Association between environmental carcinogen emissions reported to the Toxic Release Inventory and breast cancer in Puerto Rico

2016 National Training Conference
TRI at 30: Working together to reduce toxics releases
Session: TRI and Human Health
10:45am – 11:45am

Edna Pacheco Acosta, Dr PH, MS
José Seguinot Barbosa, JD PhD
Erick Suárez Pérez, PhD
Ana Patricia Ortíz, PhD
Jaime Matta, PhD

October, 2016

Breast cancer in Puerto Rico, 2006-2010

• Represent 29.7 % of all female cancers

• Mortality:
  • leading cause of female cancer death
    (18.0 %)

• Probability diagnosed with breast cancer
  • 1 in 10 during their lifetime

• Incidence:
  • 73.4 per 100,000 females per year

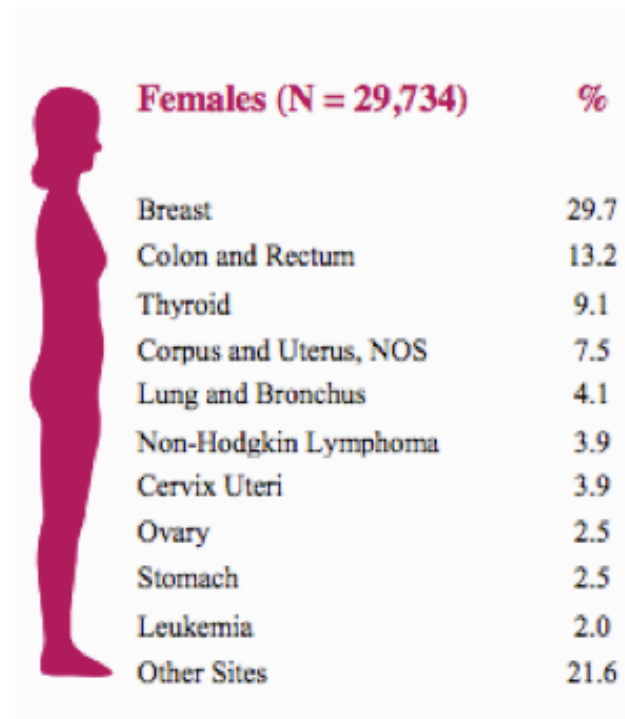• Median age at diagnosis
  • 60 years.

Females (N = 29,734)	%
Breast	29.7
Colon and Rectum	13.2
Thyroid	9.1
Corpus and Uterus, NOS	7.5
Lung and Bronchus	4.1
Non-Hodgkin Lymphoma	3.9
Cervix Uteri	3.9
Ovary	2.5
Stomach	2.5
Leukemia	2.0
Other Sites	21.6

Figure 1. Top ten cancer sites in Puerto Rico

Tortolero-Luna G, Zavala-Zegarra D, Pérez-Ríos N, Torres-Cintrón CR, Ortiz-Ortiz KJ, Traverso-Ortiz M, Román-Ruiz Y, Veguilla-Rosario I, Vázquez-Cubano N, Merced-Vélez MF, Ojeda-Reyes G, Hayes-Vélez FJ, Ramos-Cordero M, López-Rodríguez A, Pérez-Rosa N. Cancer in Puerto Rico, 2006-2010. Puerto Rico Central Cancer Registry. San Juan, PR, 2013.

Risk factors for breast cancer

Individual

- Gender
- Age
- Familial history of breast cancer
- Ethnicity
- Hormone Use
- Alcohol
- Obesity

Under investigation:
- DNA repair capacity (DRC)

Environmental

- Environmental pollutants potential cause of:
  - increasing breast cancer incidence
    - rates variations worldwide[1]
- Magnitude of the contribution of the environmental pollutants
  - etiology of breast cancer 1-19% [2]

1 Laden 1997, Kelsey 1993, Brody 2003, Brophy 2007, IOM 2012, IBCERCC, 2013
2 Wild 2009

Aims

Overall:

To determine if there is an association between residential proximity to Toxic Release Inventory (TRI) facilities with carcinogens emissions and breast cancer in women.

1. To describe the socio-demographic, reproductive, life style and cancer history profile of the participants.

2. To describe the spatial association between the residential proximity within less or equal one (≤ 1) mile distance to any TRI facilities emitting carcinogens.

3. To estimate the magnitude of the association between the residential proximity within ≤ 1 mile distance to any TRI facilities emitting carcinogens and breast cancer controlling for potential confounders.

