Evidence-Based Medicine

Increased low back pain prevalence in females than in males after menopause age: evidences based on synthetic literature review

Yì Xiáng J. Wáng, Jùn-Qīng Wáng, Zoltán Káplár

Department of Imaging and Interventional Radiology, Faculty of Medicine, The Chinese University of Hong Kong, Prince of Wales Hospital, Shatin, Hong Kong SAR, China

Correspondence to: Dr. Yì Xiáng J. Wáng. Department of Imaging and Interventional Radiology, Faculty of Medicine, The Chinese University of Hong Kong, Prince of Wales Hospital, Shatin, N.T., Hong Kong SAR, China. Email: yixiang_wang@cuhk.edu.hk.

Abstract: Female sex hormones play an important role in the etiology and pathophysiology of a variety of musculoskeletal degenerative diseases. Postmenopausal women show accelerated disc degeneration due to relative estrogen deficiency. This literature review aims to validate or falsify this hypothesis, i.e., while overall females have higher prevalence of low back pain (LBP) across all age groups, this male vs. female difference in LBP prevalence further increases after female menopause age. The literature search was performed on PubMed on January 2, 2016. The search word combination was *(low back pain) AND prevalence AND [(males OR men) AND (females OR women)]*. The following criteria were taken to include the papers for synthetic analysis: (I) only English primary literatures on nonspecific pain; (II) only prospective studies on general population, but not population with occupational LBP causes, of both males and female subjects studied using the same LBP criterion, ages-specific information available, and males and female subjects were age-matched; (III) studies without major quality flaws. In total 98 studies with 772,927 subjects were analyzed. According to the information in the literature, participant subjects were divided into four age groups: (I) school age children group: 6–19 years; (II) young and middle aged group: 20–50 years; (III) mixed age group: data from studies did not differentiate age groups; (IV) elderly group: ≥50 years old. When individual studies were not weighted by participant number and each individual study is represented as one entry regardless of their sample size, the median LBP prevalence ratio of female *vs.* males was 1.310, 1.140, 1.220, and 1.270 respectively for the four age groups. When individual studies were weighted by participant number, the LBP prevalence ratio of female *vs.* males was 1.360, 1.127, 1.185, and 1.280 respectively for the four groups. The higher LBP prevalence in school age girls than in school age boys is likely due to psychological factors, female hormone fluctuation, and menstruation. Compared with young and middle aged subjects, a further increased LBP prevalence in females than in males was noted after menopause age.

Keywords: Physiological gender difference; intervertebral disc degeneration; epidemiology; low back pain (LBP); menstruation; menopause

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Introduction

Low back pain (LBP) is usually defined as pain, muscle tension, or stiffness localized below the costal margin and above the inferior gluteal folds, with or without leg pain (sciatica). LBP occurs in about 60–80% of people at some points in their lives, and can begin in childhood (1-7). It is a disorder with many possible etiologies, with many definitions, and occurring in many groups of populations. The vast literature available on prevalence of LBP is not only heterogeneous, but also sometimes contradictory. This variability may be due to differences among study factors such as the age of the sample, the definition of LBP, and

the strategy for extracting data. The prevalence can be described in terms such as point prevalence (the number of persons in a defined population who have LBP at a particular point in time, usually the time the survey was carried out), period prevalence (the number of persons who have LBP at any time during a specified time interval), and lifetime prevalence (the number of persons who have LBP at some points in their life). LBP has also been shown to be associated with certain psychosocial factors, including presence of psychological conditions, maladaptive coping strategies, poor job satisfaction, higher physical work demands, poor general health or functional level, tobacco use, obesity, receipt of workers' compensation or disability/sick leave, and unresolved litigation or compensation issues related to the back pain (8-10). There may be also cultural differences in the pain perception or reporting, with some ethnic minorities having the attitude that pain is to be endured without complaint (8,11).

The overall prevalence of LBP is higher in women than in men (12,13). Women are also affected by many chronic pain conditions and painful conditions of the musculoskeletal system in greater numbers than men are (14). A biopsychosocial model of chronic pain attributes sex differences in pain to interactions between biological, psychological, and sociocultural factors (15,16). The heightened pain sensitivity among women can also partially explain greater reports of pain by women compared to men (17,18). Menstrual cycle fluctuations in pain sensitivity may help to explain sex differences in pain reporting in younger adults (19). Biologic response to pregnancy and childbearing, physical stress of child-rearing, perimenopausal abdominal weight gain are additional causes for LBP (12). Population-based studies have shown that the prevalence of widespread pain increases with age, peaking in the seventh and eighth decades (20,21). Recently, it has been show that genetics also played a role in the development of LBP (1,22,23).

Lumbar disc degeneration and its associated changes such as disc space narrowing are related to LBP (24). Lumbar disc degeneration is a common musculoskeletal condition, the prevalence of which increases with age (25-29). Disc degeneration can progress to disk herniation, spinal canal stenosis, and, in conjunction with facet joint arthrosis, degenerative spondylolisthesis. In an analysis of published data of 600 autopsy specimens of young and middle-aged subjects younger than 50 years, intervertebral disc degeneration was observed in men in the second decade of life, occurring at an earlier age than in women; the severity of age matched disk degeneration was also being generally greater in men (25). In a later independent histologic study, Łebkowski (26) investigated 308 lumbar intervertebral discs at autopsy from 57 women (mean age, 41.8 years) and 79 men (mean age, 42.1 years). Disc degeneration became first readily apparent during the 2nd decade of life, though it was observed to occur in men almost a decade earlier than in women. In a MR imaging-based survey of young adults 20–22 years, lumbar disc degeneration was significantly more frequent in men (30). These results confirm the general perception that young men are more susceptible to disc degeneration than young women are, most likely due to increased mechanical stress and physical injury. However, after menopause which is around the age of 49–50 years, lumbar discs in females degenerate at a notably quicker rate than male lumbar discs in males, after later 50s, disc space narrowing become more apparent and more severe than age matched males (31-33).

