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# Association of psoriasis and psoriatic arthritis with osteoporosis and pathological fractures

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***Background:*** Previous studies examining the relationship between psoriasis (Pso), osteoporosis, and pathological fractures found conflicting results.

***Objective:*** To determine whether Pso and psoriatic arthritis (PsA) are associated with osteoporosis and fractures in US adults.

***Methods:*** Cross-sectional study of 198,102,435 children and adults, including 183,725 with Pso and 28,765 with PsA from the 2006-2012 National Emergency Department Sample, including 20% of the emergency care visits throughout the United States.

***Results:*** In a pooled analysis across all 7 years, patients with Pso had significantly higher odds (multivariate logistic regression; odds ratio, 95% confidence intervals) of diagnosis with osteopenia (2.86, 2.70-3.02), osteoporosis (2.97, 2.89-3.06), osteomalacia (4.40, 2.50-7.74), ankylosing spondylitis (13.34, 12.02-14.81), and pathological fractures (2.35, 2.19-2.53). Similar associations were observed for PsA. Pso was also associated with vertebral (1.17, 1.09-1.25), pelvic (1.18, 1.06-1.31), femoral (1.68, 1.60-1.78), and tibial/fibular fractures (1.28, 1.16-1.41). Whereas, PsA was associated with stress (2.87, 1.08-7.64) and vertebral (1.45, 1.24-1.70), pelvic (1.75, 1.41-2.18), femoral (2.07, 1.85-2.32), and tibial/fibular (1.60, 1.28-2.01) fractures.

***Limitations:*** Data on severity and treatments of Pso were not available.

***Conclusion:*** Pso and PsA were associated with osteopenia, osteoporosis, ankylosing spondylitis, and pathologic fractures. (J Am Acad Dermatol http://dx.doi.org/10.1016/j.jaad.2016.11.046.)

***Key words:*** ankylosing spondylitis; burden; comorbidities; cost of care; emergency care; hospitalization; length of stay; osteomalacia; osteopenia; osteoporosis; psoriasis; psoriatic arthritis; urgent care.

Psoriasis (Pso) has been linked to a number of different comorbid health conditions, including cardiovascular[1,2] and rheumatologic disorders[3-5] and serious infections.[6,7] Previous studies found conflicting results about the association between Pso, osteoporosis, and fractures. Some studies found an association between Pso and osteoporosis.[8] Others found no association between Pso and bone mineral density (BMD)[9,10] and osteoporosis.[11] Several studies found conflicting results about whether BMD was significantly decreased in psoriatic arthritis (PsA).[12-16] Indeed, patients with Pso and PsA have risk factors for decreased BMD, including low vitamin D,[17] chronic inflammation,[18] high rates of cigarette smoking,[19] and systemic corticosteroid usage.

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Osteopenia and osteoporosis are associated with amplified risk for fractures,[20] which are in turn associated with increased morbidity and mortality.[21] However, numerous clinical factors contribute to fracture risk independent of BMD, including age, smoking,[19] excessive alcohol intake,[22] rheumatoid arthritis,[5] and ankylosing spondylitis (AS),[23] which have been previously linked with Pso. We hypothesized that patients with Pso and PsA are at high risk for osteoporosis and pathological fractures. In the present study, we sought to determine whether Pso and PsA are associated with osteoporosis and fractures in US adults.

**CAPSULE SUMMARY**

- Patients with psoriasis have multiple risk factors for osteoporosis and fractures.
- Patients with psoriasis and patients with psoriatic arthritis had higher rates of osteoporosis, osteomalacia, ankylosing spondylitis, and pathological fractures.
- Psoriasis patients might benefit from increased screening for osteoporosis.

## METHODS

Data were analyzed from the 2006-2012 Nationwide Emergency Department Sample (NEDS). NEDS contains all ED visits from a stratified sample of 20% of US hospital-based EDs. Sample weights were created to reflect the sampling design, providing representative estimates of all ED visits nationwide. Patient consent was not obtained as the databases were de-identified when received. This study was approved by the Institutional Review Board at Northwestern University.

Pso and PsA were identified using International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) codes (696.0 and 696.1) from all listed discharge diagnoses. These codes have previously been validated.[24] The ICD-9-CM codes for identifying different outcomes are presented in Supplemental Table I (available at https://data.mendeley.com/datasets/w925zmzsd4/1).

### Data analysis

Data processing and statistical analyses were performed with SAS version 9.4 (SAS Institute, Cary, NC). Baseline characteristics of patients with and without Pso and PsA were determined using SURVEY procedures adjusting for survey weighting, sampling clustering, and strata. Summary statistics were determined, including sum, mean, standard deviation, minimum, maximum, and median, for the total price of ED care, disposition from the ED, procedures performed in the ED, total charge of ED and inpatient care if admitted, and average length of inpatient care if admitted.

Logistic regression models were constructed with Pso or PsA as the independent variables. The dependent variables were osteoporosis, osteopenia, osteomalacia, AS, and specific type of fractures. Models were constructed for each year individually and in pooled analysis by merging the data sets and dividing the sampling weights by the number of years (n = 7). Multivariate models included age (continuous), sex (male or female), primary payer (private, government [including Medicare/Medicaid], self pay, no charge, or other), and income percentile (<75th or ≥75th). Data on race and ethnicity were not available within NEDS.[25] To determine other predictors of fractures in patients with Pso, we constructed multivariate logistic regression models using stepwise selection (alpha = 0.05) with diagnosis of any fractures as the dependent variable and 8 independent variables.

