BACKGROUND: Ethnic minority women are commonly reported to have more aggressive breast cancer than White women, but there is little contemporary national evidence available.

METHODS: We analysed data from the National Cancer Registration and Analysis Service on women diagnosed with invasive breast cancer during 2013–2018. Multivariable logistic regression yielded adjusted odds ratios (and 95% confidence intervals) of less favourable tumour characteristics (high stage, high grade, ER negative, Her2 positive) by ethnicity (black African, black Caribbean, Indian, Pakistani and white) in younger (30–46 years) and older (53–70 years) women.

RESULTS: In 24,022 women aged 30–46 at diagnosis, all ethnic minority groups apart from Indian women had a significantly greater odds of certain less favourable tumour characteristics compared to white women in fully adjusted models. In 92,555 women aged 53–70, all ethnic minorities had a significantly greater adjusted odds of several of the less favourable tumour characteristics. These differences were most marked in black African and black Caribbean women.

CONCLUSIONS: Ethnic minority women are at greater risk of breast cancers with less favourable characteristics, even after allowing for age and other potential confounders. These differences are greater in older than younger women, and in the Black rather than South Asian ethnic groups.
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RESULTS

From the NCRAS data, 244,135 women were registered with a diagnosis of unilateral invasive breast cancer (ICD-10 C50) between January 1, 2013 and December 31, 2018. Among these women, 221,885 women (90.9%) had a recorded ethnicity in one of the five groups of interest. 24,022 (10.8%) of these women were aged 30–46 years of age and 92,555 (41.7%) of these women were aged 53–70 years at diagnosis and formed the two populations for analysis.

For the adjustment variables, data were complete for age at diagnosis, region, year of diagnosis and the measure of comorbidity using the Charlson Index. Information on deprivation was missing for less than 0.1% of the population, and a record of attendance at the last routine screen before cancer diagnosis was missing for 6.5% of women aged 53–70 years at diagnosis and ranged from 6.5 to 8.9% across the ethnic groups.

The characteristics of the younger women are summarised in Table 1. Of the 24,022 younger women aged 30–46 years at diagnosis, 91.6% were white; the remaining women were Indian (2.5%), black Caribbean (1.4%), Pakistani (2.0%) and black African (2.5%). The average age at diagnosis was similar and ranged from 39.9 years in black African and Pakistani women to 40.7 years in black Caribbean women. Highly significant differences were observed for deprivation scores (p < 0.0001) and comorbidity (p = 0.0007) between the ethnic minority groups with almost half of black Caribbean, Pakistani and black African women in the most deprived quintile, compared to less than a fifth of Indian and white women. Pakistani women had the poorest health of all the ethnic groups with a fifth recording at least one comorbidity.

In general, all ethnic minority women presented with higher proportions of the less favourable tumour characteristics other than Her2-positive disease. For example, compared to white women, black African women had significantly higher proportions of high stage disease (26.6% versus 17.6%, p < 0.0001), high grade disease (57.4% versus 47.6%, p < 0.0001) and ER-negative disease (30.1% versus 23.0%, p = 0.005). The overall proportion of missing data was 7.8% for stage, 2.7% for grade, 25.1% for ER status and 20.8% for Her2 status, with ethnic minority women having higher proportions of missing data.

The results of multivariate analysis of the odds of the less favourable tumour characteristics by ethnicity in the younger women are shown in Fig. 1. In analyses with minimal adjustment,
Table 1. The characteristics of women aged 30–46 years at diagnosis with breast cancer between 2013 and 2018.

