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The prevalence of inflammatory back pain: population-based estimates from the US National Health and Nutrition Examination Survey, 2009–10

Michael H Weisman[1], **James P Witter**[2], and **John D Reveille**[3]

[1]Division of Rheumatology, Cedars-Sinai Medical Center, Los Angeles, California, USA

[2]Rheumatic Diseases Clinical Program, National Institute of Arthritis and Musculoskeletal and Skin Diseases, National Institutes of Health, Bethesda, Maryland, USA

[3]Division of Rheumatology, University Texas, Houston, Texas, USA

Abstract

Objective—To estimate the current US inflammatory back pain (IBP) prevalence using four published case definitions.

Methods—Analysis of an IBP data collection instrument specifically designed for the 2009–10 National Health and Nutrition Examination Survey. Subjects were 5103 US adults ages 20–69 with complete data. IBP prevalence as determined by Calin *et al* criteria, European Spondylarthropathy Study Group (ESSG) criteria, and Berlin criteria 8a and 7b.

Results—Age-adjusted US prevalence of IBP by Calin criteria was 5.0% (95% CI 4.2% to 5.8%). Prevalence of IBP was 5.6% (95% CI 4.7% to 6.5%) by ESSG criteria, and 5.8% (95% CI 5.2% to 6.4%) and 6.0% (95% CI 4.9% to 7.1%) by Berlin Criteria 8a and 7b, respectively. IBP prevalence did not differ significantly by age groups or between men and women. IBP prevalence was significantly lower among non-Hispanic black persons compared with non-Hispanic white persons for the Calin and ESSG IBP criteria. For the ESSG and Berlin 7b criteria, non-Hispanic white persons had significantly higher IBP prevalences compared with Mexican Americans.

Conclusions—IBP is associated with spondyloarthritis. Awareness of the prevalence of IBP may be useful for planning future epidemiological studies as well as development and validation of diagnostic and classification criteria for specific clinically defined diseases.

INTRODUCTION

The syndrome of inflammatory back pain (IBP) is a key feature of and tied to spondyloarthritis (SpA), or inflammatory spinal arthritis, one of the most prevalent forms of inflammatory arthritis in adults.[1] The first measurement criteria for IBP were introduced in 1977;[2] other criteria have followed.[3–5] There have been few large scale population-based studies of IBP and the results have been quite variable. A community survey in Mexico estimated the prevalence of IBP at 3.0% (95% CI 2.7% to 3.4%).[6] Reanalysis of data collected as part of the National Health and Nutrition Examination Survey (NHANES) II

Correspondence to: Michael H Weisman, Cedars-Sinai Medical Center, Division of Rheumatology, Los Angeles, California 3556, USA; michael.weisman@cshs.org.

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(1971–1975) indicated a lower bound estimate for US IBP prevalence by Berlin Criteria 7b of 6.7% among those who reported having had a back pain episode for at least 4 months, and 0.8% of the overall US adult population at that time.[7] The primary goal of the current study was to provide US national prevalence estimates for IBP from the NHANES 2009–10 survey utilising four published IBP case definition criteria. A secondary goal was to describe IBP prevalence among major US demographic subgroups.

METHODS

NHANES Data

NHANES is a cross-sectional, nationally representative survey monitoring the health and nutritional status of the civilian, non-institutionalised US population. Data are collected via household interviews, direct standardised physical examinations and biological specimen collections. Respondents are selected through a complex, multistage, probability design. The 2009–10 NHANES survey over-sampled major US demographic subgroups such as Hispanics and non-Hispanic black persons as well as persons with low income.[8]

A total of 6684 persons aged 20–69 years were screened for participation; 5106 were interviewed. Three subjects eligible for interviews did not receive the IBP questionnaire, yielding a total of 5103 complete records for analysis and an overall response rate of 76.4%. Demographic data, including age and self-designated race-ethnicity, were collected during the household interview. For this analysis, age was categorised into approximate tertiles at 20–35, 36–49 and 50–69 years. Participant's gender was observed by NHANES interviewers. Table 1 presents the demographic distribution of the study sample by age, gender, race/ethnicity and back pain characteristics.