Complete case-analysis was performed. Post hoc correction for multiple dependent tests was performed by minimizing the false discovery rate with the approach of Benjamini and Hochberg[26] and corrected *P* values are presented. Two-sided, corrected *P* values ≤.05 were considered significant.

## RESULTS

### Study characteristics

There were 198,102,435 ED visits included in NEDS between 2006-2012; 183,725 and 28,765 visits (or 830,265 and 129,614 visits when accounting for sample weighting) involved a diagnosis of Pso and PsA, respectively. In pooled analysis, patients with Pso compared with those without Pso were older (mean ± standard deviation, 54.4 ± 0.1 vs 38.4 ± 0.2 years), less likely to be female (48.5% vs 55.2%), more likely to use Medicare as their primary source of payment (39.4% vs 20.8%), and more evenly distributed across income quartiles (Table I).[27,28] Patients with PsA were also older (mean ± standard deviation, 56.1 ± 0.2 vs 38.4 ± 0.2 years), more likely to use Medicare as their primary source of payment (41.6% vs 20.8%), and more evenly distributed across all income quartiles but had a similar sex distribution (55.2% vs 55.2% female). Similar results were found for individual years from 2006 to 2012 (Supplemental Tables II and III; available at https://data.mendeley.com/datasets/w925zmzsd4/1).

### Osteopenia, osteoporosis, osteomalacia, and AS

Pso was associated with significantly higher odds of AS, osteopenia, and osteoporosis in all 7 years

*Abbreviations used:*

| | |
|---|---|
| aOR: | adjusted odds ratio |
| AS: | ankylosing spondylitis |
| BMD: | bone mineral density |
| CI: | confidence interval |
| ED: | emergency department |
| ICD-9-CM: | International Classification of Disease, Ninth Revision, Clinical Modification |
| NEDS: | Nationwide Emergency Department Sample |
| PsA: | Psoriatic arthritis |
| Pso: | Psoriasis |

($P < .0001$ for each year) and osteomalacia in 4 of 7 years ($P \leq .002$ for 2006-2009) of the available 7 years (2006-2012). In pooled meta-analyssis, Pso was associated with significantly higher odds of osteopenia (pooled adjusted odds ratio [aOR] 2.86, 95% confidence interval [CI] 2.70-3.02]), osteoporosis (2.97, 95% CI 2.89-3.06), osteomalacia (4.40, 95% CI 2.50-7.74), and AS (13.34, 95% CI 12.02-14.81) (Table II and Supplemental Table IV; available at https://data.mendeley.com/datasets/w925zmzsd4/1). Similarly, PsA was associated with significantly higher odds of AS, osteopenia, and osteoporosis (Table II and Supplemental Table V; available at https://data.mendeley.com/datasets/w925zmzsd4/1).

There were consistent sex differences in associations of Pso and PsA with osteopenia, osteoporosis, and AS. Prevalences of osteopenia and osteoporosis were significantly higher in both men and women with Pso than in those without Pso (overall and in all 7 years); however, the prevalences of osteopenia (men with and without Pso, 0.31% vs 0.08%; women with and without Pso, 1.07 vs 0.31%) and osteoporosis (men with and without Pso, 0.97% vs 0.19%; women with and without Pso, 5.86 vs 1.31%) were increased in women with Pso (Fig 1). Osteomalacia was increased overall in women with Pso compared with those without Pso (0.01% vs 0.001%), particularly in 5 of 7 years, but it was not increased overall in men (0.0006% vs 0.0007%) and was increased in only 2 of 7 years for men. In contrast, the prevalences of AS were increased in both men and women with Pso than in those without Pso (men with and without Pso, 0.25% vs 0.02%; women with and without Pso, 0.15% vs 0.006%) but was more common in men with and without the disease overall and in all 7 years.

Prevalences of osteopenia were higher in both men and women with PsA than in those without PsA in all 7 years, but the prevalence of osteopenia was much higher among women with PsA than men with PsA (men with and without PsA, 0.63% vs 0.08%; women with and without PsA, 1.37% vs 0.22%). Prevalence of osteoporosis among women with PsA was higher than that among men with PsA and men and women without PsA overall (men with and without PsA, 1.55% vs 0.19%; women with and without PsA, 6.70% vs 1.32%) and in all 7 years; prevalence of osteoporosis among men with PsA was comparable to that seen among women without PsA. Prevalences of AS were higher among men and women with PsA than those without and were higher among men with the disease than women overall (men with and without PsA, 0.91% vs 0.02%; women with and without PsA, 0.57% vs 0.006%) and in 6 of 7 years (Supplemental Fig 1; available at http://www.jaad.org).

### Pathological fractures

Pso and PsA were associated with pathological fractures in each of the 7 years available and overall (pooled aOR; 2.35, 95% CI 2.19-2.50 and 3.40, 95% CI 2.60-4.20, respectively). In particular, Pso was positively associated with fractures of the vertebrae, pelvis, femur, tibia, and fibula but inversely associated with fractures of the humerus, ulna and radius, and hand and wrist. Similarly, PsA was positively associated with stress fractures and fractures of the vertebrae, pelvis, and femur but inversely associated with fractures of the ulna and radius and hand and wrist.

