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Can large surveys conducted on highly selected populations provide valid information on the epidemiology of common health conditions? An analysis of UK Biobank data on musculoskeletal pain

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Abstract

Introduction: Biobank-type studies are typically large but have very low participation rates. It has been suggested that these studies may provide biased estimates of prevalence but are likely to provide valid estimates of association. We test these hypotheses using data collected on pain in a large Biobank study in the United Kingdom.

Methods: UK Biobank recruited 503,325 persons aged 40–69 years (participation rate 5.5%). Participants completed questionnaires, including pain, lifestyle and environment factors. As a comparison, we used both a large population study of pain (MUSICIAN: $n = 8847$, aged: 40–69 years) conducted 2008–2009 and the National Child Development study (NCDS) which recruited all persons in Great Britain born during one week of 1958 and followed them up at age 44 years ($n = 9377$).

Results: 'Any pain' (UK Biobank 61.0%; MUSICIAN 63.9%), chronic pain (42.9%, 52.2%) and site-specific musculoskeletal pain (back 26.2%, 29.7%; shoulder/neck 23.3%, 25.3%) were generally similar in UK Biobank and MUSICIAN. The prevalence of chronic pain and most regional musculoskeletal pains in UK Biobank were all within 2% of that in NCDS.

Conclusion: UK Biobank has provided estimates of the prevalence of pain which are similar to those from previous large-scale studies, although a formal comparison of the estimates cannot be made. It has also confirmed known associations with the reporting of pain. Despite its very low participation rate, such a study provides the opportunity to investigate novel exposure–pain relationships and investigate rarer exposures and characteristics to further our knowledge of the epidemiology of pain.

Keywords

UK Biobank, pain, musculoskeletal, prevalence, associations

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Introduction

In the recent past, there has been an increase, internationally, in the number of large-scale epidemiological studies undertaken to investigate the genetic and environmental influences on disease. These studies which typically include the collection of biological samples are generically termed 'Biobanks' and the Public Population Project in Genomics and Society (P^3G) has been formed to provide the international research community access to the expertise, resources and innovative tools to exploit such collections of data. An example of such a study is 'UK Biobank'. This study recruited half a million people aged between 40 and 69 years from across Great Britain (http://www.ukbiobank.ac.uk). Participants completed questionnaires on aspects of health and lifestyle. They also provided blood, urine and saliva samples and agreed to have their health followed over time, including through routinely collected health data.

In contrast to more traditional epidemiological studies, Biobanks, although large in numbers, often have very low participation rates. Epidemiologists have traditionally been concerned about studies with low participation rates, because of selection bias, and different prevalence of diseases and exposures has been demonstrated among non-participants in epidemiological studies, including for the reporting of pain.[1] As non-participation increases, the potential for bias also increases. Typically, large-scale Biobanks are concerned with examining genetic influences on disease or the joint effect of genetic with environmental factors and although there may be selection bias present and thus participants are not representative of a sampling frame from which they were drawn, it has been argued that the mechanisms of disease (observed through associations) are unlikely to differ between participants and non-participants.[2] Although whether this universally applies has been challenged.[3] Furthermore, with very large sample sizes, there may be sufficient numbers within each socio-demographic and clinical subgroup (including sub-groups which are proportionally under-represented) to allow stratification-specific examination of associations.

We wished to quantify the likely effect of selection bias on one of the most common health conditions which has been collected by UK Biobank, namely pain (with a focus on sites related to musculoskeletal pain). Specifically, we wished to determine whether UK Biobank would confirm findings from previous UK epidemiological studies: (a) the prevalence of pain and (b) site-specific associations with age, and strong associations with low socio-economic status and adverse psychosocial factors. Finally, because of its size, UK Biobank is able to look at potential associations with rare exposures or disease determinants which other studies have been insufficiently powered to examine, and as an example of this, we chose ethnic group.

Methods

A summary of the features of UK Biobank and the comparator studies used is given in Table 1.

UK Biobank

Detailed methods used by UK Biobank[4] have been published previously, and here, we provide only summary details of relevance to the current analysis. The study aimed to recruit persons aged 40–69 years who were registered with a general practitioner (GP) within the National Health Service (NHS). As it is estimated that over 95% of persons are so registered, this provides a suitable population sampling frame in the United Kingdom[5] Overall, around 9.2 million invitations were issued to people living within about 25 miles of one of the 22 assessment centres in England, Scotland and Wales. In total, the study recruited 503,325 people between 2006 and 2010, a participation rate of 5.5%.

