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Title: Association between musculoskeletal pain with social isolation and loneliness: analysis of the English Longitudinal Study of Ageing.

Running Title: Pain, social isolation and loneliness.

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ABSTRACT

Objectives: To determine whether a relationship exists between musculoskeletal pain and social isolation and loneliness.

Methods: A cross-sectional analysis of the English Longitudinal Study of Ageing (ELSA) cohort was undertaken. ELSA is a nationally representative sample of the non-institutionalised population of individuals aged 50 years and over based in England. Data were gathered on social isolation through the ELSA Social Isolation Index, loneliness through the UCLA Loneliness Scale and musculoskeletal pain. Data for covariates included: physical activity, depression score, socioeconomic status, access to transport and demographic characteristics. Logistic regression analyses were undertaken to determine the relationship between social isolation and loneliness with pain and the additional covariates.

Results: 9299 participants were included in the analysis. This included 4125 (44.4%) males, with a mean age of 65.8 years. There was a significant association where social isolation was lower for those in pain (Odd Ratio (OR): 0.87; 95% confidence intervals (CI): 0.75 to 0.99), whereas the converse occurred for loneliness where this was higher for those in pain (OR: 1.15; 95% CI: 1.01 to 1.31). Age, occupation, physical activity and depression were all associated with increased social isolation and loneliness.

Conclusions: People who experience chronic musculoskeletal pain are at greater risk of being lonely, but at less risk of being socially isolated. Health professionals should consider the wider implications of musculoskeletal pain on individuals, to reduce the risk of negative health implications associated with loneliness from impacting on individual's health and wellbeing.

Keywords: Pain; elderly; community; lonely; isolated; health outcomes

Word Count: 2551

INTRODUCTION

Musculoskeletal pain is a prevalent health challenge for all age groups worldwide, but most notably in older adults.[1,2] It is associated with increased disability, frailty, loss of independence and reduced quality of life.[3] The burden of musculoskeletal disease has increased, with the disability-adjusted life years increasing from 20.6 million to 30.9 million between 1990 and 2010.[1]

Social isolation is the consequence of a decrease in social network size with a reduction in the number of social contacts.[4] It can be either active, i.e. withdrawal from one's network, or passive where an individual's social network moves or dies for example.[5] Loneliness is the psychological embodiment of social isolation,[5] and represents an individual's perception of dissatisfaction in the quality or quantity of their social contacts. Loneliness, therefore, incorporates the discrepancy between the relationships an individual has and the relationships they would like to have.[4] There are significant negative health consequences associated with social isolation and loneliness. These include an increased risk of cardiovascular disease,[6] infectious diseases,[7] cognitive decline[8] and all-cause mortality.[9] Both social isolation and loneliness impair quality of life, physical and mental health.[4,5] Both are particularly prevalent with increasing age, with up to 50% of older people at risk of social isolation[10] and approximately a third of older individuals experiencing some degree of loneliness.[11,12]

People with chronic musculoskeletal pain may actively reduce contact with friends, family and other social networks.[1,13] This has been attributed to patients decreasing their social networks through friends 'disappearing' having not understood the pain or the quality of contacts being reduced as patients feel that have to hide their true state of being.[4] This may lead to greater social isolation and loneliness with reduced opportunities for physical activity impacting on physical and mental health.

Previous literature has highlighted the association between social isolation and loneliness with mortality,[5,14] However, it remains unclear whether there is a relationship between social isolation or loneliness and musculoskeletal pain.[15] Given the impact musculoskeletal pain has on an individual's health and wellbeing, and the potential complex nature which musculoskeletal disease has with social isolation and loneliness, it is important to understand how these may or may not relate to one another. The purpose of this study was therefore to determine whether a relationship exists between musculoskeletal pain, social isolation and loneliness.

METHODS

We have followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline to report this comparative prospective cohort study.[16]

Participants

Data were identified from the English Longitudinal Study of Ageing (ELSA) cohort. The ELSA study is an ongoing national cohort of English community-dwelling adults born on or before February 29th 1952. It is a nationally representative sample of the non-institutionalised general population.[17] In this present cross-sectional analysis, data were initially identified from all 9432 people included in Wave 2 (2004/2005).

