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ORIGINAL RESEARCH

Prevalence and Pattern of Radiographic Intervertebral Disc Degeneration in Vietnamese: A Population-Based Study

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Abstract Intervertebral disc degeneration (IDD) is one of the most common skeletal disorders, yet few data are available in Asian populations. We sought to assess the prevalence and pattern of radiographic IDD in a Vietnamese population. This population-based cross-sectional investigation involved 170 men and 488 women aged ≥40 years, who were randomly sampled from the Ho Chi Minh City (Vietnam). Anthropometric data, clinical history and self-reported back and neck pain were ascertained by a questionnaire. Plain radiographs (from the cervical spine, thoracic spine to the lumbar spine) were examined for the presence of disc space narrowing and/or osteophytosis using the Kellgren–Lawrence (KL) grading system. The presence of radiographic IDD was defined if the KL grade was 2 or greater in at least one disc. The prevalence of radiographic IDD was 62.4 % ($n = 106$) in men and 54.7 % ($n = 267$) in women. The most frequently affected site was the lumbar spine with prevalence being 50.6 and 43.2 % in men and women, respectively. The prevalence of IDD increased with advancing age: 18.8 % among those aged 40–49 years, and increased to 83.4 % in those aged ≥60 years. Self-reported neck pain and lower back pain were found in 30 and 44 % of individuals, respectively. There was no statistically significant association between self-reported neck pain and cervical spine OA. These data suggest that radiographic IDD is highly prevalent in the Vietnamese population, and that self-reported back pain is not a sensitive indicator of IDD.

Keywords Intervertebral disc degeneration · Epidemiology · Prevalence · Vietnamese

Introduction

Osteoarthritis (OA) is a degenerative skeletal disorder characterized by cartilage loss and osteophyte formation in joints. Although OA can affect any joint in the body, it is mostly found in the hands, knees, hips and spine. An individual may have OA at multiple joints. The consequence of OA is disability and reduced mobility. Indeed, OA is recognized as the most common cause of disability in the elderly [1]. Spinal OA or intervertebral disc degeneration (IDD) is a subtype of OA, but may not have the same aetiology as OA of the hand and hip [2, 3]. However, IDD is commonly associated with or a cause of back pain, which is highly prevalent in the general population. The lifetime risk of back pain has been estimated to be 8 out of 10 in the American population [4].

Although the prevalence of IDD has been well documented in Caucasian populations, it has not been well characterized in Asian populations. Past studies in Caucasian populations suggest that the prevalence of IDD

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varies remarkably between populations depending on age and sex of participants, method of ascertainment used and the specificity of joint sites [5]. A retrospective study found that the prevalence of spinal osteoarthritis was as high as 80 % among Caucasian individuals aged 40 years and older [6]. During the past 5 years, there have been few studies of IDD in Chinese and Japanese populations. In a radiograph-based study on 4,000 Chinese men women aged 65 years and older, the prevalence of IDD was greater than 90 % [7], which is similar to an estimate using the Schneiderman's system of classification [8]. Another study on 2,599 Southern Chinese using magnetic resonance imaging (MRI) technique found that the prevalence of disc degeneration was approximately 73 % [9]. In the Wakayama Spine Study [10] (Japan), the investigators found that disc degeneration was present in ~90 % of men and women aged 50 years and older. Taken together, these data suggest that IDD in Asian populations is comparable to that in Caucasian populations.

Few data on IDD are available for Southeast Asian populations, which are ageing rapidly. The proportion of people aged 65 years and older in Asia is estimated to increase from ~7 % in 2008 to 16 % in 2040 [11]. Due to its high prevalence and disability associated with IDD, the ageing of the population will impose a significant skeletal burden both to the individual patient and to society. In an effort to contribute to the international literature of osteoarthritis, we have undertaken a study to assess the prevalence of IDD in a Vietnamese population. We also analysed the patterns of joint distribution of disc degeneration.

Study Design and Methods

Study Design

The study was designed as a cross-sectional investigation, with the setting being Ho Chi Minh City, a major city in Vietnam. The study was conducted in accordance with the principles of medical ethics of the World Health Organization. All participants were provided with full information about the study's purposes, and gave written informed consent to participate in the study. The research protocol and procedures were approved by the Scientific Committee of the People's Hospital 115 and Pham Ngoc Thach University of Medicine.

