Hair dye and chemical straighteners in relation to breast cancer risk in a large US population

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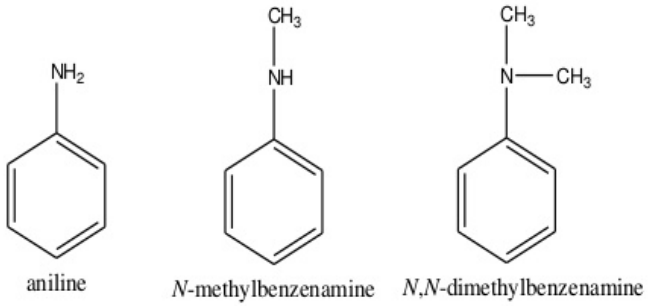
Hair products as a source of potential carcinogens

Use of hair dye and other hair products is common

- >1/3 of U.S. women above the age of 18 uses hair dye

Hair dye contains more than 5,000 chemicals

- Mutagenic and endocrine disrupting chemicals



Aromatic Amines

Aromatic amines are used as colorless dye intermediates that react with dye couplers to from pigment molecules

- Induce mammary tumors in rodents
- Women using hair dye were 8x more likely to have aromatic amine–DNA adducts in breast ductal epithelial cells

National Cancer Institute, Ambrosone et al., 2007

Hair products as a health disparities concern

Hair product constituents vary depending on whether they are marketed to Black or white women

- Products marketed to Black women contain more endocrine disrupting compounds
- Product use patterns vary by race

Chemical treatments to permanently or semi-permanently straighten or relax hair (straighteners)

- Used predominately by women of African descent
- Certain formulations are known to include the carcinogen formaldehyde

Rosenberg et al., 2007; Helm et al., 2018; Zota et al., 2017; Weathersby et al., 2013

Previous epidemiologic research

Hair dye and breast cancer results have been very inconsistent

- Very few studies have included black women
- Two recent case-control studies suggested excess of 25% risk
  - Llanos et al., observed a 51% higher risk associated with dark dyes use in African-American women in Women's Circle of Health Study (WCHS)

Chemical straighteners

- No increase in risk in Black Women's Health Study
- Two recent case-control studies suggest a positive association
  - Ghana breast health study: 58% higher risk
  - WCHS: 74% higher risk overall in white women, suggestive association in African-American women with ER- disease

Heikkinen et al., 2015; Llanos et al., 2017; Rosenberg et al., 2007; Brinton et al., 2018

Objective

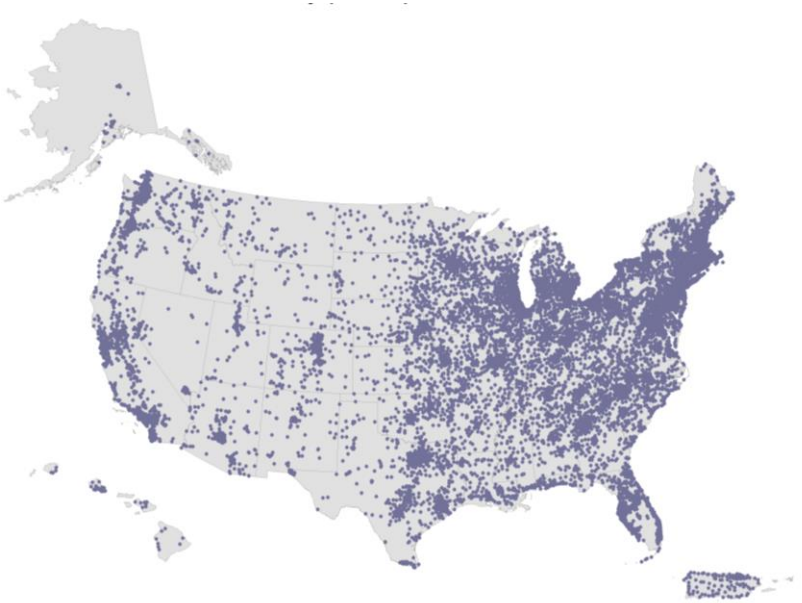
Estimate the association between hair dye and chemical straightener use and breast cancer risk in a prospective cohort