Original ethical approval was given by the London Multi-Centre Research Ethics Service (MREC/01/2/91) and written informed consent obtained from all participants. Anonymised unlinked data for this study were provided by the UK Data Service.

Measurements

All data were collected during the routine face-to-face follow-up interval.

Social Isolation

Social isolation was measured using the validated and previously reported ELSA Social Isolation Index.[17,18] This index is derived from five questions related to: marital/cohabiting status; monthly contact (including face-to-face, telephone, or written/e-mail contact) with children, other family members and friends; and participation in organisations such as social clubs or residents groups, religious groups or committees.[17,18] Scores range from zero to five where higher scores indicate greater social isolation. The cut-point for the existence of social isolation was ≥2.[19]

Loneliness

Loneliness was measured using the validated three-item short form of the Revised University of California, Los Angeles (UCLA) Loneliness Scale.[20] Participants indicated how frequently they 'felt left

out', 'isolated from others' and 'felt lonely', with response options of 'hardly ever' or 'never', 'some of the time', and 'often'. Scores range from three to nine where higher scores indicate greater loneliness.[20] The cut-point for the existence of loneliness was ≥6.[19]

Pain

Musculoskeletal pain was assessed through participants indicating whether they were often troubled by bone/joint/muscle pain or not (yes/no).

Participant Characteristics

Data included age, gender, BMI (body mass index), ethnic classification (ELSA defined as white/non-white) and occupational status (as measured with the National Statistics Socio-economic Classification-3 (NS-SEC3).

Depression

Depressive symptoms were assessed using the eight-item version of Center for Epidemiologic Studies Depression (CES-D) scale,[21] with a cut-off value of ≥3 used to classify someone with depressive symptoms.[19]

Physical Activity

Participants were asked how often they engaged in mild, moderate or vigorous physical activity. For each level of activity, participants responded either as being: 'very active' (more than once a week), 'active' (once a week), 'moderately active' (one to three times per month), and 'inactive' (hardly ever/never). We derived a summary index of physical activity by summing responses to the three physical activity items which were dichotomized using a cut-point of once a week or more often.[22] This physical activity assessment method has been previously used to determine the level of physical activity participation undertaken by older people.[22,23] It has demonstrated excellent convergent validity within this population.[24]

Data Analysis

All data were initially analysed with descriptive statistics to present the frequency (%) or mean and standard deviation (SD) values.

Given the potential relationship between pain and depression on social isolation and loneliness, the association between patient characteristics, pain and depression with the response variables of social isolation or loneliness were assessed using logistic regression. In these models, 'pain' was analysed using the 'often troubled by pain' variable (binary: yes/no). This modelling strategy used all the explanatory variables of *a priori* interest in an initial logistic regression model to examine the univariate relationship between each variable and the outcome. Following this, we eliminated (using a backward step-wise regression approach) each variable (in turn) that was least significant until a final multivariable model was arrived at which only included explanatory variables that met the significance criteria (P<0.05). Regression model data were presented as odd ratio (OR) and 95% confidence intervals (CI).

All analyses were performed in the R statistics package (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Cohort Characteristics

A total of 9432 participants were identified from Wave 2 of the ELSA cohort. Of these, there were available data from 9299 participants who did or did not report being often troubled by pain (**Table 1**). A total of 133 (1.4%) participants were missing from the analyses.

The characteristics of the cohort are illustrated in **Table 1**. The overall study sample included 4125 (44.4%) males, with a mean age of 65.8 years (SD: 10.8) and mean BMI of 27.9 kgm^{-2} (SD: 4.9 kgm^{-2}). Of these, 97.6% were white ethnicity. Twenty-three percent of the cohort reported depressive symptoms based on the CES-D threshold. The cohort consisted of 2871 (30.9%) being managerial/professional occupations whilst 4059 (43.6%) were routine and manual occupations.

Social Isolation
There was no statistically significant relationship between pain and social isolation in the initial regression model (OR: 0.88; 95% CI: 0.76 to 1.03). Of those who were socially isolated, 42% were often

troubled by pain compared to 36% of those who were not socially isolated (**Table 2**) but this was not statistically significant. There was however a significant association between social isolation and age (OR: 1.01; 95% CI: 1.00 to 1.02), BMI (OR: 0.98; 95% CI: 0.97 to 0.99), gender (OR: 0.81; 95% CI: 0.70 to 0.94), occupation (OR: 1.61; 95% CI: 1.36 to 1.91), the frequency to which participants undertook moderate (OR: 1.60; 95% CI: 1.28 to 1.99) and vigorous levels of physical activity (OR: 1.51; 95% CI: 1.22 to 1.89) and depression (OR: 1.68; 95% CI: 1.43 to 1.99).

