Published by Oxford University Press on behalf of the International Epidemiological Association
International Journal of Epidemiology 2011;40:712–718
doi:10.1093/ije/dyr008

CANCER

Inequalities in participation in an organized national colorectal cancer screening programme: results from the first 2.6 million invitations in England

Christian von Wagner,[1]* Gianluca Baio,[2] Rosalind Raine,[2] Julia Snowball,[3] Stephen Morris,[2] Wendy Atkin,[4] Austin Obichere,[5] Graham Handley,[6] Richard F Logan,[7] Sandra Rainbow,[8] Stephen Smith,[9] Stephen Halloran[3] and Jane Wardle[1]

[1]Health Behaviour Research Centre, Department of Epidemiology and Public Health, University College London, London, Greater London, UK, [2]Health Care Evaluation Group, Department of Epidemiology and Public Health, University College London, London, Greater London, UK, [3]NHS Bowel Cancer Screening Southern Hub, Royal Surrey County Hospital NHS Trust, Guildford, Surrey, UK, [4]Department of Surgery and Cancer, Imperial College London, St Mary's Campus, London, Greater London, UK, [5]University College London Hospital, London, Greater London, UK, [6]NHS Bowel Cancer Screening Northeast Hub, Gateshead Health Foundation Trust, Queen Elizabeth Hospital, Gateshead, Tyne and Wear, UK, [7]NHS Bowel Cancer Screening Eastern Hub, Division of Epidemiology and Public Health, Queens Medical Centre University of Nottingham, Nottingham, Nottinghamshire, UK, [8]NHS London Bowel Cancer Screening Hub, St Marks Hospital, Northwick Park, Middlesex, London, UK and [9]NHS Midlands & Northwest Bowel Cancer Screening Hub, University Hospitals Coventry and Warwickshire NHS Trust, Coventry, Rugby, UK

*Corresponding author. Health Behaviour Research Centre, Department of Epidemiology and Public Health, University College London, 1-19 Torrington Place, London WC1E 6BT, UK. E-mail: c.wagner@ucl.ac.uk

Accepted 10 January 2011

Background An organized, population-based, colorectal cancer screening programme was initiated in England in 2006 offering biennial faecal occult blood testing (FOBT) to adults aged 60–69 years. Organized screening programmes with no associated financial costs to the individual should minimize barriers to access for lower socio-economic status (SES) groups. However, SES differences in uptake were observed in the pilot centres of the UK programme, so the aim of this analysis was to identify the extent of inequalities in uptake by SES, ethnic diversity, gender and age in the first 28 months of the programme.

Design Cross-sectional analysis of colorectal cancer screening uptake data.

Methods Between October 2006 and January 2009, over 2.6 million adults aged 60–69 years were mailed a first FOBT kit by the five regional screening hubs. Uptake was defined as return of a test kit within 13 weeks. We used multivariate generalized linear regression to examine variation by area-based socioeconomic deprivation, area-based ethnicity, gender and age.

Results Uptake was 54%, but showed a gradient across quintiles of deprivation, ranging from 35% in the most deprived quintile to 61% in the least deprived. Multivariate analyses confirmed an independent effect of deprivation, with stronger effects in women and older people. The most ethnically diverse areas also had lower uptake (38%) than other areas (52–58%) independent of SES, age, gender and regional screening hub. Ethnic disparities were more pronounced

in men but equivalent across age groups. More women than men returned a kit (56 vs 51%), but there was also an interaction with age, with uptake increasing with age in men (49% at 60–64 years; 53% at 65–69 years) but not women (57 vs 56%).

Conclusions Overall uptake rates in this organized screening programme were encouraging, but nonetheless there was low uptake in the most ethnically diverse areas and a striking gradient by SES. Action to promote equality of uptake is needed to avoid widening inequalities in cancer mortality.

