

eTable 1. The list of immune-mediated diseases/statuses.

Immune-Mediated Disease/Status	ICD-10 Codes
Allergy	T78.4
Anaphylactic shock	T78.2, T78.0, T80.5, T88.6
Asthma	J45, J46
Allergic rhinitis	J30.1, J30.2, J30.3, J30.4
Hypersensitivity pneumonitis due to organic dust	J67
Allergic and dietetic gastro-enteritis and colitis	K52.2
Atopic dermatitis	L20
Allergic contact dermatitis	L23
Urticaria	L50, L56.3
Cutaneous autosensitisation	L30.2
Allergic purpura	D69.0
Angioneurotic oedema	T78.3
Hypersensitivity angiitis	M31.0
Sarcoidosis	D86
Crohn's disease	K50
Ulcerative colitis	K51
Coeliac disease	K90.0
Atrophic gastritis	K29.4
Primary biliary cirrhosis	K74.3
Autoimmune hepatitis	K75.4
Acute rheumatic fever/Chronic rheumatic heart diseases	I00-I02, I05-I09, L54.0
Dressler's syndrome	I24.1
Acute nonspecific idiopathic pericarditis	I30.0
Acute nephritic syndrome	N00
Rapidly progressive nephritic syndrome	N01
Chronic nephritic syndrome	N03
Nephrotic syndrome	N04, N05
Tubulo-interstitial nephritis	N10, N11, N12
Autoimmune hemolytic anemia	D59.0, D59.1
Idiopathic thrombocytopenic purpura	D69.3
Pernicious anaemia	D51.0
Antiphospholipid syndrome	D68.6
Autoimmune thyroiditis	E06.3
Graves' disease	E05.0
Diabetes (Type I)	E10
Addison diseases	E27.1
Autoimmune polyglandular failure	E31.0
Systemic Lupus erythematosus	M32, L93
Rheumatoid arthritis	M05, M06, M08, M09
Psoriatic and enteropathic arthropathies	M07
Palindromic rheumatism	M12.3
Polyarteritis nodosa and related conditions	M30
Necrotising vasculopathies	M31(except M31.0)
Dermatopolymyositis	M33, M36.0
Systemic sclerosis	M34
Sicca syndrome	M35.0

Polymyalgia rheumatica	M35.3
Behcet's disease	M35.2
Diffuse (eosinophilic) fasciitis	M35.4
Multifocal fibrosclerosis	M35.5
Ankylosing spondylitis	M45
Myositis	M60, M63.3
Rheumatism	M79.0
Relapsing polychondritis	M94.1
Mixed connective tissue disease	M35.1
Vasculitis	I77.6, L95
Fibromyalgia	M79.7
Reiter's disease	M02.3
Other specified systemic involvement of connective tissue	M35.8
Systemic involvement of connective tissue, unspecified	M35.9
Bullous disorders	L10-L14
Lichen planus	L43
Psoriasis	L40, L41
Erythema nodosum	L52
Alopecia areata	L63
Vitiligo	L80
Localised scleroderma	L94.0
Pyoderma gangrenosum	L88
Multiple sclerosis	G35
Guillain-Barre syndrome	G61.0
Myasthenia gravis	G70.0
Diffuse sclerosis	G37.0
Amyotrophic lateral sclerosis	G12.2
Episcleritis	H15.1
Iridocyclitis	H20
Amyloidosis	E85.0
Interstitial cystitis	N30.1
Endometriosis	N80
Immunodeficiency	B20-B24,D80,D81,D82, D83,D84
Organ transplant	T86, Z94
Other disorders involving the immune mechanism, not elsewhere classified	D89

eTable 2. The list of potentially HPV-associated diseases.

Category	Potentially HPV-Associated Diseases	ICD-10 Codes
Benign	Warts	B07, A63.0
Malignant/Anogenital	Neoplasm of penis	C60
	Carcinoma in situ penis	D07.4
	Neoplasm of anus	C21
	Carcinoma in situ anal canal, anus	D01.3
	Neoplasm of vulva	C51
	Carcinoma in situ vulva	D07.1
	Neoplasm of vagina	C52
	Carcinoma in situ vagina	D07.2
	Neoplasm of anus	C21
	Carcinoma in situ anal canal, anus	D01.3
	Neoplasm of cervix	C53
	Carcinoma in situ cervix	D06
Malignant/Oropharyngeal	Neoplasm of oropharynx	C10、C05.1、C05.2、 C01、C09、C02.4, C02.8

eTable 3. Clinical and demographic characteristics of female participants with benign/malignant HPV-associated diseases.

