Achtergronddocument

Beroepsgebonden lumbosacraal radiculairsyndroom

Registratierichtlijn D023

CAS code L621 HNP L4-L5 / L5-S1

Nederlands Centrum
voor Beroepsziekten

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Cascode L621 HNP L4-L5 HNP L5-S1

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I Omschrijving

De incidentie van het lumbosacraal radiculair syndroom (LRS) in Nederland, gemeten volgens de International Classification of Primary Care en gedefinieerd als lage rugpijn met uitstraling, bedraagt in de huisartspraktijk 9 per 1000 patiënten per jaar (95%BI (betrouwbaarheidsinterval) 8,4-10,2). Dit is ongeveer éénderde van die van lage rugpijn zonder uitstraling (26,6/1000/jr) (Van der Linden 2004). De aandoening komt bij vrouwen iets meer voor dan bij mannen (9,8/1000/jr vs. 8,7/1000/jr) en de incidentie neemt geleidelijk toe met de leeftijd. Onder de 14 jaar komt LRS nauwelijks voor, de piek ligt in de leeftijdscategorie 45-64 jaar (16/1000/jr). Boven het 65^{e} levensjaar schommelt de incidentie rond de 11/1000/jr. Met betrekking tot de prevalentie in de huisartspraktijk valt dezelfde trend naar leeftijd waar te nemen als bij de incidentie: gemiddeld 15 per 1000 patiënten. De hoogste prevalentie valt ook hier in de leeftijdscategorie 45-64 jaar (28/1000, mannen en vrouwen ongeveer gelijk).

II Klinische diagnostiek

Het lumbosacraal radiculair syndroom wordt gedefinieerd als (Nederlandse Vereniging voor Neurologie 2008): in de bil en/of het been uitstralende pijn, vergezeld van één of meerdere symptomen of verschijnselen die suggestief zijn voor een aandoening van een specifieke lumbosacrale zenuwwortel. Aangezien een gouden standaard voor een zenuwwortelaandoening ontbreekt, komt de definitie van deze syndroomdiagnose voort uit overeenstemming van deskundigen. Voor deze beroepsziekteregistratierichtlijn is de definitie van de Nederlandse Vereniging voor Neurologie (2008) gehanteerd: een klinisch zekere wortelaandoening met of zonder radiologisch substraat. Voor de diagnostiek stelt de Nederlandse Vereniging voor Neurologie (2008):

- Bij de anamnese zijn de belangrijkste onafhankelijke voorspellers van een discushernia met wortelcompressie op een MRI: op de voorgrond staande pijn in het been, typisch (monoradiculaire) dermatomere pijn en toename van pijn in het been bij drukverhogende momenten;
- Het lichamelijk onderzoek heeft geringe toegevoegde waarde wanneer bovenstaande anamnestische factoren worden vastgesteld;
- Bij het lichamelijk onderzoek (volgende op de anamnese) zijn spierzwakte, en vinger-vloer afstand >25 cm onafhankelijke voorspellers van wortelcompressie op MRI;
- De proef van Lasègue heeft een lage tot matige sensitiviteit en specificiteit. De proef van Lasègue heeft geen toegevoegde waarde wanneer de spierkracht en vinger-vloerafstand worden onderzocht. Andere zenuwprikkelingsproeven hebben een nog lagere sensitiviteit, maar een hogere specificiteit.

III Pathogenese

De meest voorkomende oorzaak van een LRS is een lumbosacrale discushernia (Nederlandse Vereniging voor Neurologie 2008). Ander oorzaken zijn een neoplasma of Borreliainfectie of (nog) onduidelijke oorzaken (Nederlandse Vereniging voor Neurologie 2008).

IV Oorzakelijke blootstelling(en)

Persoon- en werkgebonden risicofactoren worden onderscheiden als mogelijke oorzaak voor LRS. Persoonsgebonden factoren die in meer of mindere mate in verband gebracht zijn met het risico op LRS zijn leeftijd, lichaamslengte, genetische aanleg, lichamelijke activiteiten en rookgedrag (Nederlandse Vereniging voor Neurologie, 2008). Werkgebonden risicofactoren zijn onder andere het verrichten van zwaar lichamelijk werk waarbij veelvuldig vooroverbuigen en draaien van de wervelkolom optreedt (Nederlandse Vereniging voor Neurologie, 2008). Specifieke beroepsgroepen met een verhoogd risico zijn bouwvakkers en arbeiders die met machines werken (Nederlandse

Vereniging voor Neurologie, 2008). Deze beroepsziekteregistratierichtlijn richt zich dan ook op fysieke risicofactoren in werk.

V Werkgerelateerde diagnostiek

De multidisciplinaire richtlijn LRS opgesteld onder verantwoordelijkheid van de Nederlandse Vereniging voor Neurologie (2008) beschrijft werkgebonden risicofactoren. De meest recente studies over werk als mogelijke oorzaak uit deze richtlijn zijn studies uit 2002. Om een recenter overzicht te krijgen is door het Nederlands Centrum voor Beroepsziekten een systematische literatuurstudie uitgevoerd in de literatuurbestanden Pubmed en Embase. De vraagstelling luidde: 'In welke mate hangen werkgerelateerde risicofactoren samen met LRS?' De zoektermen zijn dezelfde als gehanteerd in de richtlijn van de Nederlandse Vereniging voor Neurologie (2008). Deze zijn gecombineerd met het etiologische Yale filter en termen voor werk en professionele sport. De specifieke zoektermen staan beschreven in tabel 1. Om een compleet overzicht te verkrijgen, is ook naar literatuur voor 2002 gezocht.

Tabel 1. De gehanteerde zoekstrategie voor werkgerelateerde risicofactoren voor LRS in PubMed en Embase.

Databestand	Zoektermen
Pubmed	
LRS	((((Lumbar-Vertebrae) OR Hernia) OR Sciatic-Neuropathy) OR Sciatica) OR Intervertebral-Disk-Chemolysis) OR Intervertebral-Disk-Displacement) OR Intervertebral-Disk)) OR ((((((herni* pulposi*[Title/Abstract]) OR ((((lumbosacral OR lumbar) radiculopathy) OR radiculitis[Title/Abstract]))) OR (((lumbar OR vertebrae) AND hernia* AND (disc?? OR prolapse?)))) OR herni* lumb*[Title/Abstract]) OR herniat* dis??[Title/Abstract]) OR radicul* syndrome[Title/Abstract]))))
Risicofactor	random*[tiab] OR cohort*[tiab] OR risk*[tiab] OR causa*[tiab] OR predispos*[tiab] OR odds ratio[mh] OR case control* OR odds ratio* OR controlled clinical trial [pt] OR randomized controlled trial [pt] OR risk[mh] OR practice guideline[pt] OR epidemiologic studies[mh] OR case control studies[mh] OR cohort studies[mh] OR age factors[mh] OR comorbidity[mh] OR epidemiologic factors[mh]
Werk	Work* OR occupation* OR sport*
Embase	
LRS	Lumbar-Vertebrae Or Hernia Or Sciatic-Neuropathy Or Sciatica OR Intervertebral-Disk-Chemolysis OR Intervertebral-Disk-Displacement OR Intervertebral-Disk OR herni* pulposi* OR lumbosacral OR lumbar radiculopathy OR radiculitis OR lumbar OR ((vertebrae AND hernia* AND disc) OR prolapse OR herni* lumb* OR herniat* dis* OR radicul* syndrome
Risicofactor	random* or cohort* or risk* or causa* or predispos* or odds ratio or case control* or odds ratio* or controlled clinical trial or randomized controlled trial or risk or practice guideline or epidemiologic studies or case control studies or cohort studies or age factors or comorbidity or epidemiologic factors
Werk	sport* OR work* OR occupation*

Op 17 september 2013 is in Pubmed gezocht, dat resulteerde in 2603 artikelen. Een zoekopdracht in Embase op 24 september 2013 resulteerde in 2412 artikelen. Vervolgens zijn de volgende inclusiecriteria toegepast:

- Het betreft een studie met originele data;
- LRS is vastgesteld door een (para)medicus;
- De kwaliteit van de studie is minimaal van niveau C: cross-sectioneel vergelijkend onderzoek, prospectief of retrospectief cohort onderzoek, of patiënt-controle onderzoek (CBO 2007);
- Het kwantitatieve risico van werkgerelateerde risicofactoren voor LRS is in de studie vermeld;
- De taal is Engels of Duits.

Na inclusie bleven 22 studies over. Eén studie is in twee verschillende artikelen (Zhang 2009, 2013) beschreven en één in drie verschillende artikelen (Kelsey 1975abc). Alle 22 studies zijn in detail beschreven in bijlage I voor de volgende kenmerken: auteur, jaartal van publicatie, land, type studie, casedefinitie LRS, doelpopulatie, aantal deelnemers, definitie van werkgerelateerde risicofactor, meetmethode van werkgerelateerde risicofactor, grootte van het risico met betrouwbaarheidsinterval, en of de risicomaat is gecorrigeerd voor persoonsgebonden risicofactoren of andere mogelijk verstorende variabelen. De studies zijn afkomstig uit tien landen: Bulgarije (1), China (2), Duitsland (2), Finland (6), Frankrijk (1), Groot-Brittannië (1), Kroatië (1), Taiwan (1), Verenigde Staten van Amerika (6), en Zweden (1). Het zijn acht cross-sectionele studies met een controlegroep, twaalf patiëntcontrole studies en vier cohort studies. De mediaan van het aantal deelnemers over de studies was 1057 (range 116-15.688). De artikelen worden hieronder beschreven, verdeeld naar de onderzochte werkgerelateerde risicofactor. De aanbeveling is in samenwerking met de tweede auteur (prof. dr. Carel Hulshof) geformuleerd in de GRADE terminologie. Daarbij is onderscheid gemaakt naar type beroep, de zwaarte van het werk en specifieke activiteiten zoals tillen en dragen, buigen en draaien van de romp, besturen van een voertuig en zitten.

Beroep

Acht studies beschrijven het risico van een beroep op het optreden van een LRS (Chung 2013, Heliovaara 1987, Hrubec 1975, Kelsey 1975a, Riihimäki 1989, Roquelaure 2010, Virtanen 2007, Wahlstrom 2012). Chung (2013) vond dat Taiwanese verpleegkundigen 2,5 keer vaker (95%BI 1.8-3.4) een LRS hebben dan Taiwanezen die geen verpleegkundige zijn. Heliovaara (1987) vond een niet significant verhoogd risico van 1,5 voor verpleegkundigen en andere vrouwelijke medisch professionals. Roquelaure (2010) vond een vergelijkbaar risico als Chung (2013) bij Franse verpleegkundigen in vergelijking met de algemene bevolking (RR=2,5 95%BI 1,3-6,4).

Heliovaara (1987), Riihimäki (1989), en Wahlstrom (2012) hebben allen onderzoek gedaan bij bouwvakkers en concludeerden dat deze beroepsgroep een verhoogd risico heeft in vergelijking met andere werknemers: 3,3 ($p<0,001$) in vergelijking met administratief werk (Heliovaara 1987) en 1,4 (95%BI 1,1-1,8) in vergelijking met schilders (Riihimäki 1989). Wahlstrom (2012) heeft 19 functies van bouwvakkers vergeleken met administratief werk of voorman zijn in de bouw: het risico varieerde van 1,08 (95%BI 0,89–1,30) voor elektriciens tot en met 1,98 (95%BI 1,21–3,26) voor koelingtechnici.