Keywords Colorectal cancer screening, inequalities, socioeconomic status, gender, age, ethnicity

Introduction

Colorectal cancer (CRC) is the second leading cause of cancer death worldwide, accounting for up to 9% of cancer deaths.[1] Up to 90% of CRC deaths can be prevented if the disease is detected at an early stage.[2] Annual or biennial CRC screening using FOBt has been found to reduce the mortality by up to 27% in those who use the test.[3]

CRC screening is recommended by the Centers for Disease Control and Prevention,[4] the European Union,[5] the US Preventive Services Task Force[6] and the World Health Organisation.[1] FOBT has been recommended in the US since 1996 as one of several possible screening modalities,[7] and is now being introduced or piloted as the primary screening modality in national programmes in Australia, England, Finland, France, Israel, Italy, Japan, Korea, Scotland and Wales.[8,9]

An organized, population-based CRC screening programme (the National Bowel Cancer Screening Programme; NBCSP) was started in England in 2006, offering biennial FOBT for adults aged 60–69 years, with abnormal tests followed up by colonoscopy. The NBCSP uses patient data from primary-care registrations, which capture ~96% of adults in this age range,[10] as the basis for screening invitations: these are sent out by five regional screening 'hubs'. Each person is sent a FOBT kit with instructions on sample collection and return of the kit (in a pre-addressed, hygienically sealed, free-post envelope), followed by a reminder if the kit is not returned within 28 days. The eligible population is re-invited every 2 years until age 69 years (being extended to age 75 years), unless they are found to have cancer or adenomas requiring surveillance. In two pilot sites, uptake was 58.5% in the first (prevalence) round of screening and 52.0% in the second (incidence) round.[11,12]

Although the primary focus of most screening programmes is overall uptake, there is growing recognition that inequalities by ethnicity or socio-economic status (SES) will ultimately undermine progress towards equality in health outcomes. Organized screening programmes are designed to minimize inequalities through direct invitations to the target population, and in the National Health Service (NHS) in the UK, all screening and treatment is provided free of charge. In the UK programme, sample collection is undertaken by the individual in their own home, thereby avoiding barriers associated with time off work, transport, or interactions with health-care professionals. The extent to which organized programmes reduce inequalities is, however, a matter of debate. Recent analyses comparing breast and cervical cancer screening rates in 22 European countries only found inequalities (by educational background) in countries with opportunistic screening, and not in countries with nationwide population-based programmes.[13] However, in the case of CRC screening, the UK pilot centres found SES differences in both first and second rounds.[11,12] The first uptake rates for the CRC screening programme in the London area also showed a striking socio-economic gradient,[14] but as London has a highly mobile, ethnically mixed population, as well as lower uptake rates than the rest of the country, the generalizability of these results to the wider programme is limited. The present study is the first to assess ethnic and socio-economic inequalities in an organized CRC screening programme.

Methods

Sample

During the study period, over 2.6 million FOBT kits were mailed to adults in the eligible age range (60–69 years) by the five regional screening hubs. The present analyses were based on recorded FOBT kit return rates aggregated to the smallest geographical unit routinely recorded by the NBCSP; namely post-code sector. Postcode sectors are defined by the first inward digit of the postcode and contain an average of 3000 addresses. Uptake data for each postcode sector were stratified by gender and age group (60–64 vs 65–69 years). Each record in the data set consists of the total number of invitations sent out and the total number of kits returned to the hubs

stratified by sex and age groups. We excluded 1128 postcode sectors for which we could not retrieve census data on ethnic diversity. The data set we analysed consisted of data on 7040 postcode sectors (>85% of the total), with an average of 378 invitations per sector.

Measures

A composite indicator of area-based socio-economic deprivation for each postcode sector was derived using the 2007 Index of Multiple Deprivation (IMD).[15] The IMD uses census-derived indicators of income, education, employment, environment, health and housing at small-area level to generate a scale from 0 (least deprived) to 80 (most deprived). Census data were also used to generate an area-level index of ethnic diversity based on the proportion of 'non-White' residents in each postcode sector (defined as all ethnic groups self-described as other than 'White British', 'White Irish' and 'White other').[16] Participation in CRC screening was defined as return of the FOBT kit to the regional screening hub within 13 weeks of the invitation letter.

