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DOI:

[10.1097/j.pain.0000000000002368](https://doi.org/10.1097/j.pain.0000000000002368)

Document Version

Peer reviewed version

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Citation for published version (APA):

Scott, W., Jackson, S. E., & Hackett, R. A. (2022). Perceived discrimination, health, and well-being among adults with and without pain: a prospective study. *Pain*, *163*(2), 258-266.
<https://doi.org/10.1097/j.pain.0000000000002368>

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Perceived discrimination, health, and wellbeing among adults with and without pain: A prospective study

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Word count: 5085

Number of text pages of manuscript (including tables): 20

Number of tables: 3 (plus 8 supplemental tables)

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Funding: WS is partly funded through the National Institute for Health Research (NIHR) Biomedical Research Centre at the South London and Maudsley NHS Foundation Trust and King's College London. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health and Social Care.

Declarations of interest: None

Previous presentation of data: None

Abstract

Discrimination negatively influences health and wellbeing in the general population, but its impact on people with pain is unclear. This study assessed discrimination, health, and wellbeing in people with and without pain. Data were from 5,871 participants from the English Longitudinal Study of Ageing. Experiences of discrimination were reported in 2010/11. Pain, self-rated health, depressive symptoms, quality of life, life satisfaction, and loneliness were assessed in 2010/11 and 2016/17. A quarter (26%, n=1,524) of the sample reported pain at baseline. Participants with pain were more likely to report discrimination than those without pain (Odds Ratio (OR)=1.28, 95% Confidence Interval (CI) 1.13;1.46). Cross-sectionally, those with pain who perceived discrimination had poorer self-rated health (OR=1.28, 95%CI 1.02;1.61), greater depressive symptoms (OR=1.90, 95%CI 1.48;2.45), were more likely to be lonely ($\beta=0.21$, 95%CI 0.15;0.26), and had lower quality of life ($\beta=-4.01$, 95%CI -4.88;-3.14) and life satisfaction ($\beta=-1.75$, 95%CI -2.45;-1.06) than those with pain who did not perceive discrimination. Prospectively, discrimination in those with pain was associated with greater depression (OR=1.67, 95%CI 1.19;2.34) and loneliness ($\beta=0.11$, 95%CI 0.05;0.17), adjusting for baseline values. In those without pain in 2010/11, discrimination predicted pain in 2016/17, controlling for covariates (OR=1.29, 95%CI 1.06;1.56). People with pain are more likely to report discrimination than those without pain and this experience is associated with increased depression and loneliness. Discrimination was predictive of incident pain in pain-free adults. These findings highlight the need to tackle discrimination to improve wellbeing in those with pain and to potentially reduce the risk of pain onset.

Introduction

Pain occurs in a social context.⁷³ Social factors are implicated in developing pain and can exacerbate pain and its quality of life impact.⁷¹ In turn, pain may fundamentally threaten one's sense of belonging and social connection.⁴³

Validation from one's social environment buffers the impact of pain on quality of life.¹⁹ However, people with pain experience invalidation and stigma due to the subjective and often contested nature of pain.¹³ Healthcare professionals and lay observers underestimate others' pain and devalue their personal attributes when pain occurs without medical explanation.^{14,15,16,52} These invalidating and stigmatising responses adversely impact the wellbeing of people with pain.^{46,47,55,63}

Invalidation and stigma toward people with pain share features with discrimination, which describes differential and unfair treatment based on arbitrary socially ascribed characteristics such as age, race, gender, sexual orientation, or disability.^{1,2} Discrimination extends beyond invalidation and stigma specific to the subjective experience of pain. It can occur in different settings, beyond pain-related interactions with healthcare professionals and individuals in one's social network. It can involve a range of experiences, from perceptions of unfair treatment in public settings such as restaurants to feeling threatened and harassed.⁶⁴ Hence, experiences of pain-related invalidation and stigma may be compounded by experiences of discrimination based on a range of characteristics in everyday life. Disability associated with pain may be one characteristic for which people with pain experience discrimination. Additionally, pain is common among people who are socially marginalised, further increasing risk of discrimination.¹¹ Therefore, it is plausible that people with pain experience greater discrimination than those without pain.

Perceived discrimination is prospectively associated with increased depression and loneliness, and poorer self-rated health, quality of life, and life satisfaction in general

population samples.^{31,32,40,41,42} One cross-sectional study in the United States (US) showed that perceived discrimination is associated with back pain among African American but not white participants.²⁰ Subsequent cross-sectional studies indicate that perceived racial/ethnic discrimination is associated with greater pain and, among people with pain, greater pain-related disability and depression.^{8,28,76} Research on discrimination and pain has used cross-sectional designs with mostly small samples, and has focused on racial/ethnic discrimination in the US. Discrimination in Europe is perceived to be widespread across characteristics such as race, sexual orientation and disability.^{21,22,23,44,45} Pain management disparities among women and older people may also point to discrimination in these groups.^{24,33} Research is needed to determine whether the association between pain and a range of discrimination experiences generalises across contexts. Prospective studies are needed to understand the impact of discrimination in people with pain over time.

We examined perceived discrimination in a large, community-based sample of adults with and without pain in England. We hypothesized that discrimination would be more commonly reported by those with versus without pain. Within the pain group, we predicted that, cross-sectionally and prospectively, discrimination would be associated with poorer health and wellbeing, indexed by greater depression symptoms and loneliness, along with poorer self-rated health, quality of life and life satisfaction. In an exploratory analysis, we assessed whether discrimination influences pain onset in initially pain-free adults.

Method

Study population

Data were from the English Longitudinal Study of Ageing (ELSA), a longitudinal panel study of adults aged 50 years and older living in England.⁶⁸ The study began in 2002 (wave 1) with follow-ups biennially. Data are collected via computer-assisted personal interview and self-completion questionnaires each wave, while anthropometric data are collected at alternate

waves. The current study used baseline data from wave 5 (2010-11; the only wave in which discrimination was assessed) and follow-up data from wave 8 (2016-17; the latest wave available at the time of data analysis).

Of the 9,090 participants in wave 5 of ELSA, 7,744 provided information on demographic characteristics, perceived discrimination, and self-reported pain. We excluded 1,874 participants with missing data on objectively measured body mass index (BMI), which was included as a covariate given consistent evidence linking obesity with both pain and discrimination.^{58,65} This left a final sample size of 5,871. Ethical approval was obtained from the London Multicentre Research and Ethics Committee (MREC/01/02/91) in accordance with the Declaration of the World Medical Association and all participants gave full informed consent.