Based on these backgrounds, we propose a hypothesis, i.e., while overall females have higher prevalence of LBP across all age groups, this male *vs*. female difference in LBP prevalence further increases after female menopause age. This is partially related to the accelerated lumbar disc degeneration and spine degeneration after female menopause (31-33). In this study we performed a literature review to look at whether this male *vs*. female difference in LBP prevalence exaggerated after female menopause age can be demonstrated.

Materials and methods

The literature search was performed on PubMed on January 2, 2016. The search word combination was *(low back pain) AND prevalence AND [(males OR men) AND (females OR women)]*. This search generated 2,897 paper titles. The titles and abstracts of these papers, and sometimes full papers when required, were screened, and the following criteria were used to include the papers for further synthetic analysis:

(I) Only English literatures on LBP were further analyzed. Review and meta-analysis articles were excluded.

(II) We only included prospective studies on general population of both males and female subjects studied using the same LBP criterion, ages-specific information available, and males and female subjects were age-matched. Patient-only studies, which tended to be retrospective, were excluded, as results

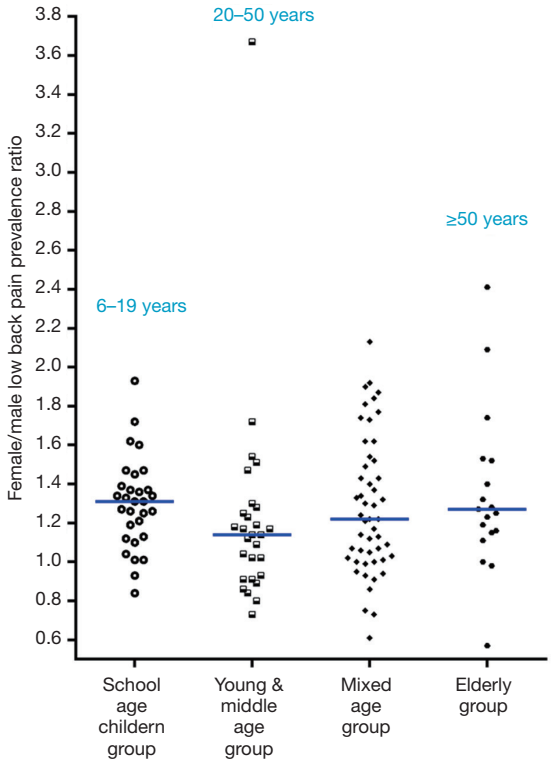

Figure 1 Female *vs.* male low back pain prevalence ratios in four age-specific groups; horizontal bars show the median values. Each individual study is represented as one entry regardless of their sample size.

from clinical groups are likely to be biased (4). The decision to seek medical care would be dependent on: (i) predisposition of the individual to use services, which is based on demographic and social characteristics as well as attitudes about medical care and efficacy of treatment; (ii) ability to obtain medical services; and (iii) subjective perception of severity of illness.

(III) Literatures with focus on LBP of occupational causes, such as industrial workers, drivers, athletes, were excluded. Occupational populations represent a selective group of individuals. In general, workers tend to be healthier, and state of health itself may determine entry into a specific occupation. Rates of back pain among occupational groups may differ because of not only the work itself but also because of differential selection into various occupations. However, studies on teachers of general subjects and farmers were included. Studies on teachers were usually of convenience samples, and they are likely not to have specific occupational causes for LBP. Studies on farmers were usually of large sample size, and in many societies farmers constitute a very large portion of the society members. It is known in some societies females can be more involved in household work, in this study house wife were not excluded.

(IV) The included studies were judged to have no major flaws. The characteristics of the population adequate, the sample size and response rate adequate.

(V) When a study applied a longitudinal design, only the prevalence rate at end of the study was recorded, or the prevalence rate which was judged to be most relevant was used for analysis.

(VI) Regional and ethics factors were not considered in this study.

Results

This study extracted 98 studies from PubMed for synthetic analysis, involved 772,927 participant subjects (*Tables S1-S4*). According to the information in the literature, participant subjects were divided into four age groups: (I) school age children group: 6–19 years; (II) young and middle age group: 20–50 years; (III) mixed age group: data from studies did not differentiate age groups; (IV) elderly group: ≥50 years old. When individual studies were not weighted by participant number and each individual study is represented as one entry regardless of their sample size, the median LBP prevalence ratio of female *vs.* males was 1.310, 1.140, 1.220, and 1.270 respectively for the four age groups (*Figure 1*). When individual studies were weighted by participant number, the LBP prevalence ratio of female *vs.* males was 1.360, 1.127, 1.185 and 1.280 respectively for the four groups (*Figure 2*).

This study demonstrated females had higher prevalence of LBP across all age groups. The female *vs.* males LBP prevalence ratio was highest for school age girls and boys. Compared with middle aged subjects, a further increased low back pain prevalence in females than in males was noted after menopause age.