Details of study procedures have been published previously [12]. Briefly, we approached community organizations, including churches and temples, and obtained the list of members, and then randomly selected individuals aged 18 years or above. We used simple random sampling technique to identify potential participants. We sent a letter of invitation to the selected individuals. Some participants were invited via phone. The participants did not receive any financial incentive, but they received a free health checkup, including lipid analyses. Participants were excluded from the study if they had rheumatoid arthritis. In this report, we included participants aged 40 years and older.

Measurements

All participants underwent a detailed investigation to obtain the following baseline data: a standardized interview gathered information on demographic data, lifestyle and nutritional status. Anthropometric parameters including age, weight and standing height were obtained. Body weight was measured on an electronic scale with indoor clothing without shoes. Height was determined without shoes on a portable stadiometer with mandible plane parallel to the floor. Body mass index (BMI) was calculated as weight in kg over height in meter squared.

Each participant was asked to provide information on current and past smoking habits. Smoking was quantified in terms of the number of pack-years consumed in each ten-year interval age group. Alcohol intake in average numbers of standard drinks per day, at present as well as within the last 5 years, was obtained. Clinical data including blood pressure, pulse and reproductive history (i.e. parity, age of menarche and age of menopause), medical history (i.e. previous fracture, previous and current use of pharmacological therapies) were also obtained.

Neck pain and low back pain were assessed by a questionnaire developed by our research group. The questionnaire consists of 30 questions with dichotomous answer (yes/no) concerning 5 symptoms: pain during movement, local persistent pain, stiffness, limited movement and joint rigidity. The presence of any of the symptoms was considered having neck pain or back pain.

Radiographic Assessment

The ascertainment of OA was based on radiographic examination. Plain anterior–posterior and lateral radiographs of the spine were taken from all participants. All radiographs were obtained using a tube-to-film distance of 105 cm, with the tube positioned approximately over C4 for cervical films, T8 for thoracic films and L2 for lumbar films. The radiographs were read by a single radiologist who was unaware of the clinical conditions or self-reported pain of participants.

The presence or absence of osteophytes, joint space narrowing, sclerosis and cysts was examined for each intervertebral space from C3–C7, T3–T12 and L1–L5 (i.e. 20 discs) by the Kellgren-Lawrence [KL] criteria [13]. The

KL criteria are also recommended by the WHO as a standard method for studying OA in epidemiologic studies [14]. The severity of OA was graded according to the following rule: 0 = none, 1 = possible osteophytes only, 2 = definite osteophytes and possible joint space narrowing and 4 = large osteophytes, severe joint space narrowing and/or bony sclerosis. The presence of IDD was defined if the KL grade was 2 or more in at least one joint.

Data Analysis

We determined the point prevalence of radiographic disc degeneration in the cervical, thoracic and lumbar spine (individually or combined) by age group and BMI group. Each individual was classified as having IDD if there was the presence of disc degeneration in any of the 20 discs. We grouped participants into three 10-year age groups: under 50, 50–59 and 60 years or above. BMI was classified into 4 groups according to the classification of obesity for Asians: 18.5, 18.5–22.9, 23.0–24.9 and 25 or above.

Bivariate and multivariable regression models were used to estimate the magnitude of association between IDD and gender, age and BMI. The association between self-reported low back pain or neck pain and the presence of IDD was analysed by the negative binomial regression model [15]. Based on the parameter estimates of this model, we calculated the prevalence ratio (i.e. ratio of the prevalence of IDD among those with self-reported back pain over the prevalence among those without self-reported back pain). The negative binomial regression model is appropriate for outcome with high prevalence, as it avoids the problem of exaggerated odds ratio in the logistic regression model. All analyses were conducted using the R Statistical Environment [16].

Results

The study involved 170 men and 488 women, whose demographic and lifestyle characteristics are shown in Table 1. The individuals' ages ranged between 40 and 98, with average being 55.5 years. Approximately, 21 % women and 32 % men had BMI greater than 25 kg/m^2 which are considered "obese" by Asian criteria. As expected, the prevalence of cigarette smoking and alcohol use in women is very low (less than 3 %) compared with men ($\sim$56 % smokers and 60 % alcohol drinkers).