Measures

Self-reported pain

Two items were used to assess pain. The first item *‘Are you often troubled with pain?’* had a binary response (yes/no). If the participant responded ‘yes’, a follow-up question asked, *‘How bad is the pain most of the time?’* with response options of ‘mild’, ‘moderate’, or ‘severe’. We focused on pain that was rated as moderate or severe, in line with previous work^{51,75} by creating a dichotomous pain variable (no/mild pain vs. moderate/severe pain).

Perceived discrimination

Participants were asked about the frequency they encounter five discriminatory situations: *“In your day-to-day life, how often have any of the following things happened to you: 1) you are treated with less respect or courtesy; 2) you receive poorer service than other people in restaurants and stores; 3) people act as if they think you are not clever; 4) you are threatened*

or harassed; and 5) you receive poorer service or treatment than other people from doctors or hospitals.” Response options were on a 6-point scale ranging from “*never*” to “*almost every day*.” The data were skewed, with most participants reporting never experiencing discrimination across the five discriminatory situations (83.7% never perceived poorer service in a medical setting; 74.5% never felt threatened/harassed; 61.5% never felt that they were treated as not clever; 60.2% never perceived poorer service in restaurants/stores and 43.2% never perceived that they were treated with less respect). Therefore, we dichotomised responses to indicate whether or not participants had experienced discrimination in the past year (a few times or more a year vs. less than once a year or never), with the exception of the fifth item which was dichotomised to indicate whether or not respondents had ever experienced discrimination from doctors or hospitals (never vs. all other options) as responses for this item were skewed with most participants (83.7%) never reporting discrimination in this setting.^{40,41,42}

A follow-up question asked participants who reported discrimination in any of the situations to indicate the reason(s) they attributed to their experience from a list of options including age, gender, race, sexual orientation, physical disability, and weight. Participants could attribute more than one reason to their experiences of discrimination. To assess the frequency of encounters with discriminatory situations, we also derived discrimination as a continuous variable, by summing the frequency reported across the five discrimination items (1= “never” to 6= “almost daily”). The possible scores on the totalled variable ranged from 5-30, with higher scores indicating more frequent encounters with perceived discrimination. Items on discrimination were based on measures that have been widely used in other longitudinal studies.^{64,74} These questions have been previously used to investigate the link between discrimination and later health and wellbeing in ELSA.^{40,41,42}

Health and wellbeing measures

Depressive symptoms were measured using the eight-item version of the Center for Epidemiologic Studies Depression Scale (CES-D), with higher scores indicating greater symptomatology.⁶¹ Items included statements such as *'I felt depressed'* and *'My sleep was restless'* rated over the past month using a binary (yes/no) response. Total scores ranged from 0 to 8. Data were skewed, so we dichotomised scores using an established cut-off (≥ 4) to indicate significant symptomatology.⁶⁷

Loneliness was assessed with the three-item Revised University of California, Los Angeles (UCLA) Loneliness Scale.³⁷ Participants rated items such as *'How often do you feel you lack companionship?'* with response options of 1, *'hardly ever/never'*; 2, *'some of the time'*; and 3, *'often'*. Ratings were averaged to produce a score ranging from 1 to 3, with higher values indicating greater loneliness.²⁹

Quality of life was measured with the CASP-19³⁸, a scale designed to assess quality of life in older people. Items cover several domains of quality of life including control, autonomy, self-realisation, and pleasure. Respondents were asked how often each statement applies to them (0 *'often'* to 3 *'never'*). Positively worded items were reverse scored. Total scores ranged from 0-57, with higher scores indicating greater quality of life.

Life satisfaction was assessed with the Satisfaction With Life Scale.¹⁷ Participants were asked to rate the extent to which they agree with five statements (e.g. *"In most ways my life is close to my ideal"*) on a scale from 0 (*strongly disagree*) to 6 (*strongly agree*). Responses were summed to produce a total score ranging from 0-30, with higher scores indicating greater life satisfaction.

Self-rated health was assessed using a single item: *"Would you say your health is...poor/fair/good/very good/excellent?"* We analysed this data as a binary variable with 0

meaning “*good/very good/excellent*” and 1 being “*poor/fair*”, as has been done in other investigations as the data were skewed.^{30,31,32}

Covariates

The covariates included in our analyses were measured at baseline (wave 5, 2010-11). These covariates were selected a priori due to associations with pain, discrimination and health outcomes reported in previous work.^{4,6,9,10,18,24,31,35,41,58,60} Participants self-reported their age, sex (man/woman), ethnicity (white/ethnic minority) and marital status (married vs. single/separated/divorced/widowed). We controlled for household non-pension wealth, the most relevant indicator of socio-economic position for this cohort.⁶⁸ Wealth was divided into quintiles across the entire wave 5 sample. Participants self-reported whether they smoked (non-smoker/smoker) and their frequency of “*vigorous/moderate/mildly energetic*” physical activity (non-sedentary = “*more than once a week/once a week/one to three times a month*” vs sedentary = “*hardly ever or never*”). Height (cm) and weight (kg) were objectively measured during the nurse visit at wave 4 (2008-09) as this was not assessed at wave 5 and used to calculate BMI (kg/m²).

Statistical analysis

Descriptive characteristics of those with and without pain at baseline (wave 5, 2010-11) were compared using independent-samples *t*-tests for continuous variables and χ^2 tests for categorical variables. Characteristics of those in the pain group who did and did not perceive discrimination were also compared this way. We used multivariable logistic regression to test whether those with pain were more likely to report perceived discrimination (yes/no) than those without pain adjusting for age, sex, wealth, ethnicity, marital status, BMI, smoking and physical activity. In preliminary analyses we utilized a painXdiscrimination interaction term to

assess whether the impact of discrimination on health and wellbeing outcomes was more severe in those with than without pain (see Supplemental Table 1). As this interaction term was significant, such that discrimination had a bigger impact on those with versus without pain, we chose to focus on participants with moderate/severe pain only for our primary analyses.

For the main analysis in the pain group, we examined differences in depressive symptoms, loneliness, quality of life, life satisfaction and self-rated health between those who perceived discrimination and those who did not, both cross-sectionally and prospectively over six-year follow-up. Categorical outcomes were analysed using logistic regression and continuous outcomes were analysed using linear regression. All models controlled for age, sex, ethnicity, marital status, wealth, BMI, smoking and physical activity. Prospective analyses also adjusted for baseline status/score on the outcome of interest. In preliminary analyses, we tested for interactions between discrimination and age, sex and ethnicity on health and wellbeing outcomes. As no significant moderation was detected, interaction terms are not presented in our final models. We also assessed whether including participants without BMI data altered the pattern of results. As the findings remained similar (see Supplemental Table 2), we restricted our analyses to those with complete BMI data. As an exploratory analysis, in the group without pain at baseline (wave 5, 2010-11) we assessed whether perceived discrimination was predictive of moderate/severe pain at follow-up (wave 8, 2016-17) adjusting for covariates. Results are presented as unstandardized B and 95% confidence intervals (CI) for continuous outcomes and odds ratios (ORs) and 95% CI for categorical outcomes. To test for multicollinearity, the Variance Inflation Factor (VIF) is presented for all linear regression analyses. Values >10 indicate the presence of multicollinearity. Results are unweighted as weighting for non-response did not change the pattern of results.