|                     | White (n = 22,001) | Indian (n = 604) | Pakistani (n = 483) | Black Caribbean (n = 325) | Black African (n = 609) | P-value |
|---------------------|--------------------|------------------|--------------------|--------------------------|-------------------------|---------|
| **Patient characteristics** |                    |                  |                    |                          |                         |         |
| Mean age at diagnosis (SD) | 40.7 (4.3)         | 40.3 (4.2)       | 39.9 (4.2)         | 40.7 (4.3)               | 39.9 (4.3)              | <0.001  |
| Most deprived quintile  | 15.9 (3 490)       | 17.3 (104)       | 48.1 (232)         | 41.5 (134)               | 41.1 (248)              | <0.001  |
| Comorbidity           | 14.3 (3 137)       | 12.3 (74)        | 19.0 (92)          | 16.6 (54)                | 10.5 (64)               | 0.001   |
| **Tumour characteristics** |                    |                  |                    |                          |                         |         |
| Stage 3              | 17.6 (3579)        | 17.6 (97)        | 20.4 (89)          | 23.8 (72)                | 26.6 (147)              | <0.001  |
| Grade 3              | 47.6 (10,196)      | 48.9 (288)       | 60.4 (279)         | 52.6 (163)               | 57.4 (334)              | <0.001  |
| ER negative          | 23.0 (3813)        | 26.8 (109)       | 25.6 (89)          | 23.3 (52)                | 30.1 (122)              | 0.005   |
| Her2 positive        | 21.5 (3767)        | 20.6 (93)        | 20.3 (78)          | 17.5 (44)                | 22.3 (98)               | 0.521   |

**OR (95% CI)**

| Stage 3              | 1.00 (0.81, 1.29)  | 1.00 (0.80, 1.25) | 1.00 (0.89, 1.43)  | 1.00 (0.85, 1.43)        | 1.00 (0.81, 1.29)       |         |
| Grade 3              | 1.00 (0.88, 1.22)  | 1.03 (0.87, 1.22) | 1.13 (0.93, 1.50)  | 1.10 (0.96, 1.43)        | 1.00 (0.81, 1.29)       |         |
| ER negative          | 1.00 (0.97, 1.52)  | 1.20 (0.96, 1.51) | 1.40 (1.06, 1.83)  | 1.58 (1.29, 1.92)        | 1.58 (1.29, 1.92)       |         |
| Her2 positive        | 1.00 (0.97, 1.52)  | 1.20 (0.96, 1.51) | 1.40 (1.06, 1.83)  | 1.58 (1.29, 1.92)        | 1.58 (1.29, 1.92)       |         |

**Fig. 1** Odds ratio of high risk versus low risk tumour characteristics by ethnic group in women aged 30–46 years at diagnosis. OR = odds ratio. Minimally adjusted for age, region and year of diagnosis and then fully adjusted for deprivation and comorbidity.
Indian women had similar odds of all the less favourable tumour characteristics examined compared to white women. Black Caribbean women had significantly greater odds only for high stage disease and Pakistani women only for high grade disease, whereas Black African women had significantly greater odds for high stage, high grade and ER-negative disease compared to white women. Adjustment for measures of health-seeking behaviour resulted in attenuation of the risk of high stage disease to a degree, but greater odds of all the less favourable tumour characteristics remained in fully adjusted models e.g. black African women compared to white women in fully adjusted models: high stage disease OR 1.58 (95% CI 1.29–2.92), for high grade disease OR 1.40 (95% CI 1.18–1.66) and ER-negative disease OR 1.36 (95% CI 1.09–1.70).

The characteristics of the older women at diagnosis are shown in Table 2. Of the 92,555 women aged 53–70 years at diagnosis, 95.9% were white, 1.8% were Indian and <1% were Black Caribbean, Pakistani and black African, respectively. The average age at diagnosis ranged from 59.3 years in black Caribbean women to 61.8 years in white women. There were highly significant differences by ethnicity for deprivation (p < 0.0001) and the presence of at least one significant comorbidity (p < 0.0001). In general, all the ethnic minority women were more deprived compared to white Women, and in poorer health except for black African women. The overall attendance for the last screen before diagnosis where this was known, was highest for white, Indian and black Caribbean women (81.3–84.4%), and lower in black African women (75.7%) and Pakistani women (71.4%) (p < 0.001). The proportion of screen-detected cancers in women who had attended for screening was different by ethnicity. White, Indian and Pakistani women had similar proportions of screen-detected cancers (67.0–69.1%), but this proportion was lower in black African (61.7%) and black Caribbean women (59.4%) (p < 0.001).

There were significant differences by ethnicity in all the tumour characteristics examined (p < 0.0001 for all). Although in general, ethnic minority women had higher proportions of all the less favourable tumour characteristics compared to white women, these differences were more marked in black Caribbean and black African women compared to Indian and Pakistani women. The proportion of missing data in this age group was 5.4% for stage, 2.9% for grade, 22.3% for ER status and 20.0% for Her2 status, and again for ER and Her2 status the proportion of missing data were highest in ethnic minority women.

