

Supplemental Data

Estimation of prevalence of autoimmune diseases in the United States using electronic health record data

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Supplemental Tables

Supplemental Table 1. List of autoimmune diseases with published prevalence^a

Autoimmune Disease	Computed Estimated US Prevalence			Female Ratio	Rate/100,000	Published Prevalence (Reference)
	Female	Male	Total			
Acquired hemophilia	< 1,000	3,447	3,984	< 22%	1.2	499 (1)
Acute disseminated encephalomyelitis	6,129	5,210	11,339	54%	3.4	1,116 (2)
Acute febrile mucocutaneous lymph node syndrome	11,416	19,691	31,107	37%	9.3	116,321 (3)
Acute hemorrhagic leukoencephalitis	ND ^b	ND	ND	ND	ND	22 (4)
Acute motor axonal neuropathy	ND	ND	ND	ND	ND	823 (5)
Addison's disease	< 1,000	No data	< 2,000	ND	ND	43,778(6)
Adult-onset Still's disease	9,271	5,440	14,711	63%	4.4	1,833 (7)
Alopecia areata	162,435	108,264	270,699	60%	81.2	699,930 (8)
Anti-glomerular basement membrane nephritis	< 1,000	< 1,000	< 2,000	ND	0.3	333 (9)
Anti-neutrophil cytoplasmic antibody-associated vasculitis	17,622	11,646	29,269	60%	8.8	222 (10)
Anti-n-methyl-D-aspartate receptor encephalitis	ND	ND	ND	ND	ND	38,329 (11)
Antiphospholipid syndrome	153,470	56,316	209,786	73%	62.9	149,985 (12)
Antisynthetase syndrome	ND	ND	ND	ND	ND	11,665 (13)
Aplastic anemia	67,196	60,836	128,032	52%	38.4	783 (14)
Atrophic gastritis	86,810	38,616	125,427	69%	37.6	79,992 (15)
Autoimmune encephalitis	2,988	1,762	4,750	63%	1.4	45,662 (16)
Autoimmune enteropathy	ND	ND	ND	ND	ND	100 (17)
Autoimmune hepatitis	150,865	42,754	193,619	78%	58.1	56,327 (18)
Autoimmune inner ear disease	ND	ND	ND	ND	ND	49,995 (19)
Autoimmune lymphoproliferative syndrome	2,605	< 1,000	3,294	< 72%	1	200 (20)
Autoimmune myocarditis	ND	ND	ND	ND	ND	ND
Autoimmune oophoritis	ND	ND	ND	ND	ND	666 (21)
Autoimmune pancreatitis	ND	ND	ND	ND	ND	15,331 (22)
Autoimmune polyendocrine syndrome type 1	2,758	ND	2,758	100%	0.8	ND