We carried out a series of sensitivity analyses. In the first, we assessed whether those who were lost to follow-up ($n = 466$) differed from those who provided data at both waves (n

= 1,058). We tested whether this impacted the results by conducting the cross-sectional analyses (wave 5) including only those who provided follow-up data at wave 8. In our second sensitivity analysis, we tested whether the prospective results from our complete case analysis at wave 8 were similar when missing outcome information was imputed (using multiple imputation with covariates and baseline outcome information as predictors) for those participants lost to follow-up ($n = 466$). Twenty imputed data sets were created, each was analysed separately, and the results were combined to produce pooled estimates of effects; this allowed the analyses to account for uncertainty caused by estimating missing data. Pooled estimates are reported for the sensitivity analysis. We also assessed whether using Wave 7 (2014-2015) instead of Wave 8 (2016-17) data as the follow-up wave changed the pattern of results. We carried out our final sensitivity analysis to test the possibility that one of the five types of discriminatory experience contributing to the measure of perceived discrimination (i.e., being treated with less respect; receiving poorer service in restaurants and stores; people acting as if you are not clever; being threatened or harassed or receiving poorer service in medical settings) was driving the results. We tested this cross-sectionally and prospectively by repeating our analyses removing each type of discriminatory experience in turn. All analyses were conducted using SPSS version 26. The analyses were not pre-registered.

Results

Participant characteristics

The characteristics of the sample at baseline (wave 5) can be found in Table 1. Of the 5,871 participants, 1,524 (26%) reported moderate/severe pain. Those reporting pain differed significantly from those without pain across all characteristics ($p < 0.011$). They were more likely to be older and female, and were less likely to be white and married, than those who did

not report pain. Participants with pain were also less wealthy. In terms of health behaviour, those with pain were more likely to smoke, be sedentary, and have a greater BMI than those without pain. Those with pain were more likely to report discrimination overall (44.2%, 95% CI 41.73;46.72% vs 36.9%, 95% CI 35.46;38.33%, $p < 0.001$) and across each of five discriminatory experiences assessed ($p < 0.035$).

Of those with pain ($n = 1,524$), 44.2% reported discrimination ($n = 674$). The most common discriminatory experiences in this group were “being treated with less respect or courtesy” (76.8%; 95% CI 73.62;80.02), “people acting as if you are not clever” (53.2%; 95% CI 49.43;57.04), and “receiving poorer service than other people in restaurants and stores” (35.8%; 95% CI 32.14;39.46). Reports of being threatened or harassed (22.3%; 95% CI 19.09;25.43) or receiving poorer service or treatment than other people in medical settings (14.6%; 95% CI 11.93;17.28) were less commonly reported. The most common attribution for the perceived discrimination was “age” (60.4%; 95% CI 57.0;64.0), followed by “physical disability” (16.8%; 95% CI 14.0;20.0), “gender” (15.7%; 95% CI 13.0;18.0) and “weight” (12.9%; 95% CI 10.0;15.0). Discrimination attributed to “race” (2.8%; 95% CI 2.0;4.0) and “sexual orientation” (1.6%; 95% CI 1.0;3.0) were less frequently reported. The characteristics of the pain group stratified by those who did and did not perceive discrimination can be found in Table 2. Those who perceived discrimination were significantly younger on average (67.06 ± 8.64 vs 69.80 ± 8.61 years, $p = 0.002$) and less likely to be female (58% vs 68.5%, $p < 0.001$) than those who did not perceive discrimination. They were also more likely to smoke (16.6% vs 11.8%, $p = 0.007$) and to have a higher BMI (30.35 ± 5.72 vs 29.27 ± 5.45 kg/m², $p < 0.001$) than those who did not report discrimination. The groups did not significantly differ on other characteristics.

Cross-sectional associations between perceived discrimination and health and wellbeing

In the overall sample, participants with moderate/severe pain were more likely to report discrimination than those with no/mild pain (OR = 1.28, 95% CI 1.13;1.46, $p < 0.001$). This was similar when discrimination was modelled as a continuous rather than categorical outcome ($\beta = 0.51$, 95% CI 0.32;0.71, $p < 0.001$, VIF = 1.13). Considering this result and that preliminary analysis detected a significant painXdiscrimination interaction on outcomes (see Supplemental Table 1), we focused our main analyses on participants with pain ($n = 1,524$).

Cross-sectional analyses (first panel Table 3) showed that after adjustment for covariates, participants with pain who perceived discrimination were more likely to have significant depressive symptomology (OR = 1.90, 95% CI 1.48;2.45, $p < 0.001$;) and to rate their health as fair/poor (OR = 1.28, 95% CI 1.02;1.61, $p = 0.035$) than those who did not perceive discrimination. The pattern of results did not change when depressive symptomatology ($\beta = 0.70$, 95% CI 0.49;0.91, $p < 0.001$, VIF = 1.05) and self-rated health (higher scores indicated worse health; $\beta = 0.16$, 95% CI 0.07-0.25, $p < 0.001$, VIF = 1.05) were modelled as continuous variables. Those who reported discrimination experienced greater loneliness ($\beta = 0.21$, 95% CI 0.15;0.26, $p < 0.001$, VIF = 1.05), and had lower quality of life ($\beta = -4.01$, 95% CI -4.88;-3.14, $p < 0.001$, VIF = 1.05) and life satisfaction ($\beta = -1.75$, 95% CI -2.45;-1.06, $p < 0.001$, VIF = 1.05) than those who did not report discrimination. The association between perceived discrimination and loneliness was robust to additional adjustment for depression ($\beta = 0.13$, 95% CI 0.08;0.18, $p < 0.001$, VIF = 1.08). We also assessed the impact of the frequency of perceived discrimination on health and wellbeing outcomes by entering discrimination as a continuous predictor variable in our models. Our results (see Supplemental Table 3) suggest that more frequent encounters with discriminatory situations were associated with poorer health and wellbeing outcomes.

