J Rehabil Med 2013; 45: 76–80

ORIGINAL REPORT

LOW BACK PAIN ASSOCIATED WITH SOCIODEMOGRAPHIC FACTORS, LIFESTYLE AND OSTEOPOROSIS: A POPULATION-BASED STUDY

Yi-Chun Chou, MD[1], Chun-Chuan Shih, MD, PhD[2,3], Jaung-Geng Lin, MD, PhD[3], Ta-Liang Chen, MD, PhD[4,5]* and Chien-Chang Liao, MPH, PhD[4,5,6]

From the [1]Department of Physical Medicine and Rehabilitation, China Medical University Hospital, Taichung, [2]School of Chinese Medicine for Post-Baccalaureate, I-Shou University, Kaohsiung City, [3]Department of Chinese Medicine, China Medical University, Taichung, [4]Department of Anesthesiology and Health Policy Research Center, Taipei Medical University Hospital, Taipei, [5]Department of Anesthesiology, School of Medicine, Taipei Medical University, Taipei and [6]Management Office for Health Data, China Medical University Hospital, Taichung, Taiwan.
**Equal contribution with first author.*

Objective: **To investigate the prevalence and factors associated with low back pain among adults in Taiwan.**
Methods: **The National Health Interview Survey, a cross-sectional study, was conducted from October 2002 to March 2003 to gather data from 24,435 adults aged 20 years and older selected randomly from Taiwan's general population. Participants with history of low back pain were assessed using a comprehensive questionnaire. Additional assessment of osteoporosis diagnosed by physician was also evaluated.**
Results: **Among the 24,435 adults, 25.7% had reported low back pain within the past 3 months. Factors associated with low back pain included female gender (odds ratio (OR) = 1.67, 95% confidence interval (CI) = 1.43–1.95), low education (OR = 1.38, 95% CI = 1.23–1.55), and blue-collar work (OR = 1.16, 95% CI = 1.07–1.26). Patients with osteoporosis were more likely than those without osteoporosis to have low back pain (OR = 2.55, 95% CI = 2.33–2.78) or frequent low back pain (OR = 4.15, 95% CI = 3.66–4.70). The ORs of frequent low back pain in association with osteoporosis in men and women were 5.77 (95% CI = 4.66–7.15) and 3.49 (95% CI = 2.99–4.07), respectively.**
Conclusion: **Low back pain is prevalent among Taiwanese adults and is associated with osteoporosis.**

Key words: low back pain; osteoporosis; prevalence; risk factors.

J Rehabil Med 2013; 45: 76–80

Correspondence address: Chien-Chang Liao, Department of Anesthesiology, Taipei Medical University Hospital, 252 Wuxing St., Taipei 110, Taiwan. E-mail: jacky48863027@yahoo.com.tw; ccliao@tmu.edu.tw

Submitted February 29, 2012; accepted August 10, 2012

INTRODUCTION

Low back pain (LBP) is a common health problem across all age groups, and its high prevalence rate has provoked concern worldwide (1–5). It has been estimated that the prevalence of LBP for lifetime, 1-year, 6-month and 3-month periods is as high as 11–84% (6–8), 22–65% (8–10), 40–64.6% (7–11), and 26.4% (12), respectively. LBP is also the most-reported work-related disorder in many countries. Most people experience one or more episodes of LBP in their lifetime; this causes high healthcare costs, work absenteeism, and disability (13). Quality of life becomes the major concern for people with LBP (13).

Generally speaking, females and elderly people report more LBP. The association between low socioeconomic status and low back pain was noted in a previous study (14). Occupations such as nurses, cooks, drivers, school employees, office workers, and industrial employees have been reported as vulnerable to LBP because of standing for long periods, lifting heavy goods, and inadequate rest (3–5). As symptoms of LBP often persist, the majority of patients have reported symptoms recurring more than once a year (1, 15).

