Effect of Occupational Physical Activities on Vertebral Dimensions in Midlife in the Northern Finland Birth Cohort 1966

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WHAT THIS PAPER ADDS

- Leisure-time physical activity (LTPA) is known to affect vertebral size, whereas the relation between occupational physical activity (OPA) and vertebral dimensions has been poorly studied.
- In our birth cohort sample of 712 participants, we found no consistent association between OPA at 31-46 years of age and vertebral size in middle age among either sex.
- The present findings suggest that differences exist between LTPA and OPA in terms of vertebral response.
- Furthermore, our results add to the evidence distinguishing between occupational and leisure-time physical activity as predictors of health.

ABSTRACT

Objectives: The vertebral cross-sectional area (CSA) is a major determinant of vertebral strength. As leisure-time physical activity (LTPA) is known to affect vertebral CSA, we hypothesized that engagement in physical activity at work might have similar effects on vertebral size. We aimed to examine the association between various adulthood occupational physical activities (OPA) and vertebral CSA, and to evaluate the association between OPA intensity and vertebral CSA.

Methods: We used the prospective population-based Northern Finland Birth Cohort 1966. Our sample consisted of 712 participants with a mean age of 46.8 years. We assessed their engagement in various individual physical work activities at the ages of 31 and 46, and created overall OPA categories (high, moderate & low intensity), which we used in the analyses to study their association with vertebral CSA in middle age. Linear regression was used as the statistical method with adjustments for LTPA, vertebral height, BMI and smoking.

Results: A statistically significant association was found between occupational sitting and smaller vertebral CSA in men, but only at the age of 31 (49.2 mm² smaller among those who sit often vs. rarely [95% confidence interval -96.0...-2.4]). No significant differences were detected between OPA categories and vertebral CSA ($p > 0.05$). Thus we found no consistent association between OPA and vertebral size among either sex.

Conclusions: Occupational physical activity seems to have very little effect on vertebral size. Our results suggest that the effect of LTPA on vertebral size is different to that of OPA.

INTRODUCTION

Osteoporosis is a bone deficiency disease that leads to decreased strength and amount of bone, beyond the normal decline in later life[1-3]. A systematic review recently suggested that small vertebral size is an independent risk factor for vertebral fractures,[4] and therefore further knowledge on its determinants would be beneficial for the prevention of osteoporosis.

Physical activity has the potential to induce osteogenic responses in the bone, thus increasing bone size and reducing bone loss[3]. As for vertebrae, biomechanical strain is reported to increase their dimensions not only during growth but throughout life[5]. We have previously reported an association between lifelong leisure-time physical activity (LTPA) and increased vertebral dimensions among women[6]; as this finding was relatively moderate in size, we hypothesized that physical activity during working hours might strengthen the association.

We only found one study[7] that investigated the association between vertebral dimensions and occupational physical activity (OPA). In a Swedish sample of 61 men and 61 women aged 22 to 85, high questionnaire-derived levels of OPA were associated with smaller bone area in the lumbar spine among men than that among controls with low OPA. A few studies[8-14] have also evaluated the association between bone mineral density in the lumbar spine and OPA, with controversial results.

In the present study, we aimed to examine the association between OPA during adulthood and vertebral dimensions in midlife in the Northern Finland Birth Cohort 1966. We assessed various

occupational physical activities at the ages of 31 and 46 and vertebral dimensions at 47 years of age. We hypothesized that high intensity occupational physical activities were associated with increased vertebral size.

MATERIALS AND METHODS

Study population

The Northern Finland Birth Cohort 1966 (NFBC1966) is a prospective population-based cohort study from birth onwards[15]. The population initially consisted of pregnant women living in the two northernmost provinces of Finland (Oulu and Lapland) with expected dates of delivery from Jan 1st to Dec 31st, 1966 (n = 12 068 mothers, n = 12 231 children, 96% of all births during 1966 in the area). The mothers and their children have been followed since 1966.

Progression of the study

When the cohort members were 31 and 46 years of age, i.e. in 1997–1998 and 2012–2014, postal questionnaires were sent to all those whose addresses were known. The questionnaires were used to enquire about the participants' health status, medication and lifestyle habits. The response rates were 75% at the age of 31 (n = 8 767) and 66% at the age of 46 (n = 6 825). At the age of 46, participants with known addresses in Finland (n = 10 321) were invited to take part in clinical examinations, and to fill in a questionnaire. A total of 5 861 (57%) participants attended.