At the assessment centre, participants completed questionnaires including items on lifestyle and environment. Information on pain was collected by means of a touch screen questionnaire. Participants were asked 'In the last month have you experienced any of the following that interfered with your usual activities?' They were then provided with a list: headache, facial pain, neck or shoulder pain, back pain, stomach or abdominal pain, hip pain, knee pain, pain all over the body. For each site for which they answered positively, they were asked whether this pain had lasted at least 3 months, and persons reporting any individual pain as chronic were defined as having 'chronic pain'. Subjects who reported 'pain all over the body' were not offered the option of choosing any further regional sites. We have not considered the regional pain sites abdominal pain, headache and facial pain further since the first two are not primarily musculoskeletal, while an analysis of the epidemiology of facial pain within UK Biobank has previously been published.[6] The determinants or exposures which we considered in relation to pain in this analysis were self-reported sex, age and ethnic group. We have classified the latter (based on the information collected by UK Biobank) as white, mixed ethnic group, Asian or Asian British, Black or Black British, Chinese or 'other' ethnic group. As an example of psychosocial factors, we have used reporting consultations to a GP with mood conditions ('Have you ever seen a general practitioner (GP) for nerves, anxiety, tension or depression?'), the number of self-reported such episodes ('How many periods have you had when you were feeling depressed

Table 1. Features of UK Biobank and comparator studies.

Study name	UK Biobank	National Child Development Study (NCDS)	MUSICIAN
Sample	Population samples around 22 Great Britain-wide recruiting centres	Persons born during one week of March 1958 in Great Britain	Population samples from two regions of Great Britain
Calendar period study commenced	2006	2002	2008
Age range	40–69 years	44 years[a]	40–69 years[b]
Focus	General health	General health	Pain
Participation rate	5.5%	78.3% of persons invited (50.4% of original birth cohort)	35.9%
N	503,325	9377	8847
Pain questions	In the last month, have you experienced any of the following that interfered with your usual activities?	Thinking back over the past month, have you had any aches or pains that have lasted for one day or longer?	Thinking back over the past month, have you had any aches or pains that have lasted for one day or longer?
Pain location data	Checklist	Body manikin shading	Body manikin shading
Mode of response	Touch-screen questionnaire	Paper questionnaire	Paper questionnaire

[a]Data used from follow-up which commenced in 2002 when 95.5% were aged 44 years, 4.1% were aged 45 years and 0.4% were aged 46 years.
[b]The study included persons aged 25 years and over but only those aged 40–69 years are included in the current analysis.

or down for at least a whole week?'), how happy they were ('In general how happy are you?') and specifically with their job ('In general how satisfied are you with the work that you do?'). Participants were asked about adverse life events ('In the last 2 years have you experienced any of the following?'); these related to death, serious illness or injury to a partner or close relative, marital separation or financial difficulties. Mood and adverse life events have been demonstrated to be strongly related to the reporting of pain.[7] Although there are considerable additional measures made on lifestyle and environment, such as diet and physical activity and linkage to routine datasets, and biological samples collected, these have not been used for the current analysis.

Although we can make comparison with UK Biobank across several studies, as direct comparisons we used first the *M*anaging *U*nexplained Mu*S*culoskeletal *C*onditions Us*I*ng traditional and *A*ccessible *N*ew approaches (MUSICIAN) study and second The National Child Development Study (NCDS).

MUSICIAN study

The MUSICIAN study involved a randomised trial to test non-pharmacologic management of chronic widespread pain (CWP).[8] Since identification of eligible patients with CWP is difficult from primary care records, a large-scale recruitment survey of persons 25 years and over was undertaken in two areas of Great Britain. For the purposes of the current analysis, we use only those within the age range of UK Biobank. Pain was identified by asking participants, 'Thinking back over the past month, have you had any aches or pains that have lasted for 1 day or longer?' Respondents answering positively were invited to shade the location(s) of their pain on 4-view body manikins. In total, 8847 persons aged 40–69 years participated (crude participation rate 35.9%). Participation generally increased with older age, from 25.8% in those 40–44 years of age to 45.3% in those aged over 65–69 years and participation was higher in females (40.1% vs 31.8%).