Kelsey (1975a), Heliovaara (1987), Roquelaure (2011), en Virtanen (2007) onderzochten het risico bij bestuurders van voertuigen. Vrachtwagenchauffeurs hebben een 4,67 ($p<0,02$) keer zo groot risico op LRS dan niet-bestuurders van vrachtwagens (Kelsey 1975a). Heliovaara (1987) vond een 4,8 ($p<0,001$) keer zo groot risico op LRS in vergelijking met management en administratief personeel. Roquelaure vond een 3,9 keer (95%BI1,8-8,8) zo groot risico voor chauffeurs in vergelijking met de algemene bevolking. Virtanen (2007) vond dat treinmachinisten met 21 jaar blootstelling en minimaal 5 uur besturen per dag een 2,4 (95%BI 1,2-4,9) keer zo groot risico hadden op een LRS dan werknemers die vooral zittend werk verrichtten.

Voor handwerklieden varieerde het risico in de studie van Heliovaara (1987) tussen 2,7 ('Other industrial Workers') en 4,4 ('Metal or machine Workers'), van Hrubec (1975) tussen 1,55 (p≤0,001) ('Craftsmen, foremen or kindred occupation') en 1,49 (p≤0,01) ('Military occupation specialty: ground combat') en van Roquelaure (2011) tussen 2,4 (95%BI 1,4-4,0) ('Blue-collar workers') en 3,9 (95%BI 1,6-9,6) ('Unskilled manufacturing workers').

Er is sterk bewijs dat het LRS vaker voorkomt bij verpleegkundigen, bouwvakkers, bestuurders van voertuigen en geschoolde of ongeschoolde handwerklieden.

Fysieke zwaarte van het werk

Negen studies hebben het risico van de fysieke zwaarte van het werk onderzocht op het optreden van een LRS (Heliovaare 1991, Kaila-Kangas 2009, Kaila-Kangaas 2011, Kostova 2001, Saftic 2006, Seidler 2003, Seidler 2009, Zhang 2009 en Zhang 2011). De fysieke zwaarte van het werk is geoperationaliseerd op verschillende manieren in deze studies. Een somscore (0-5) wordt gevormd op basis van de aanwezigheid van vijf fysiek belastende kenmerken in het werk; zoals tillen en dragen en opgelegd werktempo (Heliovaara 1991), aantal jaren dat fysiek zwaar werk is verricht (Kaila-Kangaas 2009), specifieke blootstellingcriteria zoals handmatig verplaatsen van lasten van meer dan 20 kg minimaal 10 keer per dag (Kaila-Kangaas 2011), minimaal middelmatig zwaar werk verrichten in een kunstmestfabriek (Kostova 2001), zwaarte op basis van de functieomschrijving en fysieke intensiteit van het werk: licht, matig of zwaar (Saftic 2006), aantal jaren licht, matig of zwaar werk verrichten en cumulatieve mechanische belasting op de rug in termen van Newton•uren op basis van tillen/dragen, buigen van de romp en lichaamstrillingen (Seidler 2003), cumulatieve mechanische belasting op de rug in termen van Newton•uren gedurende 10 jaar voordat LRS is gediagnosticeerd (Seidler 2009), geen, gedeeltelijk of alleen handmatig werk verrichten (Zhang 2009), rugbelasting in termen van erg licht, licht, matig en zwaar op basis van de meest voorkomende activiteiten in het werk zoals zitten, buigen en draaien van de romp en tillen (Zhang 2009, 2011).

De resultaten van de studies laten zien dat het risico op LRS voor fysiek zwaar werk verhoogd is ten opzichte van de referentiepopulatie die geen fysiek zwaar fysiek werk verrichtte. Heliovaare (1991) vond dat een toename in de somscore voor de fysieke zwaarte van het werk resulteerde in een stijging van de OR, van 1,7 (95%BI 1,2-2,5) bij 1 punt tot en met 2,4 (95%BI 1,0-5,7) bij 5 punten. Kaila-Kangaas (2009) vond bij mannen dat 11-20 jaar blootstelling resulteerde in OR=2,37 (95%BI 1,35–4,13). Bij vrouwen was het niet significante risico verlaagd: OR=0,72 (95%BI 0,22–2,41). Kaila-Kangaas (2011) vond opnieuw dat bij mannen blootstelling aan zwaar fysiek werk resulteerde in een verhoogd risico op het optreden van LRS: OR=1,83 (95%BI 1,13–2,98).

Kostova (2001) vond dat blootstelling aan minimaal middelmatig zwaar werk in een kunstmestfabriek niet resulteerde in een verhoogd risico op het optreden van LRS: OR=0,70 (95%BI 0,42-1,16). Saftic (2006) vond dat de classificatie op basis van de functieomschrijving voor zwaar werk resulteerde in een niet significant verhoogd risico op het optreden van een LRS (OR=1,94 (95%BI 0,13-3,75)) en dat dit risico verhoogd en significant was op basis van de mate van inspanning van de zwaarte van het werk (OR=2,94 (95%BI 1,07-4,81)).

Seidler (2003 en 2009) vond in beide studies dat meer dan 10 jaar zwaar werk verrichten het risico op het optreden van een LRS verdubbelde (OR=2,1 (95%BI 0,9 to 4,6)) (2003) en dat dit zowel voor een 'matig tot hoge' cumulatieve mechanische belasting gold voor mannen en vrouwen:

- mannen: ‘matige belasting’ (5,0–<21,51*10^6Nh), OR=2,3 (95%BI 1,5–3,4) en ‘hoge belasting’ (≥21,51*10^6Nh), OR= 3,5 (95%BI 2,3–5,4);
- vrouwen: ‘matige belasting’ (4,04 – <14,47*10^6Nh), OR=2,5 (95%BI 1,6–3,9) en ‘hoge belasting’ (≥14,47*10^6Nh), OR=2,5 (95%BI 1,6–3,9).

Zhang (2009, 2011) vond dat onafhankelijk van de leeftijd het risico op het optreden van een LRS verhoogd was. De OR varieerde per leeftijdsklasse voor zwaar werk verrichten tussen 2,0 (95%BI 1,5-2,6) en 5,2 (95%BI 1,7-15,4) (Zhang 2009) en voor de gehele groep: OR=4,6 (95%BI 2,7-8,0) (Zhang 2011).

Er is sterk bewijs dat het LRS vaker optreedt na meerdere jaren zwaar fysiek werk verrichten, vooral bij mannen en vooral bij meer dan 10 jaar blootstelling.

Tillen en dragen

Vijf studies hebben het risico van tillen en dragen onderzocht op het optreden van een LRS (Kaila-Kangas 2009, Kelsey 1975c, Kelsey 1984, Seidler 2003, Seidler 2009). In al deze studies is tillen en dragen geassocieerd met een verhoogd risico op LRS. Kaila-Kangas vond dat gedurende 11-20 jaar tillen van lasten tussen de 5-20 kg gedurende meer dan 2 uur per dag resulteerde in een verhoogd risico op LRS bij mannen en bij vrouwen: OR=2,24 (95%BI 1,23–4,09) en OR=1,33 (95%BI 0,56–3,17). Voor het gedurende 11-20 jaar tillen van lasten van meer dan 20 kg minimaal 10 keer per dag was de OR=1,78 (95%BI 0,90–3,50) bij mannen en OR=0,72 (95%BI 0,22–2,41) bij vrouwen. Kelsey (1975c) vond dat beroepen waarin tillen (OR=1,25) en dragen (OR=1,13) voorkwam een niet-significant verhoogd risico hadden op LRS. Kelsey (1984) vond dat het tillen van lasten van meer dan 11,3 kg tussen de 5-25 keer per dag en vaker dan 25 keer per dag resulteerde in een verhoogd risico op LRS: RR=1,3 (95%BI 0,7-2,5) en RR=3,5 (95%BI 1,5-8,5), respectievelijk. Voor het dragen van lasten zwaarder dan 11,3 kg met de beide zelfde dagelijkse frequenties was het risico respectievelijk RR=2,1 (95%BI 1,0-4,3) en RR=2,7 (95%BI 1,2-5,8). Seidler 2003 vond geen trend (p=0,18) voor de cumulatieve belasting (kg^2*uren) door tillen en dragen van >0–10 000 kg^2*uren met een OR=0,8 (95%BI 0,3-1,8)**,** >10.000–150.000kg^2*uren, OR=1,3 (95%BI 0,6-2,8) en >150.000kg^2*uren, OR=1,6 (95%BI 0,7-3,4) vergeleken met niet tillen en dragen. Seidler (2009) vond wel een dosis-response relatie en een effect van tillen en dragen van lasten zwaarder dan 5 kg als de cumulatieve belasting werd uitgedrukt als belasting op de rug in termen van Newton•uren (Nh). Bij mannen was de OR voor de drie categorieën: 0 – <2.34*10^6Nh, 1,0 (referentie), 2,34-<8,98*10^6Nh, OR=1,5 (95%BI 1,0–2,2) en ≥8,98*10^6Nh, OR=2,8 (95%BI 1,9–4,1). Bij vrouwen was de OR voor de vier categorieën: 0 Nh, OR=1,0 (referentie), >0–<1,58*10^6Nh, OR=1,5 (95%BI 1,0–2,4), 1,58–<9,06*10^6Nh, OR=2,4 (95%BI 1,6–3,6) en ≥9,06*10^6Nh, OR=2,3 (95%1,5–3,5).

Er is sterk bewijs dat LRS vaker optreedt bij het herhaald dagelijks tillen en/of dragen van lasten zwaarder dan 5 kg, te denken valt aan meer dan 10 jaar blootstelling en/of tillen en/of dragen meer dan 2 uur per dag, of vaker dan 25 keer per dag.

Buigen en/of draaien van de romp

Vier studies hebben het risico van buigen of draaien van de romp onderzocht op het optreden van een LRS (Kaila-Kangas 2009, Kelsey 1984, Seidler 2003, Seidler 2009). Voor buigen is de relatie op het risico op LRS onderzocht in drie studies (Kaila-Kangas 2009, Seidler 2003, Seidler 2009) en voor draaien in één studie (Kelsey 1984). Kaila-Kangas vond dat gedurende 11-20 jaar meer dan 1 uur

buigen per dag resulteerde in een niet significant verhoogd risico op LRS bij mannen: OR=1,50 (95%BI 0,82–2,75) en bij vrouwen in een niet-significant verlaagd risico OR=0,91 (95%BI 0,39–2,15). Seidler 2003 vond een trend (p=0,02) voor de cumulatieve belastingsuren door meer dan 90 graden te buigen van 0 uur, OR=1,0 (referentie) en >0–1500 uren, OR=1,4 (95%BI 0,7-2,8) en >1500 uren, OR=2,7 (95%BI 1,2 to 6,4). Ook Seidler 2009 vond een relatie tussen buigen van de romp van meer dan 20 graden en het hebben van een LRS voor de cumulatieve belasting op de rug in termen van Newton•uren (Nh). Bij mannen was de OR voor de vier categorieën: 0 Nh, OR=1,0 (referentie), >0–<4,85*10^6Nh, OR=1,6 (95%BI 0,8–2,1), >4,85–14,62*10^6Nh, OR=2,3 (95%BI 1,4–3,6) en ≥14.62*10^6Nh OR=2,9 (95%BI 1,9–4,6). Bij vrouwen was de OR voor de vier categorieën: 0 Nh, OR=1,0 (referentie), >0–<2,77*10^6Nh, OR=1,9 (95%BI 1,2–3,0), >2,77–8,83 *10^6Nh, OR=2,5 (95%BI 1,6–3,8) en ≥8,83*10^6Nh, OR=3,2 (95%BI 2,1–4,9). Kelsey (1984) vond een niet significant verhoogd risico voor draaien van de romp en het risico op een LRS onafhankelijk van de frequentie per dag <5 keer RR=1,7 (95%BI 0,8-3,6), 5-25 keer RR=1,2 (95%BI 0,7-2,1), en meer dan 25 keer RR=1,3 (95%BI 0,7-2,3).