Those who attended the clinical examinations and lived in the Oulu region (within 100 km of the city of Oulu; n = 1 988) were additionally invited to undergo lumbar magnetic resonance imaging (MRI). The MRI study population consisted of 1 540 participants, as 448 participants (23% of those invited) did not participate in the imaging due to 1) no show (n = 409), 2) claustrophobia (n = 35), 3) severe obesity preventing the use of the machine (n = 3), or 4) a pacemaker (n = 1). After the imaging, 828 participants (42% of those initially invited) were excluded from the study due to 1) difficulties in measuring vertebral dimensions (segmentation error, severe disc degeneration, endplate erosions, presence of spondylodesis or Schmorl's nodes; n = 159), 2) bone-affecting

medication (calcium supplements and/or osteoporosis medication; $n = 42$), and 3) missing data on occupational activities (due to e.g. unemployment) or any of the covariates at either 31 or 46 years ($n = 627$). Therefore, the final eligible population was $N = 712$ participants (36% of those initially invited to MR imaging).

Lumbar magnetic resonance imaging and vertebral dimensions

We performed MRI scans using a 1.5-T imaging system (Signa HDxt, General Electric, Milwaukee, WI) between 2012 and 2014, when the participants were on average 47 years old. The imaging sequences followed routine lumbar spine protocol, including T2-weighted fast-recovery fast spin-echo (frFSE) images in sagittal (TR/effTE 3500/112 ms, 4 averages, FOV 280x280 mm, acquisition matrix 448x224, slice thickness 3 mm with 1 mm interslice gap) and transverse planes (TR/effTE 3600/118 ms, 4 averages, FOV 180x180 mm, acquisition matrix 256x224, slice thickness 4 mm with 1 mm interslice gap).

Using the MR images, we measured eight dimensions (in millimetres, mm) from the corpus of the fourth lumbar vertebra (L4) to calculate the axial cross-sectional area (mm^2) and mean height (mm) of L4 (**Figure 2**). Vertebral height dimensions (anterior height, posterior height, minimum height) were measured using the sagittal view and the most medial slice that was available. Width dimensions, i.e. minimum mediolateral width and maximum mediolateral width, were measured using the appropriate axial MRI slices, which varied between participants. Typically, the minimum width was encountered near the middle part of the vertebra and the maximum width near either the superior or inferior end of the vertebra. Depth dimensions, i.e. anteroposterior dimensions, were measured using axial slices. The superior depth dimension was measured using the most superior appropriate slice just before the intervertebral disc. Correspondingly, the inferior depth dimension was measured using the most inferior slice possible. In order to measure the middle depth

dimension, we chose the slice that existed halfway between the superior and inferior ends of the vertebra.

CSA values were calculated using the acknowledged formula $CSA = \pi * a * b$, where a = vertebral width/2 and b = vertebral depth/2[16]. We used the mean of maximum and minimum mediolateral dimensions as the width dimension, and the mean of superior, inferior and middle anteroposterior dimensions as the depth dimension (**Figure 2**). We also used vertebral height as a covariate in the analyses. This height dimension we calculated as the mean of anterior, posterior and minimum height dimensions of L4.

The same researcher took all the MRI measurements, using NeaView Radiology software (Neagen Oy, Oulu, Finland) version 2.31. The measurements were made prior to gathering or analysing any other data regarding the participants.

Intra-rater reliability and measurement error

In order to calculate the intraclass correlation coefficient (ICC) and measurement errors, 400 MRI measurements were taken for a second time by the original measurer, as described in our previous paper.[6]

Assessment of occupational physical activities

Engagement in various physical activities at work was self-reported at 31 and 46 years of age, i.e. in 1997–1998 and 2012–2014, via identical surveys. The participants were asked how often they engaged in various physical tasks/activities when working. The activities were: 1) hard physical

labour that is strenuous for the whole body, 2) repetitive movements, 3) standing in one place, 4) leaning forward, 5) having to twist your back, 6) constant moving or walking from one place to another, 7) lifting loads of 1–15kg, 8) lifting loads of >15kg, 9) working with upper limbs raised so that your arm is above your shoulder, and 10) sitting still. The response alternatives for each activity were a) never or very rarely, b) rarely, c) occasionally, d) often, and e) very often. The response alternatives were dichotomized as follows: performed rarely (Options a to c) or performed often (d and e).

