Original Article

Regression Model for Socio-demographic, Behavioural and Occupational Risk Factors in Lumbar Disc Herniation (LDH) and Lumbar Disc Degeneration (LDHD)-In Comparison to Apparently Healthy Subjects.

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Objective: Present study was aimed to develop a regression model for selected socio-demographic, behavioural and occupational factors with lumbar disc herniation (LDH) and lumbar disc hearniation and degeneration (LDHD) in a selected population in comparison to healthy individuals.

***Materials & Methods*:** The study was conducted using 104 cases with disc herniation and controls (n=104) without LDH. Analysis was conducted in sub groups of patients with LDH (n=67) and LDHD (n=37) in comparison to control subjects. Pre-tested questionnaire was administered to all participants to gather information.

***Results & Discussion*:** Among the cases 35.6 % presented with LDHD while 64.4 % had only LDH. Among the socio-demographic characters, body mass index <25 kgm^{-2} was a significant protective factor for both LDHD (OR=0.31; 95% CI=0.13-0.72) and LDH (OR=0.39; 95% CI=0.20-0.77). Involvement in daily activities with heavy (OR=5.1; 95 % CI=2.1-11.8) and moderate strain (OR=3.1; 95 % CI=1.5-6.6) to back, sitting more than eight hours per day (OR=5.1; 95 % CI=1.0-25.7), smoking (OR=5.0; 95 % CI=1.5-16.4) and sleeping in supine position (OR=2.09; 95% CI=1.09-4.06) were significant risk factors for LDH. Only daily physical activities with heavy strain act as a significant risk factor (OR=3.1; 95 % CI=1.1-8.5) for the development of LDHD. Types of mattresses used did not have a significant difference among cases and controls. Majority of cases (56.7 %) did not know the causative factor that led to LDH. According to the regression model, BMI, smoking and involvement in physical activities with moderate and heavy strain to back were considered as significant risk factors for the development of LDH or LDHD.

Conclusion: In regression model BMI, smoking and daily physical activities with moderate and heavy strain to back were found to be the significant risk factors for development of LDH or LDHD.

Key words: Lumbar disc herniation, lumbar disc herniation and degeneration, regression model.

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Introduction

Lumbar disc herniation (LDH) is considered as a major socio-economic problem not only in Sri Lanka but also in many developed countries. Although there are numerous determinants for lower back pain (LBP), lumbar disc herniation (LDH) is the most common concern.[1, 2] Evidence suggest that annual cost spent on LBP associated with LDH in United States exceeds 100 billion dollars each year whereas in United Kingdom it is estimated as 12 billion pounds per annum. In Netherlands it was reported as 1.7 % of the

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gross national production, these data support the evidence that LBP is a major burden for the economy of the country.[2, 3] Studies have reported that 60-80 % of the population have suffered of LBP associated with LDH at least once during their lifetime. [2, 4] In addition to the direct costs, indirect costs such as, significant percentage of sick leaves among affected employees, costs of lost wages, reduced productivity, psychological distress and costs for additional care given are major problems linked with LDH associated LBP.[1] It is suggested that LDH is one of the main determinants in limiting activities among adults below 45 years of age.[5]

Despite several studies carried out worldwide to determine the cause for LDH, yet the exact cause/s are unknown. [4, 6] It is hypothesized that some conventional factors such as age, gender, severe mechanical and physical loading, trauma, strenuous sporting activities, vibrations and smoking as main causative factors for LDH.[7-10] Evidences suggest that degeneration usually start at a very early stage of life where mild changes could be seen in first decade of life and more significant changes from second decade onwards causing lumbar disc herniation and degeneration (LDHD) However, studies emphasized that LBP associated LDH or LDHD are most common during fourth to fifth decade of life. [3, 11-13] Furthermore, studies carried out on LDH have indicated that males are more vulnerable for LDH compared to females. [13-15] Further, evidences confirm that there is a significant association of sporting activities with LDH. [16-18]

Although there is an increased trend for hospitalization of patients with LDH, the information pertaining to behavioural and occupational risk factors that lead to LDH is not available in Sri Lankan context. Thus, the present study was carried out to identify the association of selected socio-demographic, behavioural, sports and occupational factors contributing to LDH. Although several biochemical factors have been considered in the risk of developing LBP associated with LDH, there were less information available on the effect of different firmness of mattresses and sleeping positions on this regard. Therefore, more importantly the present study focused on sleeping positions and the sleeping systems (mattresses used) used by the study participants as these factors were not considered much in reported literature pertaining to LDH, but conventionally considered as crucial factors for LBP associated with LDH. Further, there are no reported studies on development of a regression model incorporating these factors. As regression models give a better view on risk factors, present study aimed to investigate possible socio-demographic, behavioural and occupational factors and development of a regression model associated with LDH and lumbar disc herniation and degeneration (LDHD).