Er is matig bewijs dat LRS vaker optreedt bij het herhaald en/of langdurig dagelijks buigen van de romp, te denken valt aan meer dan 20 graden buigen van de romp gedurende meer dan 1 uur per dag.

Er is zwak bewijs dat draaien van de romp geen risicofactor is voor LRS.

Combinatie van tillen, dragen en buigen van de romp

Twee studies hebben het gecombineerde risico van tillen en dragen met het buigen van de romp onderzocht voor het optreden van een LRS (Seidler 2003, Seidler 2009). Beide studies vonden dat de combinatie resulteerde in een verhoogd risico op het optreden van een LRS. Seilder (2003) vond het grootste risico bij het langdurig (>1500 uur) meer dan 90 graden met de romp voorovergebogen werken en minder of meer tillen: tillen en/of dragen ≤150 000 kg^2*uren, OR=3,2 (95%BI 1,0-10,5) en tillen en/of dragen >150 000 kg^2*uren; OR=2,2 (95%BI 0,7-7,3). Seidler (2009) vond bij een toename van de cumulatieve belasting op de rug in termen van Newton•uren (Nh) een OR van OR=1,7 (95%BI 1,1–2,7) bij een blootstelling van 5,0 – <21,51*10^6Nh en OR=3,4 (95%BI 2,2–5,0) bij >21.51*10^6Nh.

Er is sterk bewijs dat LRS vaker optreedt bij de combinatie van tillen en/of dragen van lasten zwaarder dan 5 kg en dagelijks buigen van de romp van meer dan 20 graden.

Besturen van een voertuig

Hoewel er sterk bewijs is dat het beroep van chauffeur samenhangt met een verhoogd risico op het optreden van een LRS is, is de vraag of dat komt door de blootstelling aan trillingen door het zittend besturen van een voertuig of dat het komt doordat chauffeurs ook vaak handmatig laden en lossen met de risicofactoren tillen en dragen en buigen van de romp. Vijf studies hebben het risico van het besturen van een voertuig op het optreden van een LRS onderzocht (Heliovaara 1991, Kaila-Kangas 2011, Krause 2004, Palmer 2012, Seidler 2003).

Heliovaara (1991) vond dat professionele chauffeurs geen verhoogd risico hadden op het optreden van een LRS (OR=0,9 95%BI 0,5-1,6). Kaila-Kangas maakte onderscheid in drie categorieën op basis van wel of niet professioneel besturen van een voertuig en wel of niet zwaar werk verrichten. Blootstelling aan besturen van een voertuig zonder zwaar werk te verrichten resulteerde niet in een

verhoogd risico op het optreden van een LRS: OR=0,30 (95%BI 0,04-2,30). Het verrichten van zwaar werk in combinatie met en zonder professioneel besturen van een voertuig resulteerde wel in een verhoogd risico op een LRS: met besturen van een voertuig OR=3,13 (95%BI 1,79–5,46) en zonder besturen van een voertuig OR=1,83 (95%BI 1,13–2,98).
Krause (2004) onderzocht het effect van professionele chauffeurs in het openbaar vervoer in San Francisco. Krause (2004) vond geen verhoogd risico voor het aantal jaren besturen van een voertuig verdeeld in de categorieën <5 jaar, 6-15 jaar en >15 jaar. Krause (2004) vond ook geen verhoogd risico voor chauffeurs die fulltime werken versus parttime werken en ook geen verhoogd risico voor chauffeurs van diesel- en trolleybussen en personenwagens ('light rail'). Krause (2004) vond wel een verhoogd risico voor het optreden van een LRS bij chauffeurs die overwerken (>50 uur per week, HR= 5,60 (1,79-17,51)) en voor de chauffeurs van de historische trams ('cable cars') in San Franciso (2,76 (1,24-6,14)). De verklaring die Krause (2004) geeft voor dit laatste resultaat is dat dit waarschijnlijk mede komt door de slechte ergonomie van de cabine en dat de trams aan het eind van de lijn handmatig moeten worden gedraaid en verplaatst.
Palmer (2012) heeft de blootstelling van chauffeurs gekwantificeerd in termen van aantal uren besturen van een voertuig (≥1 uur per dag, ≥3 uur per dag) en trillingsblootstelling (maximaal en gerekend over een 8-urige werkdag). Voor deze vier maten werd geen verhoogd risico op het optreden van een LRS gevonden. De hoogste OR was voor chauffeurs blootgesteld aan een trillingsniveau ≥0,5 ms^{-2} over een 8-urige werkdag met een OR=1,0 (95%BI 0,5-2,2).
Seidler (2003) berekende het cumulatieve aantal uren blootstelling aan hele lichaamstrillingen. Seidler (2003) vond een niet-significant verhoogd risico voor het optreden van een LRS, gecorrigeerd voor tillen en dragen en buigen van de romp. De OR varieerde tussen 1,7 (95%BI 0,7-4,3) en 1,8 (95%BI 0,7-4,3). De OR varieerde tussen 1,9 (95%BI 0,7-4,9) en 2,1 (95%BI 0,9-4,8), wanneer ook rekening werd gehouden met het besturen van een voertuig over slecht begaanbare ondergrond

Er is sterk bewijs dat LRS niet vaker optreedt alleen door het besturen van een voertuig wanneer er daarnaast geen sprake is van tillen en dragen en buigen van de romp.

Zitten

Drie studies hebben het risico van zitten zonder dat er sprake is van besturen van een voertuig onderzocht voor het optreden van een LRS (Kelsey 1975c, Seidler 2003). Kelsey (1975c) vond een niet significant verhoogd risico op het optreden van een LRS: RR=1,58 (p=0,06). Seidler vond dat het cumulatief aantal uren zitten een niet significant verlaagd risico had met het optreden van een LRS waarbij onder andere gecorrigeerd is voor leeftijd : >10.000–30.000 uur, OR=0,8 (95%BI 0,4-1,7) en >30.000, OR=0,9 (95%BI 0,3-2,6). In de studies naar de fysieke zwaarte van het werk is zittend werk veelal de referentiepopulatie van niet-blootgestelden.

Er is matig bewijs dat LRS niet vaker optreedt door langdurig zitten waarbij geen sprake is van lichaamstrillingen.

Knielen

Een studie heeft het risico van knielen onderzocht voor het optreden van een LRS (Kaila-Kangas 2009). Kaila-Kangas (2009) vond bij mannen afhankelijk van het aantal jaren blootstelling aan meer dan 1 uur knielen per dag een niet-significant verhoogd risico op het optreden van een LRS: 0 jaar,

OR=1 (referentie), 1-10 jaren OR=1,45 (95%BI 0,83-2,56), 11-20 jaren OR=1,82 (95%BI 0,95–3,51), >20 jaren OR=0,91 (95%BI 0,44–1,88). Voor vrouwen waren de OR: 0 jaar, OR=1, 1-10 jaar OR=0,96 (95%BI 0,46–2,02), 11-20 jaar OR=1,23 (95%BI 0,57–2,64) en >20 jaar OR=0,92 (95%BI 0,42–2,02).

Er is beperkt bewijs dat LRS niet vaker optreedt door meer dan 1 uur per dag geknield werken

VI Niet werkgerelateerde factoren

Persoonsgebonden factoren die in meer of mindere mate in verband zijn gebracht met het risico op LRS zijn leeftijd, lichaamslengte, genetische aanleg, lichamelijke activiteiten en rookgedrag (Nederlandse Vereniging voor Neurologie, 2008). In de studies naar werkgebonden risicofactoren wordt in een aantal studies ook gecorrigeerd voor geslacht, BMI, etniciteit, nationaliteit, depressieve symptomen, en in de naaste familie optreden van een LRS. Een voorbeeld van de grootte van de persoonsgebonden risico's bij bouwvakkers wordt verwezen naar de studie van Wahlstrom (2012). Wahlstrom (2012) berekende voor bouwvakkers de grootte van de persoonsgebonden risico's leeftijd, lengte, gewicht en rookgedrag gecorrigeerd voor het beroep dat werd verricht. Bouwvakkers ouder dan 30 jaar en jonger dan 60 jaar hadden een verhoogd risico. De hoogste OR waren voor de leeftijdscategorieën 30-39 jaar OR=1,87 (95%BI 1,58–2,23) en 40-49 jaar OR=1,75 (95%BI 1,47–2,08). Bouwvakkers langer dan 1,8 m hadden een verhoogd risico op het optreden van een LRS (180–189 cm, OR=1,28 (95%BI 1,17–1,40), 190–199 cm, OR=1,55 (95%BI 1,30–1,86). Bouwvakkers lichter dan 70 kg hadden een verlaagd risico (OR=0,83 (95%BI 0,75–0,93) en zwaarder dan 89 kg een verhoogd risico op een LRS ((90–99 kg, OR=1,28 (95%BI 1,10–1,48), 100–119 kg, OR=1,40 (95%BI 1,12–1,76) en 120–149 kg 1,34 (95% BI 0,60–2,99)). Roken resulteerde ook in een verhoogd risico op een LRS: OR= 1,27 (95%BI 1,15–1,39).

VII Referenties

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Bijlage I Data-extractietabel van de 22 geïncludeerde artikelen over klinisch vastgestelde lumosacraal radiculair syndroom en werk als mogelijke risicofactor.