Osteoporosis is a skeletal disease marked by low bone mass and micro-architectural deterioration of bone tissues, leading to bone fragility and consequent increase in the risk of fractures (16, 17). However, few studies have focused on links between osteoporosis and LBP.

This study investigates the association of sociodemographic factors and chronic diseases, especially osteoporosis, with increased risk of LBP, using retrospective data from Taiwan's National Health Interview Survey.

METHODS

Data sources

From October 2002 to March 2003, Taiwan's National Health Research Institutes and the Bureau of Health Promotion conducted an island-wide National Health Interview Survey (NHIS) using face-to-face questionnaire interviews. The researchers used multi-stage stratified systematic sampling methods to collect a representative sample of 32,660 non-institutionalized subjects aged 15 years and over living in Taiwan. Approximately 323 interviewers were trained to conduct these interviews. The interviewer explained the study purpose first. If the interviewee was in the eligible age group, the interview was then initiated or scheduled. This 2002 NHIS Survey was a cross-sectional study whose detailed sampling and measurement were described elsewhere (18, 19). Written consent was obtained from participants during interviews. Parental or guardian consent was obtained for minors, and the NHIS was approved by Taiwan's Bureau of Health Promotion.

 doi: 10.2340/16501977-1070 ISSN 1650-1977

Study subjects

In the current study, participants aged 20 years and older were included as eligible subjects. The 2002 NHIS included questions on sociodemographic factors, health status, knowledge about chronic diseases, history of diseases, health behaviours and use of medical services. The questions relating to LBP were as follows: "(1) In the past 3 month, have you complained of LBP? (2) Within past 3 months, how often have you complained of LBP: occasionally or always?" People always complaining of LBP are defined as having frequent LBP. We considered as the case group people who had complained of LBP (ever, sometimes or always) in the past 3 months. Those who had not complained of LBP were considered as the comparison group. Osteoporosis was self-reported by persons who had an osteoporosis diagnosis from a physician. Two criteria for osteoporosis diagnosis were: (*i*) a history of fragility fracture (fracture at sites typically associated with low bone mineral density (BMD) in hip, pelvis, wrist, or spine); and (*ii*) dual-energy X-ray absorptiometry (DEXA) applied to sites of biological relevance, including hip, spine, and forearm. If patient's BMD decreased more than 2.5 standard deviations (SD) compared with the general population in the same age group, then he or she was defined as having osteoporosis (17).

Statistical analysis

We compared differences in age, sex, educational level, occupation, marital status, and body mass index between people with and without self-reported LBP in χ^2 tests. The differences in osteoporosis and lifestyle, such as smoking habits, environmental tobacco smoke, daily sitting hours and regular exercise, were also compared between people with and without self-reported LBP. Those who reported frequent LBP were sub-grouped for further analysis. We performed a multiple logistic regression analysis of factors that may be associated with LBP and frequent LBP, and we calculated odds ratios with confidence intervals. We further performed a sex-stratified analysis to investigate the relationship between osteoporosis and frequent LBP in men and women in the multiple logistic regressions. All analyses were completed using the statistical package SAS version 8.1 (SAS Institute Inc., Cary, NC, USA).

Ethical approval

This study was conducted in accordance with the Declaration of Helsinki. To protect personal privacy, the electronic database was decoded, with patient identifications scrambled for further public access for research. According to Bureau of Health Promotion regulations, written informed consent was obtained from all participants. This study was evaluated and approved by the Bureau of Health Promotion and National Health Research Institutes review board.

