

# Hair dye and chemical straightener use and breast cancer risk in a large US population of black and white women

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# Breast cancer incidence persistent in the United States

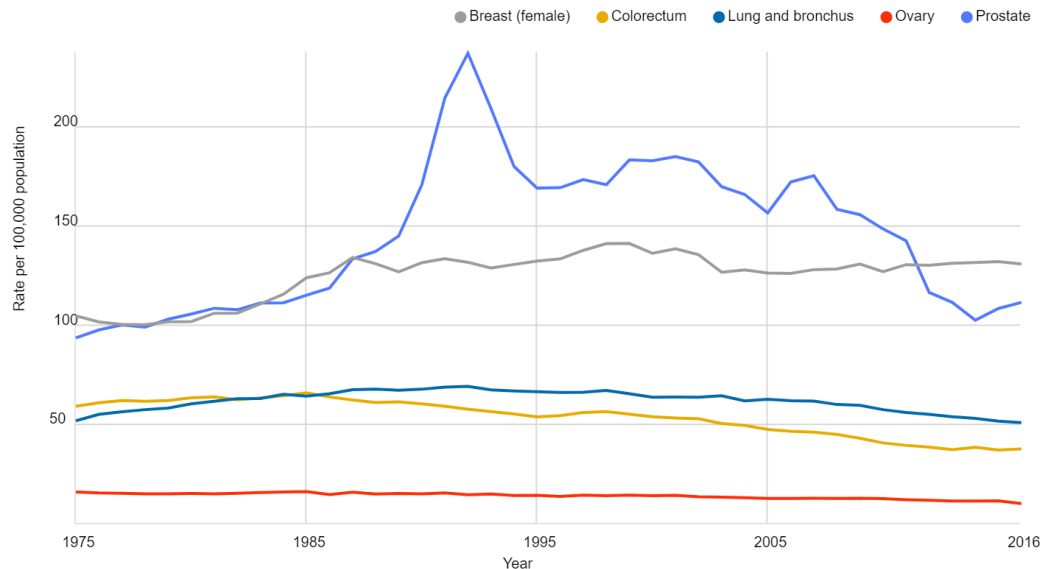
Most commonly diagnosed cancer among women in the US

270,000 new female breast cancer cases in 2019

2<sup>nd</sup> leading cause of cancer-related death

## Trends in incidence rates, 1975-2016

Per 100,000, age adjusted to the 2000 US standard population.



# Black women at higher risk of aggressive breast cancer subtypes

Figure 7. Trends in Female Breast Cancer Incidence Rates by Race/Ethnicity, US, 2001-2016

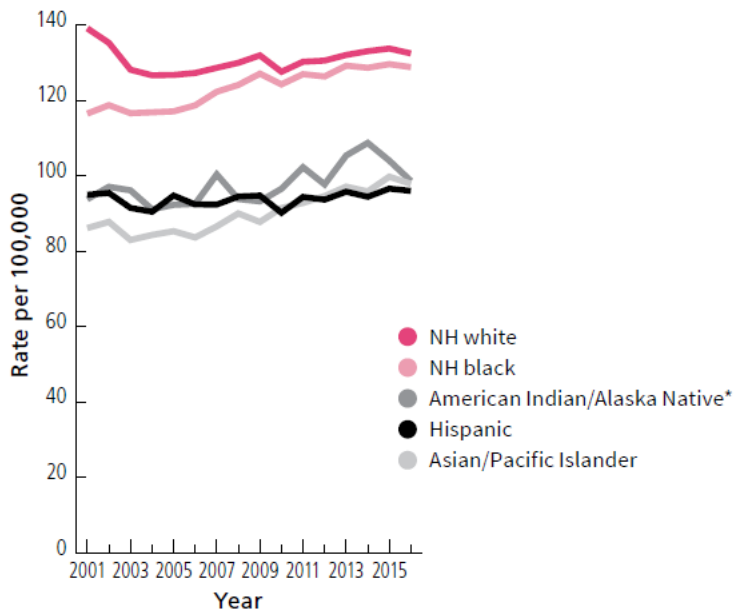


Figure 4. Distribution of Breast Cancer Subtypes by Race/Ethnicity, Ages 20 and Older, US, 2012-2016