NCDS

The NCDS recruited all children born in Great Britain during a specific week of March in 1958. Altogether the sample consisted of 18,558 individuals and comprehensive details have been presented previously.[9] These children have thereafter been followed-up at seven points through their childhood and adult life. Most recently, a biomedical survey was conducted, commencing in 2002 (at 44 years) on the remaining participants still in contact with the survey and not previously requiring a proxy interview: 78.3% agreed to participate. The questions asked about pain at this follow-up were identical to those used in the MUSICIAN study.

Statistical analysis

UK Biobank versus MUSICIAN study. For both studies, the crude prevalence of any pain, chronic pain and regional musculoskeletal pains was calculated. The

Table 2. Prevalence of pain reporting in UK Biobank and the MUSICIAN study and by musculoskeletal site, gender and age (standardised to UK 2011 population structure).

		Overall (%)	Gender (%)		Age group-specific prevalence (%)					
			Male	Female	40–44	45–49	50–54	55–59	60–64	65–69
UK Biobank	Any pain	61.0	59.5	62.4	61.9	62.6	62.0	60.1	58.6	59.9
	Chronic pain	42.9	40.0	45.7	39.6	42.3	43.6	43.8	43.8	45.7
	Shoulder/neck Pain	23.3	22.2	24.5	22.7	23.8	24.1	23.6	22.7	23.0
	Back pain	26.2	27.4	25.1	26.9	26.5	26.0	25.9	25.5	26.4
	Hip pain	10.2	8.3	12.0	6.8	8.3	10.0	11.1	12.5	14.4
	Knee pain	20.7	21.6	19.7	16.8	18.5	20.9	22.3	23.2	24.7
MUSICIAN	Any pain	63.9	63.0	64.8	61.8	63.3	64.3	64.9	65.1	64.8
	Chronic pain	52.2	49.8	54.8	48.5	48.3	52.9	53.8	56.1	56.8
	Shoulder/neck pain	25.3	22.3	28.4	23.5	25.1	25.8	27.0	25.8	25.3
	Back pain	29.7	29.6	29.7	30.3	30.3	29.8	28.7	30.8	27.2
	Hip pain	24.7	22.9	26.5	21.9	23.0	24.4	25.6	27.4	27.8
	Knee pain	24.3	23.6	25.0	19.0	22.7	22.5	26.7	28.3	29.4

directly adjusted prevalence (standardised prevalence (SP)) was thereafter calculated in both studies by weighting according to the age, gender, or age and gender structure reported in the 2011 UK census (denoted as SP_{age}, SP_{gender} and $SP_{age/gender}$, respectively).[10]

UK Biobank versus NCDS. By definition, most of the participants in the NCDS were of a similar age when they responded in the follow-up which commenced in 2002: 95.5% were aged 44 years, 4.1% were aged 45 years and 0.4% were aged 46 years. Therefore, we directly adjusted the prevalence proportions obtained within UK Biobank to this age distribution.

Furthermore, for UK Biobank, the prevalence of any pain and chronic pain was calculated for each of the socio-demographic and potential associated factors used in this analysis and risk ratios (RRs) with 99% confidence intervals (CIs) calculated by Poisson regression adjusted for age and gender. In addition, the prevalence of each regional pain was calculated by self-reported ethnic group and RRs with 99% CIs calculated using 'white' as the reference group and, using Poisson regression, adjusted first for age and sex and second for other potential confounders: income, employment status and number of adverse life events. All analyses were conducted in STATA Statistical Software: Release 13.0.

