South Asian Ethnicity, Socio-economic Status and Psychological Mediators of Faecal Occult Blood Colorectal Screening Participation: A Prospective Test of a Process Model.

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Abstract

Objective: Although ethnicity and socio-economic status (SES) correlate with health inequality, efforts to explain variance in health behavior attributable to these factors are limited by difficulties in population sampling. We used ethnicity identification software to test effects of psychological beliefs about screening as mediators of ethnicity *and* SES on faecal occult blood colorectal screening behavior in a no-cost health care context. **Method:** N=1678 adults aged 50-67 years of whom 28 % were from minority South Asian religio-linguistic ethnic groups (Hindu-Gujarati/Hindi, Muslim-Urdu and Sikh-Punjabi) participated in a prospective survey study. Subsequent screening participation was determined from medical records. **Results:** Screening non-participation in the most deprived SES quintile was 1.6 times that of the least deprived quintile. Non-participation was 1.6 times higher in South Asians compared to non-Asians. A process model in which psychological variables mediated effects of ethnicity and SES on uptake was tested using structural equation modeling. Self-efficacy and perceived psychological costs of screening were, respectively, positive and negative direct predictors of uptake. Paths from Hindu, Muslim and Sikh ethnicity, and SES on uptake were fully mediated by lower self-efficacy and higher perceived psychological costs. Paths from South Asian ethnicity to participation via self-efficacy and psychological costs were direct, and indirect via SES. **Conclusion:** SES is implicated, but does not fully account for low colorectal screening uptake among South Asians. Targeting increased self-efficacy and reduced perceived psychological costs may minimize health inequality effects. Future research should test independent effects of SES and ethnicity on lower self-efficacy and higher psychological costs.

South Asian Ethnicity, Socio-economic Status and Psychological Mediators of Faecal Occult Blood Colorectal Screening Participation: A Prospective Test of a Process Model.

Despite established inequalities in a range of health outcomes and virtually all health behaviors, there is a paucity of research that has directly evaluated the roles of *both* ethnicity and socio-economic status (SES) together with mediating psychological influences on health related behavior and uptake of health services. This is most likely because the low absolute frequency of minority ethnic people in the population creates significant difficulty in surveying adequate numbers even in large randomised population surveys. For example, the largest minority ethnic group in the UK population is South Asian, representing 5% of the UK population (UK Census 2011). Further, incomplete recording of ethnicity in population databases or in medical records (Iqbal, Johnson, Szczepura, Wilson, Gumber et al., 2012) precludes collecting samples in which South Asian men and women are accurately represented through oversampling. The present study overcame these difficulties by employing name recognition software (*Nam Pehchan;* Cummins et al.,1999) to pre-screen names in a population database so as to oversample from the South Asian population and achieve an ethnically diverse sample comprising adequate numbers of both South Asian and non-Asian Britons. The goal of this prospective study was to test a process model evaluating the role of SES and psychological variables in mediating effects of ethnicity on objectively-observed faecal occult blood test (FOBt) colorectal screening participation. It is important to consider the roles of ethnicity and SES on screening participation to establish the extent to which ethnic disparities in health-seeking behavior can be attributed to SES.

Colorectal cancer is the third most common cancer worldwide (International Agency for Research on Cancer, 2012) and in the UK and US (Office for National Statistics, 2012; American Cancer Society, 2015). Survival rates are favorable when disease is detected at an early stage, but patients presenting with advanced disease have a high mortality rate

(Maringe, Walters, Rachet, Butler, Fields et al. (2013). Screening by faecal occult blood testing (FOBt) significantly reduces colorectal cancer mortality and can reduce cancer incidence through detection and removal of colorectal adenomas (Hewitson, Glasziou, Irwig, Towler & Watson, 2007; Hewitson, Glasziou, Watson, Towler & Irwig, 2008). Hewitson et al (2007) reported a 16% reduction in relative risk of colorectal cancer mortality in trial participants allocated to FOBT screening conditions. When their analysis included only those who actually completed screening, the relative risk reduction was 25%, underlining the importance of identifying psychological processes that might explain and promote screening participation.

Screening uptake tends to be low and to vary with socio-economic status (e.g. Decker, Demers, Nugent, Biswanger & Singh, 2015; Joseph, King, Miller & Richardson, 2012). Even in the UK where the National Health Service routinely invites all eligible adults for free screening and any necessary treatment, uptake rates in the most deprived quintile of residential areas are almost half those of the least deprived quintile of areas (35% vs. 61%; von Wagner, et al., 2011). Whereas socio-economic status indicators can be attached to individual patient postal codes in order to examine inequality, estimates of inequalities amongst minority ethnic populations have tended to rely on area-level analyses that cannot be linked to individual screening records. However, the use of name-recognition software to identify South Asian ethnicity showed that South Asians demonstrated significantly lower FOBt screening uptake than non-Asian Britons (32.8% vs. 61.3%) (Szczepura, Price & Gumber, 2008; Price, Szczepura, Gumber & Patnick, 2010).

Screening has been described as a ‘risky’ health behavior insofar as it involves making a decision to undergo procedures with uncomfortable or upsetting short-term effects to learn of future disease threat and obtain a longer-term health benefit (Rothman & Salovey, 1997; Orbell, Perugini & Rakow, 2004). Motivation for screening participation therefore involves

dual psychological influences; motivation to reduce disease threat (vulnerability to and severity of disease) and motivation to engage in a recommended response (by taking up screening) which involves appraisals of likely effectiveness, difficulties and psychological costs associated with unpleasant procedures or outcomes (response efficacy, self-efficacy and response costs). These psychological correlates are common to many theoretical accounts of health related behavior (Ripptoe & Rogers, 1987; Janz & Becker, 1984; Weinstein, 1988; Schwarzer, 2008). Application of these theories has been advocated to identify the psychological variables that explain substantive variance in screening behavior. This is considered an important formative step in identifying the target constructs that can be manipulated in behavioral interventions to promote screening.

Application of health behavior theories may also assist in tackling these health inequalities by identifying the psychological variables that account for effects of social structural variables such as ethnicity and SES on health behavior. Psychological factors may explain variability in health behavior due to socioeconomic and cultural factors beyond financial constraints that limit access to care. For example, social conditions that cannot cushion short term loss, or which have been characterized by limited efficacy to overcome or prevent negative life experience may enhance the perceived costs of participating in screening or diminish self efficacy to complete the test. There is some empirical evidence that these appraisals may differ by socio-economic status (e.g., Orbell, Johnstone & Crombie, 1996; Whitaker, Good, Miles et al., 2011). However, there is a paucity of studies that have employed population samples, prospectively collected data, objectively observed behavior, or used mediation analyses to examine whether psychological constructs mediate socio-economic status effects on screening participation (von Wagner, Good, Whitaker & Wardle, 2011). Moreover, studies to date have employed largely homogeneous white samples and none have employed a sufficiently diverse sample to enable investigation of ethnicity, socio-

economic status and psychological variables in the same anaysis, so that it remains uncertain whether variance attributable to ethnicity and SES might be explained by similar psychological processes. Considerable evidence suggests that ethnicity covaries with SES (e.g., Williams, Mohammed, Leavell & Collins, 2010), suggesting the hypothesis that pathways to health behavior may be explained by psychological variables associated with low SES. The extent to which variability in screening participation attributable to ethnicity cannot be accounted for by low SES will indicate the need for further investigation of distinct ethnicity influences on health behavior.

