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# Ethnic and socioeconomic disparities in participation in breast cancer risk assessment: findings from the BCAN-RAY study (NCT05305963)

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**Background:** Breast cancer risk assessment for women aged 30–39 years would facilitate the offer of early screening and prevention approaches in those at increased risk. The Breast CANcer Risk Assessment in Young women (BCAN-RAY) study (NCT05305963) is evaluating the feasibility of breast cancer risk assessment in women aged 30–39 years without a strong family history, aiming to recruit a diverse ethnic and socioeconomic sample. The present analysis compares uptake rates to the study by ethnicity and socioeconomic status.

**Methods:** A total of 14,366 women aged 30–39 years, without a strong family history of breast cancer, were invited via general practices across Greater Manchester and Cheshire. Aggregated data on ethnicity and socioeconomic status of residence (via Index of Multiple Deprivation quintiles) at general practice level were used for invited women and self-reported ethnicity for those enrolled into the study. Chi-squared tests assessed differences in study uptake according to ethnicity and socioeconomic status.

**Results:** Overall uptake to BCAN-RAY was 5.2% (750/14,366 women). Highest uptake was seen in White women (654/5,005; 13.1%) compared to Black (10/511; 2%) and Asian women (50/2,089; 2.4%) [$\chi 2$ (4) = 219.86, $p < 0.001$]. Women residing in the most deprived areas were also underrepresented among enrolled participants [$\chi 2$ (4) = 75.31, $p < 0.001$].

**Conclusion:** Alternative delivery models need to be considered to improve accessibility and engagement in future research and in any implementation to routine practice.

KEYWORDS
breast cancer, ethnicity, health inequalities, risk assessment, risk stratification, socioeconomic status

# Introduction

Advances in breast cancer risk prediction models have enabled enhanced estimation of a woman's likelihood of developing the disease (1, 2). Provision of personalized breast cancer risk estimates at the population level to date have mainly focused on implementing risk-based breast cancer screening programmes (3–5). However, this focus on population screening programmes excludes younger women who may benefit from screening and preventive strategies (6). The Breast CANcer Risk Assessment in Younger women (BCAN-RAY) study (NCT05305963) evaluated a comprehensive breast cancer risk assessment strategy among a population of women aged 30–39 years without a strong family history of breast cancer, aiming for ethnic and socioeconomic diversity in the sample (7). Previous attempts to implement risk assessment during routine mammographic screening have recruited low numbers of women from ethnic minority backgrounds and those living in socioeconomically deprived areas, highlighting the potential for such approaches to widen existing inequalities in breast cancer care (5, 8). The aim of the present analysis was to compare ethnicity and socioeconomic status between invited women who did not enroll and those who did enroll in BCAN-RAY, to assess the presence of disparities in participation.

# Methods

## Setting and participants

General practices across Greater Manchester and Cheshire in the North-West of England were approached to participate in BCAN-RAY as participant identification centers, with 17 practices agreeing to take part. Each practice conducted an electronic database search to identify women aged 30–39 years who were likely to meet the study's eligibility criteria. All potentially eligible women were invited by postal letter from their general practice between May 2023 and May 2025. No reminders were sent, and the invitation process was identical across all sites. The invitation letter presented the research as an opportunity to identify which women in their thirties have an increased risk of getting breast cancer so that early breast screening and prevention could be offered. Women were directed to view the participant information sheet online where the risk assessment process was outlined in detail.

Women met BCAN-RAY study inclusion criteria if they were (1) born biologically female, (2) aged 30–39 years and (3) able to provide informed consent. Exclusion criteria are listed in Box 1. For this study, strong family history was defined as a first-degree relative diagnosed with breast cancer under the age of 50 or two or more second-degree relatives diagnosed with breast cancer at any age (9). Recruitment closed once 750 women had enrolled.