Results

Prevalence of pain according to demographic factors in UK Biobank and MUSICIAN

In total, 498,071 participants in UK Biobank between 40 and 69 years old responded to the question about pain they had experienced in the last month. Of these, 301,840 answered that they had any pain, providing a crude prevalence of 60.6% and an age and gender SP ($SP_{age/gender}$) of 61.0%, 99% CI: 60.8%, 61.2%, while 217,608 reported pain which was chronic, providing a crude prevalence of chronic pain of 43.7%, a $SP_{age/gender}$ of 42.9%, 99% CI: 42.7%, 43.1%. Pain was more common in females than males (SP_{age} 62.4% vs 59.5%, RR: 1.05, 99% CI: 1.04, 1.06) as was chronic pain (SP_{age} 45.7% vs 40.0% RR: 1.14, 99% CI: 1.13, 1.15). The most common regional musculoskeletal pain reported was back pain ($SP_{age/gender}$ 26.2%) followed by shoulder/neck (23.3%) and knee pain (20.7%) and hip pain (10.2%). For all regional pains with the exception of back (female 25.1% vs male 27.4%) and knee pain (19.7% vs 21.6%), the prevalence was higher in women (Table 2). Reporting of any pain only varied to a small extent across this age group: SP_{gender} was 61.9–62.6% between 40 and 49 years and thereafter decreased to 59.9% by age 65–69 years. The reporting of chronic pain increased modestly across the age range from 39.6% at age 40–44 years to 45.7% at age 65–69 years. For knee and hip pain, there was a clear pattern of increasing prevalence with older age (knee pain 16.8% at age 40–44 years to 24.7% at age 65–69 years; hip pain 6.8% to 14.4%). Back pain, and shoulder/neck pain, did not vary much across this age range, with all age-specific prevalence estimates around 26% and 23%, respectively.

In total, 8847 participants in MUSICIAN between 40 and 69 years old provided an answer for the question about pain they had experienced in the last month. Of these, 5679 answered positively, providing a crude prevalence of 64.2% ($SP_{age/gender}$ 63.9%, 99% CI: 62.5%, 65.2%), while 4684 reported pain which was chronic, providing a prevalence of chronic pain of

53.2% ($SP_{age/gender}$ 52.3%, 99% CI: 50.9%, 53.7%). Pain was more common in females than males (SP_{age} 64.8% vs 63.0%, RR: 1.03, 99% CI: 0.99, 1.07). The most common regional pain reported was back pain ($SP_{age/gender}$ 29.7%) followed by shoulder/neck (25.3%), hip pain (24.7%) and knee pain (24.3%). For all regional musculoskeletal pains, prevalence was higher in women, but the excess prevalence was least for back pain (female 29.7% vs male 29.6%) and knee pain (25.0% vs 23.6%), the two sites which showed a small excess prevalence in males within UK Biobank. Prevalence increased with older age from SP_{gender} 61.8% in 40–44 years to 65.1% at age 60–64 years with a small decrease to 64.8% at ages 65–69 years. The prevalence of chronic pain generally increased across the eligible age range from 48.5% at age 40–44 to 56.8% at age 65–69 years (Table 2). For knee and hip pain, there was a clear pattern of increasing prevalence with older age (knee pain 19.0% at age 40–44 years to 29.4% at age 65–69 years; hip pain 21.9% to 27.8%). Back pain and shoulder/neck pain did not show any clear pattern in prevalence across this age range.

Pain reporting in UK Biobank in comparison to NCDS

The prevalence of chronic pain and the regional pain sites shoulder/neck pain, back pain and knee pain reported in UK Biobank among subjects of 44–46 years were all within 2% of that reported within NCDS. Only the reporting of any pain (62.8% UK Biobank vs 53.3% NCDS) and hip pain (7.4% vs 15.4%) were out with this margin of agreement (Table 3).

Pain reporting in relation to socio-economic factors

In UK Biobank, the prevalence of pain and particularly chronic pain in the previous month was strongly related to various measures of social and economic status. The $SP_{age/gender}$ of chronic pain decreased monotonically as income group increased, from 52.5% among those with annual incomes less than £18,000 to 33.5% among those with income greater than £100,000 (RR: 0.64, 99% CI: 0.62, 0.66; Table 4): Similarly those who left education prior to 16 years (53.2%) were more likely to report chronic pain than those who remained in education to at least 17 years (41.4%, RR: 0.77, 99% CI: 0.76, 0.78). In relation to employment, chronic pain was least common among those in paid employment (39.8%) and those doing unpaid or voluntary work (42.3%), while almost all persons who were unable to work because of ill-health reported chronic pain (78.9%; RR: 1.99, 99% CI: 1.96, 2.01).

Table 3. Prevalence of pain reporting by musculoskeletal site in UK Biobank and NCDS study (standardised to age structure of respondents in NCDS follow-up commencing in 2002).

	Prevalence (%)	
	UK Biobank	NCDS
Any pain	62.8	53.3
Chronic pain	41.6	40.9
Shoulder/neck pain	23.5	20.4
Back pain	27.4	26.2
Hip pain	7.4	15.4
Knee pain	17.1	19.1

NCDS: National Child Development Study.