There were consistent sex differences in associations of Pso and PsA with pathological fractures overall, particularly stress fractures and fractures of the vertebrae, humerus, pelvis, femur, tibia, and fibula. Prevalences of pathological fractures and fractures of the vertebrae, pelvis, femur, tibia, and fibula were significantly higher in both men and women with Pso than in those without Pso overall and in all years; however, the prevalences of stress fractures and fractures of the vertebrae, humerus, pelvis, and femur were highest in women with Pso in all 7 years (Fig 1). Similarly, prevalences of pathological fractures and fractures of the vertebrae, pelvis, femur, tibia, and fibula were highest in women with PsA in all years (Supplemental Fig 1; available at http://www.jaad.org).

Additional predictors of fractures in patients with and without Pso are presented in Supplemental results (available at http://www.jaad.org).

### Disposition and cost of care

Among patients without fracture, patients with Pso who presented to the ED had markedly higher rates of inpatient admission than those without Pso (range 51.2%-60.9% vs 14.0%-15.2%, respectively). Similarly, among patients with fractures, those who also had Pso had higher rates of inpatient admission than those

**Table I.** Predictors of any fracture in patients without psoriasis and psoriatic arthritis (pooled 2006-2012)

| | Psoriasis | | Psoriatic arthritis | |
|---|---|---|---|---|
| **Variable** | **Adjusted OR (95% CI)** | ***P* value** | **Adjusted OR (95% CI)** | ***P* value** |
| Age | | | | |
| 0-19 | 1.00 (ref) | - | - | - |
| 20-39 | 0.57 (0.55-0.60) | <.0001 | - | - |
| 40-59 | 0.39 (0.37-0.41) | <.0001 | - | - |
| 60-79 | 0.57 (0.54-0.59) | <.0001 | - | - |
| 80-99 | 1.04 (1.00-1.08) | .08 | - | - |
| 100+ | 1.42 (1.30-1.55) | <.0001 | | |
| Admission day | | | | |
| Weekday | 1.00 (ref) | - | - | - |
| Weekend | 1.08 (1.08-1.09) | <.0001 | - | - |
| Chronic conditions* | | | | |
| 0-1 | 1.00 (ref) | - | 1.00 (ref) | - |
| 2-5 | 0.09 (0.09-0.10) | <.0001 | 0.04 (0.002-0.71) | .03 |
| ≥6 | 0.04 (0.04-0.05) | <.0001 | 0.02 (0.001-0.36) | .009 |
| Season | | | | |
| January-March | 1.00 (ref) | - | - | - |
| April-June | 1.05 (1.04-1.06) | <.0001 | - | - |
| July-September | 1.07 (1.06-1.08) | <.0001 | - | - |
| October-December | 1.07 (1.06-1.08) | <.0001 | - | - |
| Sex | | | | |
| Male | 1.00 (ref) | - | 1.00 (ref) | - |
| Female | 1.32 (1.31-1.33) | <.0001 | 1.40 (1.25-1.55) | <.0001 |
| Primary payer | | | | |
| Private | 1.00 (ref) | - | 1.00 (ref) | - |
| Medicaid | 0.65 (0.63-0.66) | <.0001 | 0.78 (0.61-1.00) | .05 |
| Medicare | 0.76 (0.75-0.77) | <.0001 | 0.86 (0.74-1.10) | .08 |
| Other | 1.32 (1.29-1.35) | <.0001 | 1.31 (0.90-1.91) | .2 |
| Self/No charge | 0.94 (0.91-0.96) | <.0001 | 0.81 (0.54-1.21) | .3 |
| Urban vs rural | | | | |
| >1 million | 1.00 (ref) | - | - | - |
| 250,000-999,999 | 1.16 (1.15-1.17) | <.0001 | - | - |
| 50,000-249,999 | 1.23 (1.21-1.25) | <.0001 | - | - |
| Fringe >1 million | 1.00 (0.99-1.01) | <.0001 | - | - |
| Micropolitan† | 1.25 (1.23-1.26) | <.0001 | - | - |
| Not micro or metro | 1.46 (1.43-1.49) | <.0001 | - | - |
| Income quartile | | | | |
| 1 | 1.00 (ref) | - | 1.00 (ref) | - |
| 2 | 1.17 (1.15-1.18) | <.0001 | 0.99 (0.84-1.15) | .9 |
| 3 | 1.23 (1.22-1.24) | <.0001 | 0.92 (0.79-1.08) | .3 |
| 4 | 1.31 (1.30-1.33) | <.0001 | 1.13 (0.97-1.31) | .1 |

*CI*, Confidence interval; *OR*, odds ratio.

*A chronic condition was defined by HCUP as a condition lasting >12 months that places limitations on activities of daily living and/or results in the need for ongoing intervention.[27]

†Micropolitan counties were defined as an urban cluster population between 10,000 and 49,999 people.[28]

without fractures (range 70.5%-83.5% vs 24.8%-25.7%, respectively). These patterns were observed consistently across all 7 years (Fig 2). Similar patterns were observed in patients with PsA (Supplemental Fig 2; available at http://www.jaad.org). The mean length of stay for patients with Pso and fractures who required inpatient admission ranged from 5.09-5.97 days (Supplemental Table VI; available at https://data.mendeley.com/datasets/w925zmzsd4/1) compared with 5.65-6.01 days for those without psoriatic disease. Most of the other Pso patients with fractures were discharged home from the ED, with ~1% being transferred to other facilities and negligible mortality.

