

**Supplementary information: Do the associations of body mass index and waist circumference with back pain change as people age? 32 years of follow-up in a British birth cohort**

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**Supplementary methods:****Questions used to assess back pain in the MRC National Survey of Health and Development*****Ages 36 and 43 years [nurse interviews]:***

Do you have any of the following (sciatica, lumbago or recurring backache) all or most of the time?

0 No

1 Yes

***Ages 53 and 60-64 years [nurse interviews]:***

In the last 12 months, have you had sciatica, lumbago or severe backache?

0 No

1 Yes

***Age 68 years [self-completion questionnaire]:***

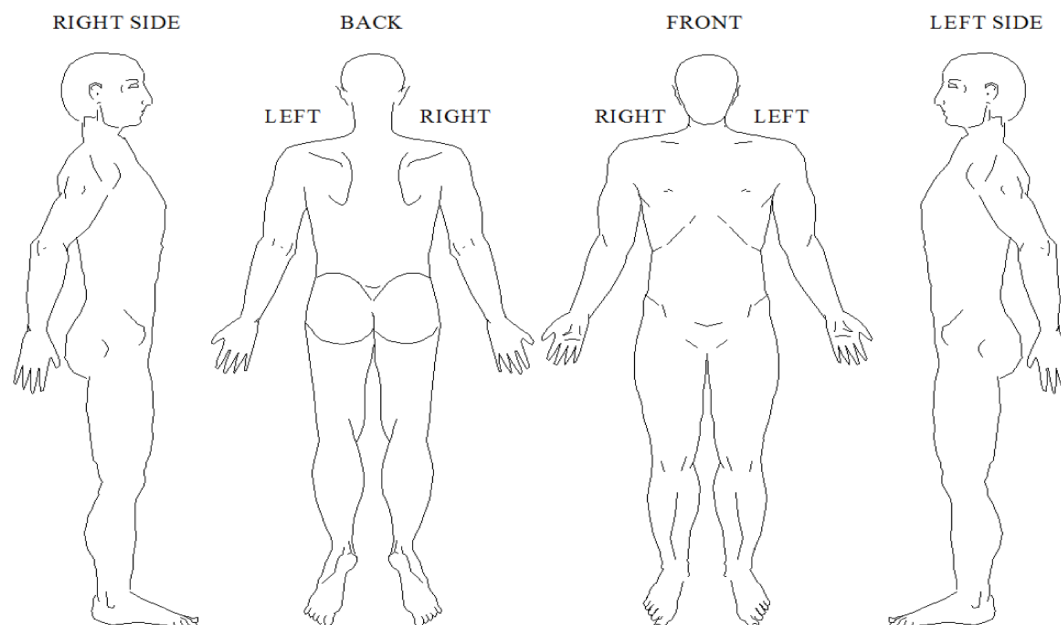
In the *last month*, have you had any ache or pain which has lasted for *one day or longer*? (Please do not include pain occurring only during the course of a feverish illness such as flu)

0 No

1 Yes

Below you will find four diagrams of the body.

Please **shade** in all the places where you have felt or feel the aches and pains.



**Table S1: Number of MRC National Survey of Health and Development participants contributing data at each age and number with missing data<sup>a</sup>**

Age	Total N contributing data at specified age (no. of males; no. of females)	N with data on back pain but missing data on BMI/WC at specified age	N with data on back pain and BMI/WC at specified age but missing data on covariates
36y	3093 (1540; 1553)	48	175
43y	2940 (1483; 1457)	52	259
53y	2700 (1332; 1368)	44	243
60-64y	1816 (872; 944)	29	390
68-69y	1777 (860; 917)	485	158

<sup>a</sup> A total of 3426 MRC NSHD participants were included in the main analyses. Participant's data could be included at a specified age if there was complete information on back pain, BMI, waist circumference and all covariates at that age

BMI: Body mass index; WC: waist circumference

**Table S2: Characteristics of the MRC National Survey of Health and Development sample included in analysis <sup>a</sup>**