RESULTS

Among 24,435 eligible study participants, 6,270 (25.7%) reported LBP within the previous 3 months. The prevalence of LBP was 18.8% in young adults aged 20–29 years, increasing to 34.9% in people aged 70 years and above ($p < 0.0001$) (Table I). Compared with males, females were more likely to have LBP (30.0% vs 21.5%, $p < 0.0001$). The 3-month prevalence of LBP was higher in people with low education than in people with high education (33.5% vs 18.1%, $p < 0.0001$). There were significant differences between people reporting LBP or not, depending on marital status ($p < 0.0001$), occupation ($p < 0.0001$), body mass index ($p < 0.0001$), smoking ($p < 0.0001$), exposure to environmental tobacco smoke ($p < 0.0001$), sitting hours ($p < 0.0001$), and regular exercise ($p < 0.0001$). The prevalence of LBP was higher in people with osteoporosis (48.6% vs 22.5%, $p < 0.0001$) than in people with no osteoporosis.

Table I. *Characteristics of study participants with and without low back pain*

	Low back pain			
	Total *n* = 24,435 *n*	No *n* = 18,165 *n* (%)	Yes *n* = 6,270 *n* (%)	*p*-value
Age				< 0.0001
20–29 years	5,123	4,160 (81.2)	963 (18.8)	
30–39 years	5,199	4,042 (77.8)	1,157 (22.2)	
40–49 years	5,062	3,751 (74.1)	1,311 (25.9)	
50–59 years	3,333	2,398 (72.0)	935 (28.0)	
60–69 years	2,892	1,974 (68.3)	918 (31.7)	
≥ 70 years	2,826	1,840 (65.1)	986 (34.9)	
Sex				< 0.0001
Male	12,498	9,807 (78.5)	2,691 (21.5)	
Female	11,937	8,358 (70.0)	3,579 (30.0)	
Education				< 0.0001
0–6 years	7,881	5,244 (66.5)	2,637 (33.5)	
7–9 years	3,819	2,858 (74.8)	961 (25.2)	
10–12 years	6,603	5,040 (76.3)	1,563 (23.7)	
≥ 13 years	6,132	5,023 (81.9)	1,109 (18.1)	
Marital status				< 0.0001
No	15,830	11,503 (72.7)	4,327 (27.3)	
Yes	5,425	4,504 (83.0)	921 (17.0)	
Others	3,180	2,158 (67.9)	1,022 (32.1)	
Occupation				< 0.0001
No	10,164	7,160 (70.4)	3,004 (29.6)	
Blue-collar	6,493	4,834 (74.5)	1,659 (25.5)	
White-collar	7,778	6,171 (79.3)	1,607 (20.7)	
Body mass index				< 0.0001
< 18.5 kg/m^2	1,508	1,124 (74.5)	384 (25.5)	
18.5–23.9 kg/m^2	12,773	9,682 (75.8)	3,091 (24.2)	
24–26.9 kg/m^2	5,884	4,358 (74.1)	1,526 (25.9)	
≥ 27 kg/m^2	3,545	2,521 (71.1)	1,024 (28.9)	
Smoking				0.0004
No	15,081	11,093 (73.6)	3,988 (26.4)	
Yes	9,351	7,069 (75.6)	2,282 (24.4)	
ETS exposure				< 0.0001
No	1,508	9,692 (76.1)	3,040 (23.9)	
Yes	12,773	8,435 (72.4)	3,223 (27.7)	
Sitting time				0.0193
0–4 h/day	13,018	9,638 (74.0)	3,380 (26.0)	
5–8 h/day	7,596	5,706 (75.1)	1,890 (24.9)	
9–12 h/day	2,943	2,195 (74.6)	748 (25.4)	
≥ 13 h/day	683	478 (70.0)	205 (30.0)	
Regular exercise				< 0.0001
No	11,201	8,102 (72.3)	3,099 (27.7)	
Yes	13,234	10,063 (76.0)	3,171 (24.0)	
Osteoporosis				< 0.0001
No	21,523	16,669 (77.5)	4,854 (22.5)	
Yes	2,912	1,496 (51.4)	1,416 (48.6)	

ETS: environmental tobacco smoking.

