

Supplementary material

Minimal Disease Activity and remission in psoriatic arthritis patients with elevated body mass index: an observational cohort study in the Swiss Clinical Quality Management cohort

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Supplementary Equations

$$(1) \text{ BMI} = \frac{\text{weight Kg}}{\text{height m}^2}$$

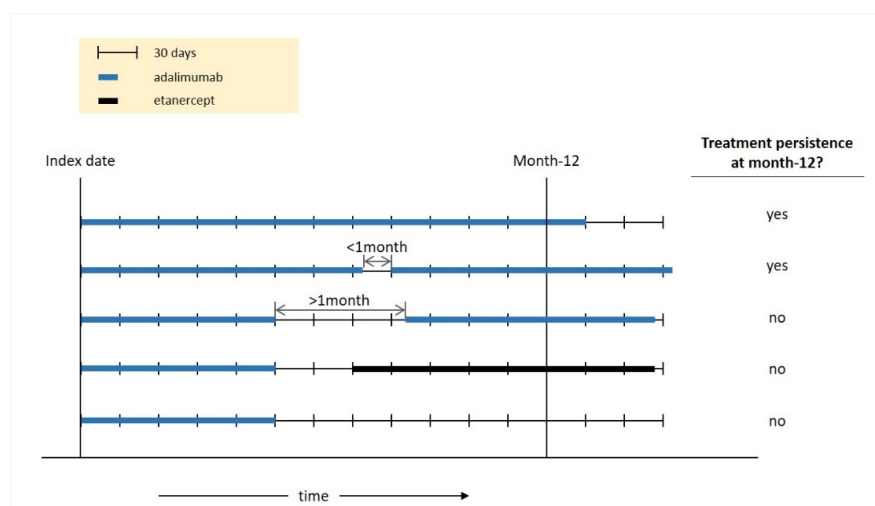
$$(2) \text{ DAPSA} = \text{sjc66} + \text{tjc68} + \text{PatActivity} + \text{PatPain} + \text{CRP}$$

$$(3) \text{ cDAPSA} = \text{sjc66} + \text{tjc68} + \text{PatActivity} + \text{PatPain}$$

$$(4) \text{ DAS28ESR} = (0.56 \times \sqrt{\text{tjc28}} + 0.28 \times \sqrt{\text{sjc28}} + 0.7 \times \ln(\text{ESR})) \times 1.08 + 0.16$$

$$(5) \text{ DAS28CRP} = (0.56 \times \sqrt{\text{tjc28}} + 0.28 \times \sqrt{\text{sjc28}} + 0.36 \times \ln(\text{CRP} + 1)) \times 1.10 + 1.15$$

Abbreviations used in the above equations: DAPSA disease activity in psoriasis arthritis score; cDAPSA clinical DAPSA; DAS28 disease activity score 28; sjc66 number of swollen joints, counting 66; sjc28 number of swollen joints, counting 28; tjc68 number of tender joints, counting 68; tjc28 number of tender joints, counting 28; CRP C-reactive protein (mg/dL); ESR erythrocyte sedimentation rate (mm/h); PatActivity patient's assessment of disease activity (0 very well - 10 very poor); PatPain patient's joint pain (0 very well - 10 very poor).



Supplementary Figure S1. Graphical representation of the assessment of treatment persistence at month-12 for an example patient who starts adalimumab as first biologic or targeted synthetic disease-modifying anti-rheumatic drug (b/tsDMARD).

Supplementary Text S1. Additional information on covariates.

High education was defined as '*höhere Fachschule*' (university of applied sciences), or '*Universitätsstudium*' (university study); and the no category for this variable was defined by '*obligatorische Schule*' (compulsory school), '*Berufslehre*' (apprenticeship), or '*Maturitätsschule*' (3-4 year high school that enables direct admission to Universities school)'.

Smoker (ever smoker) was defined by at least one record of smoker prior index date.

Patient and physician assessments on disease activity, pain, or skin manifestations, as well as medication, disease specific manifestations (musculoskeletal manifestations, dactylitis, enthesitis, sacrolitis, spinal involvement, coxitis, peripheral arthritis, nail manifestations) and comorbidities are recorded as specific variables in SCQM.