Hypothesis:

Women living in areas with Toxic Release Inventory TRI facilities reporting carcinogens emissions will be more likely to have breast cancer while controlling for potential confounding factors.
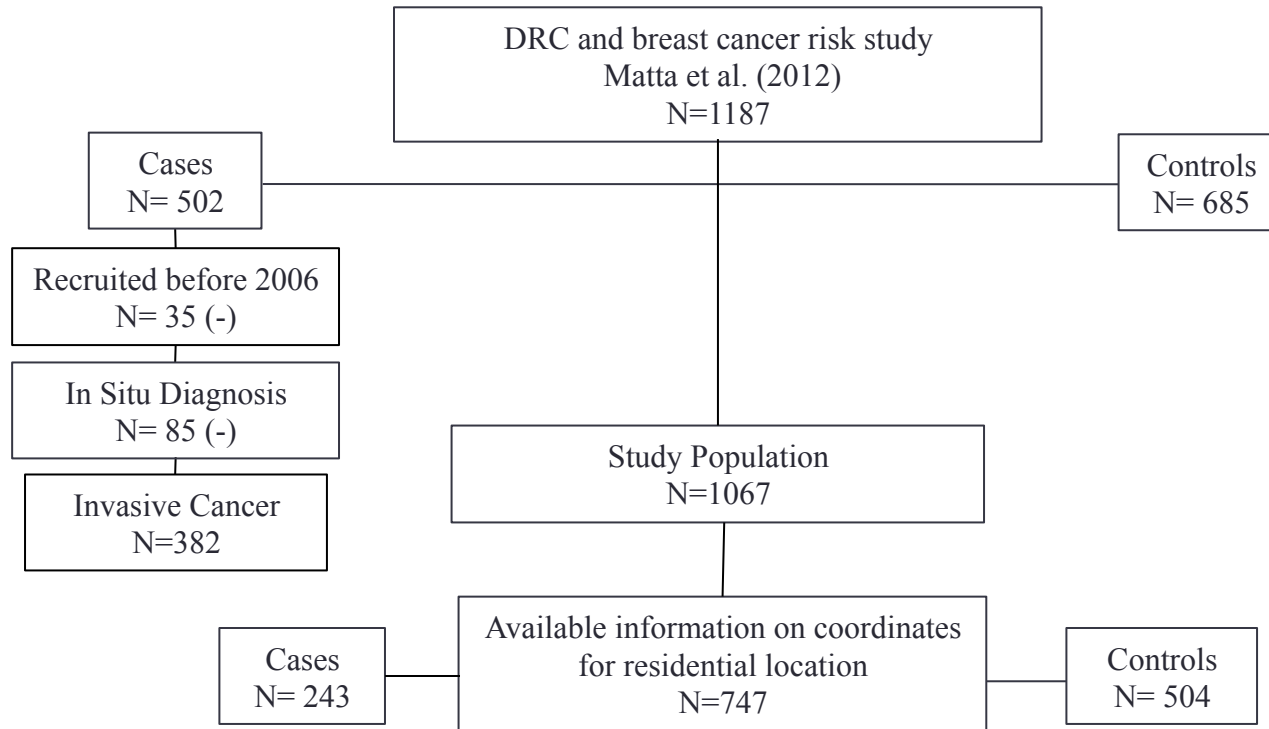
Secondary data, combining:

- Primary data from a case control study (2006-2013)
  - DRC and breast cancer risk study among Puerto Rican women (Matta et al. 2012)

- Environmental pollution data
  - Toxic Release Inventory (1998-2006)

Primary Study: Matta, J (PI). Molecular epidemiology studies on the role of DNA repair in breast cancer. NIH/NIGMS MBRS SC. NCI (co-funding) 8/4/2010 – 07/31/2013.
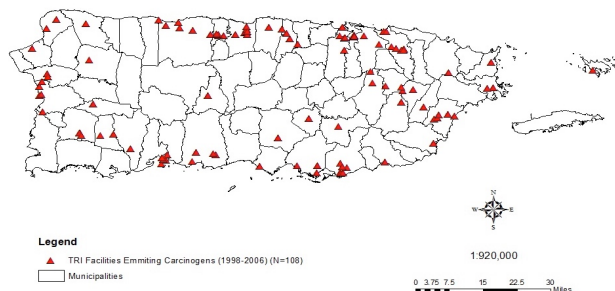Article: Matta J, Echenique M, Negrón E, Morales L, Vargas W, Sánchez Gaetán F, Ramírez Lizardi E, Torres A, Ortíz Rosado J, Bolaños G, González Cruz J, Laboy J, Barnes R, Santiago Medina S, Romero A, Martínez R, Dutil J, Suarez E, Alvarez Garriga C, Bayona M. (2012) The association of DNA repair with breast cancer risk in women. A comparative observational study. BMC Cancer 2012 12:490.