- Evaluate whether the association varies by race

Sister Study

Prospective cohort study (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*



Follow-up

- Participants complete annual health updates and biennial surveys
- Breast cancer diagnoses (invasive and *DCIS*) are self-reported and confirmed using medical records

2,749 incident cases
8.3 years of follow-up

Sandler et al., 2017

Hair product exposure assessment

Permanent hair dye, semi-permanent hair dye, temporary dyes, and chemical straighteners in 12 months before enrollment

- Did not use
- 1-2 times/year
- Every 3-4 months
- Every 5-8 weeks
- Once a month
- More than once a month

(1) Dichotomous: did not use vs. used

(2) Frequency: did not use vs.
(LOW) used 1-2 or 3-4 times in the past year
(HIGH) used every 5-8 weeks or ≥once a month

Dye color (dark, light or both)

Duration of permanent and semi-permanent dye use (years)

Non-professional application to others

Statistical Analysis

Cox proportional hazards models with age as the timescale

Adjusted for age at menarche, menopausal status at enrollment, educational attainment, body mass index, smoking history, oral contraceptive use, parity, and age at first birth

Stratified by self-identified race (non-Hispanic white and black)

Evaluated association by menopausal status at diagnosis and ER tumor subtype

Study participant baseline characteristics

Average age of 55 years

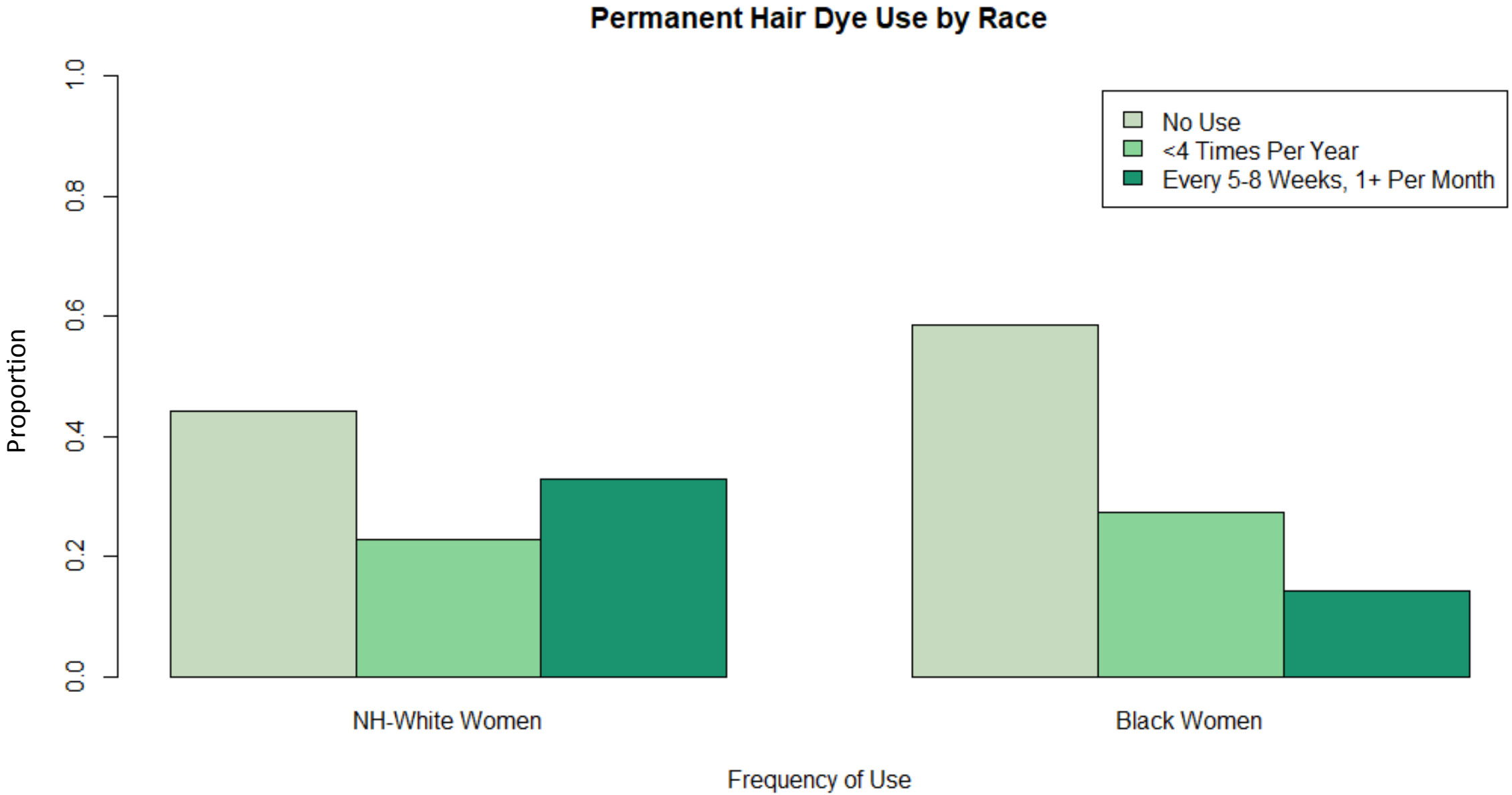
82% Non-Hispanic white, 9% black

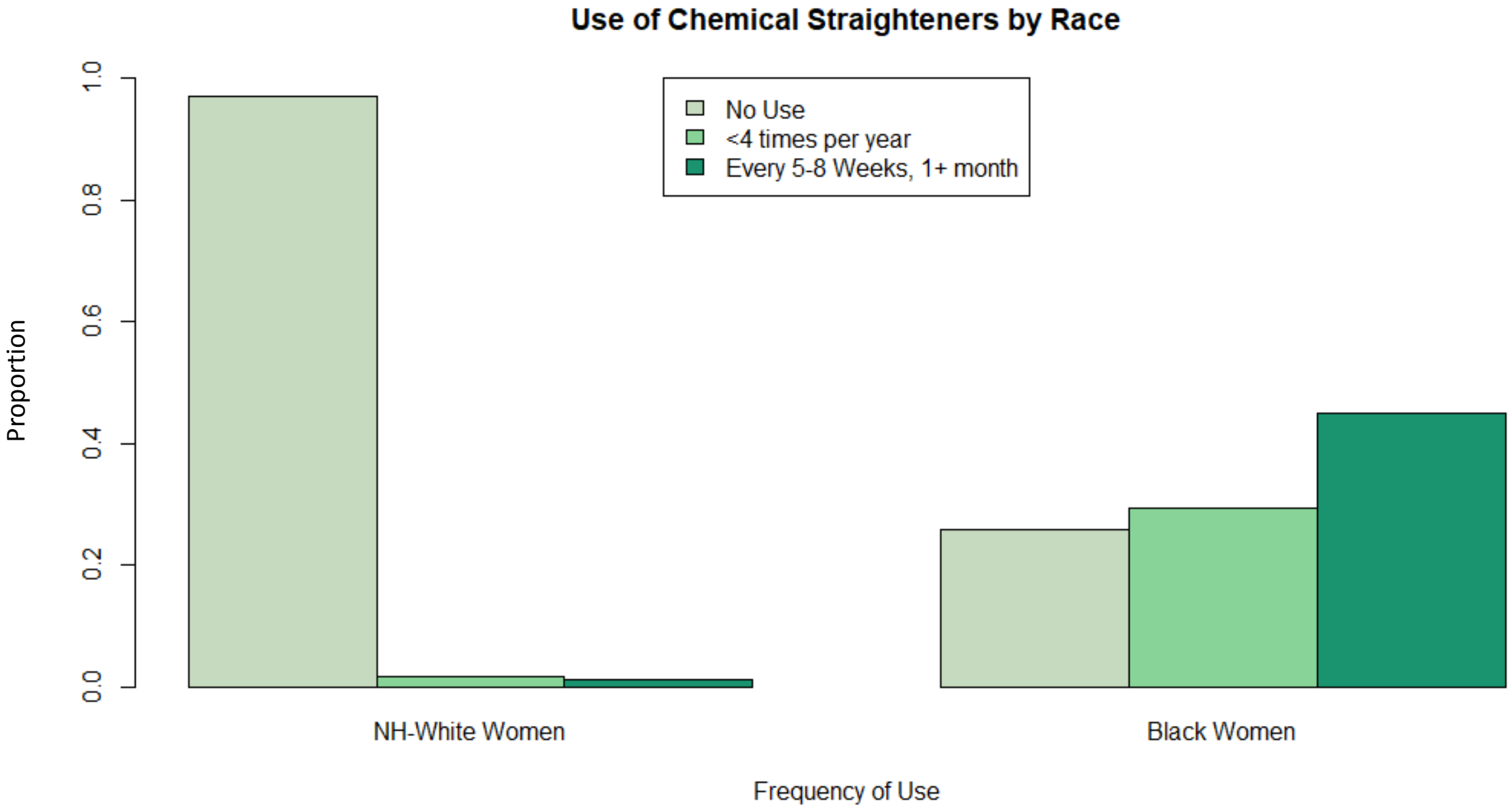
75% household income >$50,000/year

~50% have a bachelor's degree or higher

55% reported permanent hair dye

10% reported straightener use

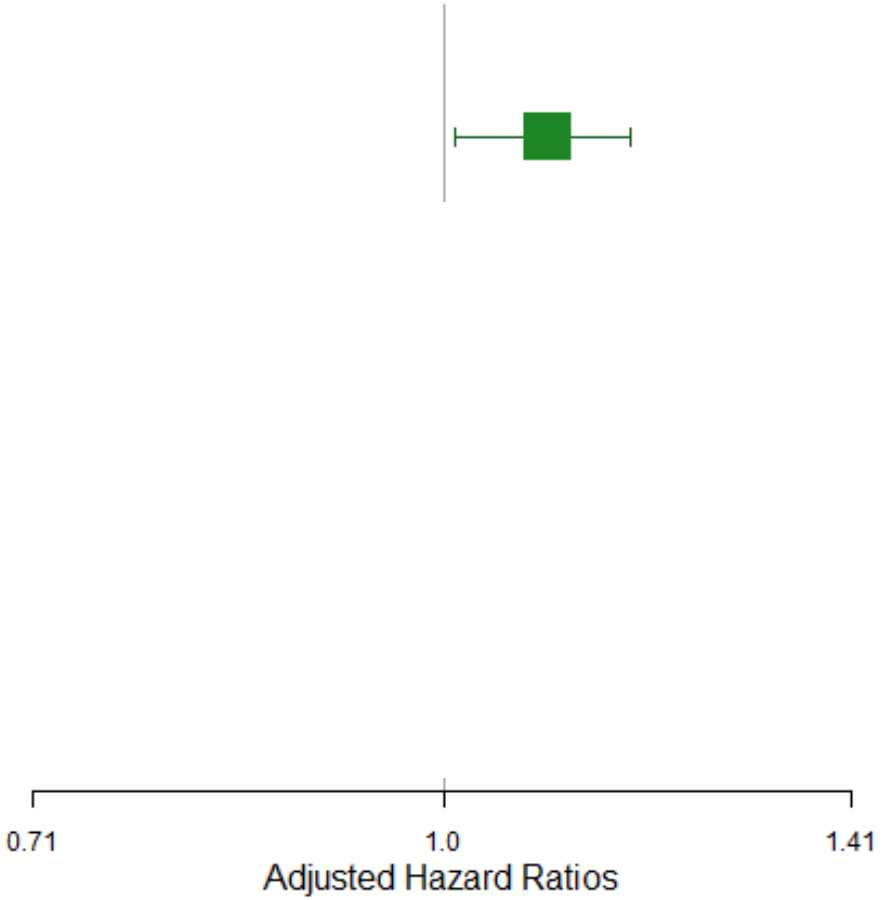

Permanent Hair Dye Use by Race
No Use
<4 Times Per Year
Every 5-8 Weeks, 1+ Per Month
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
NH-White Women
Black Women
Frequency of Use



