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Validity of clinical psoriatic arthritis diagnoses made by rheumatologists in the Swedish National Patient Register

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Objectives: Knowledge of the correspondence between clinical ICD diagnoses and classification criteria fulfilment is crucial to interpret studies identifying cases via ICD codes. We assessed the degree to which patients registered with ICD-10 diagnoses of psoriatic arthritis (PsA) in the Swedish National Patient Register (NPR) fulfil established PsA classification criteria.

Method: Four hundred patients with at least one outpatient visit to one of five rheumatology or internal medicine departments (three university/two county departments across Sweden) in 2013–2015, with a main ICD-10 diagnosis of PsA (L40.5, M07.0–M07.3), were randomly selected (80 cases/site). Through a structured medical record review, positive predictive values (PPVs) for fulfilment of the following classification criteria were assessed: CASPAR, Moll and Wright, Vasey and Espinoza, and modified ESSG criteria for PsA. A subset analysis regarding CASPAR fulfilment was also performed among cases with available rheumatoid factor and peripheral X-ray status (central CASPAR items; n = 227).

Results: Of the 400 patients with a main ICD-10 diagnosis of PsA, 343 (86%) fulfilled at least one of the four PsA classification criteria. PPVs for the different criteria were: CASPAR 69% (82% in the subset analysis), Moll and Wright 51%, Vasey and Espinoza 76%, and modified ESSG 64%. Overall, only 6.5% of the 400 PsA diagnoses were judged as clearly incorrect by the medical record reviewers.

Conclusion: The validity of rheumatologist-made, clinical ICD-10 diagnoses for PsA in the Swedish NPR is good, with PPVs of 69–82% for CASPAR fulfilment and 86% for meeting any established PsA classification criteria.

Psoriatic arthritis (PsA) is a chronic inflammatory disease associated with psoriasis and is part of the spondyloarthritides (SpA) group of disorders. The clinical presentation of PsA is heterogeneous, with musculoskeletal manifestations comprising arthritis, dactylitis, enthesitis, and spondylitis, and apart from psoriasis other extra-articular manifestations, such as inflammatory bowel disease and uveitis, may also occur (1–3). In the absence of established diagnostic criteria or specific biomarkers, the clinical diagnosis of PsA and its differentiation from other arthritides, such as rheumatoid arthritis (RA), is sometimes a challenge, and the diagnostic work-up encompasses evaluation of personal and family history of psoriasis, clinical findings, laboratory tests, and imaging.

The heterogeneity of PsA has led to repeated attempts to construct classification criteria (4, 5). The first to reach

widespread use was proposed by Moll and Wright in the 1970s, defining PsA as a combination of psoriasis, inflammatory arthritis, or spondylitis, and absence of rheumatoid factor (RF) (6). Later criteria are generally more complex (7–11), some including synovial fluid analysis (7) or human leucocyte antigen (HLA) profile (11). As part of the SpA family, a modification of the European Spondyloarthropathy Study Group (ESSG) criteria for SpA has also been proposed to define PsA, by including a demand for psoriasis or a family history of this (4, 12). Since their publication in 2006, however, the CIASSification criteria for Psoriatic ARthritis (CASPAR) have replaced all prior criteria sets as today's standard PsA classification criteria (13). Nonetheless, the differences in included items and their weights cause all the proposed PsA classification criteria to capture somewhat different patient populations, and no single, universally accepted gold standard exists.

In Sweden, clinical diagnoses in the form of International Classification of Diseases (ICD) diagnostic codes (14) from visits and healthcare episodes in specialized (i.e. non-primary) care are systematically reported to the

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National Patient Register (NPR) at the National Board of Health & Welfare (15). Based on ICD codes in the NPR, national cohorts of patients with specific diagnoses can thus be identified, and linking this to other data sources offers unique opportunities to study occurrence, risk factors, and outcomes of different diagnoses. For the interpretation of such register-based, epidemiological studies, however, knowledge of the correspondence between clinical ICD diagnoses and fulfilment of established classification criteria for the relevant condition is fundamental.

For RA and ankylosing spondylitis (AS), prior validation studies of the respective ICD codes in the NPR found positive predictive values (PPVs) for the fulfilment of relevant classification criteria of 91% for RA and 70–89% (depending on the criteria used) for AS (16, 17). Regarding PsA, only a smaller, regional study is available, reporting the proportion of PsA ICD diagnoses from specialized care that could be confirmed by medical record review to range from 69% to 93%, according to the assessors' judgement (18).

Thus, the main objective of the present study was to validate the ICD codes for PsA in the Swedish NPR in relation to fulfilment of the CASPAR and other established PsA classification criteria by a nationwide approach.

Method

Study setting

In Sweden, administrative data, including dates and ICD codes, from visits and healthcare episodes in specialized (i.e. non-primary) care are reported to the NPR (15). The NPR consists of the inpatient register (IPR), containing information regarding inpatient care episodes since 1964, and with 100% coverage from 1987 onwards, and the outpatient care register (OPR). The latter was started in 2001, and since then it has been mandatory for healthcare providers in specialized care to report data on outpatient visits to physicians to the OPR, although the coverage remains lower than in the IPR, mainly lacking information from some private caregivers. In 2011, the OPR coverage was estimated at 87% (19). For each reported healthcare visit/episode in the NPR, one main and, optionally, one or more secondary ICD diagnoses are recorded. Since 1997, clinical diagnoses in Sweden have been registered according to the Swedish version of the ICD-10. Before this, previous versions were used, as follows: ICD-7, 1964–1968; ICD-8, 1968–1986; and ICD-9, 1987–1996.

