Original Article

Prevalence of Developmental Dysplasia of the Hip in Chinese Adults: A Cross-sectional Survey

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Abstract

Background: The prevalence of developmental dysplasia of the hip (DDH) is unknown in China. We aimed to determine the prevalence of DDH in Chinese adults.

Methods: In this study, we performed a cross-sectional survey of a nationally representative sample of Chinese adults. All participants underwent questionnaire investigation, physical examination, and X-ray examination. Factors associated with DDH were analyzed with logistic regression.

Results: We invited 29,180 individuals aged 18 years and over to participate, randomly selected from 18 primary sampling units (street districts in urban areas and townships in rural areas). The survey and examination were completed in 25,767 people (10,296 men and 15,471 women). DDH was diagnosed in 391 people, yielding an overall DDH prevalence of 1.52%. Based on this information, we estimate the number of individuals with DDH in China to be approximately 16.05 million. DDH prevalence increased with age (odds ratio = 1.53 [1.03–2.27], $P = 0.036$), was significantly higher among women than men (2.07% vs. 0.75%, $P < 0.001$), and was higher among rural residents than urban residents (1.75% vs. 1.29%, $P < 0.001$). Economic development was independently associated with the presence of DDH. There was no evidence of an association between body mass index alone, education, or current smoking or drinking and risk of DDH ($P > 0.05$).

Conclusions: DDH has become an important public health problem. Special attention should be paid to residents with DDH. Screening for DDH should be performed in China.

Key words: Adult; China; Developmental Dysplasia of the Hip; Prevalence; Risk Factors

Introduction

Developmental dysplasia of the hip (DDH) is a common congenital abnormality that affects the developing hip joint. The prevalence of DDH is reported in Europe and the United States.[1-4] The reported prevalence of DDH ranges from as low as 1 per 1000 to as high as 34 per 1000 live births. The exact prevalence of DDH is difficult to determine because of discrepancies in the definition of the condition, type of examination used, and skill level of clinicians.[5-8] Higher prevalence was reported when ultrasonography used in addition to clinical examination.[9,10] The prevalence and related epidemiologic factors of DDH have not yet been elucidated in China. We thus performed a national survey from June 2012 to August 2013 to estimate the prevalence of DDH and associated risk factors among Chinese adults.

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Methods

Study population

We used a multistage, stratified sampling method to select a nationally representative sample of individuals aged 18 years and over in the general population. We initially stratified 31 Chinese provinces and municipalities into three regions, Eastern, Central, and Western China, according to economic

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criteria. In the first stage of sampling, three provinces were randomly selected from each region: Liaoning, Zhejiang, and Hainan Provinces for Eastern China; Heilongjiang, Hunan Province, and Inner Mongolia Autonomous Region for Central China; Shanxi, Yunnan Province, and Xinjiang Uyghur Autonomous Region for Western China. In the second stage, one rural and one urban districts were randomly selected from each province or autonomous region. In the third stage of sampling, one subdistrict (referred to as one street district in urban districts and as one township in rural districts) was randomly selected from each urban and rural districts. In the final stage, individuals were randomly chosen from the selected subdistricts (i.e., township or street district). Only one participant was selected from each household, without replacement. Simple random sampling methods without replacement were used at each stage.

The formula below was used to estimate minimum the sample sizes for each sampling unit, $n = 315$.

$n_0 = \mu^2_{\alpha/2}\pi(1-\pi)/\delta^2$, $\mu = 1.96$, $\alpha = 0.05$, $\delta = 0.02$, $\pi = 0.0034$.

It suggests that 5670 individuals should be enrolled in the study. We invited 29,180 individuals aged 18 years and over to participate, randomly selected from 18 primary sampling units (street districts in urban areas and townships in rural areas). The survey and examination were completed by 25,767 individuals (10,296 men and 15,471 women).

Ethical approval

The Ethics Committee of Affiliated Zhongshan Hospital of Dalian University approved the study. All participants gave written informed consent before data collection.

Data collection

Data collection was conducted in examination centers at local hospitals or community clinics in the participants' residential areas. Participants completed a lifestyle and medical history questionnaire. Questionnaires solicited information on gender, age, anthropometric information, demographic factors, education, and current smoking and drinking habits. The questionnaire was administered by trained staff from Affiliated Zhongshan Hospital of Dalian University. Body height was measured to the nearest centimeter and body weight to the nearest kilogram. Body mass index (BMI) was calculated as weight divided by height squared. A Chinese version of BMI cutoffs was used to specify BMI levels. Underweight, normal weight, overweight, obesity, and severe obesity were defined as BMI <18.5, 18.5–22.9, 23.0–24.9, 25.0–29.9, and ≥30 kg/m^2, respectively.