When analysed in the step-wise regression model, the variables which remained statistically significant with social isolation are presented in **Table 3**. Participants who reported being often troubled by pain were 13% less likely to report being socially isolated (OR: 0.87; 95% CI: 0.75 to 0.99). Increasing age (OR: 1.02; 95% CI: 1.01 to 1.02), occupations which are more intermediate or manual in nature (OR: 1.70; 95 CI: 1.43 to 1.99), those who were more sedentary when assessed by moderate physical activity (OR: 1.60; 95% CI: 1.34 to 1.91) and vigorous physical activity (OR: 1.60; 95% CI: 1.30 to 1.96) and those with self-reported depression (OR: 1.80; 95% CI: 1.56 to 2.09) had a greater probability of being socially isolated. Females had a reduced risk of being socially isolated (OR: 0.82; 95% CI: 0.72 to 0.93),

Loneliness

There was a statistically significant relationship between pain and loneliness on the initial regression model (OR: 1.23; 95% CI: 1.06 to 1.43). Of those who were lonely, 47% were often troubled by pain compared to 34% of those who were not lonely (**Table 2**). There were significant associations between loneliness and age (OR: 1.01; 95% CI: 1.00 to 1.02), BMI (OR: 0.98; 95% CI: 0.97 to 0.99), gender (OR: 1.31; 95% CI: 1.13 to 1.52), ethnicity (OR: 1.77; 95% CI: 1.04 to 2.94), occupation (OR: 1.50; 95% CI: 1.27 to 1.78) and depression (OR: 5.46; 95% CI: 4.71 to 6.34).

When analysed using the step-wise regression model, the variables which remained statistically significant with loneliness are presented in **Table 4**. Participants who were often troubled by pain were 15% more likely to report being lonely (OR: 1.15; 95% CI: 1.01 to 1.31). The data indicated that increasing age (OR: 1.01; 95% CI: 1.00 to 1.02), females (OR: 1.28; 95% CI: 1.13 to 1.45), non-white ethnicity (OR: 1.91; 95% CI: 1.34 to 2.90), occupations which are more intermediate or manual in nature (OR: 1.52; 95 CI: 1.31 to 1.77), and greater sedentary behaviours when assessed by moderate physical activity (OR: 1.51; 95% CI: 1.28 to 1.78) had a greater probability of reporting loneliness. Of

particular note, there was a five-fold greater probability of reporting loneliness when individuals were depressed compared to those who were not (OR: 5.23; 95% CI: 4.59 to 5.96).

DISCUSSION

This is the first study to investigate the relationship between social isolation, loneliness and musculoskeletal pain using validated measures at a population-based level. These findings indicate that individuals with musculoskeletal pain have a greater probability of experiencing loneliness, but, are less likely to experience social isolation. However, factors such as age, occupation, level of physical activity and depression are consistently associated with the probability of individuals experiencing social isolation or loneliness.

Whilst the data indicates that there is an association where musculoskeletal pain had a negative impact to increase loneliness, the opposite occurred in social isolation where musculoskeletal pain was associated with a decrease in social isolation. This was unexpected. It is hypothesised that, for this population, being in pain may result in an increase in contact with friends, family members or social networks potentially in a caring or support role or taking them to healthcare appointments. Whilst this is an increase in social contact, individuals, based on this data, still perceived themselves to be lonely. This may be attributed to the difference in these two constructs. Whilst social isolation is the frequency of contact between individuals and society, loneliness is a perception of feeling isolated regardless of the breadth of actual social networks.[25,26] The findings suggest that whilst pain may not hinder the degree to which people have or engage in society, they seem to perceive being less connected. This can have a detrimental health consequence including anxiety, depression, atrophy and overall physical deconditioning.[27-29] Consideration as to how to enhance this perception of pre-existing social networks with cognitive behaviour interventions may help prevent loneliness from negatively impacting on these individual's lives.