Prescription drugs dispensed by Swedish pharmacies have been registered in the Prescribed Drug Register (PDR) since 2005. Linkage of information from different administrative/healthcare registers within Sweden can be done via the personal identification number, unique to every permanent resident.

Study population

All individuals, alive and residing in Sweden on 31 December 2015, and having received at least one ICD code for PsA (ICD-8: 696.00; ICD-9: 696A; ICD-10: L40.5, M07.0, M07.1, M07.2, or M07.3) as main or secondary diagnosis in 1968–2015, were identified from the NPR. For the current validation, a subpopulation of all such prevalent PsA patients in 2015 was selected, by defining inclusion criteria requiring at least one ICD-10 code for PsA as the main diagnosis from an outpatient visit (i.e. in the OPR) to a rheumatology or internal medicine department in 2013–2015. The rationale for the 2013–2015 time period was to ensure that the medical records would be accessible, sometimes spanning several decades, but at the same time to allow some years to have passed before the medical record review was performed in 2019 (see 'Validation process and outcomes', below), to enable some accumulation of clinical information also for incident cases. Furthermore, PsA patients in Sweden are typically diagnosed and treated in specialized outpatient care (18), normally at departments of rheumatology or internal medicine (in non-university hospitals, rheumatology is often part of internal medicine), although milder cases, not requiring disease-modifying anti-rheumatic drug therapy, may be referred back to primary care after the diagnosis has been made.

For the validation process, 400 patients (the validation cohort) were selected from five hospitals across Sweden (80 patients per site), all fulfilling the inclusion criteria described above (see 'Study population'). The five validation sites – Helsingborg Hospital (Helsingborg), Sahlgrenska University Hospital (Gothenburg), Karolinska University Hospital (Stockholm), Falun Hospital (Falun), and Norrland University Hospital (Umeå) – were chosen to ensure a geographical spread across Sweden, as well as including both university (n = 3) and county (n = 2) clinics (Figure 1). At each site, 40 patients who had received their first ever PsA ICD code in 2013–2015 (i.e. incident-appearing from a register identification perspective) and 40 with at least one PsA ICD code prior to 2013 (prevalent-appearing) were selected. Apart from this stratification, the case selection at each site was carried out randomly.

Ethics

Ethical approval was granted by the Regional Ethics Committee in Stockholm, Sweden (Dnr. 2015/1844-31/2 with amendment Dnr. 2018/182-32). Consent from individual patients was not required by the approval.

Validation process and outcomes

For the validation of ICD-10 codes for PsA against established classification criteria, the medical records

