**Supplementary Methods**

**The two-stage hierarchical logistical regression model**

Autoimmune conditions were analyzed individually and by three groups based on their gastrointestinal involvement (eTable 1 in the Supplement). Autoimmune conditions that directly involve the liver, pancreas, biliary tree, or other parts of the gastrointestinal tract were specified as the “primary gastrointestinal” group, including autoimmune hepatitis, celiac disease, Crohn’s disease, pernicious anemia, primary biliary cirrhosis, primary sclerosing cholangitis, type 1 diabetes, and ulcerative colitis. Autoimmune conditions that may involve these organs secondarily were classified into the “secondary gastrointestinal-associated” group, including ankylosing spondylitis, dermatitis herpetiformis, erythema nodosum, Graves’ disease, Hashimoto’s thyroiditis, hypersensitivity angiitis, immune thrombocytopenic purpura, localized scleroderma, polyarteritis nodosa, polymyositis/dermatomyositis, reactive arthritis, sarcoidosis, Sjögren’s syndrome, systemic lupus erythematosus, and systemic sclerosis. These “primary gastrointestinal” and “secondary gastrointestinal-associated” groups were mutually exclusive from each other. Autoimmune conditions not in these two groups were specified to the “not gastrointestinal-associated” group, including Addison’s disease, alopecia areata, amyotrophic lateral sclerosis, aplastic anemia, autoimmune hemolytic anemia, chronic rheumatic heart disease, discoid lupus erythematosus, granulomatosis with polyangiitis, Guillain-Barré syndrome, membranous nephropathy, multiple sclerosis, myasthenia gravis, polymyalgia rheumatica, psoriasis, pure red cell aplasia, rheumatic fever, rheumatoid arthritis, scleritis, Takayasu’s arteritis, temporal arteritis, uveitis, and vitiligo.

To assess the combined effects of conditions within the same group, we fitted a two-stage hierarchical logistic regression model separately to the three groups (“primary gastrointestinal”, “secondary gastrointestinal-associated”, and “not gastrointestinal-associated”).23 The hierarchical models also accounted for correlations due to multiple autoimmune conditions occurring in the same individual and thus improved the accuracy of risk estimates, especially for rare diseases. The hierarchical models were additionally adjusted for the same covariates the models for individual conditions.

In the first stage, we fitted a logistic regression model of the form logit(p) = α+ βX +γW, where p is the probability of being a case, X stands for the individual condition and W denotes other independent variables (i.e., sex, age, year of diagnosis). The coefficients β represent the log-OR of X, the condition of interest, and γ the log-ORs of the other covariates.

In the second stage, we modeled β using information on the similarity of conditions in the same group. We assumed the linear model β = π + δ for the log-ORs for individual conditions, where π is the overall group mean. We assumed that conditions within a group are exchangeable, and modeled the δ’s as independent normal random variables with variance τ. The δ’s stand for residual effects that may arise from differences in the effects of conditions within the group. We also present estimated individual condition effects, by combining the fixed and predicted random effects for the individual conditions.

**Supplementary Figure 1.** Flow diagram of study population selection

5% random sample of Medicare-enrolled beneficiaries without cancer

(*n* = 1,044,040)

5% random sample of SEER-Medicare PEDSF

(n = 257,412)

Total PC cases (ICD-O codes C25.0-C25.9) in PEDSF between 1992 and 2015

(*n* = 144,474)

*Exclusion:*

malignant code ≠ 3 (*n* = 607)

PC cases with malignant code 3

(*n* = 144,474)

*Exclusion:*

diagnosed at autopsy or by death certificate (*n* = 5,188)

Controls were alive and either free of cancer or PC (for first primary or later primary, respectively) as of July 1 of the calendar year that the case was diagnosed, and frequency-matched to the cases (4:1 ratio) by age, sex, and calendar year of diagnosis. Controls were subject to the same exclusion criteria as the cases.

PC cases not diagnosed at autopsy or by death certificate

(*n* = 138,679)

*Exclusion:*

1. younger than 66 or older than 99 years (*n* = 20,567);

2. diagnosed before 1992 or after 2015 (*n* = 1,584);

3. unknown month of diagnosis (*n* = 850);

4. death at or before diagnosis (*n* = 49);

5. <13 months of Part A, B, non-HMO coverage (*n* = 32,655);

6. no Medicare claim (*n* = 2,900)

First primary controls

(*n* = 244,324)

Later primary controls

(*n* = 75,972)

First primary cases

(*n* = 61,081)

Later primary cases

(*n* = 18,993)

Controls included in the study

(*n* = 320,296)

PC cases included in the study

(*n* = 80,074)

Abbreviation: HMO, health maintenance organization; ICD-O, international classification of disease for oncology; PC, pancreatic cancer; PEDSF, patient entitlement diagnosis summary file; SEER, Surveillance, Epidemiology, and End Results.

**Supplementary Table 1.** International Classification of Disease 9 (ICD-9) codes used to identify autoimmune conditions in the SEER-Medicare database, 1992-2015.

|  |  |  |
| --- | --- | --- |
| **Autoimmune conditions** | **ICD-9 codes** | **Group** |
| Addison's disease | 255.4, 255.41 | Non-gastrointestinal disease |
| Alopecia areata | 704.01 | Non-gastrointestinal disease |
| Amyotrophic lateral sclerosis | 335.20 | Non-gastrointestinal disease |
| Ankylosing spondylitis | 720.0 | Gastrointestinal-associated disease |
| Aplastic anemia | 284.9 | Non-gastrointestinal disease |
| Autoimmune hemolytic anemia | 283.0 | Non-gastrointestinal disease |
| Autoimmune hepatitis | 571.42 | Gastrointestinal disease |
| Celiac disease | 579.0 | Gastrointestinal disease |
| Chronic rheumatic heart disease | 416 | Non-gastrointestinal disease |
| Crohn's disease | 555.X | Gastrointestinal disease |
| Dermatitis herpetiformis | 710.3 | Gastrointestinal-associated disease |
| Discoid lupus erythematosus | 695.4 | Non-gastrointestinal disease |
| Erythema nodosum | 695.2 | Gastrointestinal-associated disease |
| Granulomatosis with polyangiitis | 446.4 | Non-gastrointestinal disease |
| Graves’ disease | 242.0 | Gastrointestinal-associated disease |
| Guillian-Barré syndrome | 357.0 | Non-gastrointestinal disease |
| Hashimoto's thyroiditis | 245.2 | Gastrointestinal-associated disease |
| Hypersensitivity angiitis | 446.2 | Gastrointestinal-associated disease |
| Immune thrombocytopenic purpura | 287.31 | Gastrointestinal-associated disease |
| Localized scleroderma | 701.0 | Gastrointestinal-associated disease |
| Membranous nephropathy | 581.1, 582.1, 583.1 | Non-gastrointestinal disease |
| Multiple sclerosis | 340 | Non-gastrointestinal disease |
| Myasthenia gravis | 358.0, 358.00, 358.01 | Non-gastrointestinal disease |
| Pernicious anemia | 281.0 | Gastrointestinal disease |
| Polyarteritis nodosa  | 446.0 | Gastrointestinal-associated disease |
| Polymyalgia rheumatica | 725 | Non-gastrointestinal disease |
| Polymyositis/dermatomyositis | 710.4, 710.3 | Gastrointestinal-associated disease |
| Primary biliary cirrhosis | 571.6 | Gastrointestinal disease |
| Primary sclerosing cholangitis | 576.1 | Gastrointestinal disease |
| Psoriasis | 696.0, 696.1 | Non-gastrointestinal disease |
| Pure red cell aplasia | 284.8, 284.81 | Non-gastrointestinal disease |
| Reactive arthritis  | 99.3 | Gastrointestinal-associated disease |
| Rheumatic fever | 390, 391.X, 392.X | Non-gastrointestinal disease |
| Rheumatoid arthritis | 714.X, excluding 714.3 | Non-gastrointestinal disease |
| Sarcoidosis | 135 | Gastrointestinal-associated disease |
| Scleritis | 379.0 | Non-gastrointestinal disease |
| Sjögren’s syndrome | 710.2 | Gastrointestinal-associated disease |
| Systemic lupus erythematosus | 710.0 | Gastrointestinal-associated disease |
| Systemic sclerosis | 710.1 | Gastrointestinal-associated disease |
| Takayasu arteritis | 446.7 | Non-gastrointestinal disease |
| Temporal arteritis | 446.5 | Non-gastrointestinal disease |
| Ulcerative colitis | 556.X | Gastrointestinal disease |
| Uveitis | 364.3 | Non-gastrointestinal disease |
| Vitiligo | 709.01, 374.53 | Non-gastrointestinal disease |
| Type 1 Diabetes | 250.01, 250.03, 250.11, 250.13, 250.21, 250.23, 250.31, 250.33, 250.41, 250.43, 250.51, 250.53, 250.61, 250.63, 250.71, 250.73, 250.81, 250.83, 250.91, 250.93 | Gastrointestinal disease |

