

# Enhancing the Carolina Mammography Registry through Linkage with the North Carolina Central Cancer Registry

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## BACKGROUND

- Since its inception in 1994, the Carolina Mammography Registry (CMR) has served as a population based mammography registry with participating breast imaging facilities spanning 34% of NC counties.
- To ensure complete breast related follow-up and outcome information on participating women, CMR data is linked with pathology data from the NC Central Cancer Registry (NCCCR).

## PURPOSE

- To describe how the CMR and NCCCR linkage enhances the CMR data collection, quality, and monitoring for breast cancer screening and outcomes in NC.

## METHODS

- The following steps are used to link women with a breast imaging examination in CMR to breast cancer cases in the NCCCR.
  - Blocking:** This step groups similar records, reducing the number of record comparisons and increasing the efficiency of the linkage.
  - Conditional Probabilistic and Deterministic Matching:** After blocking, each comparison is given a match score (see examples in Tables 1 and 2).
  - Linkage Algorithms:** Two linkage algorithms are used to determine the best match from the potential matched comparisons. The conservative linkage algorithm utilizes the match scores assigned in Step 2, whereas the liberal linkage algorithm does not use the match scores.
  - Clerical Review:** Case-by-case review of uncertain matches is completed when the linkage algorithms disagree.

Table 1: Match Score Example A

Personal Identifiers	NCCCR Record A1	CMR Record B1	Match Score
First Name	Petunia	Petunia	6.84
Last Name	Dursley	Dursley	16.29
SSN4	1111	1171	-3.14
DOB Month	05	05	3.57
DOB Day	25	26	-5.61
DOB Year	1954	1954	6.65
Middle Initial	E	E	3.35
Address	4 Privet Drive	4 Privet Drive	17.50
City	Little Whinging	Little Whinging	10.15
Zip	27278	27278	9.74
Final Match Score			65.34

Table 2: Match Score Example B

Personal Identifiers	NCCCR Record A1	CMR Record B2	Match Score
First Name	Petunia	Petunia	6.84
Last Name	Dursley	Evans	-6.38
SSN4	1111	1111	13.11
DOB Month	05	05	3.57
DOB Day	25	25	4.93
DOB Year	1954	1954	6.65
Middle Initial	E	N	-0.66
Address	4 Privet Drive		0
City	Little Whinging		0
Zip	27278		0
Final Match Score			28.06

## RESULTS

- The final CMR and NCCCR linked dataset is used to evaluate non-invasive and invasive cancer diagnoses by socio-demographic characteristics, breast cancer risk factors (family history of breast cancer and breast density), imaging modalities (mammography, ultrasound, breast magnetic resonance imaging) and mammographic findings (Table 3).
- We are also able to evaluate breast cancer type, grade, stage, size, and estrogen or progesterone positive characteristics by mode of detection (screen detected and interval detected cancers) (Table 4).