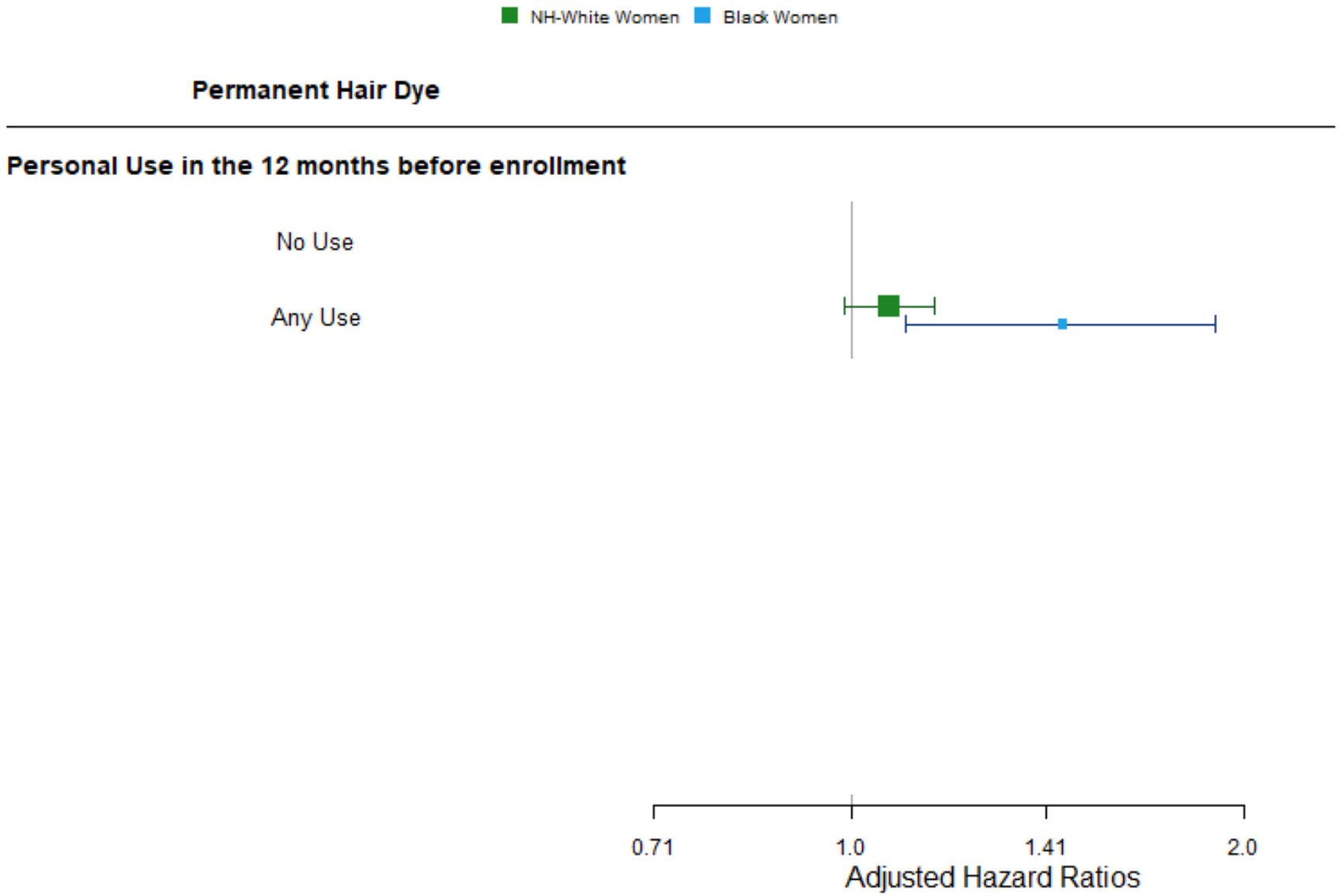
Eberle, Sandler, Taylor and White in press 2019 Int J Cancer