 Abbreviations: SEER, Surveillance, Epidemiology, and End Results.

**Supplementary Table 2.** Sex-specific associations between autoimmune conditions and all primary pancreatic cancers in the SEER-Medicare database, 1992-2015a

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Autoimmune conditions** | **Control** | **Males** | **Control** | **Females** |
| ***N* =** **144,484** | ***N* = 36,121** | **ORb (95% CI)** | ***P* value** | ***N* =** **175,812** | ***N* = 43,953** | **ORb (95% CI)** | ***P* value** |
| Addison’s disease | 263 | 71 | 0.91 (0.69-1.19) | 0.48 | 366 | 99 | 0.94 (0.75-1.19) | 0.62 |
| Alopecia areata | 46 | 14 | 1.27 (0.69-2.32) | 0.45 | 215 | 50 | 0.82 (0.60-1.13) | 0.23 |
| Amyotrophic lateral sclerosis | 33 | >11 | 1.40 (0.74-2.67) | 0.30 | 21 | <11 | 0.53 (0.15-1.80) | 0.31 |
| Ankylosing spondylitis | 160 | 56 | 1.34 (0.98-1.83) | 0.06 | 100 | 43 | **1.65 (1.14-2.38)** | **0.008** |
| Aplastic anemia | 67 | 30 | **1.61 (1.03-2.50)** | **0.04** | 123 | 28 | 0.73 (0.48-1.12) | 0.15 |
| Autoimmune hemolytic anemia | 45 | 16 | 1.23 (0.69-2.21) | 0.48 | 91 | 20 | 0.81 (0.50-1.33) | 0.41 |
| Autoimmune hepatitis | <11 | <11 | 0.89 (0.16-4.95) | 0.89 | >20 | <11 | 0.97 (0.41-2.26) | 0.94 |
| Celiac disease | 106 | 32 | 1.10 (0.73-1.64) | 0.65 | 235 | 58 | 0.91 (0.68-1.22) | 0.53 |
| Chronic rheumatic heart disease | 2,368 | 696 | 0.96 (0.88-1.05) | 0.40 | 3,705 | 1,115 | 1.03 (0.96-1.10) | 0.48 |
| Crohn’s disease | 359 | 121 | **1.23 (1.00-1.52)** | **0.05** | 602 | 174 | 1.04 (0.87-1.24) | 0.65 |
| Dermatitis herpetiformis | 32 | <11 | 0.41 (0.14-1.20) | 0.10 | 49 | >11 | 0.92 (0.49-1.72) | 0.79 |
| Discoid lupus erythematosus | 61 | 18 | 1.14 (0.67-1.95) | 0.63 | 237 | 85 | 1.34 (1.03-1.72) | 0.03 |
| Erythema nodosum | <11 | <11 | 0.80 (0.17-3.85) | 0.78 | >30 | <11 | 0.80 (0.37-1.74) | 0.58 |
| Granulomatosis with polyangiitis | 31 | >11 | 1.50 (0.76-2.95) | 0.24 | 38 | <11 | 1.10 (0.54-2.22) | 0.80 |
| Graves’ disease | 252 | 72 | 1.05 (0.80-1.37) | 0.74 | 758 | 248 | **1.22 (1.05-1.41)** | **0.008** |
| Guillain-Barré syndrome | 116 | 30 | 0.88 (0.59-1.33) | 0.55 | 71 | 27 | 1.36 (0.86-2.14) | 0.19 |
| Hashimoto's thyroiditis | 272 | 71 | 0.95 (0.73-1.25) | 0.73 | 844 | 240 | 1.06 (0.92-1.23) | 0.42 |
| Hypersensitivity angiitis | 28 | <11 | 0.86 (0.37-2.02) | 0.74 | 64 | >11 | 0.90 (0.51-1.58) | 0.71 |
| Immune thrombocytopenic purpura | 119 | 36 | 1.08 (0.74-1.59) | 0.69 | 104 | 35 | 1.22 (0.82-1.80) | 0.32 |
| Localized scleroderma | 50 | 15 | 1.18 (0.65-2.12) | 0.59 | 472 | 151 | **1.28 (1.06-1.55)** | **0.009** |
| Membranous nephropathy | 78 | <11 | **0.42 (0.21-0.84)** | **0.01** | 31 | >11 | **2.14 (1.19-3.88)** | **0.01** |
| Multiple sclerosis | 164 | 35 | 0.79 (0.55-1.14) | 0.21 | 338 | 79 | 0.84 (0.66-1.08) | 0.17 |
| Myasthenia gravis | 213 | 40 | 0.70 (0.50-0.99) | 0.04 | 157 | 43 | 0.97 (0.69-1.37) | 0.88 |
| Pernicious anemia | 2,183 | 645 | 1.06 (0.97-1.16) | 0.21 | 3,929 | 1,155 | **1.09 (1.02-1.17)** | **0.01** |
| Polyarteritis nodosa | 17 | <11 | 0.92 (0.33-2.55) | 0.87 | 30 | <11 | 1.15 (0.54-2.44) | 0.72 |
| Polymyalgia rheumatica | 937 | 283 | **1.16 (1.01-1.33)** | **0.04** | 2,454 | 675 | 1.04 (0.96-1.14) | 0.33 |
| polymyositis/dermatomyositis | 108 | 22 | 0.76 (0.47-1.20) | 0.24 | 140 | 41 | 1.08 (0.75-1.54) | 0.68 |
| Primary biliary cirrhosis | 29 | <11 | 0.96 (0.46-2.03) | 0.92 | 131 | >20 | 0.79 (0.52-1.20) | 0.27 |
| Primary sclerosing cholangitis | 312 | 147 | **1.38 (1.13-1.70)** | **0.002** | 290 | 135 | **1.34 (1.09-1.66)** | **0.006** |
| Psoriasis | 1,926 | 521 | 1.00 (0.91-1.11) | 0.98 | 2,153 | 625 | 1.11 (1.01-1.21) | 0.03 |
| Pure red cell aplasia | 479 | 172 | 1.20 (1.00-1.43) | 0.05 | 595 | 235 | **1.39 (1.19-1.62**) | **3.3 × 10-5** |
| Reactive arthritis | 16 | <11 | 0.67 (0.19-2.33) | 0.53 | 11 | <11 | 0.88 (0.24-3.22) | 0.85 |
| Rheumatic fever | 45 | <11 | 0.83 (0.41-1.67) | 0.61 | 92 | >30 | 1.34 (0.88-2.03) | 0.17 |
| Rheumatoid arthritis | 3,307 | 866 | **0.92 (0.85-1.00)** | **0.04** | 7.875 | 2,168 | 1.01 (0.96-1.06) | 0.71 |
| Sarcoidosis | 118 | 32 | 0.91 (0.61-1.36) | 0.65 | 272 | 89 | 1.09 (0.85-1.39) | 0.51 |
| Scleritis | 138 | 35 | 1.02 (0.70-1.49) | 0.92 | 208 | 55 | 1.10 (0.81-1.49) | 0.54 |
| Sjögren’s syndrome | 133 | 40 | 1.08 (0.75-1.54) | 0.69 | 739 | 196 | 1.06 (0.90-1.24) | 0.49 |
| Systemic lupus erythematosus | 181 | 51 | 0.99 (0.72-1.36) | 0.95 | 782 | 234 | 1.10 (0.95-1.28) | 0.21 |
| Systemic sclerosis | 29 | <11 | 0.66 (0.27-1.62) | 0.37 | 256 | >50 | 0.82 (0.61-1.10) | 0.19 |
| Takayasu's arteritis | <11 | <11 | 0.63 (0.07-5.37) | 0.67 | >10 | <11 | 0.55 (0.12-2.60) | 0.45 |
| Temporal arteritis | 209 | 68 | 1.25 (0.95-1.66) | 0.11 | 703 | 205 | 1.11 (0.94-1.30) | 0.21 |
| Type 1 diabetes | 7,205 | 2,582 | **1.09 (1.04-1.15)** | **4.7 × 10-4** | 8,727 | 3,198 | **1.12 (1.07-1.17)** | **3.1 × 10-6** |
| Ulcerative colitis | 689 | 238 | **1.23 (1.06-1.43)** | **0.007** | 896 | 273 | 1.14 (0.99-1.31) | 0.07 |
| Uveitis | 194 | 66 | 1.24 (0.93-1.65) | 0.15 | 364 | 86 | 0.90 (0.71-1.15) | 0.41 |
| Vitiligo | 83 | 28 | 1.29 (0.83-2.01) | 0.25 | 136 | 27 | 0.79 (0.52-1.20) | 0.27 |