Information on comorbidities was extracted from the SCQM health issues dataset or table, which contains patient reported information. Lack of disease or health issue was assumed unless otherwise stated. Cardiovascular event/disease included cerebrovascular disease, coronary heart disease, deep vein thrombosis, heart infarct, heart insufficiency, peripheral vascular disease, pulmonary embolism, hypertension, hypotension, other cardiovascular disease, and other heart disease, ever before the index date. Diabetes included type I and type II, ever before index date. Other metabolic problems included adrenal disease, thyroid disease, diseases of other endocrine glands, dysfunctions of water electrolyte balance or acid alkaline balance, hyperlipidaemia, and hyperuricemia, within the 6-months prior index date. Depression/anxiety includes depression and anxiety, within the 6-months prior index date.

Supplementary Table S1. Variables included in the multiple imputation.

Variable	Version 1 Included	Version 2 Included	Predicted	Predictor	Method	Missingness	Levels	Range
Outcome ^a (MDA/DAPSArem/DAPSAremLDA/Persistence)	yes	-	-	yes	-	-	yes; no.	-
Outcome ^a (DAS28rem)	-	yes	-	yes	-	-	yes; no.	-
Patient ID	yes	yes	-	-	-	-	-	1-774
BMI category	yes	yes	-	-	-	-	normal weight; overweight; obese.	-
BMI kg/m ²	yes	yes	-	yes	-	-	-	16.56 - 51.42
Sex	yes	yes	-	yes	-	-	female (women); male (men).	-
Age	yes	yes	-	yes	-	-	-	18.37 - 84.65
Disease duration, years	yes	yes	yes	yes	pmm	17 (2.20)	-	0.04 - 47.31
High education	yes	yes	yes	yes	logreg	146 (18.86)	yes; no.	-
ESR mm/h	yes	yes	yes	yes	pmm	105 (13.57)	-	1 - 110
CRP mg/dL	yes	yes	yes	yes	pmm	127 (16.41)	-	0 - 11.10
Physician's global disease activity (0-10)	yes	yes	yes	yes	pmm	31 (4.01)	-	0 - 9
Physician's global skin manifestation	yes	yes	yes	yes	polyreg	61 (7.88)	none; almost none; mild; mild to moderate; moderate; moderate to severe; severe.	-
Patient's assessment on disease activity (0-10) (PatActv)	yes	yes	yes	yes	pmm	185 (23.90)	-	0 - 10
Patient's joint pain (0-10) (PatPain)	yes	yes	yes	yes	pmm	174 (22.48)	-	0 - 10
Number of swollen joints 28 (sjc28)	yes	yes	yes	yes	pmm	20 (2.58)	-	0 - 22
Number of swollen joints 66 (sjc66)	yes	yes	yes	yes	pmm	72 (9.30)	-	0 - 48
Number of tender joints 28 (tjc28)	yes	yes	yes	yes	pmm	28 (3.62)	-	0 - 28
Number of tender joints 68 (tjc68)	yes	yes	yes	yes	pmm	73 (9.43)	-	0 - 68
DAPSA	yes	-	yes	yes ^b	passive imputation ^d	298 (38.5)	-	0.10 - 121
DAS28	-	yes	yes	yes ^c	passive imputation ^e	99 (12.79)	-	0.20 - 7.60
HAQ (0-3)	yes	yes	yes	yes	pmm	167 (21.58)	-	0 - 3
SF-12mcs (0-100)	yes	yes	yes	yes	pmm	206 (26.61)	-	18.74-67.78
SF-12pcus (0-100)	yes	yes	yes	yes	pmm	206 (26.61)	-	16.74-61.25
b/tsDMARD	yes	yes	-	yes	-	-	TNFi biologic; other biologic; tsDMARD.	-
csDMARD at index	yes	yes	-	yes	-	-	yes; no.	-
Prednisone at index	yes	yes	-	yes	-	-	yes; no.	-
Dactylitis	yes	yes	-	yes	-	-	yes; no.	-
Sacroiliitis	yes	yes	-	yes	-	-	yes; no.	-
Enthesitis	yes	yes	-	yes	-	-	yes; no.	-
Spinal involvement	yes	yes	-	yes	-	-	yes; no.	-
Coxitis	yes	yes	-	yes	-	-	yes; no.	-
Dactylitis	yes	yes	-	yes	-	-	yes; no.	-

Abbreviations: BMI body mass index; ESR erythrocyte sedimentation rate; CRP C-reactive protein; PsA psoriasis arthritis; MDA Minimal Disease Activity; DAPSA Disease Activity Index for Psoriatic Arthritis; DAS28 28-joint disease activity score; HAQ Health Assessment Questionnaire; b/tsDMARD biologic or targeted synthetic disease modifying anti-rheumatic drug; csDMARD conventional synthetic disease modifying anti-rheumatic drug; TNFi tumor necrosis factor alpha inhibitor; tsDMARD targeted synthetic disease modifying anti-rheumatic drug; pmm predictive mean matching; logit logistic regression; polyreg polytomous logistic regression.

