Socioeconomic variation in uptake of colonoscopy following a positive faecal occult blood test result: a retrospective analysis of the NHS Bowel Cancer Screening Programme

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BACKGROUND: Bowel cancer is a serious health burden and its early diagnosis improves survival. The Bowel Cancer Screening Programme (BCSP) in England screens with the Faecal Occult Blood Test (FOBt), followed by colonoscopy for individuals with a positive test result. Socioeconomic inequalities have been demonstrated for FOBt uptake, but it is not known whether they persist at the next stage of the screening pathway. The aim of this study was to assess the association between colonoscopy uptake and area socioeconomic deprivation, controlling for individual age and sex, and area ethnic diversity, population density, poor self-assessed health, and region.

METHODS: Logistic regression analysis of colonoscopy uptake using BCSP data for England between 2006 and 2009 for 24,180 adults aged between 60 and 69 years.

RESULTS: Overall colonoscopy uptake was 88.4%. Statistically significant variation in uptake is found between quintiles of area deprivation (ranging from 86.4 to 89.5%), as well as age and sex groups (87.9–89.1%), quintiles of poor self-assessed health (87.5–89.5%), non-white ethnicity (84.6–90.6%) and population density (87.9–89.3%), and geographical regions (86.4–90%).

CONCLUSION: Colonoscopy uptake is high. The variation in uptake by socioeconomic deprivation is small, as is variation by subgroups of age and sex, poor self-assessed health, ethnic diversity, population density, and region.

Keywords: colonoscopy; colorectal cancer; screening; socioeconomic status; deprivation

Colorectal cancer (CRC) accounts for 8% of cancer deaths worldwide, making it the fourth leading cause of cancer death (Ferlay et al, 2010). In the United Kingdom there are ~38,000 CRC cases and 16,000 CRC deaths each year (Cancer Research UK, 2010). Survival is strongly related to stage of disease, with up to 90% survival if the disease is diagnosed at an early stage (Smith et al, 2001). Combined results from four randomised controlled trials show that annual or biennial screening for CRC using the Faecal Occult Blood Test (FOBt), with further investigation by colonoscopy or other diagnostic procedure following a positive result, reduces CRC mortality by 16% (Hewitson et al, 2008). After adjusting for screening participation, screening is associated with a 25% relative risk reduction in CRC mortality (NHS Bowel Cancer Screening Programme, 2011).

Colorectal cancer screening in England is organised by the NHS Bowel Cancer Screening Programme (BCSP; NHS Bowel Cancer Screening Programme, 2011), which began in 2006, offering biennial FOBt to all adults aged 60–69 years. Screening is coordinated by five regional screening hubs. Eligible individuals within each hub are sent a FOBt kit with instructions on sample collection and return, followed by a reminder if the kit is not returned within 4 weeks. Participants with a positive FOBt result are given an appointment at a local specialist nurse clinic where the significance of a positive FOBt is explained and the merits of further investigations, usually by colonoscopy, are assessed and discussed. Individuals who are not contraindicated are offered a colonoscopy at the local screening centre.

There is good evidence that among those tested CRC screening is both effective at reducing CRC mortality (Hewitson et al, 2008)
and cost-effective (Tappenden et al, 2004). However, uptake of FOBt was only 56.8% among 478,250 invitations sent out in the first round of the UK CRC Screening Pilot from 2000 to 2003 (UK Colorectal Cancer Screening Pilot Group, 2004), 52.1% among 127,746 invitations sent out in the second round of the Pilot from 2003 to 2005 (Weller et al, 2007), and 53.6% in the first 2.6 million invitations sent out in the NHS BCSP between 2006 and 2009 (von Wagner et al, 2011). FOBt uptake has also been shown to vary significantly by area deprivation and ethnic diversity (UK Colorectal Cancer Screening Pilot Group, 2004; Weller et al, 2007; von Wagner et al, 2009; von Wagner et al, 2011). For example, von Wagner et al (2011) found a gradient in FOBt uptake across quintiles of deprivation, ranging from 35% in the most deprived quintile to 61% in the least deprived. These inequalities occur against a background of widening socioeconomic inequalities in CRC survival: the deprivation gap in 5-year survival between rich and poor became significantly wider among patients diagnosed in England and Wales in 1996–1999, reaching 6% for men and 7% (women) for colorectal cancer, and 9% (men) and 8% (women) for rectal cancer (Coleman et al, 2004). Reducing these inequalities depends, at least in part, on reducing inequalities in uptake at each stage of the BCSP screening pathway, which first involves identifying the stages in the pathway where inequalities occur, so that appropriate interventions for increasing uptake can be designed and implemented.