Statistical analysis

To describe the relationship between uptake of FOBT and the predictors, we categorized the continuous predictors using quintiles of their national distributions. We then used multivariate generalized linear (binomial) regression to examine differences in screening uptake by deprivation, ethnicity, gender and age group. The regression analysis weighted the response by the number of invitations sent out in each area. We tested several specifications of the model, including non-linear terms for both the area-based deprivation and ethnic diversity (Supplementary Appendix A1 available as supplementary data at *IJE* online). Non-linear terms were only marginally different from unity and therefore did not contribute meaningfully to our model of uptake. For the sake of parsimony, we therefore decided to use a linear model to describe the relationship between demographic and area-based predictors of uptake. We also tested several interaction terms and only retained those that predicted uptake (age by gender, IMD score by gender, IMD score by age group and ethnic diversity by gender). We reported the results of the main regression analysis using odds ratios (ORs) (Table 2). Since the main predictors were continuous, we computed the estimated probabilities of uptake as functions of area-based deprivation and ethnic diversity while fixing the values of the other covariates to their population average.

Results

Over the period studied, 2 658 859 FOBT kits were sent out, of which 53.6% were returned. Uptake rates by gender, age, deprivation quintile, ethnic diversity quintile and regional screening hub are shown in Table 1. Uptake in the most affluent quintile of postcode sectors (61%) was considerably higher than in the most deprived quintile (35%), with a linear trend across intermediate levels of deprivation. This association is illustrated in Figure 1 using the full distribution of IMD scores.

Multivariate analysis (Table 2) using the continuous measure of deprivation and controlling for area-level ethnic diversity, gender, age and regional screening hub, confirmed an independent association between deprivation and uptake, with the estimated probability of returning the FOBT kit decreasing by 0.41% with every unit increase in IMD (i.e. increasing levels of area-based deprivation). Table 2 shows that this association was moderated by gender and age. As illustrated in Figure 1, the decline in uptake with increasing deprivation was stronger in women than men, and in the older (65–69 years) age group than younger (60–64 years) age group.

Table 1 Demographic variation in screening uptake

Demographic factors	Non-adjusted uptake rates (%)
Overall uptake	53.65
Gender	
Men	50.96
Women	56.35
Age (years)	
60–64	52.78
65–69	54.54
Area-based deprivation quintiles (IMD score 0–80)	
Quintile 1 (0–9.87)	61.07
Quintile 2 (9.88–14.60)	57.79
Quintile 3 (14.61–21.61)	54.98
Quintile 4 (21.62–33.49)	49.99
Quintile 5 (33.50–80)	35.04
Area-based ethnic diversity (% of non-White residents within a postcode sector)	
Quintile 1 (0–1.04)	54.98
Quintile 2 (1.05–1.77)	55.59
Quintile 3 (1.78–3.65)	54.66
Quintile 4 (3.66–11.80)	52.14
Quintile 5 (11.81–100)	38.17
Regional screening hubs	
London	40.78
Northeast	56.34
Southern	58.31
Midlands and Northwest	51.98
Eastern	58.14

Table 2 Multivariate analyses of predictors of screening uptake

Demographic predictors	OR [95% confidence interval (CI)]
Area-based deprivation (IMD score: 0–80)	0.9829 (0.9825–0.9832)
Deprivation by gender	0.9951 (0.9947–0.9955)
Deprivation by age	1.0018 (1.0014–1.0022)
Area-based ethnic diversity (0–100)	0.9909 (0.9906–0.9912)
Ethnic diversity by gender	1.0019 (1.0015–1.0022)
Gender (Female)	1.2528 (1.2391–1.2665)
Age (60–64 years)	0.8142 (0.8055–0.8230)
Age by gender	1.2015 (1.1897–1.2134)
Regional screening hubs (compared with London hub)	
Northeast	1.5972 (1.5803–1.6143)
Southern	1.3802 (1.3660–1.3945)
Midlands and Northwest	1.4326 (1.4191–1.4463)
Eastern	1.4489 (1.4342–1.4637)