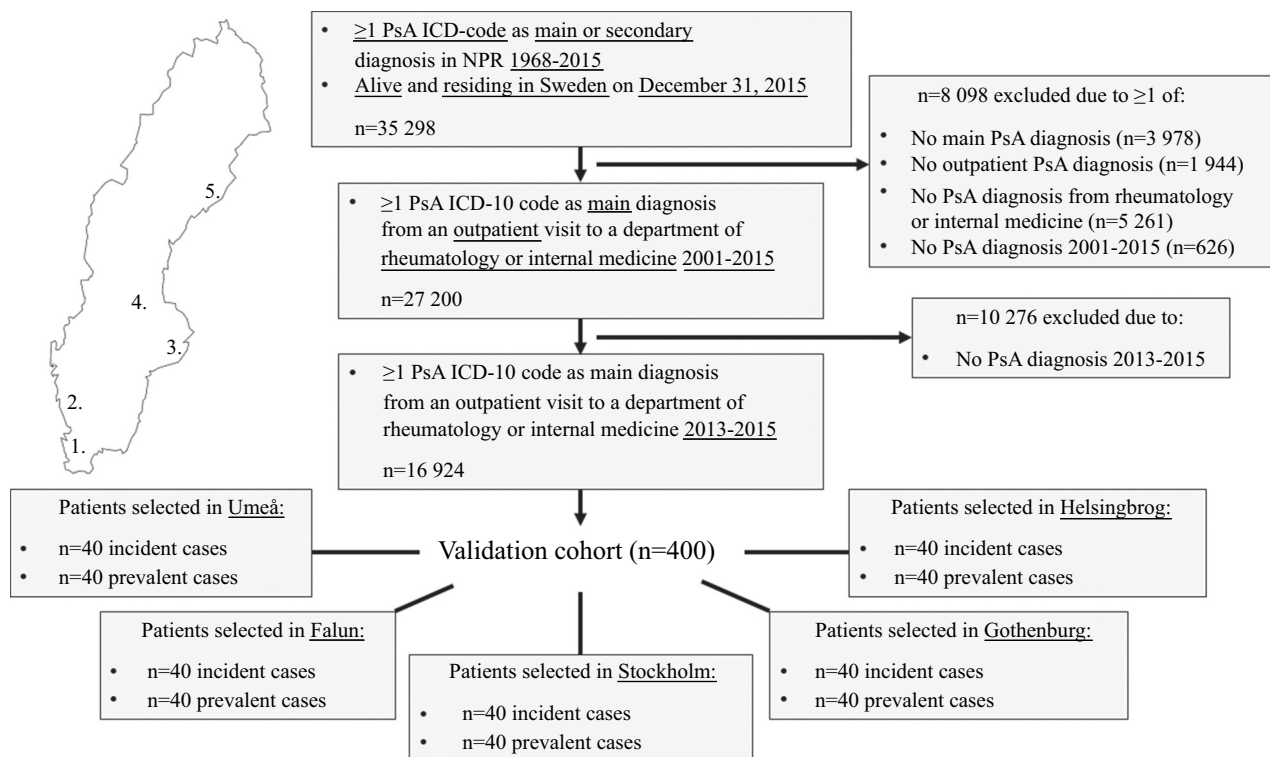


Figure 1. Flowchart describing the patient selection to the validation cohort. Validation sites shown in the map of Sweden: 1. Helsingborg Hospital (Helsingborg); 2. Sahlgrenska University Hospital (Gothenburg); 3. Karolinska University Hospital (Stockholm); 4. Falun Hospital (Falun); 5. Norrland University Hospital (Umeå). Inclusion criteria for the validation cohort were having received at least one ICD-10 code for PsA as the main diagnosis from an outpatient visit to a department of rheumatology or internal medicine in 2013–2015. From each of the five different study sites, 40 incident (with first ever ICD code for PsA 2013–2015) and 40 prevalent (at least one PsA ICD code prior to 2013) cases were randomly selected. ICD-10, International Classification of Diseases, 10th Revision; NPR, Swedish National Patient Register; PsA, psoriatic arthritis.

from specialized care (i.e. non-primary care, but also encompassing specialities beyond rheumatology and internal medicine) of the 400 patients in the validation cohort were reviewed according to a structured protocol (see online supplement). The reviews were performed during 2019 by five physicians (coauthors JKW, GMA, EK, VS, and SW), all specialists in rheumatology, and each responsible for all 80 reviews at their study site. The data extraction protocol had been jointly developed and tested by the five assessors prior to the start of the reviews. Records were reviewed from as far back in time as deemed relevant and possible for logistical/access reasons and up until the time of the review in 2019.

The primary outcome was the PPV of having received at least one main ICD-10 code for PsA from a department of rheumatology or internal medicine in the NPR in 2013–2015 for the fulfilment of the CASPAR criteria for PsA (13). As secondary outcomes, the corresponding PPVs were also assessed for the fulfilment of the Moll and Wright (6), Vasey and Espinoza (8), and modified ESSG criteria for PsA (4, 12), as well as for fulfilment of at least one of the four included PsA criteria. Classification criteria sets requiring synovial fluid or HLA profiling were not

included owing to the low likelihood of finding such information in the medical records (7, 11). Moreover, fulfilment of the Assessment of SpondyloArthritis international Society (ASAS) classification criteria for peripheral or axial SpA (20) and of the modified 1987 American College of Rheumatology (ACR) classification criteria for RA (21) was also evaluated. PPVs were calculated for the full validation cohort, as well as for the prevalent and incident groups separately. In keeping with how medical records are structured, missing information regarding a specific criteria item was treated as negative. For items on imaging, the information available in the clinical radiologist reports was used.

Apart from assessing PPVs in the full validation cohort ($n = 400$), stricter PsA case definitions were also evaluated: (i) requiring at least two PsA ICD codes ever, of which at least one as main diagnosis from a department of rheumatology or internal medicine in 2013–2015 ($n = 353$); (ii) excluding cases with at least one main RA diagnosis from a department of rheumatology or internal medicine ever ($n = 345$); and (iii) applying a combination of (i) and (ii) ($n = 301$). Because of the retrospective design, a fair amount of

missing data was expected regarding imaging, RF, and HLA-B27 status, thus limiting the ability to assess fulfilment of classification criteria including such items. Therefore, subset analyses were also performed, restricted to cases for whom such information was present.

As further secondary outcomes, the degrees of overlap between fulfilment of different criteria were evaluated: (i) between the four PsA criteria sets; and (ii) between fulfilment of any PsA criteria and the ASAS peripheral or axial SpA and ACR RA criteria. Moreover, we aimed to assess the clinical certainty of the PsA diagnoses in three ways: (i) as judged by the rheumatologists performing the medical record reviews (scored as: Certain PsA/Uncertain PsA/Not PsA); (ii) by the proportion for whom PsA remained the clinical diagnosis according to the treating physician at the latest available follow-up visit prior to the medical record review; and (iii) by assessing the proportion of cases who had also received ICD codes for other arthritic diseases.

To assess the generalizability of results from the validation cohort to all PsA cases in Sweden, age, sex, and register-based frequencies of psoriasis, extra-articular manifestations, and use of relevant drugs [according to ICD codes in the NPR and Anatomical Therapeutic Chemical classification (ATC) codes in the PDR] were compared between the validation cohort and all PsA cases in the NPR, according to different case definitions.

Finally, for the incident-appearing PsA cases ($n = 200$), the time from symptom onset to the first recorded PsA ICD code was assessed to determine the feasibility of identifying incident PsA based on ICD codes in the NPR.