IBP classification criteria

An IBP questionnaire (arthritis questionnaire (ARQ)) was specifically developed for the NHANES 2009–2010 to provide population-based prevalence estimates for four published IBP classification criteria: Calin, European Spondylarthropathy Study Group (ESSG) and two IBP criteria sets,[4] referred to here as Berlin criteria sets 8a and 7b. A fifth IBP classification criterion, the ASAS criteria,[5] was published after the study had been fielded and could not be included. The ARQ questionnaire development process is described separately;[7] a copy of the questionnaire is available at the NHANES website.[9]

The NHANES IBP questionnaire created operational definitions for IBP parameters such as morning stiffness, pain awakening from sleep and pain response to exercise. The text for each question was formulated at an 8th grade reading level, cognitively tested and was interviewer administered. The instrument used a spinal pain diagram[10] to identify history of chronic pain, aching or stiffness at one of five specific axial locations (neck, upper, mid and lower back and sacroiliac joint area). For those with axial pain at any of these sites, additional detail was obtained: age-at-onset of symptoms, timing of development of symptoms, temporal pattern of pain variation, duration of symptoms of the longest pain episode (6 weeks and/or 3 months), history of pain, aching and/or stiffness at the particular site, pattern of the onset of the pain, course of pain over a typical day, morning stiffness, history of rest pain, whether pain results in wakening from sleep, pain response to exercise, and history of alternating buttock pain.

Elements of the NHANES 2009–2010 IBP questionnaire and IBP case criteria are listed in table 2. Each criteria set requires a history of back pain of more than 3 months and a history of morning stiffness in the back. Case criteria vary regarding the presence of a gradual onset of back pain, age-at-onset of pain in younger adulthood, history of worsening of back pain with rest/sleep, back pain improvement with exercise and alternating buttock pain. ESSG

IBP criteria are quite similar to the original Calin criteria with the exception that ESSG criterion for age-at-onset of back pain is <45 years, whereas the Calin criteria specify an age at onset of <40 years.

Details of history of morning stiffness or exact location of back pain were not precisely defined in some of the original publications. For the analysis in table 3, we specified 'back pain' to be a history of a pain that lasted for 3 months or longer in either the upper, mid or low back (ie, in areas 2, 3 or 4 on the ARQ1 back pain diagram) when calculating prevalence for Calin and ESSG criteria. For Berlin criteria 8a and 7b, back pain was specified as 'low back pain' (area 4 on the ARQ1 back pain diagram). Morning stiffness in the back was specified as stiffness that had persisted >30 min for each of the criteria.

Statistical analysis

Interview sample weights were employed to account for differential probabilities of selection within the complex NHANES sample design as well as to obtain IBP prevalence estimates and standard errors. Sample weights account for unequal selection probabilities of subgroups and adjust for non-response and non-coverage. Statistical analysis was performed using SUDAAN (Release 10.0; Research Triangle Institute, Research Triangle Park, North Carolina, USA) and SAS (Release 9.2, SAS Institute, Cary, North Carolina, USA). Age adjustment was carried out by the direct method using the 2009–10 Census Bureau projections for the US civilian, non-institutionalised population. SE was estimated by Taylor series linearisation. Equality of the prevalence of IBP by selected demographic variables was tested (univariately) at the α=0.05 level using a Student t statistic and appropriate degrees of freedom. Statistical testing for linear trend across variable subgroups was performed using SUDAAN Proc Descript Polynomial function. NHANES analytic guidelines were used to set criteria for minimum acceptable sample sizes (based on design effect and specified proportion) and relative standard errors to assess statistical stability of computed estimates. Estimates with relative standard errors ≥30% and sample sizes less than recommended are designated as potentially unreliable and should be interpreted with caution.[11] Refer to two recently published manuscripts for additional information concerning 2009–2010 survey methodologies.[12,13]

RESULTS

A total of 980 out of 5103 (19.2%) persons in the NHANES 2009–10 survey had a history of pain from at least one axial site on the pain diagram for <3 months; table 1 shows that 89% of these had current axial pain at the time of the interview and, of these, almost 95% had a total duration of their axial pain for ≤1 year. Over 40% of those with chronic axial pain had an age-at-onset of <30 years of age, and about two-thirds of chronic axial pain had a constant pain pattern.