Study participants in primary study

TRI, Puerto Rico 1998-2006

Facilities Location

Legend
▲ TRI Facilities Emmiting Carcinogens (1998-2006) (N=108)
▢ Municipalities

1:920,000

0 3.75 7.5   15   22.5   30
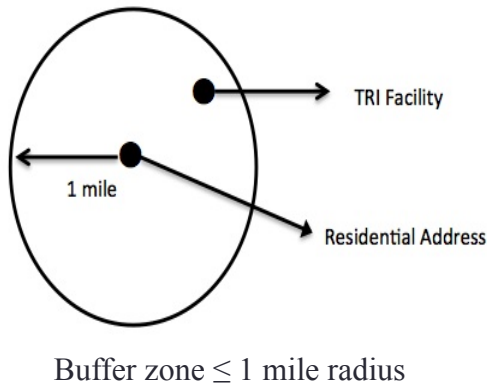   Miles

108 Facilities
29 Types of carcionogens

Top ten carcinogenic releases

1. Dichloromethane
2. Nickel
3. Benzene
4. Styrene
5. Chloroform
6. Ethylbenzene
7. 1,4 Dioxane
8. Formaldehyde
9. Naphtalene
10. Ethylene Oxide

Study Variables

Buffer zone ≤ 1 mile radius

Outcome variable: Diagnosis of breast cancer

Exposure variables:

i) Residential proximity (≤ 1m vs. > 1m) to a TRI facility

ii) If there is one or more TRI industrial facilities within ≤ 1 mile radius from the participant's residential address, the exposure is categorized as:

1. Low risk:
    a. Distance ≤ 1 mile radius
    b. Median time between the TRI report of at least one carcinogen of high risk and time elapsed between diagnosis/ recruitment is lower than 10 years.
2. High risk:
    a. Distance ≤ 1 mile radius
    b. Median time between the TRI report of at least one carcinogen of high risk and time elapsed between diagnosis/ recruitment is higher than 10 years.

Benzene, ethylene oxide, dioxins, nickel compounds, formaldehyde, chromium. Median time 10 years

Level of exposure of participants in relation to TRI historical data and year of recruitment
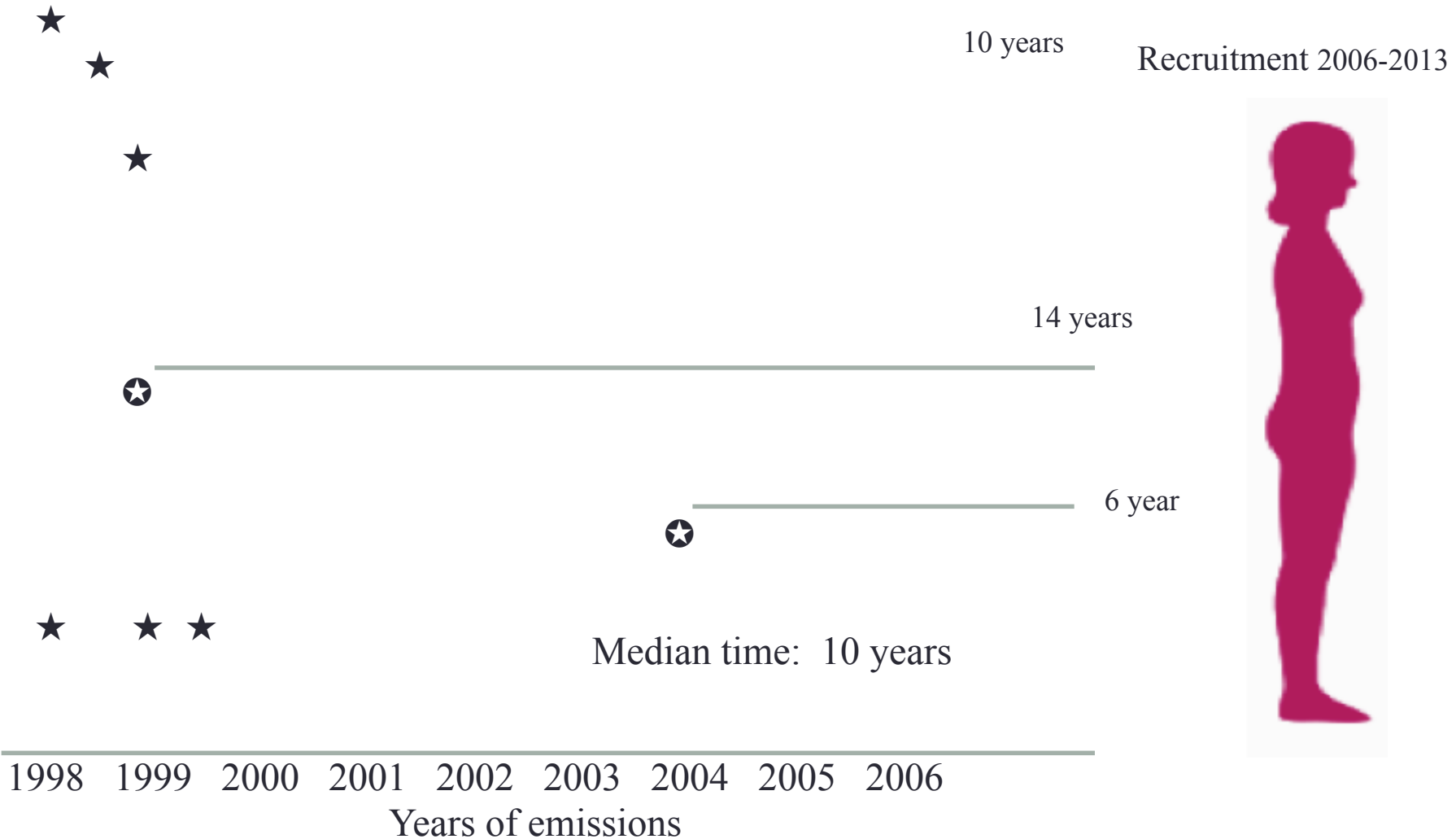
TRI carcinogens emissions