Although a socioeconomic gradient in FOBt uptake has been established (UK Colorectal Cancer Screening Pilot Group, 2004; Weller et al, 2007; von Wagner et al, 2009; von Wagner et al, 2011), little is known about variation in uptake of colonoscopy following a positive FOBt result (Steele et al, 2010a). The first round of the UK CRC screening pilot showed that 81.5% participants who had a positive FOBt test received a colonoscopy (UK Colorectal Cancer Screening Pilot Group, 2004). In the second round of the pilot, 91.7% of 1171 participants who had a positive FOBt test attended the follow-up specialist nurse clinic and 82.8% had a colonoscopy (Weller et al, 2007). Deprivation was negatively associated with colonoscopy uptake in a pilot study in North East Scotland between 2000 and 2006; the effect was greater in men than in women and did not persist across the whole period (Steele et al, 2010a). Colonoscopy uptake was no different between South Asian and non-South Asian participants during the first two rounds of the UK CRC screening pilot (Szczechura et al, 2008).

The aim of this study was to assess the association between colonoscopy uptake and socioeconomic status, measured by area socioeconomic deprivation. We used a large, national dataset for England from the national screening programme to investigate whether or not uptake was associated with area deprivation, controlling for individual age and sex, and area poor self-assessed health, ethnic diversity and region (all of which have been associated with FOBt uptake). We also assessed the role of population density, as a measure of rurality, which has been associated with lower use of primary and secondary health care services, with rural populations having poorer access than others (Watt et al, 1994).

MATERIALS AND METHODS

Data and variables

Our main source of data was the NHS BCSP. We extracted data on individuals who completed an FOBt test between October 2006 and January 2009, and received a positive result. Our outcome measure was uptake of colonoscopy, defined as undergoing the colonoscopy procedure. We excluded those who had a positive FOBt less than 60 days before the data were extracted. The mean time interval between notification of a positive FOBt result and colonoscopy was 29 days. From the extracted data we excluded the small number of individuals who self-referred, were outside the 60–69 year age range, or for whom data on postcode of residence were not available. We also excluded individuals who attended the specialist nurse clinic following a positive FOBt result and were judged to be unsuitable for colonoscopy due to significant cardiovascular or respiratory morbidity, too frail to undergo standard laxative preparation, taking warfarin, or history of incomplete colonoscopy (NHS BCSP, 2010). In these groups, imaging, for example, by computer tomographic colonography, may be indicated (NHS BCSP, 2010).

For each individual, data were recorded on age, sex, and postcode of residence. We used the National Statistics Postcode Directory to link each person to a corresponding lower layer super output area (LSOA). There are 32,482 LS0As in England, each with a minimum population of 1000 residents and 400 households, and with a national mean of 1500 residents. LS0As were designed to include postcodes of similar social backgrounds based on housing tenure and dwelling type, and to be as geographically compact as possible. We used this linkage to merge LS0A-level data from the Neighbourhood Statistics website to individual BCSP participants (Neighbourhood Statistics website, 2011). We used LS0A data on deprivation, ethnic diversity, population density, and self-rated health. Deprivation was assessed using the Index of Multiple Deprivation (IMD) 2007 (Noble et al, 2008), which combines seven domains (income, employment, health deprivation, and disability, education training and skills, barriers to housing and services, crime, and living environment) based on 38 indicators, into a single deprivation score for each LS0A, with higher IMD scores representing greater deprivation. LS0As are the smallest geographical units for which IMD scores are available. Ethnic diversity was measured by the percentage of the LS0A population who are non-white. This was derived from 2001 Census data, and based on the percentage of residents who described themselves as being from ethnic groups other than ‘white British’, ‘white Irish’, and ‘white other’. Rurality was measured by population density, calculated as the number of people resident in each LS0A (based on 2001 Census data) divided by the size of the LS0A in hectares. We controlled for poor health, which was measured using self-assessed health status data from the 2001 Census, in which individuals were asked to categorise their health as ‘very good’, ‘good’, ‘fairly good’, or ‘poor’. Our measure was the percentage of the LS0A population reporting poor health. We also included age group (<65 years, ≥65 years) and sex interactions.

To test whether the results depended on the functional form of the variables of interest, area deprivation, poor self-assessed health, ethnic diversity, and rurality were measured as categorical variables and also as continuous variables. For the former we constructed quintiles of each measure based on national distributions (see Supplementary Online Material). We also included indicators for geographical region (BCSP hub) to investigate regional variation in uptake.