Characteristic	Benign HPV-associated diseases			Malignant HPV-associated diseases		
	Yes (n=413)	No (n=271404)	P value	Yes (n=897)	No (n=270920)	P value
Age at recruitment, y			< 0.001			0.110
mean(SD)	57.9 (8.0)	56.4 (8.0)		56.8 (8.0)	56.4 (8.0)	
median(IQR)	60.0 (52.0-64.0)	57.0 (50.0-63.0)		58.0 (50.0-63.0)	57.0 (50.0-63.0)	
Ethnicity, n(%)						
white	401 (97.1)	255564 (94.2)	0.002	860 (95.9)	255105 (94.2)	0.020
non-white	7 (1.7)	14592 (5.4)		32 (3.6)	14567 (5.4)	
Missing	5 (1.2)	1248 (0.5)		5 (0.5)	1248 (0.4)	
TDI			0.180			<0.001
mean(SD)	-1.1 (3.2)	-1.3 (3.0)		-1.0 (3.2)	-1.3 (3.0)	
median(IQR)	-1.9 (-3.7-1.3)	-2.1 (-3.6-0.5)		-1.8 (-3.5-1.0)	-2.1 (-3.6-0.5)	
Missing	0 (0.0)	324 (0.1)		1 (0.1)	323 (0.1)	
Years of formal education,y			0.091			0.056
mean(SD)	13.3 (5.3)	13.7 (5.1)		13.4 (5.1)	13.7 (5.1)	
median(IQR)	10.0 (10.0-20.0)	13.0 (10.0-20.0)		13.0 (10.0-20.0)	13.0 (10.0-20.0)	
Missing	9 (2.2)	5300 (2.0)		26 (2.9)	5283 (2.0)	
Smoking status,n(%)						
Never	238 (57.6)	161055 (59.3)	0.330	417 (46.5)	160876 (59.4)	<0.001
Previous	125 (30.3)	84792 (31.2)		326 (36.3)	84591 (31.2)	
Current	45 (10.9)	24063 (8.9)		146 (16.3)	23962 (8.8)	
Missing	5 (1.2)	5 (0.6)		8 (0.9)	1491 (0.6)	
Pack years of smoking			0.510			<0.001
mean(SD)	21.2 (14.5)	20.3 (15.5)		23.3 (18.9)	20.2 (15.5)	
median(IQR)	18.3 (11.0-27.2)	16.9 (8.6-28.5)		20.9 (10.0-32.3)	16.9 (8.6-28.5)	
Missing	289 (70.0)	199898 (73.7)		573 (63.9)	199614 (73.7)	
Alcohol status,n(%)						
Never	12 (2.9)	15884 (5.9)	0.026	49 (5.5)	15847 (5.8)	0.220
Previous	19 (4.6)	9886 (3.6)		42 (4.7)	9863 (3.6)	
Current	380 (92.0)	244818 (90.2)		800 (89.2)	244398 (90.2)	
Missing	2 (0.5)	816 (0.3)		6 (0.6)	812 (0.3)	
Aspirin use,n(%)	210 (50.8)	125178 (46.1)	0.042	409 (45.6)	124979 (46.1)	0.990
Missing	11 (2.7)	5284 (1.9)		26 (2.9)	5269 (1.9)	
Age first had sexual intercourse,y			0.180			<0.001
mean(SD)	18.8 (3.0)	19.1 (3.6)		18.5(3.2)	19.1 (3.6)	
median(IQR)	18.0 (16.5-21.0)	18.0 (17.0-21.0)		18.0 (16.0-20.0)	18.0 (17.0-21.0)	
Missing	69 (16.7)	37478 (13.8)		113 (12.6)	37434 (13.8)	
No. of lifetime sexual						

partners,n(%)						
≤ 1	118 (28.6)	72602 (26.8)	0.170	123 (13.7)	72597 (26.8)	<0.001
2 - 5	140 (33.9)	93657 (34.5)		315 (35.1)	93482 (34.5)	
≥ 6	65 (15.7)	53432 (19.7)		235 (26.2)	53262 (19.7)	
Missing	90 (21.8)	51713 (19.0)		224 (25.0)	51579 (19.0)	
same-sex intercourse,n(%)	7 (1.7)	6855 (2.5)	0.390	21 (2.3)	6841 (2.5)	0.780
Missing	56 (13.6)	30936 (11.4)		96 (10.7)	30896 (11.4)	
No. of lifetime same-sex sexual partners,n(%)						
≤ 1	4 (1.0)	3027 (1.1)	0.790	12 (1.3)	3019 (1.1)	0.440
2 - 5	2 (0.5)	2693 (1.0)		8 (0.9)	2687 (1.0)	
≥ 6	1 (0.2)	834 (0.3)		1 (0.1)	834 (0.3)	
Missing	406 (98.3)	264850 (97.6)		876 (97.7)	264380 (97.6)	

eTable 4. Clinical and demographic characteristics of female participants with malignant HPV-associated diseases by anatomical sites.