The mean adjusted cost of ED care per se was slightly higher for patients with a diagnosis of Pso compared with those without Pso across 2006-2012, albeit not with major differences ($2341 and $2290). Among patients with Pso, the mean

**Table II.** Pooled analysis of the association of psoriasis and psoriatic arthritis with osteoporosis and fractures, 2006-2012

| Variable | Number (%) No psoriasis N = 197,918,710 | Number (%) | Pooled aOR (95% CI) | *P* value |
|---|---|---|---|---|
| | | Psoriasis N = 183,725 | | |
| Osteopenia | 307,822 (0.16%) | 1235 (0.67%) | 2.86 (2.70-3.02) | <.0001 |
| Osteoporosis | 1,601,757 (0.81%) | 6126 (3.3%) | 2.97 (2.89-3.06) | <.0001 |
| Osteomalacia | 2035 (0.001%) | 12 (0.006%) | 4.40 (2.50-7.74) | <.0001 |
| Ankylosing spondylitis | 19,553 (0.01%) | 370 (0.20%) | 13.34 (12.02-14.81) | <.0001 |
| Pathological fracture | 225,914 (0.11%) | 783 (0.43%) | 2.35 (2.19-2.53) | <.0001 |
| Stress fracture | 6619 (0.003%) | 16 (0.009%) | 1.93 (1.18-3.15) | .01 |
| Vertebral fracture | 521,197 (0.26%) | 833 (0.45%) | 1.17 (1.09-1.25) | <.0001 |
| Humerus fracture | 555,326 (0.28%) | 507 (0.28%) | 0.82 (0.75-0.89) | <.0001 |
| Ulna and radius fracture | 1,214,146 (0.61%) | 470 (0.26%) | 0.45 (0.41-0.49) | <.0001 |
| Hand and wrist fracture | 1,301,261 (0.66%) | 318 (0.17%) | 0.29 (0.26-0.32) | <.0001 |
| Pelvic fracture | 210,626 (0.11%) | 349 (0.19%) | 1.18 (1.06-1.31) | .003 |
| Femur fracture | 639,444 (0.32%) | 1582 (0.86%) | 1.68 (1.60-1.78) | <.0001 |
| Tibia and fibula fracture | 311,018 (0.16%) | 395 (0.21%) | 1.28 (1.16-1.41) | <.0001 |
| **Variable** | **No psoriatic arthritis N = 198,073,760** | | **Psoriatic arthritis N = 28,765** | |
| Osteopenia | 308,722 (0.16%) | 285 (0.99%) | 4.13 (3.67-4.64) | <.0001 |
| Osteoporosis | 1,606,590 (0.81%) | 1293 (4.5%) | 4.04 (3.80-4.29) | <.0001 |
| Osteomalacia | 2042 (0.001%) | 5 (0.02%) | 10.95 (4.55-26.34) | <.0001 |
| Ankylosing spondylitis | 19,717 (0.01%) | 209 (0.73%) | 48.21 (41.91-55.47) | <.0001 |
| Pathological fracture | 226,521 (0.11%) | 176 (0.61%) | 3.41 (2.94-3.96) | <.0001 |
| Stress fracture | 6631 (0.003%) | 4 (0.01%) | 2.87 (1.08-7.64) | .03 |
| Vertebral fracture | 521,870 (0.26%) | 160 (0.56%) | 1.45 (1.24-1.70) | <.0001 |
| Humerus fracture | 555,839 (0.28%) | 84 (0.29%) | 0.82 (0.66-1.02) | .08 |
| Ulna and radius fracture | 1,214,521 (0.61%) | 95 (0.33%) | 0.56 (0.46-0.69) | <.0001 |
| Hand and wrist fracture | 1,301,529 (0.66%) | 50 (0.17%) | 0.33 (0.25-0.43) | <.0001 |
| Pelvic fracture | 210,893 (0.11%) | 82 (0.29%) | 1.75 (1.41-2.18) | <.0001 |
| Femur fracture | 640,725 (0.32%) | 301 (1.0%) | 2.07 (1.85-2.32) | <.0001 |
| Tibia and fibula fracture | 311,878 (0.16%) | 75 (0.26%) | 1.60 (1.28-2.01) | <.0001 |

*aOR*, Adjusted odds ratio; *CI*, confidence interval.

adjusted cost of ED care was consistently higher for patients with fractures than for those without fractures, albeit not with major differences ($2445 and $2237). Among patients requiring inpatient admission, those with fractures had a higher adjusted cost of care across all years compared with those without fracture (Fig 2). Inflation-adjusted cost of both ED and inpatient care both displayed a steady gradual increase from 2006-2012 among patients with Pso. Similar patterns were observed in patients with PsA (Supplemental Fig 2; available at http://www.jaad.org).

## DISCUSSION

In the present study, we found higher rates of osteopenia, osteoporosis, osteomalacia, and AS in adults with Pso and PsA, which were reproducible across multiple study years. Osteopenia, osteoporosis, and osteomalacia were more common in women, whereas AS was more common in men with psoriatic disease. Pso and PsA were associated with higher rates of pathological fractures, particularly of the vertebrae, pelvis, femur, tibia, and fibula. Fractures occurring in psoriatic disease were associated with higher rates of hospitalization, prolonged hospitalization, and increased costs of care. Together, the results suggest that patients with psoriatic disease pose a substantial public health burden with respect to their increased risk for low BMD and fractures.