If preventive services such as screening are differentially used by different SES and ethnic groups, mortality rates would subsequently show even stronger disparities over time (e.g., Maringe et al., 2013). In the present study we aimed to identify the factors that explain the association of South Asian ethnicity and socio-economic status with participation in FOBt colorectal screening. We expect to provide valuable insight into the processes by which psychological and social structural variables impact on screening and provide data that may inform intervention development. Specifically, we predict that (a) South Asians will have lower participation in FOBt screening compared to the non-South Asian population, (b) low socio-economic status will be inversely associated with FOBt screening participation, (c) the association of ethnicity with participation in FOBt screening will be mediated by socio-economic status, and (d) psychological variables will be direct predictors of uptake and mediate the paths from ethnicity and socio-economic status to FOBt screening participation.

Method

Setting, Participants and Design

The colorectal cancer screening program in the UK is funded nationally and organized and delivered regionally, without direct involvement of primary care providers. All age-eligible men and women are sent a biennial guaiac-based FOB test to complete at home.

Participants were people (N = 2944) living in two UK regions, Warwickshire in England and Tayside in Scotland. The study was approved by the UK Northern and Yorkshire MREC January 2007 (REC reference: 06/MRE03/67). Local Research and Development approval was subsequently granted by Warwickshire Primary Care Trust (PCT), Coventry PCT, University Hospitals Coventry and Warwickshire (UHCW) and NHS Tayside.

Random samples of men and women meeting the eligibility criteria for an invitation to FOBt screening were drawn from screening databases in England and Scotland. Over-sampling was utilized to ensure representation of people with lower socio-economic status and of South Asian ethnicity. Over-sampling by SES category was derived from Carstairs indexes linked to individual postal codes. In order to ensure that adequate numbers of minority ethnic South Asians were included, name recognition software, *Nam Pehchan*, for which sensitivity and specificity values of 95% (Gumber, 2006) and 97% (Honer, 2003) have been recorded, was used to assign an ethnicity label to 132,992 men and women in the screening database in England. The program contains a dictionary of South Asian names that are matched against the complete name or the name stem in order to provide a list of South Asians together with a language and religion marker for each person so that individuals can be placed into different religio-linguistic groups: Hindu-Gujarati; Hindu-Other, Muslim-Urdu; Sikh-Punjabi (Szcepura et al., 2003 Appendix 1). Within South Asia these categories signal cultural and religious practices (including diet) that are meaningful and relevant within the health care context. The software identifed a total of 6,450 individuals belonging to one of these groups (4.8%) and a stratified sample was drawn from this subsample. For the purposes of the present analyses, the two Hindu subcategories were collapsed into a single category. The response rate was 49%. Response to the questionnaire varied by age and SES but there was no association with gender. Older participants (χ^2 (3) = 48.792, $p < .001$) and the least deprived (χ^2 (1) = 55. 093, $p < .001$) were more likely to return a completed questionnaire.

Non-Asians were more likely to return a questionnaire than South Asians (χ^2 (1) = 629.878, p < .001).

Linkage to NHS screening records. Data from questionnaires was linked to response to a subsequent FOBT invitation approximately 24 months later using National Health Service identification numbers. NHS matched screening outcome data was available for 1851 questionnaire respondents at follow up. Questionnaire respondents who were not invited to complete an FOB test in the intervening years because they were age ineligible, deceased, undergoing current treatment, had moved away from the screening region or could not be identity matched are summarized in Figure 1.

Cross validation of ethnicity identifcation. A UK census format ethnicity self report item was included in the survey. Respondents were asked to assign themselves to one of five categories (Black or Black British, Mixed, Asian or Asian British, White, Chinese/Other) and to further specify their ethnicity within the chosen category. Responses to this item were cross referenced against the ethnicity labels assigned by the *Nam Pehcham* software (Appendix 1). Fifty eight people did not provide ethnicity self report data and a further 115 people were misclassified (6%). It was decided that the most approriate strategy in the present context was to exclude these 173 participants whose ethnicity was unverifiable, leaving a final sample of 1678. Characteristics of the final ethnically and socio-economically diverse study sample are summarized in Table 1.

Procedure

All eligible adults were sent a postal questionnaire along with a letter explaining that the purpose of the study was to understand what people think about bowel cancer and what they think about doing the bowel cancer screening test. A freepost return envelope was included. Letters sent to sampled individuals identified a priori by name recognition software as South Asian included a passage translated into five languages inviting people to seek

assistance from an English speaker if required. A reminder letter was sent one week later, and a second booklet and reminder letter was sent two weeks later. They were informed that questionnaire completion constituted consent to participate and those returning completed questionnaires were entered into a prize lottery for a £50 downtown store gift certificate.

Measures

Socio-demographic measures. Age, gender and SES index scores linked to individual postal codes were available for all participants from the screening database. SES was derived from the Carstairs index which is an established measure widely used in Office of National Statistics studies and health research (e.g. Coleman et al, 1999; Evans, Newton, Ruta, MacDonald & Morris, 2000). Developed by Carstairs and Morris (1989), the Carstairs index provides a measure of material deprivation in small areas (averaging 15 houses) derived from four census indicators: male unemployment, lack of car ownership, overcrowding indexed by number of persons per room in household and employment in social classes IV or V. The scores included in this study were derived from 2001 census data. Larger, positive values indicate lower socio-economic status or higher deprivation. Although the Carstairs index relies upon a small-area rather an individual measure of SES, the present study involved older adults, many of whom were born abroad or retired, making indices related to education or income unreliable and difficult to assess. The preferred strategy was to employ a reliable established indicator which also had the advantage of being available for every single individual in the study since it was derived from their postal code. Membership of the South Asian groups Hindu, Muslim, and Sikh were operationalized as dummy-coded dichotomous variables (0 = non-member of the stipulated ethnic group, 1 = member of the stipulated ethnic group). Gender was coded 0 = woman, 1 = man.

Psychological measures. Thirty items were included to assess the five psychological constructs. The constructs were operationalized and piloted according to standard procedures

and previous studies to ensure content validity (Conner & Norman, 2005; Norman, Boer & Seydel, 2005; Milne, Sheeran & Orbell, 2000). Focus groups were employed to elicit specific relevant content in the behavioral domain of FOBt screening. All items were scored on six-point Likert scales unless specified otherwise. *Severity* comprised eight items assessing physical and psychosocial perceived impacts of bowel cancer, for example "If I were to develop bowel cancer; it could almost certainly cause my death (disagree very strongly-agree very strongly". *Vulnerability* comprised six items (e.g.,"I think that my chances of developing bowel cancer are very low (agree very strongly-disagree very strongly)". *Response efficacy* comprised eight positive expectancies each scored on a scale from extremely likely to happen-extremely unlikely to happen, for example "Doing a bowel cancer screening test in the future would reduce my chances of dying from bowel cancer". *Response costs* comprised five negative expectancies each scored on a scale from extremely likely to happen–extremely unlikely to happen, for example "Doing a bowel cancer screening test in the future would be embarrassing; would lead to unpleasant treatment if abnormalities were present; would be disgusting; would be unhygienic". *Self-efficacy* comprised three items "If I am invited to do a bowel cancer screening test in the future; I am certain that I could do it (extremely certain-extremely uncertain)". Full questionnaire items are presented in Appendix 2 as supplemental materials.

Data Analysis

Structual equation model testing mediation effects. Structural equation modelling was employed to test the hypotheses of our process model that included psychological variables and socio-economic status as mediators in a two-stage mediation model. In the first instance, a confirmatory factor analysis (CFA) model was estimated to test whether the covariance matrices among items could be adequately explained by a set of latent and non-latent variables representing the hypothesized psychological and demographic constructs and

a dichotomous measure of participation in the FOBt screen. Specifically, items pertaining to the self-efficacy (n = 3), response efficacy (n = 8), response cost (n = 5), perceived severity (n = 8), and perceived vulnerability (n = 6) were set to indicate latent variables in the model while SES (Carstairs index) was included as a non-latent variable. In addition, we included age and gender as control variables in the model such that each variable was set to predict all other model variables. Consistent with standard practice for CFA models all latent and non-latent variables were allowed to covary and a single indicator of each latent factor was set to unity to define its scale. Following adequate fit of the CFA model a structural equation model was estimated that included structural parameters representing the hypothesized relations among the model constructs. Specifically, the demographic variables were set as independent predictors of the psychological variables and the psychological variables were proposed as independent predictors of participation. Direct effects of the demographic variables on participation were also freed.