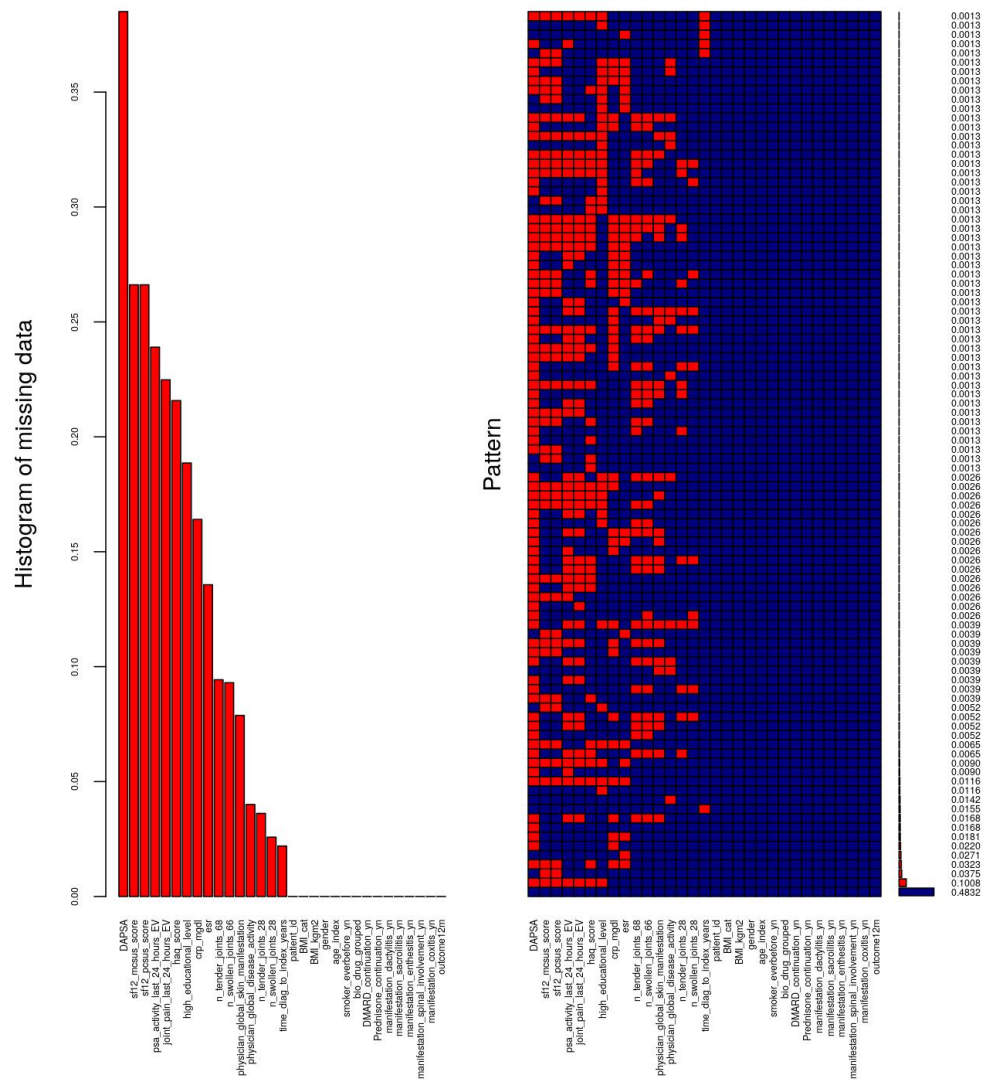
^a Multiple imputation was run distinctly for each outcome.

^b DAPSA not used as predictor for: sjc66, tjc68, PatActivity, PatPain, CRP.