Diagnostics

DDH was diagnosed based on clinical examination and imaging studies. The bilateral hip joints of all participants were carefully examined. Examination included gait observation; palpation of the soft tissues and bony prominences of the hip; range of motion assessment of the hip, pelvis, and lumbar spine; neurovascular tests and special tests including the Thomas test, Trendelenburg's test, and FABER test.[11] All participants underwent X-ray examination of the bilateral hip joints. Several reference lines and angles are useful in evaluating anteroposterior radiographs of the pelvis. Shenton's line[12] is a curved line that begins at the lesser trochanter, continues along the femoral neck, and connects to a line along the inner margin of the pubis. In the dislocated hip, Shenton's line has a step-off because the femoral neck lies cephalad to the line from the pubis. The center edge angle (CEA),[13] ACM angle, and Sharp angle[14,15] are useful measurements. In adults, a break in Shenton's line suggests displacement of the femoral head from the bony acetabulum. A CEA <20°, ACM angle >50°, and SHARP angle >45° (male) or 48° (female) are considered abnormal.

Every participant was required to completely fill in a questionnaire survey. The same training programs and test standards were used at each location to address potential sources of bias. All study investigators and staff members completed a training program to familiarize them with the study aims and the specific tools and methods used in the study. Clinical staff members were also trained to perform standard physical examination of the hip joint. A group of six orthopedic surgeons and radiologists was responsible for reading/interpreting X-ray images.

Statistical analysis

The study was designed to provide precise estimates of the prevalence of DDH according to gender, age group, BMI level, urban, or rural residence as well as region. Continuous covariates are presented as means with SD. Categorical covariates are presented as percentages. The comparison of continuous variables was done by Student's *t*-test and categorical variables by Chi-square test. Overall DDH prevalence and 95% confidence interval (*CI*) were calculated as was prevalence according to gender, age, and other subgroup criteria. In addition, the region-standardized prevalence of DDH among Chinese adults was estimated in the overall population and among the three stratified regions based on China census data.[16] All calculations were weighted to represent the total Chinese adult population aged 18 years and over.

A multivariable logistic regression model was used to investigate the association between relevant covariates and the prevalence of DDH. Covariates included in the multivariable logistic regression models were age (in 10-year groupings), gender, BMI, interaction between age and BMI, urban versus rural residence, high latitude versus low latitude, region (Eastern or Western China vs. Central China), education (completion of high school or higher vs. no completion of high school), smoking (yes vs. no), and drinking (yes vs. no). Age and BMI were continuous covariates; the remaining parameters were categorical. Odds ratios [*OR*s] with corresponding 95% *CI* were calculated. All statistical tests were two-sided; a value of $P < 0.05$ was considered statistically significant. We used SPSS software (version 19.0, SPSS Inc., Chicago, IL, USA) for data entry and management and R software (version 3.1, R Foundation for Statistical Computing, Vienna, Austria) for statistical analyses.

Results

We invited 29,180 people to participate, of whom 25,767 (10,296 men, 15,471 women) agreed. DDH was diagnosed in 391 people according to clinical examination and imaging studies, yielding an overall DDH prevalence of 1.52% (0.75% among men and 2.07% among women; 1.29% in urban and 1.75% in rural areas). The characteristics of the study participants are shown in Table 1. The mean age was 48.83 ± 17.85 years for men and 51.96 ± 13.89 years for women. The mean BMI was higher among women than men (25.11 kg/m^2 for women and 23.67 kg/m^2 for men). The proportion of participants with less than a high school education was very high in both genders (88.9% for men and 86.5% for women). Among men, 45.3% had smoking experience and 40.8% had drinking experience, whereas few women did (4.8% of women smoking and 5.2% drinking).