Characteristic	Oropharyngeal			Anogenital			Cervical		
	HPV-associated diseases			HPV-associated diseases			HPV-associated diseases		
	Yes (n=147)	No (n=271670)	P value	Yes (n=750)	No (n=271067)	P value	Yes (n=311)	No (n=271506)	P value
Age at recruitment, y			0.800			0.110			<0.001
mean(SD)	56.5 (7.2)	56.4 (8.0)		56.8 (8.1)	56.4 (8.0)		54.0 (8.6)	56.4 (8.0)	
median(IQR)	57.0 (51.0-62.0)	57.0 (50.0-63.0)		58.0 (50.0-63.0)	57.0 (50.0-63.0)		54.0 (46.0-61.0)	57.0 (50.0-63.0)	
Ethnicity, n(%)									
white	146 (99.3)	255819 (94.2)	0.007	714 (95.2)	255251 (94.2)	0.210	285 (91.6)	255680(94.2)	0.140
non-white	0 (0.0)	14599 (5.4)		32 (4.3)	14567 (5.4)		23 (7.4)	14576 (5.4)	
Missing	1 (0.7)	1252 (0.4)		4 (0.5)	1249 (0.5)		3 (1.0)	1250 (0.5)	
TDI			0.002			0.026			0.015
mean(SD)	-0.6 (3.6)	-1.3 (3.0)		-1.1 (3.1)	-1.3 (3.0)		-0.9 (3.3)	-1.3 (3.0)	
median(IQR)	-1.5 (-3.5-1.9)	-2.1 (-3.6-0.5)		-1.8 (-3.5-0.9)	-2.1 (-3.6-0.5)		-1.8 (-3.5-1.2)	-2.1 (-3.6-0.5)	
Missing	0 (0.0)	324 (0.1)		1 (0.1)	323 (0.1)		1 (0.3)	323 (0.1)	
Years of formal education,y			0.210			0.120			0.710
mean(SD)	13.2 (5.0)	13.7 (5.1)		13.4 (5.1)	13.7 (5.1)		13.8 (5.1)	13.7 (5.1)	
median(IQR)	10.0 (10.0-20.0)	13.0 (10.0-20.0)		13.0 (10.0-20.0)	13.0 (10.0-20.0)		13.0 (10.0-20.0)	13.0 (10.0-20.0)	
Missing	5 (3.4)	5304 (2.0)		21 (2.8)	5288 (2.0)		12 (3.9)	5297 (2.0)	
Smoking status,n(%)									
Never	46 (31.3)	161247 (59.4)	<0.001	371 (49.5)	160922 (59.4)	<0.001	161 (51.8)	161132 (59.3)	<0.001
Previous	57 (38.8)	84860 (31.2)		269 (35.9)	84648 (31.2)		100 (32.2)	84917 (31.3)	
Current	41 (27.9)	24067 (8.9)		105 (14.0)	24003 (8.9)		47 (15.1)	24061 (8.9)	
Missing	3 (2.0)	1496 (0.5)		5 (0.7)	1494 (0.6)		3 (1.0)	1499 (0.6)	
Pack years of smoking			<0.001			0.028			0.450
mean(SD)	26.4 (15.3)	20.3 (15.5)		22.4(19.8)	20.3 (15.5)		21.5 (15.0)	20.3 (15.5)	
median(IQR)	25.5 (13.1-37.0)	16.9 (8.6-28.5)		20.0 (9.2-30.0)	16.9 (8.6-28.5)		20.0 (9.2-29.5)	16.9 (8.6-28.5)	
Missing	72 (49.0)	200115 (73.7)		501 (66.8)	199686 (73.7)		215 (69.1)	199972 (73.7)	
Alcohol status,n(%)									
Never	2 (1.4)	15894 (5.8)	0.004	47 (6.3)	15849 (5.8)	0.650	22 (7.1)	15874 (5.8)	0.520
Previous	11 (7.5)	9894 (3.6)		31 (4.1)	9874 (3.6)		9 (2.9)	9896 (3.6)	
Current	133 (90.5)	245065 (90.2)		667 (88.9)	244531 (90.2)		277 (89.1)	244921 (90.2)	
Missing	1 (0.6)	817 (0.3)		5 (0.7)	813 (0.3)		3 (1.0)	815 (0.3)	
Aspirin use,n(%)	64 (43.5)	125324 (46.1)	0.640	345 (46.0)	125043 (46.1)	0.880	131 (42.1)	125257 (46.1)	0.290
Missing	4 (2.7)	5291 (1.9)		22 (2.9)	5273 (1.9)		12 (3.9)	5283 (1.9)	
Age first had sexual intercourse,y			<0.001			<0.001			<0.001
mean(SD)	18.0 (2.6)	19.1 (3.6)		18.6 (3.3)	19.1 (3.6)		18.2 (3.3)	19.1 (3.6)	
median(IQR)	17.0 (16.0-19.0)	18.0 (17.0-21.0)		18.0 (16.0-20.0)	18.0 (17.0-21.0)		18.0 (16.0-19.0)	18.0 (17.0-21.0)	
Missing	18 (12.2)	37529 (13.8)		95 (12.7)	37452 (13.8)		49 (15.8)	37498 (13.8)	
No. of lifetime sexual									