To obtain a classification for OPA intensity, we decided beforehand to focus on the highly intense tasks 1, 6 and 8[17-19]. The participants who had performed at least one of these tasks often or very often (Options d or e) at both 31 and 46 years were classified as the high intensity group (**Figure 1**). Those who had performed none of the highly intense tasks often, at both 31 and 46 years (Options a to c), formed the low intensity group, and the rest belonged to the moderate intensity group.

Assessment of smoking, body mass index and leisure-time physical activity

Smoking habits were elicited at 46 years using two questions: 1) “Have you ever smoked cigarettes (yes/no)?” and 2) “Do you currently smoke (yes/no)?” Three categories were formed on the basis of the answers: 1) non-smoker, 2) former smoker, and 3) current smoker. Body mass index (BMI, kg/m²) at the age of 46 was calculated for each participant using height and weight values that were systematically measured by a trained study nurse as part of the clinical examinations.

LTPA was self-reported at the age of 46. The participants were asked how often they participated in brisk physical activity/exercise during their leisure-time. The term 'brisk' was defined as physical activity causing at least some sweating and getting out of breath, corresponding to moderate-to-

vigorous intensity. The response alternatives were: 1) daily, 2) 4–6 times a week, 3) 2–3 times a week, 4) once a week, 5) 2–3 times a month, and 6) once a month or less often. Alternatives 1 and 2 were combined into one category (“ ≥ 4 times per week”), as the number of respondents was small, and other categories were kept as-is.

Statistical analyses

We used multivariable linear regression modelling in the analyses. Vertebral size, i.e. the CSA of L4 (continuous variable), was regarded as the dependent variable in all analyses, while occupational physical task variables acted as the explanatory variables. As the vertebral CSA[20] and occupational physical demands at work[21] were *a priori* known to differ between sexes, we expected a significant interaction, and therefore performed all analyses separately for men and women.

First, we aimed to confirm our hypothesis that high intensity occupational physical tasks would be associated with increased vertebral dimensions. We investigated this by comparing the high and moderate intensity groups to the low intensity group, which acted as the reference category, in terms of vertebral CSA. Adjustments for vertebral height, BMI, smoking and LTPA were also included in the model.

Our second aim was to investigate how various physical activities at work associated with vertebral dimensions. For this purpose, we included all specific tasks at both time points in one analysis. This way 1) different tasks and 2) different time points of the same task acted as covariates for each other, and we were able to detect how each task individually associated with vertebral CSA.

Adjustments for vertebral height, BMI, smoking and LTPA were also included in the model. Each physical activity variable was dichotomized, and the “performed often” category was compared to the “performed rarely” category, which formed the reference category.

The analyses contained adjustments for the known determinants of vertebral size[4-6, 22]: 1) the height of the L4 vertebra, continuous variable; 2) BMI at 46 years, continuous variable; 3) lifetime smoking status determined at 46 years, categorical variable; and 4) leisure-time physical activity at 46 years, categorical variable.

Beta estimates of the explanatory variables were gathered with their 95% confidence intervals.

Statistical analyses were conducted using the SPSS software (IBM, Armonk, NY, USA) version 22, 64-bit edition.

As the exclusion rate was high, the representativeness of our sample was evaluated. The characteristics of the participants of this study were compared to the rest of the cohort, which provides the best available estimation of the Northern Finnish population, using the chi-squared test for categorical variables and the independent-samples t-test for continuous variables. Analyses of each sex were conducted separately.

Ethics

The study adheres to the principles of the Declaration of Helsinki with voluntary participation and signed informed consents at each stage. The data were handled on a group level and personal details

were replaced by identification codes. The Ethics Committee of the Northern Ostrobothnia Hospital District approved the research.

RESULTS

Our sample consisted of 712 participants, 49.7% of whom were men and 50.3% women (**Table 1**). The mean age of the participants was 46.8 (standard deviation 0.4, range 45.8-47.8 years) years at MR imaging. According to the World Health Organization's BMI classification, 33% of men and 46% of women were within the normal weight range. Most participants had never smoked regularly in their lives, and were physically active at least two times per week (**Table 1**).

Table 1. Characteristics of participants.