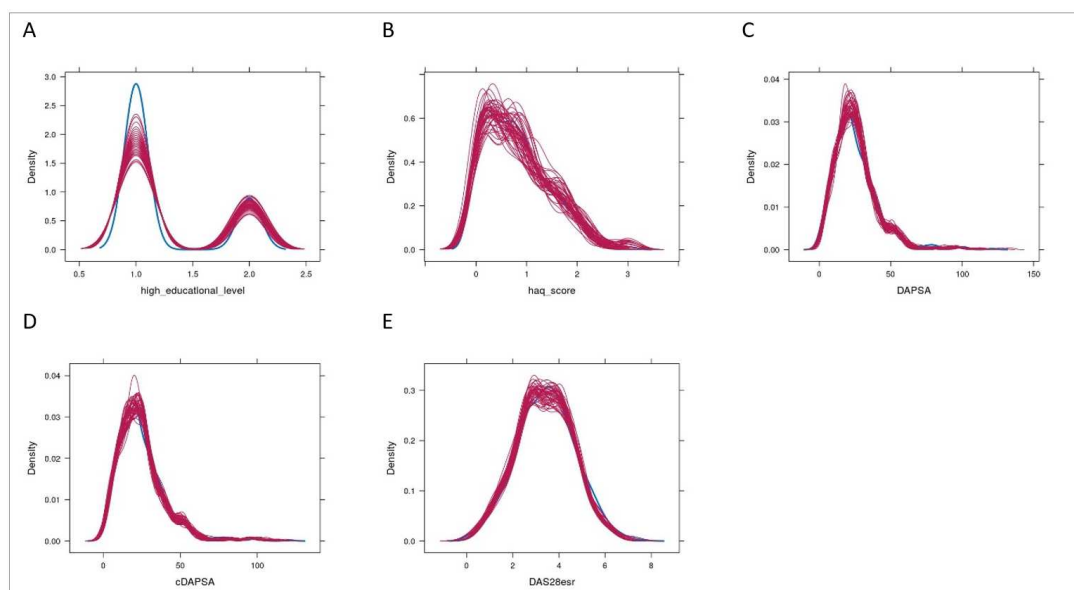
^c DAS28 not used as predictor for: sjc28, tjc28, ESR.

^d DAPSA passive imputation: $DAPSA = sjc66 + tjc68 + PatActivity + PatPain + CRP$

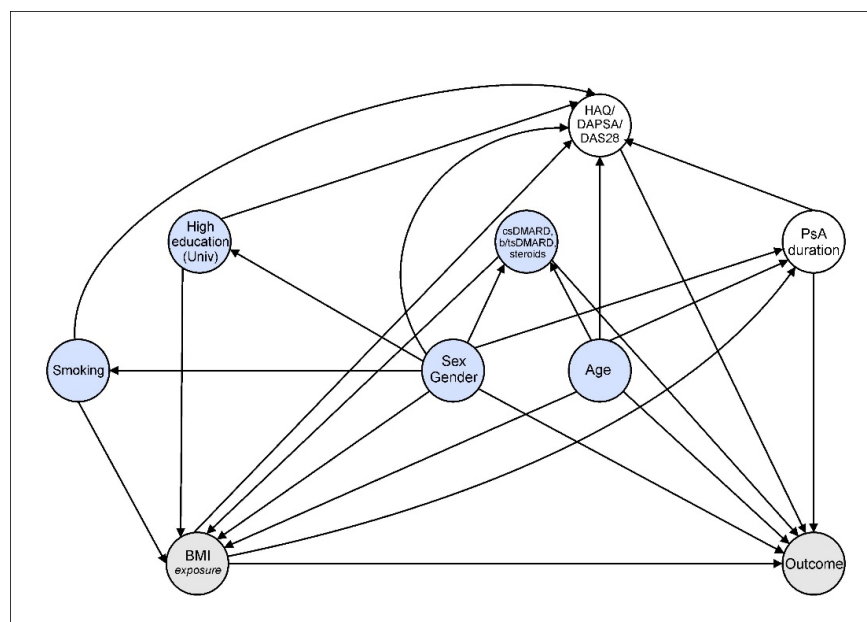
^e DAS28 passive imputation: $DAS28ESR = (0.56 \times \sqrt{tjc28} + 0.28 \times \sqrt{sjc28} + 0.7 \times \ln(ESR)) \times 1.08 + 0.16$