	Male	Female
<b>Highest education level achieved by age 26y, N (%)</b>		
A-level/equivalent or above	706 (41.0)	463 (27.2)
O-level/equivalent or below	357 (20.7)	587 (34.5)
None	660 (38.3)	653 (38.3)
<b>Own occupational class at age 53y, N (%)</b>		
High (I/II)	853 (49.5)	593 (34.8)
Middle (IIINM/IIIM)	662 (38.4)	740 (43.5)
Low (IV/V)	208 (12.1)	370 (21.7)
<b>Time varying covariates<sup>b</sup></b>		
<b>Height (cm), mean (SD), at age:</b>		
36y	175.4 (6.5)	162.4 (6.0)
43y	175.2 (6.6)	162.4 (6.2)
53y	174.7 (6.5)	161.6 (5.9)
60-64y	174.8 (6.5)	161.9 (5.9)
69y	174.0 (6.4)	160.7 (5.9)
<b>Smoking status, N (%), at age:</b>		
36y		
Current	530 (34.4)	524 (33.7)
Ex	617 (40.1)	518 (33.4)
Never	393 (25.5)	511 (32.9)
43y		
Current	460 (31.0)	417 (28.6)
Ex	522 (35.2)	373 (25.6)
Never	501 (33.8)	667 (45.8)
53y		
Current	323 (24.3)	315 (23.0)
Ex	544 (40.8)	391 (28.6)
Never	465 (34.9)	662 (48.4)
60-64y		
Current	97 (11.1)	105 (11.1)
Ex	410 (47.0)	322 (34.1)
Never	365 (41.9)	517 (54.8)
68-69y		
Current	76 (8.8)	65 (7.1)
Ex	411 (47.8)	314 (34.2)
Never	373 (43.4)	538 (58.7)
<b>Leisure time physical activity, N (%), at age:</b>		
36y		
Inactive	475 (30.8)	651 (41.9)
Less active	407 (26.4)	376 (24.2)
Most active	658 (42.7)	526 (33.9)
43y		

	Inactive	714 (48.2)	805 (55.3)
	Less active	354 (23.9)	338 (23.2)
	Most active	415 (28.0)	314 (21.6)
53y			
	Inactive	627 (47.1)	689 (50.4)
	Less active	252 (18.9)	227 (16.6)
	Most active	453 (34.0)	452 (33.0)
60-64y			
	Inactive	557 (63.9)	585 (62.0)
	Less active	118 (13.5)	142 (15.0)
	Most active	197 (22.6)	217 (23.0)
68-69y			
	Inactive	491 (57.1)	520 (56.7)
	Less active	101 (11.7)	141 (15.4)
	Most active	268 (31.2)	256 (27.9)

**Symptoms of anxiety and depression, N(%), at age:**

36y	No	1482 (96.2)	1420 (91.4)
	Yes	58 (3.8)	133 (8.6)
43y			
	No	1350 (91.0)	1233 (84.6)
	Yes	133 (9.0)	224 (15.4)
53y			
	No	1147 (86.1)	1035 (75.7)
	Yes	185 (13.9)	333 (24.3)
60-64y			
	No	765 (87.7)	739 (78.3)
	Yes	107 (12.3)	205 (21.7)
69y			
	No	781 (90.8)	764 (83.3)
	Yes	79 (9.2)	153 (16.7)

SD: Standard Deviation; y: years

<sup>a</sup> Maximum N=3426 (this includes participants with a valid measure of back pain, BMI, waist circumference and each covariate for at least one age)

<sup>b</sup> See number of participants with valid data at specified age in Supplementary Table S1

**Table S3: Coefficients from the multilevel models for standardised BMI and waist circumference with back pain across adulthood (N=3426)**