Abbreviation: CI, confidence interval; FDR, false discovery rate; HMO, health maintenance organization; OR, odds ratio; SEER, Surveillance, Epidemiology, and End Results.

aCells with < 11 observations and any cell that could be used to derive the value of a cell with < 11 observations were suppressed to comply with SEER-Medicare data use agreement.

b Multivariable-adjusted unconditional logistic regression models were used to calculate OR and 95% CI, adjusting for age (grouped as 66-69, 70-74, 75-79, 80-84, 85-89, 90-99 years), sex (male, female), race/ethnicity (non-Hispanic White, non-Hispanic Black, Asian, Hispanic, other/unknown), calendar year of diagnosis/selection (1992-2000, 2001-2005, 2006-2009, 2010-2015), geographic region (SEER registry), Medicaid eligibility (ever, never), average number of physician visits per 6 months in the 5 years before diagnosis/selection (quintiles), average duration of Medicare part A, B, non-HMO coverage (quintiles), Medicare low-income subsidy (ever, never, unknown), overweight/obesity (ever, never diagnosed), smoking behavior-related diagnoses (ever, never diagnosed), chronic obstructive pulmonary disease (ever, never diagnosed), alcohol-related diagnoses (ever, never diagnosed), type 2 diabetes mellitus (ever, never diagnosed), acute/chronic pancreatitis (ever, never diagnosed).

NOTE: Associations that passed Benjamini-Hochberg correction (FDR = 0.10) were shown in bold.

**Supplementary Table 3.** Age-specific associations between autoimmune conditions and all primary pancreatic cancers in the SEER-Medicare database, 1992-2015a