Analysis

We tested for differences in colonoscopy uptake by quintiles of area deprivation, individual age and sex, and quintiles of poor self-assessed health, non-white ethnicity, and population density using χ² tests. We used logistic regression to regress colonoscopy uptake (1 = had colonoscopy, 0 = otherwise) against these variables. We ran unadjusted and adjusted models, the former including each variable individually, the latter including all variables jointly, both with and without region indicators.

We also ran models with continuous versions of these variables; we controlled for age and sex in every model and included statistically significant terms for area deprivation, non-white ethnicity, population density, and poor self-assessed health.
In these models we experimented with including combinations of linear, quadratic, and cubic terms for each variable and used the specification that best fitted the data in terms of the statistical significance of the individual terms and the explanatory power of the models.

We tested the joint significance of the variables (all odds ratios = 1, all coefficients = 0) using Wald tests. In our adjusted analyses using quintiles, we calculated predictive margins, that is, adjusted probabilities of colonoscopy uptake in each quintile, fixing the other variables at their sample mean values. We calculated average marginal effects for each quintile as the difference in the predictive margins between quintiles to give the difference in the adjusted probability of uptake between each quintile. We drew unadjusted plots of the raw data using locally weighted scatterplot smoothing. In our adjusted analyses, using continuous variables, we plotted the predicted probability of colonoscopy uptake against each variable, fixing the other variables at their sample mean values. In every model, we adjusted for clustering at the regional (BCSP hub) level to account for the possibility that observations were not independent within regions.

RESULTS

The total number of positive FOBT results in the BCSP between October 2006 and January 2009 was 27 629. Of these, 3449 individuals (12.5%) were excluded from the sample, either because they were self-referrals and therefore more likely to attend subsequent investigations all else equal (n = 838), or because they were outside the 60–69 year age range (n = 734), or because data on postcode of residence were not available (n = 17), or because they attended the nurse clinic and were found to be unsuitable for colonoscopy for the reasons stated (n = 1860). Hence, the final sample was 24 180 individuals, of whom 21 383 (88.4%) received a colonoscopy for the reasons stated (n = 1860). Hence, the final sample was 24 180 individuals, of whom 21 383 (88.4%) received a colonoscopy for the reasons stated (n = 1860). Hence, the final sample was 24 180 individuals, of whom 21 383 (88.4%) received a colonoscopy for the reasons stated (n = 1860). Hence, the final sample was 24 180 individuals, of whom 21 383 (88.4%) received a colonoscopy for the reasons stated (n = 1860).

Figure 1  Colonoscopy uptake among individuals with a positive FOBT result. Number of individuals during the period October 2006 to January 2009 is shown in brackets. Abbreviation: FOBT = Faecal Occult Blood test.

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Table 1 Unadjusted analyses of variables associated with colonoscopy uptake among individuals with a positive FOBt result (24 180 observations in every model)