Statistics

The proportions of cases fulfilling the different classification criteria were compared between the five study sites, males and females, and younger and older patients by the chi-squared test. (Results are presented in Supplementary Tables S5 and S6.) Apart from this, only descriptive statistics were used.

Results

Study population and disease characteristics

In total, 35 298 individuals, alive and residing in Sweden on 31 December 2015, with at least one ICD code for PsA in the NPR 1968–2015, were identified. Of these, 16 924 fulfilled the study inclusion criteria, from whom the validation cohort of 400 patients was selected (Figure 1). From the generalizability assessments performed, the included validation cohort appeared to be representative of the overall PsA population in Sweden (Supplementary Table S2).

Characteristics of the validation cohort are presented in Table 1, while a more detailed description of all classification criteria items assessed is displayed in Supplementary Table S3. For some items, a high degree of missing data hampers interpretation (Supplementary Table S3), and also affects the possibility for patients to fulfil the corresponding classification criteria. Of the 400 subjects, 353 (88%) had clinically verified skin/nail psoriasis, while the corresponding figure for a medical history of psoriasis was 375 (94%; four prevalent- and 21 incident-appearing cases lacked psoriasis history). Regarding PsA manifestations, 368 patients (92%) displayed clinically verified arthritis (seen in 88%), dactylitis (in 24%), and/or enthesitis (in 39%) at least once, whereas inflammatory back pain was reported by 95 cases (24%). The combination of a medical history of psoriasis and any PsA manifestation (arthritis, dactylitis, enthesitis, or inflammatory back pain) was present in 355 (89%), and arthritic changes in the hands/feet on plain X-rays in 124 patients (31%; a figure that could potentially be higher, since 20% of cases lacked X-ray data).

The numerically lower frequencies of several criteria items observed in the incident group (Table 1; Supplementary Table S3) may partly reflect their shorter disease duration and thus follow-up time (with fewer visits/less available information) in the medical records.

Classification criteria fulfilment

Of the 400 patients in the validation cohort, 275 (69%) fulfilled the CASPAR criteria for PsA based on the information available in their medical records (i.e. the PPV for CASPAR fulfilment was 69%) (Figure 2). The use of stricter PsA case definitions resulted in similar estimates (PPV 68–73%) (Table 2). Since RF status and X-ray changes in hands/feet are both central items for CASPAR, missing information regarding these items (33% and 20%, respectively) will, however, have negatively affected the estimation. When limiting the assessment to patients for whom RF and X-ray information was available ($n = 227$), the PPV rose to 82% (Table 2).

In total, 343 (86%) of the 400 patients fulfilled at least one of the four assessed PsA classification criteria (i.e. the PPV for fulfilment of at least one criteria set was 86%) (Figure 2). The corresponding estimates when using stricter case definitions ranged from 88% to 91% (Table 2). The Vasey and Espinoza criteria were met by the numerically highest proportion of patients (76%) and the Moll and Wright definition by the lowest (55%) (Figure 2), but a substantial overlap was observed, with 36% fulfilling all four PsA criteria and 61% three or more of these (Figure 3A).

Most patients not fulfilling any PsA criteria had either no verified arthritis (23 of 57 cases) or polyarticular disease (25 of 57 cases) (Supplementary Table S4). Of

Table 1. Demographics and disease characteristics.

	All PsA cases (n = 400)	Incident PsA cases (n = 200)	Prevalent PsA cases (n = 200)
Male sex	184 (46)	100 (50)	84 (42)
Age at validation (years)*	59 ± 14	56 ± 15	63 ± 13
Age at symptom onset (years)	42 ± 15	44 ± 16	40 ± 14
Symptom duration at validation (years)			
Mean ± sd	17 ± 12	12 ± 8.8	23 ± 12
Median (IQR)	14 (8.3–24)	8.7 (6.4–15)	20 (14–30)
Time from symptom onset to first PsA ICD code (years)†			
Mean ± sd	n/a	6.9 (8.7)	n/a
Median (IQR)	n/a	3.0 (1.1–10)	n/a
Psoriasis family history	165 (41)	85 (43)	80 (40)
Psoriasis	333 (83)	153 (77)	180 (90)
Nail psoriasis	136 (34)	68 (34)	68 (34)
Arthritis	353 (88)	158 (79)	195 (98)
Monoarthritis‡	7.2	12	3.1
Oligoarthritis‡	43	47	40
Polyarthritis‡	50	41	57
DIP-joint arthritis	101 (25)	35 (18)	66 (33)
Symmetrical arthritis	132 (33)	53 (27)	79 (40)
Dactylitis	96 (24)	41 (21)	55 (28)
Enthesitis	155 (39)	61 (31)	94 (47)
Inflammatory back pain	95 (24)	44 (22)	51 (26)
Anterior uveitis	12 (3.0)	2 (1.0)	10 (5.0)
Inflammatory bowel disease	13 (3.3)	8 (4.0)	5 (2.5)
RF positive	28 (7.0)	15 (7.5)	13 (6.5)
ACPA positive	17 (4.3)	9 (4.5)	8 (4.0)
Arthritic X-ray changes in hands/feet	124 (31)	44 (22)	80 (40)

Data are shown as n (%), mean ± sd, or median (interquartile range).