Prevalence of IDD

The overall prevalence of radiographic IDD was 57 % ($n = 375$), with men having higher prevalence than women (62.4 % vs. 54.7 %; Table 2). The majority of IDD was found in the lumbar spine (51 % in men and 43 % in women), followed by cervical spine (43.5 % in men and 28 % in women). A substantial proportion of individuals had IDD in 2 regions. For instance, 17 % of men and 10 % of women had IDD in both the cervical spine and lumbar spine. Approximately, 10 % of individuals (i.e. men and women combined) had IDD in all 3 regions. Further analysis suggests that radiographic IDD was frequently found at L4, followed by L3, C5, L2 and C6 (Fig. 1).

There was a significant correlation in IDD between sites. For example, individuals with cervical IDD were also more likely to have lumbar IDD (Phi coefficient 0.31, $P < 0.0001$). Similarly, there was a significant correlation between cervical IDD and thoracic IDD (Phi coefficient 0.24, $P < 0.0001$), and between lumbar IDD and thoracic IDD (Phi coefficient 0.43, $P < 0.0001$).

Advancing age was associated with an increased risk of radiographic IDD (Fig. 2). Among those aged between 40 and 49, approximately 19 % had IDD, mainly cervical spine and lumbar spine. Among those aged between 50 and 59, $\sim$64 % of participants had IDD, of which almost half had IDD in the lumbar spine. The prevalence of IDD increased to 83 % among participants aged 60 years and above; in this age group, lumbar spine disc degeneration and thoracic disc degeneration were found in 72 and 37 % of men and women, respectively.

There was an inverse relationship between BMI and risk of IDD, such that obese individuals had lower prevalence of IDD than non-obese individuals. For instance, the prevalence of IDD among those with BMI <25 was 53 %, but this prevalence increased to 69 % among those with BMI $\geq$25 kg/m^2 (Fig. 3).

Self-Reported Symptoms and Radiographic IDD

The prevalence of self-reported pain and symptoms in the neck was 29 %, with women reporting more frequent (33 %) than men (20 %). A majority of the self-reported symptoms were stiffness and pain in shoulder (Table 3). The prevalence of self-reported low back pain and symptoms was 44 %, with women reporting higher prevalence than men (49 % vs. 30 %). Again, a majority of self-reported symptoms were pain and stiffness.

There were age-sex differences in the prevalence of pain. For neck pain, the prevalence peaked in the 50–59 age group in women (39 %) and men (22 %), and declined among those aged 60 years and above (28 % in women and 19 % in men). For low back pain, the prevalence increased linearly with advancing age in women, but not in men. In women, approximately 50 % of participants aged 50–59 reported to have low back pain, and this prevalence increased to 58 % among those

Table 1 Characteristics of 488 women and 170 men in the study

Characteristics	Women ($n = 488$)	Men ($n = 170$)
N	488	170
Age	55.9 (12.6)	55.1 (15.8)
40–49 (*n*, %)	146 (29.9)	56 (32.9)
50–59	176 (36.1)	51 (30.0)
60+	166 (34.0)	63 (37.1)
Height (cm)	153.2 (5.2)	163.6 (5.7)
Weight (kg)	53.1 (7.5)	62.2 (9.1)
Body mass index (kg/m^2)	22.6 (2.9)	23.2 (3.2)
<18.5 (*n*, %)	24 (4.9)	11 (6.5)
18.5–22.9	256 (52.6)	70 (41.2)
23.0–24.9	106 (21.8)	34 (20.0)
>25.0	101 (20.7)	55 (32.4)
Education attainment (*n*, %)		
Illiterate	15 (3.1)	1 (0.6)
Primary school	85 (17.5)	8 (4.7)
Secondary school	307 (75.0)	108 (63.9)
College and university	55 (11.3)	41 (24.3)
Occupation (*n*, %)		
Sales/small business	79 (16.2)	28 (16.6)
Factory workers	9 (1.9)	9 (5.3)
Office workers	77 (15.8)	18 (10.7)
Professionals	12 (2.5)	16 (9.5)
Retired	69 (14.2)	49 (29.0)
Housewives	182 (37.4)	–
Current alcohol drinker (*n*, %)	14 (2.9)	102 (60.4)
Current smoking (*n*, %)	6 (1.2)	94 (55.6)
Current tea drinker (*n*, %)	249 (51.1)	98 (58.0)

Table 2 Prevalence of intervertebral disc degeneration (%) of the cervical, thoracic and lumbar spine in 170 men and 488 women