Materials and Methods

Study design and setting

Cases (subjects with disc herniation) were recruited from a hospital in the capital of Sri Lanka which drains patients from all over the country and thereby representing almost all districts of Sri Lanka. Controls represented several districts of Sri Lanka. The analysis was carried out at University of Sri Jayewardenepura Sri Lanka. Subgroup analysis was conducted in LDH subjects (n=67) and subjects with LDHD (n=37) in comparison to control subjects (n=104). Ethical approval was obtained by the Ethics Review Committee of Faculty of Medical Sciences, University of Sri Jayewardenepura, Colombo, Sri Lanka (29/14). After detailing out the study protocol, informed written consent was obtained from all participants.

Study population

The 104 cases were patients who had low back pain with lumbar disc herniation confirmed by Magnetic Resonance Image (MRI) by a consultant neurosurgeon and consultant radiologist. Inclusion criteria for controls (n=104) were adult volunteers without low back pain at least for the past one-month period of the study and did not have LDH. Both case and control subjects were between 18-74 years of age. The concomitant presence of other bone disorders such as osteoarthritis, osteoporosis and pregnancy and, malignancies were exclusion criteria for both cases and controls, while cases with trauma and accidents related LDH were also excluded. Cases presented with LDH with concomitant degeneration was grouped as LDHD subjects (n=37) whereas cases with herniation only grouped as LDH subjects (n=67).

Sample size calculation

Where, $$n = \left(\frac{Z\sigma}{\delta}\right)^2$$

n = Sample size

Z= Standard normal deviate for chosen confidence level.

Since 95 % confidence level was used the value is 1.96

σ = Standard deviation
δ = precision of 0.5
At 5% significance level and with a precision of 0.5 the total sample size was calculated.

Data collection

A pre-test was carried out to validate the questionnaire (data not included in the study). A standardized, interviewer administered questionnaires lasting 10-15 minutes was administered to each patient by the principal investigator enquiring their demographic data, daily activities, physical and behavioural activities, occupational status, sleeping pattern, type of mattress used, general health status and current health condition. Major causative factor stated by the patients for disc herniation was noted from the clinical history. Participants were given the opportunities to clarify their doubts in a familiar and comfortable language of the individual (English, Tamil or Sinhala).

Age had been calculated to the nearest completed year and educational levels were categorized according to the national criteria. BMI was calculated according the standard formula and height of each participant was measured without shoes in straight standing style and when the heels of the foot, buttocks and head was stuck to the wall using a standard stadiometer with a moveable ruler to the closest 0.1 cm while weight measured without shoes, using an electronic weighing scale to the closest 0.1 kg. Smokers were defined as individuals who smoked any tobacco in the past twelve months of the study and included those who stopped smoking within past year and consumption of alcohol was defined as individuals who consumed alcohols usually or occasionally in the past twelve months of the study and also included who stopped consuming alcohol within past year. [19] Severity of daily physical activities were categorized according to the Yusuf *et al* (2004) and Seidler *et al* (2003). [20] Individuals who regularly engaged in lifting heavy weights, frequent climbing of stairs and involved in vigorous physical exercises more than 4 hours per week were categorized as heavy strain to back, while individuals regularly engaged in activities which elicit moderate strain such as gardening, cycling, standing and driving more than 4 hours per week were categorized as moderate strain to back.