Permanent Hair Dye Use and Risk of Breast Cancer

Permanent Hair Dye Use	HR
Personal use in the 12 months before enrollment	
No Use	Ref
Any Use	1.09



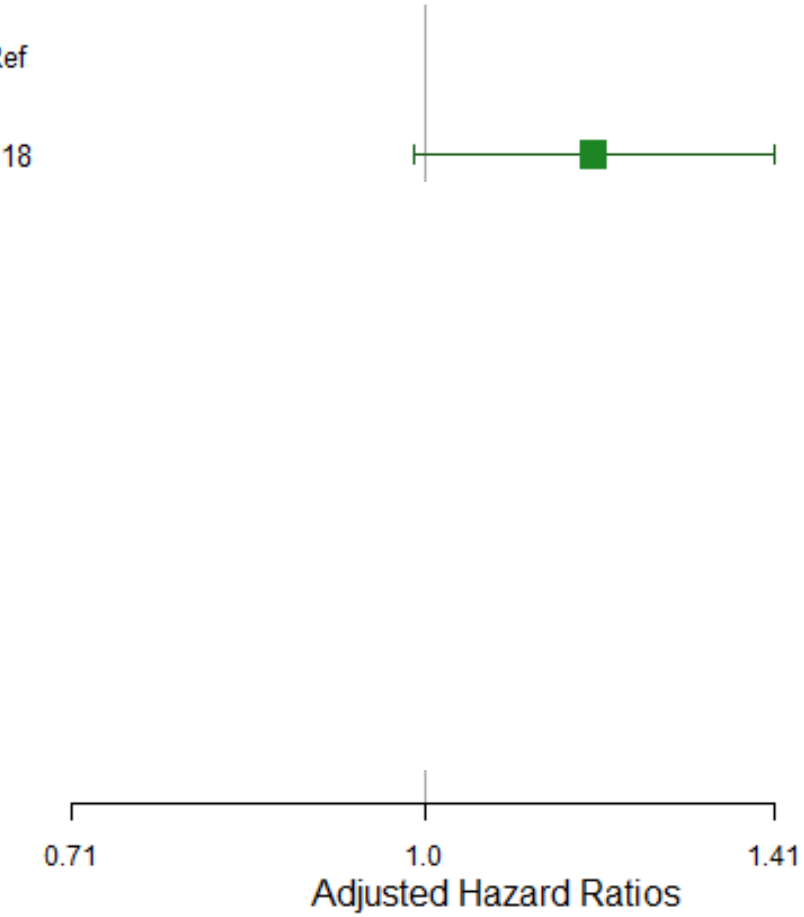
Permanent Hair Dye Use and Risk of Breast Cancer by Race