Site	Women ($n = 488$)	Men ($n = 170$)	Men and women
Cervical spine (C)	28.3 ($n = 138$)	43.5 ($n = 74$)	32.2
Thoracic spine (T)	15.8($n = 77$)	25.3 ($n = 43$)	18.2
Lumbar spine (L)	43.2 ($n = 211$)	50.6 ($n = 86$)	45.1
C or T	36.3 ($n = 177$)	51.8 ($n = 88$)	40.3
C or L	53.7 ($n = 262$)	61.2 ($n = 104$)	55.6
T or L	44.5 ($n = 217$)	53.5 ($n = 91$)	46.8
Any of the above	54.7($n = 267$)	62.4 ($n = 107$)	56.8

aged 60+ years; in men, the prevalence peaked in the age group of 50–59 (36 %) and then declined to 32 % among those aged 60+ years.

There was no statistically significant association between radiographic cervical disc degeneration and self-reported symptoms in the neck. The prevalence of cervical disc degeneration among those who self-reported having neck symptoms was 36 %, and among those who reported no neck symptoms were 30 % (prevalence ratio [PR] 1.29, 95 % CI 0.90–1.84). However, individuals self-reported having low back symptoms were more likely to have lumbar spine disc degeneration (PR 1.59, 95 % CI 1.16–2.18).

Predictors of IDD Risk

In multivariable negative binomial regression analysis, 3 factors were found to be significantly associated with the risk of IDD: gender, age and BMI (Table 4). The prevalence ratio (PR) of IDD associated with women was 0.56 (95 % CI 0.36–0.89). Each 5-year increase in age was associated with 86 % increase (PR 1.86, 95 % CI 1.67–2.06)

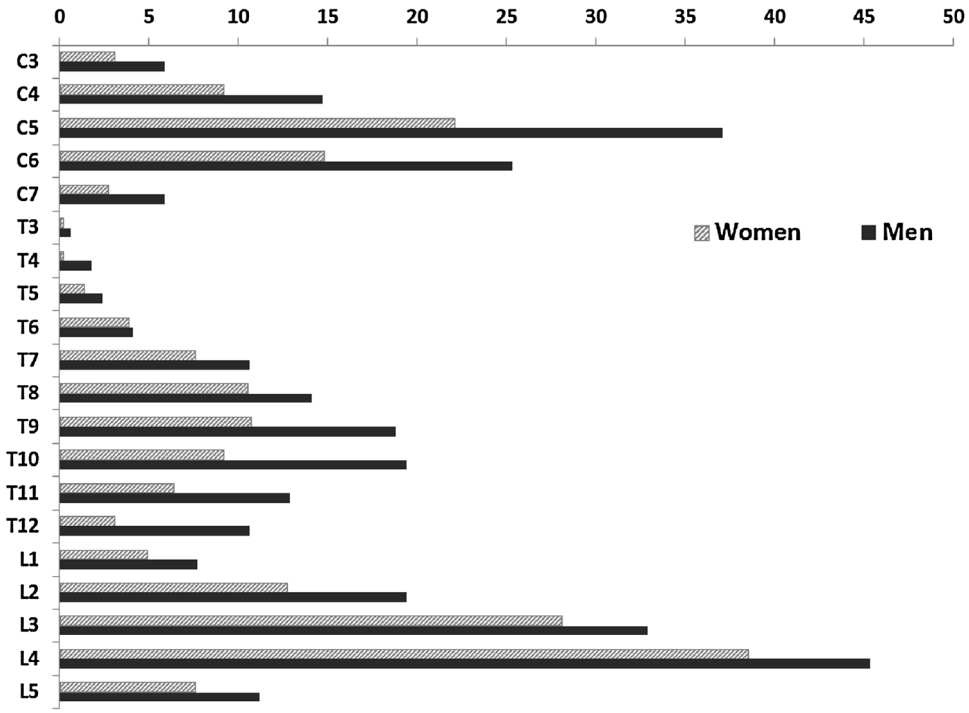

Fig. 1 Prevalence of intervertebral disc degeneration in men and women aged ≥40 years

