Pain at multiple body sites and health related quality of life in older adults: results from the North Staffordshire Osteoarthritis Project (NorStOP)

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Short title: Multiple site pain and health related quality of life

Abstract

Objectives: Number of pain sites is a potentially important marker of health related quality of life (HRQoL) but remains unexplored in older people. This cross-sectional study investigated whether, in older people including the oldest old, number of pain sites was independently associated with poorer mental and physical HRQoL, and if the association was moderated by age.

Methods: A postal questionnaire sent to a population sample of adults aged ≥50 years in North Staffordshire, UK, included the SF-12 Mental Component Summary (MCS) and Physical Component Summary (PCS), a blank body pain manikin, socio-demographic, health behaviour and morbidity questions. Participants shaded sites of pain lasting ≥1 day in the past four weeks on the manikin. Osteoarthritis consultation data was obtained for participants consenting to medical record review.

Results: 13,986 individuals (adjusted response 70.6%) completed a questionnaire, of which 12,408 provided complete pain data. The median number of pain sites reported was 4 (IQR 0-8). General linear models showed an increasing number of pain sites was significantly associated with poorer MCS (β=-0.43; 95%CI -0.46,-0.40) and PCS (-0.87; -0.90,-0.84). Adjustment for covariates attenuated the associations but they remained significant (MCS: -0.28; -0.31,-0.24; PCS: -0.63; -0.66,-0.59). The association between number of pain sites and MCS, and PCS, was moderated by age, but the strongest associations were not in the oldest old~~and increased in strength up to age 70-79 years. Although PCS was moderated by age, the strength of association changed little between ages 50-69, and decreased thereafter~~.

Conclusions: Number of pain sites appears a potentially modifiable target for improving physical and mental HRQoL in older people. Future analyses should investigate the influence of NPS on HRQoL over time in older people.

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Introduction

Musculoskeletal pain commonly occurs at multiple body sites in community dwelling older adults, with 21% to 43% of persons aged 65 years and over reporting pain at two or more sites [1-3], the variation possibly dependent on the maximum number of pain sites (NPS), and chronicity of pain, measured. The prevalence of multiple pain sites appears relatively stable over time [4] and similar across age groups [5] with studies of older people showing only a slight decline in the prevalence of multiple site pain after about age 75 years [2, 3, 6].

NPS has been shown to have an almost linear relationship with poor health outcomes in a population aged 24 to 76 years, with a greater NPS associated with reductions in overall health, sleep quality, psychological health [5], functional ability [7] and work disability [8]. In older populations, there is evidence of a dose-response relationship between the extent of pain (none, single site, multiple site and/or widespread) and some health outcomes related to older age: poorer lower extremity function [2], risk of falls [6], risk of disability [1] and sleep difficulties [9] in those aged from 65, 70, 65 and 64 years, respectively. Furthermore, the prevalence of pain that interferes with daily life continues to increase with age, from 32% in women aged 50 to 59 years to 50% in those aged 80 or more [10].

Health related quality of life (HRQoL) is a concept which represents an individual's perceived health status and overall physical and mental well-being that is not specific to any disease [11]. In a national debate in the United Kingdom (UK) on measures of well-being, overall health and individual well-being were two of the domains found to be important to individuals [12]. Although persons with more extensive pain, such as those with widespread pain, and fibromyalgia, report poorer HRQoL than those with no widespread pain [13, 14], to our knowledge, no previous studies have investigated the relationship between NPS and HRQoL in individuals older than 75 (the oldest old). NPS represents not only a simple and useful gauge of how much pain a person has [15] but

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also, potentially, a focus for intervention strategies in which physical and mental HRQoL are key disease-independent outcomes in the oldest old. The aim of this study was to test the hypotheses that, in community-dwelling older people, an increasing NPS would be associated with reduced HRQoL and that the relationship would be moderated by age, with the greatest impact in the oldest old.

Methods

The North Staffordshire Osteoarthritis Project (NorStOP) included a large population-based survey of musculoskeletal pain in adults aged 50 years and over from North Staffordshire, UK, using postal questionnaires. Details of NorStOP survey methods have been published previously [10, 16, 17]. Briefly, questionnaires were mailed with a letter from the general practice and a study information leaflet. Reminders were sent to non-responders two and four weeks after the initial questionnaire. Consent to use the data collected in the postal questionnaires was implied through the returning of the questionnaires to the research centre [18]. The questionnaire included a consent form on which participants could additionally provide written permission for their medical records to be reviewed. Approval for the study was granted by the North Staffordshire Research Ethics Committee (REC reference numbers 1351 and 1430).