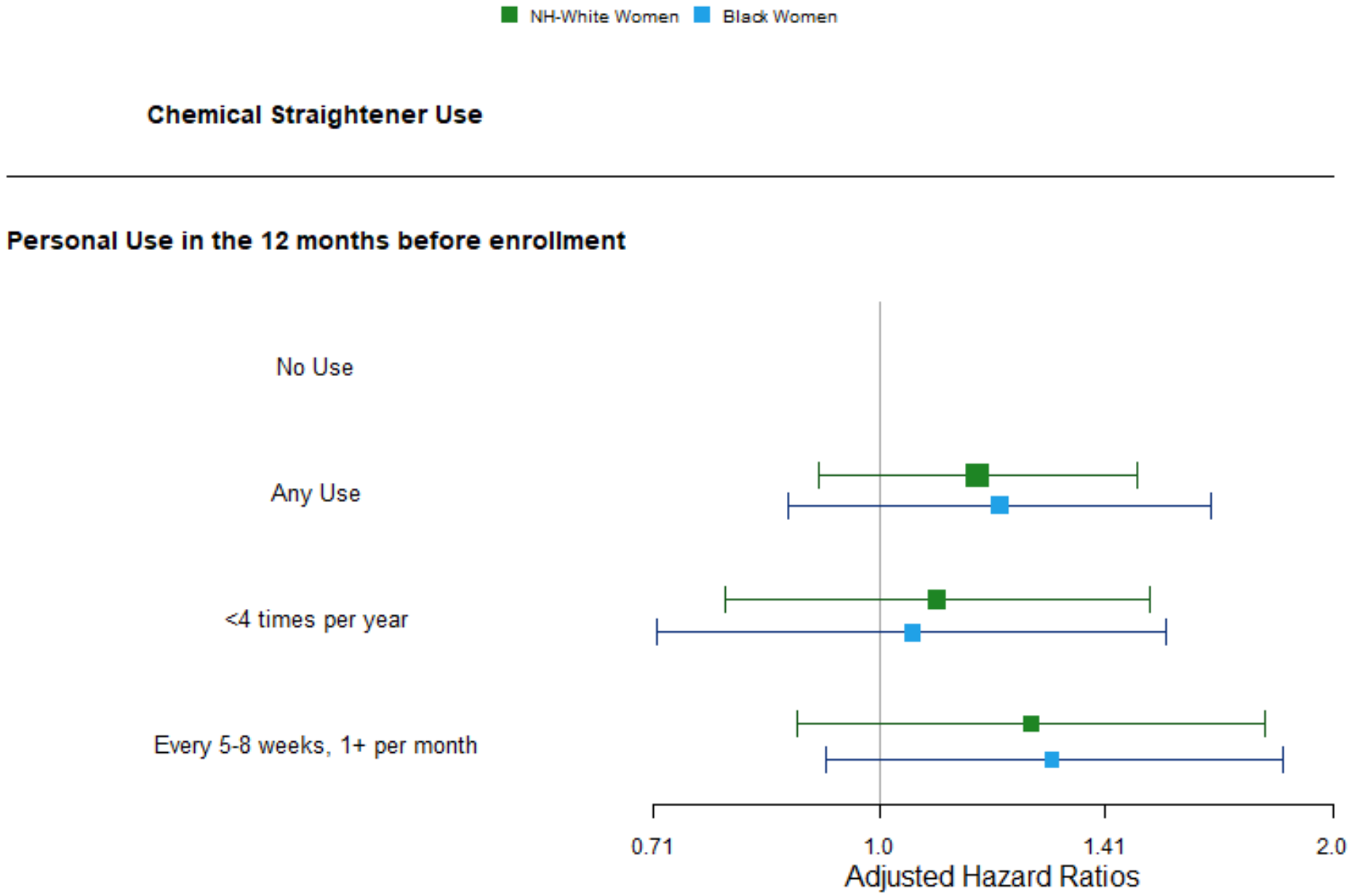
heterogeneity p=0.04

Chemical Straightener Use and Risk of Breast Cancer

Chemical Straightener Use	HR
Personal Use in the 12 months before enrollment	
No Use	Ref
Any Use	1.18



Chemical Straightener Use and Risk of Breast Cancer by Race



Other findings

Straightener use and permanent hair dye associations appeared stronger in estrogen receptor (ER)-negative tumors

- Little variability by menopausal status at diagnosis

Little to no increase in risk for increasing years of dye use

No higher risk for semi-permanent dye, temporary dyes

- Higher risk for application of semi-permanent dye to others (HR=1.28; 95% CI: 1.05-1.56)

Considerations

Prospective design limited the possibility of recall bias (differential recall by case status); but, recall error is still a possibility

Exposure collection time-period ascertained more recent formulations (for example: Brazilian Keratin treatments)

Future studies need better power to jointly consider race and subtype

Unable to evaluate formulation of products and the constituents are not reliably documented on labels

All women in our study have a family history of breast cancer

Conclusions

In a large prospective study of white and black women in the US, we observed positive associations with permanent dye and chemical straightener use in relation to breast cancer risk

Associations with dye were stronger in black women; associations with straightener did not vary by race

- However, frequency of use is much higher in black women

These results confirm recent case-control findings that both dye and chemical straightener use may play a role in breast cancer risk and contribute to health disparities by race

Given the widespread use of hair dye products, even a small increase in risk may have considerable public health impact

Acknowledgements

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