	<b>BMI</b>			
	<b>Model 1</b>		<b>Model 2<sup>a</sup></b>	
	<b>Log-odds (SE)</b>	<b>P value</b>	<b>Log-odds (SE)</b>	<b>P value</b>
BMI (per SD)	0.119 (0.071)	0.03	0.112 (0.056)	0.05
Sex (female)	0.221 (0.072)	0.002	0.500 (0.102)	<0.001
Age 43	0.683 (0.073)	<0.001	0.674 (0.074)	<0.001
Age 53	1.008 (0.074)	<0.001	0.993 (0.076)	<0.001
Age 60-64	0.869 (0.083)	<0.001	0.895 (0.087)	<0.001
Age 68	0.786 (0.084)	<0.001	0.876 (0.088)	<0.001
Age 43*BMI	-0.019 (0.071)	0.8	-0.009 (0.071)	0.9
Age 53*BMI	0.037 (0.072)	0.5	0.045 (0.072)	0.5
Age 60-64*BMI	0.148 (0.082)	0.07	0.148 (0.081)	0.07
Age 68*BMI	-0.040 (0.084)	0.6	-0.046 (0.084)	0.6

	<b>Waist circumference</b>			
	<b>Model 1</b>		<b>Model 2<sup>a</sup></b>	
	<b>Log-odds (SE)</b>	<b>P value</b>	<b>Log-odds (SE)</b>	<b>P value</b>
WC (per SD)	0.160 (0.057)	0.005	0.129 (0.057)	0.02
Sex (female)	0.221 (0.071)	0.002	0.442 (0.102)	<0.001
Age 43	0.684 (0.073)	<0.001	0.674 (0.074)	<0.001
Age 53	1.010 (0.074)	<0.001	0.990 (0.076)	<0.001
Age 60-64	0.875 (0.083)	<0.001	0.896 (0.087)	<0.001
Age 68	0.787 (0.084)	<0.001	0.867 (0.088)	<0.001
Age 43*WC	-0.048 (0.072)	0.5	-0.049 (0.072)	0.5
Age 53*WC	-0.011 (0.073)	0.9	-0.009 (0.073)	0.9
Age 60-64*WC	0.076 (0.083)	0.4	0.063 (0.083)	0.5
Age 68*WC	-0.050 (0.084)	0.6	-0.058 (0.084)	0.5

Note. BMI: body mass index; WC: waist circumference; SE: standard error; SD: Standard Deviation

As BMI and WC are standardised and so have a mean of 0 and SD of 1, the main effects of age represent the estimate at the mean BMI

<sup>a</sup> Model 2: model 1 + education, occupational class and time-varying covariates (height, cigarette smoking status, physical activity and symptoms of anxiety and depression)

**Table S4: Associations between body composition measures<sup>a</sup> at age 60-64 and back pain at age 68 (n=1186)**

Sex-standardised body composition measures	Model 1 <sup>b</sup>		Model 2 <sup>c</sup>	
	Odds ratio (95%CI)	P value	Odds ratio (95%CI)	P value
Lean mass index	0.93 (0.79, 1.10)	0.4	0.91 (0.77, 1.08)	0.3
Fat mass index	1.23 (1.04, 1.45)	0.01	1.24 (1.04, 1.47)	0.02

<sup>a</sup>Assessment of body composition measures has been described in detail by Bann et al[1]

<sup>b</sup> Model 1: includes sex, lean mass index and fat mass index

<sup>c</sup> Model 2: model 1 + education at age 26, occupational class at age 53 and the following covariates (assessed at age 60-64): height, cigarette smoking status, physical activity and symptoms of anxiety and depression

**Table S5: Odds Ratios (OR) of back pain at each age per 1 kg/m<sup>2</sup> increases in BMI and 1 cm increases in waist circumference at the same age estimated from multilevel logistic models (12 326 observations nested within 3426 individuals)**