Discussion

Among all chronic pain problems and spinal pain conditions, LBP is the most common and important clinical, social, economic, and public health problem affecting the

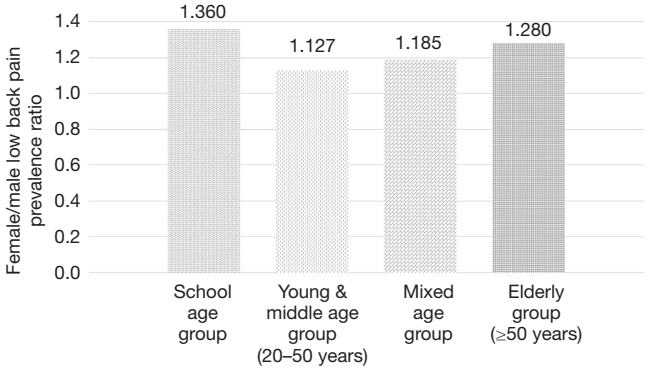

Figure 2 Female *vs*. male low back pain prevalence ratio in four age-specific groups. Each individual study is weighted by their sample size, and studies at each age-specific group are summed together.

population indiscriminately across the world (8). LBP is known to be of multi-factorial causes (3,34,35). Employment and workplace factors, both physical and psychological, such as heavy lifting, pushing, pulling, vehicle driving, and prolonged walking or standing were found to be predictors of LBP and there are similar associations with stressful and monotonous work and dissatisfaction with work. Body mass index has been found to be linked to LBP in obese people (36). Associations between LBP and social class, low levels of educational and low income have been reported. Persons with greater education are more likely to be in professional, managerial, or other skilled occupations where there is more flexibility to eliminate pain-provoking job situations and physical demand (4,37). Compared with a lower or a higher frequency of exercise, a moderate frequency of exercise from one to five times a week was associated with a lower LBP risk level (4). LBP has been reported consistently in a higher proportion of females than males (3,4,12,13,38,39). Our synthetic analysis further confirmed this phenomenon. Gender prevalence ratios also revealed a higher prevalence of pain in females for headache, migraine, temporomandibular pain, burning mouth pain, neck pain, shoulder pain, back pain, knee pain, abdominal pain, and fibromyalgia (8). Women have shown to have a lower threshold of perception of pain and in reaction to it (40,41). Several authors have observed that although females are more likely to report symptoms, physician verified abnormalities are approximately equal to those of males (42,43). However, occupational LBP is seen in higher proportions in men (44,45).

Some data suggested LBP prevalence increased in the recent years (8,46). It could be that the actual prevalence has not changed but the reporting has; or it could be that the questions used to assess the prevalence have changed; or LBP prevalence really increased due to life style changes of the population. Harkness *et al*. showed there were significant differences in the prevalence of pain increasing from 2- to 4-fold between two surveys (47). Chronic pain is a common symptom and significant problem for older adults. Epidemiologic data in the elderly suggests that up to 50% of community-dwelling older adults and as many as 80% of residents of long-term care facilities experience persistent pain. Bressler *et al*. (48) undertook a systematic review of the literature from 1966 through 1998 and reported that persons over 65 years of age experience low back pain with greater frequency and have been under-represented in research, as well as in management. Further, age related prevalence of persistent pain appears to be much more common in the elderly associated with functional limitations and difficulty in performing daily life activities. In an evaluation of pain characteristics of adults 65 years of age and older referred to a tertiary pain care clinic, the older patients had relatively more physical problems concordant with their complaints, but fewer psychological factors contributing to disability than the younger pain patients (49). On the other hand, we expect the higher LBP prevalence in school age girls than in school aged boys is more likely due to psychological factors, female hormone fluctuation, and menstruation.

That post menopausal women has higher incidence of LBP than men has been reported distinctively in a number of studies. In 1969 Lawrence (50) surveyed 713 males and 809 females aged ≥35 years with lumbar radiograph in Manchester, UK. Back-hip-sciatic pain was present at the time of the survey in 79 (11%) of the males and in 153 (19%) of the 809 females. In those with pain at the time of the survey the incidence had raised till age 40 in males and then remained constant, but in females it continued to rise sharply up to and over the age of 65 (*Figure S1A*). Nagi *et al*. (3) in 1973 showed a greater proportion of females (21%) reported back pain as compared to males (14%). It was suggested a number of women might have experienced back pain in connection with the biological processes associated with the menses. However, when age controls were introduced, Nagi *et al*. noted that women over 50 years of age were more likely than men to report back pain (26% and 17%, respectively). In 1995, Papageorgiou *et al*. (51) reported the South Manchester Back Pain Survey with study population of 4,501 (age: 18–75 years old). The 1-month

period prevalence of LBP was 31.2%, 33.1%, 38.5%, 34.9% for the age range of 18–29, 30–44, 45–59, and ≥60 years respectively for males; 32.2%, 41.5%, 49.2%, 43.7% for the age range of 18–29, 30–44, 45–59, and ≥60 years respectively for females. In our own Osteoporotic Fractures in Men (Hong Kong) and Osteoporotic Fractures in Women (Hong Kong) Studies data published in 2013 (52). A total of 2,000 Chinese men and 2,000 Chinese women, aged ≥65 years, were prospectively recruited from local communities for a prospective cohort study from August 2001 to March 2003. The LBP prevalence was 30.6% for men and 53.3% for women (P<0.001). In 2010, Cho *et al*. (53) published LBP data collected for 4,181 subjects from a rural farming community in Korea, with a mean age of 56.6 years. 6-month prevalence of LBP was 38.5% for men and 55.6% for women. The prevalence of LBP increased significantly with age in women (*Figure S1B*).

Estrogen participates in a variety of biological processes through different molecular mechanisms. The collagen wasting is commonly observed in bone and skin in the postmenopausal period due to decreased estrogen levels (54,55). Estrogen has favorable effects on the lipid profile, antioxidant activity, and enhanced fibrinolysis (56). Estrogen may reduce the risk for arteriosclerosis, which has been considered a risk factor for LBP (57). Estrogen plays an important role in the etiology and pathophysiology of a variety of musculoskeletal degenerative diseases. The prevalence of osteoarthritis (OA) is higher among women than among men, and this prevalence increases considerably after menopause (58,59). Moreover, with the same degree of radiographic damage, OA is also more symptomatic in women (58,59). After menopause women have more severe disc space narrowing than age matched men (28,29,60). This may be associated with the physiological changes caused by relatively lower level of sex hormones after menopause in women, and the accelerated lumbar disc degeneration (33).