Study population

The sampling frame for NorStOP was all patients aged 50 years and over registered with six general practices (n=20,293) who were part of Primary Care Research West Midlands North (http://www.crncc.nihr.ac.uk/about_us/ccrn/wmids-north/corporate/pcrn_westmids_north). In the UK, general practice registers provide convenient sampling frames for population surveys, with about 98% of the British population registered with a general practitioner (GP) [19]. Prior to mailing, 79 people were excluded by the practices' GPs, e.g. due to severe psychiatric or terminal illness, resulting in 20,214 questionnaires being mailed. During mailing, 396 people were excluded

(143 deaths or departures from the practices, 53 people with cognitive problems and 200

questionnaires returned as addressee unknown), giving an eligible study population of 19,818.

Study questionnaire

Primary outcome measures

Mental HRQoL and physical HRQoL were measured using the Mental and Physical Component

Summary scales (MCS and PCS) of the Medical Outcomes Study (MOS) Short Form-12 health

survey (SF-12) [20]. The SF-12 is internationally validated [21], with evidence for acceptable

reliability [22, 23] and validity [22-24] in older people, although evidence for its internal construct

validity varies [22, 23]. MCS and PCS scores, standardised to the US general population scores

(mean=50 (SD=10)), range from 0 to 100 with lower scores indicating worse HRQoL [20].

Primary exposure measure

NPS was measured by asking if, in the past four weeks, participants had experienced pain lasting

for ≥1 day in any part of their body [16]. Those answering "yes" were asked to shade the site of

their pain(s) on a blank body manikin. Completed manikins were scored using a transparent

template that divided the manikin into 44 mutually exclusive pain sites. NPS was then summed to

give a total score ranging from 0 to 44. These data collection and scoring methods have been

routinely used to measure pain location and distribution in both clinical and research settings [10,

13, 16-18, 25-33], and shown to have adequate test-retest, and high inter- and intra-rater

reliability for measuring pain distribution [31] and provide a similar prevalence of pain as written

questions [29].

Potential confounders of the relationship between pain and HRQoL

The following self-reported data on factors potentially confounding the relationship between pain

and HRQoL were collected:

The individual social factors were employment status, marital status and socioeconomic status (obtained by classifying current/most recent occupation according to the Standard Occupational Classification 2000 (SOC2000) [34], from which the National Statistics Socio-economic Classification (NS-SEC) [35] was derived).

The health behaviours measured were self-reported body mass index (BMI; calculated from weight in kg/height in m^2), smoking status and frequency of alcohol consumption.

Morbidities commonly associated with older age were assessed by asking if participants suffered from chest problems, heart problems, deafness, problems with eyesight (excluding the need for glasses), raised blood pressure and diabetes.

Osteoarthritis (OA), which may be associated with HRQoL, was measured by electronic recording of OA (as a Read code) by a GP in a consultation. Read codes are a hierarchy of morbidity, symptom and process codes used to label consultations in UK general practice [36], and map to disease codes in the International Classification of Diseases (ICD-10). Read codes starting N05 were used to identify the diagnosis of OA. In responders who had consented to use of their medical records, consultation records for OA were identified for the two years prior to baseline.

Statistical analysis

The analysis included participants who provided complete pain data, defined as either "yes" to pain in past 4 weeks question and shading on the manikin, or "no" to pain in past 4 weeks question and no shading on the manikin. Participant characteristics are presented according to NPS, for which those reporting ≥1 pain site were categorised into four groups with approximately equal numbers of respondents (1-3, 4-6, 7-11 and 12-44 pain sites) [10]. Chi-square and one-way analysis of variance (ANOVA) tests examined the strength of associations between NPS and all other measures. For analysis of the association between MCS, and PCS, mean scores and NPS, participants reporting ≥30 pain sites were grouped together (30-44), since there were few

participants with values in this range (n=193); a one-way ANOVA was used to test this association according to age group, and illustrated using a lowess scatterplot.