partners,n(%)									
≤ 1	11 (7.5)	72709 (26.8)	<0.001	112 (14.9)	72608 (26.8)	<0.001	37 (11.9)	72683 (26.8)	<0.001
2 - 5	62 (42.2)	93735 (34.5)		253 (33.7)	93544 (34.5)		103 (33.1)	93694 (34.5)	
≥ 6	40 (27.2)	53457 (19.7)		195 (26.0)	53302 (19.7)		93 (29.9)	53404 (19.7)	
Missing	34 (23.1)	51769 (19.0)		190 (25.3)	51613 (19.0)		78 (25.1)	51725 (19.1)	
same-sex intercourse,n(%)	3 (2.0)	6859 (2.5)	0.900	18 (2.4)	6844 (2.5)	0.890	7 (2.3)	6855 (2.5)	0.930
Missing	16 (10.9)	30976 (11.4)		80 (10.7)	30912 (11.4)		39 (12.5)	30953 (11.4)	
No. of lifetime same-sex sexual partners,n(%)									
≤ 1	1 (0.7)	3030 (1.1)	0.620	11 (1.5)	3020 (1.1)	0.390	4 (1.3)	3027 (1.1)	0.580
2 - 5	2 (1.4)	2693 (1.0)		6 (0.8)	2689 (1.0)		3 (1.0)	2692 (1.0)	
≥ 6	0 (0.0)	835 (0.3)		1 (0.1)	834 (0.3)		0 (0.0)	835 (0.3)	
Missing	144 (97.9)	265112 (97.6)		732 (97.6)	264524 (97.6)		304 (97.7)	264952 (97.6)	

eTable 5. Clinical and demographic characteristics of male participants with benign/malignant HPV-associated diseases.