## BCAN-RAY study procedure

Participants completed a comprehensive breast cancer risk assessment comprising a self-reported risk factor questionnaire, a saliva sample for genetic analysis, and a hospital visit for low-dose mammography to measure breast density. Participants were contacted by telephone or email to arrange the hospital visit which took place at the Nightingale Center, a UK center of excellence for breast cancer treatment and research. Appointments were available on weekdays and Saturday mornings and participants could reschedule if required. The Nightingale Center is well served by public transport, and travel and parking costs were reimbursed. One hour was allocated for each appointment.

Women identified as being at increased risk were offered a telephone appointment with an experienced breast oncologist (SJH) with expertise in risk assessment, screening and prevention, working in a family history clinic. During this consultation, early screening and preventive options including risk-reducing medication were discussed in line with National Institute for Health and Care Excellence (NICE) recommendations (6). Further methodological details are provided in the BCAN-RAY study protocol (9).

## Statistical analysis

Participating practices extracted self-reported ethnicity where available and residential postcode data from their records for all women invited to take part in BCAN-RAY. Study uptake was defined as completion of the full risk assessment process. Comparative groups were specified as women who were invited and enrolled in the study ($n = 750$) vs. invited women who did not enroll.

Socioeconomic status estimates were derived from postcodes and converted into deprivation deciles using the 2019 Index of Multiple Deprivation (IMD), a standardized geographic measure of relative deprivation for small areas in England. The IMD combines seven domains–education, crime, employment, health deprivation and disability, income, barriers to housing and services, and living environment–to produce an overall measure of unmet needs. Neighborhoods are ranked from most to least deprived and were grouped into five equal categories for analysis (quintile 1 = most deprived; quintile 5 = least deprived). Aggregated, non-identifiable IMD data were shared with the research team, along with reasons for any missing data.

Ethnicity data were mapped onto the five high-level ethnic categories used in the 2021 Census for England (White; Asian or Asian British; Black, Black British, Caribbean or African; Mixed or multiple and Other ethnic group) (10). The Census defines ethnic group based on self-identification, reflecting the group to which the person feels they belong. This could be based on their culture, family background, identity, or physical appearance. Sensitivity analyses were conducted to assess whether alternative coding assumptions for ethnicity categories that did not clearly map onto any of the chosen categories affected the results.

For each analysis, uptake within each IMD quintile or ethnic group was calculated as the number of enrolled women in that category divided by the number of invited women with available data for that category. Only women with complete data for the variable being analyzed were included in the relevant denominators. Chi-squared analyses using SPSS (version 29) were

BOX 1 Study exclusion criteria.

- Strong family history of breast cancer, defined as a first degree relative diagnosed with breast cancer under the age of 50 or two or more second-degree relatives diagnosed with breast cancer at any age.
- Already under follow up in a breast cancer family history clinic or have a known mutation in a moderate or high-risk breast cancer gene.
- Any prior malignancy (excluding non-melanoma skin cancer).
- Had a double mastectomy (both breasts removed).
- Breast implants or breast augmentation surgery.
- Currently pregnant.
- Currently breast-feeding or stopped breast-feeding less than six months ago.
- Any condition that would make breast cancer risk assessment inappropriate such as a severe psychiatric or physical illness (assessed by the individual responsible for identifying and inviting women).
- Unable to understand written English.

used to assess whether uptake differed significantly across IMD quintiles and across ethnic groups. Where these omnibus tests were significant, *post hoc* pairwise comparisons between IMD quintiles were conducted using $2 \times 2$ chi-square tests. To control for multiple testing across the ten possible pairwise contrasts, $p$-values were adjusted using the Holm step-down procedure. The same approach was applied to ethnicity. All statistical tests were two-sided and used a significance level of 5%.