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Autoimmune conditions** | **Control** | **Age < 75 years** | **Control** | **Age ≥ 75 years** |
| ***N* =** **113,536** | ***N* = 28,384** | **ORb (95% CI)** | ***P* value** | ***N* = 206,760** | ***N* = 51,690** | **ORb (95% CI)** | ***P* value** |
| Addison’s disease | 162 | 61 | 1.24 (0.92-1.68) | 0.17 | 467 | 109 | 0.82 (0.66-1.01) | 0.06 |
| Alopecia areata | 83 | 20 | 0.86 (0.52-1.40) | 0.53 | 178 | 44 | 0.91 (0.65-1.27) | 0.57 |
| Amyotrophic lateral sclerosis | 16 | <11 | 1.89 (0.80-4.47) | 0.15 | 38 | <11 | 0.79 (0.38-1.68) | 0.55 |
| Ankylosing spondylitis | 85 | 36 | **1.58 (1.06-2.35)** | **0.02** | 175 | 63 | **1.41 (1.05-1.90)** | **0.02** |
| Aplastic anemia | 29 | 17 | **1.87 (1.01-3.46)** | **0.05** | 161 | 41 | 0.88 (0.62-1.25) | 0.47 |
| Autoimmune hemolytic anemia | 39 | 11 | 1.02 (0.52-2.01) | 0.95 | 97 | 25 | 0.97 (0.62-1.52) | 0.88 |
| Autoimmune hepatitis | 11 | <11 | 1.83 (0.65-5.16) | 0.25 | 23 | <11 | 0.52 (0.15-1.80) | 0.30 |
| Celiac disease | 115 | 26 | 0.81 (0.52-1.25) | 0.33 | 226 | 64 | 1.06 (0.80-1.41) | 0.68 |
| Chronic rheumatic heart disease | 1,127 | 411 | 1.05 (0.93-1.18) | 0.42 | 4,946 | 1,400 | 0.99 (0.93-1.05) | 0.67 |
| Crohn’s disease | 337 | 111 | 1.13 (0.91-1.41) | 0.27 | 624 | 184 | 1.13 (0.95-1.33) | 0.17 |
| Dermatitis herpetiformis | 34 | <11 | 0.51 (0.21-1.24) | 0.14 | 47 | >11 | 0.90 (0.46-1.76) | 0.76 |
| Discoid lupus erythematosus | 100 | 38 | 1.34 (0.91-1.96) | 0.14 | 198 | 65 | 1.31 (0.98-1.75) | 0.06 |
| Erythema nodosum | 12 | <11 | 0.64 (0.14-2.90) | 0.56 | 35 | <11 | 0.81 (0.37-1.78) | 0.60 |
| Granulomatosis with polyangiitis | 21 | <11 | 2.04 (0.95-4.36) | 0.07 | 48 | >11 | 1.00 (0.52-1.89) | 0.99 |
| Graves’ disease | 315 | 104 | 1.19 (0.95-1.50) | 0.13 | 695 | 216 | 1.19 (1.01-1.39) | 0.03 |
| Guillain-Barré syndrome | 46 | 13 | 1.01 (0.54-1.88) | 0.98 | 141 | 44 | 1.07 (0.76-1.52) | 0.70 |
| Hashimoto's thyroiditis | 340 | 104 | 1.10 (0.88-1.38) | 0.38 | 776 | 207 | 1.02 (0.87-1.19) | 0.81 |
| Hypersensitivity angiitis | 22 | <11 | 0.80 (0.32-2.04) | 0.65 | 70 | >11 | 0.92 (0.54-1.59) | 0.78 |
| Immune thrombocytopenic purpura | 57 | 18 | 1.01 (0.59-1.73) | 0.98 | 166 | 53 | 1.20 (0.87-1.65) | 0.26 |
| Localized scleroderma | 114 | 32 | 1.08 (0.73-1.61) | 0.70 | 408 | 134 | **1.30 (1.07-1.59)** | **0.01** |
| Membranous nephropathy | 39 | 12 | 0.93 (0.48-1.81) | 0.84 | 70 | 16 | 0.96 (0.55-1.66) | 0.87 |
| Multiple sclerosis | 253 | 56 | 0.79 (0.59-1.06) | 0.12 | 249 | 58 | 0.87 (0.65-1.17) | 0.37 |
| Myasthenia gravis | 98 | 20 | 0.72 (0.44-1.18) | 0.19 | 272 | 63 | 0.84 (0.64-1.11) | 0.23 |
| Pernicious anemia | 1,014 | 348 | 1.15 (1.02-1.31) | 0.03 | 5,098 | 1,452 | 1.07 (1.00-1.13) | 0.04 |
| Polyarteritis nodosa | 15 | <11 | 1.16 (0.42-3.23) | 0.77 | 32 | <11 | 1.01 (0.47-2.14) | 0.99 |
| Polymyalgia rheumatica | 505 | 138 | 0.99 (0.82-1.20) | 0.95 | 2,886 | 820 | 1.08 (1.00-1.17) | 0.06 |
| polymyositis/dermatomyositis | 81 | 25 | 1.10 (0.70-1.74) | 0.68 | 167 | 38 | 0.86 (0.60-1.23) | 0.40 |
| Primary biliary cirrhosis | 57 | 16 | 0.93 (0.52-1.64) | 0.79 | 103 | 21 | 0.77 (0.48-1.24) | 0.28 |
| Primary sclerosing cholangitis | 115 | 52 | 1.07 (0.75-1.51) | 0.72 | 487 | 230 | **1.46 (1.24-1.72)** | **6.9 × 10-6** |
| Psoriasis | 1,261 | 371 | 1.07 (0.95-1.21) | 0.26 | 2,818 | 775 | 1.05 (0.97-1.14) | 0.23 |
| Pure red cell aplasia | 242 | 89 | 1.12 (0.88-1.44) | 0.36 | 832 | 318 | **1.37 (1.20-1.57)** | **3.6 × 10-6** |
| Reactive arthritis | 16 | <11 | 0.75 (0.22-2.58) | 0.64 | 11 | <11 | 0.77 (0.21-2.82) | 0.69 |
| Rheumatic fever | 32 | <11 | 1.00 (0.47-2.13) | 1.00 | 105 | >30 | 1.24 (0.82-1.85) | 0.31 |
| Rheumatoid arthritis | 3,003 | 843 | 0.97 (0.90-1.05) | 0.47 | 8,179 | 2,191 | 0.99 (0.95-1.05) | 0.83 |
| Sarcoidosis | 169 | 52 | 1.01 (0.73-1.38) | 0.97 | 221 | 69 | 1.06 (0.80-1.40) | 0.67 |
| Scleritis | 106 | 20 | 0.73 (0.45-1.18) | 0.20 | 240 | 70 | 1.24 (0.95-1.63) | 0.12 |
| Sjögren’s syndrome | 239 | 63 | 0.99 (0.75-1.32) | 0.96 | 633 | 173 | 1.08 (0.91-1.29) | 0.36 |
| Systemic lupus erythematosus | 345 | 98 | 0.98 (0.78-1.24) | 0.90 | 618 | 187 | 1.14 (0.96-1.35) | 0.13 |
| Systemic sclerosis | 105 | 25 | 0.88 (0.56-1.37) | 0.56 | 180 | 35 | 0.76 (0.52-1.09) | 0.14 |
| Takayasu's arteritis | <11 | <11 | - | 0.90 | >10 | <11 | 0.65 (0.18-2.33) | 0.51 |
| Temporal arteritis | 126 | 31 | 0.86 (0.58-1.28) | 0.47 | 786 | 242 | 1.18 (1.02-1.37) | 0.03 |
| Type 1 diabetes | 4,898 | 1,965 | **1.15 (1.08-1.22)** | **3.7 × 10-6** | 11,034 | 3,815 | **1.09 (1.05-1.14)** | **4.3 × 10-5** |
| Ulcerative colitis | 455 | 151 | **1.21 (1.01-1.47)** | **0.04** | 1,130 | 360 | **1.18 (1.04-1.33)** | **0.009** |
| Uveitis | 118 | 35 | 1.02 (0.70-1.50) | 0.91 | 440 | 117 | 1.04 (0.85-1.28) | 0.70 |
| Vitiligo | 69 | 17 | 1.00 (0.58-1.72) | 0.99 | 150 | 38 | 0.97 (0.67-1.40) | 0.88 |

Abbreviation: CI, confidence interval; FDR, false discovery rate; HMO, health maintenance organization; OR, odds ratio; SEER, Surveillance, Epidemiology, and End Results.

aCells with < 11 observations and any cell that could be used to derive the value of a cell with < 11 observations were suppressed to comply with SEER-Medicare data use agreement.

b Multivariable-adjusted unconditional logistic regression models were used to calculate OR and 95% CI, adjusting for age (grouped as 66-69, 70-74, 75-79, 80-84, 85-89, 90-99 years), sex (male, female), race/ethnicity (non-Hispanic White, non-Hispanic Black, Asian, Hispanic, other/unknown), calendar year of diagnosis/selection (1992-2000, 2001-2005, 2006-2009, 2010-2015), geographic region (SEER registry), Medicaid eligibility (ever, never), average number of physician visits per 6 months in the 5 years before diagnosis/selection (quintiles), average duration of Medicare part A, B, non-HMO coverage (quintiles), Medicare low-income subsidy (ever, never, unknown), overweight/obesity (ever, never diagnosed), smoking behavior-related diagnoses (ever, never diagnosed), chronic obstructive pulmonary disease (ever, never diagnosed), alcohol-related diagnoses (ever, never diagnosed), type 2 diabetes mellitus (ever, never diagnosed), acute/chronic pancreatitis (ever, never diagnosed).

NOTE: Associations that passed Benjamini-Hochberg correction (FDR = 0.10) were shown in bold.

**Supplementary Table 4.** Race-specific associations between autoimmune conditions and all primary pancreatic cancers in the SEER-Medicare database, 1992-2015a