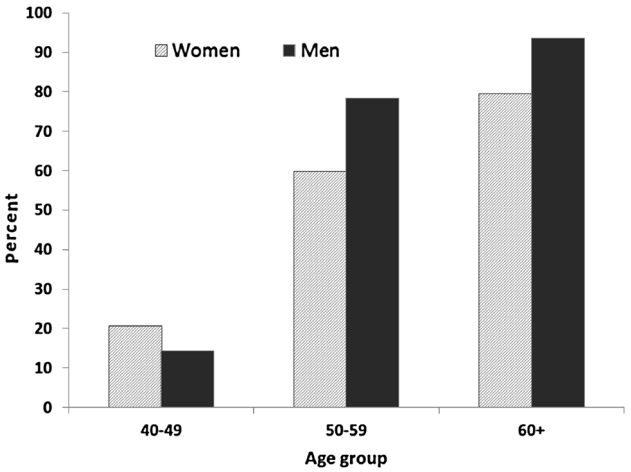

Fig. 2 Prevalence of intervertebral disc degeneration by age among men and women aged ≥40 years

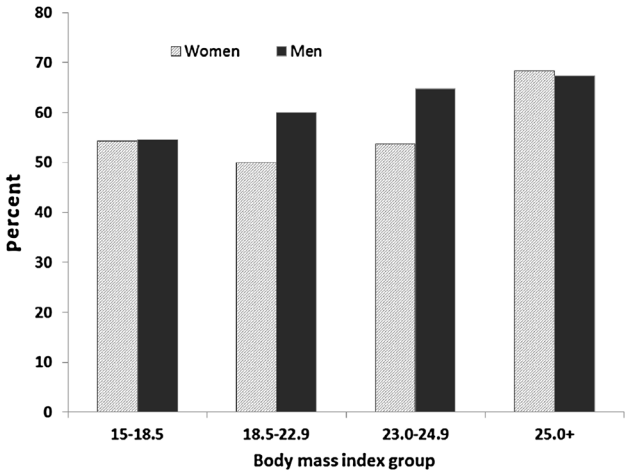

Fig. 3 Prevalence of intervertebral disc degeneration by BMI among men and women aged ≥40 years

in the risk of IDD. The statistically significant association between BMI and IDD was observed for thoracic disc degeneration (PR 1.43, 95 % CI 1.05–1.95), but not in other sites.

Discussion

In Southeast Asian populations, there is a dearth of data concerning osteoarthritis, particularly IDD. In this population-based study in a Vietnamese population, we have shown that almost 60 % of individuals aged 60 and above have radiographic IDD, with men having higher prevalence than women. We have also shown that self-reported neck pain or low back pain was not a sensitive indicator of IDD.

To the best of our knowledge, this is the first comprehensive population-based study of prevalence of IDD in the Vietnamese population or indeed in Southeast Asian populations. Therefore, it is difficult to place the present results in the context of literature. Nevertheless, a previous study in a Caucasian population found that the prevalence

Table 3 Prevalence (%) of self-reported pains and symptoms in the neck and low back

	Women ($n = 479$)	Men ($n = 168$)	Men and women ($n = 647$)
Neck			
Pain during movement	19.0	13.7	17.6
Pain in shoulder	17.5	12.5	16.2
Stiffness	21.5	13.1	19.3
Limited movement	2.3	1.8	2.2
Rigidity	7.7	4.2	6.6
Any of the symptoms	32.6	19.6	29.2
Low back			
Pain during movement	38.8	25.0	35.2
Pain in legs	20.9	10.1	18.1
Stiffness	21.3	11.9	18.9
Limited movement	5.9	1.8	4.8
Rigidity	7.5	2.4	6.2
Any of the symptoms	48.6	30.4	43.9

Table 4 Predictors of radiographic IDD: prevalence ratio of radiographic IDD associated with gender, age and body mass index (BMI)

Risk factors	IDD	Disc degeneration in cervical spine	Disc degeneration in thoracic spine	Disc degeneration in lumbar spine
Gender (women)	0.56 (0.36–0.89)	0.46 (0.31–0.69)	0.67 (0.44–1.02)	0.53 (0.33–0.86)
Age (+5 years)	1.86 (1.67–2.06)	1.41 (1.31–1.52)	1.69 (1.54–1.85)	1.53 (1.39–1.68)
BMI (+5 kg/m^2)	1.34 (0.97–1.85)	1.17 (0.87–1.58)	1.43 (1.05–1.95)	1.26 (0.88–1.82)

of IDD was up to 80 % [6], and three recent studies in Chinese [7–9] and Japanese [10] all found a substantially higher prevalence than ours. The difference is likely due to difference in methods of ascertainment and population characteristics. In our study, we used the Kellgren-Lawrence method to diagnose IDD, whereas the previous study used an independent scoring method for the diagnosis [6, 7] and/or MRI [8, 10]. Our 9 study population included men and women aged 40 years and older, whereas the previous study was based on women aged between 20 and 82. These differences could partly account for the observed difference in estimates of prevalence.