The multiple logistic regression analysis showed females had a higher risk of LBP than males (odds ratio (OR) = 1.52, 95% confidence interval (CI) = 1.40–1.65) (Table II). Less-educated (0–6 years) people were at higher risk of LBP compared with more-educated (≥13 years) people. Compared with married people, the risk of LBP was higher in single persons, and also higher in smokers than non-smokers (OR = 1.24, 95% CI = 1.14–1.35). Exposure to environmental tobacco smoke,

Table II. *Factors associated with low back pain and frequent low back pain*

	Low back pain (n = 6,270) OR (95% CI)	Frequent low back pain (n = 1,840) OR (95% CI)
Age		
20–29 years	1.00 (reference)	1.00 (reference)
30–39 years	0.97 (0.87–1.09)	1.04 (0.83–1.30)
40–49 years	1.03 (0.91–1.16)	1.24 (0.99–1.56)
50–59 years	0.94 (0.82–1.09)	1.07 (0.83–1.39)
60–69 years	0.96 (0.82–1.13)	1.14 (0.86–1.50)
≥70 years	1.13 (0.96–1.32)	1.36 (1.02–1.81)
Sex		
Male	1.00 (reference)	1.00 (reference)
Female	1.52 (1.40–1.65)	1.67 (1.43–1.95)
Education		
0–6 years	1.38 (1.23–1.55)	1.70 (1.38–2.09)
7–9 years	1.16 (1.04–1.30)	1.16 (0.94–1.43)
10–12 years	1.17 (1.06–1.28)	1.14 (0.95–1.37)
≥13 years	1.00 (reference)	1.00 (reference)
Marital status		
No	1.39 (1.25–1.54)	1.51 (1.23–1.85)
Yes	1.00 (reference)	1.00 (reference)
Others	1.27 (1.11–1.46)	1.29 (1.01–1.66)
Occupation		
No	1.14 (1.04–1.24)	1.39 (1.19–1.62)
Blue-collar	1.16 (1.07–1.26)	1.22 (1.03–1.44)
White-collar	1.00 (reference)	1.00 (reference)
Body mass index		
<18.5 kg/m^2	1.00 (reference)	1.00 (reference)
18.5–23.9 kg/m^2	0.95 (0.84–1.08)	1.15 (0.90–1.46)
24–26.9 kg/m^2	0.99 (0.86–1.13)	1.21 (0.94–1.57)
≥27 kg/m^2	1.09 (0.94–1.26)	1.31 (1.00–1.71)
Smoking		
No	1.00 (reference)	1.00 (reference)
Yes	1.24 (1.14–1.35)	1.36 (1.17–1.58)
ETS exposure		
No	1.00 (reference)	1.00 (reference)
Yes	1.12 (1.05–1.19)	1.09 (0.98–1.22)
Sitting time		
0–4 h/day	1.00 (reference)	1.00 (reference)
5–8 h/day	1.01 (0.94–1.08)	1.13 (1.01–1.28)
9–12 h/day	1.12 (1.02–1.24)	1.47 (1.25–1.74)
≥13 h/day	1.25 (1.04–1.51)	1.97 (1.50–2.59)
Regular exercise		
No	1.19 (1.12–1.27)	1.45 (1.30–1.61)
Yes	1.00 (reference)	1.00 (reference)
Osteoporosis		
No	1.00 (reference)	1.00 (reference)
Yes	2.55 (2.33–2.78)	4.15 (3.66–4.70)

OR: odds ratio; CI: confidence interval; ETS: environmental tobacco smoke. Additionally adjusted for hypertension and diabetes in both multivariate logistic regressions. Frequent low back pain: excluded those with infrequent low back pain.

long-term sitting, and having no regular exercise were significantly associated with risk of LBP, and such risk was higher in people with osteoporosis than in those without (OR = 2.55, 95% CI = 2.33–2.78).