The associations between MCS, and PCS, scores and NPS (0-44) were analysed using general linear models. Results are presented as β coefficients with 95% confidence intervals (CI). The adjusted R^2 values were used to describe the percentage of variability that was explained by each model. Standard residual diagnostics were applied to assess model fit (see Supplementary Data at *Rheumatology* online). The analyses were conducted as follows: (1) The linear regression models were cumulatively adjusted for (i) age group and sex, (ii) BMI, alcohol, smoking, employment status, marital status and individual socioeconomic status, (iii) morbidities and (iv) consultation for OA; (2) An interaction term between age group and NPS (age group x NPS), i.e. categorical variable x continuous variable, was fitted added to the model to test moderation by age group in the fully adjusted model. A significant interaction between age group and NPS would indicate that the effect of NPS on HRQoL was different in different age groups; and (3) In theis case of a significant interaction in (2), separate fully adjusted models (with no interaction term) of the association between HRQoLMCS, and PCS, and NPS were would be derived for each age group, to examine any trend in strength of association. Data were analysed with the PASW Statistics version 18, SPSS Inc, Chicago, Illinois, USA.

Multiple imputation was applied to assess the impact of missing data on the results (see Supplementary Data available at *Rheumatology* online).

Results

From the eligible study population of 19,818, a total of 13,986 people completed and returned questionnaires, giving an adjusted response of 70.6%. Of those, 12,408 participants provided complete pain data (88.7%). 1,578 participants did not provide complete pain data (275 answered

"yes" to pain in past 4 weeks but did not shade on the manikin; 77 answered "no" to pain in past 4 weeks but shaded pain on the manikin; 1226 did not answer pain in past 4 weeks question).

8890 (71.6%) participants reported ≥1 pain site out of a possible 44; 669 (5.4%) had single site pain. 8221 (66.3%) participants reported pain at ≥2 sites, and 6408 (51.6%) reported pain at ≥4 sites. The distribution of NPS in the study population showed a similar pattern for each age group (Figure 1).

Female participants were more likely to report a higher NPS than males but there was no relationship with age (Table 1). Most health and socioeconomic circumstances were significantly associated with increasing NPS: MCS and PCS scores decreased (worsening mental and physical HRQoL), and BMI, the likelihood of being a current/previous smoker, reporting a morbidity, not working due to ill health or being a routine/manual worker, increased.

There was evidence of negative linear (unadjusted) associations between MCS, and PCS, mean scores and NPS in all four age groups (Figure 2). MCS mean scores decreased with increasing NPS approximately in parallel for the four age groups (Figure 2a). These associations varied little with age group. PCS mean scores decreased strongly with increasing NPS (Figure 2b). Differences in PCS mean scores between age groups diminished as NPS increased, with the four lines converging at approximately 28 pain sites.

The complete case analysis and models based on imputed data yielded similar regression coefficients (data not shown); hence, results from the complete case analyses are presented here. Both MCS and PCS scores decreased for every additional pain site reported (Table 2). These linear associations were independent of age group and sex. Additional adjustment for social factors, health behaviours and morbidities attenuated the strength of the associations between MCS, and

PCS, and NPS but the associations remained statistically significant. Additional adjustment for consultation for OA slightly reduced the strength of the associations further but they remained statistically significant. The percentage of variability in both MCS and PCS explained by the unadjusted models was increased by the fully adjusted models. There was no pattern to the residuals when plotted against the predicted values, indicating no evidence of heterogeneity and a reasonable model fit for the fully adjusted models.

Addition of an interaction term (age group and x NPS) to the fully adjusted MCS model showed that the association between MCS and NPS was moderated by age ($F_{3, 7414}$ = 12.419, p<0.001). This significant interaction suggests the effect of NPS on MCS is different for different age groups. A similar result was observed after adding an interaction term (age group and x NPS) to the fully adjusted PCS model, indicating that the overall association between PCS and NPS was also moderated by age ($F_{3, 7414}$ = 6.006, p<0.001).

Separate fully adjusted models (with no interaction term) of the association between MCS, and PCS, and NPS were derived for each age group (Table 3). Although some differences were observed in the associations between HRQoL and NPS according to age, the changes were modest overall for mental HRQoL. For MCS, the strength of association increased up to age 70-79, followed by a slight decrease in strength; for PCS, the strength of association was higher than for MCS but changed little between age 50-69, and decreased thereafter.