# Hair dye use is widespread in the United States

NCI estimates 1/3 of women and 10% of men over the age of 18 in the US use hair dye

## Oxidative

Permanent dye

- Colorless precursors, alkalinizing and oxidizing (coupling) agents
- Oxidizing agents react with precursor → molecules bind to cortex (inner layer)

## Non-oxidative

Semi-permanent, Temporary dyes and rinses

- Colored particles bind to cuticle (outer layer) of hair
- Minimal concentrations of oxidizing and alkalinizing agents

# Endocrine disrupting activity observed in oxidizing agents

## Endocrine disrupting chemicals (EDCs)

2,4-diaminoanisole sulfate and para-Phenylenediamine induce mammary gland tumors in animal models

4-aminobiphenyl (ABP) adducts were 8 times more likely to be present in breast tissue of women that use hair dye.

## Estrogens and EDCs not indicated on labels

**Products marketed to black women, darker-colored dyes contain higher concentrations of EDCs**



# Chemical straightener use common among Black women

More than 60% of Black women, <10% of white women use chemical straighteners

## **Lye and non-lye hair relaxers**

Lye active ingredients: sodium hydroxide, calcium hydroxide

Non-lye active ingredients: potassium hydroxide, lithium hydroxide, guanidine carbonate or ammonium thioglycolate

Scalp burns, hair breakage

## **Brazilian Keratin Treatments (BKT)**

Active ingredients: Formaldehyde reacts with keratin when heated

Fewer burns, less breakage

# Research aims

## **Aim 1. Describe the association of hair dye use with breast cancer risk**

Does the association vary by frequency of use, type or color of dye, race, ER or menopausal status?

## **Aim 2. Describe the association of chemical straightener use with breast cancer risk**

Does the association vary by frequency of use, race, ER or menopausal status?

# Study Population & Design

## **Prospective observational cohort (n=50,884)**

Recruitment from 2003-2009

### **Eligibility criteria**

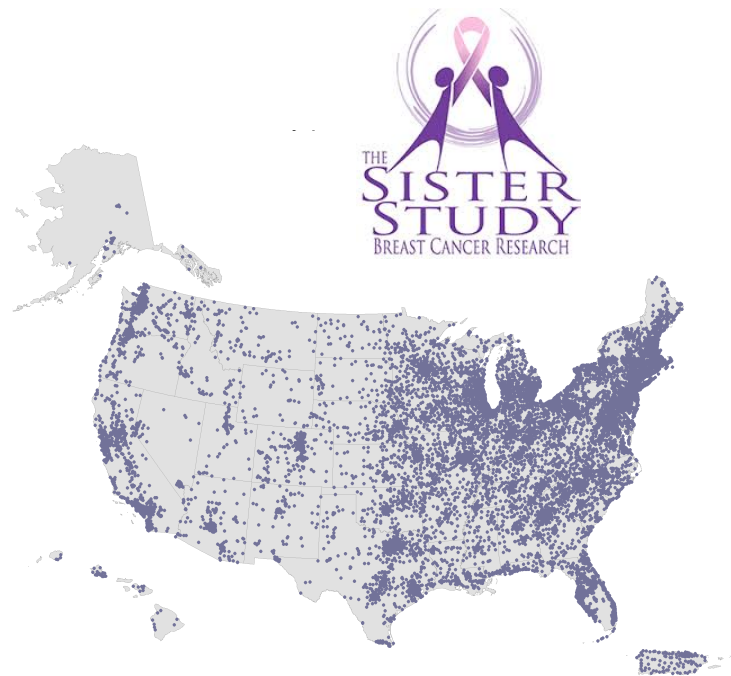
- Breast cancer-free women
- Ages 35-74
- Residents of the U.S. and Puerto Rico
- Sister diagnosed with breast cancer