Autoimmune polyendocrine syndrome type 2	ND	ND	ND	ND	ND	ND
Autoimmune polyendocrine syndrome type 3	ND	ND	ND	ND	ND	ND
Autoimmune thrombocytopenic purpura	306,251	221,126	527,378	58%	158.2	23,331 (23)
Autoimmune thyroiditis	1,536,929	233,615	1,770,544	87%	531.2	1,833,150 (24)
Autoimmune urticaria	ND	ND	ND	ND	ND	2,666,400 (25)
Autoimmune uveitis	173,851	109,950	283,802	61%	85.2	343,965 (26)
Balo concentric sclerosis	< 1,000	ND	< 2,000	ND	0.1	ND
Behcet's disease	37,237	15,017	52,255	71%	15.7	17,331 (27)
Bickerstaff's encephalitis	ND	ND	ND	ND	ND	ND
Bullous pemphigoid	45,972	37,927	83,899	55%	25.2	86,324 (28)
Celiac disease	514,965	190,171	705,137	73%	211.6	2,916,375 (29)
Chronic inflammatory demyelinating polyneuropathy	39,842	52,025	91,867	43%	27.6	11,232 (30)
Cicatrical pemphigoid	20,534	9,960	30,494	67%	9.1	338 (31)
Cogan syndrome	ND	ND	ND	ND	ND	ND
Cold autoimmune hemolytic anemia	5,823	3,907	9,730	60%	2.9	5,399 (32)
Crohn's disease	620,625	490,064	1,110,689	56%	333.3	2,282,271 (33)
Cryptogenic organizing pneumonia	14,787	12,718	27,506	54%	8.3	3,666 (34)
Cutaneous lupus erythematosus	72,482	10,420	82,903	87%	24.9	253,308 (35)
Dermatitis herpetiformis	6,589	7,662	14,251	46%	4.3	31,163 (36)
Dermatomyositis	108,264	30,418	138,682	78%	41.6	71,392 (37)
Encephalopathy Associated with Autoimmune Thyroid Disease	ND	ND	ND	ND	ND	6,999 (38)
Enthesitis-related arthritis	45,282	35,168	80,451	56%	24.1	ND
Epidermolysis bullosa acquisita	< 1,000	< 1,000	< 2,000	ND	0.1	96 (39)
Episcleritis	40,149	15,553	55,703	72%	16.7	175,315 (40)
Essential mixed cryoglobulinemia	8,504	6,129	14,634	58%	4.4	ND
Evans syndrome	5,746	6,895	12,642	45%	3.8	71,992 (5)
Felty syndrome	2,758	< 1,000	3,218	< 73%	1	33,330 (41)
Gestational pemphigoid	3,984	ND	3,984	100%	1.2	100 (42)
Giant cell arteritis	126,347	54,553	180,900	70%	54.3	235,143 (43)
Granulomatosis with polyangiitis	88,726	59,150	147,877	60%	44.4	53,328 (44)
Graves' disease	1,125,937	314,067	1,440,004	78%	432.1	2,096,457 (45)

Graves' ophthalmopathy	ND	< 1,000	< 2,000	ND	ND	298,959 (46)
Guillain-Barré syndrome	39,842	39,919	79,761	50%	23.9	5,466 (47)
IgA nephropathy	< 1,000	ND	< 2,000	ND	ND	12,665 (48)
Immunoglobulin A vasculitis	21,836	20,381	42,217	52%	12.7	15,034 (49)
Immunoglobulin G4 related disease	ND	ND	ND	ND	ND	2,666 (50)
Inclusion body myositis	11,646	18,695	30,341	38%	9.1	3,333 (51)
Intermediate uveitis	ND	ND	ND	ND	ND	5,666 (14)
Juvenile arthritis	184,272	67,732	252,004	73%	75.6	33,041 (52)
Juvenile dermatomyositis	7,662	2,068	9,730	79%	2.9	7,332 (37)
Lambert-Eaton myasthenic syndrome	2,911	1,302	4,214	69%	1.3	983 (53)
Lichen sclerosus	311,002	14,481	325,483	96%	97.7	166,650 (54)
Linear IgA disease	< 1,000	ND	< 2,000	ND	ND	466 (55)
Lupus nephritis	114,854	21,530	136,384	84%	40.9	70,801 (56)
Lupus vasculitis	ND	ND	ND	ND	ND	26,855 (57)
Microscopic polyangiitis	9,041	2,911	11,952	76%	3.6	31,163 (44)
Mixed connective tissue disease	< 1,000	ND	< 2,000	ND	ND	9,853 (58)
Multiple sclerosis	1,017,672	348,393	1,366,065	74%	409.9	801,496 (59)
Myasthenia gravis	58,154	55,396	113,551	51%	34.1	58,327 (60)
Myelin oligodendrocyte glycoprotein disease	ND	ND	ND	ND	ND	8,365 (61)
Narcolepsy with cataplexy	48,117	25,054	73,172	66%	22	46,662 (62)
Necrotizing vasculitis	14,940	5,286	20,227	74%	6.1	14,998 (63)
Neuromyelitis optica	32,716	10,037	42,754	77%	12.8	8,199 (64)
Neuromyotonia	ND	ND	ND	ND	ND	ND
Opsoclonus myoclonus syndrome	ND	ND	ND	ND	ND	24 (65)
Paraneoplastic cerebellar degeneration	ND	ND	ND	ND	ND	4,078 (66)
Pemphigus vulgaris	39,459	27,889	67,349	59%	20.2	17,164 (67)
Pernicious anemia	40,608	16,626	57,235	71%	17.2	1,645,668 (68)
Polymyalgia rheumatica	413,826	251,314	665,141	62%	199.6	793,820 (43)
Polymyositis	44,976	20,840	65,816	68%	19.7	44,995 (69)
Post-myocardial infarction syndrome	1,225	1,609	2,834	43%	0.9	89,000 (70)
Primary biliary cholangitis	110,793	15,094	125,887	88%	37.8	97,656 (71)
Primary sclerosing cholangitis	23,905	33,559	57,465	42%	17.2	20,281 (72)
Psoriasis	1,290,977	1,047,707	2,338,685	55%	701.7	10,498,950 (73)