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Autoimmune conditions** | **Control** | **White (non-Hispanic)** | **Control** | **Black (non-Hispanic)** |
| ***N* =** **264,161** | ***N* = 65,790** | **ORb (95% CI)** | ***P* value** | ***N* = 23,841** | ***N* = 7,884** | **ORb (95% CI)** | ***P* value** |
| Addison’s disease | 532 | 146 | 0.95 (0.79-1.15) | 0.62 | 44 | 11 | 0.61 (0.31-1.20) | 0.15 |
| Alopecia areata | 212 | 46 | 0.84 (0.61-1.16) | 0.29 | 33 | 14 | 1.09 (0.58-2.07) | 0.78 |
| Amyotrophic lateral sclerosis | 43 | 15 | 1.38 (0.76-2.50) | 0.30 | <11 | <11 | 0.68 (0.13-3.49) | 0.64 |
| Ankylosing spondylitis | 233 | 89 | **1.44 (1.12-1.85)** | **0.004** | <11 | <11 | 4.17 (0.99-17.54) | 0.05 |
| Aplastic anemia | 144 | 40 | 0.98 (0.68-1.40) | 0.91 | 29 | 11 | 1.04 (0.51-2.11) | 0.91 |
| Autoimmune hemolytic anemia | 116 | 31 | 0.96 (0.64-1.44) | 0.85 | <11 | <11 | 1.08 (0.21-5.68) | 0.93 |
| Autoimmune hepatitis | 26 | <11 | 1.04 (0.46-2.37) | 0.93 | <11 | <11 | - | 0.92 |
| Celiac disease | 327 | 88 | 0.98 (0.77-1.25) | 0.89 | <11 | <11 | 0.61 (0.07-5.38) | 0.66 |
| Chronic rheumatic heart disease | 5,069 | 1,469 | 0.97 (0.92-1.04) | 0.46 | 567 | 233 | 1.13 (0.97-1.33) | 0.13 |
| Crohn’s disease | 863 | 269 | 1.13 (0.98-1.30) | 0.08 | 44 | 18 | 1.20 (0.69-2.10) | 0.52 |
| Dermatitis herpetiformis | 65 | 12 | 0.62 (0.33-1.17) | 0.14 | <11 | <11 | 1.99 (0.62-6.38) | 0.25 |
| Discoid lupus erythematosus | 238 | 72 | 1.18 (0.90-1.54) | 0.24 | 36 | 24 | 1.94 (1.14-3.30) | 0.01 |
| Erythema nodosum | 38 | <11 | 0.69 (0.30-1.56) | 0.37 | <11 | <11 | - | 0.93 |
| Granulomatosis with polyangiitis | 59 | 17 | 1.16 (0.67-2.02) | 0.59 | <11 | <11 | 2.03 (0.48-8.66) | 0.34 |
| Graves’ disease | 798 | 249 | 1.16 (1.00-1.34) | 0.05 | 92 | 43 | 1.40 (0.97-2.02) | 0.07 |
| Guillain-Barré syndrome | 150 | 47 | 1.10 (0.79-1.54) | 0.56 | 16 | <11 | 0.63 (0.21-1.95) | 0.43 |
| Hashimoto's thyroiditis | 983 | 274 | 1.03 (0.89-1.18) | 0.72 | 52 | 13 | 0.70 (0.38-1.30) | 0.26 |
| Hypersensitivity angiitis | 74 | 19 | 0.89 (0.53-1.49) | 0.65 | <11 | <11 | 0.96 (0.18-5.06) | 0.96 |
| Immune thrombocytopenic purpura | 193 | 59 | 1.07 (0.79-1.44) | 0.67 | 11 | <11 | 0.62 (0.13-2.86) | 0.54 |
| Localized scleroderma | 481 | 149 | 1.25 (1.04-1.51) | 0.02 | 17 | <11 | 1.61 (0.73-3.57) | 0.24 |
| Membranous nephropathy | 85 | 22 | 0.93 (0.57-1.49) | 0.75 | <11 | <11 | 1.97 (0.61-6.36) | 0.25 |
| Multiple sclerosis | 446 | 99 | 0.81 (0.65-1.01) | 0.06 | 40 | <11 | 0.79 (0.39-1.59) | 0.51 |
| Myasthenia gravis | 323 | 79 | 0.89 (0.69-1.14) | 0.36 | 17 | <11 | 0.53 (0.15-1.85) | 0.32 |
| Pernicious anemia | 5,278 | 1,560 | **1.09 (1.03-1.15)** | **0.005** | 378 | 125 | 0.93 (0.75-1.14) | 0.49 |
| Polyarteritis nodosa | 42 | 12 | 1.03 (0.53-1.97) | 0.94 | <11 | <11 | 3.19 (0.44-22.93) | 0.25 |
| Polymyalgia rheumatica | 3,174 | 885 | 1.06 (0.99-1.15) | 0.11 | 115 | 42 | 1.08 (0.75-1.55) | 0.68 |
| polymyositis/dermatomyositis | 210 | 54 | 0.95 (0.70-1.30) | 0.77 | 21 | <11 | 0.70 (0.26-1.87) | 0.48 |
| Primary biliary cirrhosis | 141 | 37 | 0.93 (0.64-1.34) | 0.69 | <11 | <11 | - | 0.92 |
| Primary sclerosing cholangitis | 449 | 224 | **1.39 (1.18-1.65)** | **1.1 × 10-4** | 30 | 21 | 1.67 (0.94-2.97) | 0.08 |
| Psoriasis | 3,642 | 1,017 | 1.04 (0.97-1.12) | 0.29 | 116 | 58 | 1.42 (1.03-1.96) | 0.03 |
| Pure red cell aplasia | 837 | 334 | **1.38 (1.21-1.57)** | **1.2 × 10-6** | 106 | 39 | 0.95 (0.65-1.39) | 0.79 |
| Reactive arthritis | 26 | <11 | 0.78 (0.32-1.90) | 0.58 | <11 | <11 | - | 0.95 |
| Rheumatic fever | 115 | 31 | 1.06 (0.71-1.58) | 0.78 | 12 | <11 | 1.78 (0.65-4.90) | 0.26 |
| Rheumatoid arthritis | 8,541 | 2,320 | 0.99 (0.94-1.04) | 0.71 | 1,138 | 438 | 1.08 (0.96-1.22) | 0.19 |
| Sarcoidosis | 277 | 82 | 1.09 (0.84-1.40) | 0.52 | 107 | 33 | 0.82 (0.55-1.22) | 0.33 |
| Scleritis | 239 | 66 | 1.10 (0.83-1.45) | 0.51 | 29 | 12 | 1.34 (0.67-2.66) | 0.40 |
| Sjögren’s syndrome | 729 | 199 | 1.06 (0.91-1.25) | 0.46 | 52 | 15 | 0.86 (0.48-1.54) | 0.61 |
| Systemic lupus erythematosus | 780 | 226 | 1.05 (0.91-1.23) | 0.50 | 94 | 42 | 1.33 (0.92-1.93) | 0.13 |
| Systemic sclerosis | 240 | 48 | 0.76 (0.55-1.03) | 0.08 | 14 | <11 | 1.52 (0.60-3.86) | 0.38 |
| Takayasu's arteritis | 17 | <11 | 0.57 (0.16-2.00) | 0.38 | <11 | <11 | - | - |
| Temporal arteritis | 821 | 252 | 1.17 (1.02-1.36) | 0.03 | 51 | 15 | 0.95 (0.53-1.71) | 0.88 |
| Type 1 diabetes | 11,626 | 4,265 | **1.11 (1.07-1.16)** | **1.1 × 10-4** | 2,428 | 1,005 | 1.09 (1.00-1.19) | 0.06 |
| Ulcerative colitis | 1,438 | 463 | **1.18 (1.06-1.31)** | **0.003** | 64 | 28 | 1.26 (0.80-1.98) | 0.32 |
| Uveitis | 394 | 103 | 1.02 (0.82-1.27) | 0.85 | 100 | 34 | 1.02 (0.69-1.51) | 0.93 |
| Vitiligo | 142 | 29 | 0.81 (0.54-1.23) | 0.32 | 33 | 14 | 1.44 (0.76-2.71) | 0.27 |

Abbreviation: CI, confidence interval; FDR, false discovery rate; HMO, health maintenance organization; OR, odds ratio; SEER, Surveillance, Epidemiology, and End Results.

aResults for race other than non-Hispanic White and non-Hispanic Black were not shown due to very small sample size. Cells with < 11 observations and any cell that could be used to derive the value of a cell with < 11 observations were suppressed to comply with SEER-Medicare data use agreement.

b Multivariable-adjusted unconditional logistic regression models were used to calculate OR and 95% CI, adjusting for age (grouped as 66-69, 70-74, 75-79, 80-84, 85-89, 90-99 years), sex (male, female), race/ethnicity (non-Hispanic White, non-Hispanic Black, Asian, Hispanic, other/unknown), calendar year of diagnosis/selection (1992-2000, 2001-2005, 2006-2009, 2010-2015), geographic region (SEER registry), Medicaid eligibility (ever, never), average number of physician visits per 6 months in the 5 years before diagnosis/selection (quintiles), average duration of Medicare part A, B, non-HMO coverage (quintiles), Medicare low-income subsidy (ever, never, unknown), overweight/obesity (ever, never diagnosed), smoking behavior-related diagnoses (ever, never diagnosed), chronic obstructive pulmonary disease (ever, never diagnosed), alcohol-related diagnoses (ever, never diagnosed), type 2 diabetes mellitus (ever, never diagnosed), acute/chronic pancreatitis (ever, never diagnosed).

NOTE: Associations that passed Benjamini-Hochberg correction (FDR = 0.10) were shown in bold.