Discussion

To our knowledge, this is the first study to examine the relationship between HRQoL and NPS in older adults, including those aged 75 and over. The hypothesis that among older people an increasing NPS would be associated with poorer HRQoL was supported with a significant linear relationship between an increasing NPS and decreasing mental and physical HRQoL assessed by

the SF-12. These relationships persisted after adjustment for age, sex, social factors, health behaviours, morbidities and consultation for OA. The fully adjusted models explained 15% of the variance in MCS scores and 48% of the variation in PCS scores. The second hypothesis was not fully confirmed because, although the associations between HRQoL and NPS were moderated by age, the strongest associations were not in the oldest old for either mental or physical HRQoL. that the association between HRQoL and NPS would be moderated by age and would be most evident in the oldest old, was confirmed. However, the impact of NPS on HRQoL differed according to outcome: mental HRQoL worsened with increasing NPS with age up to 70-79 years, whereas the reduction in physical HRQoL with increasing NPS at age 50-69 improved with age thereafter.

This study demonstrates a dose-response relationship between the extent of pain and both physical and mental HRQoL in older people, including those aged 75 and over. It builds on results from a study of a younger range of adults (24-76 years old) in which there was a linear relationship between a smaller range of pain sites (1-10) and psychological distress, and poor general physical and psychological health [5]. The current study is also in line with studies of older populations including those aged 75 and over which have found that physical and mental markers of geriatric syndromes [37], such as increased risk of disability [1], poorer lower extremity function [2], locomotor disability [26], cognitive complaints [18] and cognitive decline [27], are associated with increased extent of pain.

In this study, mental HRQoL improved slightly from age 50 up to 80 years and deteriorated thereafter, showing a similar pattern to that of previous population-based studies [22, 24, 38]. The results further suggest that, although there may be very small changes in mental HRQoL overall with age in older people, if pain is present then mental HRQoL deteriorates. Hence, although as NPS increases, mental HRQoL worsens, this association appears to increase in strength with age up to 70-79 years and then decrease slightly thereafter.

At the population level, widespread pain, and NPS, have been shown to be a relatively stable trait over time in adults aged up to 85, and 62, respectively [4, 28]. However, there is significant individual variation in the reporting of NPS over time. Data from studies of chronic widespread pain show that two thirds of individuals with chronic widespread pain at baseline no longer reported it at follow-up although half continued to report some pain, with only 15% becoming pain free [28, 3938]. Furthermore, it is likely that recovery will be associated with better outcomes. With the predicted rise in the percentage of the population aged 50 and over, chronic musculoskeletal pain and its main consequence - disability in later life [4039] - in older people will form an increasing workload for clinicians working in primary [4140] and secondary care, relative to that of other chronic diseases in the next 20 years [4241]. Assuming that NPS is a continuum [15], then the question remains: how can we shift not only the population, but individuals too, down the continuum whereby the impact on health-related outcomes, such as mental and physical HRQoL, is likely to be reduced?

This study has several strengths. It was a large general population survey of older people, including a substantial number of the oldest old (36% of participants were aged 70 years or over and 12% were 80 or over), with a high response to the questionnaire. Inclusion of the widely used SF-12 to measure mental and physical HRQoL allows comparison of the results with other studies. Additionally, compared to the SF-36 from which it was derived, the SF-12 has fewer items and can be completed more quickly, reducing respondent burden [11, 20, 4342]. This may be an important consideration for the participation of older people in a study, particularly those aged 65 and over with existing impairments and disabilities [4443]. Some authors have suggested that older person-specific measures of HRQoL would be preferable as they may have greater validity in older adults [4443, 4544], although a structured review of such instruments found limited evidence for their performance [4544]. Hence, we cannot exclude the possibility that an older person-specific HRQoL

measure may have provided a more precise picture of the association of HRQoL with NPS. Several potential confounders for the association between HRQoL and NPS, including morbidities common in those with multiple site pain [4645] and of older age, were assessed. Adjustment for consultation for OA was included since symptomatic OA has been shown to be associated with reduced HRQoL [4746]. However, we do not believe that NPS represents underlying OA because: chronic musculoskeletal pain is not necessarily associated with advanced radiographic changes in joints in which the symptoms are located [4847]; chronic musculoskeletal pain commonly affects multiple (including non-joint) sites in the body [1]; and the genetic factors that predispose to developing chronic musculoskeletal pain are independent of the genetic factors that predispose to developing OA [4948].