Pure red cell aplasia	4,290	4,597	8,887	48%	2.7	ND
Rasmussen disease	ND	ND	ND	ND	ND	ND
Reactive arthritis	9,500	11,646	21,147	45%	6.3	307,135 (74)
Relapsing polychondritis	12,795	4,827	17,622	73%	5.3	1,166 (75)
Rheumatic fever	7,968	3,447	11,416	70%	3.4	16,665 (76)
Rheumatoid arthritis	1,709,171	445,164	2,154,336	79%	646.4	1,866,480 (77)
Rheumatoid vasculitis	9,730	1,149	10,880	89%	3.3	984,901 (78)
Sjögren's disease	628,134	66,966	695,100	90%	208.6	966,570 (79)
Stiff person syndrome	12,948	6,895	19,844	65%	6	333 (80)
Sympathetic ophthalmia	< 1,000	< 1,000	< 2,000	ND	0.4	99 (81)
Systemic lupus erythematosus	988,326	114,241	1,102,567	90%	330.8	243,808 (82)
Systemic scleroderma	194,998	35,934	230,933	84%	69.3	74,992 (83)
Transverse myelitis	16,166	9,117	25,284	64%	7.6	8,199 (84)
Type 1 diabetes mellitus	715,788	634,263	1,350,051	53%	405.1	999,900 (85)
Ulcerative colitis	502,246	421,795	924,042	54%	277.3	1,867,313 (33)
Vitiligo	159,906	130,714	290,621	55%	87.2	499,950 (86)
Vogt–Koyanagi–Harada syndrome	7,355	2,681	10,037	73%	3	1,249 (87)
Warm autoimmune hemolytic anemia	70,337	50,799	121,136	58%	36.3	39,996 (24)

^a Data from Mass General Brigham, University Florida/Shands and University of Southern California

^b ND, no data- no published papers available or too few patients (less than 20 patients with the condition from the 3 sites) to be able to determine prevalence.

Supplemental Table 2. Prevalence of diseases considered but not included in the analysis due to inadequate evidence of autoimmune disease

Disease	Computed Estimated US Prevalence			Female Ratio	Rate/100,000	Published Prevalence (Reference)
	Female	Male	Total			
Adipositis dolorosa	ND ^b	ND	ND	ND	ND	ND (88)
Age related macular degeneration	326,939	202,584	529,523	62%	158.9	ND
Ankylosing spondylitis	120,140	182,433	302,574	40%	90.8	866,580 (89)
Anti-sperm antibodies	ND	ND	ND	ND	ND	ND
Autoimmune angioedema	ND	ND	ND	ND	ND	1,999 (90)
Autoimmune neutropenia	ND	ND	ND	ND	ND	1,666 (91)
Autoimmune orchitis	ND	ND	ND	ND	ND	ND
Autoimmune progesterone dermatitis	ND	ND	ND	ND	ND	ND
Autoimmune retinopathy	ND	ND	ND	ND	ND	ND
Brachial neuropathy	442,942	286,253	729,196	61%	218.8	5,466 (92)
Chronic lyme disease	202,201	153,470	355,672	57%	106.7	ND
Chronic recurring multifocal osteomyelitis	12,565	17,316	29,881	42%	9.0	333 (93)
Complex regional pain syndrome	153,700	51,565	205,266	75%	61.6	68,559 (94)
Cutaneous mastocytosis	17,699	11,263	28,962	61%	8.7	33,330 (95)
Endometriosis	1,001,352	< 1,000	1,001,505	N/A	300.5	806,250 (96)
Eosinophilic esophagitis	154,236	259,743	413,980	37%	124.2	111,655 (97)
Eosinophilic fasciitis	4,980	2,528	7,508	66%	2.3	5,166 (98)
Epilepsy	1,839,886	1,661,054	3,500,940	53%	1,050.4	ND
Erythema nodosum	36,241	6,053	42,294	86%	12.7	9,999 (99)
Fibromyalgia	1,704,727	106,732	1,811,460	94%	543.5	5,816,085 (100)
Hidradenitis suppurativa	309,776	88,419	398,196	78%	119.5	2,283,105 (101)
Idiopathic pulmonary fibrosis	68,651	123,971	192,623	36%	57.8	1,161,050 (102)
Interstitial cystitis	194,692	17,929	212,621	92%	63.8	55,161 (103)
Lichen planus	188,409	61,066	249,476	76%	74.9	ND
Ligneous conjunctivitis	ND	< 1,000	< 2,000	ND	ND	ND
Microscopic colitis	40,762	11,569	52,331	78%	15.7	343,299 (104)
Mooren's ulcer	< 1,000	< 1,000	< 2,000	ND	0.2	ND
Morphea	107,038	12,029	119,068	90%	35.7	5,166 (105)