	% (N)	
	Men N = 354 49.7%	Women N = 358 50.3%
Age at imaging, years; mean (SD)	46.8 (0.4)	46.7 (0.4)
Cross-sectional area of the L4 vertebra, cm ² ; mean (SD)	13.3 (1.7)	10.6 (1.3)
Height of L4, cm; mean (SD)	2.8 (0.1)	2.7 (0.1)
Height, cm; mean (SD)	178.9 (5.9)	165.0 (5.8)
Weight, kg; mean (SD)	85.8 (11.6)	71.0 (13.9)
BMI, mean (SD)	26.9 (3.4)	26.3 (5.2)
BMI, classified (WHO)		
<18.5	0.3 (1)	0.8 (3)
18.5–24.9	32.5 (115)	45.8 (164)
25.0–29.9	49.4 (175)	32.7 (117)
≥30	17.8 (63)	20.7 (74)
Smoking		
Non-smoker	51.7 (183)	58.9 (211)
Former	33.6 (119)	27.1 (97)
Current	14.7 (52)	14.0 (50)
LTPA, participation frequency		
Once a month or less	13.8 (49)	10.9 (39)
2–3 times/month	12.1 (43)	11.5 (41)
Once a week	23.7 (84)	17.3 (62)
2–3 times/week	36.4 (129)	41.1 (147)
≥4 times/week	13.8 (49)	19.0 (68)
Intensity of occupational physical activity		
Low	37.6 (133)	33.5 (120)

Moderate	26.0 (92)	33.2 (119)
High	36.4 (129)	33.2 (119)

SD = Standard deviation, BMI = Body Mass Index, WHO = World Health Organization, LTPA = Leisure-time physical activity

Performing repetitive motions and sitting still were the most common occupational physical tasks reported by the participants in our sample (**Table 2**). In all, 36% of men and 33% of women belonged to the high intensity OPA group, and 38% and 34% to the low intensity OPA group, respectively (**Table 1**).

Table 2. Self-rated prevalence of various occupational physical activities.

	At 31 years % (N)		At 46 years % (N)	
	Men	Women	Men	Women
Hard physical labour				
Rarely	72.9 (258)	80.2 (287)	81.6 (289)	80.2 (287)
Often	27.1 (96)	19.8 (71)	18.4 (65)	19.8 (71)
Repetitive movements				
Rarely	52.0 (184)	43.3 (155)	56.8 (201)	44.7 (160)
Often	48.0 (170)	56.7 (203)	43.2 (153)	55.3 (198)
Standing in one place				
Rarely	81.9 (200)	74.6 (267)	86.2 (305)	82.1 (294)
Often	18.1 (64)	25.4 (91)	13.8 (49)	17.9 (64)
Leaning forward				
Rarely	68.1 (241)	57.0 (204)	72.9 (258)	59.8 (214)
Often	31.9 (113)	43.0 (154)	27.1 (96)	40.2 (144)
Twisting one's back				
Rarely	76.0 (269)	63.1 (226)	78.5 (278)	65.4 (234)
Often	24.0 (85)	36.9 (132)	21.5 (76)	34.6 (124)
Constant moving				
Rarely	50.3 (178)	44.7 (160)	62.7 (222)	62.8 (225)
Often	49.7 (176)	55.3 (198)	37.3 (132)	37.2 (133)
Lifting loads of 1–15 kg				
Rarely	58.5 (207)	66.5 (238)	67.8 (240)	72.9 (261)
Often	41.5 (147)	33.5 (120)	32.2 (114)	27.1 (97)

Lifting loads of >15 kg				
Rarely	75.1 (266)	86.9 (311)	80.8 (286)	86.9 (311)
Often	24.9 (88)	13.1 (47)	19.2 (68)	13.1 (47)
Working with upper limbs raised				
Rarely	87.9 (311)	91.3 (327)	85.3 (302)	91.6 (328)
Often	12.1 (43)	8.7 (31)	14.7 (52)	8.4 (30)
Sitting still				
Rarely	48.0 (170)	53.9 (193)	39.8 (141)	47.8 (171)
Often	52.0 (184)	46.1 (165)	60.2 (213)	52.2 (187)