The results are consistent with smaller cross-sectional studies that found an association of psoriatic disease with osteoporosis and increased fracture risk.[13,15,23] Increased risk for osteoporotic fractures in psoriatic disease is concerning because of their increased morbidity and mortality. In a 5-year prospective cohort study of 493 persons who sustained a low-trauma fracture, mortality was increased in both men and women after fractures of the proximal femur, vertebrae, and other major fractures.[21] In the

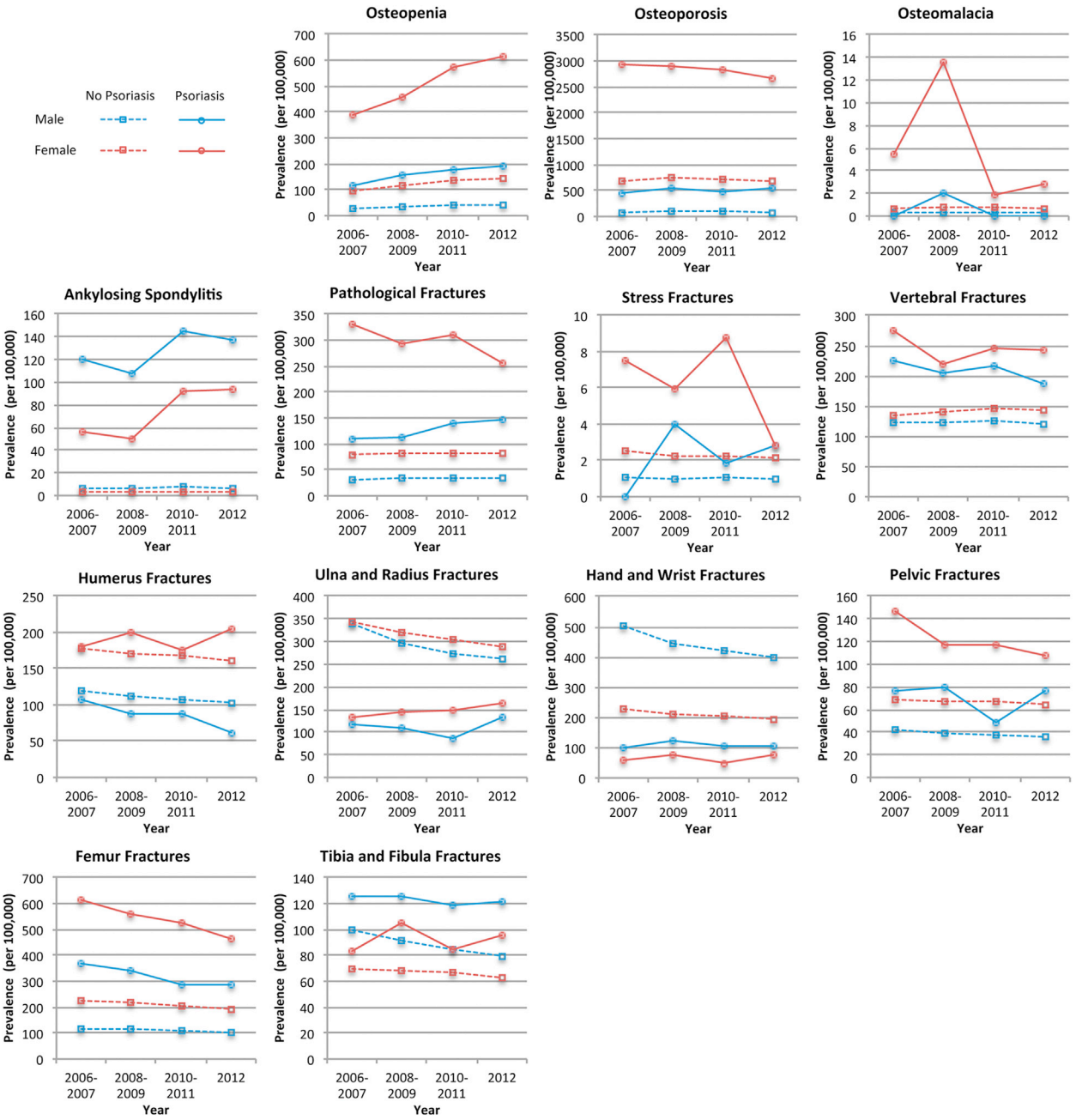


**Fig 1.** Prevalence of osteopenia, osteoporosis, osteomalacia, ankylosing spondylitis, and fractures in patients with and without psoriasis by sex, 2006-2012. Prevalence of fractures during various time intervals (2006-2007, 2008-2009, 2010-2011, and 2012) are plotted for each comorbidity for male patients with psoriasis (*solid-blue line*), female patients with psoriasis (*solid-red line*), male patients without psoriasis (*dashed-blue line*), and female patients without psoriasis (*dashed-red line*).

present study, mortality rates in the ED and hospital setting were low in patients with psoriatic disease and fractures. Future studies are needed to determine the impact of osteoporotic fractures on long-term mortality risk in Pso.