BMI				
	Model 1 <sup>a</sup>		Model 2 <sup>b</sup>	
Per kg/m <sup>2</sup> BMI at:	OR (95% CI)	P value	OR (95% CI)	P value
36y	1.03 (1.00,1.07)	0.04	1.03 (1.00,1.06)	0.05
43y	1.02 (1.00,1.05)	0.06	1.03 (1.00,1.05)	0.05
53y	1.04 (1.01,1.06)	0.002	1.04 (1.01,1.06)	0.002
60-64y	1.06 (1.03,1.08)	<0.001	1.05 (1.03,1.08)	<0.001
68y	1.02 (0.99,1.04)	0.2	1.02 (0.99,1.04)	0.2
Waist circumference				
	Model 1 <sup>a</sup>		Model 2 <sup>b</sup>	
Per cm WC at:	OR (95% CI)	P value	OR (95% CI)	P value
36y	1.014 (1.004,1.023)	0.005	1.011 (1.001,1.020)	0.03
43y	1.011 (1.002,1.020)	0.01	1.008 (0.999,1.017)	0.07
53y	1.013 (1.005,1.021)	0.002	1.011 (1.002,1.019)	0.01
60-64y	1.019 (1.009,1.030)	<0.001	1.016 (1.006,1.026)	0.002
68y	1.009 (0.999,1.019)	0.07	1.006 (0.996,1.015)	0.3

*Note.* BMI: body mass index; OR: Odds Ratio; y: years

<sup>a</sup> Model 1: Includes age as a categorical variable, BMI or WC and an age by BMI or age by WC interaction (as appropriate), adjusted for sex (as there was no evidence of a sex by BMI ( $p=0.5$ ) or sex by WC ( $p=0.7$ ) interaction)

<sup>b</sup> Model 2: Includes age as a categorical variable, BMI or WC and an age by BMI or age by WC interaction (as appropriate), adjusted for sex, education, occupational class and time-varying covariates (height, cigarette smoking status, physical activity and symptoms of anxiety and depression)



**Table S6: Odds Ratios (OR) of back pain at each age per 1 kg/m<sup>2</sup> increase in BMI and 1 cm increase in waist circumference at the previous age estimated from multilevel logistic models (8 595 observations nested within 3044 individuals)**

		BMI			
		Model 1 <sup>a</sup>		Model 2 <sup>b</sup>	
Per kg/m <sup>2</sup> BMI at age:	Back pain at age:	OR (95% CI)	P value	OR (95% CI)	P value
36y	43y	1.02 (0.99, 1.05)	0.1	1.02 (0.99, 1.05)	0.2
	43y	1.04 (1.02, 1.07)	0.002	1.04 (1.02, 1.07)	0.004
	60-64y	1.06 (1.03, 1.09)	<0.001	1.05 (1.02, 1.08)	<0.001
60-64y	68y	1.02 (0.99, 1.05)	0.2	1.02 (0.99, 1.05)	0.3
		Waist circumference			
		Model 1 <sup>a</sup>		Model 2 <sup>b</sup>	
Per cm WC at age:	Back pain at age:	OR (95% CI)	P value	OR (95% CI)	P value
36y	43y	1.012 (1.002,1.021)	0.01	1.009 (0.999, 1.018)	0.07
	53y	1.015 (1.006, 1.025)	0.001	1.013 (1.004, 1.022)	0.005
	60-64y	1.019 (1.009, 1.030)	<0.001	1.016 (1.005, 1.026)	0.003
60-64y	68y	1.007 (0.996, 1.019)	0.2	1.004 (0.993, 1.015)	0.5

*Note.* BMI: body mass index; SD: Standard Deviation; OR: Odds Ratio; y: years

<sup>a</sup> Model 1: Includes age as a categorical variable, BMI or WC and an age by BMI or age by WC interaction (as appropriate), adjusted for sex (as there was no evidence of a sex by BMI (p=0.7) or sex by WC (p=0.9) interaction)

<sup>b</sup> Model 2: Includes age as a categorical variable, BMI or WC and an age by BMI or age by WC interaction (as appropriate), adjusted for sex, education, occupational class and time-varying covariates (height, cigarette smoking status, physical activity and symptoms of anxiety and depression)

## References

1. Bann D, Kuh D, Wills AK, et al. Physical activity across adulthood in relation to fat and lean body mass in early old age: Findings from the Medical Research Council National Survey of Health and Development, 1946–2010. *Am J Epidemiol.* 2014;179:1197-207.