Table 3 presents US population-based prevalence estimates and 95% CI for IBP criteria, representing an individual's lifetime prevalence of IBP. Using Calin criteria, 5.0% (95% CI 4.2% to 5.8%) of US adults ages 20–69 years met classification criteria for a current or previous episode of IBP; there was no statistically significant difference in IBP prevalence by age or by gender or between non-Hispanic white persons and Mexican Americans. There was a statistically significant difference in estimated IBP prevalence between non-Hispanic white persons and non-Hispanic black persons (5.9 vs 3.3%; t=3.99, p<0.01).

Overall prevalence of IBP utilising the ESSG criteria was 5.6% (95% CI 4.7% to 6.5%). There was no significant difference in estimated ESSG IBP prevalence by age or gender. However, non-Hispanic white persons had significantly higher ESSG IBP prevalences than

either non-Hispanic black persons or Mexican Americans (6.5% vs 4.1% and 4.4%, respectively; t=2.77, p=0.02 and t=2.14, p=0.05, respectively).

Berlin criteria were validated only for adults less than age 50; therefore, IBP prevalences estimated are only for the subgroup of participants who were 20–49 years old at the time of the survey (N=3188). The overall US prevalence estimate for IPB by Berlin criteria 8a was 5.8% (95% CI 5.2% to 6.4%); there were no significant differences in estimated IBP prevalence by age, gender or race/ethnicity. Overall prevalence of IBP in Berlin criteria 7b was 6.0% (95% CI 4.9% to 7.1%). There were, however, significant differences in IBP prevalence by race/ethnicity: non-Hispanic white persons had significantly higher Berlin criteria 7b IBP prevalences than did Mexican Americans (7.2% vs 4.2%; t=2.23, p=0.04). The prevalence of IBP by Berlin criteria 7b did not significantly differ between non-Hispanic white persons and non-Hispanic black persons.

Finally, for each of the IBP criteria sets, the percentage of cases with IBP was estimated among the subset of persons with chronic axial pain in this sample. For the Calin *et al* IBP criteria, this estimate was 28.0% (95% CI 23.6% to 32.4%); for the ESSG IBP criteria, it was 30.7% (95% CI 25.8% to 35.6%); for the Berlin 8a IBP criteria, it was 35.5% (95% CI 31.5% to 39.5%); and for the Berlin 7b IBP criteria set, the estimate was 30.8% (95% CI 33.5% to 42.5%).

DISCUSSION

The primary objective of this study was to provide US national level population-based prevalence estimates for IBP according to the most widely published IBP case definitions without reference to any radiographic or serological data. An additional objective was to describe prevalence of IBP for each of the major demographic subgroups in the population and to identify any differences in prevalence of IBP by demographic factors.

Overall, national prevalence of IBP among US adults ages 20–69 years ranged from 5.0% to 6.0%. Calin's original IBP criteria set produced the lowest overall prevalence, while the two Berlin IBP criteria sets produced the highest estimates. Across the four IBP criteria sets, there was little evidence that IBP prevalence differed significantly by age or gender. There was some evidence that IBP prevalence differed by race/ethnicity; IBP prevalence was significantly higher among non-Hispanic white persons compared with non-Hispanic black persons according to Calin and ESSG criteria. For the ESSG and Berlin 7b criteria, estimated IBP prevalence among non-Hispanic white subjects was greater than that estimated for Mexican Americans.