We tested our hypotheses using a structural equation model (SEM). In the model, the three dummy-coded dichotomous variables representing ethnicity group membership (Hindu, Muslim, Sikh) were set as predictors of SES, SES as predictor of each of the latent psychological variables (self-efficacy, response costs, response efficacy, vulnerability, and severity), and the psychological variables as predictors of participation. This model enable us to test a series of three-path sequential indirect effects of each ethnicity variable on participation through SES and each psychological variable (e.g., hindu ethnicity→SES→self-efficacy→participation). We also included direct effects of the ethnicity variables on the psychological variables. This enabled us to test a series of two-path indirect effects of each ethnicity variable on participation through each psychological variable (e.g., muslim ethnicity→response costs→participation). This tested the alternative hypothesis that effects of ethnicity on participation are subsumed by the psychological constructs, but independent of

SES. Finally, we also included direct effects of the ethnicity variables and SES on participation to test whether direct effects of these demographic variables in the presence of the indirect effects. This enabled us to test whether the effects of ethnicity on participation are due to variations in SES, or beliefs regarding the behavior and condition, both, or neither. Tests of indirect effects in the model were conducted consistent with methods advocated by Hayes (2013) using simultaneous estimation and confidence intervals. The MPlus computer program (Muthén & Muthén, 2015) was used to estimate the specified CFA and SEM models using a robust maximum likelihood method. Multiple criteria were adopted to evaluate model goodness-of-fit including the comparative fit index (CFI), non-normed fit index (NNFI), the standardized root mean square of the model residuals (SRMSR), root mean square error of approximation (RMSEA), and the 95% confidence intervals of the RMSEA (CI_{95}). Values in excess of .90 are indicative of reasonable model fit for the CFI and NNFI indexes (Bentler, 1990), although values approaching or exceeding .95 are preferable (Hu & Bentler, 1999). Cut-off values of .50 and .08 or less for the SRMSR and RMSEA are considered indicative of good fit, with narrow 95% confidence intervals for the RMSEA (Hu & Bentler, 1999). In addition, we also examined the adequacy of the solution estimates of the CFA model, namely, the standardized factor loadings which should exceed .70, the average variance extracted from the items in each factor which should exceed .50, and the composite reliability (ρ_c) estimates which should be greater than .80.

Results

FOBt Uptake at Follow-up

Overall 382 respondents (22.8%) did not complete FOBT at follow up. As hypothesized, participation in screening at follow-up varied by ethnicity. Non-participation rates were respectively; 19.6% British white, 30.6% Hindu, 42.6% Muslim and 25.3% Sikh (χ^2 (3) = 36.45, $p < .001$). Non-participation also varied by SES (χ^2 (4) = 14.65, $p < .001$) and

showed a linear association across the distribution of SES, rather than a specifically high non-participation amongst the most deprived group. Non-participation rates across five quintiles (most deprived to least deprived) were 29.8%, 24.4%, 21.3%, 23.0% and 18%. No association was observed with age (M = 58.18, SD = 5.14 screened vs. M = 57.96, SD = 5.37 non screened; t (1676) = -.73, p =.462) or gender (χ^2 (1) = .04, p = .846; 23% vs 22.6% non-participation for women and men respectively).

Confirmatory Factor Analysis and Structural Equation Model

The CFA supported the construct validity of the latent psychological variables. CFA goodness-of-fit estimates revealed adequate fit of the model according to the multiple criteria adopted (Scaled χ^2 (595) = 963.706, $p < .001$; CFI = .958, NNFI = .949, SRMSR = .039; RMSEA = .033, CI_{95} = .030, .037). Solution estimates for the latent variables and intercorrelations among all study variables are presented in Table 2. Examination of solution estimates revealed that factor loadings exceeded or approached .70 and average variance extracted (AVE) and composite reliability (ρ) values for each factor approached or exceeded the recommended .50 and .80 criterion values for well-defined factors. The misspecification due to the low factor loadings was considered relatively minor and inconsequential relative to the fit of the global model and was deemed unlikely to have considerable impact on the structural parameters, suffice to say that the latent constructs are dominated by commonality in the perceptions captured by the strongly-loading items and not by the perceptions captured in the items with low factor loadings.

The structural equation model was estimated to test our hypothesis that SES and the psychological constructs mediated effects of ethnicity on FOBt participation. Specifically, SES and psychological constructs (response efficacy, vulnerability, self-efficacy, response cost, and severity) were set as mediators of the relationship between the ethnicity variables and participation. The resultant model exhibited good fit with the data (Scaled χ^2 (497) =

983.286, $p < .001$; CFI = .957, NNFI = .949, SRMSR = .039; RMSEA = .034, CI_{95} = .031, .037). Standardized parameter estimates for the direct and indirect effects in the model are presented in Table 3 and statistically significant paths are illustrated in Figure 2.

Membership of Hindu, Muslim, and Sikh ethnic groups were statistically significant direct predictors of SES, and SES was a statistically significant predictor of self-efficacy and response cost. In addition, there were statistically significant direct effects of Hindu, Muslim, and Sikh ethnic groups on response efficacy, vulnerability, self-efficacy, and response cost. However, only self-efficacy and response cost were statistically significant direct predictors of participation. Given self-efficacy and response cost were the only predictors of participation, we expected three-path indirect effects of the ethnicity variables on participation with SES and self-efficacy or response cost as multiple sequential mediators. Consistent with our hypotheses, we found statistically significant and negative three-path indirect effects of Sikh, Hindu, and Muslim ethnicity on participation through SES and self-efficacy. However, the effects of ethnicity on participation were not exclusively mediated by SES. There were also statistically significant indirect effects of ethnicity on participation that were through the psychological variables and not mediated by SES. Specifically, there were statistically significant two-path indirect effects of Sikh, Hindu, and Muslim ethnicity on participation with self-efficacy or response costs as the single mediator. The only exception was the indirect effect of Muslim ethnicity on participation through response cost, which fell short of the conventional level for statistical significance (p = .052). Importantly, there were no direct effects on of any of the ethnicity variables or SES on participation. Effects of ethnicity on participation were therefore mediated by SES and the psychological variables in the three-path indirect effects, or by the psychological variables only in the two-path indirect effects. Effect sizes for the statistically significant direct (median β = .104) and indirect (median β = .020) paths in the model were small.

Although not hypothesized, we found significant negative effects of age on self-efficacy and gender on response costs, and a significant positive effect of gender on severity. While our current model aimed to evaluate the mediating psychological processes by which ethnicity and SES related to the FOBt participation, we also considered alternative models. One alternative model proposes that SES and ethnicity might moderate effects of the psychological variables on participation (e.g., Schüz, 2017). To test this proposal, we ran a series (n = 20) of logistic regression models in which participation was regressed in turn on each of the psychological variables along with either SES or one of the ethnicity dummy-coded variables, together with multiplicative terms representing the SES x psychological variable or ethnicity x psychological variable interacton effects. The interaction terms did not obtain a significant relation with participation in any of the regression models, suggesting no evidence for the hypothesized interaction effects in these data.