The expert views of hormone replacement treatment (HRT) evolved during the last 10 years since the publication of WHI trials (61,62). Dose regimen, combination of estrogen with progestins versus estrogen alone, the administration route and duration of treatment such as the choice of repetitive or periodic administration simulating the menstrual cycle are some of the factors that may be involved in the benefit discrepancies. The Estrogen and Thromboembolism Risk (ESTHER) study confirmed that oral estrogens increased venous thromboembolism risk, whereas transdermal estrogens had little or no impact on the development of thrombosis (63). The presence of gene polymorphisms may also be implicated. HRT may benefit a large number of postmenopausal women, but a subset of women may have higher risk of cardiovascular and thrombotic complications (64). Estrogen receptor modulators and phytoestrogens may retain the desired effects but avoid undesirable effects (65). HRT has been shown to be protective against menopause-associated OA (66,67). However, in one study Musgrave *et al*. (68) reported women taking HRT reported more back pain and back pain-related disability than did those not taking HRT. An in-depth understanding of the role of the gonadal hormones in LBP modulation remains unclear; whether HRT is useful for patients with severe LBP warrants further studies.

There are a number of limitations for the current study. Only English literatures were included in this review, and only database of PubMed was used. There was a lack of a universal definition and delimitation of LBP and the absence of important specifications of LBP such as the frequency of episodes, its intensity and duration in some studies; therefore we reported the ratio of female *vs*. male LBP prevalence instead of absolute LBP prevalence. The LBP in survey subjects are assumed to be nonspecific. Specific LBP is due to organic diseases that include spinal fractures, cancers, infections, and cauda equina syndrome can be identified. The probability that a particular case of back pain has a specific cause identified on back radiographs is less than 1% (69). Additionally, for the a few studies the age-specific grouping could only be approximated (*Table S1-S4*). This study also did not establish an exact causal role of accelerated spine degeneration in post-menopausal women for the increased LBP prevalence. Our literature review is likely not being exhaustive; however, we believe this limitation is unlikely to have impact on the conclusion of our study.

In conclusion, our synthetic literature review demonstrated females had higher prevalence of LBP across all age groups. This female *vs*. male difference was highest for school age children. Compared with middle aged subjects, a further increased low back pain prevalence in females than in males was noted after menopause age. Clarification of the hormonal influences on pain modulation will advance our understanding of sex differences in clinical pain conditions such as LBP. The evidence showed in this study may open a new line of further clinical researches.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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Supplementary

Table S1 School age group

Author/year	Regions	Definition of LBP	Male sample size	Male age (years)	Female sample size	Female age (years)	M & F age mean (years)	Female prevalence (%)	Male prevalence (%)	F/M
Hertzberg 1985 (70)	Norway	One or more periods of pain/year	147	16	148	16	16	14.2	13.6	1.04
Salminen *et al*. 1992 (71)	Finland	LBP at some time	788	14	725	14	14	33.9	27.0	1.26
Taimela *et al*. 1997 (72)	Finland	LBP interfered with school work or leisure activities during the preceding 12 months	577	7–16	594	7–16	7–16	9.4	10.1	0.93
Gunzburg *et al*. 1999 (73)	Belgium	LBP at least once in life	202	9	190	9	9	38.0	34.0	1.12
Vikat *et al*. 2000 (74)	Finland	LBP during the preceding half year	5,063	12–18	6,032	12–18	12–18	33.1	20.7	1.31
Watson *et al*. 2002 (75)	England	LBP in the preceding month ≥one day	667	11–14	779	11–14	11–14	28.0	19.0	1.47
Kovacs *et al*. 2003 (76)	Spain	LBP in the preceding 7 days	3,344	13–15	3704	13–15	13–15	33.0	17.1	1.93
Prista *et al*. 2004 (77)	Mozambique	LBP several times in the preceding year	94	11–16	110	11–16	13	16.0	11.0	1.45
Hestbaek *et al*. 2004 (78)	Denmark	LBP 1-30 days in the preceding year	4,580	12–22	4,857	12–22	12–22	29.0	24.0	1.21
Sjolie 2004 (79)	Norway	Lifetime prevalence	47	14.7±0.7	38	14.7±0.7	14.7±0.7	78.0	57.0	1.37
Cakmak *et al*. 2004 (80)	Turkey	Lifetime prevalence	731	17–26	796	17–26	19.93±2.29	43.0	39.0	1.10
Jones *et al*. 2004 (81)	England	Lifetime prevalence	249	10–16	251	10–16	10–16	42.6	37.8	1.13
Shehab *et al*. 2005 (82)	Kuwait	Lifetime prevalence	199	10–18	201	10–18	10–18	64.7	50.8	1.27
Bejia *et al*. 2005 (83)	Tunisia	Lifetime prevalence	296	11–19	326	11–19	14.1±1.3	27.7	27.3	1.01
Kjaer *et al*. 2005 (84)	Denmark	LBP within the preceding month or week	205	12–14	234	12–14	13.1	26.0	19.0	1.37
Oksuz 2006 (85)	Turkey	LBP ≥24 h in the preceding 12 months	293	18–24	485	18–24	18–24	28.9	18.1	1.60
Mogensen *et al*. 2007 (86)	Denmark	One-month prevalence	233	12–13	206	12–13	12–13	44.0	35.0	1.26
Mikkonen *et al*. 2008 (87)	Finland	LBP during the preceding 6 months period but not consulted with health professionals	908	16	1,079	16	16	43.0	31.0	1.39
Mikkonen *et al*. 2008 (87)	Finland	LBP during the preceding 6 months period but not consulted with health professionals	908	18	1,079	18	18	57.0	42.0	1.36
Heuscher *et al*. 2010 (88)	USA	LBP in the preceding year that caused to alter some aspect of normal living or seek treatment	192	19.7±2.7	273	19.7±2.7	19.7±2.7	61.8	38.2	1.62
Auvinen *et al*. 2010 (89)	Finland	Any LBP during the preceding 6 months	778	16	973	16	16	47.6	35.8	1.33
Auvinen *et al*. 2010 (89)	Finland	Any LBP during the preceding 6 months	772	18	965	18	18	62.5	46.7	1.34
Yao *et al*. 2011 (90)	China	LBP at least once in the preceding 3 months	977	10–18	1,106	10–18	14.43±2.37	33.1	24.7	1.34
Onofrio AC *et al*. 2012 (91)	Brazil	LBP in the preceding 30 days	567	13–19	666	13–19	15.9±1.2	15.2	12.2	1.25
O'Sullivan *et al*. 2012 (92)	Australia	Current non-chronic LBP	610	17	678	17	17.0±0.3	15.3	8.9	1.72
Tiira *et al*. 2012 (93)	Finland	LBP or consult a physician for LBP in the preceding year	900	18	1,086	18	18	50.0	42.0	1.19
Dolphens *et al*. 2012 (94)	Belgium (Flemish)	Lifetime prevalence	639	11.4–15	557	11.4–15	M: 12.6±0.54; F: 10.6±0.47	24.0	28.5	0.84
Wirth *et al*. 2013 (95)	Switzerland	LBP during survey period or within the preceding month	373	6–16	435	6–16	10.3±2.8	14.0	10.7	1.31
Minghelli *et al*. 2014 (96)	Portugal	LBP in the preceding year	437	10–16	529	10–16	12.24±1.53	55.2	37.5	1.47
Chiwaridzo *et al*. 2014 (97)	Zimbabwe	Lifetime prevalence & LBP lasted ≥24 h	286	13–19	246	13–19	M: 16.2±1.79; F: 15.8±1.65	43.0	42.7	1.01