Statistical data analysis

Data were coded and captured on Excel and SPSS version 20.0. Frequencies and percentages were calculated for all data. Odds ratio was calculated to assess the risk factors for disc herniation in the study population and p value ≤ 0.05 was considered statistically significant. Risk estimates for developing either LDHD or LDH was calculated using logistic regression analysis. Crude odds ratio (OR) and 95 % confidence interval (CI) were calculated for age, BMI, gender, marital state, education and employment at the enrollment for the study using chi-square test. An unadjusted ORs were calculated for severity of daily physical activities, occupational exposure, engaged in sports, duration of sitting, smoking and consumption of alcohol. The exposure categories (0, 1, 2 etc.) were included as internal scaled variables in logistic regression model. Measures of exposure were based on self-declaration of the subjects. For the purpose of analysis, cases were further categorized into two subgroups; patients who presented with both degeneration and herniation (LDHD group) and patients who presented only with lumbar herniation (LDH group). Missing values were analysed as a separate category (results not shown here).

Results

Socio-demographic characteristics of the study subjects

As investigators have checked the eligibility criteria for both controls and cases prior to the study by clinical examination (conducted by a consultant radiologist and a consultant neurosurgeon) and by an interviewer administered questionnaire, all eligible study participants (cases=104; controls=104) were included for the analysis of all variables mentioned except for variable BMI (Table 1) and sleeping positions (Table 2).

Socio-demographic characteristics of the study subjects are presented in Table 1. Disc herniation and degeneration was present in 37 (35.6%) of the cases (LDHD) and rest of the subjects had only lumbar disc herniation (LDH= 64.4 %). In cases, the mean age (SD) for subjects with LDH was 41.5 (±14.8) years, while subjects with LDHD was 47.4 (±17) years. Control subjects showed a mean age of 43.2 (±15.2) years. Majority of the cases with LDHD (51.5%), LDH (64.2%) and controls (60.5%) were less than 50 years of age. However, there was no significant difference in the age between LDHD group (OR=0.69; 95% CI=0.32-1.46) and LDH group (OR=1.16; 95% CI=0.62-2.20) when compared to that of control group (Table 1).

Response rate for BMI in controls, cases with LDHD and cases with LDH was 95.1%, 83.8% and 86.6% respectively. Few cases were reluctant to participate in height and weight measurement due to the severity of pain where control subjects declined to remove foot ware for the weight measurement. These were the limitations for calculating BMI. It was recorded that majority of cases with LDHD (67.7%) and LDH (62.1%) were in over weight and obese category (≥ 25 kgm^{-2}). The mean (SD) BMI in both LDHD and LDH groups was above the normal limits, 39.1 (27.5) kgm^{-2} and 36.7 (24.3) kgm^{-2} respectively. The BMI of the control subjects (27.1±16.6 kgm^{-2}) was also above the normal limits but significantly lower than the case subjects (LDHD and LDH group). BMI less than 25 kgm^{-2} acts as a protective factor for LDHD (OR=0.31; 95% CI=0.13-0.72) and LDH group (OR=0.39; 95% CI=0.20-0.77). Significant difference was not observed between groups for gender difference. In this cohort of study, majority of the subjects in both cases (LDHD=81.1%; LDH=77.6%) and controls (73.1%) were married. Similarly, there was no significant difference in marital status among the study groups. Majority of the subjects in cases (LDHD=67.6%; LDH=73.1%) and controls (62.5%) had secondary or higher level of education with no significant difference between study groups. In all study groups higher percentages of subjects were employed (LDHD (64.9%), LDH (65.7%) and controls (80.8%) respectively). Employment at the time of enrollment did not indicate a significant difference among the three study groups (Table 1).

Behavioural and occupational physical workload

It was reported that LDHD and LDH were associated with behavioural and occupational physical workload that caused strain to the lower back. When occurrence of LDH was assessed in relation to behavioural and occupational risk factors among cases and controls, majority of the cases (LDHD=56.7%; LDH=68.6%) were engaged in activities which causes heavy or moderate strain to back when compared to controls (36.5%) (Table 2). The odds ratio (OR) for daily activities with heavy strain to back yielded a statistically significant risk value of 3.1 (95% CI=1.1-8.5) in cases with LDHD and odds ratio of 5.1 (95% CI=2.1-11.8) in cases with LDH only. Although daily activities with moderate strain to back did not show a statistically significant association

Table 1. Baseline demographic characteristics in case groups and control group.