Recruitment 2006-2013

1998   1999   2000   2001   2002   2003   2004   2005   2006
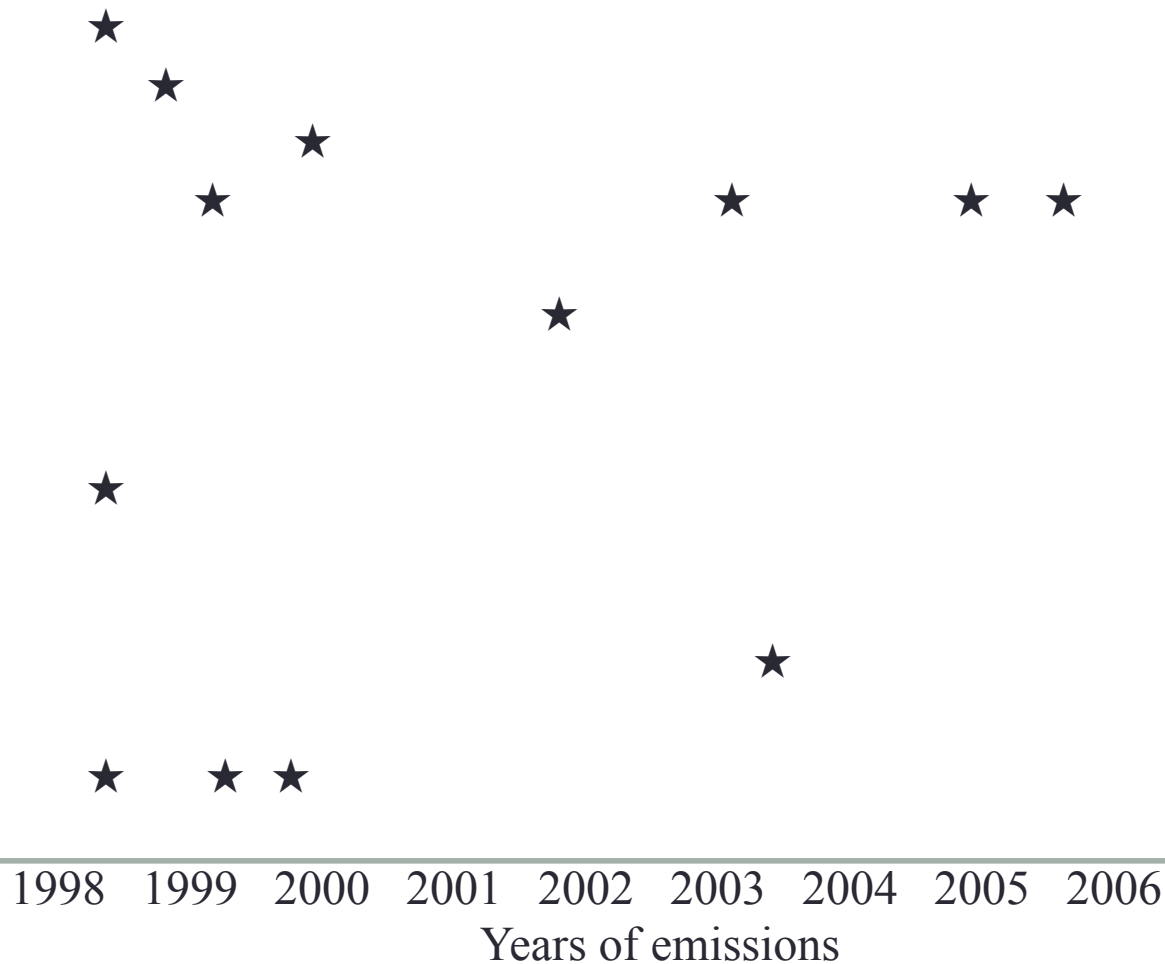
Years of emissions