### **Baseline**

- Extensive questionnaires, in-home visits

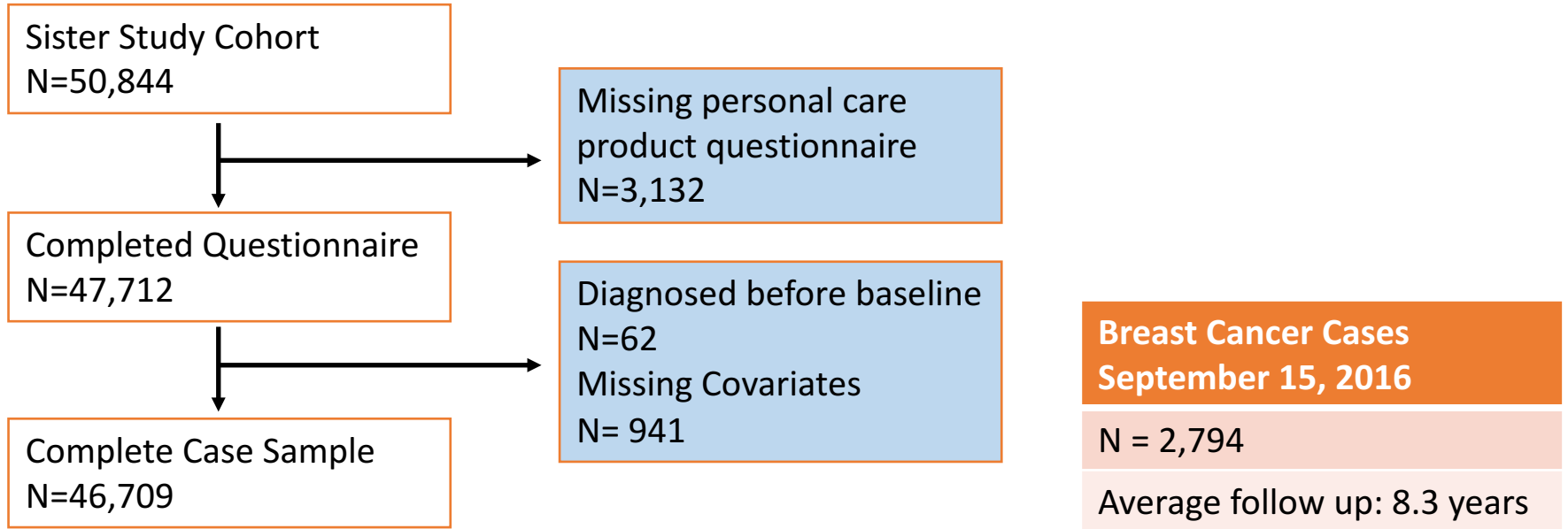
### **Follow-up**

- Annual health updates, biennial surveys, study hotline
- Breast cancer diagnosis confirmed by medical record review with 98% accuracy
- Pathology reports obtained for ~80% of participants





# Study Sample



# Exposures

## **Personal use of hair dye and chemical straighteners**

- Any use in the past 12 months
- Frequency of use in past 12 months
- Duration of use (<5 years, 5+ years)
- Type and color of dye typically used (dark colors, light colors, both)

## **Non-professional application of hair dye and chemical straighteners to others**

- Any applications in the past 12 months
- Frequency of applications in past 12 months

# Outcomes & Statistical Analysis

## Outcomes

Primary outcome: Invasive breast cancer or Ductal Carcinoma in situ (DCIS)

Secondary outcomes: Invasive disease by ER status, Menopausal status at time of diagnosis

## Analysis

Cox proportional hazard models

- Age as timescale
- Test for heterogeneity by race
- Adjusted models: Age, race/ethnicity, education, ever oral contraceptive use, BMI, smoking status, parity, age at first birth, age at menarche and menopausal status

## Exposure varied by demographic & reproductive characteristics

### **55% reported permanent hair dye use in past 12 months**

42% of Black women vs. 56% of White women

Mean age: 54.7 years (users) vs. 56.9 years (non-users)