The hypothesized mechanism underlying the potential association between psoriatic disease and reduced BMD involves enhanced bone resorption secondary to increased concentrations of tumor necrosis factor $\alpha$ and interleukin 6.[18] If so, it is possible that systemic treatment options that reduce such inflammation, such as methotrexate or biologics, might actually reduce the risk for osteoporosis and fractures. On the other hand, some persons

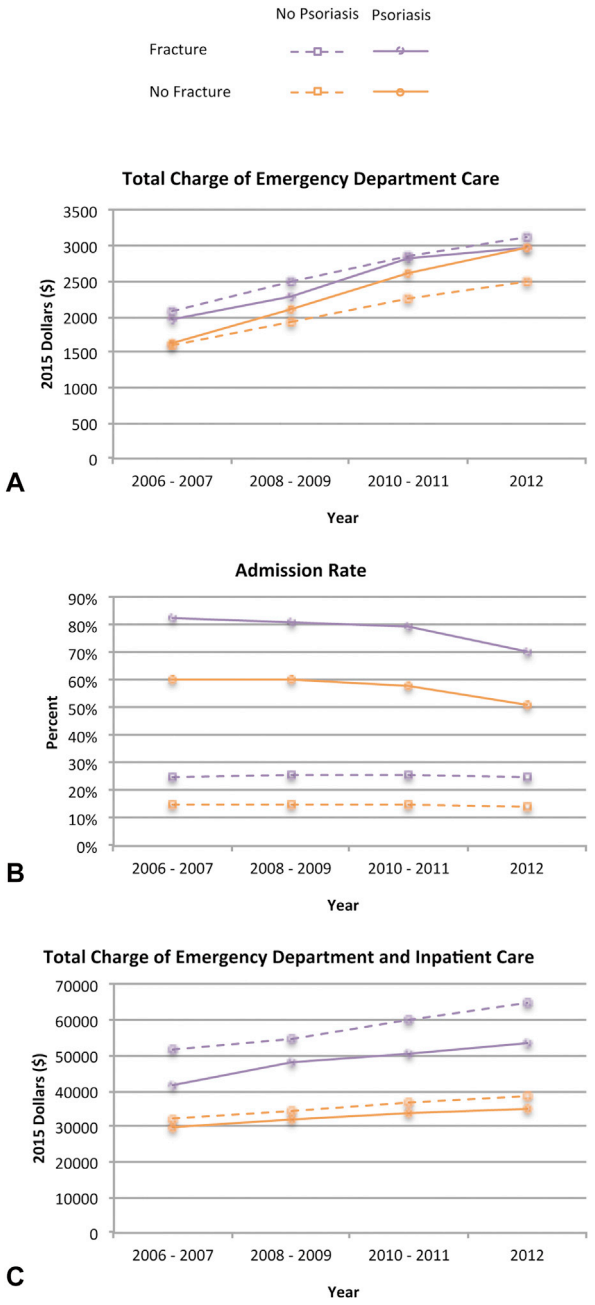


**Fig 2.** Trends in cost of emergency department care (**A**), hospital admission rates (**B**), and combined cost of emergency and inpatient care (**C**) for patients with and without psoriasis and fractures. Results are stratified into 4 groups: fracture, no psoriasis (*dashed-purple line*); no fracture, no psoriasis (*dashed-yellow line*); fracture, psoriasis (*solid-purple line*); and no fracture, psoriasis (*solid-yellow line*).

with psoriasis might be treated with systemic corticosteroids (despite not being recommended in the clinical guidelines for psoriasis management), which can adversely affect BMD resulting in osteoporosis and fractures.[29] Moreover, patients with Pso with extensive skin disease might use large quantities of topical corticosteroids, which might be absorbed and cause adverse systemic effects.[30,31] Weight-bearing physical activity is required for proper bone remodeling.[32] However, previous studies found that patients with Pso have lower cardiorespiratory fitness and might be less physically active.[33,34] In the present study, Pso and PsA were inversely associated with fractures of the humerus, ulna and radius, and hand and wrist, which typically occur in younger more physically active patients. Thus, patients with psoriatic disease might be less likely to engage in physical activities that predispose them to such fractures. Encouraging psoriatic patients to engage in more weight-bearing, physical activities might improve bone remodeling and help lower their osteoporosis risk. In addition, patients with psoriatic disease have low vitamin D levels,[17] which might affect calcium metabolism and BMD. It is possible that vitamin D replacement therapy might mitigate the risk for osteoporosis and fractures in patients with Pso.

The results of the present study suggest that patients with psoriatic disease would benefit from increased surveillance for osteoporosis and strategies to minimize risk for osteoporosis and fractures. It is unclear what the ideal approaches are in this respect and future studies are needed to clarify these points. However, some simple and low-cost interventions can be integrated into clinical practice. It appears that women, older patients, and those with PsA and AS are at highest risk. A cursory assessment of osteoporosis risk can be achieved by asking patients about their personal history of fractures, systemic corticosteroid use, rheumatoid or psoriatic arthritis, and AS.[35] Finally, referral for age-appropriate bone density monitoring and consideration of referral to an endocrinologist or other specialist may be appropriate in high-risk patients. Given the higher rates of hospitalization and increased cost of care for fractures in psoriatic disease, it appears that earlier intervention might reduce fracture risk and subsequent health care utilization.