Pain reporting in relation to psychosocial factors

The reporting of pain was related to the measured psychosocial factors, with stronger associations being observed with chronic pain. Those who had consulted a GP for 'nerves, anxiety, tension or depression' had an excess risk of reporting chronic pain ($SP_{age/gender}$ 52.2% vs 38.0%; RR: 1.36, 99% CI: 1.34, 1.37) and the likelihood of reporting chronic pain increased strongly with the reported number of episodes of depression (no episodes: 35.5%; 1 episode: 39.1%, 2/3 episodes 44.1%; >3 episodes 52.4%; Table 5). Similarly, there was a monotonic increase in the prevalence of chronic pain reporting according to how unhappy respondents were (extremely happy 35.7% to extremely unhappy 72.5% RR: 2.10, 99% CI: 1.91, 2.30). The same relationship was found when respondents, who were employed, were asked about how satisfied they were with their job (extremely happy 38.3% to extremely unhappy 59.4% RR: 1.56, 99% CI: 1.44, 1.69). Finally, in relation to life events in the past 2 years, there was an increase in chronic pain prevalence with number of adverse events (38.2% with 0 events, up to 72.5% for 4 or more events RR: 1.94, 99% CI: 1.86, 2.02).

Pain reporting in relation to self-reported ethnicity

In comparison to persons who identified their ethnicity as 'white' (pain $SP_{age/gender}$ 60.3%), persons identifying themselves as Asian (71.8%; RR: 1.19, 99% CI: 1.17, 1.21), Black (70.2%; RR: 1.15, 99% CI: 1.13, 1.18), mixed ethnicity (66.3%, RR: 1.09, 99% CI: 1.05, 1.13), with the exception of Chinese, (71.5%, RR: 1.18, 99% CI: 1.15, 1.21) were more likely to report pain (Table 6). After adjustment for potential confounders (income, employment status and

Table 4. Pain and chronic pain reporting in relation to socio-economic factors in UK Biobank.

		Any pain		Chronic pain	
		Standardised pain prevalence	RR (99% CI)[a]	Standardised pain prevalence	RR (99% CI)[a]
Age group	40–44	61.9	1	39.6	1
	45–49	62.6	1.01 (0.999–1.02)	42.3	1.07 (1.05–1.09)
	50–54	62.0	1.00 (0.99–1.01)	43.6	1.10 (1.08–1.12)
	55–59	60.1	0.97 (0.96–0.98)	43.8	1.11 (1.09–1.13)
	60–64	58.6	0.95 (0.94–0.96)	43.8	1.11 (1.09–1.12)
	65–69	59.9	0.97 (0.96–0.98)	45.7	1.15 (1.14–1.17)
Gender	Male	59.5	1	40.0	1
	Female	62.4	1.05 (1.04–1.06)	45.7	1.14 (1.13–1.15)
Income	Less than £18,000	68.4	1	52.5	1
	£18,000 to £30,999	61.4	0.89 (0.88–0.90)	43.9	0.84 (0.82–0.85)
	£31,000 to £51,999	59.1	0.84 (0.83–0.85)	40.0	0.76 (0.75–0.77)
	£52,000 to £100,000	56.2	0.79 (0.78–0.80)	37.0	0.70 (0.69–0.72)
	Greater than £100,000	52.6	0.74 (0.73–0.75)	33.5	0.64 (0.62–0.66)
Age at leaving school	Under 16	68.5	1	53.2	1
	16	63.4	0.88 (0.88–0.89)	45.6	0.85 (0.84–0.86)
	17 and over	60.0	0.84 (0.83–0.85)	41.4	0.77 (0.76–0.78)
Primary employment status	Employed/self-employed	59.6	1	39.8	1
	Retired	59.8	1.04 (1.03–1.05)	45.4	1.10 (1.09–1.11)
	Looking after home	64.2	1.05 (1.04–1.07)	45.9	1.09 (1.07–1.12)
	Unable to work because of sickness	88.2	1.50 (1.48–1.51)	78.9	1.99 (1.96–2.01)
	Unemployed	65.3	1.11 (1.08–1.13)	45.7	1.17 (1.14–1.21)
	Unpaid/voluntary work	60.0	1.01 (0.96–1.06)	42.3	1.03 (0.96–1.10)
	Students	62.8	1.03 (0.98–1.10)	41.3	1.04 (0.95–1.13)