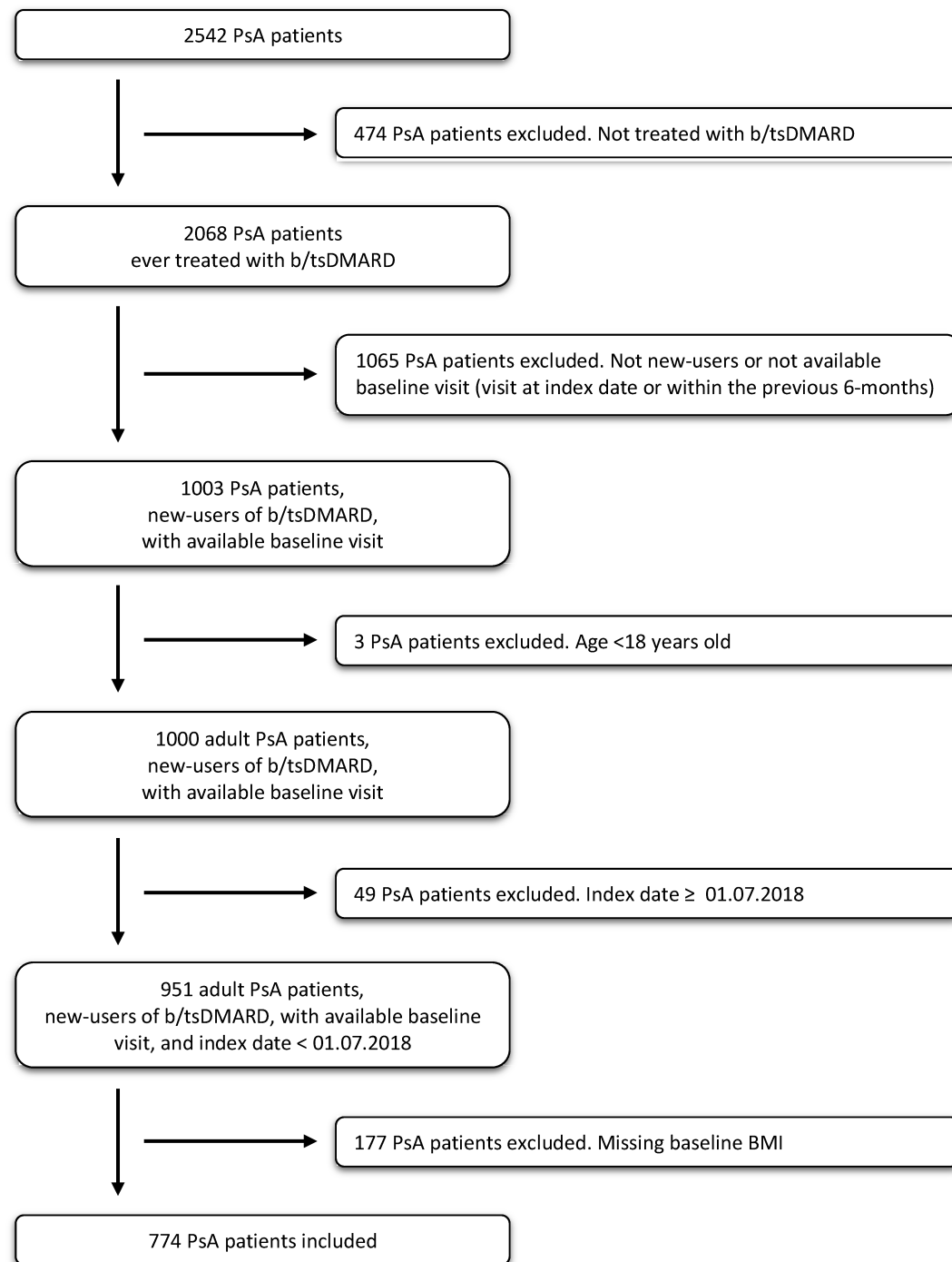
Supplementary Figure S2. Graphical representation of the missingness among baseline variables included in the imputations for primary analysis (i.e., achievement of Minimal Disease Activity (MDA) within the first year after index date). The 48.32% of patients had complete information on all the included variables. In the right figure, blue indicates availability of the data, and red missingness.



Supplementary Figure S3. Density plots for the imputed variables high educational level [A], Health Assessment Questionnaire (HAQ) [B], and Disease Activity Index for Psoriatic Arthritis (DAPSA) [C] for the primary outcome, achievement of Minimal Disease Activity (MDA) within the first year after index date. Additionally, density plot for the imputed clinical DAPSA (cDAPSA) [D] and 28-joint disease activity score (DAS28) [E] for the secondary outcomes cDAPSA-remission and DAS28-remission within the first year of treatment, respectively. The variable distribution in the original dataset is shown in blue, and the corresponding distribution in each imputed dataset is shown in red.