*Fifteen patients (10 prevalent and five incident) had died prior to the medical record assessment.

†Not applicable for prevalent PsA cases since the registration of ICD codes from outpatient care in the Swedish National Patient Register started in 2001.

‡Percentage of patients with arthritis of known distribution. Polyarthritis was defined as displaying five or more swollen joints at the same assessment at least once. Missing data incident/prevalent, n (%): age at symptom onset and symptom duration, 7 (3.5%)/9 (4.5%); time from symptom onset to first PsA ICD code, 7 (3.5%)/n/a; psoriasis family history, 64 (32%)/78 (39%); psoriasis, 4 (2.0%)/3 (1.5%); nail psoriasis, 3 (1.5%)/7 (3.5%); arthritis, 1 (0.5%)/0 (0%); arthritis distribution, 3 (1.5%)/2 (1.0%); DIP-joint arthritis, 3 (1.5%)/2 (1.0%); symmetrical arthritis, 4 (2.0%)/2 (1.0%); dactylitis, 2 (1.0%)/1 (0.5%); enthesitis, 9 (4.5%)/0 (0%); inflammatory back pain, 4 (2.0%)/1 (0.5%); anterior uveitis, 3 (1.5%)/0 (0%); inflammatory bowel disease, 2 (1.0%)/0 (0%); RF 71 (36%)/61 (31%); ACPA, 50 (25%)/96 (48%); X-ray changes, 49 (25%)/31 (16%).

ACPA, anti-citrullinated protein antibody; DIP, distal interphalangeal; ICD, International Classification of Diseases; IQR, interquartile range; n/a, not applicable; PsA, psoriatic arthritis; RF, rheumatoid factor.

the 343 subjects meeting any of the PsA criteria, 12 (3.5%) did so despite lacking a medical history of skin/nail psoriasis. Owing to the lower frequencies of several criteria items among the incident patients, fulfilment of all PsA criteria was somewhat lower in this group (Figure 2 and Table 2).

The ASAS criteria for axial or peripheral SpA were fulfilled by 345 (86%) of the 400 patients (Figure 2). Of these, only 24 met the axial criteria, although this should be viewed with great caution

owing to the high numbers of missing data regarding sacroiliac joint imaging and HLA-B27 status (74–86%) (Supplementary Table S3), which are central to this criteria set. Of the 345 patients fulfilling either set of ASAS criteria, only 17 did not also fulfil any of the four PsA criteria (Figure 3B). Of the 400 patients, 108 (27%) met the ACR RA criteria (Figure 2) [RF positive/negative/missing: n = 18/66/24; anti-citrullinated protein antibody (ACPA) positive/negative/missing: 9/61/38; RF and

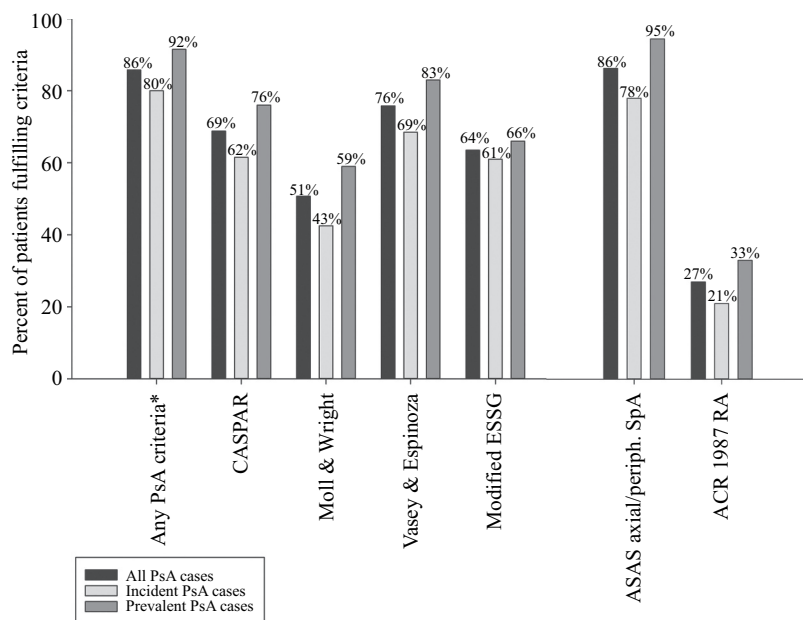


Figure 2. Classification criteria fulfilment. Proportions of patients in the full validation cohort (n = 400) fulfilling different classification criteria (i.e. percentages corresponding to positive predictive values of having received at least one main ICD-10 code for PsA from an outpatient visit to a department of rheumatology or internal medicine in NPR 2013–2015 for the fulfilment of the different criteria). *CASPAR, Moll and Wright, Vasey and Espinoza, or modified ESSG criteria for PsA. ACR, American College of Rheumatology; ASAS, Assessment of SpondyloArthritis international Society; CASPAR, CLASSification criteria for Psoriatic ARthritis; ESSG, European Spondyloarthropathy Study Group; periph., peripheral; PsA, psoriatic arthritis; RA, rheumatoid arthritis; SpA, spondyloarthritis.