We found that advancing age was clearly a risk factor for IDD. It is remarkable that by the age 60 and above, 8 out of 10 individuals have some evidence of radiographic IDD. The strong association between age and radiographic IDD has also been observed in virtually all previous epidemiologic studies [17, 18]. The effect of age is consistent with the view that IDD is an age-related degenerative disease. It is postulated that the increased risk in IDD with advancing age is due to age-related oxidative stress and damage [19], but this has not been tested in empirical studies. We also noted that men had a higher prevalence of IDD than women, and this trend was previously observed [3, 20]. The gender-related difference could be due to occupational exposure and physical activity. In Vietnam, men are more likely than women to work physically demanding jobs, and this could explain the higher prevalence of IDD in men in our population.

It is well known that OA of the knees and hips is associated with greater body mass index [17]. In this study, we also found that BMI was a significant predictor of the risk of IDD. Our finding is consistent with previous studies which showed that higher BMI was associated with a greater risk of IDD in the general population [10, 21, 22] as well as in overweight and obese populations [9]. However, in our study, we found that the magnitude of BMI-IDD association was generally weak (average prevalence ratio being 1.2–1.4), suggesting that BMI is not a good prognostic factor for IDD.

Low back pain (LBP) can be seen as a consequence of spine OA [20, 23, 24]. In this study, the point prevalence of self-reported LBP was 44 % (with women having higher prevalence than men—prevalence ratio 1.6). Our estimate is in fact highly agreeable with the Saskatchewan Health and Back Pain Survey [25], in which the overall prevalence of LBP was 49 %. However, it is difficult to estimate the true prevalence of self-reported LBP due to its subjective nature [26]. In this study, we found that although self-reported LBP was statistically associated with a greater risk of IDD, it is neither sensitive nor specific for the accurate identification of IDD. Moreover, we found that the point

prevalence of self-reported neck pain was 29 % (with women reporting higher prevalence than men), and this estimate is highly comparable to a previous estimate (26 %) among those aged 20 and 69 years in a North American population [25]. Again, we noted that a self-reported neck pain is not a sensitive indicator of IDD of the cervical spine. At present, there are no reliable prognostic factors that allow clinicians to accurately identify individuals with high risk of IDD.

The present results must be interpreted within the context of strengths and potential limitations. The study was based on a random sample using a rigorous random sampling technique to ensure the representativeness of the general population. The study population is highly homogeneous, which reduces the effects of potential confounders that could compromise the estimates. Nevertheless, the participants in this study were sampled from an urban population; as a result, the study's finding may not be generalizable to the rural populations. Because we excluded individuals with diseases deemed to interfere with bone metabolism, the prevalence of IDD reported here could be an underestimate of the true prevalence in the general population. In this study, we used the Kellgren-Lawrence method for the diagnosis of IDD, but this method is one of many available methods [27]. Moreover, although the Kellgren-Lawrence method has been shown to have good interobserver reliability [27], it may not be as sensitive and accurate as the MRI technique in the diagnosis of IDD. Another disadvantage of the Kellgren-Lawrence method is that it could not distinguish between subtypes of osteoarthritis as the other methods [28, 29] can. The questionnaire for low back pain and neck pain was used a dichotomous answer which did not allow us to quantify the severity of pain, and hence could limit the analysis of association between LBP and IDD.

In summary, we have shown that radiographic IDD is present in 6 out of 10 adult individuals of Vietnamese background, and this prevalence is equivalent to the prevalence of osteoarthritis of the knees, hips and hands in Caucasian populations. We have also shown that the prevalence of low back pain (44 %) and neck pain (29 %) is equivalent to that in Caucasian populations, but the presence of low back pain or neck pain is not a good predictor of IDD. Given the rapid ageing population in Asia, these findings suggest that intervertebral disc degeneration will become a significant public problem in Asian populations.

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Conflict of Interest The authors declare that they have no conflict of interest.

Statement of human rights All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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