Supplementary Figure S4. Direct acyclic graph (DAG) displaying the clinical rationale for selection of confounders. The nodes represent the exposure, outcome and covariates, and the lines or edges represent the assumed relationship between them. Grey nodes represent the exposure and the outcome. Blue nodes represent the confounders included in the study full adjusted model. White nodes represent other variables included in sensitivity analyses.



Supplementary Figure S5. Flow chart reflecting the cohort selection based on inclusion and exclusion criteria.

Supplementary Table S2. Sensitivity analyses, including the respective composite disease activity score or health standardised survey in the multivariable logistic regression of each study outcome.

	n sample size	Maximum follow-up 9-months		Maximum follow-up 12-months		Maximum follow-up 15-months	
		n events	ORadj ^c (95% CI)	n events	ORadj ^c (95% CI)	n events	ORadj ^c (95% CI)
MDA							
Normal weight	306	45 (14.7)	1 (ref.)	66 (21.6)	1 (ref.)	86 (28.1)	1 (ref.)
Overweight	285	21 (7.4)	0.67 (0.35-1.29)	40 (14.0)	0.69 (0.42-1.15)	61 (21.4)	0.85 (0.54-1.36)
Obese	183	12 (6.6)	0.47 (0.19-1.14)	19 (10.4)	0.48 (0.25-0.96)	30 (16.4)	0.72 (0.4-1.27)
DAPSA-remission							
Normal weight	306	31 (10.1)	1 (ref.)	51 (16.7)	1 (ref.)	67 (21.9)	1 (ref.)
Overweight	285	11 (3.9)	0.7 (0.29-1.72)	20 (7.0)	0.56 (0.28-1.1)	31 (10.9)	0.6 (0.33-1.08)
Obese	183	8 (4.4)	0.78 (0.28-2.17)	12 (6.6)	0.49 (0.22-1.1)	17 (9.3)	0.49 (0.24-1)
DAPSA-remLDA							
Normal weight	306	47 (15.4)	1 (ref.)	84 (27.5)	1 (ref.)	117 (38.2)	1 (ref.)
Overweight	285	37 (13.0)	0.91 (0.48-1.75)	76 (26.7)	1.03 (0.63-1.69)	104 (36.5)	0.79 (0.5-1.25)
Obese	183	22 (12.0)	0.87 (0.41-1.85)	37 (20.2)	0.68 (0.38-1.22)	52 (28.4)	0.62 (0.36-1.04)
cDAPSA-remission							
Normal weight	306	36 (11.8)	1 (ref.)	57 (18.6)	1 (ref.)	77 (25.2)	1 (ref.)
Overweight	285	22 (7.7)	1.04 (0.51-2.13)	39 (13.7)	0.91 (0.52-1.6)	53 (18.6)	0.78 (0.47-1.29)
Obese	183	12 (6.6)	0.72 (0.28-1.81)	16 (8.7)	0.53 (0.25-1.11)	23 (12.6)	0.57 (0.3-1.07)
DAS28-remission							
Normal weight	306	68 (22.2)	1 (ref.)	115 (37.6)	1 (ref.)	153 (50.0)	1 (ref.)
Overweight	285	64 (22.5)	1.13 (0.68-1.9)	109 (38.2)	0.93 (0.6-1.43)	140 (49.1)	0.93 (0.6-1.42)
Obese	183	29 (15.8)	0.67 (0.36-1.27)	51 (27.9)	0.62 (0.37-1.04)	70 (38.3)	0.69 (0.42-1.13)
Treatment persistence							
Normal weight	306	204 (66.7)	1 (ref.)	183 (59.8)	1 (ref.)	159 (52.0)	1 (ref.)
Overweight	285	184 (64.6)	0.92 (0.61-1.4)	161 (56.5)	0.88 (0.59-1.3)	148 (51.9)	1.04 (0.71-1.54)
Obese	183	111 (60.7)	0.92 (0.56-1.49)	94 (51.4)	0.92 (0.58-1.46)	81 (44.3)	1.04 (0.66-1.64)

ORadj^c: odds ratio adjusting for: sex, age, high educational level, smoker, b/tsDMARD, csDMARD, corticosteroid, and HAQ (for MDA) or DAPSA (for DAPSA-remission/DAPSA-remission/LDA) or DAS28 (for DAS28-remission).