Discussion

Uniquely, this study employed indices of small area SES, and ethnicity, psychological variables and behavior assessed at the individual level to evaluate the role of socio-economic status and psychological constructs in mediating effects of ethnicity on colorectal screening uptake in a no cost health care service. As expected, South Asian ethnic minorities and people with lower SES were under-represented amongst the screened population at follow up. SES also showed a gradient relationship with FOBt uptake, consistent with previous research (e.g. von Wagner et al., 2011). A structural equation model showed that the paths from South Asian Hindu, Muslim and Sikh ethnicity, and socio-economic status on uptake were fully mediated by lower self-efficacy and higher perceived response costs. The paths from South Asian ethnicity to participation via self-efficacy and response costs were both direct, and indirect via socio-economic status, indicating a residual influence of ethnicity on uptake that

was not attributable to socioeconomic status but which was nonetheless mediated by lower self efficacy and higher response costs.

FOBt screening delivered within a cost-free health care system involves a self-administered sampling procedure that does not involve travel to clinics, time off work or contact with health professionals. In this context, perceived psychological costs of completing the test kit and self efficacy to complete the kit fully explained variability in uptake attributable to socioeconomic status. Social and economic conditions that limit opportunities for future planning, or that cannot cushion short-term emotional, social and economic costs, might be considered in future research as circumstances that enhance response costs associated with screening, particularly those occurring in the short term (Orbell, Perugini & Rakow, 2004; Whitaker et al, 2011). These enhanced costs include those that may arise from potential treatment implications of an abnormal result, if the test is taken, such as hospital appointments, medical procedures and time off work, and also from aversive aspects of the self sampling procedure itself, such as disgust and embarrassment. It is not clear why these latter costs might show a gradient relationship with SES. A possible reason could be that housing conditions might impact upon privacy or embarrassment associated with collecting samples and storing the kit before posting. Screening by FOBt is a complex behavior, requiring confidence to follow instructions to undertake self-sampling (and to do it correctly) and ability to manage negative emotions associated with handling faeces (e.g., embarrassment, disgust) (O'Sullivan & Orbell, 2004). Generally low self agency as a consequence of social experience may explain the SES differentials observed here. Evidence that self-efficacy and response costs are important mediators of both SES and ethnicity via SES suggests that a common strategy might be appropriate to address social sources of self-agency that may impact upon efficacy to plan how to collect samples, or plan to manage negative emotion, for example (Greiner et al., 2014; Schwarzer, 2008). In addition, Orbell et

al. showed that emphasising short term benefits of screening participation may be useful in shifting attitudinal focus towards screening participation.

The South Asian samples included in the present study were all less likely to complete a screening kit than non-Asian Britons. Our findings suggest two psychological routes by which ethnicity might exert residual effects on behavior because we obtained direct effects of ethnicity on participation via self efficacy and response costs.The religio-linguistic sub-populations distinguished by these analyses differ on a number of dimensions from the white British sample, including country of origin, religion, language and literacy, and traditional diet (Szczepura, 2010; Szczepura et al, 2003). It is possible that cultural influences impact on self efficacy and enhance the psychological costs of collecting and storing stool samples, and of positive results, if social stigma is attached to a cancer diagnosis, or potential interactions with medical professionals are perceived to be aversive. South Asian cultures also tend to score more highly on collectivism than non-Asian cultures (Hofstede, Hofstede & Minkov, 2010). Collectivism confers an interdependent self conception in which the self is embedded in social context and defined by social relations. Behavioral motives are guided by avoiding negative outcomes and social group disruption, such as not burdening others in the family, and conformity to community norms and expectations, although much of the previous evidence is based on East Asian samples. It is possible that evidence that collectivist cultures are more responsive to health messages that emphasize avoidance of loss associated with not acting, or that emphasize relational outcomes, or affirm values concerned with avoiding negative things in life (e.g., Sherman, Uskul & Updegraff, 2011) may inform future investigation of non-participation in screening in South Asian communities. Establishing cultural group screening norms and emphasizing community aspects of mass screening programs may also be important.

The threat appraisal variables, severity and vulnerability, were not significantly related to FOBt uptake in our structural model, consistent with evidence that coping appraisal is more reliably associated with a range of health behaviors, perhaps because of its conceptual proximity to behavioral enactment (e.g. Milne, Sheeran & Orbell, 2000). Although not significantly associated with uptake, it was interesting to observe significant direct relationships from ethnicity to perceived vulnerability and response efficacy for all three ethnic minorities such that membership of a South Asian group was associated with lower perceived vulnerability to colorectal cancer and lower perceived screening efficacy. These variables were not associated with socioeconomic status in the current structural model. A few studies have suggested that low perceived vulnerability in South Asian populations might be attributable to beliefs that vulnerability is indicated by existing symptoms, (e.g. Lo, Waller, Vrinten, Kobayashi & von Wagner, 2015) consistent with low endorsement of cognitions concerning benefits of early detection and treatment observed in the present study. An alternative, albeit, to date, under-investigated, possibility might be that South Asian populations consider their ethnicity to confer group protection from colorectal cancer. World cancer statistics indicate significantly lower incidence of bowel cancer in South Asia than in Western countries (International Agency for Research on Cancer, 2012) and older British immigrant South Asian populations such as those currently age eligible for screening may therefore perceive low ingroup risk. Historical trends in risk are, however, unlikely to be sustained during acculturalisation and low participation in screening may ultimately lead to a widening gap in cancer survival (Sczepura et al., 2008; Maringe, Mangtani, Coleman & Rachet, 2015). Observed rises in disease incidence and increasingly prevalent behavioral risk in South Asia has led to recent calls for bowel cancer screening (e.g., Bhurgri et al., 2011). Importantly, current findings indicate that variability in perceived vulnerability was not associated with variability in screening uptake. Increasing perceived vulnerability might

therefore have little direct impact on uptake, consistent with meta analytic findings that show small effect sizes for the relation between perceived risk and behavior whether assessed correlationally (Atkinson, Salz, Touza, Yi & Hay, 2015) or experimentally (Sheeran, Harris & Epton, 2014). Efforts to increase perceived vulnerability may have limited impact on behavior change unless also accompanied by interventions that simultaneously address coping appraisal variables by increasing self efficacy and decreasing perceived psychological costs of screening.

Age and gender were unrelated to screening participation. Although not hypothesized, a few direct effects of age and gender on psychological variables were observed. Men perceived colorectal cancer as more serious, while women perceived the test to be associated with greater psychological costs. Relatively younger adults perceived higher self efficacy to complete the test kit, consistent perhaps with fewer mobility limitations.

Study Strengths and Limitations

The sub-optimal reponse rate is a limitation of the study although the response rate observed in the current study is in line with similar studies (e.g. Miles, Rainbow & von Wagner, 2011). However strengths of the study include the objective assessment of screening participation, stratified random population sampling and the observed prospective relationship of both socio-economic status and ethnicity to subsequent screening uptake. In this study, which included only questionnaire respondents who might be considered to have good literacy, screening non-participation in the most deprived SES quintile was 1.6 times that of the least deprived SES quintile. Similarly, non-uptake among South Asians was 1.6 times higher than that of non-Asians. Muslims also had the lowest observed uptake amongst South Asian groups, consistent with Szczepura et al (2008). It seems most likely that consideration of questionnaire non-respondents might only enhance these observed inequalities.

The small effect sizes for the statistically significant direct and indirect effects of the ethnicity, psychological, and SES variables should also be highlighted. Although effect sizes from the current analysis were modest in absolute terms, they are consistent with previous research examining effects of demographics and psychological variables in cancer screening contexts (Orbell & Hagger, 2006; Orbell, Hagger, Brown & Tidy, 2006; Smith et al., 2016). Small effect sizes, particularly those expressed as correlations and beta coefficients, also translate to clinically important effects when considered at the population level (Rutledge & Loh, 2004). For example, effects of indices of SES on screening uptake have typically been shown to be small in regression analyses, but these effects translate to substantive numbers failing to attend screening (Solmi et al., 2016). Finally, the current study excluded a measure of intentions, a measure often included in social cognitive models, as a mediator of effects of psychological antecedents on behavioral outcomes. This was because our intention measure failed to achieve discriminant validity with our measure of self-efficacy.