Characteristics	Control subjects (n=104)	LDHD[a] (n=37)		LDH[b] (n=67)	
	n (%)	n (%)	OR (95% CI)	n (%)	OR (95% CI)
Age					
< 50 years	63 (60.5)	19 (51.5)		43 (64.2)	
≥ 50 years	41 (39.4)	18 (48.6)	0.69 (0.32-1.46)	24 (35.8)	1.16 (0.62-2.20)
BMI					
< 25 kgm^{-2}	60 (60.6) (n=99)	10 (32.2) (n=31)	0.31 (0.13-0.72) *	22 (37.9) (n=58)	0.39 (0.20-0.77) *
≥ 25 kgm^{-2}	39 (39.3) (n=99)	21 (67.7) (n=31)		36 (62.1) (n=58)	
Gender					
Female	50 (48.1)	19 (51.3)	1.14 (0.53-2.41)	31 (46.2)	0.93 (0.50-1.72)
Male	54 (51.9)	18 (48.6)		37 (55.2)	
Marital status					
Married	76 (73.1)	30 (81.1)	1.58 (0.62-4.00)	52 (77.6)	
Unmarried	28 (26.9)	7 (18.9)		15 (22.4)	1.28 (0.62-2.62)
Educational level					
Primary	39 (37.5)	12 (32.4)	0.80 (0.30-1.77)	18 (26.9)	0.61 (0.31-1.19)
Secondary or Higher	64 (62.5)	25 (67.6)		49 (73.1)	
Employment at enrollment					
Employed	84 (80.8)	24 (64.9)		44 (65.7)	0.45 (0.22-0.91)
Unemployed	20 (19.2)	13 (35.1)	0.44 (0.19-1.01)	23 (34.3)	

[a]LDHD-Patients with lumbar disc herniation and degeneration; [b]LDH-Patients with lumbar disc herniation

Table 2. Behavioral and occupational risk factors in case groups and control group

Variable	Control subjects (n=104)	LDHD[a] (n=37)		LDH[b] (n=67)	
	n (%)	n (%)	Unadj. OR (95 % CI)	n (%)	Unadj. OR (95 % CI)
1.Severity of daily physical activities					
a)Light strain to back or sedentary	66 (63.5)	16 (43.2)	1 (-)	21 (31.3)	1 (-)
b)Moderate strain to back	25 (24)	11 (29.7)	1.8 (0.7-4.4)	25 (37.3)	3.1 (1.5-6.6) *
c)Heavy strain to back	13 (12.5)	10 (27)	3.1 (1.1-8.5)	21 (31.3)	5.1 (2.1-11.8) *
2.Occupational groups					
a)Occupations without physical work	95 (91.3)	32 (86.5)	1 (-)	59 (88.1)	1 (-)
b)Occupations-light physical work load	7 (6.7)	2 (5.4)	0.8 (0.16-4.3)	3 (4.5)	0.7 (0.17-2.8)
c)Occupations-moderate physical work load	1 (1)	2 (5.4)	5.9 (0.52-67.7)	4 (6)	6.4 (0.70-59.0)
d)Occupations-high physical work load	1 (1)	1 (2.7)	2.9 (0.18-48.8)	1 (1.5)	1.6 (0.09-26.2)
3.Engaged in sports					
a)Not engaged in sports	57 (54.8)	16 (44.4)	1 (-)	37 (55.2)	1 (-)
b)Moderately strenuous sporting activities	5 (4.8)	3 (8.3)	2.0 (0.44-9.6)	4 (6)	1.1 (0.28-4.7)
c)Strenuous sporting activities	42 (40.4)	17 (47.2)	1.2 (0.6-2.8)	26 (38.8)	0.73 (0.37-1.4)
4.Duration of sitting (hrs)					
a)2-4	61 (58.7)	25 (67.6)	1 (-)	42 (62.7)	1 (-)
b)5-8	41 (39.4)	8 (21.6)	0.47 (0.19-1.1)	18 (26.9)	0.6 (0.32-1.2)
c)>8	2 (1.9)	4 (10.8)	4.8 (0.8-28.3)	7 (10.4)	5.1 (1.0-25.7) *
5. Smoking					
a)Smoking	5 (4.8)	5 (13.5)	3.1 (0.78-12.8)	12 (17.9)	5.0 (1.5-16.4) *
b)Not smoking	99 (95.2)	32 (86.5)	1 (-)	55 (82.1)	1 (-)
6. Alcohol consumption					
a)Consuming alcohol	29 (27.9)	12 (32.4)	0.96 (3.9-2.3)	21 (31.3)	0.78 (0.36-1.7)
b)Not consuming alcohol	75 (72.1)	25 (67.6)	1 (-)	46 (68.7)	1 (-)
7. Sleeping positions					
a)Supine	26 (25.5) (n=102)	9 (25) (n=36)	0.97 (0.41-2.34)	28 (41.8) (n=67)	2.09 (1.09-4.06) *
b)Other postures	76 (74.5) (n=102)	27 (75) (n=36)	1 (-)	39 (58.2) (n=67)	1 (-)
8. Types of sleep system					
a)firm	22 (21.2)	7 (18.9)	0.87 (0.33-2.24)	7 (10.4)	0.43 (0.17-1.08)
b)moderately firm	82 (88.8)	30 (81.1)	1 (-)	60 (89.6)	1 (-)