Table 3: Characteristics of Women by Breast Cancer Diagnoses

Women Characteristics	Non-Invasive N(%)	Invasive N(%)
<b>Total</b>	4,638	25,967
<b>Age</b>		
40-49	925 (19.9)	4,506 (17.4)
50-59	1,275 (27.5)	6,785 (26.1)
60-69	1,352 (29.2)	6,892 (26.5)
70-79	842 (18.2)	5,449 (21.0)
80+	244 (5.3)	2,335 (9.0)
<b>Race</b>		
White	3,152 (68.0)	17,969 (69.2)
Black	940 (20.3)	4,654 (17.9)
Other	54 (1.2)	287 (1.1)
Missing	492 (10.6)	3,057 (11.8)
<b>Education</b>		
<High School	338 (7.3)	2,267 (8.7)
High School Graduate	744 (16.0)	4,616 (17.8)
Some College/Technical School	623 (13.4)	3,629 (14.0)
College Graduate	632 (13.6)	3,403 (13.1)
Missing	2,301 (49.6)	12,052 (46.4)
<b>Rural/Urban Status</b>		
Rural	1,798 (38.8)	11,268 (43.4)
Urban	2,837 (61.2)	14,682 (56.5)
Missing	3 (0.1)	17 (0.1)
<b>Family History of Breast Cancer</b>		
Yes	598 (12.9)	3,339 (12.9)
No	3,003 (64.8)	16,113 (62.1)
Missing	1,037 (22.4)	6,515 (25.1)
<b>BIRADS* Mammographic Breast Density</b>		
Almost Entirely Fat	96 (2.1)	783 (3.0)
Scattered Fibro-glandular	1,915 (41.3)	11,069 (42.6)
Heterogeneously Dense	1,841 (39.7)	9,533 (36.7)
Extremely Dense	187 (4.0)	1,164 (4.5)
Missing	599 (12.9)	3,418 (13.2)
<b>Imaging Modality</b>		
Mammography (Screening/Diagnostic)	4,201 (90.6)	20,175 (77.7)
Other Imaging (Ultrasound/MRI)	437 (9.4)	5,792 (22.3)
<b>BIRADS Imaging Assessment</b>		
1 (Negative)	265 (5.7)	2,050 (7.9)
2 (Benign Findings)	240 (5.2)	1,479 (5.7)
3 (Probably Benign)	280 (6.0)	1,089 (4.2)
0 (Needs Additional Imaging)	1,349 (29.1)	4,680 (18.0)
4 (Suspicious)	2,271 (49.0)	10,602 (40.8)
5 (Malignant)	184 (4.0)	5,783 (22.3)
6 (Known Malignancy)	11 (0.2)	70 (0.3)
Missing	38 (0.8)	214 (0.8)

\*Breast Imaging-Reporting and Data System (BIRADS)