Conclusion

In summary, our process analysis of the effect of ethnicity on screening uptake supports the view that socio-economic status is implicated in, but does not fully explain, variance attributable to South Asian ethnicity. Whilst interventions that target perceived negative psychological costs of screening and enhance self efficacy are indicated to tackle inequality within a no cost health care context, it will also be important to consider how ethnicity might impact directly on these beliefs and develop strategies that address ethnicity specific sources of low self-efficacy and high response costs.

References

American Cancer Society (2015) *Colorectal Cancer*. Retrieved from http://www.cancer.org/acs/groups/cid/documents/webcontent/003096-pdf.pdf, June 2015.

Atkinson, T.M., Salz, T., Touza, K.K., Li, Y., Hay, J.L. (2015). Does colorectal cancer risk perception predict screening behaviour? A systematic review and meta analysis. *Journal of Behavioral Medicine, 38,* 837-850.

Bhurgri, Y., Khan, T., Kayani, N., Ahmad, R., Usman, A., Bhurgri, A., Bashir, I., Hasan, S, Zaidi, SMH (2011). Incidence and current trends of colorectal malignancies in an unscreened, low risk population. *Asian Pacific Journal of Cancer Prevention, 12*, 703-708.

Carstairs, V. & Morris, R. (1989). Deprivation, mortality and resource allocation. *Community Medicine, 11*, 364-372.

Coleman M P *et al* (1999) *Cancer Survival Trends in England and Wales, 1971–1995: deprivation and NHS Region*. Studies on Medical and Population Subjects No 61, TSO: London.

Conner, M. & Norman, P. (2005). *Predicting Health Behaviour*, Maidenhead: McGraw-Hill.

Cummins, C., Winter, H., Cheng, KK., Maric, R., Silcocks, P., Varghese, C. (1999). An assessment of the Nam Pehchan computer program for the identification of names of South Asian ethnic origin. *Journal of Public Health Medicine*, 21, 401-406.

Decker, K.M., Demers, A.A., Nugent, Z., Biswanger, N., Singh, H. (2015). Longitudinal rates of colon cancer screening use in Winnipeg, Canada: The experience of a universal health-care system with an organized colon screening program. *American Journal of Gastroenterology*, *110*, 1640-1646.

Evans J M, Newton R W, Ruta D A, MacDonald T M and Morris A D (2000) Socio-economic status, obesity and prevalence of Type 1 and Type 2 diabetes mellitus. *Diabetic Medicine* **17**(6), 478–480.

Greiner, K.A., Daley, C.M., Epp, A., James, A., Hung-Wen, Y. et al. (2014). Implementation intentions and colorectal screening: A randomized trial in safety-net clinics. American

Journal of Preventive Medicine, 47, 703-714.

Gumber, A. (2006). *Ethnicity and name analysis: Potential for improved ethnic monitoring in the NHS using Nam Pehchan*. Proceeedings of Annual International Conference on Global Social Justice and Environmental Sustainability. London, UK.

Hayes, A. F. (2013). Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. New York, NY: Guildford Press.

Hewitson, P., Glasziou, P., Irwig, L., Towler, B. Watson, E. (2007). Screening for colorectal cancer using the faecal occult blood test, Hemoccult. *Cochrane Database Systematic Review* (1); CD001216.

Hewitson, P., Galsziou, P., Watson, E., Towler, B., Irwig, L. (2008). Cochrane systematic review of colorectal cancer screening using the faecal occult blood test (hemoccult): An update. *American Journal of Gastroenterology*, 103, 1541-1549. DOI: 10.1111/j.1572-0241.2008.01875.x

Hofstede, G., Hofstede, G.J., Minkov, M. (2010). *Cultures and Organizations: Software of the Mind* (3rd Edn.) New York: McGraw-Hill, USA.

Honer, D. (2003). *Identifying Ethnicity: A comparison of two computer software programs designed to identify names of south Asian origin*. Thesis submitted for Master of Public Health, University of Birmingham, UK.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1-55. doi: 10.1080/10705519909540118

International Agency for Research on Cancer (2012) GLOBOCAN 2012: Estimated cancer incidence, mortality and prevalence worldwide in 2012. Retrieved from http://globocan.iarc.fr/Pages/fact_sheets_cancer.aspx, June 2015.

Iqbal, G., Johnson, M., Szczepura, A., Wilson, S., Gumber, A., Dunn, J. (2012). UK ethnicity

data collection for healthcare statistics: the South Asian perspective. *BMC Public Health, 12,* 243-251.

Janz, N. & Becker, M.H. (1984). The health belief model: a decade later. *Health Education Quarterly,11*,1-47.

Joseph, D., King, J., Miller, J., Richardson, L. (2012). Centers for Disease Control and Prevention (CDC). Prevalence of colorectal cancer screening among adults- Behavioral Risk Factor Surveillance System, United States, 2010. *MMWR. Morbidity and Mortality Weekly Report, 61* (Suppl), 51-56.

Maringe C, Walters S, Rachet B, Butler J, Fields T, Finan P, Maxwell R, Nedrebø B, Påhlman L, Sjövall A, Spigelman A. (2013). Stage at diagnosis and colorectal cancer survival in six high-income countries: a population-based study of patients diagnosed during 2000–2007. *Acta Oncologica*, 52(5):919-32.

Milne, S., Sheeran, P. & Orbell, S. (2000). Prediction and intervention in health-related behavior: A meta-analytic review of protection motivation theory. *Journal of Applied Social Psychology, 30,* 106-143.

Miles, A, Rainbow, S, von Wagner, C. (2011). Cancer Fatalism and Poor Self-Rated Health Mediate the Association between Socioeconomic Status and Uptake of Colorectal Cancer Screening in England. *Cancer Epidemiology, Biomarkers and Prevention, 20, 2132-2140*.

Muthén, L. K., & Muthén, B. O. (2015). *Mplus Statistical Software version 7.31*. Los Angeles, CA: Muthén & Muthén

National Cancer Intelligence Network (2009). *Cancer Incidence and Survival by Major Ethnic Group, England, 2002-2006*. National Cancer Intelligence Network: London.

Norman, P., Boer, H. & Seydel, E.R. (2005). Protection Motvation Theory. In M. Conner and P.Norman (Eds.) pp. 81-126. *Predicting Health Behaviour,* Maidenhead: McGraw-Hill.

Office for National Statistics (2012). *Cancer Registration Statistics, England, 2012*. Office for National Statistics, 2014.

Office for National Statistics (2013). *Key Statistics and Quick Statistics for local authorities in the United Kingdom: Census 2011*. pp.5-6.

Orbell, S., Crombie, I., Johnston, G. (1996). Social cognition and social structure in the prediction of cervical screening uptake. *British Journal of Health Psychology*, *1*, 35-50.

Orbell, S., Hagger, M., Brown, V. & Tidy, J. (2006). Comparing two theories of health behavior: A prospective study of noncompletion of treatment following cervical cancer screening. *Health Psychology*, 25, 604-615.

Orbell, S. & Hagger, M. (2006). "When no means no": Can reactance augment the theory of planned behavior? *Health Psychology*, 25, 586-594.

Orbell, S., Perugini, M. & Rakow, T. (2004). Individual differences in sensitivity to health communications: Consideration of future consequences. *Health Psychology* 23, 388-396.

O'Sullivan, I. & Orbell, S. (2004). Self-sampling to reduce mortality from colorectal cancer: A qualitative exploration of the decision to complete a Faecal Occult Blood Test (FOBT). *Journal of Medical Screening*, 11, 16-22

Price, C.L., Szczepura, A., Gumber, A., Patnick, J. (2010). Comparison of breast and bowel cancer screening uptake patterns in a common cohort of South Asian women in England. *BMC Health Services Research*, *10*, 103

Rippetoe, P.A. & Rogers, R.W. (1987). Effects of components of protection motivation theory on adaptive and maladaptive coping with a health threat. *Journal of Personality and Social Psychology, 52*, 596-604.