for LDHD group, it appeared as a risk factor for the cases with LDH only, with OR of 3.1 (95% CI=1.5–6.6) (Table 2).

When the physical demanding nature of the occupation was concerned, majority of the subjects in control (91.3%), LDHD (86.5%) and LDH (88.1%) groups were not employed in physical demanding occupations. Occupations with moderate to high physical work load revealed a non-significant risk association in both LDHD (OR=5.9 (95% CI=0.52–67.7) and OR=2.9 (95 % CI=0.18–8.8)) and LDH (OR=6.4 (95% CI=0.70–9.0) & OR=1.6 (95% CI=0.09–26.2) group (Table 2).

Results also indicated that engaging in sports and duration of sitting does not have a significant association in patients with LDHD. However, sitting more than 8 hours a day revealed a statistically significant OR of 5.1 (95% CI=1.0–25.7) in subjects with only LDH in Table 2.

Smoking showed a significantly elevated OR of 5.0 (95% CI=1.5–6.4) in patients with LDH only which acts as a strong contributory risk factor for LDH. Although there was a risk OR of 3.1 (95% CI=0.78–2.8) in patients with LDHD, it was not significant. Consumption of alcohol was not a significant risk factor for both LDH and combined degeneration (Table 2).

When the supine sleeping posture was compared with other sleeping postures including prone and

Table 3. Association of risk models for lumbar disc herniation and lumbar disc herniation and degeneration in study population

Variable	Subjects with LDHD		Subjects with LDH	
	Adjusted OR	95 % CI	Adjusted OR	95 % CI
1.Age	1.01	0.98-1.04	0.99	0.96-1.0
2.BMI	1.02	1.00-1.04*	1.02	1.02-1.04*
3.Gender	3.30	0.96-11.42	2.00	0.79-5.12
4.Smoking	3.43	0.72-16.36	6.44	1.69-24.51*
5.Alcohol	1.83	0.48-7.08	1.27	0.43-3.75
6.Sports a)Strenuous sports b)Moderately strenuous sports	 1.28 2.54	 0.49-3.31 0.39-16.32	 0.59 1.2	 0.26-1.29 0.23-6.03
7.Moderate and Heavy strain to back	1.99	0.78-5.03	3.36	1.57-7.09*
8.Physically demanding occupations a)Severely demanding b)Moderately demanding c)Less demanding	 0.71 3.85 0.65	 0.03-20.21 0.27-54.69 0.11-4.00	 0.29 3.81 0.59	 0.07-12.27 0.35-41.64 0.12-2.99
9.Sitting more than 8 hours per day	5.34	0.79-36.02	3.65	0.63-21.11

lateral supine posture, it yielded a significant risk odds ratio of 2.09 (95% CI=1.09-4.06) in patients with LDH. However, supine posture was not considered as a risk posture for the patients with LDHD. Majority of the patients in two case groups (LDHD=81.1% & LDH=89.6%) and control group (88.8%) have used moderately firm mattresses for sleeping which did not show a significant difference between study groups (Table 2).According to the regression model, BMI has been considered as a significant risk factor for the development of lumbar spine diseases for both LDHD (OR=1.02 (95% CI=1.0–1.04)) and LDH (OR=1.02 (95%CI=1.02–1.04)). Smoking and heavy to moderate strain to back revealed statistically significant ORs of 6.44 (95% CI=1.69–24.51) and 3.36 (95% CI=1.57–7.09) in the regression model for patients with only LDH (Table 3).