Table 2 shows the crude overall prevalence of DDH and the prevalence of DDH stratified by gender according to age, BMI level, residence, and region. The prevalence of DDH increased with increasing age from 1.21% among those 18–29 years of age to 1.92% among those 50–59 years. Participants aged 60 years and over had a lower prevalence of DDH than younger participants. The prevalence of DDH was higher in individuals with normal BMI (1.68%) than among severely obese (1.34%) participants. When comparing DDH prevalence among BMI levels, the prevalence increased from underweight to normal weight categories, then declined with increasing BMI. There was a lower prevalence among urban residents (1.29%) than rural residents (1.75%). More participants in the Western region had DDH (1.84%) than did participants in Eastern (1.30%) and Central regions (1.38%). There was a higher prevalence of DDH among participants from low-latitude regions (1.65%) than among those from high-latitude regions (0.80%).

Table 1: Characteristics of participants with DDH

Characteristics	Women (n = 15,471)	Men (n = 10,296)	Statistics	P
Age (years), mean ± SD	51.96 ± 13.89	48.83 ± 17.85	15.00*	<0.001
Height (cm), mean ± SD	160.12 ± 6.64	169.63 ± 7.10	−108.11*	<0.001
Weight (kg), mean ± SD	64.18 ± 10.86	68.01 ± 11.25	−27.13*	<0.001
BMI (kg/m^2), mean ± SD	25.11 ± 4.48	23.67 ± 3.88	27.49*	<0.001
Age (years), n (%)				
18–29	1119 (7.2)	2023 (19.6)	1195.10†	<0.001
30–39	1755 (11.3)	1270 (12.3)		
40–49	3632 (23.5)	1811 (17.6)		
50–59	4081 (26.4)	1749 (17.0)		
60–69	3334 (21.5)	2070 (20.1)		
70 and over	1550 (10.0)	1373 (13.3)		
BMI, n (%)				
Underweight	710 (4.6)	748 (7.3)	663.05†	<0.001
Normal weight	4708 (30.4)	4054 (39.4)		
Overweight	2899 (18.7)	2167 (21.0)		
Obese	4906 (31.7)	2654 (25.8)		
Severely obese	2248 (14.5)	673 (6.5)		
Urban residence, n (%)				
Rural	7082 (54.2)	5867 (43.0)	310.15†	<0.001
Urban	8389 (45.8)	4429 (57.0)		
Latitude residence, n (%)				
High	1976 (12.8)	2014 (19.6)	217.18†	<0.001
Low	13,495 (87.2)	8282 (80.4)		
Regions, n (%)				
Central	5028 (32.5)	3015 (29.3)	93.48†	<0.001
Eastern	5257 (34.0)	3224 (31.3)		
Western	5186 (33.5)	4057 (39.4)		
Education levels, n (%)				
Below high school	13,388 (86.5)	9158 (88.9)	32.64†	<0.001
High school or above	2083 (13.5)	1138 (11.1)		
Smoking, n (%)				
No	14,730 (95.2)	5629 (54.7)	6123.80†	<0.001
Yes	741 (4.8)	4667 (45.3)		
Drinking, n (%)				
No	14,664 (94.8)	6093 (59.2)	5001.30†	<0.001
Yes	807 (5.2)	4203 (40.8)		

*t values; †χ^2 values. BMI: Body mass index; SD: Standard deviation; DDH: Developmental dysplasia of the hip.

The age-specific prevalence of DDH was different in men versus women (0.75% vs. 2.07%, $P < 0.001$) [Table 2]. In men, participants aged 50–59 years had a higher risk (1.37%) than participants in other age levels, whereas in women, the highest risk occurred between the ages of 18 and 29 years (2.77%). Figure 1 shows the prevalence of DDH stratified by gender according to age, BMI level, residence, and region. The result shows that the prevalence of DDH was significantly higher in women than men in all groups except age group of 50–59 years and obese group ($P < 0.05$). The age-specific prevalence of DDH variation trend is shown in Figure 1a. In women, the prevalence decreased with age, whereas in men, it showed an inverse U-shape. The highest prevalence of DDH in women was in the age group of 18–29 years and in men was in the age group of 50–59 years. The highest value is twice as much in women as it is in men. Overall, there was a lower prevalence of DDH in participants aged 60 years and over than in younger participants ($P = 0.036$). The prevalence of DDH varies by BMI level [Figure 1b], with the highest value occurring in women in normal BMI group and in men was in obese group. Figure 1b shows that the prevalence in women increased from underweight group to normal weight group, then declined with increasing BMI. In man, the variation trend shows the prevalence of DDH increasing with BMI level till to the obese group, then decreased in severely obese group.