ACPA positive: n = 5], again with a substantial overlap with PsA criteria fulfilment (only 20 patients fulfilled the RA but none of the four PsA criteria) (Figure 3B).

Clinical certainty of PsA diagnoses

According to the clinical judgement of the rheumatologists performing the medical record reviews, only 6.5% (n = 26) of the 400 PsA diagnoses were judged as clearly incorrect, with 76% (n = 305) considered certain (Table 3). Moreover, for 87% of the cases, PsA remained the clinical diagnosis according to the treating physician at the most recent follow-up visit available in the medical record at the time of review (Table 3). Results regarding the proportions of cases also having received ICD codes for other arthritic diseases are presented in the online supplement.

Time from symptom onset to PsA diagnosis among incident cases

The median (interquartile range) time from reported symptom onset to the first recorded PsA ICD code in the NPR for the incident-appearing group was 3.0 (1.1–10) years (Table 1). This estimate may be artificially long, however, since for 37 incident-appearing patients the reported symptom onset actually occurred before 2001, when the recording of outpatient care ICD diagnoses in the NPR was initiated. If the true diagnosis dates for these patients occurred prior to 2001 (and in outpatient care), they would thus have been missed. Even if excluding

these 37 cases, however, the median (interquartile range) time from symptom onset to first PsA ICD code remained quite long, at 2.1 (0.9–5.0) years.

Discussion

Main findings

In this nationwide validation study of ICD codes for PsA in the Swedish NPR (n = 400 cases, found to be representative of the overall PsA population), the PPV of having received at least one ICD-10 code for PsA as the main diagnosis from an outpatient visit to a rheumatology or internal medicine department was 86% for the fulfilment of at least one of four established PsA classification criteria (CASPAR, Moll and Wright, Vasey and Espinoza, and modified ESSG). For the CASPAR alone, the corresponding PPV was 69%, but rising to 82% when limiting the assessment to cases for whom relevant RF and X-ray information was available. Moreover, according to the rheumatologists performing the medical record reviews, only 6.5% of the assessed diagnoses were judged as clearly wrong. Although 27% of the patients fulfilled ACR criteria for RA, only 20 patients (5% of all the 400 cases) did so without simultaneously meeting any of the PsA criteria.

On the other hand, in light of the rather long median time from symptom onset to the first recorded PsA ICD code in the NPR for the incident-appearing group, it does not appear feasible to use the date of the first ICD code in NPR as a proxy for the time of PsA onset. However, such relationships may potentially change over time.

Table 2. Subset analyses regarding classification criteria fulfilment.

	All PsA cases (n = 400)	Incident PsA cases (n = 200)	Prevalent PsA cases (n = 200)
Cases with at least two PsA ICD codes*	(n = 353)	(n = 153)	(n = 200)
Any PsA classification criteria†	314 (89)	131 (86)	183 (92)
CASPAR criteria	257 (73)	105 (69)	152 (76)
Moll and Wright criteria	194 (55)	76 (50)	118 (59)
Vasey and Espinoza criteria	284 (81)	118 (77)	166 (83)
Modified ESSG criteria	232 (66)	100 (65)	132 (66)
Cases with no main diagnosis ICD code for RA†	(n = 345)	(n = 176)	(n = 169)
Any PsA classification criteria†	302 (88)	147 (84)	155 (92)
CASPAR criteria	235 (68)	110 (63)	125 (74)
Moll and Wright criteria	174 (50)	75 (43)	99 (59)
Vasey and Espinoza criteria	269 (78)	126 (72)	143 (85)
Modified ESSG criteria	231 (67)	116 (66)	115 (68)
Cases with at least two PsA ICD codes* and no main diagnosis ICD code for RA†	(n = 301)	(n = 132)	(n = 169)
Any PsA classification criteria†	273 (91)	118 (89)	155 (92)
CASPAR criteria	217 (72)	92 (70)	125 (74)
Moll and Wright criteria	165 (55)	66 (50)	99 (59)
Vasey and Espinoza criteria	250 (83)	107 (81)	143 (85)
Modified ESSG criteria	209 (69)	94 (71)	115 (68)
Cases with available RF data	(n = 268)	(n = 129)	(n = 139)
Moll and Wright criteria	203 (76)	85 (66)	118 (85)
Cases with available RF data and radiographs of hands and/or feet	(n = 227)	(n = 104)	(n = 123)
CASPAR criteria	186 (82)	75 (72)	111 (90)
Modified ACR 1987 RA criteria	82 (36)	30 (29)	52 (42)
Cases with available RF data, radiographs of hands and/or feet and SI-joint radiographs	(n = 70)	(n = 24)	(n = 46)
Vasey and Espinoza criteria	61 (87)	18 (75)	43 (94)
Cases with available HLA-B27 data and SI-joint imaging	(n = 34)	(n = 14)	(n = 20)
ASAS criteria for axial SpA	11 (32)	5 (36)	6 (30)
ASAS criteria for axial or peripheral SpA	34 (100)	14 (100)	20 (100)

Data are shown as n (%).

*Of which at least one as main diagnosis from a department of rheumatology or internal medicine in 2013–2015.

†No main diagnosis ICD code for RA from a department of rheumatology or internal medicine ever (prior to the validation).

‡CASPAR, Moll and Wright, Vasey and Espinoza, or modified ESSG criteria for PsA.