## Results

A total of 14,366 women were invited to participate in BCAN-RAY via 17 general practices operating across 25 sites (multiple locations for some practices), with wide variation in patient ethnicity and socioeconomic status (Table 1), yielding an overall uptake of 750/14,366 (5.2%)

### Uptake by socioeconomic status (IMD quintile)

Fourteen thousand three hundred and fifty five records were received (99.9% of total invited). During the linkage of residential postcodes to IMD quintiles, 277 could not be matched due to invalid entries. This resulted in a final sample of 14,078 in the analysis, including all 750 enrolled participants and 13,328 invited women who did not enroll. There was a statistically significant association between IMD quintile and participation (Table 2). Uptake varied from 3.4% (quintile 1) to 7.7% (quintile 5), and after Holm correction only differences between the least deprived group (quintile 5) and the two most deprived groups (quintiles 1 and 2) remained statistically significant (adjusted $p = 0.010$), indicating that the largest disparities in participation occurred between women living in the least and most deprived areas. No other differences between quintiles reached statistical significance after adjustment.

### Uptake by ethnicity

For ethnicity analyses, 14,342 records were received (99.8% of all invited).Of these, 515 records were excluded because participants had not shared their ethnicity with their general practice and 847 were excluded due to missing data. Individuals whose self-reported ethnic group did not map onto one of the five high-level Census 2021 ethnic groups used in the present analysis were also excluded ($n = 3{,}908$; see Supplementary file 1 for the full list of excluded ethnic categories). This resulted in a final sample of 9,072 in the analysis, comprising 750 enrolled participants and 8,322 invited women who did not enroll. There was a statistically significant association between ethnicity and participation (Table 3). Uptake was significantly higher among women identifying as white (13.1%) than among any of the four ethnic minority groups (2–5.5%), and after Holm correction these differences remained statistically significant for all contrasts between the white group and the Asian, Black, Mixed or multiple, and Other groups (adjusted $p = 0.010$). No comparisons between ethnic minority groups remained statistically significant after adjustment, indicating that disparities in participation were driven primarily by lower uptake among all ethnic minority groups when compared with women of white ethnicity. Sensitivity analyses adjusting for various coding assumptions yielded consistent results (see Supplementary file 2).

## Discussion

Overall, uptake to the BCAN-RAY study was low at 5.2%. Statistically significant differences in uptake were observed by

TABLE 1 Characteristics of the women invited at general practices involved in BCAN-RAY.

| Practice number | Local authority district | Number invited | % uptake | Estimated % ethnic groups in practice population[a] | | | | Deprivation quintile of practice location[b] |
|---|---|---|---|---|---|---|---|---|
| | | | | White | Asian | Black | Mixed & other | |
| 1 | Trafford | 516 | 6.6 | 80.8 | 12.1 | 1.4 | 5.7 | 5 |
| 2 | Manchester | 1170 | 3.2 | 61.0 | 21.5 | 5.8 | 11.7 | 2 |
| 3 | Cheshire East | 257 | 3.9 | 93.9 | 2.7 | 0.0 | 3.4 | 5 |
| 4 | Trafford | 1118 | 9.8 | 83.1 | 9.3 | 2.0 | 5.6 | 4 |
| 5 (4 sites) | Cheshire East | 500 | 2.2 | 94.4 | 2.6 | 0.0 | 3.0 | 2 |
| 6 | Tameside | 605 | 5.3 | 93.2 | 3.7 | 1.3 | 1.8 | 1 |
| 7 (2 sites) | Manchester | 841 | 2.0 | 32.6 | 33.5 | 20.6 | 13.3 | 1 |
| 8 | Manchester | 597 | 7.7 | 79.3 | 9.2 | 3.6 | 7.9 | 3 |
| 9 | Rochdale | 500 | 8.0 | 87.2 | 3.9 | 5.2 | 3.7 | 1 |
| 10 | Trafford | 551 | 4.9 | 89.2 | 5.5 | 2.0 | 3.3 | 3 |
| 11 | Cheshire East | 929 | 3.9 | 97.4 | 1.4 | 0.0 | 1.2 | 2 |
| 12 (2 sites) | Wigan | 436 | 4.8 | 96.2 | 1.3 | 0.0 | 2.5 | 1 |
| 13 | Trafford | 943 | 6.5 | 81.7 | 11.5 | 1.1 | 5.7 | 5 |
| 14 | Manchester | 588 | 1.7 | 38.7 | 39.7 | 10.4 | 11.2 | 2 |
| 15 | Salford | 903 | 5.9 | 90.8 | 3.8 | 1.7 | 3.7 | 4 |
| 16 (4 sites) | Bury | 3185 | 4.6 | 86.1 | 9.2 | 1.5 | 3.2 | 4 |
| 17 | Trafford | 727 | 8.1 | 77.4 | 13.7 | 2.4 | 6.5 | 4 |