There are a number of limitations to this study. The range of pain sites measured was 0-44. Inevitably, if the manikin had been divided into fewer pain sites, the prevalence of multiple site pain would have been lower; however, our aim was to use the manikin to estimate as precisely as possible the extent of pain experienced by our population. Although manikins are routinely used in population-based pain research [10, 13, 16-18, 25-33], they can be subject to missing data. In our study, of those who did not provide complete pain data, 2.2% reported pain in the past 4 weeks but did not shade pain on the manikin. However, the addition of this small extra number of participants to the total is unlikely to have influenced the results significantly. Clinically, some patterns from self-completed pain diagrams compare favourably with diagnosis of referrals to rheumatology clinics, suggesting their potential future use in prioritising rheumatology referrals, but further study is needed [32]. The manikin used in our study potentially captures both acute and chronic pain, which may limit its clinical relevance, e.g. any acute pain included in our measure will dilute the overall effect, potentially giving an under-estimation of chronic pain. However, there is evidence that a blank body manikin captures worse pain (longer duration, more severe, more disability) than a pre-shaded manikin [29], which would be consistent with the

characteristics of chronic, rather than acute, pain. Furthermore, the recall of pain over extended

periods of time may be subject to bias. Although NPS reported remains fairly stable over time [4],

our study was cross-sectional. We therefore suggest repeating our study longitudinally to

determine if decreases in NPS would lead to improved HRQoL over time.

Non-respondents to the questionnaire were more likely to be male and younger than

respondents. This could affect the prevalence of pain reporting, although there was a non-

significant difference in pain prevalence between responders to the first mailing and late

responders [16], and it is unlikely that the associations between NPS and HRQoL will be affected.

Furthermore, the associations from the imputation and the complete case analyses were similar.

The study was conducted in a more deprived area in terms of health, employment and education,

but less deprived in housing and services, than in England overall [17] which may limit the

generalisability of the findings. The morbidity data was self-reported, some of which may be prone

to reporting bias [5049-5251]. However, the agreement between self-reported and medical record

data has been shown to be good for diabetes, hypertension and some specific heart problems

[5049-5251]. While we adjusted for self-reported morbidity data, we did not adjust for diagnosed

morbidities (e.g. coronary heart disease, chronic obstructive pulmonary disorder) which may have

explained some of the association between physical HRQoL and NPS. If this were true, we would

have expected to find the strongest association (unadjusted for diagnosed morbidities) between

physical HRQoL and NPS in the older age groups, since the prevalence of diagnosed morbidities

increases with age; however, the strongest association between physical HRQoL and NPS was in

the younger age groups (age 50-69 years). Also, there may be confounders, additional to those

measured in this study, which contribute to older people's declining function (e.g. cognitive

problems, anxiety, depression, sleep) and may provide further explanation of some of the

associations. Lastly, Tthe errors were non-normal, but the sampling distributions of the model

parameters will be approximately normal for large sample sizes according to the Central Limit

Theorem [5352]. ~~Lastly, there may be confounders which were unmeasured in this study.~~

This study has shown that both mental and physical HRQoL decrease with increasing NPS in older

people, including those aged 75 and over. ~~Although~~ Age moderates the associations between NPS

and mental, and physical, HRQoL although the strongest associations are not in the oldest old. ~~the~~

~~impact of NPS on mental HRQoL increases with age up to age 70-79, the strong relationship~~

~~between NPS and physical HRQoL decreases after age 60-69; hence, the specific impact of NPS~~

~~depends on whether the outcome is mental or physical HRQoL.~~ NPS could provide a clear and

measureable "thermometer" and target for interventions aimed at maintaining and improving

HRQoL in the older~~st~~ age groups in society. Based on these data, the next step would be to

conduct longitudinal analyses to understand the influence of NPS on mental and physical HRQoL

over time in older people.~~One strategy could be to identify the factors that predict a reduction in~~

~~NPS over time and develop interventions from those that are modifiable. If none of the factors are~~

~~modifiable, the mechanisms of association between pain sites and mental and physical HRQoL~~

~~could be examined.~~

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Key messages

- Physical and mental HRQoL decline with increasing NPS in older people.

- The impact of NPS on mental HRQoL increases with age up to age 70-79.

- NPS could provide a target for improving HRQoL in older people.