The results for the multivariate analysis for each of the less favourable tumour characteristics by ethnicity in women aged 53–70 years are shown in Fig. 2. In minimally adjusted analyses, all ethnic minority women had significantly higher odds of high stage, high grade and ER-negative disease compared to white women. Although adjustment for confounders attenuated these risks to some degree, increased odds of high grade and ER-negative tumours were observed in all ethnic minority groups and increased odds of high stage and Her2 positive were observed in the two black subgroups, compared to white women. For example, black African women were around twice as likely to have high stage (OR 1.88 (95% CI 1.51–2.34)) and high grade (OR 2.42 (95% CI 2.03–2.89)) disease, and almost three times more likely to have ER-negative disease (OR 2.86 (95% CI 2.30–3.54)) compared with white women in fully adjusted models. The odds of Her2-positive disease were highest for black Caribbean women in fully adjusted models (OR 1.36 (95% CI 1.10–1.68)).

Restriction of analyses to women with information available on all confounders made little difference to the main findings. When the minimally adjusted associations with ethnicity were adjusted for each potential confounder, the likelihood ratio X² statistics changed by less than 30% suggesting that residual confounding by comorbidity, deprivation and screening attendance does not account for the fully adjusted associations (Supplementary Tables 1 and 2).

**DISCUSSION**

In this large national study of contemporary data, clear differences were found in the tumour characteristics of breast cancer in women of different ethnic groups. Among younger women aged 30–46, and in the ethnic groups examined, only Indian women had a similar tumour characteristic profile compared to white women. For older women aged 53–70, all ethnic minority women had a less favourable tumour characteristic profile compared to white women, but these differences were more marked for black Africans and black Caribbeans. In general, differences in the risk of less favourable tumour characteristics were greater in the older than in the younger women.

These findings of higher risks of less favourable tumour characteristics in women of ethnic minority backgrounds, particularly black women, have been reported previously,

| Table 2. The characteristics of women aged 53–70 years at diagnosis with breast cancer between 2013 and 2018. |
|-----------------------------------------------|
| White | Indian | Pakistani | Black Caribbean | Black African | P-value |
|-------|--------|-----------|----------------|--------------|---------|
| Mean deprived quintile | 14.4 (12,759) | 18.9 (309) | 46.6 (366) | 35.1 (282) | 41.7 (223) | <0.001 |
| Comorbidty | 25.9 (22,976) | 38.1 (626) | 55.6 (437) | 34.7 (279) | 27.5 (148) | <0.001 |
| Attended for last screen | 84.4 (70,126) | 83.6 (1257) | 71.4 (515) | 81.3 (606) | 75.7 (371) | <0.001 |
| Stage 3 | 11.5 (9651) | 13.2 (201) | 15.3 (113) | 17.3 (132) | 22.5 (114) | <0.001 |
| Grade 3 | 28.2 (24,317) | 32.5 (513) | 38.7 (292) | 43.4 (334) | 51.8 (270) | <0.001 |
| ER negative | 14.0 (9674) | 19.8 (209) | 19.5 (112) | 26.2 (147) | 34.0 (134) | <0.001 |
| Her2 positive | 13.7 (9788) | 15.2 (186) | 17.1 (109) | 19.0 (111) | 18.3 (75) | <0.001 |

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take into account factors that may influence tumour characteristics at diagnosis, and which are also likely to vary by ethnicity, including age at diagnosis, measures that influence health-seeking behaviour, such as deprivation, comorbidity and attendance for routine mammographic screening.

The approach taken here to analyse the population in two distinct age groups also takes account of the different routes to diagnosis for breast cancer in different age groups. Younger women have breast cancer diagnosed largely as a result of presenting with a symptom and are known to present with higher rates of less favourable tumour characteristics.\textsuperscript{33} Whereas, older women could have the disease diagnosed as a result of presenting with a symptom or through asymptomatic detection through population-based screening. The proportion of ethnic minority women was higher among the younger women, which is a reflection of their generally younger age in the population,\textsuperscript{10} but the average age at breast cancer diagnosis in the two groups was similar for all ethnic groups.