Prospective associations between perceived discrimination and health and wellbeing in people with pain

In prospective analyses (second panel Table 3) participants with pain who perceived discrimination had greater depressive symptomology 6 years later than those who did not perceive discrimination, independent of covariates including baseline depression (OR = 1.67, 95% CI 1.19;2.34, $p = 0.003$). The pattern of results was similar when depressive symptomology was modelled as a continuous variable ($\beta = 0.30$, 95% CI 0.06;0.54, $p = 0.015$, VIF = 1.10). Discrimination experienced by those with pain was prospectively associated with higher loneliness scores ($\beta = 0.11$, 95% CI 0.05;0.17, $p = 0.001$, VIF = 1.11), adjusting for baseline values. The loneliness finding remained when depressive symptoms were taken into account ($\beta = 0.11$, 95% CI 0.04;0.16, $p = 0.001$, VIF = 1.12). No significant prospective associations were detected for quality of life, life satisfaction or self-rated health ($p > 0.283$). Our findings were similar when discrimination was modelled as a continuous rather than a categorical variable (see Supplemental Table 3).

Prospective association between perceived discrimination and pain onset among participants without pain at baseline

We assessed whether perceived discrimination in those without pain at baseline ($n = 4347$) was associated with the onset of moderate/severe pain at follow-up. A total of 3271 adults who were initially pain-free provided follow-up data on pain. Those who perceived discrimination at baseline were more likely to report moderate/severe pain at 6-year follow-up than those who did not perceive discrimination (19.5% vs 16.2%), adjusting for covariates (OR = 1.29, 95% CI 1.06;1.56, $p = 0.010$). The results were consistent when discrimination was entered as a continuous variable in the models (OR = 1.06, 95% CI 1.04;1.09, $p < 0.001$), suggesting that

those who encountered discrimination more frequently were more likely to report pain at follow-up than those who encountered it less frequently.

Sensitivity analyses

In the first sensitivity analysis, we assessed whether those who were lost to follow-up ($n = 466$) differed from those who provided data at both waves ($n = 1,058$). As can be seen in Supplemental Table 4, those who were lost to follow-up were significantly older on average (71.94 ± 9.38 vs 67.11 ± 7.87 years, $p < 0.001$) and were less likely to be female (60.1% vs 65.5%, $p = 0.043$) and married (58.2% vs 64%, $p = 0.030$) than those who provided complete data. Those who were lost to follow-up were less wealthy ($p = 0.004$) and were more likely to smoke (18.2% vs 12%, $p < 0.001$) and to be sedentary (43.1% vs 21.7%, $p < 0.001$). We tested whether these differences impacted the results by conducting the cross-sectional analyses (wave 5) including only those who provided follow-up data at wave 8 ($n = 1,058$). As can be seen in Supplemental Table 5, the pattern of results remained unaltered. In our second sensitivity analysis, we tested whether the prospective results from our complete case analysis at wave 8 were similar when missing outcome information was imputed for those participants lost to follow-up ($n = 466$). Imputing missing outcome data did not change the pattern of results (Supplemental Table 6). In our third sensitivity analysis we assessed whether using Wave 7 (2014-2015) as the prospective follow-up wave, instead of Wave 8 (2016-17) altered the results. As can be seen in Supplemental Table 7, the pattern of results was similar. In our final sensitivity analysis, we tested the possibility that one of the five types of discriminatory experience contributing to the measure of perceived discrimination was driving the results. The cross-sectional analyses were unchanged when each type of discriminatory experience was removed in turn (upper panel Supplemental Table 8). The prospective analyses (lower panel Supplemental Table 8) were mostly unaltered, except when removing ‘being treated with less

respect or courtesy' from the measure the prospective association between discrimination and poorer life satisfaction reached significance ($p = 0.039$).

Discussion

Using a large, prospective community-based sample in England, we found that participants with pain reported greater experiences of discrimination than those without pain. Cross-sectionally, participants with pain who reported discrimination had worse depressive symptoms, self-rated health, loneliness, quality of life, and life satisfaction than those with pain who did not experience discrimination. These findings held prospectively for depression and loneliness, controlling for covariates including baseline depression and loneliness. These results demonstrate the health and wellbeing impact of discrimination experiences among people with pain. For those without pain initially, discrimination predicted moderate/severe pain 6-years later. Our findings linking discrimination with negative health and wellbeing are therefore relevant for those with pain and those at risk of developing pain.

People with pain reported greater discrimination across all domains compared to people without pain. Among people with pain, "receiving poorer service or treatment than other people in medical settings" was the least frequently reported discrimination experience, although fourteen percent of participants still experienced discrimination in this setting. This is surprising, given that pain is associated with high levels of health service use⁷ and that previous research has focused on medical professionals as a source of pain invalidation, which describes discounting and lack of understanding of pain.⁴⁶ Thus, in addition to medical encounters, our data suggest that people with pain experience discrimination across a range of contexts.

We cannot make causal inferences about the links between pain and discrimination given the correlational nature of our study; however, bidirectional associations may be indicated. Stress related to repeated discrimination may increase the likelihood of pain through

chronic over-activation of the hypothalamic-pituitary-adrenal axis.^{5,20,28,57} It is also plausible that people with pain experience greater discrimination because of pain-related characteristics. While age was the most common attribution for discrimination – unsurprising given the sample characteristics – physical disability was the second most frequent attribution. Pain behaviour (e.g., guarding a body part) may be a salient indicator of physical disability, and could thus account for higher rates of discrimination reported in people with pain. Indeed, observers rate people with pain as less likeable, dependable, and competent when they display pain behaviour.^{3,52} Pain behaviour in the absence of an obvious medical cause may lead to scepticism about the veracity of pain¹⁴; this may be compounded by pervasive societal rhetoric questioning the legitimacy of disability²⁵ and humans’ evolved inclination to detect people perceived to be ‘cheating the system’.⁴³ Therefore, negative evaluations and scepticism may fuel discriminatory behaviour toward people in pain across contexts.

Pain duration was not measured within ELSA. However, both acute and chronic pain may be associated with discrimination insofar as the pain is perceived to occur without clear medical cause or is associated with significant pain behaviour or disability, as discussed. However, greater chronicity of pain may increase possible exposures to discrimination based on pain and related disability over time. Mental health disorders are commonly comorbid with chronic pain³⁶, which may further increase discrimination risk.⁷⁰

Our results are consistent with previous research linking discrimination to poorer health and wellbeing in general population samples.^{30,31,32} The present study adds to this by demonstrating the toll of discrimination on people with pain. Our findings are also consistent with research showing racial/ethnic discrimination is associated with pain, disability, and depression among people with chronic pain.^{28,76} This previous work was cross-sectional and focused on US samples. Our prospective results therefore add to the evidence base in establishing that perceived discrimination in people with pain predicts greater depressive

symptoms and loneliness over 6-year follow-up, net of baseline associations. These findings demonstrate that discrimination has negative consequences for future wellbeing in those with pain living in England. Additionally, our measure of discrimination was broad and not specific to racial/ethnic discrimination and the sample was overwhelmingly white British, so racial discrimination was not the most prominent form reported here. This suggests the link between discrimination and negative outcomes may apply to a range of discrimination experiences.