Discussion

Evidences suggests that degeneration starts at a very early stage of life where mild changes are seen in the first decade of life and more significant changes from second decade onwards. [3,11,21] It is reported that LBP, lumbar disc herniation and degeneration are common in the fourth to fifth decade of life. [5,12,22] One study has indicated that mean age for LDH as 37 years, [12] while other studies have reported mean ages as 45 ± 13 years and 42 ± 10 years [15] and 41 ± 10 years. [21] Mean ages in all study groups of the present study were in fifth decade of life which was similar to the previous reported findings mentioned above. However, contrast to our findings, one study has recorded 61 - 70 years as the peak age for LDHD in both genders. [23]

We observed a significant difference in BMI between cases and control indicating majority of the patients in LDHD group (67.7%) and LDH group (62.1%) were in overweight or obese categories according to BMI. However, control group had 51% subjects with normal BMI. Although there were many heterogeneous data available regarding the association of BMI and LDH, majority of the data emphasized that increased BMI or obesity is a risk factor for LDH. Present study also confirms the above fact as BMI less than 25 kgm^{-2} as a protective factor with odds ratio of 0.31 (95% CI=0.13-0.72) in LDHD group and 0.39 (95 % CI=0.20-0.77) in the LDH group. Studies conducted on histological assessment of intervertebral disc tissue further confirmed that high degree of degeneration is also associated with elevated BMI. [23] As overweight and obesity encounters an increased pressure and weight on the intervertebral tissue thus, initiate herniation and degeneration of the intervertebral discs.

Study findings regarding gender and LDH in the present study are in accordance with reported similar studies. A study conducted with 205 surgical patients reported that men to women ratio in patients who are undergoing lumbar surgery was 1.5:1 in surgical setting.[13] This was in accordance with the study carried out by Kelsey and co-workers (1984). However, in non-surgical setting it was reported that men to women ratio was 1:1. In addition, another study showed that prevalence ratio for male:female was 1:0.61 with

a significance of p=0.0001. [23] Similar observations were noted in a study which recruited 48 patients with LBP. Above study affirmed similar male prominent gender distribution with 67% males and 33% females. [15] Further, a reported study has also indicated that LDH is found in 4.8% men over 35 years and 2.5% women over 35 years suggesting that men are more prone to LDH. [12] The present study finding in Sri Lankan subjects with LDH also adds to the study findings that males are more prone to develop LDH compared to females.

Majority of cases (both LDHD and LDH groups) and controls had secondary or higher educational level. Experts suggest that subjects who are employed with higher education level having more sedentary lifestyle and they lack of exercise on back muscles, which leads to weaken the power of the muscles. This could trigger the herniation of the intervertebral disc, when the vertebral column encounters a sudden load. However, according to the present study control group also had a good educational level, hence this phenomenon cannot be applied to the present scenario.

In the present study, there was a significant difference in smoking among cases and controls (p=0.012) with high frequency of smoking reported in cases (16.3%) compared to controls (4.8%). Our findings are in accordance with previous studies which affirm the association between smoking and LDH. Studies have reported that smoking in past years is associated with increased risk of LDH. [14] Further studies have highlighted that nicotine in cigarettes may cause narrowing of blood vessels hence impair the blood flow to the disc tissue causing disc degeneration. [22,24] A twin study reported by Battie et al (1995) remarked that there were 18% greater mean disc degeneration scores in lumbar spine of smokers when compared to non-smokers. Interestingly, a study has stated that smoking cannot be regarded as a risk factor for disc degeneration although there was considerable percentage (41 %) of smokers in the study. [25] Therefore, this present study finding on smoking further adds evidence to previously reported studies on the positive association between LDH/LDHD and cigarette smoking. Further, studies have identified that intervertebral disc being the largest avascular tissue in the human body, narrowing of blood vessels by nicotine can interrupt the diffusion process via cartilage end plate, thus leading the disc to degenerate.