F/M: ratio of female prevalence and male prevalence (= female prevalence divided by male prevalence).

Table S2 Young & middle age group

Author/year	Regions	Definition of LBP	Male sample size	Male age (years)	Female sample size	Female age (years)	M & F mean age (years)	Female prevalence (%)	Male prevalence (%)	F/M
Ward *et al*. 1968 (98)	UK	LBP ≥3 days off work during the previous 5 years	7,659	25–44	7,689	25–44	25–44	2.0	2.5	0.80
Biering-Sørensen 1983 (99)	Danmark	Lifetime prevalence	928 (M&F)	30	928 (M&F)	30	30	62.0	68.0	0.91
Burton *et al*. 1989 (100)	UK	LBP	274	~35.1	271	~35.1		43.0	59.0	0.73
Viikari-Juntura *et al*. 1991 (101)	Finland	LBP during the preceding 12 months	82	32–44	72	32–44	36.9	37.5	24.4	1.54
Palmer *et al*. 2000 (102)	UK	LBP ≥24 h during the preceding 12 months	1,135	20–59	1,461	20–59	20–59	34.8	37.5	0.93
Palmer *et al*. 2000 (102)	UK	LBP ≥24 h during the preceding 12 months	5,305	20–59	5,058	20–59	20–59	44.9	53.7	0.84
McMeeken *et al*. 2001 (103)	Australia	LBP in the preceding year	228	11–25	386	9–27	M: 17.3±1.9; F: 16.9±2.1	32.0	37.0	0.86
Kovacs *et al*. 2003 (76)	Spain	Lifetime prevalence	4,476	45.7 ± 5.9	4,833	43 ± 5.7	M: 45.7±5.9; F: 43±5.7	78.2	62.6	1.25
Gummesson *et al*. 2003 (104)	Sweden	Current self-reported LBP ≥6 months, and having been experienced at least weekly	219	25–34	244	25–34	25–34	6.6	1.8	3.67
Gummesson *et al*. 2003 (104)	Sweden	Current self-reported LBP ≥6 months, and having been experienced at least weekly	213	35–44	279	35–44	35–44	15.0	2.3	6.52
McBride *et al*. 2004 (105)	New Zealand	LBP in the preceding 12 months	492	26	477	26	26	51.0	57.0	0.89
Harkness *et al*. 2005 (47)	England (study 1)	LBP on the day of the survey	508	18–64	547	18–64	45 (median)	9.1	8.1	1.12
Harkness *et al*. 2005 (47)	England (study 2)	LBP ≥1 day during the preceding month	835	18–64	1,118	18–64	42 (median)	18.2	17.8	1.02
Poussa *et al*. 2005 (106)	Finland	LBP ≥8 days during the preceding year	222	20.8–23.3	208	20.8–23.3	21.9 ± 0.3	18.4	16.9	1.09
Oksuz 2006 (85)	Turkey	LBP ≥24 h in the preceding 12 months	533	25–34	798	25–34	25–34	39.7	23.1	1.72
Oksuz 2006 (85)	Turkey	LBP ≥24 h in the preceding 12 months	558	35–44	667	35–44	35–44	42.0	27.8	1.51
Barrero *et al*. 2006 (107)	China	1 year self-reported LBP	386	<30	521	<30	<30	63.0	43.0	1.47
Barrero *et al*. 2006 (107)	China	1 year self-reported LBP	386	30–35	521	30–35	30–35	63.0	54.0	1.17
Barrero *et al*. 2006 (107)	China	1 year self-reported LBP	2,317	35–40	2,853	35–40	35–40	64.0	56.0	1.14
Barrero *et al*. 2006 (107)	China	1 year self-reported LBP	2,317	40–45	2,853	40–45	40–45	68.0	57.0	1.19
Barrero *et al*. 2006 (107)	China	1 year self-reported LBP	3,206	45–50	2,772	45–50	45–50	72.0	61.0	1.18
Gourmelen *et al*. 2007 (108)	France	LBP ≥30 days in the preceding 12 months	14,248 (M&F)	30–44	14,248 (M&F)	30–44	30–44	16.4	12.6	1.30
Shiri *et alet al*. 2008 (109)	Finland	LBP during the preceding 12 months	1,157	24–39	1,418	24–39	31.5±5	30.7	30.2	1.02
Ono *et al*. 2012 (110)	Japan	LBP during the preceding 1 month	987	44.3±14.7	1,183	44.8±15.5	M: 44.3±14.7; F: 44.8±15.5	32.0	25.0	1.28
Birabi *et al*. 2012 (111)	Nigeria	LBP in the preceding 12 months	132	18–58	178	18–58	36.71±8.98	51.0	49.0	1.04
Yue *et al*. 2012 (112)	China	LBP ≥1 day during the preceding 12 months	295	32.25±0.46	598	32.18 ± 0.31	M: 32.25±0.46; F: 32.18±0.31	47.5	41.7	1.14
Hartvigsen *et al*. 2013 (113)	Denmark	LBP in preceding 2 weeks	1,298	16–44	1,335	16–44	16–44	16.2	13.9	1.17
Erick and Smith 2014 (114)	Botswana	12 months self-reported prevalence of LBP	472	36.29±7.02	1,260	39.34 ± 9.02	M: 36.29±7.02; F: 39.34±9.02	58.7	47.7	1.23
Rottermund *et al*. 2015 (115)	Poland	LBP ≥3 months during a 12-month period preceding the examination	158	40.0±10.2	840	38.5±9.1	/	43.0	47.4	0.91