The higher levels of deprivation and poorer health observed in the ethnic minority groups, and their potential subsequent effect on health-seeking behaviour for breast cancer are well known\textsuperscript{2,3,6,17,18,34} as are differences in uptake of screening, and these data provide further evidence for these differences. Although nationally, attendance for screening is reported at around 70%, in this study of women with breast cancer, attendance for the last screen before diagnosis is understandably higher. Interestingly, Indian and black Caribbean women attended at similar rates to white women, and Pakistani and black African women were less likely to have attended their last screen prior to diagnosis and these findings are consistent with other studies. Attendance for screening in ethnic minority groups, is not only influenced by factors including community values and beliefs,\textsuperscript{35} but also time since migration to the host country and the effect of acculturation. In black communities in the UK, first generation black African women are less likely to attend for screening than second generation black Caribbean women.\textsuperscript{36} In
South Asian communities, lower uptake of screening are reported in Muslim compared to Hindu communities, which would be largely represented by Pakistanis and Indians respectively.\textsuperscript{37} In both younger and older women, Indian and Pakistani women had similar risks of high stage disease compared to white women, following adjustment of the confounders of deprivation, presence of comorbidity and attendance for screening. In comparison, black Caribbean and black African women in both age groups had higher risks of high stage disease at presentation even after adjustment for measures of health-seeking behaviour. As expected, the younger women in general had higher proportions of the less favourable tumour characteristics such as high grade and ER-negative disease compared to older women. Black Caribbeanbs and black Africans also had higher risks of Her2-positive disease.

Tumours with less favourable characteristics are more likely to be diagnosed in the interval between screens than at screening, and this could explain the lower proportion of screen-detected cancers observed in Black Caribbeanbs and black African women compared to the other groups in the older women.\textsuperscript{38,39} Adjustment by screening attendance made little difference to the risks of these tumour characteristics, suggesting that there are intrinsic differences in these tumour characteristic profiles in these older women.

It is unclear as to why there are differences in tumour characteristics between ethnic groups, and why these differences should be more marked in older women. The observed differences could be due, in part, to the personal characteristics of women that are known to influence the tumour characteristics of breast cancer. For example, ER-positive cancers are known to be associated with established risk factors for breast cancer such as parity and breast feeding,\textsuperscript{40,41} body mass index\textsuperscript{42} and use of hormone replacement therapy.\textsuperscript{43} Data from a large prospective study in the UK has shown that these factors vary materially by ethnicity\textsuperscript{44} and some of the increased risk of particularly ER-negative disease observed could be explained by these factors.

The main strengths of this paper are the use of a very large national dataset using routinely collected contemporary data, with high levels of recording of ethnicity (>95%), and significantly improved cancer registration data following the implementation of COSD. These data are now almost complete for stage and grade, and although, the overall completeness of ER and Her2 status remains lower, this dataset represents the most reliable national data that are available.\textsuperscript{24} The completeness of the ethnicity recording allows for detailed analysis by different ethnic groups and present findings in distinct groups of individuals, such as black Africans and black Caribbeanbs rather than just Blacks, and in Indians and Pakistanis, rather than just Asians. Using routinely collected data have limitations, as little information is available on the personal characteristics of the women diagnosed with breast cancer, which can influence the profile of tumour characteristics as outlined above.

In conclusion, there are differences in the tumour characteristics of breast cancer in women of different ethnic minorities. Where these differences exist in comparison to white women, they are more marked in older than younger women, and in black Caribbean and black African than in Indian and Pakistani women. Further work is needed to understand what the drivers of these differences may be, and where these differences may impact outcomes and experience of the disease in different ethnic groups.

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**AUTHOR CONTRIBUTIONS**

T.G., G.R., I.B. conceived and designed the work that led to the submission and interpreted the results. J.B. acquired the data. All authors drafted or revised the manuscript, approved the final version and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

**ADDITIONAL INFORMATION**

**Ethics approval and consent to participate** Ethical approval for the study was obtained from the North East Tyne and Wear South Research Ethics Committee (REC number 15/NE/0247). Individual patient consent not required as pseudonymised data used.

**Consent for publication** Not applicable.

**Data availability** The data used in this study are held by University of Oxford under a data sharing contract with Public Health England and are not available for sharing. These data are available by individual application to the Office of Data Release at Public Health England (https://www.gov.uk/government/publications/accessing-public-health-england-data).

**Competing interests** The authors declare no competing interests.

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