To further strengthen the study, the present study also attempted to distinguish the relationship between the sleeping postures and type of mattress used in LDH subjects. These factors are considered as critical conventional factors contributing to LBP associated with LDH. However, present study did not find any significant association with types of mattresses used and LDH/LDHD. However, there were limited literature on these parameters. A study conducted in 313 adults with LBP has proven that medium firm mattresses had better outcome for pain while in bed (OR=2.35; 95% CI=1.13-4.93) compared to the pain on rising on the same mattress type (OR=1.92; 95% CI=0.97-3.86) when compared to patients using firm mattresses. Finally, authors have concluded that medium firm mattresses could improve the pain and disability in patients with chronic lower back pain. [26] Further, it was also believed that mattresses with soft surfaces increase LBP due to incorrect support to the vertebral column and decrease the quality of sleep. [27]

It is believed that loading of the intervertebral disc is an important factor which determines LDHD and LDH. Therefore, different impact on the disc by different sleeping postures could not be disregarded in the etiology of LDHD and LDH. However, studies done on direct measurement of spinal loading is limited and studies on sleeping postures are scarce. Interestingly, present study has observed that sleeping in supine posture as a significant risk factor with odds ratio of 2.09 (95% CI=1.09-4.06) in patients with LDH. However, this phenomenon could not be observed in patients with LDHD. It was stated that proper sleeping system could align the spine on to its neutral posture as do in upright position, whereas non-neutral postures can apply unbalanced loading on intervertebral discs and facet joints. Further, intervertebral discs tend to restore and grow through hydration during sleeping. As the gravity changes during sleeping, intervertebral disc tissues are unloaded and can rehydrate to restore its elasticity. [28]

Therefore, findings related to sleeping postures and type of mattress used adds valuable insight to the studies on risk factors associated with LDH and LDHD.

In the current analysis of the study, we specially focused on the association between physical workload and LDH. Accordingly, results of this case-control study on occupational risk factors associated with LDH are well correlated with the reported studies on similar theme. Heavy physical work such as lifting and carrying heavy objects are proposed risk factors for LDH associated

LBP. [16] Another study on identical twins also found similar findings. [29] It is also reported that heavy lifetime occupational and physical loading have an association with disc degeneration in upper lumbar levels (p=0.055 - 0.01) whereas sedentary work was associated with less significant degeneration (p=0.006). [29] Contrast to our findings, observations by a different study conducted in monozygotic twins stated that there was no significant difference observed in the level of leisure time physical activities when the monozygotic twins were compared to entire twin cohort in Finland. [30] Similarly, a review has shown that workers with many sedentary activities had higher prevalence rates for LBP symptoms and sick leaves due to LBP [OR=1.46; (95% CI=1.18–1.29) for sedentary leisure activities)]. They have also indicated that physical activities in leisure time (either sports or daily physical activities) do not associate with prevalence rates for low back morbidity. [31] A review study concluded contradictory findings stating that sedentary lifestyle and leisure time is not associated with LBP. [32] Our study further confirmed that severity of daily physical activities causing strain to back have a considerable effect on LDHD.

Occupation was recorded as a risk factor by Manek and MacGregor (2005). The authors stated that occupations with night shifts, lifting, bending, twisting, pulling and pushing favours LDHD. [16] According to the present study authors found heavy lifting, bending and twisting as severe or moderate risk occupations that had a strong significant association with LDH [OR=5.96 (95% CI=1.22–29.18)]. Another study also emphasized that main causes for LBP associated with LDH in workplace are heavy lifting, repeated loads from manual handling, work postures incurring postural stress and whole-body vibrations. [33] Contradictory to our findings a twin population study stated that there is no significant association with occupational loading and LDHD. [34] Therefore, our findings with perceived work strains on LDH cannot be disregarded.