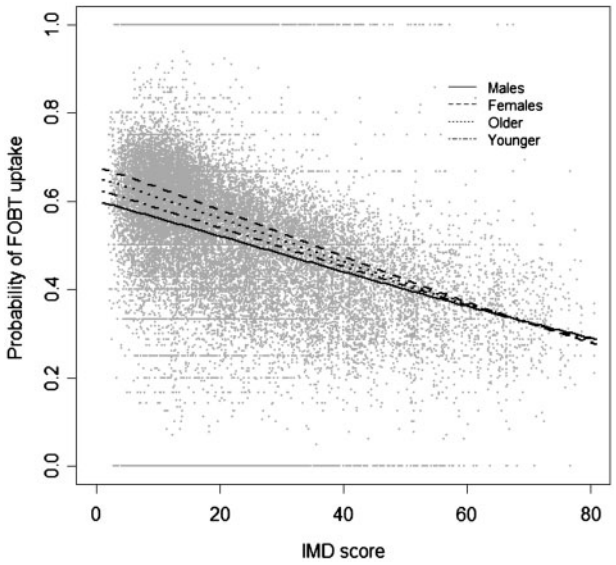

Figure 1 Uptake by area-level deprivation gradient (grey dots represent individual postcode sectors stratified by age and gender) with separate regression lines for gender and age groups

Table 1 illustrates that uptake was lowest for the most ethnically diverse areas. Despite the fact that the effect was not graded in the same way as observed for area-based deprivation, ethnic diversity (measured continuously) was an independent predictor of uptake in our multivariate linear model (see Supplementary Appendix 1 available as supplementary data at *IJE* online for evidence that adding a non-linear effect for area-based ethnic diversity did not contribute to the model).

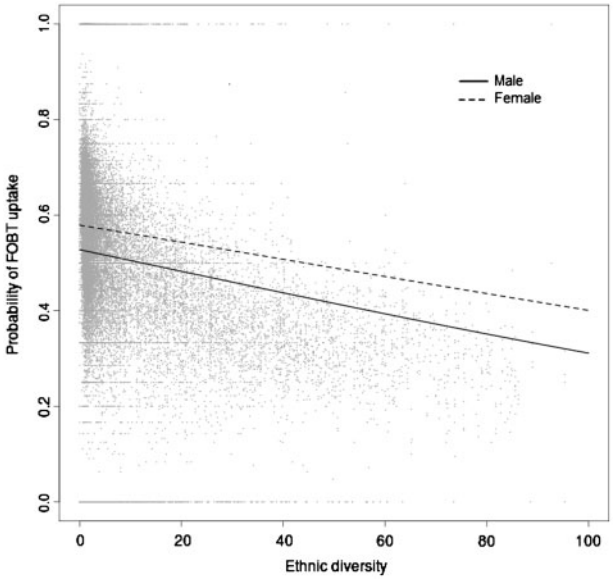

Figure 2 Uptake by percent of non-white residents within a postcode sector (grey dots represent individual postcode sectors stratified by age and gender) with separate regression lines for males and females

Figure 2 illustrates that as the percentage of non-White residents in an area increased by 1%, the estimated probability of uptake was reduced by 0.22%. We also observed an interaction between ethnic diversity and gender (but not age) with the decline of participation associated with greater area-level ethnic diversity being more pronounced in men than women.

Both gender and age predicted uptake in the multivariate model (Table 2). More women than men returned a kit (56.3 vs 51.0%), and uptake was slightly lower in younger age groups than older age groups (52.8% in 60- to 64-year olds; 54.5% in 65- to 69-year olds). There was also an interaction between gender and age, with men's uptake increasing with age (49.0–53.0%) while women's barely changed (56.6–56.1%).

Comparisons between the regional screening hubs serving five broad geographical areas across England showed that uptake was substantially lower in the London area (40.8%) than across the rest of England, where uptake rates ranged from 52.0 to 58.3%. Nonetheless, the patterning by SES, ethnicity, gender and age was replicated in each regional screening hub individually (data not shown).

Discussion

Just over half (54%) of those invited completed the FOBT in the first 2 years of the UK CRC screening programme. This is encouraging for a new programme and compares favourably with results from Australia and The Netherlands, where uptake rates of 46 and 49%, respectively, have been reported.[17,18] It is also considerably higher than the self-reported use of

FOBT in the US, although there it is just one of several colorectal screening options.[19]

However, these promising results disguised considerable ethnic and socio-economic variability. Area-level socio-economic deprivation showed a strong and graded association with uptake, which was observed across the whole sample as well as in each individual regional screening hub. This gradient was steeper among the older (65–69 years) of the two age groups. Factors underlying a general increase of uptake by age (e.g. greater engagement with health-care services) may have been offset by practical barriers associated with an earlier onset of functional decline[20] or reduced life expectancy,[21] which could diminish the perceived benefits of screening among older people from lower SES backgrounds. The SES gradient was also steeper in women than men, perhaps because women are more likely to socialize locally[22] and may therefore be more influenced by the characteristics of their neighbourhood.