**Supplementary Table 5.** Associations between autoimmune conditions and pancreatic cancers in the SEER-Medicare database, 1992-2015a

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Autoimmune conditions**  | **Control** | **First primary cases** |  | **Later primary cases** |  |  | **All primary cases** |
| ***N =* 320,296** | ***N =* 61,081** | **Univariate model** |  | ***N =* 18,993** | **Univariate model** |  | ***N* = 80,074** | **Univariate model** |  | **Hierarchical model** |
| **OR (95% CI)b** |  | **OR (95% CI)b** |  | **OR (95% CI)b** | ***P* value** | ***PFDR* value c** |  | **OR (95% CI)d** | ***P* value** |
| **Primary gastrointestinal**  | 24,536 |  |  |  |  |  |  | 8,350 |  |  |  |  | **1.10 (1.07-1.14)** | **4.8 × 10-11** |
| Autoimmune hepatitis | 34 | <11 | 0.97 (0.42-2.27) |  | <11 | 0.86 (0.15-4.97) |  | <11 | 0.95 (0.44-2.04) | 0.90 | 0.93 |  | **1.10 (1.07-1.14)** | **4.8 × 10-11** |
| Celiac disease | 341 | 66 | 0.95 (0.72-1.25) |  | 24 | 1.05 (0.66-1.68) |  | 90 | 0.97 (0.76-1.23) | 0.79 | 0.91 |  | **1.10 (1.04-1.16)** | **4.5 × 10-4** |
| Crohn’s disease | 961 | 212 | 1.11 (0.95-1.30) |  | 83 | 1.11 (0.86-1.44) |  | 295 | 1.11 (0.97-1.27) | 0.11 | 0.34 |  | **1.10 (1.07-1.14)** | **4.8 × 10-11** |
| Pernicious anemia | 6,112 | 1,288 | 1.05 (0.99-1.12) |  | 512 | **1.16 (1.04-1.29)** |  | 1,800 | **1.08 (1.02-1.14)** | **0.006** | **0.045** |  | **1.10 (1.07-1.14)** | **4.8 × 10-11** |
| Primary biliary cirrhosis | 160 | >20 | 0.89 (0.59-1.35) |  | <11 | 0.64 (0.29-1.42) |  | 37 | 0.82 (0.57-1.19) | 0.30 | 0.70 |  | 0.90 (0.68-1.20) | 0.48 |
| Primary sclerosing cholangitis | 602 | 206 | **1.42 (1.19-1.69)** |  | 76 | 1.28 (0.96-1.70) |  | 282 | **1.37 (1.18-1.59)** | **3.7 × 10-5** | **5.6×10-4** |  | **1.36 (1.18-1.56)** | **2.3 × 10-5** |
| Type 1 diabetes | 15,932 | 4,378 | **1.13 (1.08-1.17)** |  | 1,402 | 1.06 (0.99-1.13) |  | 5,780 | **1.11 (1.07-1.15)** | **5.1 × 10-9** | **2.3×10-7** |  | **1.10 (1.07-1.14)** | **4.8 × 10-11** |
| Ulcerative colitis | 1,585 | 347 | 1.14 (1.01-1.29) |  | 164 | 1.25 (1.04-1.51) |  | 511 | **1.18 (1.07-1.31)** | **0.001** | **0.016** |  | **1.15 (1.06-1.24)** | **4.2 × 10-4** |
| **Secondary gastrointestinal associated**  | 5,705 |  |  |  |  |  |  | 1,701 |  |  |  |  | **1.08 (1.01-1.15)** | **0.02** |
| Ankylosing spondylitis | 260 | 71 | **1.51 (1.14-2.00)** |  | 28 | 1.26 (0.80-1.98) |  | 99 | **1.45 (1.14-1.84)** | **0.002** | **0.019** |  | **1.38 (1.11-1.72)** | **0.004** |
| Dermatitis herpetiformis | 81 | <11 | 0.61 (0.31-1.20) |  | <11 | 0.92 (0.38-2.20) |  | 17 | 0.72 (0.42-1.23) | 0.23 | 0.62 |  | 0.87 (0.59-1.27) | 0.46 |
| Erythema nodosum | 47 | <11 | 0.79 (0.35-1.81) |  | <11 | 0.76 (0.21-2.78) |  | <11 | 0.79 (0.40-1.59) | 0.52 | 0.83 |  | **1.08 (1.01-1.15)** | **0.02** |
| Graves’ disease | 1,010 | 235 | 1.16 (1.00-1.35) |  | 85 | 1.23 (0.95-1.59) |  | 320 | **1.18 (1.03-1.34)** | **0.01** | **0.074** |  | **1.13 (1.03-1.25)** | **0.01** |
| Hashimoto's thyroiditis | 1,116 | 214 | 1.00 (0.86-1.17) |  | 97 | 1.11 (0.88-1.41) |  | 311 | 1.03 (0.91-1.18) | 0.60 | 0.86 |  | **1.08 (1.01-1.15)** | **0.02** |
| Hypersensitivity angiitis | 92 | >11 | 0.92 (0.53-1.58) |  | <11 | 0.81 (0.32-2.06) |  | 23 | 0.89 (0.55-1.42) | 0.62 | 0.86 |  | **1.08 (1.01-1.15)** | **0.02** |
| Immune thrombocytopenic purpura | 223 | 44 | 1.01 (0.72-1.42) |  | 27 | 1.45 (0.91-2.32) |  | 71 | 1.15 (0.87-1.51) | 0.33 | 0.70 |  | **1.08 (1.01-1.15)** | **0.02** |
| Localized scleroderma | 522 | 120 | 1.22 (0.99-1.50) |  | 46 | 1.43 (1.00-2.04) |  | 166 | **1.27 (1.06-1.52)** | **0.009** | **0.058** |  | **1.23 (1.05-1.44)** | **0.01** |
| Polyarteritis nodosa | 47 | <11 | 0.99 (0.47-2.07) |  | <11 | 1.18 (0.40-3.50) |  | 14 | 1.06 (0.58-1.95) | 0.85 | 0.89 |  | **1.08 (1.01-1.15)** | **0.02** |
| polymyositis/dermatomyositis | 248 | 47 | 0.97 (0.70-1.35) |  | 16 | 0.85 (0.48-1.49) |  | 63 | 0.94 (0.71-1.24) | 0.66 | 0.91 |  | **1.08 (1.01-1.15)** | **0.02** |
| Reactive arthritis  | 27 | <11 | 0.89 (0.33-2.38) |  | <11 | 0.43 (0.05-3.65) |  | <11 | 0.76 (0.31-1.85) | 0.54 | 0.84 |  | **1.08 (1.01-1.15)** | **0.02** |
| Sarcoidosis | 390 | 96 | 1.18 (0.93-1.50) |  | 25 | 0.67 (0.43-1.05) |  | 121 | 1.03 (0.84-1.27) | 0.78 | 0.91 |  | **1.08 (1.01-1.15)** | **0.02** |
| Sjögren’s syndrome | 872 | 172 | 1.06 (0.89-1.26) |  | 64 | 1.04 (0.78-1.39) |  | 236 | 1.06 (0.91-1.22) | 0.46 | 0.77 |  | **1.08 (1.01-1.15)** | **0.02** |
| Systemic lupus erythematosus | 963 | 214 | 1.13 (0.97-1.32) |  | 71 | 0.95 (0.72-1.25) |  | 285 | 1.08 (0.94-1.23) | 0.28 | 0.69 |  | **1.08 (1.01-1.15)** | **0.02** |
| Systemic sclerosis | 285 | 43 | 0.76 (0.54-1.05) |  | 17 | 0.97 (0.55-1.70) |  | 60 | 0.80 (0.60-1.06) | 0.12 | 0.34 |  | 0.84 (0.65-1.07) | 0.16 |
| **Not gastrointestinal associated**  | 27,375 |  |  |  |  |  |  | 7,739 |  |  |  |  | **1.06 (1.02-1.10)** | **0.007** |
| Addison’s disease | 629 | 114 | 0.88 (0.71-1.08) |  | 56 | 1.04 (0.76-1.43) |  | 170 | 0.93 (0.78-1.11) | 0.41 | 0.73 |  | 0.99 (0.87-1.12) | 0.83 |
| Alopecia areata | 261 | 41 | 0.81 (0.57-1.14) |  | 23 | 1.09 (0.67-1.78) |  | 64 | 0.89 (0.68-1.18) | 0.42 | 0.73 |  | 1.00 (0.86-1.17) | 0.96 |
| Amyotrophic lateral sclerosis | 54 | >11 | 1.12 (0.59-2.13) |  | <11 | 0.97 (0.31-3.03) |  | 17 | 1.09 (0.62-1.91) | 0.76 | 0.91 |  | **1.06 (1.02-1.10)** | **0.007** |
| Aplastic anemia | 190 | 34 | 0.77 (0.53-1.12) |  | 24 | **2.09 (1.21-3.61)** |  | 58 | 1.03 (0.76-1.39) | 0.84 | 0.91 |  | **1.06 (1.02-1.10)** | **0.007** |
| Autoimmune hemolytic anemia | 136 | 23 | 0.87 (0.55-1.39) |  | 13 | 1.11 (0.57-2.14) |  | 36 | 0.96 (0.66-1.40) | 0.82 | 0.91 |  | **1.06 (1.02-1.10)** | **0.007** |
| Chronic rheumatic heart disease | 6,073 | 1,328 | 1.03 (0.96-1.09) |  | 483 | 0.93 (0.83-1.03) |  | 1,811 | 1.00 (0.95-1.06) | 0.96 | 0.96 |  | 1.02 (0.97-1.07) | 0.44 |
| Discoid lupus erythematosus | 298 | 80 | 1.33 (1.03-1.72) |  | 23 | 1.19 (0.72-1.96) |  | 103 | 1.30 (1.03-1.64) | 0.02 | 0.12 |  | **1.19 (0.99-1.44)** | **0.06** |
| Granulomatosis with polyangiitis | 69 | >11 | 1.28 (0.73-2.25) |  | <11 | 1.30 (0.49-3.47) |  | 22 | 1.28 (0.79-2.09) | 0.32 | 0.70 |  | **1.06 (1.02-1.10)** | **0.007** |
| Guillain-Barré syndrome | 187 | >40 | 1.25 (0.89-1.74) |  | <11 | 0.58 (0.28-1.20) |  | 57 | 1.06 (0.78-1.44) | 0.69 | 0.89 |  | **1.06 (1.02-1.10)** | **0.007** |
| Membranous nephropathy | 109 | >20 | 0.93 (0.57-1.50) |  | <11 | 0.95 (0.38-2.35) |  | 28 | 0.92 (0.60-1.40) | 0.68 | 0.89 |  | **1.06 (1.02-1.10)** | **0.007** |
| Multiple sclerosis | 502 | 83 | 0.80 (0.63-1.01) |  | 31 | 0.91 (0.60-1.37) |  | 114 | 0.83 (0.67-1.01) | 0.07 | 0.26 |  | 0.87 (0.73-1.05) | 0.15 |
| Myasthenia gravis | 370 | 58 | 0.79 (0.59-1.05) |  | 25 | 0.92 (0.59-1.45) |  | 83 | 0.82 (0.64-1.04) | 0.10 | 0.34 |  | 0.87 (0.71-1.07) | 0.20 |
| Polymyalgia rheumatica | 3,391 | 727 | 1.11 (1.02-1.21) |  | 231 | 0.97 (0.83-1.13) |  | 958 | 1.07 (1.00-1.16) | 0.06 | 0.25 |  | **1.06 (1.02-1.10)** | **0.007** |
| Psoriasis | 4,079 | 834 | 1.05 (0.97-1.14) |  | 312 | 1.05 (0.92-1.19) |  | 1,146 | 1.06 (0.99-1.13) | 0.12 | 0.34 |  | **1.06 (1.02-1.10)** | **0.007** |
| Pure red cell aplasia | 1,074 | 172 | 0.85 (0.72-1.01) |  | 235 | **2.00 (1.68-2.37)** |  | 407 | **1.31 (1.16-1.47)** | **8.4 × 10-6** | **1.9×10-4** |  | **1.28 (1.15-1.44)** | **1.7 × 10-5** |
| Rheumatic fever | 137 | >30 | 1.31 (0.89-1.95) |  | <11 | 0.78 (0.33-1.82) |  | 41 | 1.16 (0.82-1.66) | 0.40 | 0.73 |  | **1.06 (1.02-1.10)** | **0.007** |
| Rheumatoid arthritis | 11,182 | 2,318 | 1.02 (0.97-1.07) |  | 716 | **0.89 (0.81-0.97)** |  | 3,034 | 0.98 (0.94-1.02) | 0.39 | 0.73 |  | 0.99 (0.95-1.03) | 0.49 |
| Scleritis | 346 | 73 | 1.20 (0.92-1.57) |  | 17 | 0.72 (0.42-1.22) |  | 90 | 1.07 (0.84-1.36) | 0.57 | 0.86 |  | **1.06 (1.02-1.10)** | **0.007** |
| Takayasu's arteritis | 17 | <11 | 0.61 (0.13-2.79) |  | <11 | 0.48 (0.05-4.84) |  | <11 | 0.57 (0.16-2.01) | 0.38 | 0.73 |  | **1.06 (1.02-1.10)** | **0.007** |
| Temporal arteritis | 912 | 205 | 1.15 (0.98-1.35) |  | 68 | 1.11 (0.84-1.48) |  | 273 | 1.14 (0.99-1.30) | 0.07 | 0.26 |  | **1.08 (1.00-1.17)** | **0.05** |
| Uveitis | 558 | 105 | 0.94 (0.76-1.17) |  | 47 | 1.27 (0.90-1.79) |  | 152 | 1.02 (0.85-1.23) | 0.81 | 0.91 |  | **1.06 (1.02-1.10)** | **0.007** |
| Vitiligo | 219 | 38 | 0.88 (0.62-1.26) |  | 17 | 1.40 (0.78-2.50) |  | 55 | 0.98 (0.73-1.33) | 0.91 | 0.93 |  | **1.06 (1.02-1.10)** | **0.007** |