Characteristic	Benign HPV-associated diseases			Malignant HPV-associated diseases		
	Yes (n=383)	No (n=228171)	P value	Yes (n=562)	No (n=227992)	P value
Age at recruitment, y			<0.001			0.001
mean(SD)	58.8 (7.7)	56.7 (8.2)		57.9 (7.4)	56.7 (8.2)	
median(IQR)	60.0 (53.5-65.0)	58.0 (50.0-64.0)		59.0 (53.0-64.0)	58.0 (50.0-64.0)	
Ethnicity, n(%)						
white	365 (95.3)	214365 (93.9)	0.170	544 (96.8)	214186 (93.9)	0.025
non-white	14 (3.7)	12309(5.4)		18 (3.2)	12305 (5.4)	
Missing	4 (1.0)	1497(0.7)		0 (0.0)	1501 (0.7)	
TDI			0.340			<0.001
mean(SD)	-1.1 (3.3)	-1.3 (3.2)		-0.1 (3.6)	-1.3 (3.2)	
median(IQR)	-2.2 (-3.5-1.1)	-2.1 (-3.6-0.6)		-1.1 (-3.0-2.5)	-2.1 (-3.6-0.6)	
Missing	0 (0.0)	296 (0.1)		1 (0.2)	295 (0.1)	
Years of formal education, y			0.320			0.006
mean(SD)	14.0 (5.3)	14.3 (5.2)		13.6 (5.2)	14.3 (5.2)	
median(IQR)	13.0 (10.0-20.0)	13.0 (10.0-20.0)		13.0 (10.0-20.0)	13.0 (10.0-20.0)	
Missing	4 (1.0)	4768 (2.1)		10 (1.8)	4762 (2.1)	
Smoking status,n(%)						
Never	176 (46.0)	111086 (48.7)	0.530	187 (33.3)	111075 (48.7)	<0.001
Previous	153 (39.9)	87206 (38.2)		231 (41.1)	87128 (38.2)	
Current	52 (13.6)	28457 (12.5)		143 (25.4)	28366 (12.4)	
Missing	2 (0.5)	1422 (0.6)		1 (0.2)	1423 (0.6)	
Pack years of smoking			0.510			<0.001
mean(SD)	21.2 (14.5)	20.3 (15.5)		32.9 (23.2)	26.1 (20.9)	
median(IQR)	25.5 (15.5-37.5)	21.4 (11.3-35.5)		28.0 (16.3-44.0)	21.3 (11.3-35.5)	
Missing	245 (64.0)	149860 (65.7)		280 (49.8)	149825 (65.7)	
Alcohol status,n(%)						
Never	13 (3.4)	6383 (2.8)	0.160	11 (2.0)	6385 (2.8)	0.001
Previous	7 (1.8)	8078 (3.5)		35 (6.2)	8050 (3.5)	
Current	362 (94.5)	212892 (93.3)		514 (91.5)	212740 (93.3)	
Missing	1 (0.3)	818 (0.4)		2 (0.4)	817 (0.4)	
Aspirin use,n(%)	173 (45.2)	94482 (41.4)	0.190	258 (45.9)	94397 (41.4)	0.027
Missing	6 (1.6)	5301 (2.3)		15 (2.7)	5292 (2.3)	
Age first had sexual intercourse,y			0.690			<0.001
mean(SD)	19.3 (4.4)	19.2 (4.3)		17.7 (3.5)	19.2 (4.3)	
median(IQR)	18.0 (17.0-21.0)	18.0 (16.0-21.0)		17.0 (16.0-19.0)	18.0 (17.0-21.0)	
Missing	51 (13.3)	29159 (12.8)		73 (13.0)	29137 (12.8)	
No. of lifetime sexual partners,n(%)						

≤ 1	68 (17.8)	43619 (19.1)	0.950	46 (8.2)	43641 (19.1)	<0.001
2 - 5	111 (29.0)	68372 (30.0)		112 (19.9)	68371 (30.0)	
≥ 6	111 (29.0)	71213 (31.2)		262 (46.6)	71062 (31.2)	
Missing	93 (24.3)	44967 (19.7)		142 (25.3)	44918 (19.7)	
same-sex intercourse,n(%)	17 (4.4)	8816 (3.9)	0.610	62 (11.0)	8771 (3.8)	<0.001
Missing	42 (11.0)	22390 (9.8)		57 (10.1)	22375 (9.8)	
No. of lifetime same-sex sexual partners,n(%)						
≤ 1	0 (0.0)	1731 (0.8)	0.094	6 (1.1)	1725 (0.8)	0.012
2 - 5	6 (1.6)	2225 (1.0)		9 (1.6)	2222 (1.0)	
≥ 6	4 (1.0)	2729 (1.2)		26 (4.6)	2707 (1.2)	
Missing	373 (97.4)	221486 (97.1)		521 (92.7)	221338 (97.1)	

eTable 6. Clinical and demographic characteristics of male participants with malignant HPV-associated diseases by anatomical sites.