Identification of specific carcinogens most relevant to breast cancer in literature

TRI carcinogen and breast cancer related emissions

Recruitment 2006-2013

High Risk

1998 1999 2000 2001 2002 2003 2004 2005 2006
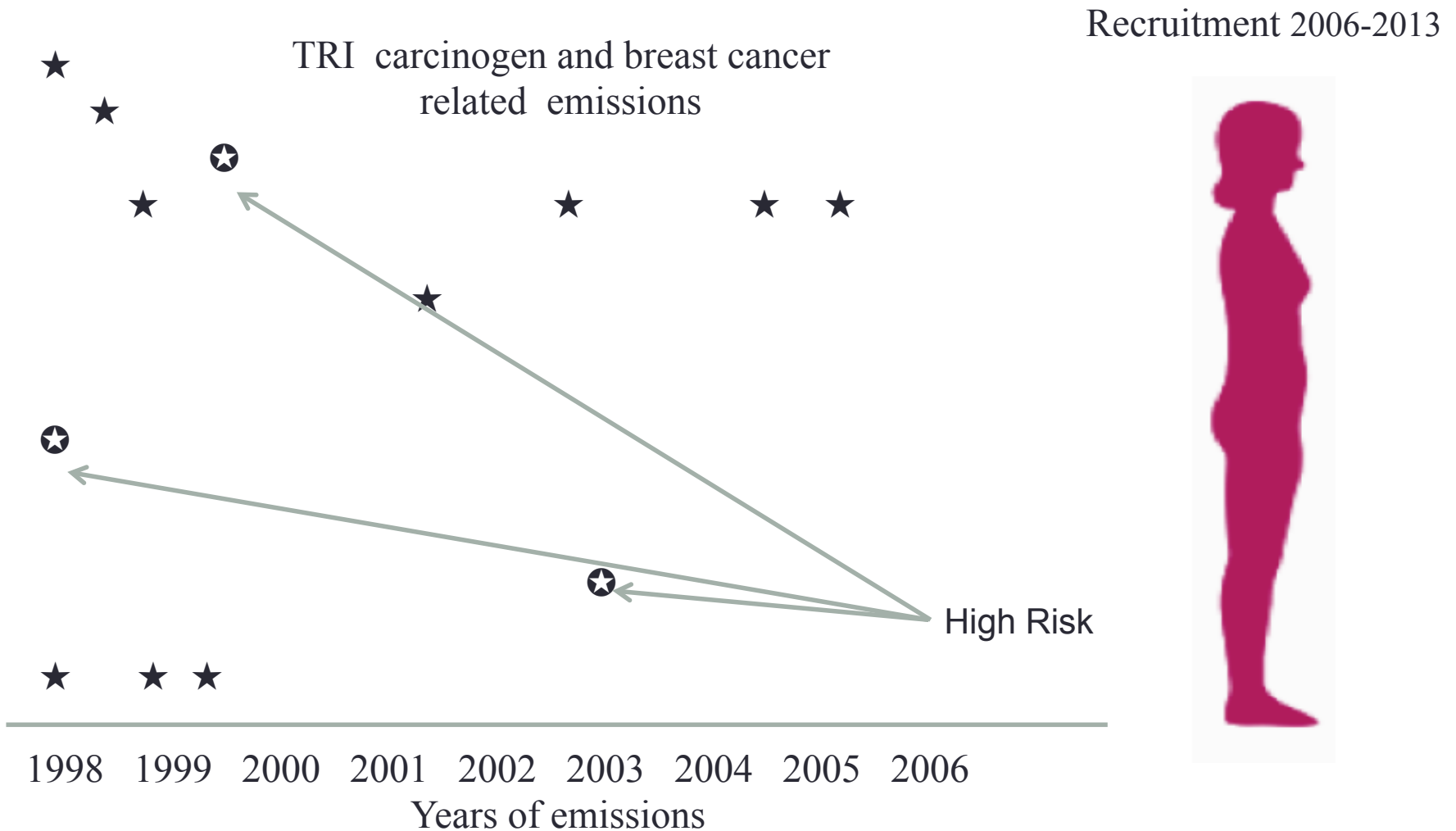
Years of emissions