Interestingly, among the subset of persons with chronic axial pain in our study sample, the estimated percentage of cases with IBP according to the various criteria ranged from 28% to 38%. The Calin *et al* and ESSG IBP criteria produced the lower estimates, while the two 'Berlin' criteria sets produced higher estimated percentages. However, these estimates refer to a sub-population of cases, the majority of whom appear to have had long term chronic pain; ours is a population-based epidemiological study and these percentages may not be fairly representative of the mix of the axial pain patients who are routinely seen in clinical practice.

Few published population-based estimates exist for IBP. Peláez-Ballestas *et al*[6] reported an IBP prevalence of 3.0% (95% CI 2.7 to 3.4) in a large community survey of 8159 individuals in Mexico. They reported significant differences in estimated IBP prevalence for two different urban areas: Mexico City (4.6%; 95% CI 3.9 to 5.2) and Nuevo León (1.5%; 95% CI 1.1 to 1.9). This report did not specify the case definition used to calculate IBP

prevalence nor did it specify locations of back pain used to estimate IPB prevalences (ie, low back pain only, or including upper, mid-back and or buttocks pain) and so any comparisons with the current US results should be considered preliminary. NHANES prevalence of IBP for Mexican Americans varied from 4.1% using the Calin criteria to 4.9% using Berlin criteria 8a; the CIs for these estimates include the overall 3.0% IBP prevalence estimate for Mexico reported by Peláez-Ballestas *et al*.

The US national level IBP prevalence estimate using the NHANES II (1976–1980) was 0.8% (95% CI 0.5% to 1.1%).[7] This was considered a lower-bound estimate of the true value because the NHANES II was fielded prior to the publication of Calin's original IBP case definition. Further, NHANES II employed a general purpose back pain questionnaire rather than a data collection instrument specifically designed to capture a history of IBP. A pain diagram, which usually produces higher pain prevalence estimates, was not utilised.

The methodological strengths of the NHANES survey are its nationally representative sample of men and women, its high response rates, oversampling of older persons and ethnic subgroups, and its standardised, quality control data collection protocol, making it an ideal vehicle for population-based prevalence estimation for chronic medical conditions such as IBP. There are important limitations to the current study, chief among which is that detailed follow-up clinical examinations were not performed nor were radiographic data or serological markers such as HLA-B27 available. As such, the validity of our IBP prevalence estimates rests on prior validation of the IBP criteria previously published in the literature.

The NHANES 2009–10 IBP questionnaire was created for administration in a population-based survey which is different from medical interviewing conducted in clinical settings. Formulating a population-based IBP questionnaire required creating operational definitions for a number of IBP case criteria, some of which were not precisely described, such as criteria regarding the pain response to exercise, being awakened in the second half of the night by back pain and defining a history of alternating buttock pain. In some instances, IBP parameters could not be fully operationalised due to practical constraints. For example, the question regarding being awakened during the second half of the night by back pain logically applies to persons who regularly sleep more than 4 h per night. Nevertheless, in feasibility studies, approximately 12% of persons with chronic axial pain were noted to sleep less than 4 h per night, and in over 90% of these cases, the respondent reported that it was their axial pain that kept them from sleeping more than 4 h at night.

The original Calin IBP criteria questionnaire was developed as a screening tool aimed at identifying a typical or usual subtype of chronic axial pain characteristic of ankylosing spondylitis (AS) or SpA.[2] It is likely that substantial numbers of patients with true AS or SpA related axial pain may not have this 'typical' pain pattern, or in fact may have minimal or no pain at all. Prevalence of axial pain in AS and SpA may also vary by stage or duration of disease, that is, it may be more prominent in early as compared with late-stage disease. Alternatively, if it is true that IBP is limited solely to the subset of persons with AS and SpA, then an IBP prevalence of 5%–6% would be a high figure given that the prevalence of AS and SpA in the USA is estimated to be approximately 1% of the adult population.[1] It is also possible that the true prevalence of IBP could exceed that of AS and SpA if a substantial number of persons with IBP do not progress to develop those diseases. Finally, the characteristic pattern of IBP may be found in patients with other chronic axial pain disorders such as undifferentiated SpA, reactive arthritis, inflammatory bowel diseases and psoriasis.