Abbreviations: n number; CI confidence interval; ref. reference; MDA Minimal Disease Activity; DAPSA-remission Disease Activity for Psoriatic Arthritis remission; DAPSA-remLDA Disease Activity for Psoriatic Arthritis remission or low disease activity; cDAPSA-remission clinical Disease Activity for Psoriatic Arthritis remission; DAS28-remission 28-joint disease activity score remission.

Supplementary Table S3. Sensitivity analysis, excluding patients without follow-up data on outcome. Multivariable logistic regression for each study outcome.

	Maximum follow-up 12-months, sensitivity analysis				
	n sample size	n events	OR ^a (95% CI)	ORadj ^b (95% CI)	ORadj ^c (95% CI)
MDA					
Normal weight	130	66 (50.8)	1 (ref.)	1 (ref.)	1 (ref.)
Overweight	131	40 (30.5)	0.39 (0.23-0.66)	0.45 (0.25-0.80)	0.5 (0.26-0.93)
Obese	81	19 (23.5)	0.28 (0.15-0.53)	0.33 (0.16-0.67)	0.37 (0.17-0.81)
DAPSA-remission					
Normal weight	113	51 (45.1)	1 (ref.)	1 (ref.)	1 (ref.)
Overweight	113	20 (17.7)	0.23 (0.12-0.43)	0.25 (0.12-0.49)	0.37 (0.16-0.82)
Obese	64	12 (18.8)	0.28 (0.13-0.59)	0.31 (0.14-0.71)	0.44 (0.17-1.13)
DAPSA-remLDA					
Normal weight	113	84 (74.3)	1 (ref.)	1 (ref.)	1 (ref.)
Overweight	113	76 (67.3)	0.66 (0.37-1.19)	0.58 (0.3-1.12)	0.57 (0.26-1.29)
Obese	64	37 (57.8)	0.48 (0.25-0.92)	0.44 (0.21-0.93)	0.42 (0.17-1.04)
cDAPSA-remission					
Normal weight	124	57 (46.0)	1 (ref.)	1 (ref.)	1 (ref.)
Overweight	131	39 (29.8)	0.44 (0.26-0.75)	0.47 (0.26-0.85)	0.61 (0.31-1.21)
Obese	74	16 (21.6)	0.32 (0.16-0.63)	0.36 (0.17-0.75)	0.44 (0.19-1.04)
DAS28-remission					
Normal weight	159	115 (72.3)	1 (ref.)	1 (ref.)	1 (ref.)
Overweight	153	109 (71.2)	0.86 (0.51-1.46)	0.55 (0.3-1.01)	0.57 (0.28-1.14)
Obese	89	51 (57.3)	0.48 (0.27-0.86)	0.3 (0.15-0.6)	0.37 (0.17-0.81)

OR: odds ratio adjusting for: sex, age;

ORadj: odds ratio adjusting for: sex, age, high educational level, smoker, b/tsDMARD, csDMARD, corticosteroid.

ORadj^c: odds ratio adjusting for: sex, age, high educational level, smoker, b/tsDMARD, csDMARD, corticosteroid, and HAQ (for MDA) or DAPSA (for DAPSA-remission/DAPSA-remission/LDA) or DAS28 (for DAS28-remission).

Abbreviations: n number; CI confidence interval; ref. reference; Abbreviations: n number; CI confidence interval; ref. reference; MDA Minimal Disease Activity; DAPSA-remission Disease Activity for Psoriatic Arthritis remission; DAPSA-remLDA Disease Activity for Psoriatic Arthritis remission or low disease activity; cDAPSA-remission clinical Disease Activity for Psoriatic Arthritis remission; DAS28-remission 28-joint disease activity score remission

Supplementary Table S4. Sensitivity analyses, excluding the 12 patients with body mass index (BMI) <18.5 kg/m². Result from the multivariable logistic regression investigating the association between body mass index (BMI) categories and various clinical outcomes, with maximum follow-up 12-months.