[a]Estimated ethnic composition of registered patients at general practices in England, based on aggregated demographic data, available from the National General Practice Profiles (11). [b]Derived from practice postcode using the 2019 Index of Multiple Deprivation, a measure of relative deprivation for small areas in England (quintile 1, most deprived; quintile 5, least deprived) (12). For practices operating across multiple sites, the postcode of their main site was used.

TABLE 2 Frequencies (and percentages) of women invited and enrolled, broken down by deprivation quintile, with a statistical test to assess association between socioeconomic status and enrolment status.

| IMD quintile | Invited (*n*) | Enrolled (*n*) | Uptake % (enrolled ÷ invited) | Test statistic | *P* value |
|---|---|---|---|---|---|
| Total | 1,4078 | 750 | | $\chi^2$ (4) = 75.31 | **<0.001** |
| 1 (most deprived) | 3,043 | 102 | 3.4[a] | | |
| 2 | 2,680 | 102 | 3.8[a] | | |
| 3 | 1,716 | 116 | 6.8[ab] | | |
| 4 | 2,539 | 172 | 6.8[ab] | | |
| 5 (least deprived) | 3,350 | 258 | 7.7[b] | | |
| Unknown | 277 | | | | |

IMD, Index of Multiple Deprivation. Uptake % is calculated as the number of enrolled women within each IMD quintile divided by the number of invited women with available IMD data in that quintile (enrolled ÷ invited). Only women with complete IMD data were included ($n$ = 14,078). Values sharing the same superscript do not differ significantly. Holm-corrected *post hoc* tests showed significant differences between the most deprived groups ([a]) and the least deprived group ([b]); adjusted $p = 0.010$. Values shown in bold are statistically significant (i.e., $P < 0.05$ or lower).

both socioeconomic status and ethnicity, with substantially lower participation among women living in the most deprived areas and among all ethnic minority groups compared with women of white ethnicity.

Uptake to BCAN-RAY was lower than in previous research studies that implemented risk assessment during routine mammographic screening in similar geographical and demographic areas (12.7–38%) (5, 8). In these studies, women were already attending a screening appointment and risk assessment was an add-on. In contrast, BCAN-RAY was not based on an existing screening service and required a separate hospital visit. Women aged 30–39 years have previously reported limited time and difficulty accessing healthcare services (13). Previous qualitative research has also shown that women in this age group perceive breast cancer as a future health concern and report limited awareness of it as a potentially preventable disease (14). Future quantitative research is needed to examine whether this lack of knowledge contributes to low engagement with risk assessment. Furthermore, uptake was lower than studies in primary care inviting women

TABLE 3 Frequencies (and percentages) of women invited and enrolled, broken down by self-reported ethnic background, with a statistical test to assess association between ethnicity and enrolment status.

| Ethnic group (2021 Census high-level categories) | Invited (*n*) | Enrolled (*n*) | Uptake % (enrolled ÷ invited) | Test statistic | *P* value |
|---|---|---|---|---|---|
| Total | 9,072 | 750 | | $\chi 2$ (4) = 219.86 | **<0.001** |
| White | 5,005 | 654 | 13.1[a] | | |
| Asian or Asian British | 2,089 | 50 | 2.4[b] | | |
| Black, Black British, Caribbean or African | 511 | 10 | 2.0[b] | | |
| Mixed or multiple ethnic groups | 373 | 17 | 4.6[b] | | |
| Other ethnic group | 344 | 19 | 5.5[b] | | |

Uptake % is calculated as the number of enrolled women within each ethnic group divided by the number of invited women with available ethnicity data in that qroup (enrolled ÷ invited). Only women with complete ethnicity data were included ($n = 9{,}072$). Values sharing the same superscript do not differ significantly. Holm-corrected *post hoc* tests showed significant differences between the white group ([a]) and all minority groups ([b]); adjusted $p = 0.010$. Values shown in bold are statistically significant (i.e., $P < 0.05$ or lower).

to complete family history questionnaires as part of a risk assessment (15).