Elderly people had a higher risk of frequent LBP compared with young adults (OR=1.36, 95% CI = 1.02–1.81) (Table II). Gender, education, marital status, and occupation were associated with risk of frequent LBP. Frequent LBP was higher in obese subjects than among underweight persons (OR = 1.31, 95% CI = 1.00–1.71). Compared with non-smokers, smokers were at higher risk of frequent LBP (OR = 1.36, 95% CI = 1.17–1.58). People with daily sitting ≥13 h had higher risk of frequent LBP compared with people with daily sitting 0–4 h (OR = 1.97, 95% CI = 1.50–2.59). People without regular exercise (OR = 1.45, 95% CI = 1.30–1.61) had increased risk of frequent LBP. The multiple logistic regression also showed that people with osteoporosis had a higher risk of frequent LBP compared with those without osteoporosis (OR = 4.15, 95% CI = 3.66–4.70).

Table III. *Association between frequent low back pain and osteoporosis by sex*

	Female OR (95% CI)[a]	Male OR (95% CI)[a]
Osteoporosis		
No	1.00 (reference)	1.00 (reference)
Yes	3.49 (2.99–4.07)	5.77 (4.66–7.15)

[a]Adjusted for age, education, marital status, occupation, body mass index, smoking, environmental tobacco smoke, sitting hours, and regular exercise. OR: odds ratio; CI: confidence interval.

Further stratification showed ORs of associated osteoporosis or not for frequent LBP in females and males were 3.49 (95% CI = 2.99–4.07) and 5.77 (95% CI = 4.66–7.15), respectively (Table III).

DISCUSSION

This population-based survey of Taiwanese people reveals a high prevalence of self-reported LBP among all age groups and both genders. We studied demographic factors, lifestyles, and osteoporosis in relation to LBP in a representative nationwide sample. The results show that osteoporosis was associated with self-reported LBP and frequent LBP. The association between osteoporosis and frequent LBP appears to be independent and more marked in men than in women after controlling for other common LBP-related factors.

Demographic factors, such as age and sex, have been associated with LBP in many studies. Age and gender, as well as certain work-related physical and psychosocial factors, influenced the prevalence of LBP (20). In our study, higher age was a significant risk factor for frequent LBP; this is consistent with the findings of Burdorf & Sorock (21). The significant association between increasing age and risk of LBP was also investigated in the previous study (22). Our results demonstrated similar findings with the previous study, which reported the gender-associated risk of LBP (1, 5, 20, 22–26). LBP has been shown to be more common among women than men for occupational groups such as white-collar workers (5), industrial workers (20), hospital staff (23), and physiotherapy students (24). In general, women are more sensitive than men to a variety of noxious stimuli. However, the menstrual cycle does not exert an influence on pain sensitivity (27). The sex differences in gender role expectation for pain are complex and may be affected by culture (28). Though young females had a higher prevalence of LBP compared with young males, the association between low BMD and risk of LBP was more significant in young males than in young females (29). In

addition, postmenopausal osteoporosis that may cause LBP could explain why women had more LBP than men (30, 31).

That social and economic disadvantage associated with generally poorer physical health has been recognized for centuries. Marital status, education, occupation, and income level also specifically influence LBP (32, 33), with previous research noting the opposite association between education and LBP risk (33). Compared with less-educated people, highly educated people tend to work in jobs with a lower risk of LBP, and also may have more knowledge about coping with or preventing LBP; the unemployed also had a lower risk of LBP (33). Our study was similar to other studies investigating socioeconomic status and risk of LBP, although few studies investigated LBP and marital status. Our finding that people with no spouse or significant other faced a higher risk of LBP raises interesting issues, and further study is needed to explain this association.

Overweight and obesity are increasingly prevalent in many countries, especially in middle-aged people. Accumulating evidence associates body mass index with metabolic syndrome and cardiovascular disease (34). As body mass index is considered an indicator of body weight status, with greater weight increasing pressure on the spine, the discs and other back structures to cause LBP (35). A cohort study in Finland suggested that abdominal obesity may increase the risk of LBP (1). Using their national survey data results, Deyo & Bass (36) suggested that obesity contributes independently to the risk of LBP. Although 1 study failed to determine the relationship between excess weight, tall stature, and risk of LBP (37), a recent study with meta-analysis concluded that overweight and obesity have the strongest association with seeking care for LBP and chronic LBP (38). Our study clearly demonstrates the influence of obesity (body mass index ≥ 27 kg/m^2) on the risk of frequent LBP.