There was a consistent difference in the relationship between pain with loneliness by age. This has been previously reported in other painful conditions, demonstrating differences in pain response, pain-related attitudes and stoicism.[30] This has been attributed to older people under-reporting pain with age-related increases in the degree of reticence to pain and reluctance to label a sensation as painful.[31] Based on this study, and previous literature in other pain-related conditions, targeting

interventions to address loneliness among those with musculoskeletal pain may be most effective if messages are tailored to specific age groups.

The association between musculoskeletal pain and loneliness and depression is supported by previous literature. Rapo-Pylkkö et al[32] reported that older adults with chronic pain more frequently presented with poorer perceived function, felt sadder, lonelier and more fatigued compared to those without chronic pain (defined as musculoskeletal pain for ≥3 months). The relationship between loneliness and negative emotions has been reported in Dures et al[33] for those with inflammatory arthritis. Whilst causation between musculoskeletal pain, loneliness and depression cannot be ascertained in this analysis given its cross-sectional design, there appears an important relationship between these variables which should be emphasised for clinical consideration. It has been suggested that depression and loneliness may be amenable to change through psychological interventions and support.[34,35] For specific musculoskeletal conditions such as rheumatoid arthritis, international and national guidelines such as the European and UK treatment guidelines and the National Institute for Health and Care Excellence (NICE) have recommend that patients should be offered psychological interventions as part of multidisciplinary care.[36-38] However, the adoption of such recommendations have been reported as variable.[39-40] Dures et al[33] suggested that patient-clinician interaction can positively or negative influence patient's psychological status depending on their perceived willingness and ability to acknowledge emotional and social challenges. Consideration of the psychological distress and global wellbeing which individuals with chronic pain have is therefore a key recommendation which may positively influence self-efficacy and self-management strategies.

This analysis presented with three key limitations. Firstly, this data was not linked to hospital or medical records. It was therefore not possible to determine the musculoskeletal pathologies which this cohort presented. However, it may be surmised that a large proportion of participants will present with osteoarthritis, given the age and joints affected.[41] Nonetheless future subgroup analyses based on type of musculoskeletal disease would be valuable to be able to determine whether there is a difference, at least, between inflammatory and non-inflammatory musculoskeletal diseases given their differences in pathological mechanisms and drivers.[42] Secondly, whilst the data provides a national representation from England, facilitated by the 'low-tech' data collection approaches, the data was largely self-reported, requiring participant recall. Accordingly there is a potential risk that the data may have been influenced by both recall error and social desirability bias which may have inflated or suppressed the effect depending on the respondent's perception of the questions asked. Nonetheless, this dataset provides a signal from a large number of participants, from differing social

circumstances and demographics, therefore providing valuable data to better understand the relationship between musculoskeletal pain, social isolation and loneliness. Finally due to considerable issues with missing data, pain was measured using whether individuals were 'often troubled by pain' as opposed to pain scores such as numerical rating scores. There is therefore no estimation on the severity of pain. Understanding the relationship between pain severity and social isolation and loneliness would be valuable for further research.

CONCLUSION

The findings of this analysis indicate that there is a relationship between musculoskeletal pain and loneliness and social isolation, where pain is associated with increased loneliness but decreased social isolation in community-dwelling older adults in England. Health professionals are recommended to consider the wider implications of pain on individuals to reduce the risks of negative health implications associated with loneliness from impacting on individual's health and wellbeing.

FIGURE AND TABLE LEGENDS

Table 1: Descriptive characteristics of the analysed cohort.

Table 2: Results of the univariate regression analysis

Table 3: Results from the step-wise regression (backward elimination) analysis for social isolation.

Table 4: Results from the step-wise regression (backward elimination) analysis for loneliness.

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DECLARATIONS

Conflicts of Interest: No author declares a conflict of interest in relation to this paper.

Ethical approval: Ethical approval for the ELSA cohort was obtained from London Multi-Centre Research Ethics Service (MREC/01/2/91).

Author Contributions:

We can confirm that the following authors have made substantial contributions to the following:

- Conception and design: TS, JD, EW, KM
- Acquisition of data: TS, JD
- Analysis and interpretation of data: TS, JD, EW, KM
- Drafting the article: TS, JD, EW, KM
- Revising it critically for important intellectual content: TS, JD, EW, KM
- Final approval of the version to be published: TS, JD, EW, KM

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Table 1: Descriptive characteristics of the analysed cohort.