F/M: ratio of female prevalence and male prevalence (= female prevalence divided by male prevalence).

Table S3 Elderly groups (>50 years)

Author/year	Regions	Definition of LBP	Male sample size	Male age (years)	Female sample size	Female age (years)	M & F age mean	Female prevalence (%)	Male prevalence (%)	F/M
Ward *et al*. 1968 (98)	UK	LBP ≥3 days off work during the previous 5 years	2,661	≥65	3,932	≥65	≥65	0.8	1.4	0.57
Biering-Sørensen 1983 (99)	Denmark	Life time prevalence	928 (M&F)	60	928 (M&F)	60	60	81.0	70.0	1.16
Lavsky-Shulan *et al*. 1985 (116)	USA	LBP most of the time within the preceding year	1,152	≥65	1,942	≥65	≥65	23.6	18.4	1.28
Tsuji *et al*. 2001 (117)	Japan	An episode of LBP within the preceding 3 months	184	67.4	305	68.4	67.8±5.8	53.1	40.2	1.32
Gummesson *et al*. 2003 (104)	Sweden	Current self-reported LBP persisting for at least 6-months duration, and having been experienced at least weekly	259	55–64	252	55–64	55–64	24.2	11.6	2.09
Gummesson *et al*. 2003 (104)	Sweden	Current self-reported LBP persisting for at least 6-months duration, and having been experienced at least weekly	234	65–74	276	65–74	65–74	15.2	3.8	4.00
Oksuz 2006 (85)	Turkey	LBP ≥24 h in the preceding twelve months	364	45–54	433	45–54	45-54	42.0	27.7	1.52
Oksuz 2006 (85)	Turkey	LBP ≥24 h in the preceding twelve months	416	≥55	443	≥55	≥55	48.1	31.5	1.53
Barrero *et al*. 2006 (107)	China	1 year self-reported LBP	3,206	50–55	2,772	50–55	50–55	75.0	61.0	1.23
Barrero *et al*. 2006 (107)	China	1 year self-reported LBP	1,190	55–60	662	55–60	55–60	69.0	58.0	1.19
Barrero *et al*. 2006 (107)	China	1 year self-reported LBP	1,190	>60	662	>60	>60	57.0	57.0	1.00
Gourmelen *et al*. 2007 (108)	France	LBP ≥30 days in the preceding 12 months	14,248 (M&F)	55–64	14,248 (M&F)	55–64	55–64	21.9	19.7	1.11
Muraki *et al*. 2009 (118)	Japan	LBP on most days in the preceding month	818	≥60	1,470	≥60	M: 74.7±6.1; F: 74.0±6.4	31.2	24.6	1.27
Muraki *et al*. 2011 (119)	Japan	LBP on most days in the preceding year	587	66.3±11.7	1,088	64.7±12.1	M: 66.3±11.7; F: 64.7±12.1	21.2	21.7	0.98
Cho *et al*. 2012 (53)	Korea	LBP ≥ a day in lifetime	1,861	55.7±13.8	2,320	57.2±13.0	56.6±13.4	67.3	53.8	1.25
Kim *et al*. 2014 (120)	Korea	LBP >1 month out of the preceding 3 months	1,796	≥50	2,198	≥50	M: 63.4±8.7; F: 62.7±8.7	37.4	15.5	2.41
Palma *et al*. 2014 (121)	Brazil	LBP in the preceding year	153	60–80	93	60–80	60–80	35.1	25.1	1.40
He *et al*. 2014 (52)	Hong Kong	LBP during the preceding 12 months	1,994	65–92	1,996	65–92	M: 72.4; F: 72.6	53.3	30.6	1.74
Teraguchi *et al*. 2015 (122)	Japan	LBP on most days during the preceding month	324	67.2±13.9	651	66.0±13.4	66.4±13.5	42.1	36.7	1.15

F/M: ratio of female prevalence and male prevalence (= female prevalence divided by male prevalence).