Author, Country, Design	Case definition LRS	Scources of participants	Number of participants	Exposure definition	Exposure assessment	Occupation	Reference definition	Incidence / Prevalence	Risk estimate 95%CI	Adjustment
Chung 2013, Taiwan, Prospective cohort 2004-2010	Herniated intervertebral disc (HID) (ICD-9-CM 722.10) based on the clinic or hospital code	Randomly selection from the approximately 90,022 registered nurses in the Taiwan National Health Insurance (NHI) program database. The nurses included in this study comprised 3861 women and 53 men. The reference population was selected from 270,802 individuals whose occupation was not nursing and included both working and non-working subjects.	N= 3914 nurses 99% ♀, age 34±8 years • 1% ♂ age 31±5 years N=11.744 non nurses • 99% ♀, age 34±8 jaar • 1% ♂ age 31±5 jaar	Job title according the Taiwan National Health Insurance Research Database	Job classification in the Taiwan National Health Insurance Research Database	Nurses	Individuals whose occupation was not nursing and included both working and non-working subjects.	Annual incidence for the number of new cases of herniated intervertebral disc divided by the size of the population at risk in each year. Nurses: • 1,45 Reference group: • 0,64	OR 2.5 (95% CI 1.8-3.4)	None
Heliovaara 1987,	The categories of hospital	All participants who, after the voluntary	592 male and female cases	Specially trained	Questionnaire	Not specifie	Professional and	Men 20-59 year	RR	None

Finland Case control	discharge diagnoses were used: herniated lumbar intervertebral disc (codes 725.10 or 725.19) and (2) sciatica (code 353.99).	medical baseline examination between 1966-1972 (participation rate 87%) had been discharged from hospital between 1970 and 1980, with diagnosis codes of herniated lumbar intervertebral disc (codes 725.10 or 725.19 of the International Classification of Diseases, 8th revision) or sciatica (353.99) were identified. For each incidence case, four control subjects matched individually for sex, age and place of residence were selected. The subjects who had reported severe	were compared with 2140 controls, matched individually for sex, age and place of residence.	research assistants coded the job titles at the three-digit level using the Nordic Standard Classification of Occupation, which is an adaptation of the ILO classification		d	other white-collar workers	(case/control) Professional and other white-collar workers • 15/171 Intermediate non-manual workers • 30/145 Forestry workers • 12/51 Farmers and other agricultural workers • 43/213 Motor vehicle Drivers • 33/107	** p<0,01 ***p<0,001 Professional and other white-collar workers • 1.0 Intermediate non-manual workers • 2,8** Forestry workers • 3,4** Farmers and other agricultural workers • 2,6** Motor	

		back pains or symptoms suggesting sciatica at the baseline examination were excluded, as were those whose initial age was less than 20 or more than 59 years.						Metal or machine Workers • 62/222 Construction Workers • 41/171 Chemical processors and paper workers • 47/198 Other industrial Workers • 59/287 Service workers and other groups • 22/97	vehicle Drivers • 4,8*** Metal or machine Workers • 4,4*** Constructio n Workers • 3,3*** Chemical processors and paper workers • 3,3*** Other industrial Workers • 2,7** Service workers and other	

								Vrouwen, 20-59 jaar (case/control) White-collar Workers • 29/173 Nurses and related medical workers • 13/59 Sales workers • 25/100	groups • 3,0** RR ** p<0,01 ***p<0,001 White-collar Workers • 1,0 Nurses and related medical workers • 1,5 Sales workers • 1,6 Agricultural workers • 1,7 Metal, paper, construction and related workers	

								Agricultural Workers • 38/153 Metal, paper, construction and related workers • 22/103 Other industrial Workers • 22/76 Cleaners and Caretakers • 19/91 Other service workers and other groups • 29/136 Housewives • 31/179	• 1,3 Other industrial Workers • 2,1 Cleaners and Caretakers • 1,2 Other service workers and other groups • 1,3 Housewives • 1,0	
Heliovaara 1991 Finland	Clinical examination by a specifically trained	6102 adults in the age of 30-64 (2946 men and 3156 women) older than 30 years voluntarily	N=289 cases: • 133 ♀ • 156 ♂	The total number of exposures (the sum index of occupational	Questionnaire	Not specified	No exposure to one or more of the five factors (=0 points for the sum index	Sum index of occupational stress (case/control):	Sum index of occupational stress (case/contro	Sex, Age

Case control	physician. Sciatica was a history of pain radiating down to the leg with a segmental distribution and findings of lumbar nerve root compression or lumbar herniation was confirmed by surgery or myelography.	participating in a nation wide health examination by the mobile clinic of the social Insurance institution		physical stress) in the last or present job, or in the previous job of longest duration for the following five factors; 1. lifting or carrying heavy objects 2. stooped, twisted, or otherwise awkward body postures 3. vibration of the whole body or use of vibrating equipment 4. a continuously repeated series of movements 5. paced work (working speed determined by a machine) Work-related driving in two			of occupational physical stress) No work-related driving of motor-vehicles	• 0: 61/2054 • 1: 56/1114 • 2: 90/1389 • 3: 52/729 • 4: 24/316 • 5: 6/71 Work-related driving motor vehicles: • No: 209/3829 • Commuting: 64/1534 • Professional: 16/310	l): OR • 0: 1.0 • 1: 1,7 (1,2-2,5) • 2: 2,0 (1,4-2,8) • 3: 2,2 (1,5-3,3) • 4: 2,5 (1,5-4,1) • 5: 2,4 (1,0-5,7) Work-related driving motor vehicles: • No: 1,0 • Commuting: 0,8 (0,6-1,1) • Professional:0,9 (0,5-1,6)	

				categories: 1.professional driver like taxi, bus, truck or tractor driver in the last or present job or in the previous job of longest duration. 2.commuting driver for work in a private car						
Hrubec, 1975 USA Case control	First hospital diagnosis of lumbar HNP during 1944-1945	Sample of cases was compiled from the records of first admissions to Army hospitals for herniated lumbar disc disease in 1944 and 1945. A systematic sample of 1408 of these cases was selected by using service numbers wit a tens digit of 2, 8 or 9 and a national Service Life Insurance (NSLI). A comparison group sample was	1095 pairs of cases (height 174 cm ± .2, weight 73 kg ± .3) and controls height 172cm ± .2, weight 69 kg ± .3).	Service records provided information on rank and military occupation speciality assignments.	Not applicable	Military personel	First hospital diagnosis of lumbar HNP during 1944-1945	Craftsmen, foremen or kindred occupation (n=993 pairs with full information): Cases 19.2% Controls 13.3% Clerical or kindred occupation (n=993 pairs with full information):	Craftsmen, foremen or kindred occupation: RR=1.55 (p≤0.001) Clerical or kindred occupation RR=0.64 (0.01≥p>0.001) Military occupation specialty:	

		selected from a file of premium record of the NSLI, matched on age and military service period and without a diagnosis of HNP prior to 1945.						Cases 7.0% Controls 10.6% Military occupation specialty: ground combat (n=896 pairs with full information): Cases 24.8% Controls 18.6% Combat credit: 2+battle starts (n=1073 pairs with full information): Cases 29.2% Controls 35.9% Rank: staff sergeant, sergeant (n=1088 pairs with full information)	ground combat RR=1.49 (0.01≥p>0.001) Combat credit: 2+battle starts: RR=0.71 (p≤0.001) Rank: staff sergeant, sergeant RR=1.35 (0.01≥p>0.001) Rank: officer RR=0.71 (0.05≥p>0.01)	

								Cases 25.9% Controls 20.7% Rank: officer (n=1088 pairs with full information) Cases 25.9% Controls 20.7%		
Kaila-Kangas, 2009 Finland Cross sectional study	In the presence of chronic (>3 months) low back complaints, sciatica was clinically diagnosed by the field physicians if the patient had a history of low back pain (LBP) radiating down to the	Participants from the Health 2000 Survey conducted in Finland between September 2000 and June 2001. Its main purpose was to achieve an overall view of the health of the Finnish population. The nationally representative 2-stage stratified cluster sampling	1861 working men and 1940 working women	A cumulative sum index for years of exposure to the five workload factor : - Heavy physical work in general - Frequent handling of lighter objects (objects heavier than 5 kg on average for	Work-related physical loading was assessed in an interview. The respondents were asked whether they had been exposed to different	Not specified	No years in jobs involving one of the work load factors.	Men (80 cases/ 1861 participants) Heavy physical work in general 0: 32/922 1-10: 14/348 11-20: 21/277 >20: 13/314 Frequent handling of	Men (OR, 95%CI) Heavy physical work in general 0: 1 1-10: 1.26 0.69–2.28 11-20: 2.37 1.35–4.13 >20: 0.98 0.49–1.95	Age, Body mass index, Smoking

	leg, and either findings of lumbar nerve root compression (positive straight-leg-raising test or a positive clinical sign) or lumbar disc herniation that had previously been onfirmed by radiographic examination or required surgery.	consisted of persons aged 30 and over and comprised 8028 persons of whom 6986 (87%) were interviewed. Of the working-age (30–64 years) subjects (n= 5871), 88% participated in the interview and 83% attended the health examination. The working-age subjects were stratified into 2 groups: those who had worked during the preceding year (n=3801) at the time of the interview and those who had not (n=1010).		at least 2 hours per work day), - Handling of heavy objects (20 kg on average at least 10 times per work day), - Kneeling (at least 1 hour per work day) - Bending (at least 1 hour per work day) and classified for the working subjects into 4 categories: none, 1 to 10, 11 to 20, and >20 years.	work-related factors daily in their current job (yes/no) and in their 5 longest lasting past jobs. They were also asked about the duration (in years) of their jobs. of exposure. Few persons had had more than 5 jobs, and the cumulative index covered the whole occupationa l history for more than 99% of the			lighter objects 0: 46/1179 1-10: 9/288 11-20: 16/191 >20: 9/203 Handling of heavy objects 0: 39/1074 1-10: 15/331 11-20: 13/214 >20: 13/242 Kneeling 0: 36/996 1-10: 16/332 11-20: 16/255 >20: 12/288 Bending 0: 37/997 1-10: 13/316 11-20: 13/236 >20: 17/312	Frequent handling of lighter objects 0: 1 1-10: 0.87 0.43–1.76 11-20: 2.24 1.23–4.09 >20: 1.00 0.47–2.09 Handling of heavy objects 0: 1 1-10: 1.30 0.70–2.42 11-20: 1.78 0.90–3.50 >20: 1.22 0.64–2.32 Kneeling 0: 1 1-10: 1.45 0.83–2.56	

					subjects.			Women (69 cases/ 1940 participants) Heavy physical work in general 0: 41/1267 1-10: 11/288 11-20: 5/182 >20: 12/203 Frequent handling of lighter objects 0: 52/1561 1-10: 3/167 11-20: 6/112 >20: 8/100 Handling of heavy objects 0: 61/1536 1-10: 2/190 11-20: 3/91	11-20: 1.82 0.95–3.51 >20: 0.91 0.44–1.88 Bending 0: 1 1-10: 1.18 0.66–2.11 11-20: 1.50 0.82–2.75 >20: 1.19 0.64–2.21 Women (OR, 95%CI) Heavy physical work in general 0: 1 1-10: 1.19 0.57–2.52 11-20: 0.74 0.29–1.87 >20: 1.25	

								>20: 3/96 Kneeling 0: 44/1309 1-10: 9/281 11-20: 8/174 >20: 8/176 Bending 0: 39/1234 1-10: 9/257 11-20: 6/208 >20: 15/241	0.64–2.43 Frequent handling of lighter objects 0: 1 1-10: 0.55 0.17–1.70 11-20: 1.33 0.56–3.17 >20: 1.71 0.79–3.72 Handling of heavy objects 0:1 1-10: 0.25 0.06–1.05 11-20:0.72 0.22–2.41 >20: 0.53 0.16–1.82 Kneeling 0:1	