There are several plausible mechanisms by which discrimination contributes to poorer wellbeing in people with pain. Anger is a common response to discrimination.⁵⁹ Anger partially mediates the association between perceived injustice, which involves a sense of unfairness about pain, and depression in people with persistent pain.⁶² Anger suppression may lead to social withdrawal,¹² compounding the impact of discrimination on wellbeing. Where individuals experience little control to change discriminatory situations or systems, they may feel helplessness that increases the likelihood of engaging in unhelpful coping behaviours.³⁹ In particular, substance use as a strategy for coping with discrimination^{26,53} may increase risk for mental health problems like depression.⁷² Biological processes associated with discrimination, such as elevated cortisol, inflammation, and altered anterior cingulate cortex and prefrontal cortex activity, might also contribute to poor mental health.⁵ Studies using mediation analyses may help shed light on these pathways.

Discrimination is a complex phenomenon occurring at the individual, interpersonal, and structural levels to create inequities in access to resources and power.^{48,49} Multiple intervention approaches are therefore needed to address discrimination⁶⁶ to improve the lives of people with or at risk of pain. Research targeting invalidation, stigma, and perceived injustice – which share features with discrimination including negative evaluation and treatment of people with pain – is in its infancy. Individual-level cognitive-behavioural interventions have focused on improving the capacity of people with pain to respond more

effectively to negative responses from others, with limited impact.^{63,69} Interpersonally, research on romantic couples shows the benefit of validation and perspective-taking by the partner without pain toward the partner experiencing pain.⁵⁰ A randomised-controlled trial found that a perspective-taking intervention for physicians reduces racial and socioeconomic biases and, consequently, pain treatment disparities.³⁴ The current data suggest that broader structural interventions are also needed to tackle widespread discrimination toward people with pain.

Individuals in Western cultures are socialised to view pain as a result of injury which does not reflect the reality of many pain experiences.⁵⁶ Concerningly, where pain is portrayed in the media, such as children's television, observers' responses often lack empathy.⁵⁶ Thus, media portrayals that accurately reflect the experience of pain and model compassionate responses toward people in pain may combat cultural views that fuel discrimination. Campaigns, such as Transport for London's "Please offer me a seat: Remember not all disabilities and conditions are visible" initiative, have potential to raise awareness and compassion toward people with pain at the population-level. Social media is a powerful advocacy tool and can amplify the voices of people with pain to re-shape illness narratives.²⁷ Research is needed to investigate the role of (social) media and public campaigns to tackle discrimination and improve wellbeing of people with pain. At the policy-level, reform is needed to ensure that procedures for assessing and communicating pain-related disability for benefits and employment purposes are non-discriminatory.²⁵

Several limitations must be considered. Firstly, the pain measure was based on a single item with four severity options and pain frequency was indexed by participants' response to being 'often troubled' by pain or not. We did not have information on pain duration, aetiology, or pain-related functional impairment. Self-reported discrimination was based on past experiences and may be affected by recall bias. Although this discrimination measure has been used previously,^{40,41,42} it only contained five items and did not capture discrimination

experiences specifically attributed to pain. Future research investigating pain and discrimination should assess pain-specific attributions. Our results reflect subjective interpretations of discrimination rather than objective encounters with discrimination. Subjectively versus objectively assessed discrimination might have different consequences for health and well-being. We included an analysis with discrimination modelled as a continuous variable to assess the frequency of discriminatory encounters on outcomes. Research is also needed to determine how other aspects of discrimination salience, such as the specific nature, degree, or chronicity of discrimination⁵⁴, may affect people with pain. The sample was comprised of predominantly white middle-aged and older adults. Therefore, research is needed to determine whether the results generalise to other samples.

Another limitation is that the data analysis plan was not preregistered. However, the analysis approach was modelled after previous studies examining discrimination and health outcomes with ELSA data and we conducted several sensitivity analyses; confidence in the robustness of the findings is increased by consistent results across these analyses. BMI data came from wave 4, while all other baseline data were collected at wave 5, so BMI could have changed over this period. Again, the sensitivity analysis without BMI as a covariate yielded similar results. Our analysis examining whether discrimination was prospectively associated with pain in the initially pain-free group was exploratory; therefore, confirmatory research is needed to replicate this finding.

To conclude, people with pain experience greater discrimination than people without pain in a community-based sample. Among people with pain, those who experienced discrimination had worse health and wellbeing than those who did not, cross-sectionally and prospectively. In those without pain initially, perceived discrimination predicted pain 6-years later. There is a need to tackle discrimination directed toward people with pain to promote

equity. Anti-discrimination efforts may ultimately improve the wellbeing of people with pain and, potentially, reduce the risk of pain.

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Table 1: Characteristics of those with and without pain at wave 5 of the English Longitudinal Study of Ageing (2010/11).

	No/low pain (n = 4347)	Moderate/severe pain (n =1524)	p
Age (years)	66.83 (8.52)	68.59 (8.64)	< 0.001
Sex (% female)	2263 (52.0%)	973 (63.8%)	< 0.001
Ethnicity (% white)	4271 (98.3%)	1481 (97.2%)	= 0.011
Marital status (% married)	3014 (69.3%)	948 (62.2%)	< 0.001
Wealth quintile (£)			< 0.001
1	493 (11.3%)	381 (25.0%)	
2	793 (18.2%)	356 (23.4%)	
3	890 (20.5%)	298 (19.6%)	
4	1004 (23.1%)	260 (17.0%)	
5	1167 (26.9%)	229 (15.0%)	
Body Mass Index (kg/m ²)	27.61 (4.68)	29.75 (5.60)	< 0.001
Smoking (% yes)	441 (10.1%)	212 (13.9%)	< 0.001
Physical activity (% sedentary)	397 (9.1%)	431 (28.3%)	< 0.001
Perceived discrimination (% yes)	1604 (36.9%)	674 (44.2%)	< 0.001
Treated with less respect/courtesy	1251 (28.8%)	517 (33.9%)	< 0.001
Poorer service in restaurants/stores	585 (13.5%)	237 (15.7%)	= 0.035
People act as if you are not clever	665 (15.3%)	354 (23.4%)	< 0.001
Threatened or harassed	297 (6.7%)	148 (9.8%)	< 0.001
Poorer service from doctors/hospitals	156 (3.6%)	98 (6.4%)	< 0.001

Data are presented as means (SD) and n (%)

Table 2: Characteristics of those with pain by perceived discrimination at wave 5 of the English Longitudinal Study of Ageing (2010/11).