Uptake was also strikingly low (38%) in the most ethnically diverse quintile of postcode sectors, although there was no trend across the other four quintiles (range: 51–56%).

In contrast to SES, ethnic differences were stronger in men, perhaps because ethnic minority women are more likely to have engaged with health-care services or because women in ethnic minority communities are less likely to be in full-time employment.[23]

Men had lower uptake than women, as observed in many other studies.[12,18,24,25] This difference was greater in 60- to 64-year olds than 65- to 69-year olds. While self-administration of FOBT does not require taking time off work, these differences may still reflect occupational demands because men are more likely than women to be in paid employment up to 65 years[26] and it could be argued that being in full-time employment reduces the amount of time spent at home and thereby opportunities to collect faecal samples. Alternatively, younger men may not be persuaded of the need for preventive health care. This trend is worrying, given that gender and age-specific 10-year cumulative incidence and mortality rates of CRC suggest that, if anything, men should initiate CRC screening earlier than women.[27]

Inequalities in participation have been observed in many prevention programmes but are still poorly understood.[28–31] The nature of the programme in the UK means that inequalities cannot be attributed to differential opportunity because everyone is mailed the kit free of charge. Nor can they be due to differential access, because the test is completed at home, although there may be more privacy barriers in more crowded homes. Also, as argued above, employment or other responsibilities (e.g. care-giving) might limit opportunities to complete the screening test. In the scientific literature, most attention has been paid to cognitive and emotional barriers, and these are often highlighted in qualitative studies with hard-to-reach groups.[32–33] One of the few large-scale quantitative studies found that the benefits of screening were rated as less important by lower SES groups, while fears and fatalistic attitudes were stronger.[34] Thus, attitudinal differences may be deterrents even when practical barriers are removed.

Work is needed to devise strategies to reduce inequalities that can be implemented as part of organized programmes. A simple, low-cost, educational intervention tested as part of the UK Flexible Sigmoidoscopy Screening Trial showed a trend towards being more effective in lower SES participants.[35] However, the graded relationship between SES and screening uptake indicates that interventions should not focus exclusively on the most disadvantaged groups but rather should tackle barriers to participation across the entire socio-economic continuum. Ensuring that information materials are salient and comprehensible regardless of level of health literacy, is a first step.[36] The possibility that inequalities in uptake may be exacerbated by the recent extension of the screening age to 75 years, merits further attention and would benefit from research into the link between SES, perceived life expectancy and attitudes towards cancer screening among older people.

A limitation of this analysis was the reliance on area-level statistics. Associations seen in area-based analyses are likely to underestimate individual effects,[37] so the true extent of inequalities may be higher. We also only examined responses to first-round invitations and do not know whether the pattern will be similar in subsequent rounds of screening. We found markedly lower uptake in London than in the rest of England, which could not be fully explained by differences in deprivation or ethnicity, although our measure of ethnic diversity did not reflect the great variety of ethnic groups in London, nor the fact that London has such a geographically mobile population. Future research would benefit from distinguishing different ethnic sub-groups to pin-point the specific beliefs and barriers that underlie ethnic disparities.

In summary, this is one of the first population-wide studies of an organized, colorectal cancer screening programme. Despite promising uptake rates for a new programme, these results show that equitable delivery does not guarantee equality of uptake. Even organized programmes need additional strategies to promote equality of uptake if they are to avoid exacerbating disparities in cancer mortality.

Supplementary data

Supplementary data are available at *IJE* online.

Funding

This study was supported by a programme grant from Cancer Research UK to J.W. which also funds

C.V.W. G.B. and R.R. are funded by the National Institute for Health Research (NIHR) University College London Hospitals/University College London (UCLH/UCL) Comprehensive Biomedical Research Centre (CBRC).