Given the relatively poor uptake rate to BCAN-RAY, alternative delivery models need to be considered to improve accessibility and engagement in future research and in any implementation to routine practice. The potential for a general practice-based programme to identify those at increased risk of breast cancer is currently being investigated (16, 17). Additionally, future rollouts should consider public health campaigns to raise awareness of the potential benefits of participating in breast cancer risk assessment to improve engagement and uptake. A "one-stop shop" delivery model available locally has previously been identified as an attractive approach to implementation (13).

Uptake to BCAN-RAY was lowest for Black women who may have the most to gain from breast cancer risk assessment as they experience higher incidence of aggressive tumor types and higher mortality rates than their white counterparts (18, 19). Studies suggest that breast cancer is sometimes perceived within Black communities as a condition predominantly affecting white women, which may contribute to limited discussion and lower perceived relevance (13, 20). Additionally, misconceptions about, and lack of understanding of, the causes of breast cancer and personal risk has been identified as a key barrier to breast screening attendance among Black women in the UK (21).

To address these barriers, future research should collaborate with trusted community leaders to develop culturally sensitive health messages tailored to community specific beliefs and perceptions that may hinder engagement with healthcare services (13, 22). Community-based, culturally tailored interventions have been shown to improve uptake of cancer screening among ethnic minority groups (23). Such approaches are particularly important in Black communities, where historical instances of exploitation and unethical research practices have contributed to long lasting mistrust in medical research (24).

## Strengths and limitations

The large dataset, drawn from areas with substantial variation in ethnicity and socioeconomic status, enabled a robust exploration of inequalities in study uptake. This is an important step when developing new services as it helps ensure that considerations of equity are embedded from the outset. Sensitivity analyses addressing ambiguous ethnicity classifications further strengthened confidence in the findings. However, a considerable proportion of ethnicity records could not be mapped onto the ethnic categories, introducing potential bias.

Using area level IMD as a proxy for socioeconomic status limits individual level interpretation and introduces the risk of ecological fallacy. We were unable to assess individual socioeconomic circumstances directly, as data on personal income, educational attainment or other individual-level SES indicators were not available. However, systematic reviews consistently show that lower educational attainment and lower household income are strongly associated with reduced participation in cancer screening and prevention activities (25, 26). This underscores the need to look beyond area deprivation.

# Conclusion

Uptake to the BCAN-RAY study was low overall with clear disparities by ethnicity and socioeconomic status. Alternative delivery models are needed to improve accessibility and engagement in future research and in any implementation to routine practice, including general practice-based approaches, local "one-stop shop" services and public health campaigns to raise awareness of the benefits of risk assessment. Community-based, culturally tailored health interventions developed in partnership with trusted leaders may improve participation among ethnic minority groups.

# Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Ethics statement

The studies involving humans were approved by North West—Greater Manchester West Research Ethics Committee (Reference: 22/NW/0268). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

## Author contributions

SHi: Formal analysis, Writing – original draft, Writing – review & editing, Investigation, Project administration, Conceptualization, Methodology. SHo: Writing – review & editing, Conceptualization, Funding acquisition, Methodology. JU-S: Methodology, Writing – review & editing, Funding acquisition, Conceptualization. RH: Investigation, Writing – review & editing. DM-M: Writing – review & editing, Investigation. SN: Investigation, Writing – review & editing. ER: Writing – review & editing, Investigation. HR: Investigation, Writing – review & editing. JS: Writing – review & editing, Investigation. CS-P: Writing – review & editing, Investigation, Software. DF: Writing – review & editing, Supervision, Methodology, Funding acquisition, Formal analysis, Conceptualization.

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## Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcacs.2026.1759843/full#supplementary-material

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