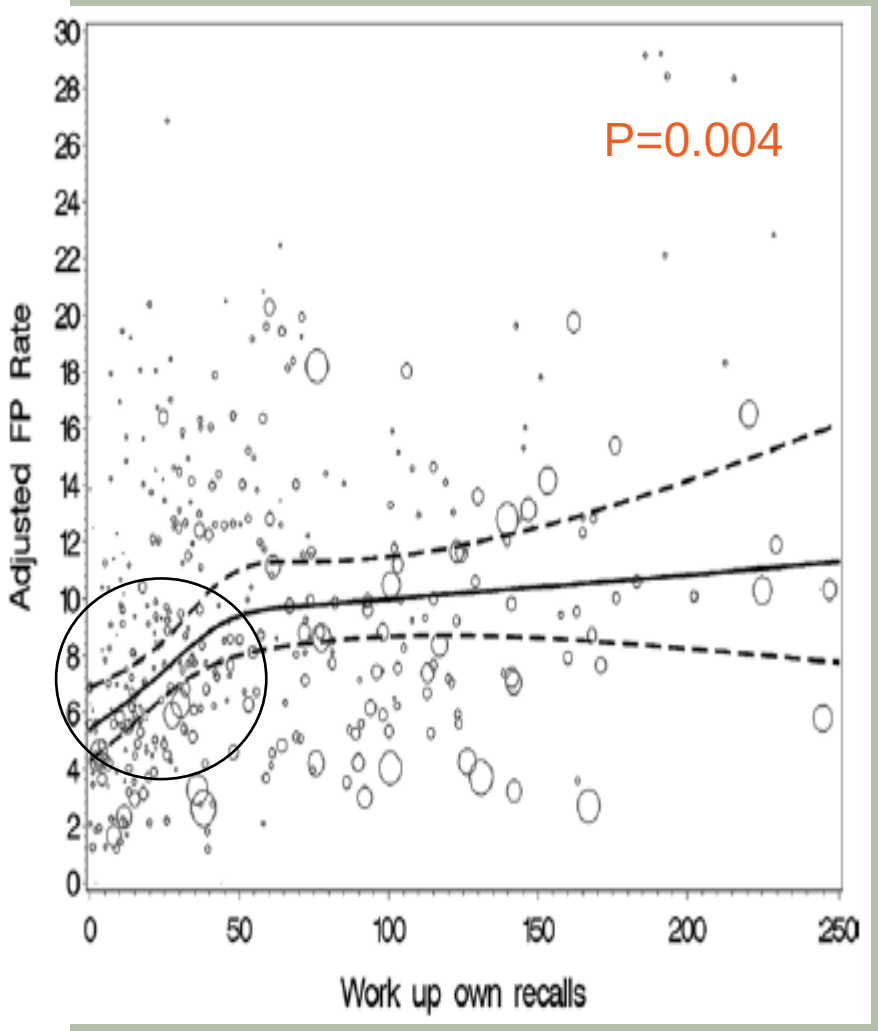
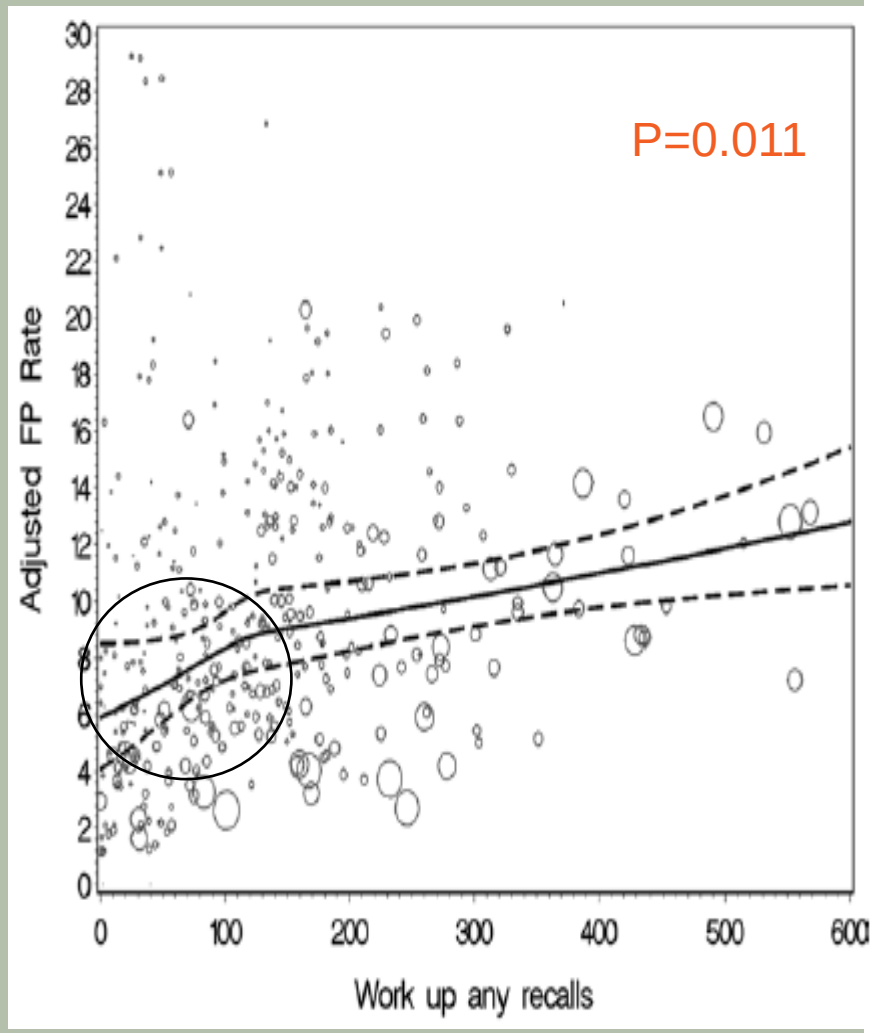
Distribution of annual diagnostic volume interpretation in BCSC radiologists, US



False-positive rate by number of work-ups





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