									1-10: 0.96 0.46–2.02 11-20: 1.23 0.57–2.64 >20: 0.92 0.42–2.02 Bending 0: 1 1-10: 1.24 0.59–2.60 11-20: 0.91 0.39–2.15 >20: 1.41 0.75–2.67	
Kaila-Kangas, 2011 Finland Cross sectional study	In the presence of chronic (>3 months) low back complaints, sciatica was clinically diagnosed by the field physicians if the patient had a history of low back pain (LBP) radiating	Participants from the Health 2000 Survey conducted in Finland between September 2000 and June 2001. Its main purpose was to achieve an overall view of the health of the Finnish population. The nationally representative 2-stage stratified cluster sampling	2323 working men	The “physical strenuousness of work” (yes/no) was a combination of two questions based on cumulative exposure: “Did your work include kneeling or squatting for an average of at least 1 hour per	The “physical strenuousness of work was assessed in an interview. The history of professional car driving was assessed	Professional drivers and other not specified jobs	No physical strenuousness of work or no history of professional driving	Number of cases / Participants No exposure to professional car driving or strenuous physical work: 25/876	OR (95%CI) No exposure to professional car driving or strenuous physical work: 1 Exposed to driving,	Age, BMI, Smoking, Working status, Distress symptoms

	down to the leg, and either findings of lumbar nerve root compression (positive straight-leg-raising test or a positive clinical sign) or lumbar disc herniation that had previously been onfirmed by radiographic examination or required surgery.	consisted of persons aged 30 and over and comprised 8028 persons of whom 6986 (87%) were interviewed. Of the working-age (30–64 years) subjects (n= 5871), 88% participated in the interview and 83% attended the health examination. The working-age subjects were stratified into 2 groups: those who had worked during the preceding year (n=3801) at the time of the interview and those who had not (n=1010).		working day” and “Did your work involve handling heavy objects such as lifting, manually carrying, or pushing objects heavier than 20 kg on average at least 10 times per work day?” If the participant answered “yes” to either of these questions and the cumulative exposure had lasted for over a year, he was classifi ed as being exposed to strenuous physical work. The history of professional car driving was assessed by	by using a questionnai re			Exposed to driving, no strenuous physical work: 1/104 No exposure to driving, exposed to strenuous physical work: 67/1060 Exposed to both driving and strenuous physical work: 28/283	no strenuous physical work: 0.30 0.04–2.30 No exposure to driving, exposed to strenuous physical work: 1.83 1.13–2.98 Exposed to both driving and strenuous physical work: 3.13 1.79–5.46	

				using a questionnaire. The participants were asked whether they had ever worked as professional car drivers, and if so, which of the following vehicles they had driven professionally: car, van, truck, trailer truck, or other special vehicle such as police, car or ambulance.						
Kelsey, 1975a USA Case control	The surgeon stated on the hospital chart a herniated disc during surgery, or the patient reported sciatic pain and a positive straight leg raising test and/or symptoms of	Persons in the age group 20-64 years in the New haven Standard Metropolitan Statistical Area who had lumbar x-rays taken at all three hospitals in the area and at the office of two of the private radiologists in New Haven during the period June 1971 to	128 male pairs of matched cases and controls on age.	Questions regarding the type of job a person held for at least a year when their symptoms arose and the time they sat on their job (none, little, half, half or more) and whether they drove a car	Interview by carefully trained non-medical interviewers using a questionnaire	Truck drivers	No possible, probable or surgical case of lumbar disc herniation with radiating symptoms	Truck driving/No truck driving Cases 15/113 Controls 4/124	Males Truck driving RR=4.67, p<.02	None

	increased pain in the low back or along the sciatic nerve when stretching or extending his leg from a sitting position. The cases are classified as surgical cases, probable cases and possible cases.	May 1973.		including make, model and year.						
Kelsey, 1975b USA Case control	The surgeon stated on the hospital chart a herniated disc during surgery, or the patient reported sciatic pain and a positive straight leg raising test and/or symptoms of increased pain in the low back or along the sciatic nerve when	Persons in the age group 20-64 years in the New haven Standard Metropolitan Statistical Area who had lumbar x-rays taken at all three hospitals in the area and at the office of two of the private radiologists in New Haven during the period June 1971 to May 1973.	217 pairs (128 males and 89 females) of matched cases and controls on age.	Questions regarding the type of job a person held for at least a year when their symptoms arose and the time they sat on their job (none, little, half, half or more) and whether they did any lifting in their job	Interview by carefully trained non-medical interviewers using a questionnaire	Not specified	No possible, probable or surgical case of lumbar disc herniation with radiating symptoms.	Half or more of the time sitting vs less than half the time sitting Both sexes < 35 years Cases 23/49 Controls 26/46 ≥ 35 years Cases 55/38 Controls 34/59	Half or more of the time sitting vs less than half the time sitting Both sexes < 35 years RR=0.81, not significant ≥ 35 years RR=7.84 (p<0.01)	None

	stretching or extending his leg from a sitting position. The cases are classified as surgical cases, probable cases and possible cases.							Any lifting or no lifting Both sexes Cases 111/56 Controls 100/67	Any lifting or no lifting Both sexes RR=1.38	
Kelsey, 1995c, USA Case control study	The surgeon stated on the hospital chart a herniated disc during surgery, or the patient reported sciatic pain and a positive straight leg raising test and/or symptoms of increased pain in the low back or along the sciatic nerve when stretching or	Persons in the age group 20-64 years in the New haven Standard Metropolitan Statistical Area who had lumbar x-rays taken at all three hospitals in the area and at the office of two of the private radiologists in New Haven during the period June 1971 to May 1973.	217 pairs (128 males and 89 females) of matched cases and controls on age.	Questions regarding the type of job a person held for at least a year when their symptoms arose and the time they sat on their job (none, little, half, half or more), whether they did any lifting in their job and whether they performed any pushing or pulling.	Interview by carefully trained non-medical interviewers using a questionnaire	Not specified	No possible, probable or surgical case of lumbar disc herniation with radiating symptoms	Not specified	Sedentary jobs, all ages RR=1.58 (p=0.06) Jobs requiring driving (males only) RR=2.75 (p=0.02) Truck driving (males only) RR=4.67	None

	extending his leg from a sitting position. The cases are classified as surgical cases, probable cases and possible cases.								(p=0.02) Jobs involving: Any lifting RR=1.25 (p>0.10) Any pushing RR=1.12 (p>0.10) Any pulling RR=1.16 (p>0.10) Any carrying RR=1.13 (p>0.10)	
Kelsey, 1984 USA Case	The surgeon stated on the hospital chart a herniated disc during surgery, or the patient	Persons in the age group 20-64 years who had lumbar x-rays or myelograms taken in three hospitals, one neurosurgical	325 pairs of matched cases and controls.	Lifting>11.3 kg • Not at all • <5 times/day • 5-25 times/day • >25 times/day	Questionnaire and diagnostic tests were administered by carefully	Not specified	Persons in the control group were individually matched (sex and age) to cases and	Not specified	Lifting>11.3 kg • Not at all RR=1 • <5 times/day RR=1.2	

control	reported sciatic pain and a positive straight leg raising test and/or symptoms of increased pain in the low back or along the sciatic nerve when stretching or extending his leg from a sitting position. The cases are classified as surgical cases, probable cases and possible cases.	private practice and two orthopaedic private practices in the New Haven and Hartford, Connecticut during the period June 1979-1981.		Carrying>11.3 kg • Not at all • <5 times/day • 5-25 times/day • >25 times/day Twisting at waist • Not at all • <5 times/day • 5-25 times/day • >25 times/day	trained nonmedical interviewers.		consisted of persons admitted to the samen medical services as the cases for conditions not related to the spine.		(0.7-2.0) • 5-25 times/day RR=1.3 (0.7-2.5) • >25 times/day RR=3.5 (1.5-8.5) Carrying>11.3 kg • Not at all RR=1 • <5 times/day RR=1.0 (0.6-1.9) • 5-25 times/day RR=2.1 (1.0-4.3) • >25 times/day RR=2.7 (1.2-5.8) Twisting at waist • Not at all RR=1 • <5 times/day RR=1.7 (0.8-3.6) • 5-25	

									times/day RR=1.2 (0.7-2.1) • >25 times/day RR=1.3 (0.7-2.3)	
Kostova 2001 Bulgaria Cross sectional	The criteria for lumbosacral radicular syndrome were subjective complaints regarding pain in the low back of varying intensity following a radicular distribution in one or both legs (sometimes the pain is relieved when the patient lies down), loss of lordosis or flattening of the lumbar spine, reduced range	Employees of the main departments of a fertilizer plant from 1995 to 1998.	N=898 group > 40 years • n=450 group ≤ 40 years • n=448	Physical work-related overuse is defined as workers exposed to moderately strenuous tasks at the work place (repair staff, loaders, transport equipment machine operators, pump machine operators) and reference as workers not exposed to repetitive motion, overexertion, heavy physical work, etc., in their jobs: operators, compressor operators,	The information was gathered by means of a selective questionnaire and a complete neurologic examination.	• Compressor operators • Operators • Repair staff • Shop managers • Administration • Laboratory assistents • Other workers	No physical work-related overuse	Risk group • N=279, 8.6% Reference group • N=613, 11.9%	OR=0.70 (95% CI 0.42-1.16)	

	of movement and tenderness of paraspinal muscles of the same region, numbness and paresthesias in the region of the affected root, positive signs of Lasseque, Neri, Wassermann, etc., objective symptoms for sensory deficit with radicular distribution, occasional weakness in the leg (sometimes of the dorsi- flexion of the big toe), and/or depressed ankle or Achilles reflexes. The			laboratory assistants, administrators. The classical occupational factors for the development of back pain syndromes such as constrained working postures and back-straining tasks, heavy physical work and repetitive manual handling, pulling, pushing, etc., are not part of the physical activities required for the risk group.						

	testing was conducted at the health center of the fertilizer plant									
Krause 2004 USA Prospective cohort study	The first incidence of a compensated severe low back injury during 7.5 years follow up. Severe were ICD-9 codes on any physician bill record indicating postlaminectomy syndrome (0.3%), spinal stenosis (2.7%), herniated lumbar disc (20.8%), sciatica (7%), or spinal instability (0.3%) were classified as severe.	Data were obtained from five different sources: A baseline health survey and medical examination of all Muni drivers between August 30th, 1993 and September 29th, 1995 administered during the mandatory biannual medical relicensing examination, that provided information on demographic (age, sex, ethnicity) and anthropometric (height and weight) variables, total years of professional driving, type of vehicle operated, and ergonomic	1,233 vehicle operators (103 more severe cases, 228 less severe cases, 902 non-cases)	The core biomechanical risk factors under study were physical workload and ergonomic problems. In transit vehicle operators, physical workload and the resultant cumulative biomechanical forces acting on the lumbar spine are largely determined by vehicle type and workstation design, which in turn determine type and amount of whole body vibration, predominant working	Medical examination dataset, questionnaire, company relicensing examination records, ergonomic evaluation, and force measurements	Transit operators	Non-cases	Incidence 1993-2001 (103 more severe cases, 228 less severe cases, 902 non-cases) Years of professional driving • 5 or less, n=192 • 6-15, n=466 • >15, n=347 Total driving hours per week • 20-30 (part-time), n=86 • 31-50 (full-time), n=809 • >50 (overtime), n=110	Hazard ratio (95% CI) Years of professional driving • 5 or less, HR= 1.05 (0.59-1.87) • 6-15, reference • >15, HR= 0.69 (0.40-1.20) Total driving hours per week • 20-30 (part-time), reference • 31-50 (full-time), HR=2.34 (0.80-6.78) • >50 (overtime), HR= 5.60 (1.79-	Years of professional driving, Years of professional driving. Vehicle type, Ergonomic problems, Body height, Body weight, Ag, Sex, Race/ethnicity, Psychological demands, Decision