The influence of lifestyle factors on LBP risk is crucial. Since the positive association between smoking and risk of LBP has been confirmed (36), it was not surprising that we found current smokers to be at higher risk of LBP compared with non-smokers. However, the relationship between environmental tobacco smoke and the risk of frequent LBP remains unclear. Being physically active is often suggested as important in preventing and managing LBP. Individuals with LBP often experienced more physically demanding work and lower physical activity during leisure-time (26). However, a previous study suggested a U-shaped relationship between physical activity and risk of LBP (39). Our results showed that having no regular exercise increased risk of LBP. Previous studies' difficulties in specifying the quantity and quality of exercise with self-reported information contributed to inconsistent findings for an association between exercise and risk of LBP (26, 39). It is also reasonable to expect that people who report less time exercising may also spend more time sitting, and our study found a positive association between risk of LBP and sitting hours with a dose-response relationship. Long-term sitting may contribute to LBP, compromising quality of life and threatening eventual problems in performing paid work.

Osteoporosis-related bone fractures remain a significant public health problem, but previous studies did not emphasize osteoporosis-related pain. A recent study indicated that lumbar bone mass was associated with LBP in males (28). In contrast, Gaber et al. (40) found that patients with chronic LBP have an increased incidence of osteopaenia and osteoporosis, without determining the causal relationship between LBP and osteoporosis. Insufficient central axial skeleton support results in unbalanced bilateral paraspinal muscles, tendons and ligaments. Scoliosis or slippage of 1 vertebra onto another (spondylolisthesis) can also cause severe discomfort in the lower back. Ours is the first population-based study to investigate the positive association between osteoporosis and risk of LBP. We found that the independent association between frequent LBP and osteoporosis was more intense in men than in women. Men were more likely than women to be physical labourers, and this may increase the burden of osteoporosis contributing to increased risk of LBP.

Our study has several limitations. First, this study may be subject to recall bias due to use of self-reported information on LBP, lifestyle and medical history. Secondly, the current study's cross-sectional design lacks a causal analysis between risk factors and self-reported LBP. Thirdly, psychological factors associated with LBP are not included in this study. Fourthly, patients with mild osteoporosis may not be included in this study because they did not seek medical care for this. Fifthly, our study did not include data on BMD, fragility fractures and medication for osteoporosis. Thus, the severity of osteoporosis and the causal relationship between osteoporosis and LBP could not be accurately assessed.

In summary, this population-based study of adults in Taiwan suggests that sociodemographic factors and lifestyles were significantly associated with risk of LBP. It also demonstrates the influence of gender on osteoporosis and risk of LBP. This knowledge can support health initiatives to educate people to reduce body weight, refrain from smoking, exercise more and avoid osteoporosis in order to prevent LBP and reduce the huge burden of injury associated with it.

ACKNOWLEDGEMENTS

This study is based in part on data from the National Health Interview Survey Original Database provided by the Bureau of Health Promotion, Department of Health, Executive Yuan and National Health Research Institutes. The interpretation and conclusions contained herein do not represent those of Bureau of Health Promotion, Department of Health, Executive Yuan or National Health Research Institutes. This study was supported by China Medical University Hospital (grant number 1MS1), Taiwan Department of Health Clinical Trial and Research Center for Excellence (grant number DOH101-TD-B-111-004) and Taiwan Department of Health Cancer Research Center of Excellence (grant number DOH101-TD-C-111-005).

REFERENCES

1. Shiri R, Solovieva S, Husgafvel-Pursiainen K, Taimela S, Saarikoski LA, Huupponen R, et al. The association between obesity and the prevalence of low back pain in young adults: the Cardiovascular Risk in Young Finns Study. Am J Epidemiol 2008; 167: 1110–1119.