ACR, American College of Rheumatology; ASAS, Assessment of SpondyloArthritis international Society; CASPAR, CIASsification criteria for Psoriatic ARthritis; ESSG, European Spondyloarthropathy Study Group; HLA, human leucocyte antigen; ICD, International Classification of Diseases; PsA, psoriatic arthritis; RA, rheumatoid arthritis; RF, rheumatoid factor; SI, sacroiliac; SpA, spondyloarthritis.

Previous research

To our knowledge, the validity of ICD codes for PsA in Sweden has previously only been assessed in a smaller, regional study from Skåne county (18), encompassing both cases identified based on ICD codes from any specialized care department (and thus in the NPR; n = 60), and from primary care only (not reported to the NPR; n = 40). According to the assessors' judgement, 69% of the PsA diagnoses from specialized care could be verified, while 24% were judged

as unverified PsA owing to insufficient information, and 6.8% as not PsA. These figures are quite comparable to the present results (76%, 17%, and 6.5%, respectively) (Table 3). However, only 49% of patients in the regional assessment were found to fulfil CASPAR criteria, versus 69% in the current study. Reasons for this discrepancy may include the requirement for a main diagnosis from rheumatology or internal medicine in the present study, and a disproportionately high share (one-third) of patients in the regional study having received only one PsA ICD code from specialized

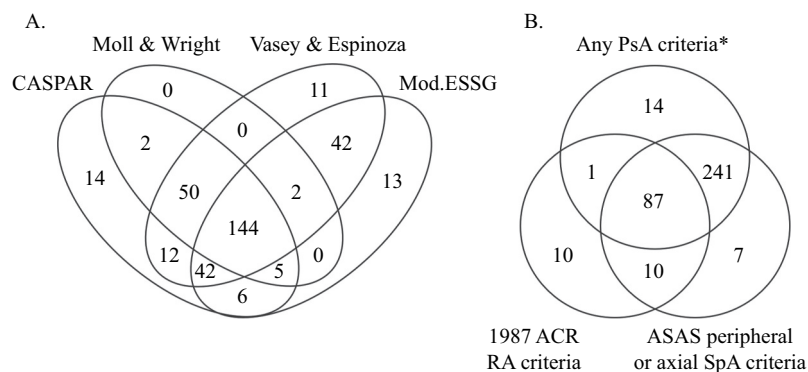


Figure 3. Overlap of classification criteria fulfilment. (A) Venn diagram displaying the numbers of cases in the full validation cohort (n = 400) meeting each of the four different PsA classification criteria, and the overlap between fulfilment of these. Patients not fulfilling any of the assessed PsA classification criteria (n = 57) are not included in the figure. (B) Venn diagram displaying the numbers of cases in the full validation cohort (n = 400) meeting any of the four assessed PsA classification criteria, the modified 1987 ACR criteria for RA, and the ASAS criteria for axial or peripheral SpA, and the overlap between fulfilment of these. Patients not fulfilling any of the included classification criteria (n = 30) are not included in the figure. *CASPAR, Moll and Wright, Vasey and Espinoza, or modified ESSG criteria for PsA. ACR, American College of Rheumatology; ASAS, Assessment of SpondyloArthritis international Society; CASPAR, CIASsification criteria for Psoriatic ARthritis; ESSG, European Spondyloarthropathy Study Group; Mod., modified; PsA, psoriatic arthritis; RA, rheumatoid arthritis; SpA, spondyloarthritis.

Table 3. Assessors' judgement and clinical diagnoses at the latest available follow-up visit.

	All PsA cases (n = 400)	Incident PsA cases (n = 200)	Prevalent PsA cases (n = 200)
Assessor's* overall judgement of diagnostic certainty			
Certain PsA	305 (76)	131 (66)	174 (87)
Uncertain PsA	68 (17)	45 (23)	23 (12)
Not PsA	26 (6.5)	23 (12)	3 (1.5)
Clinical diagnosis according to the treating physician at the latest available follow-up visit			
Psoriatic arthritis	349 (87)	158 (79)	191 (96)
Undifferentiated seronegative arthritis	5 (1.3)	4 (2.0)	1 (0.5)
Undifferentiated spondyloarthritis (peripheral and/or axial)	3 (0.8)	2 (1.0)	1 (0.5)
Reactive arthritis	0 (0)	0 (0)	0 (0)
Inflammatory bowel disease-related arthritis	2 (0.5)	2 (1.0)	0 (0)
Ankylosing spondylitis	1 (0.3)	1 (0.5)	0 (0)
Rheumatoid arthritis	7 (1.8)	5 (2.5)	2 (1.0)
Polymyalgia rheumatica	0 (0)	0 (0)	0 (0)
Crystal arthropathy	3 (0.8)	3 (1.5)	0 (0)
Chronic widespread pain syndrome	5 (1.3)	3 (1.5)	2 (1.0)
Osteoarthritis	8 (2.0)	7 (3.5)	1 (0.5)
Non-inflammatory arthralgia	13 (3.3)	12 (6.0)	1 (0.5)
Other diagnosis	4 (1.0)	3 (1.5)	1 (0.5)

Data are shown as n (%).

*Rheumatologist performing the medical record review.