RR: risk ratio; CI: confidence interval.
[a]Adjusted for age and/or sex, standardised.

number of adverse life events), these differences between the groups still remained but were considerably attenuated. The relationships were similar for chronic pain, although slightly less strong, especially after adjustment (RR_{adj}: 1.04–1.12). Only persons identifying themselves as of Chinese ethnicity were not more likely to report pain (61.0%, RR: 1.00, 99% CI: 0.95, 1.06) and indeed were less likely to report chronic pain (RR: 0.86, 99% CI: 0.79, 0.95). The excess pain prevalence in non-Chinese (in comparison to those identifying themselves as white) was observed for all musculoskeletal pain sites. For those of Chinese origin, there were no differences, compared to whites in the prevalence of back pain (27.3% vs 25.8%, RR: 1.06, 99% CI: 0.95, 1.19), but they were significantly more likely to report neck or shoulder pain (28.7% vs 23.0%, RR: 1.24, 99% CI: 1.11, 1.39) and significantly less likely to report hip pain (6.7% vs 10.3%, RR: 0.72, 99% CI: 0.56, 0.92).

Discussion

The highly selected population recruited to UK Biobank has demonstrated pain prevalence (overall and musculoskeletal site-specific) which is only very slightly lower than a large population study conducted in two centres in Scotland and England, and very similar prevalence for chronic pain and musculoskeletal site-specific to a national UK birth cohort study. Both the latter demonstrated considerably higher participation rates (65% and 36%) than UK Biobank (5.5%). Reported pain in the UK Biobank has demonstrated clear associations with measures of low socio-economic status, adverse psychosocial factors and life events which have previously been established in several UK epidemiological studies. As an example of its ability to analyse prevalence in small population sub-groups, it has provided the clearest evidence to date that reporting of pain does vary by ethnic group but that this can largely be explained by socio-economic factors, and adverse life events.

Table 5. Pain and chronic pain reporting in relation to psychosocial factors in UK Biobank.

		Any pain		Chronic pain	
		Standardised pain prevalence (%)	RR (99% CI)[a]	Standardised pain prevalence (%)	RR (99% CI)[a]
GP consultation for nerves, anxiety, tension, depression	No	56.7	1	38.0	1
	Yes	69.2	1.22 (1.21–1.22)	52.2	1.36 (1.34–1.37)
Depressive episodes	0	53.0	1	35.5	1
	1	57.1	1.07 (1.05–1.09)	39.1	1.09 (1.06–1.12)
	2 or 3	61.9	1.15 (1.13–1.17)	44.1	1.23 (1.20–1.26)
	More than 3	69.3	1.29 (1.27–1.32)	52.4	1.47 (1.43–1.50)
Happiness	Extremely happy	51.7	1	35.7	1
	Very happy	53.5	1.03 (1.00–1.06)	36.4	1.02 (0.98–1.06)
	Moderately happy	61.8	1.19 (1.15–1.22)	44.0	1.23 (1.19–1.28)
	Moderately unhappy	71.4	1.37 (1.32–1.42)	54.8	1.57 (1.49–1.65)
	Very unhappy	77.9	1.49 (1.42–1.57)	62.7	1.80 (1.67–1.93)
	Extremely unhappy	85.3	1.64 (1.54–1.75)	72.5	2.10 (1.91–2.30)
Job satisfaction	Extremely satisfied	55.0	1	38.3	1
	Very satisfied	54.2	0.98 (0.96–1.01)	36.1	0.94 (0.90–0.98)
	Moderately satisfied	59.7	1.07 (1.04–1.10)	40.8	1.06 (1.02–1.10)
	Moderately satisfied	64.0	1.15 (1.11–1.19)	44.5	1.17 (1.11–1.23)
	Very satisfied	69.4	1.25 (1.19–1.31)	50.4	1.34 (1.25–1.43)
	Extremely satisfied	74.9	1.34 (1.27–1.42)	59.4	1.56 (1.44–1.69)
Number of adverse life events	0	56.3	1	38.2	1
	1	63.9	1.13 (1.12–1.14)	45.4	1.19 (1.18–1.21)
	2	70.4	1.24 (1.23–1.26)	52.6	1.39 (1.37–1.41)
	3	78.3	1.38 (1.36–1.40)	62.3	1.66 (1.62–1.70)
	4 or more	85.1	1.50 (1.46–1.54)	72.5	1.94 (1.86–2.02)

RR: risk ratio; CI: confidence interval.
[a]Adjusted for age and sex, standardised.