There are several reported literatures that suggest the relationship between sports and LDHD. Hence, present study also hypothesized sports as a contributory factor for LDHD. However, authors could not find significant association with LDH/LDHD and sports. According to published literature, evidence have stated that there was high incidence of radiographic abnormalities of spondylolysis in college level football players (80.5%). [16] In addition, above study also stated that spondylolysis as a significant risk factor for LBP in football players. Observations from another study was in agreement with previous studies stating that football players were at increased risk of developing LBP and disc degeneration. [17] Another study conducted in Japan among rugby players (n=327) also supported the above relationship of LBP and strenuous sporting activities. That study also emphasized radiographic abnormalities seen in spondylolysis as a significant radiological risk factor for LBP in high school rugby players. [18] A similar study conducted in elite athletes also revealed that disc degeneration is significantly higher in elite athletes (75%) when compared to non-athletes (31%). [35] However, a similar case control study carried out in former elite athletes showed that odds ratios for back pain was significantly lower among athletes than among control subjects suggesting contradictory findings of the above report. Authors have also stated that LBP is less common in athletes when compared to control subjects [OR=0.62; (95 % CI=0.37 – 0.98) for endurance sports: OR=0.60; (95% CI=0.44–0.82) for sprinting and games: OR= 0.67; (95% CI=0.47-0.96) for contact sports such as wrestling and boxing]. The study further commented that maximal weightlifting is associated with disc degeneration of the entire lumbar spine, whereas soccer associated degeneration confined to lower lumbar spine region only. Authors further emphasized that there was no accelerated disc degeneration in runners and shooters. [36] Number of factors could have interfered with the results of present study with LDH and sports. Majority of participants of the present study were unable to mention the duration of involvement in sports, reason for stop playing and unable to recall the specific sporting activities they were engaged during school time. Therefore, these factors could have greatly reduced the specificity of sports definitions and might also lead to numerous misclassifications of the type of sports (strenuous sports or mild strenuous or etc.). Though there is no significant association between sports and LDH, present study could highlight some valuable information regarding sports and LDH. According to the history of involvement in sports among the recruited subjects in our study emphasizes that improper training or lack of back muscle strengthening exercise may attribute for sports associated LBP and LDHD in Sri Lankan context. Further, according to expertise experience it is

hypothesized that people who have engaged in sports have developed a good muscle tone during the period of active involvement in sports, but when they quit or stop regular sporting activities the developed muscle tone will decrease and as a result when they participate in strenuous work or sports, the load that comes to the body will directly pass through the vertebral column without involvement of back muscles. Hence, the intervertebral disc tends to herniate which is enhanced by the excessive load that triggers degeneration.

Traditionally it was believed that traumatic occupations and heavy physical/mechanical loading were the major contributing factors that leads LBP and LDHD. [7, 9] However, according to the present study more than half of the study subjects (56.7%) did not have any of the above predisposing factors associated with LDH. Therefore, it is suggested that there could be other factors associated with regular or occupational behavior that is related to LBP in this cohort of patients.

Recurrence of LDH in the present study was 13.5% and was in agreement to previous findings of recurrence of lumbar disc disease (5–15%). [37, 38] However, above published studies further commented that there was no significant association of age, sex and level of herniation and the recurrence of LDH.

The limitations of the present study include a convenience sample with case-control study design. Secondly, assessment of BMI had a limitation as some of the cases were reluctant to measure height and weight due to severity of pain while some controls refused to remove foot ware to measure the weight. Further, social behavior also had a limitation as it was based on direct questioning of the participants only. Also, self-reported data on sleeping posture and data on daily physical activities were regarded as limitations of the study. There are several notable strengths in our study such as assessing of sleeping postures, types of sleeping systems and developing of a regression model associated with LDH are considered as strengths. Though the sample size was adequate to detect the hypothesized effects of socio-demographic, behavioural and occupational factors associated with disc herniation among Sri Lankan subjects, large studies would add more comprehensive findings in the etiology of disc herniation.

Conclusion

According to the regression model BMI, smoking and daily physical activities with moderate to heavy strain to back are significant risk factors for development of LDH or LDHD. In addition, present study highlights that there was no significant association between type of mattress used by the study participants although these were considered as triggering factors for LDH and LDHD. Further, more than 50% of the subjects who presented with LDH or LDHD were less than fifty years of age.

Declarations

Sources of funds

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Conflicts of Interest

The authors report no conflicts of interest either financially or non-financially. The authors alone are responsible for the content and writing of the paper.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Ethics Review Committee, Faculty of Medical Sciences, University of Sri Jayewardenepura, Colombo, Sri Lanka (29/14) with the 1964 Helsinki declaration and its later amendments.

Informed Consent to participate

Informed consent was obtained from all individual participants included in the study.

Competing interests

The authors declare that they have no competing interests either financially or non-financially.

Author's Contribution

Athiththan LV, Withanage ND and Perera S conceived the study concept and contributed in the study design. Withanage ND wrote the first draft of the first manuscript, conducted experimental studies and carried out data analysis. Prathapan S supported in results interpretation. Athiththan LV, Prathapan S and Peiris H contributed in manuscript editing. Withanage ND and Athiththan LV are guarantors of the work and Withanage ND has the full access to data and takes responsibility for the study.

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