Missing data incident/prevalent, n (%): assessor's overall judgement of diagnosis validity, 1 (0.5%)/0 (0%). PsA, psoriatic arthritis.

care ever. In fact, of the 20 cases with two or more such ICD codes, 74% fulfilled CASPAR criteria, a finding very similar to our corresponding 73% estimate (Table 2).

In the few international PsA validation studies published to date, the gold standards used were not classification criteria fulfilment, making comparisons to the current results difficult. Instead, most use diagnosis according to the responsible physician/rheumatologist as standard, reporting PPVs of various ICD-9 or Read (22) code-based PsA definitions for such a diagnosis in the range of 57–100% (23–26). One study, however, reported 67% of 73 cases with at least one ICD-9 code for PsA from rheumatology to have a correct diagnosis according to the medical record reviewer (27), a figure fairly consistent with our estimate of 76% with certain PsA according to the assessors. Moreover, case definitions requiring diagnostic codes specifically from rheumatology have been shown to render higher PPVs (26, 27), as has the requirement for two or more diagnostic events (as also seen in the present study) (Table 2) (27).

Strengths and limitations

The nationwide approach and structured medical record review (from as far back in time as deemed relevant, and not limited to rheumatology or internal medicine records) by specialists in rheumatology, and using a jointly predefined and tested protocol, are important strengths of this study. The inclusion of four different established PsA classification criteria, as well as various means to evaluate the clinical certainty of the PsA diagnoses, provides a comprehensive assessment of the validity of the PsA ICD codes in the NPR.

By including prevalent as well as incident cases from both university and county clinics across Sweden, we believe the generalizability of our results to be good in relation to the entire PsA population, fulfilling our case definition with at least one PsA ICD code as main diagnosis from an outpatient visit to a rheumatology or internal medicine department (corresponding to 77% of all individuals with at least one PsA ICD code in the NPR) (Figure 1). This was also strengthened by the generalizability assessments performed (Supplementary Table S2). However, patients diagnosed with PsA in primary care, only in inpatient care, or within specialized care departments other than rheumatology or internal medicine were not part of the present validation. As for primary care, the prior regional validation study found that only 8.4% of all PsA cases had never been diagnosed in specialized care (18). Moreover, diagnoses from private rheumatologists, some of whom may not report ICD codes to the NPR, were also not validated. The extent of private care is, however, limited in Sweden, and most patients followed at such units will occasionally also consult public rheumatology departments.

The fact that certain rheumatologists at some of the study sites (but not all) had an academic interest in PsA may potentially have affected the validation results positively. Included cases were, however, randomly selected (rather than among those clinically followed by rheumatologists with such academic interest), and the good agreement of criteria fulfilment across all study sites speaks against such bias (Supplementary Table S5). Moreover, with the continuously evolving knowledge of PsA and its typical characteristics, we cannot rule out secular trends in ICD-code validity. Such problems, however, are likely to increase the further back in time one looks, and the outpatient part of the NPR, which the current validation concerns, was not started until 2001.

Regarding differentiation from RA, only 22 of the 108 patients meeting the ACR RA criteria were known to be RF and/or ACPA positive, and it is possible that use of the 2010 ACR/European League Against Rheumatism (EULAR) RA criteria instead, with their greater weighting of serology, would have resulted in less overlap between PsA and RA criteria fulfilment (28).

The relatively high degree of missing data for some criteria items (Supplementary Table S3) is partly a consequence of the retrospective design. In medical records, the lack of information regarding some types of items (e.g. ‘dactylitis diagnosed by physician’) will often correspond to a true absence, since negative findings are often not noted down. This may, however, not always be the case, and by treating missing data as negative, the current results regarding classification criteria fulfilment should be viewed as conservative estimates, since more cases would be likely to meet the criteria if all relevant information were available.

Conclusion

The validity of clinical PsA diagnoses from outpatient rheumatology or internal medicine units in the Swedish NPR is good, with a positive predictive value of 69–82% of having received at least one main ICD-10 diagnosis of PsA for CASPAR criteria fulfilment, and of 86% for meeting at least one of four established PsA classification criteria. Thus, the use of this definition to identify PsA cases for future epidemiological studies on the basis of ICD codes in the NPR appears feasible.

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Disclosure statement

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research support from Roche. VS: consultant for Astra Zeneca, Novartis, and Sanofi. SE: consultant for AbbVie, Janssen and Novartis. JA: grant/research support for the Swedish biologics register ARTIS from AbbVie, BMS, Eli Lilly, Merck, Pfizer, Roche, Samsung Bioepis, Sanofi, and UCB. LTHJ: consultant for AbbVie, Eli Lilly, Janssen, Novartis, and Pfizer. No potential conflicts of interest were reported by the remaining authors (GMA, SW, UL, and DDG).







Authors contributions

JKW contributed to study conception and design, acquisition of data, analysis and interpretation of data, and drafting of the manuscript. GMA, EK, VS, SW, and DDG contributed to study conception and design, acquisition and interpretation of data, and critically revised the manuscript, making intellectual contribution to its content. SE, UL, JA, and LTHJ contributed to study concept and design, interpretation of data and critically revised the manuscript, making intellectual contribution to its content. All authors read and approved the final manuscript.

Supplemental material

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