Methodological issues

There are several methodological issues to consider. First, there has been no major UK study, of which we are aware, which has used exactly the same wording as the UK Biobank questions on pain, nor has any large-scale population survey of pain used touch screen questionnaires. We have previously shown that recording pain information by means of shading body manikins on a paper questionnaire and indicating painful body regions on computer can lead to differences in prevalence.[11] Furthermore, small differences in the wording of questions on pain can lead to differences in estimated prevalence.[12] Comparing UK Biobank with MUSICIAN study/NCDS definition of pain, the former required that pain had caused some interference with activities while the latter that it had lasted at least 1 day. There was also a difference in the way information was collected on site of pain. UK Biobank asked participants about pain in regional sites of the body and 'pain all over', while the MUSICIAN study and NCDS determined the site of pain from shading on a blank body manikin which was then coded using a template. It has been shown, for shoulder pain, that the former leads to slightly lower prevalence estimates.[13] This is probably because the former results in subjects making a judgement from where the pain is arising, while the latter method of recording, codes pain as being present in a region even if the subject does not consider that pain is *arising* from that region. Thus, radiating back pain illustrated on a body manikin might result in pain being recorded in the lower back, hip and knee regions, while subjects if questioned might report only back pain. Although the prevalence of regional pains reported between UK Biobank and the two comparator studies was similar overall, there was a sizeable difference for hip pain. The coding area for hip pain in the body manikin includes the buttocks and extends from the hip to just above the knee[14] and when coded from the manikin, likely includes pain arising from elsewhere, such as the back and knee.

Both comparator studies have advantages and disadvantages. While UK Biobank was conducted within major population centres throughout the UK, MUSICIAN was conducted in only two centres: in Aberdeen city, north-east Scotland and Cheshire,

Table 6. Pain, chronic pain and pain by musculoskeletal site according to self-reported ethnicity in UK Biobank.

		Ethnic group-specific prevalence (%)					
		White	Mixed	Asian	Black	Chinese	Any other
Any pain	Standardised prevalence	60.3	66.3	71.8	70.2	61.0	71.5
	RR (99% CI)[a]	1	1.09 (1.05–1.13)	1.19 (1.17–1.21)	1.15 (1.13–1.18)	1.00 (0.95–1.06)	1.18 (1.15–1.21)
	RR adj (99% CI)[b]	1	1.04 (0.99–1.08)	1.12 (1.10–1.15)	1.05 (1.03–1.08)	0.98 (0.92–1.05)	1.12 (1.08–1.15)
Chronic pain	Standardised prevalence	42.6	46.7	47.7	45.2	36.5	47.0
	RR (99% CI)[a]	1	1.11 (1.05–1.17)	1.15 (1.12–1.19)	1.08 (1.05–1.12)	0.86 (0.79–0.95)	1.13 (1.08–1.18)
	RR adj (99% CI)[b]	1	1.04 (0.98–1.11)	1.06 (1.02–1.10)	0.95 (0.91–0.99)	0.88 (0.79–0.97)	1.02 (0.97–1.08)
Shoulder/ neck pain	Standardised prevalence	23.0	28.7	30.7	25.5	28.7	28.7
	RR (99% CI)[a]	1	1.24 (1.15–1.35)	1.35 (1.30–1.41)	1.11 (1.05–1.17)	1.24 (1.11–1.39)	1.25 (1.17–1.33)
Back pain	Standardised prevalence	25.8	27.6	33.4	31.3	27.3	34.7
	RR (99% CI)	1	1.07 (0.99–1.16)	1.28 (1.23–1.33)	1.21 (1.16–1.27)	1.06 (0.95–1.19)	1.34 (1.27–1.42)
Hip pain	Standardised prevalence	10.3	10.0	8.3	10.8	6.7	8.9
	RR (99% CI)[a]	1	1.10 (0.95–1.27)	0.92 (0.85–1.01)	1.19 (1.09–1.30)	0.72 (0.56–0.92)	0.97 (0.86–1.10)
Knee pain	Standardised prevalence	20.4	21.9	25.4	25.3	17.9	23.1
	RR (99% CI)[a]	1	1.19 (1.09–1.29)	1.35 (1.30–1.41)	1.40 (1.33–1.46)	0.96 (0.84–1.10)	1.25 (1.17–1.34)