	Often Troubled With Pain	
	Yes (N=3513)	**No (N=5786)**
Age, Mean (SD)	66.7 (10.6)	65.1 (10.6)
BMI, Mean (SD)	28.9 (5.4)	27.4 (4.5)
Gender		
Male	38.5%	46.7%
Female	61.5%	53.3%
Ethnicity		
White	96.8%	98.1%
Non-white	3.2%	1.9%
Occupation (NS-SEC3)		
Managerial/professional	25.0%	35.0%
Intermediate	24.3%	25.1%
Routine and manual	50.7%	39.8%
Loneliness		
Not lonely	74.3%	85.0%
Lonely	25.7%	15.0%
Social Isolation		
Not socially isolated	83.3%	86.1%
Socially isolated	16.7%	13.9%
Mild Physical activity		
More than once a week	71.3%	81.7%
Once a week	11.2%	9.2%
1 to 3 times a month	3.8%	3.3%
Hardly ever or never	13.7%	5.8%
Moderate Physical activity		
More than once a week	46.4%	68.2%
Once a week	14.4%	14.8%
1 to 3 times a month	10.2%	6.1%
Hardly ever or never	29.0%	10.9%
Vigorous Physical activity		
More than once a week	12.3%	21.2%
Once a week	6.4%	11.8%
1 to 3 times a month	8.3%	12.0%
Hardly ever or never	73.0%	55.0%
Self-reported depression (CES-D score)		
Not depressed	62.8%	85.2%
Depressed	37.2%	14.8%

BMI – body mass index; CES-D - Center for Epidemiologic Studies Depression; N – number of participants; NS-SEC3 - National Statistics Socio-economic Classification-3; SD – standard deviation

Table 2: Results of the univariate regression analysis

	Social Isolation				Loneliness			
	Not Socially Isolated (N=7908)	**Socially Isolated (N=1391)**	**Odd Ratio (95% CI)**	**P-value**	**Not Lonely (N=7528)**	**Lonely (N=1771)**	**Odd Ratio (95%CI)**	**P-value**
Often Troubled With Pain								
No	64%	58%	Reference	Reference	66%	53%	Reference	Reference
Yes	36%	42%	0.88 (0.76, 1.03)	0.118	34%	47%	1.23 (1.06, 1.43)	0.006
Age, Mean (SD)	64.8 (10.0)	68.6 (12.0)	1.01 (1.00, 1.02)	0.002	64.7 (10)	68.1 (12)	1.01 (1.00, 1.02)	0.043
BMI, Mean (SD)	27.9 (4.8)	27.7 (5.1)	0.98 (0.97, 0.99)	0.031	27.9 (4.7)	27.9 (5.1)	0.98 (0.97, 0.99)	0.012
Gender								
Male	43%	45%	Reference	Reference	46%	39%	Reference	Reference
Female	57%	55%	0.81 (0.70, 0.94)	0.006	54%	61%	1.31 (1.13, 1.52)	<0.001
Ethnicity								
White	98%	95%	Reference	Reference	99%	95%	Reference	Reference
Non-white	2%	5%	1.25 (0.68, 2.16)	0.452	1%	5%	1.77 (1.04, 2.94)	0.032
Occupation (NS-SEC3)								
Managerial/professional occupations	34%	23%	Reference	Reference	35%	23%	Reference	Reference
Intermediate occupations	26%	22%	1.14 (0.94, 1.40)	0.192	25%	24%	1.40 (1.16, 1.70)	<0.001
Routine and manual occupations	41%	54%	1.61 (1.36, 1.91)	<0.001	40%	53%	1.50 (1.27, 1.78)	<0.001
Mild Physical activity								
More than once a week	80%	69%	Reference	Reference	81%	70%	Reference	Reference
Once a week	10%	11%	0.99 (0.78, 1.25)	0.916	9%	12%	1.17 (0.93, 1.47)	0.176
One to three times a month	3%	4%	1.11 (0.76, 1.58)	0.579	4%	3%	0.73 (0.47, 1.11)	0.150
Hardly ever or never	7%	15%	1.22 (0.93, 1.60)	0.142	6%	15%	0.97 (0.72, 1.28)	0.798
Moderate Physical activity								
More than once a week	64%	47%	Reference	Reference	65%	47%	Reference	Reference
Once a week	15%	13%	1.08 (0.88, 1.33)	0.460	15%	14%	1.15 (0.94, 1.40)	0.173
One to three times a month	7%	9%	1.47 (1.14, 1.89)	0.003	7%	9%	1.08 (0.83, 1.40)	0.548
Hardly ever or never	14%	30%	1.60 (1.28, 1.99)	<0.001	13%	30%	1.23 (0.99, 1.54)	0.061
Vigorous Physical activity								