Rothman, A.J. & Salovey, P. (1997). Shaping perceptions to motivate healthy behavior: The role of message framing. *Psychological Bulletin*, *121*, 3-19.

Schwarzer, R. (2008). *Modeling health behaviour change: The health action process approach* (HAPA). Retrieved January 2015 from http://userpage.fu-berlin.de/~health/hapa.htm.

Sheeran, P., Harris, P., Epton, T. (2014). Does heightening risk appraisals change people's intentions and behavior? A meta-analysis of experimental studies. *Psychological Bulletin*, 140, 511-543.

Sherman, D., Uskul, A., Updegraff, J. (2011). The role of the self in responses to health communications: A cultural perspective. *Self and Identity*,10, 284-294.

Shüz, B. (2017). Socio-economic status and theories of health behaviour: Time to upgrade a control variable. *British Journal of Health Psychology*, 22, 1-7.

Smith, S. G., McGregor, L. M., Raine, R., Wardle, J., von Wagner, C., & Robb, K. A. (2016). Inequalities in cancer screening participation: examining differences in perceived benefits and barriers. *Psycho-Oncology*, *25*, 1168-1174.

Solmi, F., Von Wagner, C., Kobayashi, L. C., Raine, R., Wardle, J., & Morris, S. (2015). Decomposing socio-economic inequality in colorectal cancer screening uptake in England. *Social Science & Medicine, 134*, 76-86.

Szczepura, A., Price, C., Gumber, A. (2008). Breast and bowel cancer screening uptake patterns over 15 years for UK south Asian ethnic minority populations, corrected for differences in sociodemographic charcteristics. *BMC Public Health*, 8, 346- 360

Szczepura A, Johnson M, Orbell S, Gumber A, O'Sullivan I, Clay D, Owen D. (2003). Ethnicity: UK Colorectal Cancer Screening Pilot. Department of Health, 2003. http://wrap.warwick.ac.uk/133/1/WRAP_Szczepura_ethnicity-finalreport.pdf

Von Wagner, C., Good, A., Whitaker, K. L., & Wardle, J. (2011). Psychosocial determinants of socioeconomic inequalities in cancer screening participation: a conceptual framework. *Epidemiologic reviews*, *33*(1), 135-147.

Weinstein, N.D., Sandman, P.M., Blalock, S.J. (2008). The Precaution Adoption Process Model. In K.Glanz, B.Rimer, K. Viswanath (Eds.) *Health Behavior and Health Education. Theory, Research and Practice*. 4th Edition. Pp.123-147. SanFrancisco: Wiley.

Whitaker, K.L., Good, A., Miles, A., Robb, K., Warlde, J., von Wagner, C. (2011). Socioeconomic inequalities in colorectal cancer screening: Does time perspective play a role? *Health Psychology*, 30, 702-709.

Williams, D.R., Mohammed, S.A., Leavell, J., Collins, C. (2010). Race, socioeconomic status and health: Complexities, ongoing challenges and research opportunities. *Annals of the New York Academy of Science*, 1186, 69-101.

Table 1

Summary of Sample Characteristics (N = 1678)

Variable	% of total sample/range	Mean	Standard Deviation
Gender			
Men	53.6%		
Women	46.4%		
Age	50-67	58.13	5.20
SES Carstairs deprivation index*	-5.45-11.69	0.82	3.99
Ethnicity			
British White European	72.2%		
British Minority Ethnic	27.8%		
South Asian			
Hindu	10.7%		
Muslim	6.0%		
Sikh	11.1%		

* Higher positive scores indicate lower SES or greater socio-economic deprivation

Table 2
Solution Estimates for Latent Factors and Zero-order Correlations Among Study Variables.

Variable	ρ	AVE	1	2	3	4	5	6	7	8	9	10	11
1. Age	–	–	–										
2. Gender	–	–	.013	–									
3. SES	–	–	-.009	-.049	–								
4. Hindu	–	–	-.043	-.038	.184**	–							
5. Muslim	–	–	-.038	.013	.391**	-.087**	–						
6. Sikh	–	–	.019	-.050	.225**	-.122**	-.089**	–					
7. Participation	–	–	.025	.020	-.143**	-.074*	-.105**	-.031	–				
8. Response efficacy	.935	.672	.015	-.016	-.097**	-.067*	-.089**	-.185**	.077*	–			
9. Self-efficacy	.884	.719	-.102**	.076*	-.252**	-.171**	-.146**	-.175**	.216**	.437**	–		
10. Response cost	.877	.594	.021	-.125**	.254**	.255**	.165**	.168**	-.200**	-.249**	-.586**	–	
11. Severity	.737	.289	-.069	.119**	-.036	.021	-.016	-.024	.033	.216**	.202**	.015	–
12. Vulnerability	.837	.473	-.053	.034	-.059	-.162	-.036	-.170**	.060	.167**	.181**	-.034	.363**

Note. ρ = Composite reliability coefficient; AVE = Average variance extracted; SES = Socio-economic status measured by the Carstairs index (high scores indicate lower SES or more deprivation). Correlations among psychological variables are factor correlations derived from the confirmatory factor analysis and are therefore attenuated for measurement error. Hindu, Muslim, and Sikh ethnicity variables are dummy-coded dichotomous variables with 1 = member of the stipulated ethnic group and 0 = non-member of the stipulated ethnic group. Gender was coded 0 = woman, 1 = man. Psychological variables are latent variables based on confirmatory factor analysis.
*$p < .05$ **$p < .01$

Table 3
Parameter Estimates for Direct and Indirect Effects in Structural Equation Model