	No perceived discrimination	Perceived discrimination	<i>p</i>
	(<i>n</i> = 850)	(<i>n</i> = 674)	
Age (years)	69.80 (8.61)	67.06 (8.46)	= 0.002
Sex (% female)	582 (68.5%)	391 (58.0%)	< 0.001
Ethnicity (% white)	827 (97.3%)	654 (97.0%)	= 0.759
Marital status (% married)	526 (61.9%)	422 (62.6%)	= 0.771
Wealth quintile (£)			= 0.131
1	196 (23.1%)	185 (27.4%)	
2	194 (22.8%)	162 (24.0%)	
3	169 (19.9%)	129 (19.1%)	
4	149 (17.5%)	111 (16.5%)	
5	142 (16.7%)	87 (13.0%)	
Body Mass Index (kg/m ²)	29.27 (5.45)	30.35 (5.72)	< 0.001
Smoking (% yes)	100 (11.8%)	112 (16.6%)	= 0.007
Physical activity (% sedentary)	241 (28.4%)	190 (28.2%)	= 0.968

Data are presented as means (SD) and n (%)

Table 3: Cross-sectional and prospective associations between perceived discrimination and health and wellbeing outcomes in those with pain (complete cases)

	Wave 5 (cross-sectional)				Wave 8 (prospective)				
	n	No perceived discrimination	n	Perceived discrimination	n	No perceived discrimination	n	Perceived discrimination	
Depression	% (SE)	834	19.7 (0.01)	670	30.6 (0.01)	574	17.2 (0.02)	460	24.6 (0.02)
	OR [95% CI]		1.00 (Ref)		1.90 [1.48; 2.45]***		1.00 (Ref)		1.67 [1.19; 2.34]**
Loneliness	Mean score (SE)	842	1.41 (0.02)	668	1.62 (0.12)	525	1.41 (0.02)	419	1.51 (0.02)
	Coeff. [95% CI]		Ref		0.21 [0.15; 0.26]***		Ref		0.11 [0.05; 0.17]***
Quality of life	Mean score (SE)	801	38.72 (0.29)	632	34.71 (0.33)	477	38.40 (0.29)	385	38.16 (0.33)
	Coeff. [95% CI]		Ref		-4.01 [-4.88; -3.14]***		Ref		-0.24 [-1.15; 0.66]
Life satisfaction	Mean score (SE)	814	19.68 (0.23)	636	17.93 (0.26)	493	19.34 (0.24)	394	18.95 (0.27)
	Coeff. [95% CI]		Ref		-1.75 [-2.45; -1.06]***		Ref		-0.40 [-1.12; 0.33]
Fair/poor self-rated health	% (SE)	850	48.0 (0.02)	673	53.0 (0.02)	587	50.5 (0.02)	470	51.7 (0.02)
	OR [95% CI]		1.00 (Ref)		1.28 [1.02; 1.61]*		1.00 (Ref)		1.05 [0.79; 1.41]

All analyses are adjusted for age, sex, wealth, ethnicity, marital status, body mass index, smoking and physical activity. Prospective analyses are additionally adjusted for baseline scores/status.

Coeff = unstandardized B coefficient (white rows), CI = confidence interval, OR = odds ratio (grey rows), SE = standard error.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Possible scores on the loneliness measure range from 1-3, on the quality of life scale range from 0-57, and on the life satisfaction scale range from 0-30.

Supplemental Table 1: Pain by discrimination interaction on health and wellbeing outcomes in those with and without pain

		Wave 5 (cross-sectional)	Wave 8 (prospective)
Depression			
PainXDiscrimination	OR [95%CI]	2.02 [1.60; 2.55]***	1.52 [1.12; 2.07]**
Loneliness			
PainXDiscrimination	Coeff. [95%CI]	0.09 [0.05; 0.14]***	0.06 [0.01; 0.10]*
Quality of life			
PainXDiscrimination	Coeff. [95%CI]	-3.71 [-4.42; -2.99]***	-0.22 [-0.92; 0.49]
Life satisfaction			
PainXDiscrimination	Coeff. [95%CI]	-1.65 [-2.20; -1.19]***	-0.53 [-1.08; 0.13]†
Fair/poor self-rated health			
PainXDiscrimination	OR [95%CI]	3.98 [3.18; 4.98]***	1.85 [1.40; 2.43]***

All analyses are adjusted for age, sex, wealth, ethnicity, marital status, body mass index, smoking and physical activity.

Prospective analyses are additionally adjusted for baseline scores/status.

Coeff = unstandardized B coefficient (white rows), CI = confidence interval, OR = odds ratio (grey rows), SE = standard error.

† $p=0.056$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Possible scores on the loneliness measure range from 1-3, on the quality of life scale range from 0-57, and on the life satisfaction scale range from 0-30.

Supplemental Table 2: Cross-sectional and prospective associations between perceived discrimination and health and wellbeing outcomes in the sample without complete body mass index data

	Wave 5				Wave 8			
	n	No perceived discrimination	n	Perceived discrimination	n	No perceived discrimination	n	Perceived discrimination
Depression								
% (SE)	1159	22.1 (0.01)	974	32.5 (0.01)	747	19.8 (0.02)	627	25.7 (0.02)
OR [95% CI]		1.00 (Ref)		1.80 [1.46; 2.22]***		1.00 (Ref)		1.48 [1.12; 1.96]**
Loneliness								
Mean score (SE)	1165	1.45 (0.02)	966	1.65 (0.02)	675	1.45 (0.02)	573	1.53 (0.02)
Coeff. [95% CI]		Ref		0.20 [0.15; 0.25]***		Ref		0.08 [0.03; 0.14]**
Quality of life								
Mean score (SE)	1117	38.07 (0.25)	921	34.34 (0.28)	617	38.03 (0.26)	523	37.45 (0.29)
Coeff. [95% CI]		Ref		-3.74 [-4.48; -3.00]***		Ref		-0.58 [-1.37; 0.21]
Life satisfaction								
Mean score (SE)	1127	19.36 (0.20)	929	17.49 (0.22)	637	19.23 (0.21)	544	18.56 (0.23)
Coeff. [95% CI]		Ref		-1.87 [-2.46; -1.28]***		Ref		-0.66 [-1.29; -0.04]*
Fair/poor self-rated health								
% (SE)	1185	49.5 (0.01)	985	54.7 (0.02)	767	50.4 (0.02)	651	53.6 (0.02)
OR [95% CI]		1.00 (Ref)		1.28 [1.06; 1.55]*		1.00 (Ref)		1.02 [0.93; 1.52]

All analyses are adjusted for age, sex, wealth, ethnicity, marital status, smoking and physical activity. Prospective analyses are additionally adjusted for baseline scores/status.