RR: risk ratio; CI: confidence interval.
[a]RR are all adjusted for age and sex.
[b]RR (adj) additionally adjusted for income, employment status and number of adverse life events.

north-west England. It includes both urban and rural locations and the areas are geographically and culturally distinct. We have previously assessed how pain reporting differs between regions in the United Kingdom in NCDS and found that there were no important or significant differences in pain reporting by area of residence.[9] Furthermore, although MUSICIAN has a participation rate over six times as high as UK Biobank, it is still relatively modest. In contrast NCDS is nationally representative with participation remaining high over its five decades of follow-up. An analysis of those lost to follow-up demonstrated that the sample remained broadly representative of the surviving cohort, although there was some under-representation of minority groups (non-white, children from families without a male head of household, children who were in institutional care)[15] However, by definition, it provides a comparison mainly at a single age.

Comparison with other studies

As noted above, changes to the wording of questions on pain can importantly affect the responses from study patients making it difficult to compare prevalence directly between study. The Health Survey for England (HSE)[16] enquired about pain in its most recent data collection wave in 2011. It samples households and reports its individual participation rate as 59%. It asked participants if they were 'currently troubled by pain and discomfort either all of the time or on and off'. If participants reported that they were, they were asked whether they had had the pain or discomfort for more than 3 months. Data reported in age groups 45–54 years and 55–64 years demonstrated chronic pain prevalence for women of 42% and 51% and for men of 33% and 43%, respectively, which is consistent with the overall chronic pain prevalence of 43.7% reported in UK Biobank. As in the current study, HSE[16] showed strong associations between reporting pain and low household income, measures of anxiety and depression, and low scores for 'happiness'.

The Global Burden of Disease study recently published data on the global prevalence of low back pain. It included 165 studies providing 966 separate estimates. The median estimate of the 1-month period prevalence was 32.1% while considering prevalence estimates from high income countries only, the median was 30.3%.[12] Although age-specific prevalence rates were not given, it was noted that prevalence peaked between 40 and 69 years in both men and women. These data are consistent with the 27.8% 1-month period prevalence of back pain which interferes with activities in UK Biobank.

This study has provided clear evidence of differences in reporting of pain according to self-reported ethnicity in a UK population. It also shows that these differences are partly explained by socio-economic factors and adverse life events. Most research into ethnic differences has been conducted in the United States. Edwards et al.[17] in a review, highlighted studies showing excess reporting in African Americans of postoperative pain,[18] angina on exercise treadmill tests[19] and in self-reported daily pain symptoms, which seemed to be partly accounted for by differences in thermal pain tolerance thresholds.[20] Rahim-Williams et al.[21] undertook a quantitative review of pain response in experimental studies. They concluded that there were important differences across modalities comparing African Americans with non-Hispanic whites whereby the former had lower pain tolerance, with important effect sizes, but less clear differences between non-Hispanic whites and other ethnic groups. The reasons for such differences could be biological, psychological and/or cultural. In one experimental study included in the previous review, it was reported that the more sensitive to experimental pain the African Americans were likely to be, the more they identified with their ethnic group.[22] This is consistent with observations we have previously made in the United Kingdom among South Asians whereby those with low levels of acculturation (i.e. their culture remained predominantly South Asian) reported higher levels of CWP compared to South Asians whose culture had changed to predominantly reflect British culture.[23]

Conclusion

This study has demonstrated that UK Biobank, despite very low participation rates, has provided results regarding the descriptive epidemiology of pain (overall) and for individual musculoskeletal pain sites, which are similar to UK epidemiological studies of smaller scale but with higher participation rates. It has also demonstrated similar prevalence proportions to other national epidemiological studies which have measured pain occurrence. Taken along with its very large sample size, UK Biobank can therefore be usefully used for more detailed research into the genetic and environmental factors associated with pain. Our study has confirmed strong associations with socio-demographic factors and adverse psychosocial factors which are also well established. At least for one of the most common health conditions, selection effects among participants do not appear to have biased prevalence estimates. Finally, it has provided the strongest evidence for self-reported ethnicity importantly influencing the reporting of pain. Some of these differences may be explained by socio-economic and psychosocial factors but warrant further investigation within this study.

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