Acknowledgement

We thank the National Bowel Cancer Screening Programme for providing uptake data.

Conflict of interest: None declared.

KEY MESSAGES

- The fact that more than one in two people invited for CRC screening in the UK return their home-based stool kit disguises important socio-economic and ethnic inequalities.
- Inequalities in CRC screening uptake will cause widening of existing inequalities in cancer mortality.
- Work is needed to devise simple, low-cost strategies to reduce inequalities that can be implemented as part of organized programmes.

References

[1] World Health Organization. *Cancer Fact Sheet no 297*. WHO. http://www.who.int/mediacentre/factsheets/fs297/en/index.html. (20 December 2010, date last accessed).

[2] Smith RA, von Eschenbach AC, Wender R *et al*. American Cancer Society guidelines for the early detection of cancer: update of early detection guidelines for prostate, colorectal, and endometrial cancers. Also: update 2001—testing for early lung cancer detection. *CA Cancer J Clin* 2001;**51:**38–75.

[3] Scholefield JH, Moss S, Sufi F, Mangham CM, Hardcastle JD. Effect of faecal occult blood screening on mortality from colorectal cancer: results from a randomised controlled trial. *Gut* 2002;**50:**840–44.

[4] Centers for Disease Control and Prevention. *Screen for Life: National Colorectal Cancer Campaign*. Centers for Disease Control and Prevention. http://www.cdc.gov/cancer/colorectal/sfl/. (20 December 2010, date last accessed).

[5] Boyle P, Autier P, Bartelink H *et al*. European code against cancer and scientific justification: third version (2003). *Ann Oncol* 2003;**14:**973–1005.

[6] US Preventive Services Task Force. Screening for colorectal cancer: U.S. Preventive Services Task Force recommendation statement. *Ann Behav Med* 2008;**149:**627–37.

[7] U.S. Preventive Services Task Force. *Guide to Clinical Preventive Services: Report of the US Preventive Services Task Force*. 2nd edn. Baltimore, MD: Williams & Wilkins, 1996.

[8] Benson VS, Patnick J, Davies AK *et al*. Colorectal cancer screening: a comparison of 35 initiatives in 17 countries. *Int J Cancer* 2008;**122:**1357–67.

[9] International Cancer Screening Network. *Inventory of Colorectal Cancer Screening Activities in ICSN Countries*. http://appliedresearch.cancer.gov/icsn/colorectal/screening.html (20 December 2010, date last accessed).

[10] The Information Centre for Health and Social Care. *GP Relevant Population Estimates: England and Wales*. NHS 2008. http://www.ic.nhs.uk/statistics-and-data-collections/population-and-geography/population/attribution-dataset-gp-registered-populations-2008. (20 December 2010, date last accessed).

[11] UK Colorectal Cancer Screening Pilot Group. Results of the first round of a demonstration pilot of screening for colorectal cancer in the United Kingdom. *Br Med J* 2004; **329:**133–35.

[12] Weller D, Coleman D, Robertson R *et al*. The UK colorectal cancer screening pilot: results of the second round of screening in England. *Br J Cancer* 2007;**97:**1601–5.

[13] Palencia L, Espelt A, Rodriguez-Sanz M *et al*. Socio-economic inequalities in breast and cervical cancer screening practices in Europe: influence of the type of screening program. *Int J Epidemiol* 2010;**39:**757–65.

[14] von Wagner C, Good A, Wright D *et al*. Inequalities in colorectal screening participation in London in the first round of the national screening programme me. *Br J Cancer* 2009;**101(Suppl. 2):**S60–63.

[15] Noble M, McLennan D, Wilkinson K, Barnes H. *The English Indices of Deprivation 2007*. London: Communities and Local Government, 2007.

[16] Office for National Statistics Census. *Key Statistics for Postcode Sectors in England and Wales, 2001*. London: Crown Copyright, 2004.

[17] Monitoring and Evaluation Steering Committee. *Australia's Bowel Cancer Screening Pilot and Beyond. Final Evaluation Report. Bowel Cancer Screening Pilot*. Australian Government, Department of Health and Ageing. October 2005. Screening Monograph No. 6/2005.