Table S4 Mixed age group

Author/year	Regions	Definition of LBP	Male sample size	Male age (years)	Female sample size	Female age (years)	M & F age mean	Female prevalence (%)	Male prevalence (%)	F/M
Ward *et al*. 1968 (98)	UK	LBP ≥3 days off work during the previous 5 years	3,985	15–24	4,017	15–24	15–24	0.8	1.1	0.73
Ward *et al*. 1968 (98)	UK	LBP ≥3 days off work during the previous 5 years	6,667	45–64	7,155	45–64	45–64	1.9	3.1	0.61
Lawrence 1969 (50)	UK	LBP	713	≥35	809	≥35	≥35	19.0	11.0	1.73
Nagi *et al*. 1973 (3)	USA	Often bothered with LBP	505	18–64	630	18–64	18–64	21.1	13.9	1.52
Frymoyer *et al*. 1980 (123)	USA	One episode of LBP during 3-year interval	1,852	≥18	2,068	≥18	≥18	9.5	11.0	0.86
Reisbord *et al*. 1985 (4)	USA	Frequent LBP during the preceding 12 months	1,320	≥18	1,462	≥18	≥18	20.1	15.0	1.34
Deyo *et al*. 1987 (124)	USA	LBP on most days for at least 2 weeks	4,904	≥25	5,500	≥25	≥25	13.4	14.2	0.94
Heliövaara *et al*. 1989 (45)	Finland	LBP syndrome diagnosed	3,637	30–99	4,363	30–99	30–99	16.3	17.5	0.93
Heliövaara *et al* 1991 (125)	Finland	LBP diagnosis	2,946	30–64	3,156	30–64	30–64	10.9	10.7	1.02
Walsh *et al*. 1992 (126)	UK	Lifetime prevalence	1,172	20–59	1,495	20–59	20–59	55.9	61.5	0.91
Darmawan *et al*. 1992 (127)	Java (rural)	LBP determined by primary health care staff	2,184	≥15	2,499	≥15	≥15	13.1	17.4	0.75
Darmawan *et al*. 1992 (127)	Java (urban)	LBP determined by primary health care staff	481	≥15	590	≥15	≥15	25.6	19.4	1.32
Papageorgiou *et al*. 1995 (51)	South Manchester, UK	LBP ≥1 day during the preceding month	1,884	18–75	2,617	18–75	18–75	41.7	34.5	1.21
Croft *et al* 1999 (128)	UK	LBP occurred during the survey	722	18–75	927	18–75	18–75	37.0	34.0	1.09
Santos-Eggimann *et al*. 2000 (129)	Switzerland	LBP >7 cumulated days over the preceding 12 months	5,299 (M&F)	25–74	5,299 (M&F)	25–74	25–74	32.6	25.0	1.30
Gummesson *et al*. 2003 (104)	Sweden	Current self-reported LBP persisting >6 months duration, and having been experienced at least weekly	209	45–54	281	45–54	45–54	11.7	7.6	1.54

Table S4 (*continued*)

Table S4 (*continued*)