60% pre-menopausal vs. 53% post-menopausal

### **9.9% reported chemical straightener use in the past 12 months**

74% of Black women vs. 3% of white women

13.3% pre-menopausal vs. 7.9% post-menopausal

11.5 % in overweight or obese vs. 6.7% normal/underweight

# Permanent hair dye use associated with all breast cancer

	<u>All participants</u>		<u>Non-Hispanic White</u>		<u>Black</u>	
	Events	Adjusted HR (95% CI)	Events	Adjusted HR (95% CI)	Events	Adjusted HR (95% CI)
<b>Personal use in the 12 months before enrollment</b>	2,794		2,402		208	
No use <sup>†</sup>	1,235	Ref	1,064	Ref	106	Ref
Any use	1,559	1.09 (1.01, 1.17)	1,338	1.07 (0.99, 1.16)	102	1.45 (1.10, 1.90)
<4 times per year	634	1.08 (0.98, 1.19)	524	1.06 (0.95, 1.18)	62	1.36 (0.99, 1.87)
Every 5-8 weeks, 1+ per month	925	1.09 (1.00, 1.19)	814	1.08 (0.98, 1.18)	40	1.60 (1.11, 2.30)
<i>p for trend</i>		0.05		0.1		0.006
<b>Dye color</b>						
None	1,235	Ref	1,064	Ref	106	Ref
Light colors only	713	1.12 (1.02, 1.23)	664	1.12 (1.01, 1.23)	21	1.46 (0.91, 2.34)
Dark colors only	683	1.08 (0.98, 1.19)	529	1.04 (0.94, 1.16)	74	1.51 (1.12, 2.05)
Light and dark colors	144	0.96 (0.81, 1.14)	133	0.97 (0.81, 1.16)	3	--

## Light-colored dye associated with premenopausal breast cancer

	<u>Pre-Menopausal</u>		<u>Post-Menopausal</u>	
	Events	Adjusted HR (95% CI)	Events	Adjusted HR (95% CI)
	<b>519</b>		<b>2,270</b>	
<b>Personal use in the 12 months before enrollment</b>				
No use	199	Ref	1,035	Ref
Any use	320	1.12 (0.94,1.34)	1,234	1.08 (0.99,1.18)
<4 times per year	164	1.14 (0.92,1.40)	467	1.06 (0.95,1.19)
Every 5-8 weeks, 1+ per month	156	1.11 (0.90,1.37)	767	1.09 (0.99,1.20)
		<i>p for trend</i>		
		0.3		0.07
<b>Dye color</b>				
None	199	Ref	1,035	Ref
Light colors only	142	1.30 (1.04, 1.62)	570	1.08 (0.98, 1.20)
Dark colors only	149	1.11 (0.89, 1.37)	530	1.07 (0.67, 1.20)
Light and dark colors	27	0.70 (0.47, 1.05)	117	1.06 (0.88, 1.29)

## Chemical straightener use associated with all breast cancer

	<u>All participants</u>		<u>Non-Hispanic White</u>		<u>Black</u>	
	Events	Adjusted HR (95% CI)	Events	Adjusted HR (95% CI)	Events	Adjusted HR (95% CI)
	2,794		2,402		208	
<b>Personal use in the 12 months before enrollment</b>						
No use <sup>†</sup>	2,543	Ref	2,334	Ref	48	Ref
Any use	251	1.18 (0.99,1.41)	68	1.16 (0.91,1.48)	160	1.20 (0.87,1.66)
<4 times per year	107	1.07 (0.86, 1.34)	37	1.09 (0.79, 1.51)	56	1.05 (0.71,1.55)
Every 5-8 weeks, 1+ per month	144	1.31 (1.05, 1.63)	31	1.26 (0.88, 1.80)	104	1.30 (0.92, 1.85)
		<i>p for trend</i>		0.2		0.1
<b>Applied to others</b>						
No use	2,716	Ref	2,380	Ref	158	Ref
Any use	78	1.27 (0.99,1.62)	22	1.38 (0.90,2.10)	50	1.22 (0.87,1.70)
<4 times per year	62	1.35 (1.03,1.77)	19	1.55 (0.98,2.44)	38	1.27 (0.88,1.84)
Every 5-8 weeks, 1+ per month	16	1.03 (0.62,1.70)	3	--	12	1.08 (0.59,1.96)
		<i>p for trend</i>		0.2		0.4