Coeff = unstandardized B coefficient (white rows), CI = confidence interval, OR = odds ratio (grey rows), SE = standard error.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Possible scores on the loneliness measure range from 1-3, on the quality of life scale range from 0-57, and on the life satisfaction scale range from 0-30.

Supplemental Table 3: Cross-sectional and prospective associations between the frequency of perceived discrimination (continuous) and health and wellbeing outcomes in those with pain

		Wave 5 (cross-sectional)	Wave 8 (prospective)
Depression			
Discrimination	OR [95%CI]	1.11 [1.07; 1.14]***	1.06 [1.02; 1.11]**
Loneliness			
Discrimination	Coeff. [95%CI]	0.04 [0.04; 0.05]***	0.01 [0.00; 0.02]*
Quality of life			
Discrimination	Coeff. [95%CI]	-0.67 [-0.55; -0.79]***	-0.06 [-0.19; 0.07]
Life satisfaction			
Discrimination	Coeff. [95%CI]	-0.26 [-0.16; -0.35]***	-0.10 [-0.20; 0.01]
Fair/poor self-rated health			
Discrimination	OR [95%CI]	1.04 [1.01; 1.07]*	1.04 [0.99; 1.08]

All analyses are adjusted for age, sex, wealth, ethnicity, marital status, body mass index, smoking and physical activity.

Prospective analyses are additionally adjusted for baseline scores/status.

Coeff = unstandardized B coefficient (white rows), CI = confidence interval, OR = odds ratio (grey rows), SE = standard error.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Possible scores on the perceived discrimination measure range from 5-30, loneliness measure range from 1-3, on the quality of life scale range from 0-57, and on the life satisfaction scale range from 0-30.

Supplemental Table 4: Characteristics of complete cases and those lost to follow-up at wave 5 of the English Longitudinal Study of Ageing (2010/11).

	Lost to follow-up (n = 466)	Complete cases (n = 1058)	p
Age (years)	71.94 (9.38)	67.11 (7.87)	< 0.001
Sex (% female)	280 (60.1%)	693 (65.5%)	= 0.043
Ethnicity (% white)	452 (97.0%)	1029 (97.3%)	= 0.775
Marital status (% married)	271 (58.2%)	677 (64.0%)	= 0.030
Wealth quintile (£)			= 0.004
1	130 (27.9%)	251 (23.7%)	
2	128 (27.5%)	228 (21.6%)	
3	82 (17.6%)	216 (20.4%)	
4	73 (15.7%)	187 (17.7%)	
5	53 (11.3%)	176 (16.6%)	
Body Mass Index (kg/m ²)	29.39 (5.27)	29.91 (5.73)	= 0.087
Smoking (% yes)	85 (18.2%)	127 (12.0%)	= 0.001
Physical activity (% sedentary)	201 (43.1%)	230 (21.7%)	< 0.001

Data are presented as means (SD) and n (%)

Complete cases are defined as those who were present at wave 5 and provided data on at least one measure at wave 8.

Supplemental Table 5: Cross-sectional and prospective associations between perceived discrimination and health and wellbeing outcomes in those with pain who provided follow-up data

	Wave 5				Wave 8			
	n	No perceived discrimination	n	Perceived discrimination	n	No perceived discrimination	n	Perceived discrimination
Depression								
% (SE)	574	16.6 (0.02)	460	27.5 (0.02)	574	17.2 (0.02)	460	24.6 (0.02)
OR [95% CI]		1.00 (Ref)		2.02 [1.46; 2.78]***		1.00 (Ref)		1.67 [1.19; 2.34]**
Loneliness								
Mean score (SE)	525	1.37 (0.02)	419	1.58 (0.03)	525	1.41 (0.02)	419	1.51 (0.02)
Coeff. [95% CI]		Ref		0.21 [0.14; 0.27]***		Ref		0.11 [0.05; 0.17]***
Quality of life								
Mean score (SE)	477	40.10 (0.38)	385	35.40 (0.42)	477	38.40 (0.29)	385	38.16 (0.33)
Coeff. [95% CI]		Ref		-4.70 [-5.82; -3.57]***		Ref		-0.24 [-1.15; 0.66]
Life satisfaction								
Mean score (SE)	493	20.10 (0.29)	394	18.22 (0.32)	493	19.34 (0.24)	394	18.95 (0.27)
Coeff. [95% CI]		Ref		-1.88 [-2.74; -1.02]***		Ref		-0.40 [-1.12; 0.33]
Fair/poor self-rated health								
% (SE)	587	42.1 (0.02)	470	47.7 (0.02)	587	50.5 (0.02)	470	51.7 (0.02)
OR [95% CI]		1.00 (Ref)		1.33 [1.01; 1.76]*		1.00 (Ref)		1.05 [0.79; 1.41]

All analyses are adjusted for age, sex, wealth, ethnicity, marital status, body mass index, smoking and physical activity. Prospective analyses are additionally adjusted for baseline scores/status.

Coeff = unstandardized B coefficient (white rows), CI = confidence interval, OR = odds ratio (grey rows), SE = standard error.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Possible scores on the loneliness measure range from 1-3, on the quality of life scale range from 0-57, and on the life satisfaction scale range from 0-30.

Supplemental Table 6: Cross-sectional and prospective associations between perceived discrimination and health and wellbeing outcomes in those with pain (imputed)

	Wave 5				Wave 8				
	n	No perceived discrimination	n	Perceived discrimination	n	No perceived discrimination	n	Perceived discrimination	
Depression	% (SE)	834	19.7 (0.01)	670	30.6 (0.01)	834	18.5 (0.02)	670	25.9 (0.02)
	OR [95% CI]		1.00 (Ref)		1.90 [1.48; 2.45]***		1.00 (Ref)		1.65 [1.18; 2.29]**
Loneliness	Mean score (SE)	842	1.41 (0.02)	668	1.62 (0.12)	842	1.44 (0.02)	668	1.54 (0.03)
	Coeff. [95% CI]		Ref		0.21 [0.15; 0.26]***		Ref		0.09 [0.04; 0.16]***
Quality of life	Mean score (SE)	801	38.72 (0.29)	632	34.71 (0.33)	801	37.23 (0.29)	632	36.95 (0.32)
	Coeff. [95% CI]		Ref		-4.01 [-4.88; -3.14]***		Ref		-0.28 [-1.13; 0.57]
Life satisfaction	Mean score (SE)	814	19.68 (0.23)	636	17.93 (0.26)	814	19.04 (0.25)	636	18.61 (0.32)
	Coeff. [95% CI]		Ref		-1.75 [-2.45; -1.06]***		Ref		-0.43 [-1.21; 0.34]
Fair/poor self-rated health	% (SE)	850	48.0 (0.02)	673	53.0 (0.02)	850	54.3 (0.02)	673	55.8 (0.02)
	OR [95% CI]		1.00 (Ref)		1.28 [1.02; 1.61]*		1.00 (Ref)		1.08 [0.83; 1.40]

All analyses are adjusted for age, sex, wealth, ethnicity, marital status, body mass index, smoking and physical activity. Prospective analyses are additionally adjusted for baseline scores/status.