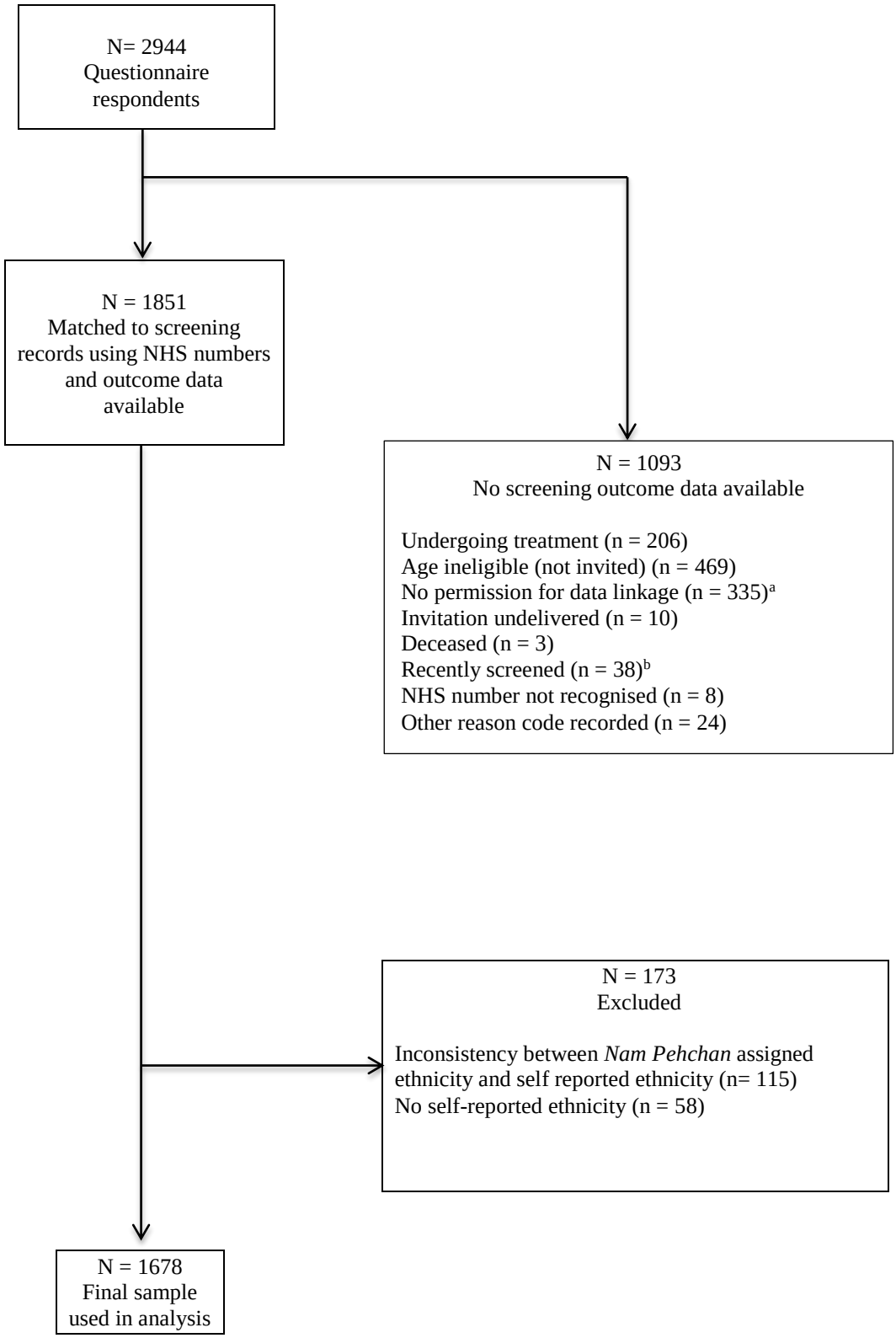
Path	Parameter Estimate[a]	SE	CI_{95}		*p*
			LB	UB	
Direct effects					
Hindu→Participation	-.005	.038	-.079	.069	.893
Muslim→Participation	-.036	.041	-.116	.044	.373
Sikh→Participation	.024	.038	-.050	.098	.532
Hindu→Response efficacy	**-.108**	**.033**	**-.173**	**-.043**	**.001**
Muslim→Response efficacy	**-.124**	**.034**	**-.191**	**-.057**	**.000**
Sikh→Response efficacy	**-.214**	**.040**	**-.292**	**-.136**	**.000**
Gender→Response efficacy	-.028	.034	-.095	.039	.409
Age→Response efficacy	.010	.033	-.055	.075	.750
SES→Response efficacy	.018	.038	-.056	.092	.634
Hindu→Vulnerability	**-.213**	**.043**	**-.297**	**-.129**	**.000**
Muslim→Vulnerability	**-.104**	**.043**	**-.188**	**-.020**	**.013**
Sikh→Vulnerability	**-.219**	**.038**	**-.293**	**-.145**	**.000**
Gender→Vulnerability	.021	.035	-.048	.090	.557
Age→Vulnerability	-.062	.033	-.127	.003	.061
SES→Vulnerability	.070	.045	-.018	.158	.121
Hindu→Self-efficacy	**-.184**	**.034**	**-.251**	**-.117**	**.000**
Muslim→Self-efficacy	**-.135**	**.037**	**-.208**	**-.062**	**.000**
Sikh→Self-efficacy	**-.177**	**.032**	**-.240**	**-.114**	**.000**
Gender→Self-efficacy	.057	.033	-.008	.122	.083
Age→Self-efficacy	**-.113**	**.033**	**-.178**	**-.048**	**.000**
SES→Self-efficacy	**-.124**	**.038**	**-.198**	**-.050**	**.001**
Hindu→Response cost	**.275**	**.036**	**.204**	**.346**	**.000**
Muslim→Response cost	**.175**	**.041**	**.095**	**.255**	**.000**
Sikh→Response cost	**.192**	**.037**	**.119**	**.265**	**.000**
Gender→Response cost	**-.104**	**.033**	**-.169**	**-.039**	**.002**
Age→Response cost	.038	.032	-.025	.101	.234
SES→Response cost	**.088**	**.039**	**.012**	**.164**	**.024**
Hindu→Severity	.027	.040	-.051	.105	.505
Sikh→Severity	-.006	.037	-.079	.067	.879
Muslim→Severity	-.007	.042	-.089	.075	.866
Gender→Severity	**.119**	**.038**	**.045**	**.193**	**.002**
Age→Severity	-.070	.038	-.144	.004	.062
SES→Severity	-.032	.043	-.116	.052	.454
Hindu→SES	**.258**	**.032**	**.195**	**.321**	**.000**
Muslim→SES	**.440**	**.038**	**.366**	**.514**	**.000**
Sikh→SES	**.294**	**.030**	**.235**	**.353**	**.000**
SES index→Participation	-.072	.040	-.150	.006	.071
Severity→Participation	-.002	.043	-.086	.082	.972
Vulnerability→Participation	.035	.037	-.038	.108	.351
Self-efficacy→Participation	**.147**	**.051**	**.047**	**.247**	**.004**
Response efficacy→Participation	-.025	.039	-.101	.051	.528
Response cost→Participation	**-.099**	**.049**	**-.195**	**-.003**	**.041**

Two-path indirect effects					
Paths mediated by SES					
Sikh→SES→Self-efficacy	**-.036**	**.012**	**-.060**	**-.012**	**.002**
Muslim→SES→Self-efficacy	**-.055**	**.018**	**-.090**	**-.020**	**.002**
Hindu→SES→Self-efficacy	**-.032**	**.011**	**-.054**	**-.010**	**.003**
Sikh→SES→Response efficacy	.005	.011	-.017	.027	.634
Muslim→SES→Response efficacy	.008	.017	-.025	.041	.634
Hindu→SES→Response efficacy	.005	.010	-.015	.025	.635
Sikh→SES→Vulnerability	.021	.014	-.006	.048	.129
Muslim→SES→Vulnerability	.031	.020	-.008	.070	.127
Hindu→SES→Vulnerability	.018	.012	-.006	.042	.122
Sikh→SES→Severity	-.009	.013	-.034	.016	.453
Muslim→SES→Severity	-.014	.019	-.051	.023	.454
Hindu→SES→Severity	-.008	.011	-.030	.014	.459
Sikh→SES→Response cost	**.026**	**.012**	**.002**	**.050**	**.028**
Muslim→SES→Response cost	**.039**	**.018**	**.004**	**.074**	**.029**
Hindu→SES→Response cost	**.023**	**.010**	**.003**	**.043**	**.029**
Paths mediated by psychological variables					
Sikh→Response efficacy→Participation	.005	.008	-.011	.021	.531
Sikh→Vulnerability→Participation	-.008	.008	-.024	.008	.363
Sikh→Self-efficacy→Participation	**-.026**	**.010**	**-.046**	**-.006**	**.009**
Sikh→Response cost→Participation	**-.019**	**.010**	**-.039**	**.001**	**.046**
Sikh→Severity→Participation	.000	.000	.000	.000	.972
Muslim→Response efficacy→Participation	.003	.005	-.007	.013	.534
Muslim→Vulnerability→Participation	-.004	.004	-.012	.004	.380
Muslim→Self-efficacy→Participation	**-.020**	**.009**	**-.038**	**-.002**	**.025**
Muslim→Response cost→Participation	-.017	.009	-.035	.001	.052
Muslim→Severity→Participation	.000	.000	.000	.000	.973
Hindu→Response efficacy→Participation	.003	.004	-.005	.011	.540
Hindu→Vulnerability→Participation	-.007	.008	-.023	.009	.362
Hindu→Self-efficacy→Participation	**-.027**	**.010**	**-.047**	**-.007**	**.009**
Hindu→Response cost→Participation	**-.027**	**.014**	**-.054**	**.000**	**.048**
Hindu→Severity→Participation	.000	.001	-.002	.002	.972
Three-path indirect effects					
Sikh→SES→Response efficacy→Participation	.000	.000	.000	.000	.706
Sikh→SES→Vulnerability→Participation	.001	.001	-.001	.003	.420
Sikh→SES→Self-efficacy→Participation	**-.005**	**.003**	**-.011**	**.001**	**.040**
Sikh→SES→Response costs→Participation	-.003	.002	-.007	.001	.155
Sikh→SES→Severity→Participation	.000	.002	-.004	.004	.972
Muslim→SES→Response efficacy→Participation	.000	.001	-.002	.002	.706
Muslim→SES→Vulnerability→Participation	.001	.001	-.001	.003	.415
Muslim→SES→Self-efficacy→Participation	**-.008**	**.004**	**-.016**	**.000**	**.040**
Muslim→SES→Response costs→Participation	-.004	.003	-.010	.002	.155
Muslim→SES→Severity→Participation	.000	.001	-.002	.002	.972
Hindu→SES→Response efficacy→Participation	.000	.000	.000	.000	.707
Hindu→SES→Vulnerability→Participation	.001	.002	-.003	.005	.414
Hindu→SES→Self-efficacy→Participation	**-.005**	**.002**	**-.009**	**-.001**	**.043**
Hindu→SES→Response costs→Participation	-.002	.002	-.006	.002	.155