Myalgic encephalomyelitis	1,324,843	586,835	1,911,679	69%	573.6	7,599,240 (106)
Myositis	397,966	114,011	511,977	78%	153.6	47,161 (107)
Palindromic rheumatism	12,412	6,206	18,618	67%	5.6	ND
Paroxysmal nocturnal hemoglobinuria	7,815	6,359	14,174	55%	4.3	416 (108)
Parry Romberg syndrome	ND	ND	ND	ND	ND	476 (109)
Pediatric autoimmune neuropsychiatric disorder associated with streptococcus	ND	ND	ND	ND	ND	370,000 (110)
Pityriasis lichenoides et varioliformis acuta	3,984	< 1,000	4,903	< 80%	1.5	101,729
POEMS syndrome	< 1,000	ND	< 2,000	ND	ND	999 (111)
Polyarteritis nodosa	15,477	10,650	26,127	59%	7.8	533 (112)
Post-acute sequelae of COVID-19	ND	ND	ND	ND	ND	ND
Primary idiopathic dilated cardiomyopathy	ND	ND	ND	ND	ND	121,654 (113)
Psoriatic arthritis	1,302	1,072	2,375	55%	0.7	516,615 (114)
Pyoderma gangrenosum	28,809	11,033	39,842	72%	12.0	19,498 (115)
Restless leg syndrome	993,996	517,264	1,511,261	66%	453.4	54,994,500 (116)
Retinocochleocerebral vasculopathy	ND	ND	ND	ND	ND	ND
Retroperitoneal fibrosis	ND	ND	ND	ND	ND	4,666 (117)
Rheumatic chorea	< 1,000	< 1,000	1,072	ND	0.3	ND
Sarcoidosis	350,615	255,758	606,374	58%	181.9	198,680 (118)
Schnitzler syndrome	ND	< 1,000	< 2,000	ND	ND	300 (119)
Scleritis	88,113	38,923	127,036	69%	38.1	17,331 (40)
Secondary Raynaud's phenomenon	15,707	1,302	17,009	92%	5.1	17,981,535 (120)
Subacute bacterial endocarditis	7,508	10,803	18,312	41%	5.5	21,664 (121)
Systemic mast cell disease	164,657	34,938	199,596	82%	59.9	ND
Takayasu arteritis	19,308	3,064	22,373	86%	6.7	1,566 (122)
Tolosa-Hunt syndrome	ND	ND	ND	ND	ND	300 (123)
Undifferentiated connective tissue disease	153	ND	< 2,000	ND	ND	256,641 (124)

^a Data from Mass General Brigham, University Florida/Shands and University of Southern California

^b ND, no data- no published papers available or too few patients (less than 20 patients with the condition from the 3 sites) to be able to determine prevalence.