2. Feng CK, Chen ML, Mao IF. Prevalence of and risk factors for different measures of low back pain among female nursing aides in Taiwanese nursing homes. BMC Musculoskelet Disord 2007; 8: 52.
3. Nagasu M, Sakai K, Ito A, Tomita S, Temmyo Y, Ueno M, et al. Prevalence and risk factors for low back pain among professional cooks working in school services. BMC Public Health 2007; 7: 171.
4. Muto S, Muto T, Seo A, Yoshida T, Taoda K, Watanabe M. Prevalence of and risk factors for low back pain among staff in school for physically and mentally handicapped children. Ind Health 2006; 44: 123–127.
5. Spyropoulos P, Papathanasiou G, Georgoudis G, Chronopoulos E, Koutis H, Koumoutsou F. Prevalence of low back pain in Greek public office workers. Pain Physician 2007; 10: 651–660.
6. Deyo RA, Tsui-Wu YJ. Descriptive epidemiology of low-back pain and its related medical care in the United States. Spine 1987; 12: 264–268.
7. Kent PM, Keating JL. The epidemiology of low back pain in primary care. Chiropr Osteopat 2005; 13: 13.
8. Walker BF. The prevalence of low back pain: a systemic review of the literature from 1966 to 1998. J Spinal Disord 2000; 13: 205–217.
9. Ihlebaek C, Hansson TH, Laerum E, Brage S, Eriksen HR, Holm SH, et al. Prevalence of low back pain and sickness absence: a "borderline" study in Norway and Sweden. Scand J Public Health 2006; 34: 555–558.
10. Louw QA, Morris LD, Grimmer-Somers K. The prevalence of low back pain in Africa: a systematic review. BMC Musculoskelet Disord 2007; 8: 105.
11. Von Korff M, Dworkin SF, Le Resche L, Kruger A. An epidemiologic comparison of pain complaints. Pain 1988; 32: 173–183.
12. Deyo RA, Mirza SK, Martin BI. Back pain prevalence and visit rates: estimates from U.S. national surveys, 2002. Spine 2006; 31: 2724–2727.
13. Suda M, Yoshida K. Low back pain deprives the Japanese adult population of their quality of life: a questionnaire survey at five healthcare facilities in Japan. Environ Health Prev Med 2008; 13: 109–115.
14. Koster A, Bosma H, Kempen GI, van Lenthe FJ, van Eijk JT, Mackenbach JP. Socioeconomic inequalities in mobility decline in chronic disease groups (asthma/COPD, heart disease, diabetes mellitus, low back pain): only a minor role for disease severity and comorbidity. J Epidemiol Community Health 2004; 58: 862–869.
15. Pengel LH, Herbert RD, Maher CG, Refshauge KM. Acute low back pain: systematic review of its prognosis. BMJ 2003; 327: 323.
16. Sedrine WB, Radican L, Reginster JY. On conducting burden-of-osteoporosis studies: a review of the core concepts and practical issues. A study carried out under the auspices of a WHO Collaborating Center. Rheumatology 2001; 40: 7–14.
17. NIH Consensus Development Panel on Osteoporosis Prevention, Diagnosis and Therapy. Osteoporosis prevention, diagnosis and therapy. JAMA 2001; 285: 785–795.
18. Shih YT, Hung YT, Chang HY, Liu JP, Lin HS, Chang CM, et al. The design, contents, operation and characteristics of the respondents of the 2001 National Health Interview Survey in Taiwan. Taiwan J Public Health 2003; 22: 419–430.
19. Huang N, Shih SF, Chang HY, Chou YJ. Record linkage research and informed consent: Who consents? BMC Health Serv Res 2007; 7: 18.
20. Ghaffari M, Alipour A, Jensen I, Farshad AA, Vingard E. Low back pain among Iranian industrial workers. Occup Med 2006; 56: 455–460.