[18] Deutekom M, van Rijn AF, Dekker E *et al*. Uptake of faecal occult blood test colorectal cancer screening by different ethnic groups in The Netherlands. *Eur J Public Health* 2009;**19:**400–02.

[19] Smith RA, Cokkinides V, Brawley OW. Cancer screening in the United States, 2008: a review of current American Cancer Society guidelines and cancer screening issues. *CA Cancer J Clin* 2008;**58:**161–79.

[20] House JS, Lepkowski JM, Kinney AM *et al*. The social-stratification of aging and health. *J Health Soc Behav* 1994;**35:**213–34.

[21] Mackenbach JP, Stirbu I, Roskam AJR *et al*. Socioeconomic inequalities in health in 22 European countries. *N Engl J Med* 2008;**358:**2468–81.

[22] Moore G. Structural determinants of men's and women's personal networks. *Am Sociol Rev* 1990;**55:**726–35.

[23] Government Equalities Office. *Fact Sheet: Ethnic Minority Women in the UK*. http://www.equalities.gov.uk/pdf/EthnicMinorityWomen.pdf (20 December 2010, date last accessed).

[24] Seeff LC, Nadel MR, Klabunde CN *et al*. Patterns and predictors of colorectal cancer test use in the adult US population. *Cancer* 2004;**100:**2093–103.

[25] Cole SR, Smith A, Wilson C, Turnbull D, Esterman A, Young GP. An advance notification letter increases participation in colorectal cancer screening. *J Med Screen* 2007;**14:**73–75.

[26] Office for National Statistics. *Focus on Gender*. Office for National Statistics. Online edition. 2008. http://www.statistics.gov.uk/focuson/gender/default.asp. (20 December 2010, date last accessed).

[27] Brenner H, Hoffmeister M, Arndt V, Haug U. Gender differences in colorectal cancer: implications for age at initiation of screening. *Br J Cancer* 2007;**12:**828–31.

[28] Gatrell A, Garnett S, Rigby J *et al*. Uptake of screening for breast cancer in South Lancashire. *Public Health* 1998;**112:** 297–301.

[29] Dailey AB, Kasl SV, Holford TR, Calvocoressi L, Jones BA. Neighborhood-level socioeconomic predictors of nonadherence to mammography screening guidelines. *Cancer Epidem Biomar Prev* 2007;**16:**2293–303.

[30] Moser K, Patnick J, Beral V. Inequalities in reported use of breast and cervical screening in Great Britain: analysis of cross sectional survey data. *Br Med J* 2009; **338:**1480–84.

[31] Pruitt SL, Shim MJ, Mullen PD, Vernon SW, Amick BC III. Association of area socioeconomic status and breast, cervical, and colorectal cancer screening: a systematic review. *Cancer Epidem Biomar Prev* 2009;**18:**2579–99.

[32] Fyffe DC, Hudson SV, Fagan JK, Brown DR. Knowledge and barriers related to prostate and colorectal cancer prevention in underserved black men. *J Natl Med Assoc* 2008; **100:**1161–67.

[33] Green AR, Peters-Lewis A, Percac-Lima S *et al*. Barriers to screening colonoscopy for low-income Latino and white patients in an urban community health center. *J Gen Intern Med* 2008;**23:**834–40.

[34] Wardle J, McCaffery K, Nadel MR, Atkin WS. Socioeconomic differences in cancer screening participation: comparing cognitive and psychosocial explanations. *Soc Sci Med* 2004;**59:**249–61.

[35] Wardle J, Williamson S, McCaffery K *et al*. Increasing attendance at colorectal cancer screening: testing the efficacy of a mailed, psychoeducational intervention in a community sample of older adults. *Health Psychol* 2003; **22:**99–105.

[36] von Wagner C, Steptoe A, Wolf MS, Wardle J. Health literacy and health actions: a review and a framework from health psychology. *Health Educ Behav* 2009;**36:** 860–77.

[37] Schootman M, Jeffe DB, Baker EA *et al*. Effect of area poverty rate on cancer screening across US communities. *J Epidemiol Commun Health* 2006;**60:**202–07.