Abbreviations: CI, confidence interval; FDR, false discovery rate; GI, gastrointestinal; HMO, health maintenance organization; OR, odds ratio; SEER, Surveillance, Epidemiology, and End Results.

aCells with < 11 observations and any cell that could be used to derive the value of a cell with < 11 observations were suppressed to comply with SEER-Medicare data use agreement.

b Multivariable-adjusted unconditional logistic regression models were used to calculate OR and 95% CI, adjusting for age (grouped as 66-69, 70-74, 75-79, 80-84, 85-89, 90-99 years), sex (male, female), race/ethnicity (non-Hispanic White, non-Hispanic Black, Asian, Hispanic, other/unknown), calendar year of diagnosis/selection (1992-2000, 2001-2005, 2006-2009, 2010-2015), geographic region (SEER registry), Medicaid eligibility (ever, never), average number of physician visits per 6 months in the 5 years before diagnosis/selection (quintiles), average duration of Medicare part A, B, non-HMO coverage (quintiles), Medicare low-income subsidy (ever, never, unknown), overweight/obesity (ever, never diagnosed), smoking behavior-related diagnoses (ever, never diagnosed), chronic obstructive pulmonary disease (ever, never diagnosed), alcohol-related diagnoses (ever, never diagnosed), type 2 diabetes mellitus (ever, never diagnosed), acute/chronic pancreatitis (ever, never diagnosed).

c *P*FDR values were calculated based on Benjamini-Hochberg procedure using an FDR threshold of 0.10.

d Hierarchical logistic regression models were used to calculate OR and 95% CI. In addition to the covariates included in univariate models, the hierarchical models additionally adjusted for all other diseases within the disease group.