21. Burdorf A, Sorock G. Positive and negative evidence of risk factors for back disorders. Scand J Work Environ Health 1997; 23: 243–256.
22. Strine TW, Hootman JM. US national prevalence and correlates of low back and neck pain among adults. Arthritis Rheum 2007; 57: 656–665.
23. Bejia I, Younes M, Jamila HB. Prevalence and factors associated to low back pain among hospital staff. Joint Bone Spine 2005; 72: 254–259.
24. Nyland LJ, Grimmer KA. Is undergraduate physiotherapy study a risk factor for low back pain? A prevalence study of LBP in physiotherapy students. BMC Musculoskelet Disord 2003; 4: 22.
25. Fernández-de-las-Peñas C, Hernández-Barrera V, Alonso-Blanco C, Palacios-Ceña D, Carrasco-Garrido P, Jiménez-Sánchez S, et al. Prevalence of neck and low back pain in community-dwelling adults in Spain: a population-based national study. Spine 2011; 36: E213–E219.
26. Björck-van Dijken C, Fjellman-Wiklund A, Hildingsson C. Low back pain, lifestyle factors and physical activity: a population based-study. J Rehabil Med 2008; 40: 864–869.
27. Klatzkin RR, Mechlin B, Girdler SS. Menstrual cycle phase does not influence gender differences in experimental pain sensitivity. Eur J Pain 2010; 14: 77–82.
28. Defrin R, Shramm L, Eli I. Gender role expectations of pain is associated with pain tolerance limit but not with pain threshold. Pain 2009; 145: 230–236.
29. Hoozemans MJ, Koppes LL, Twisk JW, van Dieën JH. Lumbar bone mass predicts low back pain in males. Spine 2012; 37: 1579–1585.
30. Manabe T, Takasugi S, Iwamoto Y. Positive relationship between bone mineral density and low back pain in middle-aged women. Eur Spine J 2003; 12: 596–601.
31. Ohtori S, Akazawa T, Murata Y, Kinoshita T, Yamashita M, Nakagawa K, et al. Risedronate decreases bone resorption and improves low back pain in postmenopausal osteoporosis patients without vertebral fractures. J Clin Neurosci 2010; 17: 209–213.
32. Hestbaek L, Korsholm L. Does socioeconomic status in adolescence predict low back pain in adulthood? A repeated cross-sectional study of 4771 Danish adolescents. Eur Spine J 2008; 17: 1727–1734.
33. Leino-Arjas P, Kaila-Kangas L, Keskimäki I, Notkola V, Mutanen P. Inpatient hospital care for lumbar intervertebral disc disorders in Finland in relation to education, occupational class, income and employment. Public Health 2002; 116: 272–278.
34. Liao CC, Su TC, Chien KL, Wang JK, Chiang CC, Lin CC, et al. Elevated blood pressure, obesity, and hyperlipidemia. J Pediatr 2009; 155: 79–83.
35. Heliovaara M. Risk factors for low back pain and sciatica. Ann Med 1980; 21: 257–264.
36. Deyo RA, Bass JE. Lifestyle and low-back pain: the influence of smoking and obesity. Spine 1989; 14: 501–506.
37. Yip YB, Ho SC, Chan SG. Tall stature, overweight and the prevalence of low back pain in Chinese middle-aged women. Int J Obes 2001; 25: 887–892.
38. Shiri R, Karppinen J, Leino-Arjas P, Solovieva S, Viikari-Juntura E. The association between obesity and low back pain: a meta-analysis. Am J Epidemiol 2010; 171: 135–154.
39. Heneweer H, Vanhees L, Picavet HS. Physical activity and low back pain: a U-shaped relation. Pain 2009; 143: 21–25.
40. Gaber TA, McGlashan KA, Love S, Jenner JR, Crisp AJ. Bone density in chronic low back pain: a pilot study. Clin Rehabil 2002; 16: 867–870.