Coeff = unstandardized B coefficient (white rows), CI = confidence interval, OR = odds ratio (grey rows), SE = standard error.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Possible scores on the loneliness measure range from 1-3, on the quality of life scale range from 0-57, and on the life satisfaction scale range from 0-30.

Supplemental Table 7: Prospective associations between perceived discrimination and health and wellbeing outcomes at Wave 7 and 8 in those with pain (complete cases)

	Wave 7 (prospective)				Wave 8 (prospective)				
	n	No perceived discrimination	n	Perceived discrimination	n	No perceived discrimination	n	Perceived discrimination	
Depression	% (SE)	632	17.8 (0.01)	529	24.1 (0.01)	574	17.2 (0.02)	460	24.6 (0.02)
	OR [95% CI]		1.00 (Ref)		1.59 [1.14; 2.20]**		1.00 (Ref)		1.67 [1.19; 2.34]**
Loneliness	Mean score (SE)	584	1.39 (0.02)	470	1.49 (0.02)	525	1.41 (0.02)	419	1.51 (0.02)
	Coeff. [95% CI]		Ref		0.10 [0.04; 0.15]***		Ref		0.11 [0.05; 0.17]***
Quality of life	Mean score (SE)	527	38.74 (0.27)	418	38.17 (0.30)	477	38.40 (0.29)	385	38.16 (0.33)
	Coeff. [95% CI]		Ref		-0.62 [-1.43; 0.18]		Ref		-0.24 [-1.15; 0.66]
Life satisfaction	Mean score (SE)	556	19.62 (0.22)	443	19.28 (0.24)	493	19.34 (0.24)	394	18.95 (0.27)
	Coeff. [95% CI]		Ref		-0.34 [-0.99; 0.31]		Ref		-0.40 [-1.12; 0.33]
Fair/poor self-rated health	% (SE)	612	49.8 (0.02)	500	53.7 (0.02)	587	50.5 (0.02)	470	51.7 (0.02)
	OR [95% CI]		1.00 (Ref)		1.26 [0.93; 1.70]		1.00 (Ref)		1.05 [0.79; 1.41]

All analyses are adjusted for age, sex, wealth, ethnicity, marital status, body mass index, smoking and physical activity and baseline scores/status.

Coeff = unstandardized B coefficient (white rows), CI = confidence interval, OR = odds ratio (grey rows), SE = standard error.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Possible scores on the loneliness measure range from 1-3, on the quality of life scale range from 0-57, and on the life satisfaction scale range from 0-30.

Supplemental Table 8: Sensitivity analysis: Perceived discrimination measure excluding each discriminatory behaviour in turn

Cross-sectional analyses (wave 5)		Model 1	Model 2	Model 3	Model 4	Model 5
Depression	OR [95%CI]	1.82 [1.41; 2.34]***	1.62 [1.26; 2.09]***	1.67 [1.30; 2.16]***	1.59 [1.24; 2.05]***	1.88 [1.46; 2.42]***
Loneliness	Coeff. [95%CI]	0.23 [0.17; 0.29]***	0.19 [0.14; 0.25]***	0.20 [0.14; 0.26]***	0.19 [0.14; 0.25]***	0.21 [0.15; 0.27]***
Quality of life	Coeff. [95%CI]	-4.54 [-5.41; -3.68]***	-4.00 [-4.86; -3.14]***	-3.87 [-4.74; -3.00]***	-3.87 [-4.73; -3.01]***	-4.01 [-4.88; -3.14]***
Life satisfaction	Coeff. [95%CI]	-2.37 [-3.00; -1.58]***	-2.09 [-2.77; -1.41]***	-1.96 [-2.65; -1.27]***	-1.99 [-2.67; -1.30]***	-1.75 [-2.44; -1.05]***
Fair/poor self-rated health	OR [95%CI]	1.43 [1.14; 1.80]**	1.34 [1.08; 1.69]**	1.26 [1.01; 1.59]*	1.32 [1.05; 1.65]*	1.30 [1.03; 1.63]*
Prospective analyses (wave 8)		Model 1	Model 2	Model 3	Model 4	Model 5
Depression	OR [95%CI]	1.51 [1.08; 2.11]*	1.52 [1.09; 2.13]*	1.63 [1.17; 2.28]**	1.46 [1.05; 2.04]*	1.61 [1.15; 2.26]**
Loneliness	Coeff. [95%CI]	0.09 [0.03; 0.15]**	0.07 [0.01; 0.13]*	0.07 [0.02; 0.14]*	0.07 [0.02; 0.14]*	0.10 [0.04; 0.16]**
Quality of life	Coeff. [95%CI]	-0.50 [-1.42; 0.43]	-0.15 [-1.04; 0.75]	-1.40 [-2.79; -0.00]	-0.31 [-1.20; 0.58]	-0.18 [-1.08; 0.73]
Life satisfaction	Coeff. [95%CI]	-0.77 [-1.51; -0.04]*	-0.37 [-1.09; 0.35]	-0.23 [-0.95; 0.49]	-0.35 [-1.07; 0.37]	-0.40 [-1.13; 0.32]
Fair/poor self-rated health	OR [95%CI]	1.26 [0.94; 1.69]	1.04 [0.78; 1.38]	1.02 [0.76; 1.36]	1.07 [0.80; 1.42]	1.02 [0.76; 1.36]

All analyses are adjusted for age, sex, wealth, ethnicity, marital status, body mass index, smoking and physical activity. Prospective analyses are additionally adjusted for baseline scores/status.

Model 1 excludes “you are treated with less respect or courtesy” from the measure of perceived age discrimination; Model 2 excludes “you receive poorer service than other people in restaurants and stores”; Model 3 excludes “people act as if they think you are not clever”; Model 4 excludes “you are threatened or harassed”; and Model 5 excludes “you receive poorer service or treatment than other people from doctors or hospitals”.

Coeff = unstandardized B coefficient (white rows), CI = confidence interval, OR = odds ratio (grey rows), SE = standard error.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Possible scores on the loneliness measure range from 1-3, on the quality of life scale range from 0-57, and on the life satisfaction scale range from 0-30.