Sensitivity analyses (Excluding BMI<18.5)	n sample size	Maximum follow-up 12-months		
		n vents	OR	ORadj
MDA				
Normal weight	294	62 (21.1)	1 (ref.)	1 (ref.)
Overweight	285	40 (14.0)	0.61 (0.39-0.95)	0.65 (0.40-1.06)
Obese	183	19 (10.4)	0.44 (0.25-0.77)	0.45 (0.24-0.84)
DAPSA-remission				
Normal weight	294	47 (16)	1 (ref.)	1 (ref.)
Overweight	285	20 (7.0)	0.40 (0.23-0.70)	0.46 (0.25-0.83)
Obese	183	12 (6.6)	0.38 (0.20-0.75)	0.43 (0.21-0.88)
DAPSA-remLDA				
Normal weight	294	80 (27.2)	1 (ref.)	1 (ref.)
Overweight	285	76 (26.7)	0.96 (0.66-1.40)	0.99 (0.65-1.50)
Obese	183	37 (20.2)	0.68 (0.44-1.06)	0.70 (0.42-1.14)
cDAPSA-remission				
Normal weight	294	294 (18)	1 (ref.)	1 (ref.)
Overweight	285	39 (13.7)	0.72 (0.46-1.14)	0.81 (0.49-1.33)
Obese	183	16 (8.7)	0.45 (0.25-0.81)	0.53 (0.28-1.00)
DAS28-remission				
Normal weight	294	110 (37.4)		
Overweight	285	109 (38.2)	1.00 (0.71-1.42)	0.89 (0.61-1.31)
Obese	183	51 (27.9)	0.65 (0.44-0.98)	0.51 (0.32-0.82)
Treatment persistence at the end of follow-up				
Normal weight	294	179 (60.9)	1 (ref.)	1 (ref.)
Overweight	285	161 (56.5)	0.81 (0.58-1.13)	0.83 (0.56-1.23)
Obese	183	94 (51.4)	0.68 (0.47-0.99)	0.8 (0.52-1.24)

OR: odds ratio adjusting for: sex, age;

ORadj: odds ratio adjusting for: sex, age, high educational level, smoker, b/tsDMARD, csDMARD, corticosteroid.

Abbreviations: n number; CI confidence interval; ref. reference; MDA Minimal Disease Activity; DAPSA-remission Disease Activity for Psoriatic Arthritis (DAPSA) remission; DAPSA-remLDA DAPSA remission or low disease activity; cDAPSA-remission clinical DAPSA remission; DAS28-remission 28-joint disease activity score remission.

Supplementary Table S5. Number of patients, overall and stratified by body mass index (BMI) category, for each corresponding set of achieved outcomes within the first year. These numerical values complement the Figure 4 Venn Diagram. Each patient may achieve none, one, or more outcomes. Each row includes patients with the same set of achieved outcomes. The symbol ✓ indicates that the corresponding outcome (column-wise) was achieved. Conversely, the symbol – indicates that the corresponding outcome was not achieved. To obtain the total number of patients achieving a specific outcome, every column with the corresponding outcome marked as achieved should be sum.

Achieved outcomes					Overall (n=774) (counts)	Normal weight (n=306) (counts)	Overweight (n=285) (counts)	Obese (n=183) (counts)
MDA	DAPSArem	DAPSAremLDA	cDAPSArem	DAS28rem				
✓	-	-	-	-	3	1	1	1
✓	-	✓	-	-	4	2	2	0
✓	-	-	-	✓	4	2	0	2
✓	-	✓	-	✓	13	7	5	1
✓	-	-	✓	-	12	2	8	2
✓	-	✓	✓	-	1	0	1	0
✓	-	-	✓	✓	2	2	0	0
✓	-	✓	✓	✓	6	2	3	1
✓	✓	✓	✓	-	6	3	2	1
✓	✓	✓	✓	✓	74	45	18	11
-	-	✓	-	-	15	5	6	4
-	-	-	-	✓	98	37	43	18
-	-	✓	-	✓	68	17	33	18
-	-	✓	✓	-	1	0	0	1
-	-	-	✓	✓	1	0	1	0
-	-	✓	✓	✓	6	0	6	0
-	✓	✓	✓	✓	3	3	0	0

Abbreviations: MDA minimal disease activity; DAPSArem Disease Activity for Psoriatic Arthritis remission; DAPSAremLDA Disease Activity for Psoriatic Arthritis remission or low disease activity; cDAPSArem clinical Disease Activity for Psoriatic Arthritis remission; DAS28rem 28-joint disease activity score remission.