The prevalence of DDH was higher among rural residents than urban residents (2.37% vs. 1.74%, $P < 0.001$ in women and 0.99% vs. 0.43%, $P < 0.001$ in men) [Figure 1c]. A higher prevalence was present among residents from the Western region than from Eastern region and Central region (2.55% vs. 1.77%, and 1.77%, $P < 0.001$, respectively, in women and 0.94% vs. 0.53%, and 0.73%, $P < 0.05$, respectively, in men) [Figure 1d].

Figure 2 shows the number of previously and newly diagnosed DDH participants. In this survey, DDH was diagnosed in 391 people, of which 152 cases were newly diagnosed and 239 cases were previously diagnosed. The proportion of newly diagnosed patients was higher in female than male [Figure 2a]. The ratio of newly diagnosed DDH patients to previously diagnosed patients was higher, especially in the 18–29 years of age group and in the 30–39 years of age group than other age groups. More previously diagnosed patients were found among participants aged older than 40 years [Figure 2b]. All newly diagnosed patients were Grade I according to the Crowe classification [Figure 2c].

In the multivariable logistic regression model, age, being a woman, low latitude, rural residence, and Western region were all significantly associated with an increased risk of DDH [Table 3]. DDH prevalence increased with age

Table 2: Overall DDH prevalence and prevalence stratified by gender according to age, BMI, residence, and region (%)

Groups	Total (n = 29,180)		Women (n = 15,471)		Men (n = 10,296)	
	Mean	95% *CI*	Mean	95% *CI*	Mean	95% *CI*
Overall	1.52	1.37–1.68	2.07	1.82–2.27	0.75*	0.59–0.94
Age (years)						
18–29	1.21	0.87–1.67	2.77	1.92–3.96	0.35	0.15–0.75
30–39	1.62	1.21–2.15	2.51	1.85–3.38	0.39	0.15–0.97
40–49	1.78	1.45–2.18	2.26	1.81–2.81	0.83	0.48–1.40
50–59	1.92	1.59–2.32	2.16	1.74–2.66	1.37	0.90–2.07
60–69	1.09	0.84–1.42	1.26	0.92–1.72	0.82	0.49–1.34
70 and over	1.23	0.88–1.72	1.74	1.17–2.56	0.66	0.32–1.29
BMI						
Underweight	1.44	0.92–2.23	2.39	1.45–3.89	0.53	0.17–1.46
Normal weight	1.68	1.42–1.97	2.55	2.13–3.05	0.67	0.45–0.98
Overweight	1.56	1.24–1.95	2.10	1.63–2.71	0.83	0.51–1.34
Obese	1.39	1.14–1.69	1.63	1.30–2.04	0.94	0.62–1.41
Severely obese	1.34	0.96–1.84	1.60	1.14–2.23	0.45	0.12–1.41
Residence						
Rural	1.75	1.53–1.99	2.37	2.04–2.76	0.99	0.76–1.29
Urban	1.29	1.10–1.50	1.74	1.48–2.05	0.43	0.27–0.68
Latitude						
High latitude	0.80	0.56–1.14	1.32	0.88–1.95	0.30	0.12–0.68
Low latitude	1.65	1.49–1.83	2.13	1.90–2.40	0.86	0.67–1.09
Regions						
Central	1.38	1.14–1.67	1.77	1.43–2.18	0.73	0.47–1.12
Eastern	1.30	1.07–1.57	1.77	1.44–2.17	0.53	0.32–0.86
Western	1.84	1.58–2.14	2.55	2.14–3.02	0.94	0.67–1.30

*Statistical significance. BMI: Body mass index; DDH: Developmental dysplasia of the hip; *CI*: Confidence interval.