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Table 1. Characteristics of the NorStOP study participants according to number of pain sites

	Total	NPS					P
		0	1-3	4-6	7-11	12-44	
Overall		3518 (28.4)	2482 (20.0)	2322 (18.7)	2022 (16.3)	2064 (16.6)	
Age *n (%)*							
50-59	4071 (32.8)	1166 (33.1)	800 (32.2)	754 (32.5)	693 (34.3)	658 (31.9)	0.116
60-69	3820 (30.8)	1019 (29.0)	792 (31.9)	720 (31.0)	617 (30.5)	672 (32.6)	
70-79	3061 (24.7)	912 (25.9)	592 (23.9)	591 (25.5)	489 (24.2)	477 (23.1)	
80+	1456 (11.7)	421 (12.0)	298 (12.0)	257 (11.1)	223 (11.0)	257 (12.5)	
Sex *n (%)*							
Female	6910 (55.7)	1863 (53.0)	1325 (53.4)	1256 (54.1)	1182 (58.5)	1284 (62.2)	<0.001
Male	5498 (44.3)	1655 (47.0)	1157 (46.6)	1066 (45.9)	840 (41.5)	780 (37.8)	
SF-12 *mean (±SD)*							
MCS	49.02 (11.18)	52.13 (9.36)	50.59 (10.49)	49.23 (11.09)	46.96 (11.62)	43.53 (12.12)	<0.001
PCS	41.00 (12.56)	48.95 (9.77)	43.42 (11.43)	40.05 (11.41)	36.51 (11.22)	29.73 (9.85)	<0.001
BMI *mean (±SD)*	26.56 (4.66)	25.65 (4.05)	26.33 (4.34)	26.50 (4.42)	27.31 (5.02)	27.68 (5.50)	<0.001
Alcohol *n (%)*							
< once per week	5619 (45.9)	1504 (43.2)	1009 (41.2)	1016 (44.3)	931 (46.4)	1159 (57.1)	<0.001
≥ once per week	6635 (54.1)	1974 (56.8)	1438 (58.8)	1277 (55.7)	1074 (53.6)	872 (42.9)	
Smoking *n (%)*							
Never	5147 (41.9)	1560 (44.8)	1102 (44.9)	921 (40.1)	794 (39.6)	770 (37.7)	<0.001
Previous	5200 (42.3)	1385 (39.7)	984 (40.1)	1016 (44.2)	895 (44.6)	920 (45.0)	
Current	1939 (15.8)	541 (15.5)	367 (15.0)	361 (15.7)	316 (15.8)	354 (17.3)	
Employment status *n (%)*							
Employed	3257 (27.1)	1052 (30.9)	734 (30.5)	653 (28.9)	497 (25.3)	321 (16.1)	0.001

Not working due to ill health	951 (7.9)	90 (2.6)	101 (4.2)	155 (6.9)	207 (10.6)	398 (20.0)	
Retired	6747 (56.1)	1935 (56.8)	1352 (56.3)	1263 (55.9)	1072 (54.7)	1125 (56.5)	
Unemployed/seeking work	126 (1.0)	32 (0.9)	27 (1.1)	29 (1.3)	18 (0.9)	20 (1.0)	
Housewife	663 (5.5)	202 (5.9)	134 (5.6)	106 (4.7)	124 (6.3)	97 (4.9)	
Other	274 (2.3)	94 (2.8)	55 (2.3)	52 (2.3)	43 (2.2)	30 (1.5)	
Marital status *n (%)*							
Married/cohabiting	8300 (67.7)	2337 (67.4)	1695 (69.1)	1581 (68.8)	1361 (68.1)	1326 (64.9)	0.026
Separated, divorced, widowed, single	3962 (32.3)	1132 (32.6)	758 (30.9)	717 (31.2)	638 (31.9)	717 (35.1)	
Socio-economic status *n (%)*							
Managerial/professional	2023 (17.5)	652 (19.8)	414 (17.9)	372 (17.1)	311 (16.4)	274 (14.4)	0.001
Intermediate	2077 (17.9)	597 (18.2)	420 (18.1)	393 (18.1)	334 (17.7)	333 (17.5)	
Routine/manual	7317 (63.2)	1998 (60.7)	1452 (62.7)	1374 (63.3)	1225 (64.7)	1268 (66.5)	
Other	157 (1.4)	42 (1.3)	30 (1.3)	32 (1.5)	22 (1.2)	31 (1.6)	
Morbidities*** *n (%)*							
Chest problems	2588 (20.9)	489 (13.9)	413 (16.6)	487 (21.0)	517 (25.6)	682 (33.0)	<0.001
Heart problems	2219 (17.9)	496 (14.1)	366 (14.7)	398 (17.1)	404 (20.0)	555 (26.9)	<0.001
Deafness	2277 (18.4)	492 (14.0)	395 (15.9)	467 (20.1)	419 (20.7)	504 (24.4)	<0.001
Eyesight problems	2659 (21.4)	598 (17.0)	453 (18.3)	495 (21.3)	495 (24.5)	618 (29.9)	<0.001
Raised blood pressure	4180 (33.7)	1087 (30.9)	781 (31.5)	748 (32.2)	706 (34.9)	858 (41.6)	<0.001
Diabetes	1061 (8.6)	283 (8.0)	169 (6.8)	199 (8.6)	190 (9.4)	220 (10.7)	<0.001