Supplemental Table 3. US Census population in 2022

US Census Population in 2022			
Age	Female	Male	Total
0-17	35,271,925	37,053,677	72,325,602
18-44	59,242,372	61,293,359	120,535,731
45-64	41,647,380	40,956,534	82,603,914
≥65	31,897,671	25,924,644	57,822,315
Total	168,059,348	165,228,214	333,287,562

Supplemental Table 4. Number of patients with one or more autoimmune diseases

Number of Autoimmune Diseases	USC ^a	UF	MGB	WUSL	UI	MCW	Total	Percent
1	10,894	32,031	110,401	121,782	43,049	61,267	379,424	65%
2	8,629	21,893	30,425	43,771	21,368	15,591	141,677	24%
3	4,539	9,982	7,293	10,723	9,015	3,794	45,346	8%
4+	1,958	2,182	2,784	4,580	692	1,510	13,706	2%
Total	26,020	66,088	150,903	180,856	74,124	82,162	580,153	

^aAbbreviations: MCW, Medical College of Wisconsin; MGB, Mass General Brigham; UF, University Florida/Shands; UI, University of Iowa; USC, University of Southern California; WUSL, University of Washington at St. Louis

Supplementary Table 5. Analysis of diagnosis code frequency (numerator) and timing (denominator)

Autoimmune Disease	0 days	1 day	7 days	30 days	90 days	365 days	30 vs. 0 days ^a
Antiphospholipid syndrome (hematologic)	739	418	396	359	320	208	51%
Crohn's disease (digestive)	1,898	1,210	1,125	1,023	900	659	46%
Multiple sclerosis (neurologic)	4,035	3,097	2,953	2,786	2,594	2,107	31%
Rheumatoid arthritis (connective tissue)	8,101	4,915	4,676	4,314	3,831	2,811	47%
Systemic lupus erythematosus (systemic)	4,691	2,970	2,845	2,638	2,347	1,703	44%
Vitiligo (skin)	883	538	479	413	368	244	53%
Any of these 6 diseases	18,498	12,354	11,723	10,857	9,777	7,370	41%

^aThis column shows the ratio that a 0-day algorithm overstates the number of cases compared to the 30-day algorithm for each disease.

Supplementary Table 6. Date-window sensitivity analysis (USC data)^a

Date-window: 0

Age	Autoimmune Disease Counts/ Denominators (%)		Projected Prevalence ^a		
	Female	Male	Female	Male	Total
0-17	73/9,439 (0.77%)	85/10,604 (0.80%)	272,788	297,016	569,805
18-44	8,042/91,017 (8.84%)	4,323/76,816 (5.63%)	5,234,485	3,449,427	8,683,912
45-64	11,317/87,591 (12.92%)	5,922/79,350 (7.46%)	5,380,957	3,056,643	8,437,600
≥65	13,235/111,661 (11.85%)	7,940/113,471 (7.00%)	3,780,780	1,814,047	5,594,827
Total			14,669,011	8,617,133	23,286,144 (6.99%)

Date-window: 30

Age	Autoimmune Disease Counts/ Denominators (%)		Projected Prevalence ^a		
	Female	Male	Female	Male	Total
0-17	18/3,571 (0.05%)	23/4,098 (0.06%)	177,792	207,964	385,755
18-44	4,542/53,306 (8.52%)	2,350/43,826 (5.36%)	5,047,816	3,286,620	8,334,435
45-64	6,351/58,371 (10.88%)	3,025/52,288 (5.79%)	4,531,403	2,369,445	6,900,847
≥65	7,189/78,373 (9.17%)	3,712/80,614 (4.61%)	2,925,910	1,193,742	4,119,652
Total			12,682,920	7,057,769	19,740,690 (5.92%)

Date-window: 60

Age	Autoimmune Disease Counts/ Denominators (%)		Projected Prevalence ^a		
	Female	Male	Female	Male	Total
0-17	18/3,254 (0.06%)	19/3,733 (0.05%)	195,112	188,594	383,706
18-44	4,219 /47,914 (8.81%)	2,146 /38,725 (5.54%)	5,216,504	3,396,657	8,613,161
45-64	5,948 /53,665 (11.08%)	2,786 /47,337 (5.89%)	4,616,018	2,410,480	7,026,498
≥65	6,691 /72,130 (9.28%)	3,400 /73,695 (4.61%)	2,958,926	1,196,062	4,154,988
Total			12,986,560	7,191,793	20,178,353 (6.05%)