The IBP concept has been in general use for more than 3 decades and is employed in clinical practice. However, it is not the same as a diagnosis of AS or SpA. Recent literature is

focused on the development of improved IBP criteria[45] and on longitudinal studies of the predictive value of IBP for AS and SpA.[14] Many practitioners may expect that once a patient meets criteria for IBP he or she has a high probability of developing AS. Such expectations need to be put in perspective. In the original IBP article by Calin *et al*, it was not formally stated whether the IBP criteria being presented were intended as epidemiological classification criteria for research use, as diagnostic criteria for a unique syndrome of IBP or as adjunctive diagnostic criteria to help clinicians identify AS cases[2]. The authors did discuss the probable operating efficiency of IBP criteria were they to be applied in a general population as a screening test for AS, so it is likely that epidemiological studies were at least one of the intended uses. Recently, new classification criteria have been proposed for IBP[45] and one of these publications has discussed their use as diagnostic criteria.[4]

There is much IBP research yet to be done, especially prospective studies of AS and SpA risk among persons meeting IBP case criteria, as well as basic research on pathophysiology: that is, do patients classified as having IBP have a definable inflammatory pathophysiology underlying their back pain as the acronym implies?[14] Future research should clarify the association between IBP and AS and whether symptoms of IBP are associated with elevated markers of inflammation and a higher prevalence of the HLA-B27 antigen. There is also the question of whether patients classified as having IBP who do not go on to develop AS or SpA represent a valid subset of IBP or whether these instances simply represent false positives in IBP classification. Furthermore, chronic back pain likely consists of a number of distinct, but as yet imprecisely defined syndromes. Separating specific subsets of cases with IBP from others with chronic axial pain could be helpful epidemiologically to reduce the heterogeneity in the remaining set of chronic back pain cases, and to permit more focused future analytic/aetiological studies and clinical trials. Finally, there are additional questions of whether IBP could be associated with medical disorders other than AS or SpA.

CONCLUSION

Our findings provide the most current US national prevalence estimates for IBP, an important subset of chronic back pain associated with AS and SpA and possibly other conditions. Knowledge of the population-based epidemiology of IBP is critical for planning future epidemiological studies as well as development of diagnostic and classification criteria for specific clinically defined diseases. Nevertheless, these estimates must be interpreted in light of the strengths and limitations previously noted for NHANES data.

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Table 1

Study Sample for the NHANES 2009–10 U.S. Inflammatory Back Pain Survey

	N	%
Total Study Sample	5103	100.00
Age Groups		
20–35 Years	1649	32.3
30–49 years	1539	30.2
50–69 Years	1915	37.5
Gender		
Males	2472	48.4
Females	2631	51.6
Race/Ethnicity Subgroups		
Mexican-Americans	1024	20.1
Other Hispanics	576	11.3
Non-Hispanic Whites	2244	44.0
Non-Hispanic Blacks	963	18.9
All Others	296	5.8
Total Axial Pain Sample*	980	100.0
Current Pain	873	89.1
No Current Pain	107	10.9
Age-at-Onset of Pain		
< 20 Years	164	16.8
20–29 Years	247	25.3
30–44 Years	306	31.4
45+ Years	258	26.5
Duration of Pain		
< 1 Year	50	5.2
1–2 Years	154	16.0
3–10 Years	343	35.7
> 10 Years	415	43.1
Temporal Pattern of Pain		
Constant, never goes away	660	67.5
Episodic, no relief > 1 mo	178	18.2
Episodic, pain relief > 1 mo	123	12.6
One pain episode only	17	1.7

*Axial pain variable= survey participants with a prior episode of neck, upper, mid or low back, or buttocks pain for 3 months or more Subgroup totals for pain age at onset, duration, and temporal pattern are reduced by item non-response.