In this sample, the mean cross-sectional area of L4 was 13.3 (standard deviation 1.7) cm² among men and 10.6 (1.3) cm² among women (**Table 1**). The level of intra-rater reliability was high (ICC = 0.963), and the values of relative measurement error (%) were distributed normally around the mean of 0.0, with a standard deviation of 4.9. According to our analysis of representativeness, the sample of this study did not differ from those excluded in terms of height, weight, BMI, vertebral CSA, vertebral height, LTPA and OPA intensity ($p > 0.05$). Among men, occupational sitting and back twisting were slightly more frequent in the current sample than among those excluded at both 31 and 46 years ($0.02 < p < 0.05$). Among women, working with the upper limbs raised at 31 years was somewhat more common in the current sample ($p = 0.03$). Importantly, there were fewer current smokers in our sample compared to the rest of the population (14.7% vs. 25.9% among men, $p < 0.001$; 14.0% vs. 19.6% among women, $p < 0.05$).

We found no association between OPA intensity categories and vertebral CSA among men or women (**Table 3**). There was also no association between specific work tasks and vertebral cross-sectional area at either 31 or 46 years; with the exception of sitting still at 31 years, which was associated with smaller vertebral size among men (0.49 cm² smaller, $p = 0.04$). However, this association no longer persisted at 46 years (**Table 3**).

Table 3. Beta coefficients from linear regression models presenting how occupational physical tasks at 31 and 46 years of age and lifetime occupational intensity categories associate with vertebral CSA in midlife.

	Men		Women	
	At 31 years	At 46 years	At 31 years	At 46 years
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Hard physical labour				
Rarely (ref)				
Often	-24.7 (-80.5; 31.1)	-37.6 (-100.2; 24.9)	-11.8 (-57.4; 33.9)	-16.2 (-65.1; 32.7)
Repetitive movements				
Rarely (ref)				
Often	26.7 (-13.4; 66.8)	9.8 (-29.1; 48.8)	28.9 (-4.1; 62.0)	7.0 (-26.0; 39.9)
Standing in one place				
Rarely (ref)				
Often	-8.9 (-59.2; 41.4)	-1.0 (-58.2; 56.1)	-5.4 (-40.3; 29.5)	-32.0 (-73.0; 9.0)
Leaning forward				
Rarely (ref)				
Often	11.2 (-35.3; 57.7)	-26.2 (-82.4; 30.0)	-27.7 (-61.2; 5.8)	2.8 (-34.0; 39.7)
Twisting one's back				
Rarely (ref)				
Often	11.1 (-42.4; 64.6)	46.2 (-20.6; 113.0)	10.4 (-24.8; 45.7)	-43.4 (-89.2; 2.3)
Constant moving				
Rarely (ref)				
Often	19.4 (-25.5; 64.3)	14.0 (-34.7; 62.7)	1.7 (-31.3; 34.6)	12.5 (-30.4; 55.4)
Lifting loads of 1–15kg				
Rarely (ref)				
Often	-31.4 (-85.3; 22.6)	-42.3 (-38.6; 15.4)	-0.0 (-38.4; 38.4)	37.2 (-6.7; 81.1)
Lifting loads of >15kg				
Rarely (ref)				
Often	-15.3 (-77.4; 46.8)	28.6 (-38.6; 95.9)	22.6 (-27.3; 72.4)	-4.1 (-59.0; 50.8)
Working with upper limbs raised				
Rarely (ref)				
Often	28.5 (-31.0; 88.0)	-7.6 (-71.7; 56.4)	-9.7 (-62.4; 43.0)	-7.4 (-62.3; 47.5)
Sitting still				
Rarely (ref)				
Often	-49.2 (-96.0; -2.4)	2.4 (-44.2; 49.0)	-18.4 (-56.1; 19.3)	-16.1 (-54.6; 22.4)
	Lifelong		Lifelong	
	β (95% CI)		β (95% CI)	
Intensity of occupational physical activity				
Low (ref)				
Moderate	6.9 (-36.0; 49.8)		-14.0 (-46.4; 18.4)	
High	9.3 (-29.9; 48.6)		17.8 (-14.8; 50.3)	

Covariates: vertebral height, BMI, smoking and LTPA
β = Beta estimate (mm²), CI = Confidence interval, LTPA = Leisure-time physical activity

DISCUSSION

This population-based birth cohort study enabled us to investigate whether physical work-related activities would increase vertebral cross-sectional area until midlife. We found no consistent associations between occupational physical activities and vertebral size in either sex.