NOTE: Associations that passed Benjamini-Hochberg correction (FDR = 0.10) were considered statistically significant and shown in bold.

**Supplementary Table 6.** Pancreatic cancer risk among participants diagnosed with autoimmune conditions for more than 5 years in the SEER-Medicare databasea

|  |  |  |
| --- | --- | --- |
|  | **Control** | **All primary cases** |
| **Autoimmune conditions** | ***N* = 220,531** | ***N* = 56,624** | **ORb (95% CI)** | ***P* value** | ***P*FDR value** |
| Addison’s disease | 185 | 45 | 0.91 (0.65-1.27) | 0.57 | 0.95 |
| Alopecia areata | **113** | 24 | 0.81 (0.52-1.27) | 0.37 | 0.82 |
| Amyotrophic lateral sclerosis | 13 | <11 | 0.74 (0.20-2.69) | 0.65 | 0.96 |
| Ankylosing spondylitis | 101 | 40 | 1.61 (1.11-2.35) | 0.01 | 0.11 |
| Aplastic anemia | 61 | 18 | 1.03 (0.60-1.77) | 0.92 | 0.96 |
| Autoimmune hemolytic anemia | 42 | <11 | 0.90 (0.44-1.82) | 0.76 | 0.96 |
| Autoimmune hepatitis | <11 | <11 | 0.71 (0.08-6.04) | 0.75 | 0.96 |
| Celiac disease | 143 | 29 | 0.80 (0.53-1.20) | 0.29 | 0.76 |
| Chronic rheumatic heart disease | 1,578 | 462 | 1.06 (0.95-1.18) | 0.31 | 0.78 |
| Crohn’s disease | 440 | 132 | 1.15 (0.94-1.40) | 0.17 | 0.59 |
| Dermatitis herpetiformis | 39 | 11 | 1.00 (0.50-1.99) | 1.00 | 1.00 |
| Discoid lupus erythematosus | 138 | 50 | 1.48 (1.06-2.07) | 0.02 | 0.13 |
| Erythema nodosum | 14 | <11 | 1.22 (0.39-3.78) | 0.73 | 0.96 |
| Granulomatosis with polyangiitis | 32 | <11 | 1.08 (0.49-2.37) | 0.85 | 0.96 |
| Graves’ disease | 422 | 144 | 1.33 (1.10-1.62) | 0.004 | **0.06** |
| Guillain-Barré syndrome | 71 | 17 | 0.97 (0.57-1.67) | 0.92 | 0.96 |
| Hashimoto's thyroiditis | 510 | 146 | 1.10 (0.91-1.32) | 0.33 | 0.78 |
| Hypersensitivity angiitis | 33 | <11 | 0.82 (0.34-1.98) | 0.66 | 0.96 |
| Immune thrombocytopenic purpura | 69 | 17 | 1.03 (0.60-1.78) | 0.91 | 0.96 |
| Localized scleroderma | 228 | 74 | 1.40 (1.07-1.83) | 0.01 | 0.11 |
| Membranous nephropathy | 38 | 11 | 1.00 (0.50-1.98) | 0.99 | 1.00 |
| Multiple sclerosis | 246 | 49 | 0.73 (0.54-1.00) | 0.05 | 0.22 |
| Myasthenia gravis | 166 | 44 | 0.97 (0.69-1.36) | 0.84 | 0.96 |
| Pernicious anemia | 2,512 | 708 | 1.06 (0.97-1.15) | 0.21 | 0.66 |
| Polyarteritis nodosa | 14 | <11 | 0.77 (0.22-2.72) | 0.68 | 0.96 |
| Polymyalgia rheumatica | 1,552 | 427 | 1.07 (0.96-1.19) | 0.25 | 0.74 |
| Polymyositis/dermatomyositis | 109 | 23 | 0.82 (0.52-1.30) | 0.39 | 0.85 |
| Primary biliary cirrhosis | 69 | 17 | 0.97 (0.56-1.66) | 0.90 | 0.96 |
| Primary sclerosing cholangitis | 170 | 48 | 0.96 (0.69-1.34) | 0.81 | 0.96 |
| Psoriasis | 1,922 | 541 | 1.10 (0.99-1.21) | 0.07 | 0.28 |
| Pure red cell aplasia | 364 | 147 | 1.45 (1.19-1.77) | 2.0×10-4 | **0.004** |
| Reactive arthritis  | 11 | <11 | 1.28 (0.40-4.10) | 0.67 | 0.96 |
| Rheumatic fever | 54 | 20 | 1.51 (0.89-2.57) | 0.12 | 0.46 |
| Rheumatoid arthritis | 5,153 | 1,462 | 1.06 (1.00-1.13) | 0.05 | 0.22 |
| Sarcoidosis | 201 | 57 | 0.98 (0.72-1.32) | 0.89 | 0.96 |
| Scleritis | 143 | 35 | 1.16 (0.80-1.70) | 0.43 | 0.88 |
| Sjögren’s syndrome | 401 | 99 | 1.01 (0.81-1.27) | 0.90 | 0.96 |
| Systemic lupus erythematosus | 424 | 138 | 1.25 (1.02-1.52) | 0.03 | 0.16 |
| Systemic sclerosis | 113 | 26 | 0.90 (0.59-1.40) | 0.65 | 0.96 |
| Takayasu's arteritis | <11 | <11 | 0.44 (0.05-3.92) | 0.46 | 0.91 |
| Temporal arteritis | 381 | 108 | 1.13 (0.91-1.40) | 0.28 | 0.76 |
| Type 1 diabetes | 7,183 | 2,587 | 1.15 (1.10-1.21) | 9.6×10-9 | **4.3×10-7** |
| Ulcerative colitis | 728 | 231 | 1.22 (1.05-1.43) | 0.009 | **0.10** |
| Uveitis | 236 | 60 | 1.09 (0.82-1.45) | 0.56 | 0.96 |
| Vitiligo | 80 | 22 | 1.05 (0.65-1.70) | 0.84 | 0.96 |

Abbreviation: CI, confidence interval; FDR, false discovery rate; HMO, health maintenance organization; OR, odds ratio; SEER, Surveillance, Epidemiology, and End Results.

aCells with < 11 observations and any cell that could be used to derive the value of a cell with < 11 observations were suppressed to comply with SEER-Medicare data use agreement.

b Multivariable-adjusted unconditional logistic regression models were used to calculate OR and 95% CI, adjusting for age (grouped as 66-69, 70-74, 75-79, 80-84, 85-89, 90-99 years), sex (male, female), race/ethnicity (non-Hispanic White, non-Hispanic Black, Asian, Hispanic, other/unknown), calendar year of diagnosis/selection (1992-2000, 2001-2005, 2006-2009, 2010-2015), geographic region (SEER registry), Medicaid eligibility (ever, never), average number of physician visits per 6 months in the 5 years before diagnosis/selection (quintiles), average duration of Medicare part A, B, non-HMO coverage (quintiles), Medicare low-income subsidy (ever, never, unknown), overweight/obesity (ever, never diagnosed), smoking behavior-related diagnoses (ever, never diagnosed), chronic obstructive pulmonary disease (ever, never diagnosed), alcohol-related diagnoses (ever, never diagnosed), type 2 diabetes mellitus (ever, never diagnosed), acute/chronic pancreatitis (ever, never diagnosed).

NOTE: Associations that passed Benjamini-Hochberg correction (FDR = 0.10) were shown in bold.