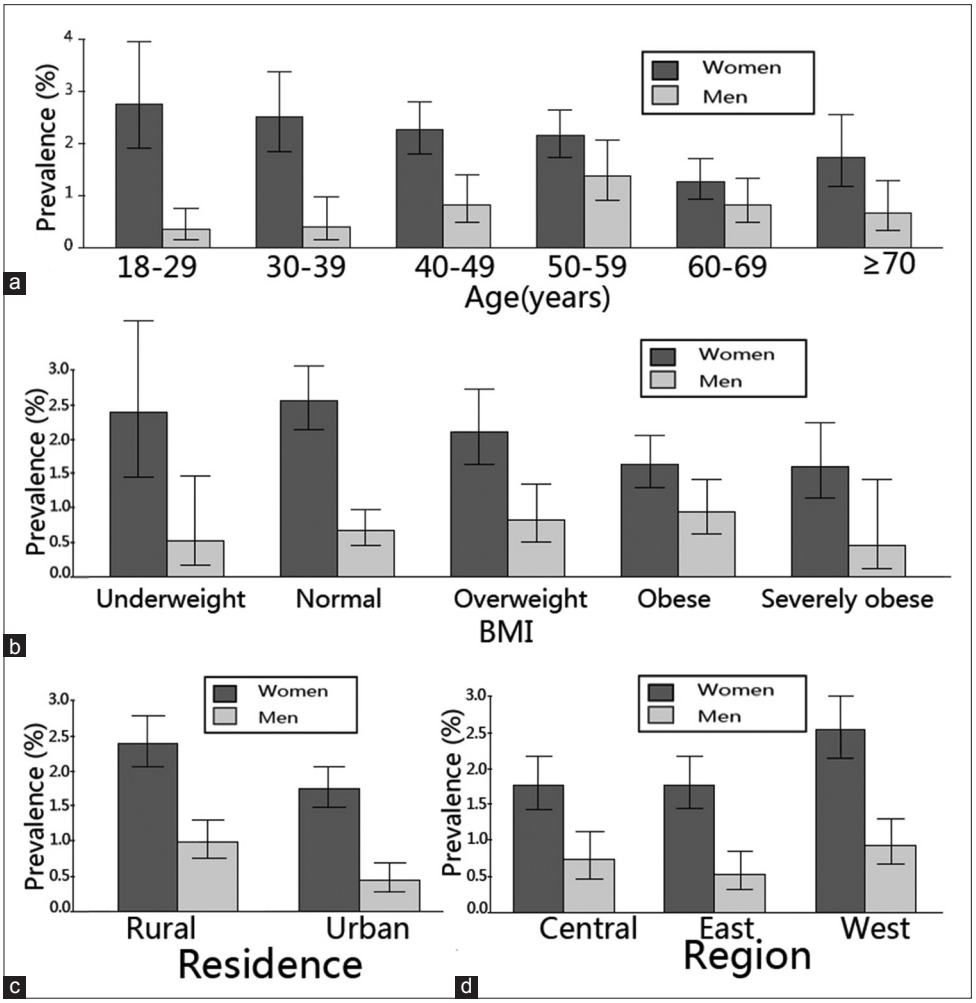

Figure 1: Prevalence of DDH stratified by gender. (a) Prevalence of DDH according to age. (b) Prevalence of DDH according to BMI level. (c) Prevalence of DDH according to residence. (d) Prevalence of DDH according to region. BMI: Body mass index; DDH: Developmental dysplasia of the hip.

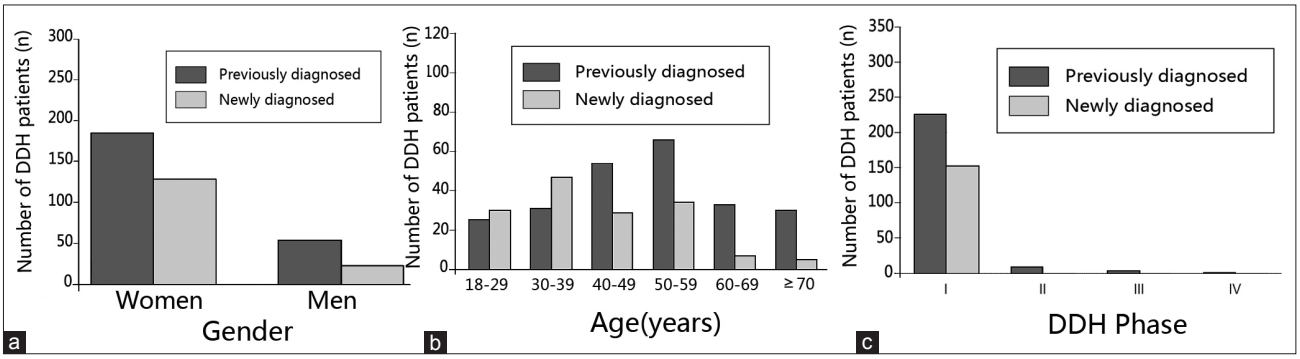

Figure 2: Previously and newly diagnosed DDH participants. (a) The number of DDH patients was stratified by gender. (b) The number of DDH patients was stratified by age. (c) The number of DDH patients was stratified by DDH phase according to the Crowe classification. DDH: Developmental dysplasia of the hip.