Date-window: 90

Age	Autoimmune Disease Counts/ Denominators (%)		Projected Prevalence ^a		
	Female	Male	Female	Male	Total
0-17	17/3,071 (0.06%)	19/3,526 (0.05%)	195,253	199,665	394,919
18-44	3,971 /44,415 (8.94%)	2,010 /35,433 (5.67%)	5,296,667	3,476,975	8,773,642
45-64	5,646 /50,422 (11.19%)	2,631 /44,074 (5.97%)	4,663,463	2,444,903	7,108,365
≥65	6,315 /67,810 (9.28%)	3,213 /68,939 (4.66%)	2,970,562	1,208,255	4,178,817
Total			13,125,944	7,329,798	20,455,742 (6.14%)

Date-window: 180

Age	Autoimmune Disease Counts/ Denominators (%)		Projected Prevalence ^a		
	Female	Male	Female	Male	Total
0-17	14/2,747 (0.05%)	15/3,135 (0.05%)	179,762	177,290	357,053
18-44	3,466/37,727 (9.19%)	1,739/29,385 (5.92%)	5,442,629	3,627,332	9,069,961
45-64	5,014/44,046 (11.38%)	2,285/37,670 (6.07%)	4,740,952	2,484,356	7,225,308
≥65	5,571/59,376 (9.38%)	2,763/59,724 (4.63%)	2,992,824	1,199,347	4,192,171
Total			13,356,167	7,488,325	20,844,492 (6.25%)

Date-window: 365

Age	Autoimmune Disease Counts/ Denominators (%)		Projected Prevalence ^a		
	Female	Male	Female	Male	Total
0-17	11/2,234 (0.05%)	10/2,507 (0.04%)	173,676	147,801	321,476
18-44	2,773 /29,463 (9.41%)	1,355 /22,357 (6.06%)	5,575,776	3,714,832	9,290,608
45-64	4,209 /36,131 (11.65%)	1,897 /30,100 (6.30%)	4,851,618	2,581,214	7,432,832
≥65	4,646 /49,058 (9.47%)	2,209 /48,502 (4.55%)	3,020,844	1,180,725	4,201,570
Total			13,621,915	7,624,572	21,246,487 (6.37%)

Date-window: 720

Age	Autoimmune Disease Counts/ Denominators (%)		Projected Prevalence ^a		
	Female	Male	Female	Male	Total
0-17	5/1,548 (0.03%)	4/1,723 (0.02%)	113,927	86,021	199,949
18-44	1,926 /20,109 (9.58%)	966 /14,994 (6.44%)	5,674,116	3,948,872	9,622,988
45-64	3,221 /27,195 (11.84%)	1,425 /21,900 (6.51%)	4,932,753	2,664,980	7,597,733
≥65	3,532 /37,367 (9.45%)	1,598 /35,801 (4.46%)	3,015,029	1,157,163	4,172,191
Total			13,735,825	7,857,036	21,592,861 (6.48%)

^aBased-on US Census Data for 2022; sex and age adjusted

Supplementary Table 7. Percent change using different date windows^a

Date-Window	Prevalence ^b	Prevalence % US Population ^b	% Change
0	23,286,144	6.99%	
30	19,740,690	5.92%	-17.96%
60	20,178,353	6.05%	2.17%
90	20,455,742	6.14%	1.36%
180	20,844,492	6.25%	1.87%
365	21,246,487	6.37%	1.89%
720	21,592,861	6.48%	1.60%

^aSex and age adjusted; ^bdata from Supplementary Table 6

Supplementary Table 8. Validation of algorithm for rheumatoid arthritis (USC data)^a

Algorithm ^b	Site	Numerator	Denominator	Projected US Prevalence	% Prevalence
Harvard	USC ^a	2,552	375,253	2,266,604	6.80%
Ours^c	USC	2,912	375,253	2,586,344	7.76%
Ours	All 6 sites	80,984	10,461,368	2,580,060	7.74%

^aAbbreviations: USC, University of Southern California; ^bPhenotype 585 (<https://phekb.org/phenotype/rheumatoid-arthritis-ra>); ^cAge adjusted, single site

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