| Sample (%) | Mean uptake (%) | OR (95% CI) | P-value |
|------------|----------------|-------------|---------|
| Deprivation (IMD score) | | | |
| 1 (most deprived) | 19.7 | 85.2 | 1.000 | — |
| 2 | 19.1 | 88.4 | 1.333*** (1.238–1.435) < 0.001 |
| 3 | 21.3 | 89.8 | 1.538*** (1.369–1.729) < 0.001 |
| 4 | 20.9 | 89.5 | 1.482*** (1.320–1.664) < 0.001 |
| 5 (least deprived) | 19.1 | 89.1 | 1.429*** (1.281–1.595) < 0.001 |
| Age (years) and sex | | | |
| < 65* Female | 17.0 | 89.1 | 1.000 | — |
| < 65* Male | 26.1 | 88.7 | 0.887 (0.861–0.909) 0.595 |
| > 65* Female | 22.5 | 87.8 | 0.928*** (0.831–0.946) < 0.001 |
| > 65* Male | 34.4 | 88.3 | 0.969 (0.820–1.051) 0.239 |
| % Non white | | | |
| 1 (highest % SAH: poor) | 23.6 | 87.3 | 1.000 | — |
| 2 | 21.3 | 88.6 | 1.136** (1.003–1.287) 0.045 |
| 3 | 20.6 | 89.9 | 1.293** (1.057–1.582) 0.012 |
| 4 | 19.2 | 88.6 | 1.137 (0.974–1.327) 0.104 |
| 5 (lowest % SAH: poor) | 15.4 | 87.8 | 1.049 (0.820–1.344) 0.702 |
| % Non white | | | |
| 1 (highest % non white) | 20.0 | 84.1 | 1.000 | — |
| 2 | 15.0 | 87.3 | 1.301*** (1.226–1.380) < 0.001 |
| 3 | 17.3 | 89.1 | 1.553*** (1.272–1.896) < 0.001 |
| 4 | 21.4 | 89.8 | 1.666*** (1.451–1.914) < 0.001 |
| 5 (lowest % non white) | 26.4 | 90.9 | 1.887*** (1.647–2.161) < 0.001 |
| Population density | | | |
| 1 (lowest population density) | 21.7 | 90.3 | 1.000 | — |
| 2 | 20.1 | 88.8 | 0.857** (0.759–0.967) 0.012 |
| 3 | 20.5 | 89.4 | 0.905 (0.777–1.054) 0.199 |
| 4 | 19.5 | 87.6 | 0.759*** (0.640–0.899) 0.001 |
| 5 (highest population density) | 18.2 | 85.7 | 0.647*** (0.516–0.811) < 0.001 |
| Region | | | |
| London hub | 16.0 | 83.7 | 1.000 | — |
| Eastern hub | 20.4 | 90.1 | 1.762*** (1.553–1.999) < 0.001 |
| North East hub | 16.0 | 90.4 | 1.833*** (1.599–2.103) < 0.001 |
| North West hub | 31.7 | 88.6 | 1.511*** (1.353–1.688) < 0.001 |
| Southern hub | 15.9 | 88.8 | 1.535*** (1.346–1.751) < 0.001 |
| Tests of joint significance (P-value) | | | |
| Deprivation (IMD score) | <0.001*** | <0.001*** |
| Age and sex | 0.241 | <0.001*** |
| % SAH: poor | 0.001*** | <0.001*** |
| % Non white | <0.001*** | <0.001*** |
| Population density | <0.001*** | <0.001*** |
| Region | <0.001*** | <0.001*** |

Abbreviations: FOBt = Faecal Occult Blood test; IMD = Index of Multiple Deprivation; OR = odds ratio; SAH = self-assessed health. *P < 0.1, **P < 0.05; ***P < 0.01. Associations expressed as OR.

We reran our models using more disaggregated ethnicity measures based on the percentage of residents in each LSOA in each of 10 non-white groups, and using an alternative rurality measure based on the Rural Definition produced by the Department of Environment, Food and Rural Affairs, which catagorises areas according to their morphology and context (DEFRA, 2005; Supplementary Online Material). The relationship between colonoscopy uptake and area deprivation was qualitatively the same as in the original results, showing small but statistically significant variations (all P < 0.05) in uptake by area deprivation. We found statistically significant variation in uptake by type of non-white ethnic group, and that uptake varied significantly by the rural classification of the area, but the extent of the variation was small (Supplementary Online Material).

We repeated the analysis using two different measures of colonoscopy uptake: undergoing a colonoscopy procedure but not excluding those who are contraindicated for colonoscopy (uptake across the whole sample was 82.1%), and attendance at the specialist nurse clinic (94.2%). The results were qualitatively the same in that both alternatives variations in uptake by area deprivation, individual age and sex, and area poor health, ethnic diversity, rurality and region were statistically significant but small (Supplementary Online Material).

DISCUSSION

Colonoscopy uptake was high (88.4%) among 24 180 participants in the NHS BCSP between October 2006 and January 2009 with a positive FOBt result. Statistically significant associations between uptake and area deprivation were observed, but the extent of the variation was small. These findings were found using unadjusted models and models adjusting for individual age and sex, and area self-assessed health, ethnic diversity, rurality and region. We also found that the variation in colonoscopy uptake by these covariates was small.

This is the first national study of socioeconomic variation in colonoscopy uptake following a positive FOBt. Our dataset was large (24 180 observations), recent (October 2006 to January 2009) and covered the whole of England. A strength of our analysis is that the size of the dataset has enabled us to investigate the association between colonoscopy uptake and deprivation, plus a number of variables simultaneously in a multivariate framework.

A potential weakness is that we have assessed the association between individual colonoscopy uptake and area variables. This was necessary because individual-level data, other than for colonoscopy uptake, age and sex, were not available. Given that we are primarily interested in socioeconomic variation, measured by IMD scores, our area variables are measured at the LSOA level, which is the lowest geographical unit at which IMD scores are available. Our method assumes that individuals living in the same area share similar characteristics. In defence of this approach, the area units were LSOAs which are small in terms of population size and geographical area, and are designed to be homogenous with respect to socioeconomic circumstances.