(*OR* = 1.53 [1.03–2.27], *P* = 0.036), was significantly higher among women than men (2.07% vs. 0.75%, *P* < 0.001), and was higher among rural residents than urban residents (1.75% vs. 1.29%, *P* < 0.001). DDH prevalence was higher among central residents from Western region than residents from Central region (*OR* = 1.92 [1.49–2.47], *P* < 0.001). In addition, there was no evidence of association of BMI alone, education, or current smoking or drinking with risk of DDH (*P* > 0.05).

Based on our prevalence estimates and the number of adults in the Chinese population in 2016, the estimated number of adults aged 18 years or older in China with DDH was 16.05 million (4.27 million men and 11.78 million women).

Table 3: Estimated odds ratios for DDH prevalence

Risk factors	*OR* (95% *CI*)	*P*
Age change by 10 years	1.53 (1.03–2.27)	0.036
Gender (men vs. women)	0.35 (0.26–0.47)	<0.001
BMI	1.07 (0.98–1.17)	0.127
Latitude (low vs. high)	2.65 (1.79–3.39)	<0.001
Urban residence (vs. rural residence)	0.60 (0.47–0.75)	<0.001
Eastern region (vs. Central region)	0.74 (0.56–0.99)	0.042
Western region (vs. Central region)	1.92 (1.49–2.47)	<0.001
Interaction of age and BMI (age change by 10 years)	0.98 (0.97–1.00)	0.030
High school and above (vs. below high school)	0.92 (0.68–1.24)	0.588
Current smoking	0.85 (0.58–1.23)	0.387
Current drinking	1.11 (0.78–1.57)	0.567

BMI: Body mass index; DDH: Developmental dysplasia of the hip; *CI*: Confidence interval; *OR*: Odds ratio.

Discussion

The exact prevalence of DDH is difficult to determine because of discrepancies in the definition of the condition, the type of examination used, and different skill levels of clinicians.[17] Prevalence estimates range from as low as 1/1000 to as high as 34/1000 live births. Higher prevalences are reported when ultrasonography is used in addition to clinical examination. However, most studies have focused on the prevalence among infants. In 1981, the point prevalence of DDH in Hong Kong was 0.1/1000 live births, which was lower than the rate of 1.5–20.0/1000 in developed countries/regions.[18] No adult DDH study has been performed in developing countries. These findings have important public health implications for developing countries such as China. In this representative sample of Chinese adults, the prevalence of DDH was 1.52%. Extrapolating from the data of the current study and based on Chinese population data from 2016,[16] an estimated 16.05 million adults in China aged 18 years and older have DDH. Our results indicate that the prevalence of DDH is high in China. In this survey [Figure 2], 38.9% (152/391) of DDH cases were newly diagnosed and 61.1% (239/391) of DDH cases were previously diagnosed. It means that more than one-third of DDH patients did not knew their bad hip conditions and do any protection before this study. This ignorance to illness may negatively impact patient outcomes. The proportion of newly diagnosed patients was higher than that of previously diagnosed patients in the 18–29 years of age group and in the 30–39 years of group; more previously diagnosed patients were found among participants aged older than 40 years. DDH severity was measured according to the Crowe classification; all newly diagnosed patients were Crowe Grade I. These results suggest the importance of DDH screening to detect DDH at an early stage, especially for young people. It is known that early diagnosis and treatment for patients with DDH can delay or avoid the need for total hip arthroplasty (THA).

The risk factors for DDH in Chinese adults are shown in Table 3 including age, gender, living condition (low or high latitude, rural or urban, and Eastern or Western region). The prevalence of DDH increased with increasing age from 1.21% among those 18–29 years of age to 1.92% among those 50–59 years. Several studies have documented a high prevalence of DDH in mid-adulthood, a finding consistent with our results. In our study, DDH occurred more frequently before the age of 60 years, especially between 50 and 59 years. There are several possible explanations for this finding. Acetabular dysplasia is often asymptomatic until patients present with degenerative changes in early- to mid-adulthood.[19,20] Some authors have speculated that most cases of DDH arise as a result of abnormalities in the anatomic structure of the hip that remain unrecognized during childhood and adolescence and only began to cause clinical symptoms in older age[21-26] (average onset of symptoms in nonsubluxated dysplastic hips occurs at 35 years of age).[22] A recent systematic review found little evidence for a relationship between hip dysplasia and late hip OA in patients older than 50 years of age.[27]