# Chemical straightener use associated with breast cancer risk in post-menopausal women

	<u>Pre-menopausal</u>		<u>Post-menopausal</u>	
	N	Hazard ratios (95% CI)	N	Hazard ratios (95% CI)
<b>Personal use in the 12 months before enrollment</b>	519		2,270	
No use <sup>†</sup>	453	Ref	2,085	Ref
Any use	66	1.05 (0.75,1.46)	184	1.26 (1.02,1.55)
<4 times per year	33	1.15 (0.77,1.70)	73	1.05 (0.80,1.37)
Every 5-8 weeks, 1+ per month	33	0.93 (0.30,1.44)	111	1.51 (1.17,1.94)
		<i>p for trend</i>		0.003
<b>Applied to others</b>				
No use <sup>†</sup>	495	Ref	2,216	Ref
Any use	24	1.18 (0.75,1.84)	53	1.34 (0.99,1.79)
<4 times per year	19	1.29 (0.79,2.10)	42	1.39 (1.00,1.92)
Every 5-8 weeks, 1+ per month	5	--	11	1.16 (0.64, 2.13)
		<i>p for trend</i>		0.1



# Hair dye use and breast cancer risk summary

## **Permanent hair dye use associated with all breast cancer risk**

↑ Frequent users

↑ Black women

↑ Light-colored dye (all breast cancer, white women, and pre-menopausal)

↑ Dark-colored dye (Black women)

No associations in ER status specific stratum

## **Semi-permanent and temporary dye use not associated with breast cancer risk**

## **Semi-permanent application to others associated with all breast cancer risk**

↑ ER +, post-menopausal

# Chemical straightener use and breast cancer risk summary

## **Personal use and application to others associated with all breast cancer**

↑ Frequent users

↑ Post-menopausal women

Non-significant suggestion that ER- breast cancers were driving association

Risk did not vary by race; prevalence of exposure varied significantly

## **Similar findings in recent studies of chemical straightener use and breast cancer**

### **Women's Circle of Health**

All breast cancer, white women: OR = 1.74, 95%CI (1.11,2.74)

ER- breast cancer: OR = 2.56, 95%CI (1.06,6.16)

### **Ghana Breast Health Study**

Current users OR = 1.39, 95% CI (1.00, 1.93)

Former users OR = 2.22, 95% CI (1.56, 3.16)

# Controversy surrounding Brazilian Keratin Treatments

2010 Oregon OSHA investigation

105 keratin treatment samples from 54 salons

Formaldehyde concentration: 6.4% - 11.8%

Formaldehyde exposure and breast cancer risk not studied

IARC Class 1 carcinogen for nasopharyngeal cancer

Health & Science

**Straight hair at what cost? Treatments using formaldehyde may pose a risk.**

Washington Post, October 17, 2011



The image shows a screenshot of a website for 'amara ORGANIC HAIR SALON'. The page features a navigation menu with links for Home, Why Amara, Services, Gallery, Prices, Tutorials, and Testimonials. Below the navigation, there is a prominent warning: 'FORMALDEHYDE' in large black letters, followed by 'Known human carcinogen' in red. To the right of this text is a red sad face icon. Below the text is a photograph of a hair salon where a stylist is using a hair dryer on a client's hair. The client is wearing a blue and white respirator mask. At the bottom of the image, the text 'WHAT YOU NEED TO KNOW!' is written in bold black letters.

## **Strengths**

- Large national sample
- Prospective cohort
- Extensive exposure information
- 90% + follow up retention
- Sufficient sample to estimate effect in black and white women

## **Limitations**

- Self-reported data
- Product formulations not known
- Exposure limited to past 12 months, use during follow up not captured

## **Future Directions**

- Assessing types of chemical straightener or relaxer
- Early life exposure in Sister Study

# Acknowledgement

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