		problems. A voluntary baseline occupational questionnaire administered after completion of the medical examination and after the decision on the driver's license renewal had been made, providing information on weekly driving hours and psychosocial job factors. Company employment records for all drivers, providing information on separation dates between March 1st, 1986 and April 28th, 2001. The workers' compensation insurer's database, containing information on work-related injuries by Muni drivers until February 13th, 2001. A medical bill review file containing all physician diagnoses		posture, amount of sitting and standing, movements of the trunk while driving, and forces exerted while operating steering wheels, levers, and foot pedals.				Vehicle type • Diesel bus, n=446 • Trolley bus, n=341 • Light rail, n=143 • Cable car, n=75 Ergonomic problems • 1st Quartile (low), n=258 • 2nd Quartile, n=217 • 3rd Quartile, n=259 • 4th Quartile, n=271 (high)	17.51) Vehicle type • Diesel bus, reference • Trolley bus, HR= 1.08 (0.69-1.67) • Light rail, HR= 1.13 (0.52-2.46) • Cable car, 2.76 (1.24-6.14) Ergonomic problems • 1st Quartile (low), reference • 2nd Quartile, HR= 0.92 (0.47-1.80) • 3rd Quartile, HR= 1.63 (0.90-2.96) • 4th Quartile, HR= 1.49 (0.81-2.74)	latitude, Supervisor support, Coworker support

		made throughout the history of each workers' compensation claim based on the 9th revision of the International Classification of Disease (ICD-9).								
Palmer, 2012 United Kingdom Case control	A consecutive series of patients referred for lumbar MRI because of LBP. Radiologists assessed MRI scans using a repeatable standardized protocol. Images were graded at three spinal levels (L3/L4, L4/L5, L5/S1) for: (i) disc herniation (protrusion, herniation, or disc sequestration); and/or (ii)	Working-aged adults resident in the area served by a public hospital.	237 cases and 820 controls were studied, including 183 professional drivers and 176 cases with prolapsed intervertrebal disc and/or nerve root entrapment	Exposure to WBV in their latest job was assessed by six metrics: (i) professional driving (>1 hour/day); (ii) professional driving (>3 hours consecutively); (iii) weekly hours driven for the vehicle most used; (iv) weekly hours driven for all vehicles (none, <16, ≥16); (v) maximum-rootmean square (rms) acceleration of	Participants completed a questionnaire on occupational history, work activities (digging, lifting, trunk bending/twisting), professional driving, and exposure to WBV (vehicle types, duration, intensity).	Professional drivers	A consecutive series of controls X-rayed for other reasons than LBP	Professional driving (≥1 hours/day) Controls: • No, n=677, 82.6% • Yes, n=143, 17.4% Cases • No, n=147, 83.5% • Yes, n=29, 16.5% Professional driving (≥3 hours/time) Controls: • No, n=765, 93.3% • Yes, n=55, 6.7% Cases	OR, 95%CI Professional driving (≥1 hours/day) • No, OR=1 • Yes, OR=0.8, 0.5–1.3 Professional driving (≥3 hours/time) • No, OR=1 • Yes, OR=0.6, 0.5-1.8 Max rms of any	Age, sex, BMI, somatizing tendency , SF-36 mental health score, smoking status, propensity to consult over back pain, fear avoidance beliefs, belief in work as

	nerve root entrapment (displacement Cases were those whose latest LBP episode (that since last pain-free for ≥1 month) began in their current/most recent job or compression)			any vehicle (0, −0.5, ≥0.6 ms−2 rms) and (vi) A(8) rms (< or ≥0.5 ms−2 rms [the action level in the European Union (EU) Physical Agents (vibration) Directive (14)]. Metrics (v) and (vi) were derived from driving times and imputed vibration magnitudes of vehicles.				• No, n=163, 92.6% • Yes, n=13, 7.4% Max rms of any machine (ms^{-2}) Controls • Not a regular driver, n=677, 82.6% • 0.5, n=87, 10.6% • ≥0.6, n=56, 6.8% Cases • Not a regular driver, n=147, 83.5% • 0.5, n=21, 11.9% • ≥0.6, n=8, 4.6% Current rms A(8) (ms^{-2}) Controls • <0.5, n=697, 85.0% • ≥0.5, n=123, 15.0%	machine (ms^{-2}) • Not a regular driver, OR=1 • 0.5, OR=1.0, 0.6-1.7 • ≥0.6, OR=0.5, 0.2-1.2 Current rms A(8) (ms^{-2}) • <0.5, OR=1 • ≥0.5, OR=1.0, 0.5-2.2	a cause of back pain, occupational digging and/or lifting and occupational bending and/or twisting.

								Cases • <0.5, n=149, 84.7% • ≥0.5, n=27, 15.3%		
Riihimäki 1989 Finland Prospective cohort	Two specially trained physiotherapists carried out a standardized interview on the occurrence of the following back symptoms: "sciatic pain," defined as back pain radiating to a leg; "lumbago," defined as sudden back pain causing constrained posture; and other back pain, referred to as "nonspecific	In 1977 all active concrete reinforcement workers who were 25-54 years of age, had at least five years' experience in their current occupation, and were registered members of the regional trade union of the Uusimaa Province were enlisted in the study. In 1982 a postal follow-up questionnaire was sent to all the men who had participated in the cross sectional study in 1977.	Concrete reinforcement workers, n=171 House painters, n=157	Registered members of the regional trade Union for concrete reinforcement workers	In a self-administered standardized questionnaire the workers were asked to indicate the number of years in their resent occupation.	Concrete reinforcement workers, house painters	The house painters were selected from the active members of the local painters' trade union of Helsinki with the use of frequency-matching according to five-year age strata. The painters also had at least five years' experience in their current occupation.	Five-year prevalence of sciatic pain in the follow-up phase of the study in 1977-1982 Concrete reinforcement workers, 60% House painters, 42%	RR, 95%CI Occupation (concrete reinforcement workers versus house painters) RR=1.4, 1.1-1.8	Age

	back pain ."									
Roguelaure, 2010 France Casecontrol	The French hospital database (PMSI) that systematically registers hospital discharges for lumbar disc surgery in case of disc related sciatica in 2002 and 2003.	The study was undertaken in the spine clinics of the University Hospital of Nantes (one of the four spine centers of the region) that performs about 38% of the lumbar disc surgery for the region's inhabitants (36% for men and 43% for women) [data for the years 2002–2003]. We limited the study to patients residing in the catchment area (Loire-Atlantique region) hospitalized between 1st January 2002 and 31st December 2003 (hospital admission dates). The population base for this study was defined as all residents of the Loire-Atlantique region between the ages of 20–59 [307,822 women	Patients with known occupation employed at time of lumbar disc surgery (54 women and 62 men, missing occupational category for one man) and the general population of the region in this occupation	Occupation	Questionnaire and French classification of occupations (PCS codes). The analysis was performed on the occupation at the time of lumbar disc surgery.	Farmers, craftsmen, salesmen and managers, upper white-collar and professionals, technicians and intermediate occupations, lower white-collar worker, blue-collar worker, skilled manufacturing worker, drivers, unskille	The whole sample of subjects included in the study as reference, whether they were employed at the time of lumbar disc surgery or not.	Incidence, number of cases (n), percentage of the general population of the region in this occupation (%Pe) Women • Farmers, n=0, %Pe=1.1 • Craftsmen salesmen and managers, n=0, %Pe=2.4 • Upper white-collar and professional, n=6, %Pe=5.3 • Technicians and intermediate occupations, n=14,	RR, 95%CI if n>5 Women • Farmers, n<5 • Craftswomen saleswomen and managers, n<5 • Upper white-collar and professional, RR=2.5 [1.0–5.9] • Technicians and intermediate occupations, RR=2.1 [1.1–4.0] • Nurses, RR=2.9 [1.3–6.4]	Age

		(49.8%) and 309,861 men (50.2%)] according to French National Institute of Statistics and Economic Studies (INSEE) census of 1999.				d manufacturing workers		%Pe=11.7 • Nurses, n=7, %Pe=4.5 • Lower white-collar workers, n=30, %Pe=32.5 • Blue-collar workers, n=4, %Pe=6.5 Men • Farmers, n=0, %Pe=2.5 • Craftsmen salesmen and managers, n=6, %Pe=2.6 • Upper white-collar and professional, n=6, %Pe=11.8	• Lower white-collar workers, RR=1.8 [1.1–3.1] • Blue-collar workers, n<5 Men • Farmers, n<5 • Craftsmen salesmen and managers, RR=2.2 [0.9–5.2] • Upper white-collar and professional, RR=0.8 [0.4–2.0] • Technicians and intermediate	

								• Technicians and intermediate occupations, n=7, %Pe=22.0 • Lower white-collar workers, n=8, %Pe=8.3 • Blue-collar workers, n=34, %Pe=30.5 • Skilled manufacturing workers, n=12, %Pe=8.8 • Drivers, n=7, %Pe=3.4 • Unskilled manufacturing workers, n=7, %Pe=5.1	occupations, RR=0.6 [0.3–1.4] • Lower white-collar workers, RR=3.6 [1.6–8.5] • Blue-collar workers, RR=2.4 [1.4–4.0] • Skilled manufacturing workers, RR=2.5 [1.3–4.7] • Drivers, RR=3.9 [1.8–8.8] • Unskilled manufacturing workers, RR=3.9 [1.6–9.6]	
Saftic,	Surgery of the lower spine	The study was conducted in 9	67 cases and 268 matched controls	Occupation type was	Standard WHO	Diverse such	For each of the cases, 4	Occupation 'Sitting or	OR, 95%CI	No

2006 Kroatia Case control	due to lumbar intervertebral disc herniation L4/L5 or L5/S1	villages on Croatian islands of Rab, Vis, Lastovo, and Mljet. The villages were chosen in 2002 to present a range of differing ethnic histories, fluctuations in population size, accessibility of genealogical records and population collaboration in research program.		divided into sitting or standing occupations and occupations involving hard physical activity. All occupations were recorded as those before eventual lower spine surgery. Intensity of physical labor at work was defined as sitting, easy, or moderate vs hard.	questionairre	as clerks, lawyers, economists, tailors, waiters, cooks, salespersons, teachers, police men, electricians, and house wives, agriculture workers, soldiers, construction workers, mechanics, and fisherm	controls were chosen from the reminder of the sample of 1001 examinees. These controls were matched to cases by the village of residence/immigrant status, gender, and age ±3 years).	standing' • Cases, n=45 67.2% • Controls, n=214, 79,9% 'Hard physical activity' • Cases, n=22 (32.8%) • Controls, n=54, 20.1% Intensity of physical labor at work: 'Sitting, easy or moderate' • Cases, n=46, 68.9% • Controls, n=232, 86.6% 'Hard' • Cases, n=21, 31.1% • Controls, n=36, 13.4%	Occupation 'Sitting or standing' • OR=1 'Hard physical activity' • OR=1.94, 0.13-3.75 Intensity of physical labor at work: 'Sitting, easy or moderate' • OR=1 'Hard' • OR=2.94, 1.07-4.81	