Table 4: Breast Cancer Characteristics by Mode of Detection\*

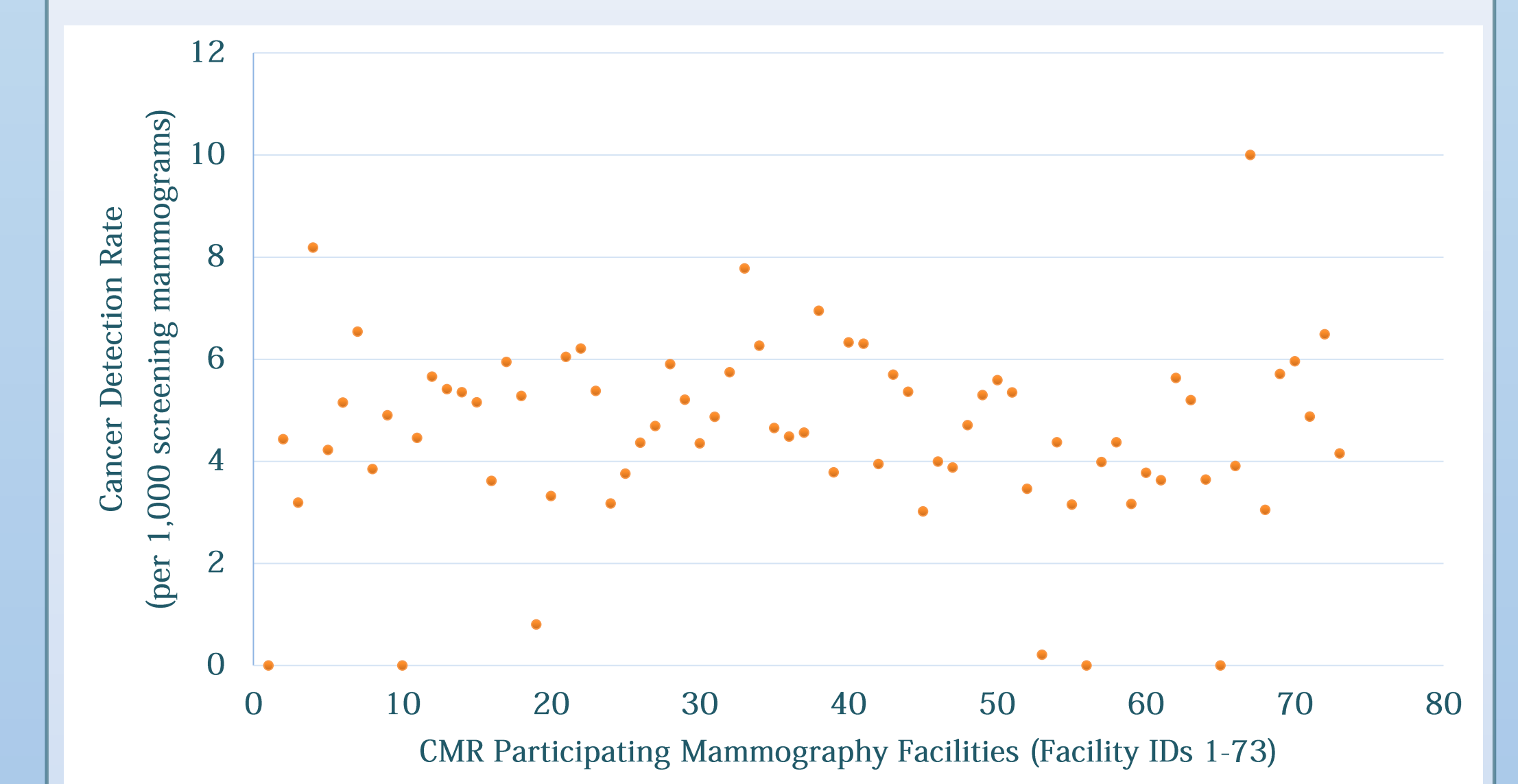
Breast Cancer Characteristics	Screen Detected N(%)	Interval Detected N(%)
<b>Total</b>	11,537	2,666
<b>Breast Cancer Type</b>		
Non-Invasive	2,262 (19.6)	216 (8.1)
Invasive	9,275 (80.4)	2,450 (91.9)
<b>Grade</b>		
Low	2,200 (19.1)	402 (15.1)
Medium	3,957 (34.3)	809 (30.3)
High	2,914 (25.3)	1,051 (39.4)
Missing	2,466 (21.4)	404 (15.2)
<b>Late Stage</b>		
Yes	1,935 (16.8)	737 (27.6)
No	8,712 (75.5)	1,753 (65.8)
Missing	890 (7.7)	176 (6.6)
<b>Size (mm)</b>		
<=10	4,061 (35.2)	558 (20.9)
11-20	2,981 (25.8)	770 (28.9)
21-30	1,349 (11.7)	520 (19.5)
>30	1,992 (17.3)	635 (23.8)
Missing	1,154 (10.0)	183 (6.9)
<b>Estrogen Receptor Positive</b>		
Yes	6,860 (59.5)	1,446 (54.2)
No	1,631 (14.1)	604 (22.7)
Missing	3,046 (26.4)	616 (23.1)
<b>Progesterone Receptor Positive</b>		
Yes	5,844 (50.7)	1,262 (47.3)
No	2,593 (22.5)	779 (29.2)
Missing	3,100 (26.9)	625 (23.4)