Time lapse between the year of emission of a high risk carcinogen and the year of recruitment

★

★

★

10 years

Recruitment 2006-2013

14 years

✪

6 year

✪

★ ★ ★

Median time: 10 years

1998 1999 2000 2001 2002 2003 2004 2005 2006

Years of emissions

Spatial distribution of residential location of study participants within one mile of a TRI facilities emitting carcinogens
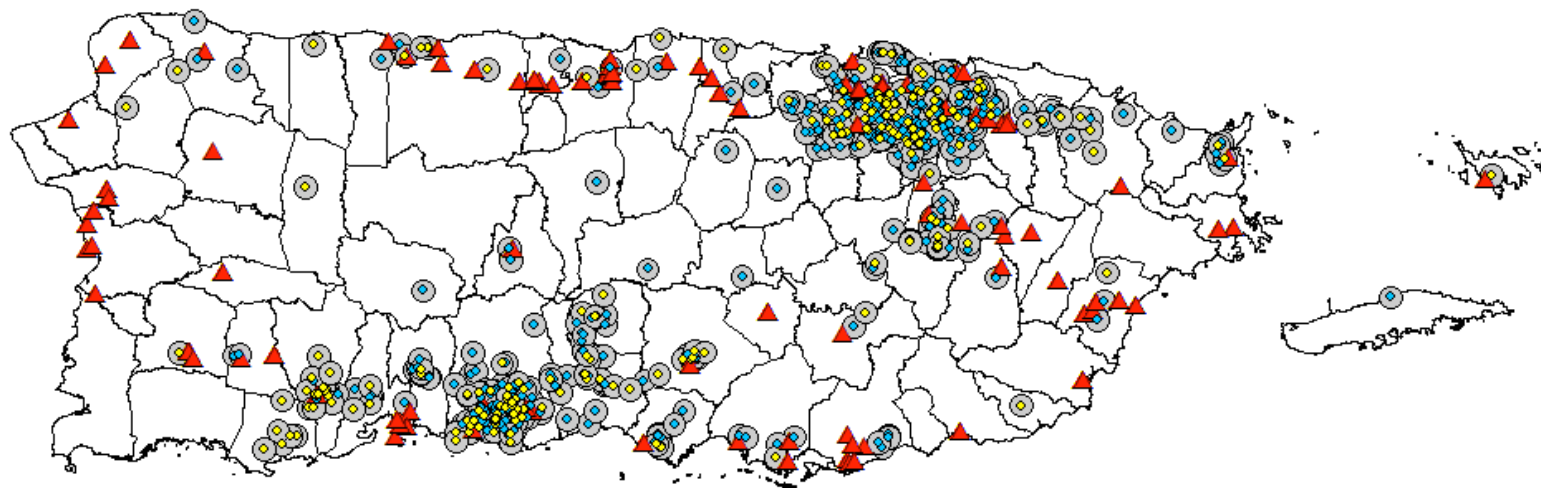
Legend

◇ Case (N=243)

◇ Control (N=504)