Data for 2003–2005 from the second round of the English site of the UK CRC Screening Pilot (Weller et al, 2007) showed that of 1171 individuals with a positive FOBt result, 1074 (91.7%) attended the follow-up specialist nurse clinic, 1001 of these (93.2%) were referred for colonoscopy and 970 (82.8% of all those with a positive FOBt result) attended the colonoscopy. Analogous figures using our data were 94.2% (24 535/26 040), 91.0% (22 337/24 535) and 82.1% (21 383/26 040), respectively. Studies in Denmark (Jørgensen et al, 2002), France (Faivre et al, 2004), Italy (Parente et al, 2009), and The Netherlands (Hol et al, 2010) have all reported similar uptake rates for colonoscopy after a positive FOBt result. In our

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main analysis we report a higher uptake rate (88.4%) because we excluded patients for whom colonoscopy was contraindicated.

One of the few studies to examine variation in colonoscopy uptake by population subgroups showed a diminishing SES gradient over time. Among 7588 individuals with a positive FOBT result who were invited for colonoscopy in a demonstration pilot in North East Scotland between 2000 and 2006, acceptance of colonoscopy was associated with area-level deprivation among men in 2000–2002 data (87.0% in the least deprived quintile to 77.8% in the most deprived quintile), and also in 2003–2004 data (93.6–85.1%), but not in 2005–2006 data (82.5–86.7%). Among women, acceptance of colonoscopy was associated with deprivation in 2003–2004 only (90.3–84.2; Steele et al., 2010a).

Although there were significant ethnic differences in FOBT uptake, colonoscopy uptake was no different between South Asian and non-South Asian individuals in England between 2000 and 2005 (Szczepur et al., 2008). In our study, although the extent of the variation in colonoscopy uptake between population subgroups...
was small, it varied most by quintiles of area-level ethnic diversity and by region. The London region (hub) had the lowest uptake (86.4%) and was also the most ethnically diverse (mean % non white 32.2% compared with mean 4.4% for all other hubs combined). Studies of screening uptake for breast cancer have also reported lower uptake in London compared with the rest of England (Eilbert et al, 2009; Renshaw et al, 2010). This may be due to the ethnic diversity in London (Eilbert et al, 2009; Renshaw et al, 2010), with cultural differences, and language and literacy influencing use of health care services among ethnic minority groups (Szczepura, 2005). Our results are consistent with these findings – in multivariate analyses we find that removing the regional indicators increases the impact of ethnic diversity on uptake – but we also note that the negative London effect persists even after controlling for ethnic diversity and deprivation, as well as other factors.

Approximately 10% of people with a positive FOBt result will have CRC (NHS Cancer Screening Programmes, 2006). Research and service innovations are therefore needed to improve uptake among the 11.6% who did not undergo colonoscopy. For example, over half of those who did not undergo colonoscopy did not attend the nurse clinic. Replacing the routine face-to-face nurse consultation with the choice of telephone interview or face-to-face consultation with the same nurse has been shown to reduce colonoscopy non-attendance rates from 14.9% to 0.8% ($P<0.001$; Rodger and Steele, 2008). In a recent Italian study, it was hypothesised that the high colonoscopy uptake rate among those with a positive FOBt (≥92%) was achieved due to the use of a fast-track system carried out by a specialist nurse to contact FOBt-positive patients and arrange the colonoscopy appointment (Parente et al, 2011). This study also emphasised that the introduction of population-based screening for CRC can produce a change in attitudes towards colonoscopy among GPs and the general population over a relatively short period of time (two full rounds of screening), suggesting that awareness about CRC screening can change attitudes towards colonoscopy and increase uptake.

Our analysis shows that once people have made their decision to participate in FOBt screening, they are then highly likely to access and use appropriate follow-up health care. However, inequalities in use of the first step of the bowel cancer screening process need to be addressed, and future policy and research should focus on this issue, for example, using repeated invitations (Steele et al, 2010b). If strategies to increase FOBt uptake are successful, it remains to be seen whether the colonoscopy uptake rates shown by our data are maintained, given that these were achieved among respondents who agreed to FOBt using the current screening pathway and are therefore likely to have a higher propensity to participate than those who require more intensive recruitment efforts. Hence, our analysis ought to be repeated as and when FOBt uptake increases, and strategies to increase colonoscopy uptake ought to be introduced if current rates are not maintained.

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Conflict of Interest

The authors declare no conflict of interest.

Supplementary Information accompanies the paper on British Journal of Cancer website (http://www.nature.com/bjc)