						en				
Seidler, 2003 Germany Case control study	Lumbar disc herniation confirmed by computed tomography (CT) or magnetic resonance imaging (MRI)	Participating physicians in three neurosurgical clinics in Frankfurt/Main and surrounding area were asked to identify prospectively all male patients between 25 and 65 years, stationary treated with currently symptomatic herniation of the lumbar discs. Furthermore, participating physicians in two orthopaedic practices and in one orthopaedic clinic were asked to identify retrospectively all male patients between 25 and 65 years with herniation of the lumbar discs or osteochondrosis/spondylosis of the lumbar spine associated with	94 cases with acute lumbar disc herniation and 197 control subjects	Occupational groups were classified a priori by an occupational physician (GE) with respect to their exposure to carrying or lifting (low, moderate, high). Cumulated hours spent in working postures with extreme forward bending were calculated up to the year of diagnosis or ‘‘reference year’’ respectively (two years prior to data collection). Cumulative exposure to lifting/carrying and trunk flexion was calculated in	Expert opinion, questionnaires, biomechanical model	Not specified	The control group consisted of 107 population control subjects (response rate 66%) and 90 patients hospitalised for treatment of urolithiasis by lithotripsy (response rate 93%)	Prevalence, controls n %, cases n % Occupational groups (a priori assessment) • Always occ. with low physical workload, controls 95 48.2, cases 42 44.7 • >0–<10 y occ. with medium physical workload, controls 13 6.6, cases 7 7.4 • >0–<10 y occ. with high physical workload, controls 10 5.1, cases 4 4.3 • >10 y occ. with medium physical workload, controls 51	OR, 95%CI Occupational groups (a priori assessment) • Always occ. with low physical workload, 1.0 – • >0–<10 y occ. with medium physical workload, 0.9, 0.3 to 3.0 • >0–<10 y occ. with high physical workload, 1.4, 0.3 to 5.9 • >10 y occ. with medium physical workload, 0.8, 0.4 to 1.7 • >10 y occ.	Age, Region, Nationality, Diseases potentially affecting the lumbar spine

		chronic complaints (low back pain, sciatica) within the preceding 10 years.		two different ways. Firstly, the squares of the weights lifted or carried at work were multiplied by the corresponding durations and summed; separate categories were formed for isolated and combined lifting/carrying and extreme forward bending. Secondly, the Mainz-Dortmund Dose model (MDD), which is based on overproportional weighting of the lumbar disc compression force in relation to the respective duration of lifting was applied with				25.9, cases 17 18.1 • >10 y occ. with high physical workload, controls 27 13.7, cases 24 25.5 Cumulated lifting/carrying (kg^2*h) • 0 kg^2*h, controls 64 32.5, cases 28 29.8 • >0–10 000 kg^2*h, controls 42 21.3, cases 15 16.0 • >10 000–150 000 kg^2*h, controls 43 21.8, cases 22 23.4 • >150 000 kg^2*h, controls 43 21.8, cases 28 29.8 Extreme (>90° trunk flexion) forward	with high physical workload, 2.1, 0.9 to 4.6 Cumulated lifting/carrying (kg^2*h) • 0 kg^2*h, 1.0 – • >0–10 000 kg^2*h, 0.8 0.3 to 1.8 • >10 000–150 000 kg^2*h, 1.3 0.6 to 2.8 • >150 000 kg^2*h, 1.6 0.7 to 3.4 Extreme (>90° trunk flexion) forward bending (h) • 0 h, 1.0 – • >0–1500 h, 1.4 0.7 to 2.8 • >1500 h, 2.7 1.2 to 6.4	

				modifications: for up to three different objects or groups of objects as well as for working postures with extreme forward bending, lumbar spine forces at L5/S1 were calculated. The daily exposures were calculated on the basis of the products of the squared lumbar spine forces and the average exposure durations. To calculate cumulated total work time exposure (prior to the diagnosis of lumbar spine disease), the sum doses for the individual work-years were summed				bending (h) • 0 h, controls 119 60.4, cases 47 50.0, cases • >0–1500 h, controls 45 22.8, cases 26 27.7 • >1500 h, controls 19 9.6, cases 35 26.7 Lifting/carrying combined with extreme forward bending • No lifting/carrying; no extreme forward bending, controls 56 28.4 cases 23 24.5 • Lifting/carrying>0–150 000 kg^2*h and/or extreme forward bending >0–1500 h, controls 79 40.1, cases	Lifting/carrying combined with extreme forward bending • No lifting/carrying; no extreme forward bending, 1.0 – • Lifting/carrying>0–150 000 kg^2*h and/or extreme forward bending >0–1500 h, 1.0 0.5 to 2.1 • Lifting/carrying >150 000 kg^2*h; extreme forward bending ≤1500 h, 1.5 0.6 to 3.8 • Lifting/carrying ≤150 000 kg^2*h; extreme	

				up.				33 35.1 • Lifting/carrying >150 000 kg^{2}*h; extreme forward bending ≤1500 h, controls 33 16.8, cases 18 19.1 • Lifting/carrying ≤150 000 kg^{2}*h; extreme forward bending >1500 h, controls 9 4.6, cases 9 9.6 • Lifting/carrying >150 000 kg^{2}*h; extreme forward bending >1500 h, controls 10 5.1, cases 10 10.6 Sum lumbar spine force through lifting/carrying and/or	forward bending >1500 h, 3.2 1.0 to 10.5 • Lifting/carrying >150 000 kg^{2}*h; extreme forward bending >1500 h, 2.2 0.7 to 7.3 Sum lumbar spine force through lifting/carrying and/or extreme forward bending (Nh) • 0 Nh, 1.0 – • >0–<2.0*10^{6} Nh, 1.2 0.5 to 2.8 • 2.0–<9.0*10^{6} Nh, 1.2 0.5 to 2.7 • >9.0*10^{6} Nh, 1.8 0.8 to 3.9	

								extreme forward bending (Nh) • 0 Nh, controls 56 28.4, cases 23 24.5 • >0–<2.0*10^6 Nh, controls 39 19.8, cases 19 20.2 • 2.0–<9.0*10^6 Nh, controls 45 22.8, cases 22 23.4 • >9.0*10^6 Nh, controls 47 23.9, cases 29 30.9 Exposure to whole body vibration • 0 h, controls 136 69.0, cases 47 50.0 • >0–1500 h, controls 37 18.8, cases 29 30.9 • >1500 h, controls 20 10.2, cases 16 17.0	Exposure to whole body vibration • 0 h, 1.0 – • >0–1500 h, 1.8 0.8 to 3.7 • >1500 h, 1.7 0.7 to 4.3 Exposure to whole body vibration • 0 h, 1.0 – • >0–1800h* weighting type of terrain, 2.1 0.9 to 4.8 • >1800h* weighting type of terrain, 1.9 0.7 to 4.9 Sum lumbar spine exposure (α) to lifting/carrying and/or extreme	

								Exposure to whole body vibration • 0 h, controls 152 77.2, cases 56 59.6 • >0–1800h* weighting type of terrain, controls 22 11.2, cases 20 21.3 • >1800h* weighting type of terrain, controls 19 9.6, cases 16 17.0 Sum lumbar spine exposure (α) to lifting/carrying and/or extreme forward bending and/or whole body vibration • 0, controls 54	forward bending and/or whole body vibration • 0, 1.0 – • <0.1, 1.1 0.5 to 2.5 • 0.1–<0.4, 1.3 0.6 to 3.1 • ≥0.4, 1.9 0.9 to 4.3 Cumulative sedentary work (h) • ≤10 000, 1.0 – • >10 000–30 000, 0.8 0.4 to 1.7 • >30 000, 0.9 0.3 to 2.6	

								27.4, cases 21 22.3 • <0.1, controls 44 22.3, cases 21 22.3 • 0.1–<0.4, controls 43 21.8, cases 21 22.3 • ≥0.4, controls 45 22.8, cases 29 30.9 Cumulative sedentary work (h) • ≤10 000, controls 51 25.9, cases 32 34.0 • >10 000–30 000, controls 67 34.0, cases 34 36.2 • >30 000, controls 64 32.5, cases 28 29.8		

Seidler, 2009 Germany Case control study	Outpatient or inpatient treatment in an included hospital because of lumbar disc herniation with sensitive and/or motor radix syndrome with clinically and radiologically verified lumbar disc herniation	Recruitment was performed prospectively in four study regions in Germany: Frankfurt am Main, Freiburg, Halle/Saale, and Regensburg. In the mentioned regions, all hospitals or practices (n = 29) treating at least five patients with lumbar disc herniation per year as well as a random sample of orthopedic practices (treating patients with lumbar disc narrowing; n = 14) were included. The corresponding physicians were asked to identify all patients between 25 and 70 years.	Cases were 286 males and 278 females, controls were 453 males and 448 females	Cumulative lumbar load during the total working life. All manual handling of objects of about 5 kilograms or more and postures with trunk inclination of 20 degrees or more are included in the calculation of cumulative lumbar load.	Structured personal interview, a complete occupational history was elicited to identify certain minimum workloads. On the basis of job task-specific supplementary surveys performed by technical experts, the situational lumbar load represented by the compressive force at the lumbosacral disc was determined via	Not specified	Control subjects were randomly selected from a one percent random sample of residents aged 25 to 70 years drawn by the local population registration offices of the respective region. Of 1,687 population controls, 901 agreed to participate (53.4%).	Prevalence, Men, controls n % and cases n, % Cumulative lumbar load through manual materials handling and/or intensive-load postures • 0 – <5.0*10^{6}Nh, controls 159 35.1, cases 54 18.9 • 5.0 – <21.51*10^{6}Nh, controls 147 32.5 cases 76 26.6 • >21.51*10^{6}Nh, controls 147 32.5 cases 156 54.5 Cumulative	Men, OR, 95%CI Cumulative lumbar load through manual materials handling and/or intensive-load postures • 0 – <5.0*10^{6}Nh, 1.0 - • 5.0 – <21.51*10^{6}Nh, 1.7 1.1–2.7 • >21.51*10^{6}Nh, 3.4 2.2–5.0 Cumulative lumbar load through manual materials handling • 0 –	Age, region, and unemployment as severe life event; OR for manual materials handling additionally adjusted for intensive-load postures and vice versa

					biomechanical model calculations.			lumbar load through manual materials handling • 0 – <2.34*10^{6}Nh, controls 163 36.0 cases 58 20.3 • 2.34 – <8.98*10^{6}Nh, controls 145 32.0 cases 77 26.9 • ≥8.98*10^{6}Nh, controls 145 32.0 cases 151 52.8 Cumulative lumbar load through intensive-load postures • 0 Nh, controls 129 28.5 cases 45 15.7 • >0 – <4.85*10^{6}Nh, controls 108 23.8 cases 45 15.7 • >4.85 – 14.62	<2.34*10^6 Nh, 1.0 - • 2.34 – <8.98*10^6 Nh, 1.5 1.0–2.2 • ≥8.98*10^6 Nh, 2.8 1.9–4.1 Cumulative lumbar load through intensive-load postures • 0 Nh, controls 1.0 - • >0 – <4.85*10^6 Nh, 1.3 0.8–2.1 • >4.85 – 14.62 *10^{6}Nh, 2.3 1.4–3.6 • ≥14.62*10^6 Nh 2.9 1.9–4.6 Lag-time analysis I: Cumulative lumbar load	