***Each morbidity was analysed separately.

Numbers of participants available for analysis: Age, Sex, each Morbidity, n= 12,408; SF-12 MCS, n= 10,823; SF-12 PCS, n= 10,823; BMI, n= 11,863; Alcohol, n= 12,254; Smoking, n= 12,286; Employment status, n= 12,018; Marital status, n= 12,262; Socioeconomic status, n= 11,574; Consultation for OA, n= 9,399.

Table 2. General linear models of association between the SF-12 MCS and PCS, and number of pain sites

	n	β	95% CI	P value	*Adjusted R^2
SF-12 mental component					
Adjustments					
None	10823	-0.43	-0.46, -0.40	<0.001	0.076
Model 1: adjusted for age and sex	10823	-0.42	-0.45, -0.39	<0.001	0.091
Model 2: model 1 + adjusted for BMI, smoking, alcohol, employment status, marital status, socioeconomic status	9560	-0.34	-0.37, -0.31	<0.001	0.132
Model 3: model 2 + adjusted for chest problems, heart problems, deafness, eyesight problems, raised blood pressure, diabetes	9560	-0.30	-0.33, -0.26	<0.001	0.152
Model 4: model 3 + adjusted for consultation for OA	7443	-0.28	-0.31, -0.24	<0.001	0.151
SF-12 physical component					
Adjustments					
None	10823	-0.87	-0.90, -0.84	<0.001	0.249
Model 1: adjusted for age and sex	10823	-0.87	-0.90, -0.84	<0.001	0.345
Model 2: model 1 + adjusted for BMI, smoking, alcohol, employment status, marital status, socioeconomic status	9560	-0.72	-0.75, -0.69	<0.001	0.435
Model 3: model 2 + adjusted for chest problems, heart problems, deafness, eyesight problems, raised blood pressure, diabetes	9560	-0.66	-0.69, -0.63	<0.001	0.475
Model 4: model 3 + adjusted for consultation for OA	7443	-0.63	-0.66, -0.59	<0.001	0.483

Regression coefficients are unstandardized. β =regression coefficient.

*Adjusted R^2 values are for the entire model in each case.

Table 3. Association between the SF-12 MCS and PCS, and number of pain sites, stratified by age group*

	n	B**	95% CI	P value	Adjusted R^{2}***
SF-12 mental component					
Age 50-59	2659	-0.15	-0.21, -0.09	<0.001	0.162
Age 60-69	2375	-0.30	-0.36, -0.24	<0.001	0.148
Age 70-79	1718	-0.40	-0.47, -0.32	<0.001	0.156
Age 80+	691	-0.31	-0.42, -0.20	<0.001	0.145
SF-12 physical component					
Age 50-59	2659	-0.64	-0.69, -0.59	<0.001	0.510
Age 60-69	2375	-0.68	-0.73, -0.62	<0.001	0.453
Age 70-79	1718	-0.59	-0.66, -0.52	<0.001	0.352
Age 80+	691	-0.48	-0.58, -0.37	<0.001	0.232

*Adjusted for sex, BMI (continuous), alcohol, smoking, employment status, marital status, individual socioeconomic status, chest problems, heart problems, deafness, eyesight problems, raised blood pressure, diabetes and consultation for osteoarthritis.

**A general linear model was generated for each age group separately.

***Adjusted R^{2} values are for the entire model for each age group.