▲ TRI Facilities Emmiting Carcinogens (1998-2006) (N=108)
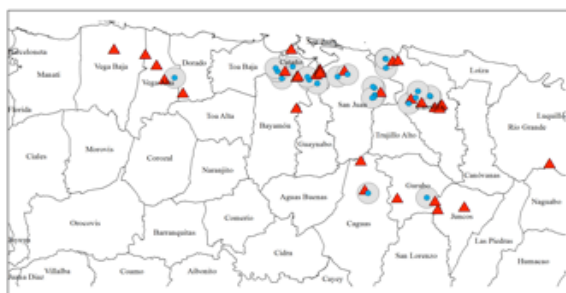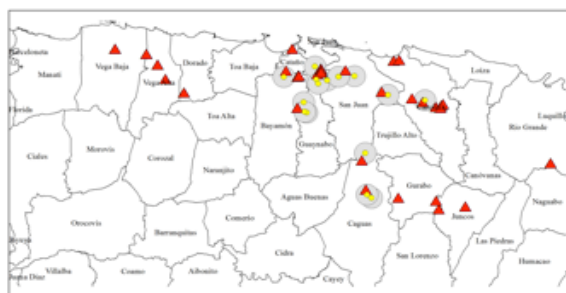
▨ 1 mile buffer

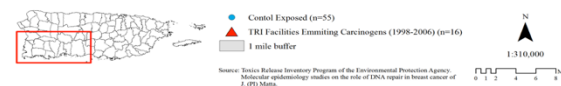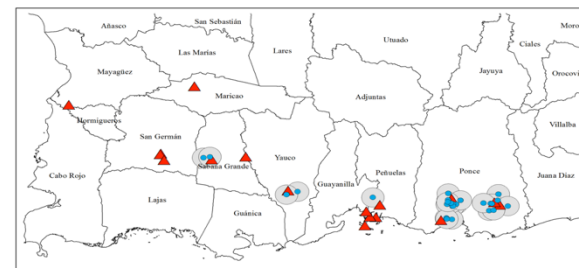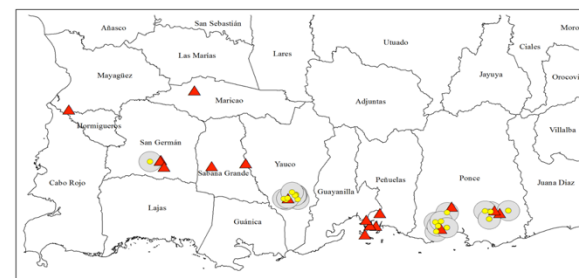▢ Municipalities

1:920,000

0 3.75 7.5   15   22.5   30
Miles

Spatial distribution of residential within one mile of TRI facilities emitting carcinogens

Metro

South

RESULTS

Magnitude of the association between selected characteristics and breast cancer (n=747)

Characteristics	Cases Number (%)	Controls Number (%)	Total Number(%)	OR_{crude} (95% CI)
Age at enrollment[1] (years)				
≤ 52	121 (49.8)	273 (54.2)	394 (52.7)	Reference
> 52	122 (50.2)	231 (45.8)	353 (47.3)	1.19 (0.87-1.61)
Marital Status				
Married	148 (61.2)	335 (67.3)	483 (65.3)	Reference
Not Married	94 (38.8)	163 (32.7)	257 (34.7)	1.30 (0.94 – 1.79)
Education (years)				
< 13	121 (49.8)	273 (54.2)	394 (52.7)	Reference
≥ 13	122 (50.2)	231 (45.8)	353 (47.3)	1.19 (0.87 – 1.61)
Body Mass Index[2]				
Normal	62 (25.6)	148 (30.0)	210 (28.5)	Reference
Overweight	96 (39.7)	215 (43.5)	311 (42.3)	1.06 (0.73 -1.56)
Obese	84 (34.7)	131 (26.5)	131 (29.2)	1.53 (1.02 -2.29)
Family cancer history[3]				
No	88 (36.7)	222 (44.0)	310 (41.7)	Reference
Yes	152 (63.3)	282 (56.0)	434 (58.3)	1.35 (1.0 – 1.86)
DRC %[3]				
> 4 %	85 (35.0)	389 (77.2)	474 (63.5)	Reference
≤ 4 %	158 (65.0)	115 (22.8)	273 (36.5)	6.28 (4.49 – 8.79)

[1] Years old at diagnosis for the cases and at recruitment for the controls
[2] p-value .05< p<. 10
[3] p-value < 0.001

Magnitude of the association between breast cancer and residential proximity to TRI (N=727)

Distance	Control N (%)	Case N (%)	OR_{crude} (95% CI)	OR_{adj}[1,3] (95% CI)	OR_{adj}[3,2] (95% CI)
>1mile	393 (80.4)	186 (78.2)	Reference	Reference	Reference
≤ 1mile	96 (19.6)	52 (21.8)	1.14 (0.78-1.67)	1.17 (0.80-1.71)	1.08 (0.71, 1.65)
Total	489 (100)	238 (100)			