This study has several strengths, including analysis of a representative cohort of ED, with 7 years of data encompassing nearly 198 million ED visits, with >183,000 patients with psoriatic disease. We were able to demonstrate the associations with osteoporosis and fractures across multiple study years, indicating good reproducibility. The ICD-9-CM code for Pso was previously validated and found it to have good reliability.[24,36] Nevertheless, it is possible that some other dermatoses were misclassified as Pso. In addition, we corrected *P* values to

address concerns of multiple statistical testing. Limitations of this study included the lack of data on race and ethnicity, severity of Pso and PsA, and medication used within the NEDS, which are potential confounders. There is potential for misclassification of the diagnostic codes for osteoporosis and fractures. Also, diagnosis codes in the ED setting might not fully reflect a patient's complete medical history because it is possible a clinician might only list diagnoses that he or she directly addressed. This might bias the clinician to only document the more severe or immediately relevant comorbidities. However, this likely results in under-coding of psoriatic disease in the ED setting. Despite this, we still found strong associations of psoriatic disease with osteoporosis and fracture; we thus do not believe this to be a major limitation. Despite the very large overall sample size in the cohort, there were low frequencies for some of the outcomes, resulting in wide CIs. Finally, NEDS contains event-level records, not patient-level records. Thus, individual patients who visit the ED multiple times in one year might be present multiple times. However, we do not believe that this is a major limitation because each ED visit likely represented a distinct fracture.

In conclusion, both Pso and PsA are associated with osteopenia, osteoporosis, osteomalacia, AS, and multiple types of fractures, particularly pathological femoral, vertebral, pelvic, tibia, and fibula fractures. Further studies are needed to confirm these findings and determine the ideal approaches to prevent and treat these comorbidities.

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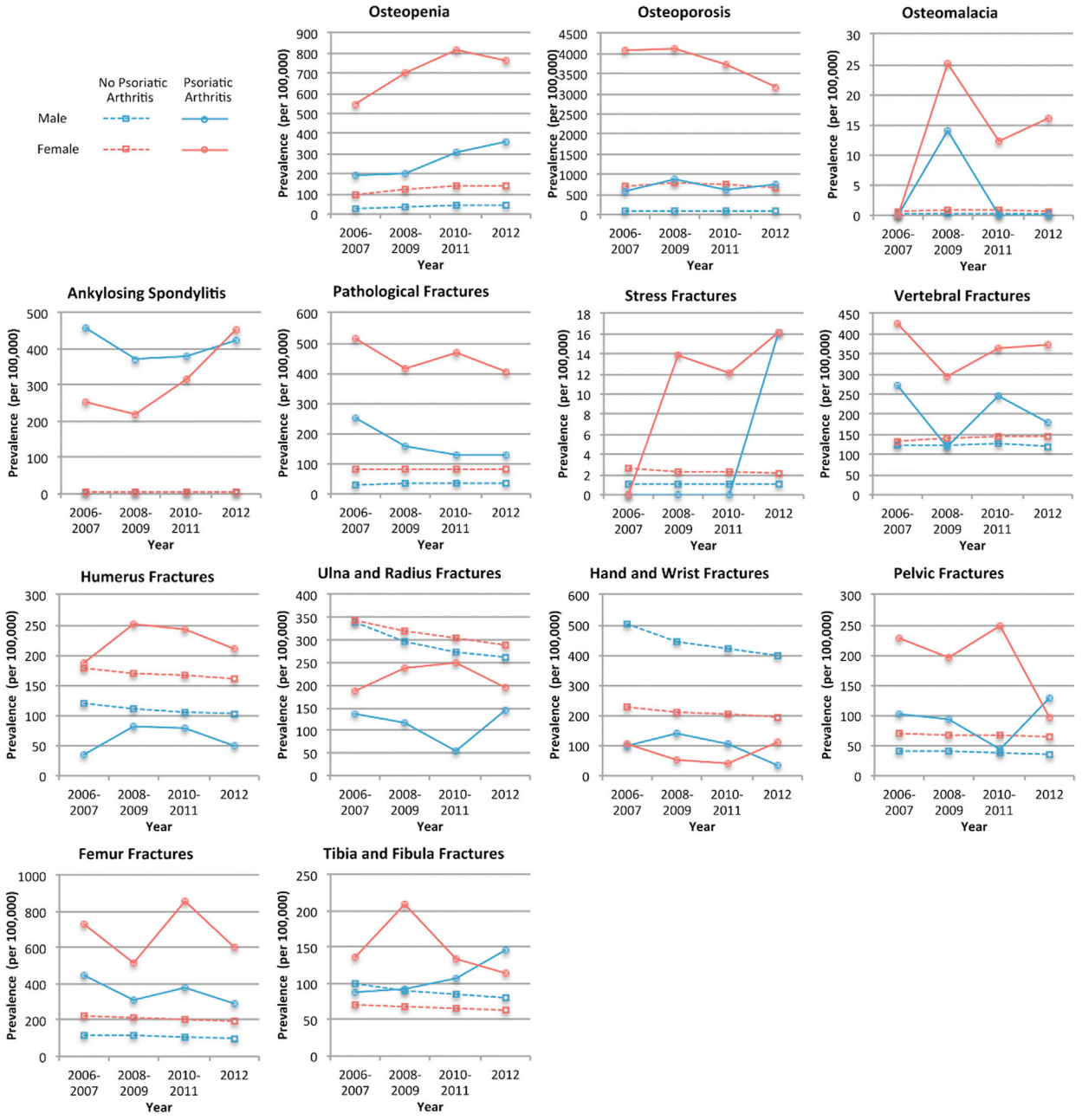
## SUPPLEMENTAL RESULTS