We detected an association between occupational sitting at 31 years and decreased vertebral size in men. However, this finding lacked consistency and may have occurred by chance; previous studies[10, 12, 14] have detected no analogous findings. Only one study has previously evaluated the association of OPA and vertebral size[7] with results in accordance to our findings, and thus it seems that OPA and vertebral size are not related. We conclude that we were unable to confirm our hypothesis in this study, i.e. to show any association between OPA and vertebral size, in either sex.

In contrast, in our earlier work we have been able to show an association between LTPA and increased vertebral size among women[6]. The present findings thus raise questions as to whether LTPA and OPA differ from each other in terms of vertebral response. Importantly, our results were adjusted for LTPA.

Biomechanical loading during adolescence and especially during the growth period is important for achieving high bone quality and peak bone mass[23]. One key difference between OPA and LTPA might be the fact that leisure-time sports activities are typically begun at a young age, whereas occupational physical activities occur at an older age. It is interesting that contrary to LTPA, less educated people and those from ethnic minorities report higher levels of OPA[24]. It is also worth

noting that OPA, unlike LTPA, has not been favourably associated with obesity, cardiovascular diseases or overall health concerns[25-27]. Indeed, our results add to the recent evidence distinguishing between occupational and leisure-time physical activity as predictors of health[28-30].

The main strengths of this study stem from its longitudinal setting in a large, well-characterized population-based birth cohort, representing all branches of working life and minimizing the confounding effect of age. In this 46-year follow-up study, the participants had reached their skeletal maturity and peak bone mass, increasing the likelihood of observing possible long-term effects of biomechanical loading on vertebral bone. We were able to inspect occupational physical activity at two time points 15 years apart.

Inevitably, some selection resulted from the requirement of being employed at both time points, i.e. at the age of 31 and 46. According to the analysis of representativeness, our sample was representative of the Northern Finnish population, although our sample had significantly fewer current smokers than the excluded group. We suggest that this is due to the strong correlation between smoking and unemployment,[31, 32] and have included adjustments for smoking status in all analyses.

Moreover, although the use of questionnaires eliciting participants' occupational physical activity levels is common in OPA studies,[7, 8, 13] it may be considered a potential weakness of this study. Relative response alternatives, such as a) never or very rarely, b) rarely, c) occasionally, d) often, and e) very often, are problematic in terms of comparability between participants. We aimed to reduce this source of error by dichotomizing the response data (i.e. a-c/d-e) and using only the

dichotomized data in our analyses. In addition, some of the activities used in the questionnaires may have been difficult to evaluate. “Hard physical labour that is strenuous for the whole body” and “constant moving or walking from one place to another” might have been easier for the participants to judge as compared to differentiating between “lifting loads of 1–15” kg and “lifting loads of >15 kg”.

We utilized the fourth lumbar vertebra (L4) as our vertebra of interest, as it is typically more stable than L5[6]. We have previously demonstrated the high accuracy of MRI in measuring vertebral size[33]. However, the location and orientation of L4 varies among individuals, and this may have affected our orientation of the MRI slices, adding to measurement error. We had no longitudinal MRI data on the participants’ lumbar spine, and were consequently limited to studying associations across the population instead of investigating actual changes in vertebral size.

We conclude that occupational physical activities were not associated with vertebral size in either sex. In contrast to the previous evidence on the beneficial effects of leisure-time physical activity, it would thus seem that occupational physical activity has very little effect on vertebral size.

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COMPETING INTERESTS

The authors declare no competing interests.

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FIGURE LEGENDS

Figure 1. Classification of participants into high, moderate and low intensity groups.

Figure 2. Measured vertebral dimensions: Depth, i.e. anteroposterior length of vertebra superiorly (Measurement 1), halfway (not shown) and inferiorly (not shown); maximum mediolateral width (Measurement 2) and minimum mediolateral width (Measurement 3) of vertebra; height of vertebra posteriorly (Measurement 4) and anteriorly (Measurement 6), and minimum height dimension between them (Measurement 5).

High-intensity occupational physical tasks:

- 1) Hard physical labour, 2) Constant moving, 3) Lifting loads of >15kg

At 31 years

At 46 years

At least one high-intensity task encountered often or very often

"High" group

At least one high-intensity task encountered often or very often

"Moderate" group

All high-intensity tasks encountered very rarely, rarely or occasionally

"Low" group

All high-intensity tasks encountered very rarely, rarely or occasionally