								*10^6Nh, controls 108 23.8 cases 84 29.4 • ≥14.62*10^6Nh controls 108 23.8, cases 112 39.2 Lag-time analysis I: Cumulative lumbar load up to 10 years prior to diagnosis or interview date (in controls) = exposure during last 10 years set to zero • 0 – <5.0*10^6Nh, controls 210 46.4 cases 69 24.1 • 5.0 – <21.51*10^6Nh, controls 133 29.4 cases 102 35.7 • ≥21.51*10^6Nh, controls 110 24.3	up to 10 years prior to diagnosis or interview date (in controls) = exposure during last 10 years set to zero • 0 – <5.0*10^6Nh, 1.0 - • 5.0 – <21.51*10^6Nh, 2.3 1.5–3.4 • ≥21.51*10^6 Nh, 3.5 2.3–5.4 Lag-time analysis II: Cumulative lumbar load; solely subjects unexposed in the last 10 years prior to diagnosis or interview date (in controls) = subjects	

								cases 115 40.2 Lag-time analysis II: Cumulative lumbar load; solely subjects unexposed in the last 10 years prior to diagnosis or interview date (in controls) = subjects exposed in the last 10 years excluded • 0 – <5.0*10^{6}Nh, controls 37 36.6 cases 15 23.8 • 5.0 – <21.51*10^{6}Nh controls 38 37.6 cases 28 44.4 • ≥ 21.51*106Nh controls 26 25.7 cases 20 31.7 Women, controls n %	exposed in the last 10 years excluded • 0 – <5.0*10^{6}Nh, 1.0 - • 5.0 – <21.51*10^{6}Nh 1.7 0.8–3.9 • ≥ 21.51*10^6 Nh 1.8 0.7–4.5 Women, OR 95% CI Cumulative lumbar load through manual materials handling and/or intensive-load postures • 0 Nh 1.0 - • >0 – <4.04*10^6 Nh 1.9 1.2–3.0 • 4.04 –	

								and cases n, % Cumulative lumbar load through manual materials handling and/or intensive-load postures • 0 Nh controls 195 43.5, cases 71 25.5 • >0 – <4.04*10^{6}Nh controls 84 18.8, cases 55 19.8 • 4.04 – <14.47*10^{6}Nh, controls 85 19.0 cases 74 26.6 • ≥14.47*10^{6}Nh, controls 84 18.8 cases 78 28.1 Cumulative lumbar load through	<14.47*10^{6}Nh, 2.7 1.8–4.2 • ≥14.47*10^6 Nh, 2.8 1.8–4.2 Cumulative lumbar load through manual materials handling • 0 Nh, 1.0 - • >0 – <1.58*10^6 Nh, 1.5 1.0–2.4 • 1.58 – <9.06*10^6 Nh, 2.4 1.6–3.6 • ≥9.06*10^6 Nh, 2.3 1.5–3.5 Cumulative lumbar load through intensive-load postures • 0 Nh, 1.0 - • >0 – <2.77*10^6	

								manual materials handling • 0 Nh, controls 218 48.7, cases 92 33.1 • >0 – <1.58*10^{6}Nh, controls 76 17.0 cases 46 16.5 • 1.58 – <9.06*10^{6}Nh , controls 77 17.2 cases 70 25.2 • ≥9.06*10^{6}Nh , controls 77 17.2 cases 70 25.2 Cumulative lumbar load through intensive-load postures • 0 Nh, controls 206 46.0 cases 75 27.0 • >0 – <2.77*10^{6}Nh, controls 80 17.9 cases 52 18.7	Nh, 1.9 1.2–3.0 • >2.77 – 8.83 *10^{6}Nh, 2.5 1.6–3.8 • ≥8.83*10^6 Nh 3.2 2.1–4.9 Lag-time analysis I: Cumulative lumbar load up to 10 years prior to diagnosis or interview date (in controls) = exposure during last 10 years set to zero • 0 Nh, 1.0 - • >0 – <4.04*10^6 Nh, 1.5 1.0–2.3 • 4.04 – <14.47*10^{6}Nh, 2.5 1.6–3.9 • ≥14.47*10^6 Nh, 2.5	

								• >2.77 – 8.83 *10^6Nh, controls 81 18.1 cases 66 23.7 • ≥8.83*10^6Nh controls 81 18.1, cases 85 30.6 Lag-time analysis I: Cumulative lumbar load up to 10 years prior to diagnosis or interview date (in controls) = exposure during last 10 years set to zero • 0 Nh, controls 215 48.0 cases 92 33.1 • >0 – <4.04*10^6Nh, controls 97 21.7 cases 60 21.6 • 4.04 – <14.47*10^6Nh, controls 70 15.6 cases 62 22.3	1.6–3.9 Lag-time analysis II: Cumulative lumbar load; solely subjects unexposed in the last 10 years prior to diagnosis or interview date (in controls) = subjects exposed in the last 10 years excluded • 0 Nh, 1.0 - • >0 – <4.04*10^6 Nh, 1.2 0.6–2.6 • 4.04 – <14.47*10^6Nh 2.2 1.0–4.8 • ≥14.47*10^6 Nh 1.4 0.6–3.1	

								• ≥14.47*10^{6}Nh, controls 66 14.7 cases 64 23.0 Lag-time analysis II: Cumulative lumbar load; solely subjects unexposed in the last 10 years prior to diagnosis or interview date (in controls) = subjects exposed in the last 10 years excluded • 0 Nh, controls 195 75.9, cases 71 64.5 • >0 – <4.04*10^{6}Nh, controls 25 9.7 cases 12 10.9 • 4.04 – <14.47*10^{6}Nh controls 18 7.0 cases 14 12.7 • ≥14.47*10^{6}Nh controls 19		

								7.4 cases 13 11.8		
Virtanen 2007 Finland Cross sectional	Intervertebral disc disease (IDD), characterized by intervertebral disc herniation and/or sciatic pain based on a Latent Class Analyses of a clinical assessment of the medical history on LBP symptoms and intensity.	Finnish male train engineers and Finnish male paper mill workers.	150 Finnish male train engineers (38 to 56 years) working for the Finnish state railways. 61 Finnish male paper mill workers similar in age distribution with sedentary jobs and no occupational exposure to vibration	Train engineer with an average of 21 years (range, 5–31 years) of exposure to whole-body vibration. They all were full-time train drivers with about 5-hour daily exposure to whole-body vibration. Moreover, they were all from the same part of Finland, which ensures that they had been operating the same kinds of locomotives and had similar exposure to vibration.	History taking	Train engineers, Paper mill workers	The occupational control group consisted of 61 male paper mill workers with sedentary jobs and no occupational exposure to vibration. They were similar to the train engineers in age distribution and educational background. All the subjects were Finnish and unrelated to each other.	Prevalence A total of 42% (38 of 91) of train engineers *versus* 17.5% (7 of 40) of sedentary workers had IDD phenotype (cluster “4”).	Train engineers belonged significantly more often to IDD-phenotype (P =0.005). *Pk zelf berekendRR=2.39, 95%CI 1.17-4.88, calculated using medcalc.org /calc/relative_risk.php*	No
Wahlstrom 2012 Sweden	Hospitalization due to lumbar disc disease and the	A cohort of Swedish construction workers who participated in a	2239 cases among 263,529 Swedish construction	Job title	Medical examination	Construction workers	White-collar and foremen working in construction	Prevalence, n total, n cases	RR (95%CI) • White-collar and	Age, height, weight, smokin

Prospective cohort study	International Classification of Diseases, Ninth Revision (ICD-9) code 722.1 (1987–1996, “Displacement of thoracic or lumbar intervertebral disc without myelopathy”) or International Classification of Diseases, Tenth Revision (ICD-10) code M51.1 (1997–2003, “Lumbar and other intervertebral disc disorders with radiculopathy”) .	national occupational health surveillance program from 1971 until 1992						• White-collar and foremen 34,717 208 • Electricians 33,938 248 • Glass workers 2476 18 • Asphalt workers 3601 27 • Insulators 2513 21 • Painters 20,681 169 • Rock workers 2678 19 • Sheet-metal workers 10,980 102 • Wood workers 57,700 526 • Machine operators 9904 90 • Preparatory workers 9859 89 • Drivers 3881 36 • Bricklayers 8167 72 • Concrete workers 27,704 243 • Repairers 2429 19	foremen 1 • Electricians 1.08 (0.89–1.30) • Glass workers 1.08 (0.67–1.76) • Asphalt workers 1.15 (0.77–1.72) • Insulators 1.25 (0.80–1.96) • Painters 1.27 (1.03–1.55) • Rock workers 1.30 (0.81–2.08) • Sheet-metal workers 1.37 (1.08–1.74) • Wood workers 1.40 (1.19–1.64)	g, and time period

								• Roofers 1210 13 • Crane operators 2996 28 • Plumbers 21,962 235 • Floor layers 4937 59 • Refrigerator technicians 1196 17	• Machine operators 1.42 (1.09–1.82) • Preparatory workers 1.50 (1.17–1.93) • Drivers 1.52 (1.06–2.16) • Bricklayers 1.52 (1.16–1.99) • Concrete workers 1.55 (1.29–1.87) • Repairers 1.60 (0.91–2.06) • Roofers 1.60 (0.91–2.80) • Crane operators 1.65 (1.11–2.44) • Plumbers 1.68 (1.39–	

									2.02) • Floor layers 1.89 (1.41–2.53) • Refrigerator technicians 1.98 (1.21–3.26)	
Zhang 2009 China Case control	Lumbar disc herniation diagnosis was evaluated by 2 or more orthopedic experts in term of patient's symptoms, signs, and imaging examination (CRT or MRI).	Patients visiting the Department of Orthopaedics of the First Affiliated Hospital, Medical College of Xi'an Jiaotong University, Shaanxi Provincial People's Hospital and Xian Tang City Hospital from January 2005 to January 2007, because of conditions such as back leg pain, diagnosis of lumbar disc herniation by CT, and/or MRI and with typical sciatica.	2010 cases and 2170 controls matched in race, gender, age and living area.	Lumbar load: • "very light" = no stable job, and very few manual, • "light" = work mainly as seat, • "middle" = work mainly as bending and shaking, • "heavy" = work mainly as weight lifting and heavy physical labor Occupational character: • Nonmanual • Half manual/half nonmanual	Questionnaire	Not specified	Subjects in the control group were randomly selected from in-patients or participants of medical examination, which had no back pain history at present or more than a month ever, sciatic nerve pain, such as spinal instability from trauma, scoliosis, and spondylolisthesis.	Not described	OR (95%CI) Men & women Age<30 years • Occupational character 5.175 1.738–15.433 Age 30-55 years • Lumbar load 1.983 1.527–2.575 Age >55	Diverse for instance family history, physical exercise, educational background, hard working, time urgency,

				• Manual					years • Lumbar load 2.909 1.830–4.627	
Zhang 2013 China Case control	Lumbar disk herniation, and typical sciatica according to the Department of Orthopaedics based on reasons of back leg pain, computed tomography/magnetic resonance. Patients with lumbar spinal stenosis, spinal congenital dysplasia, intraspinal tumor, and spondylolisthesis were excluded from this study.	Lumbar disk herniation patients admitted to the Department of Orthopaedics of the First Affiliated Hospital, Medical College of Xi'an Jiaotong University, Shaanxi Provincial People's Hospital, and Xian Tang City Hospital from January 2005 to January 2007.	131 patients and 137 subjects in the control group	Lumbar load • Level I (slight) represents no fixed occupation and little physical labor; • Level II (mild) represents mainly sitting at work; • Level III (moderate) represents mainly bending over and twisting and whole-body vibrating at work; • Level IV (severe) represents mainly heavy lifting and heavy labor work	Questionnaire	Not specified	Subjects were selected randomly from in-patients or participants of medical examinations who had no history of back pain at present, for more than a month, or ever; sciatic nerve pain; spinal instability from trauma; scoliosis; or spondylolisthesis.	Prevalence Lumbar load Levels I and II • Patients n=57, 44.5% • Controls n=104, 78.8% Levels II and IV • Patients, n=71, 55.5% • Controls n=28, 21.2%	OR (95%CI) Lumbar load 4.627 (2.686 - 7.969)	