Hindu→SES→Severity→Participation	.000	.000	.000	.000	.972

Note. A two-path indirect effect involves the effect of an ethnicity variable on an outcome variable with a single mediator. A three-path indirect effects involves the effect of an ethnicity variable on an outcome variable with two sequential mediators. Effects in boldface are statistically significant ($p < .05$). [a]Coefficients are standardized values. CI_{95} = 95% confidence intervals of the parameter estimate; LB = Lower bound of the 95% confidence interval; UB = Upper bound of the 95% confidence interval. SES = Socio-economic status measured by the Carstairs index(high scores indicate lower SES or more deprivation); Hindu, Muslim, and Sikh variables are dummy-coded dichotomous enthnicity variables with 1 = member of the stipulated ethnic group and 0 = non-member of the stipulated ethnic group.

Figure 1: Flow Chart



[a]Identifying participants' National Health Service (NHS) number data was not made available to the research team for this subset of participants in one region who had previously declined screening.
[b]Medical records showed that these participants were currently assigned to regular repeat screening as a consequence of an earlier abnormal result.

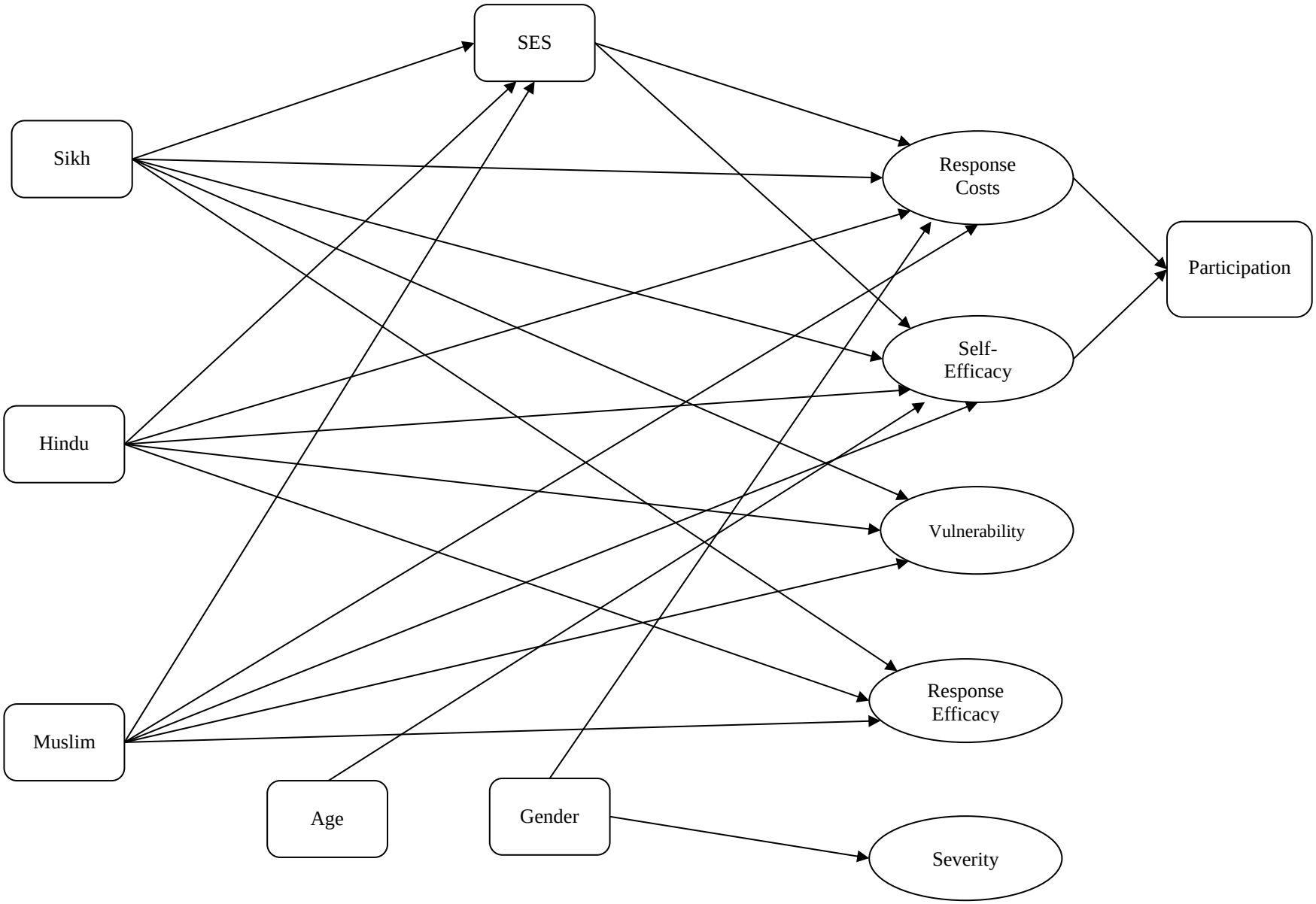

SES
Sikh
Hindu
Muslim
Age
Gender
Response Costs
Self-Efficacy
Vulnerability
Response Efficacy
Severity
Participation

Figure 2. Structural equation model showing statistically significant effects among study constructs. Measurement elements of the latent constructs in the model omitted for clarity. Parameter estimates are displayed in Table 3.
SES = Socio-economic status measured by the Carstairs index(high scores indicate lower SES or more deprivation). Gender was codes 0 = woman, 1 = man. Errors in prediction (ε) freely estimated but not included in diagram: Response efficacy, ε = .943; vulnerability, ε = .925; self-efficacy, ε = .871; response cost, ε = .833; severity, ε = .979; participation, ε = .934; Carstairs index, ε = .713. Correlated errors among predictor variables in the model (ϕ) freely estimated but not included in diagram: Response efficacy-vulnerability, ϕ = .119, p = .002; Response efficacy-self-efficacy, ϕ = .409, p < .001; Response efficacy-response cost, ϕ = -.195, p < .001; Response efficacy-severity, ϕ = .224, p < .001; Vulnerability-self-efficacy, ϕ = .112, p = .009; Vulnerability-response cost, ϕ = .069, p = .095; Self-efficacy-response cost, ϕ = -.524, p < .001; Self-efficacy-severity, ϕ = .195, p < .001; Response cost-severity, ϕ =.038, p = .372; Vulnerability-severity, ϕ = .375, p < .001.