More than once a week	20%	12%	Reference	Reference	20%	12%	Reference	Reference
Once a week	11%	6%	1.00 (0.72, 1.36)	0.977	11%	7%	1.194 (0.90, 1.59)	0.224
One to three times a month	11%	9%	1.47 (1.11, 2.00)	0.007	11%	9%	1.212 (0.92, 1.60)	0.176
Hardly ever or never	58%	73%	1.51 (1.22, 1.89)	<0.001	57%	72%	1.228 (1.00, 1.52)	0.054
Self-reported depression (CES-D score)								
Not depressed	81%	65%	Reference	Reference	86%	55%	Reference	Reference
Depressed	19%	35%	1.68 (1.43, 1.99)	<0.001	14%	45%	5.46 (4.71, 6.34)	<0.001

BMI – body mass index; CES-D - Center for Epidemiologic Studies Depression; CI – confidence intervals; N – number of participants; NS-SEC3 - National Statistics Socio-economic Classification-3; OR – odd ratio; SD – standard deviation

Table 3: Results from the step-wise regression (backward elimination) analysis for social isolation.

	Odd Ratio (95% CI)	P-value
Often Troubled With Pain		
No	Reference	Reference
Yes	0.87 (0.75, 0.99)	0.038
Age	1.02 (1.01, 1.02)	<0.001
Gender		
Male	Reference	Reference
Female	0.82 (0.72, 0.93)	0.002
Occupation (NS-SEC3)		
Managerial/professional occupations	Reference	Reference
Intermediate occupations	1.25 (1.04, 1.50)	0.015
Routine and manual occupations	1.70 (1.45, 1.99)	<0.001
Moderate Physical activity		
More than once a week	Reference	Reference
Once a week	1.03 (0.85, 1.24)	0.756
One to three times a month	1.43 (1.136, 1.781)	0.002
Hardly ever or never	1.60 (1.34, 1.91)	<0.001
Vigorous Physical activity		
More than once a week	Reference	Reference
Once a week	1.03 (0.77, 1.38)	0.846
One to three times a month	1.46 (1.12, 1.91)	0.004
Hardly ever or never	1.59 (1.30, 1.96)	<0.001
Self-reported depression (CES-D score)		
Not depressed	Reference	Reference
Depressed	1.80 (1.56, 2.09)	<0.001

CES-D - Center for Epidemiologic Studies Depression; NS-SEC3 - National Statistics Socio-economic Classification-3; SD – standard deviation

Table 4: Results from the step-wise regression (backward elimination) analysis for loneliness.

	Odd Ratio (95%CI)	P-value
Often Troubled With Pain		
No	Reference	Reference
Yes	1.15 (1.01, 1.31)	0.031
Age	1.01 (1.00, 1.02)	0.004
Gender		
Male	Reference	Reference
Female	1.28 (1.13, 1.45)	<0.001
Ethnicity		
White	Reference	Reference
Non-white	1.91 (1.24, 2.90)	0.003
Occupation (NS-SEC3)		
Managerial/professional occupations	Reference	Reference
Intermediate occupations	1.36 (1.14, 1.61)	<0.001
Routine and manual occupations	1.52 (1.31, 1.77)	<0.001
Moderate Physical activity		
More than once a week	Reference	Reference
Once a week	1.21 (1.02, 1.44)	0.030
One to three times a month	1.22 (0.97, 1.52)	0.079
Hardly ever or never	1.51 (1.28, 1.78)	<0.001
Self-reported depression (CES-D score)		
Not depressed	Reference	Reference
Depressed	5.23 (4.59, 5.96)	<0.001

CES-D - Center for Epidemiologic Studies Depression; NS-SEC3 - National Statistics Socio-economic Classification-3; SD – standard deviation