[1] Adjusted for age, BMI, civil status, and familial history of cancer.
[2] Adjusted for age, BMI, civil status, familial history of cancer and DRC.
[3] No evidence of significant interaction terms in the logistic regression model (p-value >0.05)

Magnitude of the association between breast cancer and residential proximity to TRI, stratified by DRC status (N=727)

	OR[1] (95% Confidence Interval)	
	DRC levels < 4 percent	DRC levels ≥ 4 percent
Residential Proximity	n=267	n=460
> 1 mile	Referent	Referent
≤ 1 mile	1.00 (.55- 1.83)	1.13 (.62-2.06)

[1] No significant interaction terms in the logistic model was found (p > 0.05).
[2] Adjusted for age, BMI, civil status, and familial history of cancer

Magnitude of the association between high and low risk exposure and breast cancer (N=727)

Distance and time first exposure	Control	Case	OR_{crude} (95% CI)	$OR_{adj}^{1,3}$ (95% CI)	$OR_{adj}^{2,3}$ (95% CI)
No-exposure	393 (80.4)	186 (78.2)	Reference	Reference	Reference
Low-risk	75 (15.3)	36 (15.1)	1.01 (.65, 1.57)	1.04 (.67, 1.61)	.98 (.60, 1.59)
High-risk	21 (4.3)	16 (6.7)	1.60 (.82, 3.15)	1.54 (.78, 3.06)	1.37 (.65, 2.92)

1 Adjusted for age, BMI, civil status, and familial history of cancer.
2 Adjusted for age, BMI, civil status, familial history of cancer and DRC.
3 No evidence of significant interaction terms was found in the logistic regression model (p-value >0.05)

Magnitude of the association between breast cancer and residential proximity to TRI and time of exposure stratified DRC status (N=727)

	OR[1,2] (95% CI)	
	DRC levels < 4 percent	DRC levels ≥ 4 percent
Residential Proximity	n=267	n=460
No-exposure	Reference	Reference
Low-risk exposure	0.86 (.43, 1.69)	1.12 (.58-2.20)
High-risk exposure	1.63 (.54, 4.95)	0.98 (.31-3.04)

1 Adjusted for age, BMI, civil status, and familial history of cancer
2 No evidence of significant interaction terms was found in the logistic model (p > 0.05).

Conclusions

A higher percentage of the cases (22% vs 19%) reported to live in ≤ 1mile radius of TRI industries. It was also noticed that this group had higher odds of breast cancer (17%). However, this excess was not statistacally significant (p>0.05).

Study results show that women living in areas with TRI facilities reporting carcinogen emissions of high risk are more likely to have breast cancer while potential confounding factors are taken into consideration (OR: 1.37, 95% CI 0.65-2.92). However, our results were not significant (p>0.05) probably due to the small sample of subjects in the high risk exposure.

Also study findings suggest the importance of considering the role of the DRC percent as a potential risk factor for BC. In the stratified analysis of the DRC (< 4% y ≥ 4%) women with high risk exposure and a DRC < 4% had a higher odds of breast cancer (OR: 1.63, IC 95%: 0.54, 4.95).

Limitations

1. No residential history or longest residence in lifetime was available.

   - No environmental information of previous exposure by residential proximity before the breast cancer diagnosis was available.

   - It was assumed that participants residential address at enrollment or at recruitment was the same when the emissions were reported.

2. Limitations using of the TRI data

   - Self report

   - Not all industries reported

Recomendations

- To better understand the impact of long term exposure to carcinogens by residential proximity in breast cancer, bigger studies should be conducted.

- Other factors like the DRC variations should be considered to better understand their role in breast cancer.

Thanks…

- Dissertation Committee
- Steve Witkin
  Project Officer TRI Explorer & TRI.Net

Further information:

edna.pacheco1@upr.edu

Center of Excellence in Women Health

UPR Medical Sciences Campus

787-758-2525 exts. 1368, 1360

" *WHEN AN ACTIVITY RAISES THREATS OF HARM TO HUMAN HEALTH OR THE ENVIRONMENT, PRECAUTIONARY MEASURES SHOULD BE TAKEN EVEN IF SOME CAUSE AND EFFECT RELATIONSHIPS ARE NOT FULLY ESTABLISHED SCIENTIFICALLY".*

Precautionary Principle