Author/year	Regions	Definition of LBP	Male sample size	Male age (years)	Female sample size	Female age (years)	M & F age mean	Female prevalence (%)	Male prevalence (%)	F/M
Walker *et al*. 2004 (130)	Australia	LBP lifetime prevalence	1,410	≥18	1,590	≥18	~28.4	79.0	79.4	0.99
Zeng *et al*. 2004 (131)	China	LBP lifetime prevalence	985	≥16	1,055	≥16	≥16	20.5	13.8	1.49
Gilgil *et al*. 2005 (132)	Turkey	LBP presented on the day of the survey	1,517	≥16	1,622	≥16	≥16	26.1	13.6	1.92
Ihlebaek *et al*. 2006 (133)	Norway	Lifetime prevalence	1158 (M&F)	17–67	1,158 (M&F)	17–67	17–67	59.1	62.4	0.95
Ihlebaek *et al*. 2006 (133)	Sweden	Lifetime prevalence	1,129 (M&F)	17–67	1,158 (M&F)	17–67	17–67	69.9	68.9	1.01
Schmidt *et al*. 2007 (134)	Germany	Lifetime prevalence	4,287	18–75	4,976	18–75	1,875	85.7	85.3	1.00
Strine & Hootman 2007 (135)	US	LBP during the preceding 3 months	29,828 (M&F)	≥18	29,828 (M&F)	≥18	≥18	17.6	16.5	1.07
Gourmelen *et al*. 2007 (108)	France	LBP for at least 1 day in the preceding 12 months	14,248 (M&F)	30–64	14,248 (M&F)	30–64	30–64	57.2	54.0	1.06
Altinel *et al*. 2008 (136)	Turkey	LBP requiring treatment or lasted whole day and for at least 2 weeks	841	18	1,194	18	>18	63.2	33.8	1.87
Leclerc *et al*. 2009 (137)	France	LBP in the preceding year for at least 30 days	7,292	30–69	8,242	30–69	30–69	19.0	15.6	1.22
Leboeuf-Yde *et al*. 2009 (138)	Denmark	LBP ≥30 days in the preceding year	15,880	20–71	19,022	20–71	20–71	55.0	55.0	1.00
Tucer *et al*. 2009 (139)	Turkey	Self-reported LBP during the survey period	958	≥18	1,219	≥18	≥18	39.9	34.9	1.14
Leijon *et al*. 2009 (140)	Sweden	LBP a couple of days per week or every day	11,975	21–64	14,636	21–64	21–64	16.4	12.0	1.37
Fernández-de-las-Peñas *et al*. 2011 (141)	Spain	LBP in the preceding 12 months and physician confirmed the diagnosis	11,645	≥16	17,833	≥16	≥16	24.5	15.1	1.62
Fernández-de-las-Peñas *et al*. 2011 (141)	Spain	LBP in the preceding 12 months and visited medical doctor for this	11,645	≥16	17,833	≥16	≥16	24.5	15.1	1.62
Jimenez-Sanchez *et al*. 2012 (142)	Spain	Chronic LBP over the preceding 12 months	5,742	≥16	6,448	≥16	≥16	14.1	7.8	1.81
Korovessis *et al*. 2012 (143)	Greece	LBP in the preceding 6 months	254	≥20	420	≥20	≥20	42.6	34.3	1.24
Hartvigsen *et al*. 2012 (114)	Denmark	LBP in the preceding 2 weeks	1,007	≥45	1,177	≥45	≥45	24.0	16.8	1.43
Liu *et al*. 2012 (144)	China	LBP >1 full day during the preceding 3 months	1073	15–84	972	15–84	15–84	40.7	36.3	1.12
Macfarlane *et al*. 2012 (145)	UK	LBP ≥1 day in the preceding month	6,312	≥25	8,368	≥25	56 (median)	29.3	27.5	1.07
Bjornsdottir *et al*. 2012 (146)	Iceland	Lifetime prevalence LBP	2,636	18–79	2,984	18–79	18–79	20.4	15.3	1.33
Chou *et al*. 2013 (147)	Taiwan	LBP in the preceding 3 months	12,498	≥20	11,937	≥20	≥20	30.0	21.5	1.40
Fujii & Matsudaira 2013 (148)	Japan	LBP in the preceding year lasting >1 day	31,659	20–79	33,837	20–79	47.65±14.83	84.5	82.4	1.03
Pedisic *et al*. 2013 (149)	Croatia	Recent LBP	531	≥15	499	≥15	M: 38.99±14.76; F: 39.31±14.97	66.3	62.9	1.05
Hu *et al*. 2013 (150)	Taiwan	LBP based on medical treatment	6,586	≥18	6,276	≥18	≥18	31.9	27.2	1.17
Meucci *et al*. 2013 (151)	Brazil	In the preceding 3 months LBP for 7 weeks or more (50 days) continuously	1,151	≥20	1,581	≥20	≥20	11.7	6.6	1.77
Sandoughi *et al*. 2013 (152)	Iran	LBP during the preceding 7 days	921	≥15	1,179	≥15	33.1±14.7	23.0	12.5	1.84
Heuch *et al*. 2013 (153)	Norway	LBP ≥3 months during the past year	8,733	30–69	10,149	30–69	30–69	20.0	14.0	1.43
Choi *et al*. 2013 (154)	Korea	LBP >1 week in the preceding year or at least once every month severely	744	≥18	832	≥18	≥18	25.1	13.2	1.90
Lee *et al*. 2013 (155)	Korea	Diagnosed with LBP by a medical doctor	3,099	≥21	4,045	≥21	≥21	21.0	12.1	1.74
Mork *et al*. 2014 (156)	Norway	LBP lasted for at least 3 consecutive months	13,501	≥20	13,395	≥20	≥20	18.0	14.0	1.29
Araújo *et al*. 2014 (157)	Portugal	LBP during the preceding month	178	60.5±14.6	311	59.0±14.1	≥ 18	44.2	20.8	2.13
Großschädl *et al* 2015 (158)	Austria	LBP in the preceding 12 months	57,056	≥15	64,430	≥15	≥15	36.3	32.2	1.13
Capkin *et al*. 2015 (159)	Turkey	Lifetime prevalence LBP	4,006	≥0	3,789	≥0	≥0	68.4	56.2	1.22

F/M: ratio of female prevalence and male prevalence (= female prevalence divided by male prevalence).

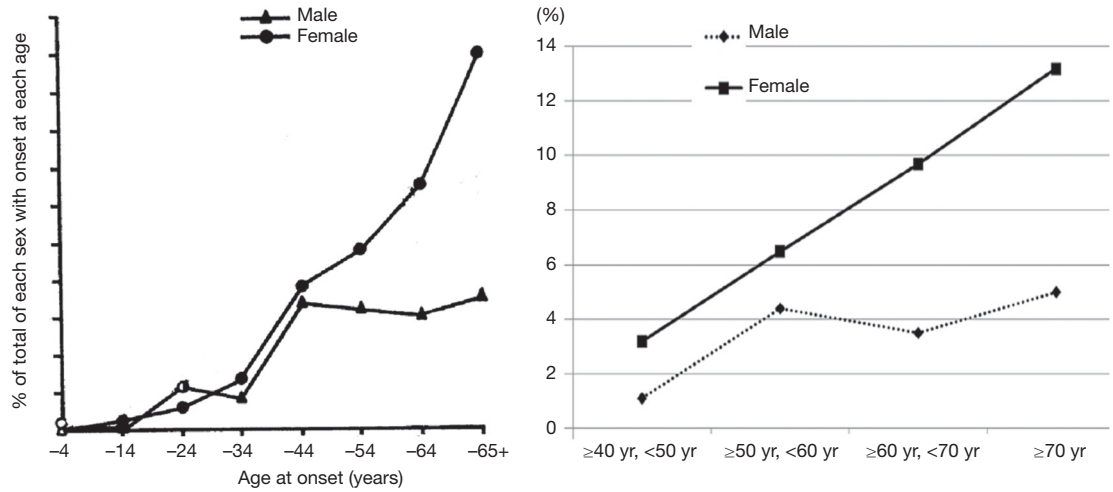

Figure S1 (A) Prevalence of present back-hip-sciatic pain, by age and sex [modified from Lawrence 1969, UK study (50)]; (B) prevalence of grade 3–4 low back pain according to age and sex [modified from Cho *et al*. 2012, Korean study (53)]. The data show after menopause women have higher low back pain prevalence than age match men.

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