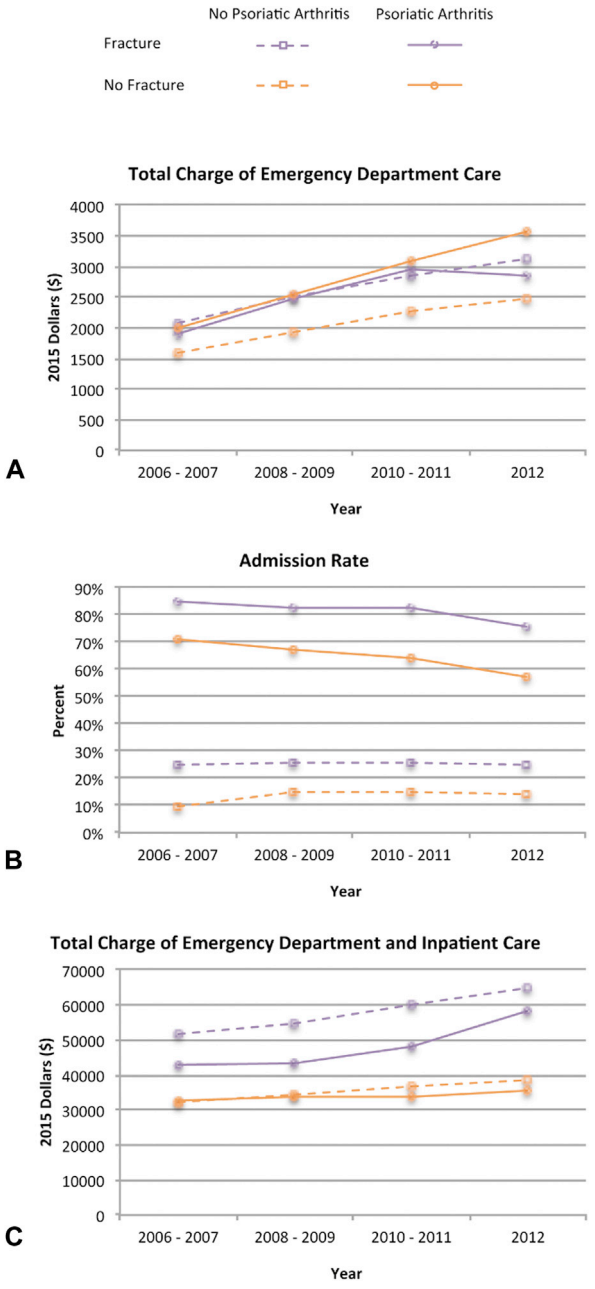
### Predictors of any fracture

Among patients without psoriasis (Pso), significant predictors of any fracture as determined by stepwise selection from data pooled across all 7 years, included 1) age group 80-99 years (adjusted odds ratio [aOR] 1.04, 95% confidence interval [CI] 1.00-1.08) or 100+ years (1.42, 95% CI 1.30-1.55) compared with age group 0-19 years; 2) admission day on a weekend (1.08, 95% CI 1.08-1.09); 3) admission during the spring (April-June; 1.05, 95% CI 1.04-1.06) or summer (July-September; 1.07, 95% CI 1.06-1.08) compared with winter (January-March); 4) insurance classified as other compared with private insurance (1.32, 95% CI 1.29-1.35); 5) residing in an area with a population <1 million; and 6) higher income quartile. Significant predictors of any fracture in patients without Pso across 6 of 7 years included admission during the autumn (October-December; 1.07, 95% CI 1.06-1.08) as compared with winter (January-March). Factors indicating a significantly decreased risk for fracture among patients without Pso across all 7 years included 1) age groups 20-79 years compared with age group 10-19 years; 2) increasing number of chronic conditions; and 3) Medicaid, Medicare, and self-pay or no charge compared with private insurance.

Among patients with Pso, significant predictors of any fracture as determined by stepwise selection across all 7 years included age >40 years compared with age group 0-19 years and female sex. Other significant predictors included admission on a weekend day (3 of 7 years); increasing number of chronic conditions (6 of 7 years); and higher income quartile (4 of 7 years). In pooled models with stepwise selection, however, only number of chronic conditions, sex, payer type, and income quartile remained significant predictors.




**Supplemental Fig 1.** Prevalence of osteopenia, osteoporosis, osteomalacia, ankylosing spondylitis, and fractures in patients with and without psoriatic arthritis by sex, 2006-2012. Prevalence of comorbidities at the indicated time intervals (2006-2007, 2008-2009, 2010-2011, and 2012) are plotted by each comorbidity for male patients with psoriatic arthritis (*solid-blue line*), female patients with psoriatic arthritis (*solid-red line*), male patients without psoriatic arthritis (*dashed-blue line*), and female patients without psoriatic arthritis (*dashed-red line*).




**Supplemental Fig 2.** Trends in cost of emergency department care (**A**), hospital admission rates (**B**), and combined cost of emergency and inpatient care (**C**) for patients with and without psoriatic arthritis and fractures. Results are stratified into 4 groups: fracture, no psoriatic arthritis (*dashed-purple line*); no fracture, no psoriatic arthritis (*dashed-yellow line*); fracture, psoriatic arthritis (*solid-purple line*); and no fracture, psoriatic arthritis (*solid-yellow line*).