Table 2

Inflammatory Back Pain (IBP) Case Definition Criteria

IBP Criterion	ARQ Item(s)	Calin *et al*	ESSG	Berlin Set 8a	Berlin Set 7b
Spinal Pain Location	ARQ010;ARQ020	"Back"	Neck/Dorsal/Back	Low Back	Low Back
Current Age	RIDAGEYR	Any Age	Any Age	<50 years	<50 years
Duration of Back Pain (3 months)	ARQ024	√	√	√	√
"Insidious" Onset of Back Pain	ARQ025	√	√		
Age-at-Onset Back Pain (years)	ARQ023	<40	<45		<30
Morning Stiffness > 30 Minutes	ARQ040	√*	√*	√	√
Pain Improves with Exercise or Activity	ARQ080	√	√		
Pain Improves with Activity/Not with Rest	ARQ060;ARQ080			√	√
Pain Awakens 2nd Half of Night	ARQ073;ARQ077			√	
Alternating Buttock Pain	ARQ100			√	

Abbreviations: ARQ = Arthritis questionnaire; √ or text in gray highlight = mandatory IBP case definition criteria;

ESSG: European Spondyloarthritis Study Group;

Berlin Criteria Sets= from Rudwaleit et al. [4].

* Duration of AM Stiffness not specified in Calin and ESSG criteria.

Table 3

Estimated Prevalence of Inflammatory Back Pain in U.S. Adults 2009–10

	Inflammatory Back Pain (IBP) Case Criteria													
	Calin *et al.* 1977				ESSG 1991			Berlin Set 8a				Berlin Set 7b		
	N	n	%	95% CI	N	%	95% CI	N*	n	%	95% CI	n	%	95% CI
Overall US Prevalence†	5103	246	5.0	4.2–5.8	274	5.6	4.7–6.5	3188	193	5.8	5.2–6.4	195	6.0	4.9–7.1
Age Group														
20–35 Years	1649	85	5.0	3.6–6.4	85	5.0	3.6–6.4	1649	75	4.8	3.6–6.0	94	6.2	4.5–7.9
36–49 Years	1539	91	5.9	4.8–7.0	105	6.8	5.8–7.8	1539	118	6.8	5.7–7.9	101	5.9	4.5–7.3
50–69 Years	1915	70	4.1	2.7–5.5	84	5.0	3.3–6.7	n.a.						
Gender†														
Males	2472	111	5.2	4.4–6.0	120	5.6	4.7–6.5	1492	79	5.4	4.4–6.4	79	5.4	4.3–6.5
Females	2631	135	4.9	3.8–6.0	154	5.6	4.3–6.9	1696	114	6.1	4.7–7.5	116	6.7	4.9–8.5
Race/Ethnicity Groups†														
Mexican-Americans	1024	39	4.1	2.6–5.6	43	4.4£	2.9–5.9	642	30	4.9	2.7–7.1	26	4.2£	1.8–6.6
Non-Hispanic Whites	2244	147	5.9	4.9–6.9	160	6.5	5.4–7.6	1412	109	6.6	5.7–7.5	115	7.2	5.9–85
Non-Hispanic Blacks	963	31	3.3£	1.8–4.8	38	4.1£	2.2–6.0	558	30	5.5	2.8–8.2	28	5.1	3.1–7.1

Abbreviations: N=total population sampled; n=number of Inflammatory Back Pain cases; %= Prevalence; 95% CI=95% confidence interval; ESSG= European Spondyloarthritis Study Group; Berlin 8a, 7b= Inflammatory Back Pain Classification Criteria from Rudwaleit *et al.* [4].

*Berlin Criteria 8a, 7b apply only to adults 20–49 years of age (N=3188).

†Estimates age adjusted to the U.S. 2000 civilian population; for race/ethnicity, only data for the major U.S. subgroups is shown.

£IBP prevalence significantly lower than Non-Hispanic whites; $p \leq .05$.