Females are at greater risk of DDH than males. The prevalence of DDH in women was 2.76 times that in men (2.07:0.75) in the present study. Previous studies have also shown a discrepancy in DDH prevalence between men and women.[28] Carter and Wilkinson[29] reported an overall prevalence of 1/1000 live births, with 1/600 girls and 1/4000 boys having the disorder. The reason for this repeated finding remains unknown. Some authors have proposed a female susceptibility to relaxin hormone; recently the possibility of gender-related relaxin hormone receptor sensitivity has been investigated.[30] Our results indicate that gender-specific discrepancy exists as a function of age. Among those younger than 59 years of age, women were at a higher risk of DDH than men; however, men aged 50–59 years were more likely than women of that age to have DDH. Men's heavy labor, which may initiate and accelerate joint degeneration, may be the reason for this age-related difference.

Living conditions (low or high latitude, rural or urban, and Eastern or Western region) are risk factors for DDH. In our study, rural residents had 1.36 times increased risk of DDH compared with urban residents. The reason for this difference may be that rural residents more frequently perform manual or heavy labor during adolescence than urban residents, which may lead to a higher incidence of progressive degenerative joint disease in adults. The reasons behind this phenomenon are probably mechanical and related to a high degree of contact stress over time on a relatively small surface area. The prevalence of DDH among participants from low latitude regions was two times higher than those from high latitude regions. There is a higher incidence of DDH in participants from the Western regions than participants in Eastern regions and Central regions. The associated reason could be ethnic background (e.g., native Chinese who use swaddling that forces the hips into extension and adduction). A higher incidence of DDH is reported in babies wrapped with the hip in extended position, as compared to the babies wrapped in flexed and abducted position.

Our findings indicate that BMI alone, education, current smoking, or drinking were not the risk factors for DDH in Chinese adults, but increasing age, being a woman, and living at low latitude, in a rural residence or the Western region, were all significantly associated with an increased risk of DDH.

DDH is the reason for THA in 20% of patients younger than 50 years and in 2.6% of all THAs performed.[31-33] Our study suggests that DDH affects a high proportion (1.52%) of adults in China. Although DDH is not considered a common chronic disease, the economic impact on a societal and individual level, including the direct costs of health care and the indirect costs resulting from lost productivity due to illness and death, is substantial. Our results showed that DDH is prevalent in China. Given its large population, China may bear the highest DDH-related burden of any country. Early diagnosis and treatment are essential to slow down the natural history of DDH and to avoid expensive hip replacement surgery in young DDH patients. Young patients have to undergo multiple hip replacement surgeries during their lifetime and suffer not only from the condition itself but also from the burden of considerable medical bills. Patients with DDH undergoing primary THA incurred higher hospital costs than patients with primary osteoarthritis (USD 16,949 vs. USD 16,485, $P = 0.012$).[34] The costs greatly increase in cases of revision hip arthroplasty. The overall estimated medical costs of treating DDH patients in China is at least USD 272 billion (16,949 × 16.05 million), which is a substantial financial burden on the Chinese health-care system. Taken together, our results indicate that DDH has become a public health challenge in China and underscore the need for urgent national strategies aimed at the prevention, detection, and treatment of DDH in the general Chinese population.

Our study has several strengths. First, it was conducted in a large nationally representative sample of the general Chinese population. Second, a few studies have comprehensively documented the DDH prevalence in adults in China. In addition, a strict quality assurance and quality control program was implemented at every phase of the study to ensure data validity and reliability. Some limitations of our study should be mentioned. First, X-rays were taken by technicians from nine provinces. Therefore, the possibility of variation among X-ray machines and technician protocols exists. However, all X-ray technicians completed a standardization and certification program before the study, and stringent quality-control procedures were used during the study. Second, the childbirth information was based on self-reported history and its authenticity was not verified.

In summary, our study indicates that DDH affects 16.05 million adults aged 18 years and older in China. Increasing age, being a woman, and living at low latitude, in a rural residence or in the Western region, were all significantly associated with an increased risk of DDH. There was no evidence of association between DDH and BMI alone, education, or current smoking or drinking.

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Conflicts of interest

There are no conflicts of interest.

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