\*This table is limited to screen detected and interval detected cancers only

## RESULTS CONTINUED

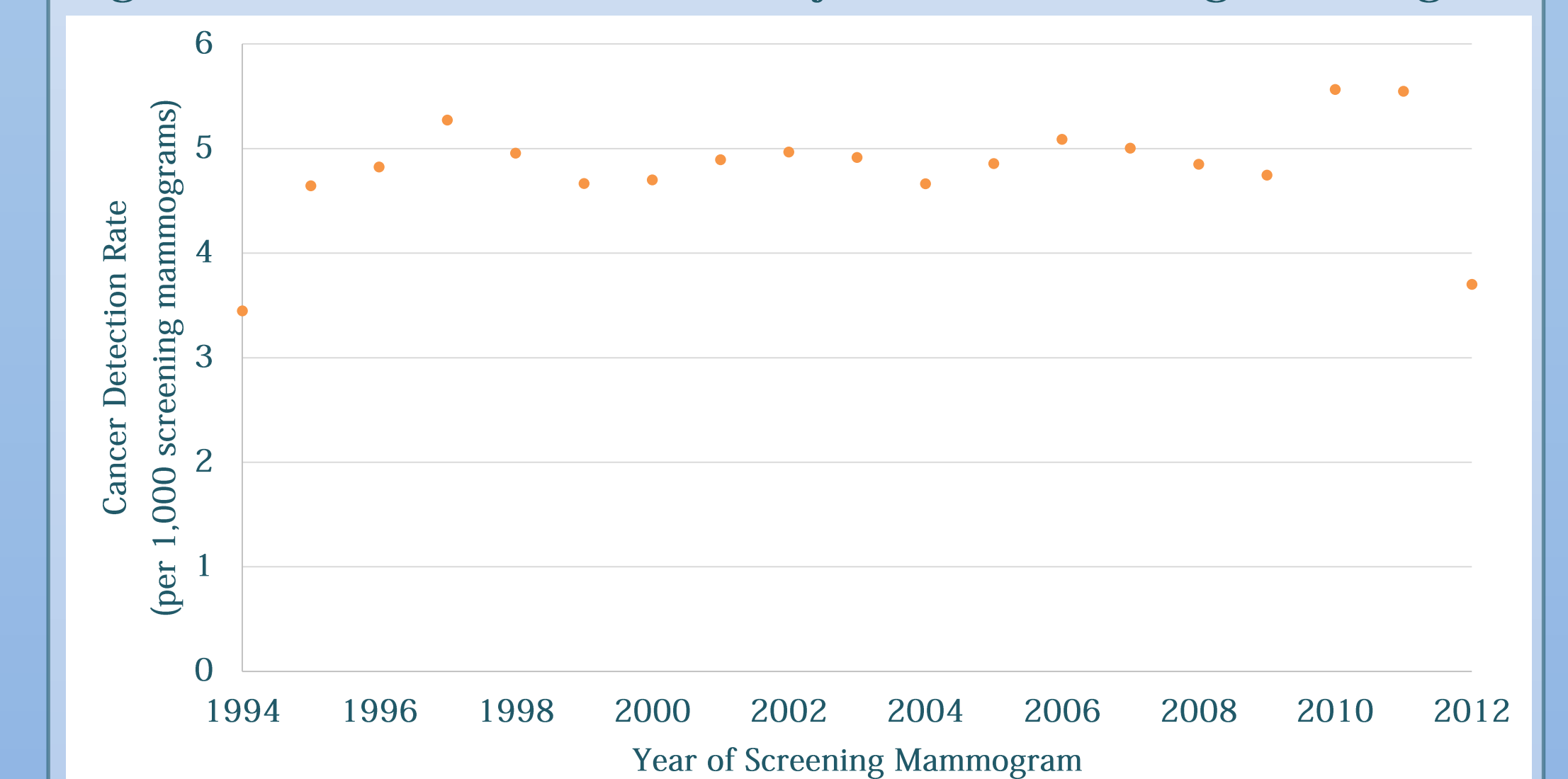
- Figure 1 illustrates the cancer detection rates for each facility per 1,000 screening mammograms.

Figure 1: Cancer Detection Rates for CMR Mammography Facilities



- Figure 2 demonstrates the cancer detection rates by year of the screening mammogram.

Figure 2: Cancer Detection Rates by Year of Screening Mammogram



- With this data, we are also able to determine the registry-wide cancer detection rate for mammography by modality.
  - The screening mammography cancer detection rate is 4.93 per 1,000 mammography examinations.
  - The diagnostic mammography cancer detection rate is 33.45 per 1,000 mammography examinations.

## CONCLUSIONS

- Through linkage of the CMR and NCCCR data, breast cancer trends may be evaluated by year, histology, mode of detection, and breast cancer risk factors to ensure continued data quality and complete information for women participating in CMR.

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