Characteristic	Oropharyngeal HPV-associated diseases			Anogenital HPV-associated diseases		
	Yes (n=388)	No (n=228166)	P value	Yes (n=228)	No (n=228326)	P value
Age at recruitment, y			0.530			<0.001
mean(SD)	57.0 (7.3)	56.7 (8.2)		59.9 (7.4)	56.7 (8.2)	
median(IQR)	58.0 (52.0-63.0)	58.0 (50.0-64.0)		62.0 (55.0-66.0)	58.0 (50.0-64.0)	
Ethnicity, n(%)						
white	373 (96.1)	214357 (93.9)	0.210	223 (97.8)	214507 (93.9)	0.044
non-white	15 (3.9)	12308 (5.4)		5 (2.2)	12318 (5.4)	
Missing	0 (0.0)	1501 (0.7)		0 (0.0)	1501 (0.7)	
TDI			<0.001			<0.001
mean(SD)	-0.1 (3.7)	-1.3 (3.2)		-0.3 (3.5)	-1.3 (3.2)	
median(IQR)	-1.1 (-3.1-2.7)	-2.1 (-3.6-0.6)		-1.2 (-3.1-2.4)	-2.1 (-3.6-0.6)	
Missing	1 (0.3)	295 (0.1)		0 (0.0)	296 (0.1)	
Years of formal education, y			<0.001			0.710
mean(SD)	13.3 (5.1)	14.3 (5.2)		14.1 (5.4)	14.3 (5.2)	
median(IQR)	13.0 (10.0-20.0)	13.0 (10.0-20.0)		13.0 (10.0-20.0)	13.0 (10.0-20.0)	
Missing	8 (2.1)	4764 (2.1)		2 (0.9)	4770 (2.1)	
Smoking status,n(%)						
Never	113 (29.1)	111149 (48.7)	<0.001	94 (41.2)	111168 (48.7)	0.015
Previous	167 (43.0)	87192 (38.2)		92 (40.4)	87267 (38.2)	
Current	108 (27.8)	28401 (12.4)		41 (18.0)	28468 (12.5)	
Missing	0 (0.0)	1424 (0.6)		1 (0.4)	1423 (0.6)	
Pack years of smoking			<0.001			0.034
mean(SD)	33.3 (24.8)	26.1 (20.9)		30.7 (17.5)	26.2 (20.9)	
median(IQR)	27.8 (15.8-44.0)	21.4 (11.3-35.5)		28.9 (19.1-40.8)	21.4 (11.3-35.5)	
Missing	182 (46.9)	149923 (65.7)		132 (57.9)	149973 (65.7)	
Alcohol status,n(%)						
Never	5 (1.3)	6391 (2.8)	<0.001	6 (2.6)	6390 (2.8)	0.650
Previous	30 (7.7)	8055 (3.5)		9 (3.9)	8076 (3.5)	
Current	352 (90.7)	212902 (93.3)		211 (92.5)	213043 (93.3)	
Missing	1 (0.3)	818 (0.4)		2 (0.9)	817 (0.4)	
Aspirin use,n(%)	167 (43.0)	94488 (41.4)	0.520	119 (52.2)	94536 (41.4)	0.001
Missing	10 (2.6)	5297 (2.3)		5 (2.2)	5302 (2.3)	
Age first had sexual intercourse, y			<0.001			0.290
mean(SD)	17.4 (2.8)	19.2 (4.3)		18.9 (4.8)	19.2 (4.3)	
median(IQR)	17.0 (16.0-19.0)	18.0 (17.0-21.0)		18.0 (16.0-21.0)	18.0 (16.0-21.0)	
Missing	43 (11.1)	29167 (12.8)		36 (15.8)	29174 (12.8)	

No. of lifetime sexual partners,n(%)						
≤ 1	19 (4.9)	43668 (19.1)	<0.001	31 (13.6)	43656 (19.1)	0.013
2 - 5	75 (19.3)	68408 (30.0)		52 (22.8)	68431 (30.0)	
≥ 6	202 (52.1)	71122 (31.2)		83 (36.4)	71241 (31.2)	
Missing	92 (23.7)	44968 (19.7)		62 (27.2)	44998 (19.7)	
same-sex intercourse,n(%)	28 (7.2)	8805 (3.9)	<0.001	34 (14.9)	8799 (3.9)	<0.001
Missing	38 (9.8)	22394 (9.8)		25 (11.0)	22407 (9.8)	
No. of lifetime same-sex sexual partners,n(%)						
≤ 1	5 (1.3)	1726 (0.8)	0.900	1 (0.4)	1730 (0.8)	<0.001
2 - 5	7 (1.8)	2224 (1.0)		2 (0.9)	2229 (1.0)	
≥ 6	10 (2.6)	2723 (1.2)		16 (7.0)	2717 (1.2)	
Missing	366 (94.3)	221493 (97.1)		209 (91.7)	221650 (97.1)	

eTable 7. Unadjusted associations between immune-mediated diseases and HPV-associated diseases by sex.

Outcome	Disease	Women					Men				
		No. of participants with the disease	No.case	Incidence (per 1,000 person-year)	HR(95%CI)	P value	No. of participants with the disease	No.case	Incidence (per 1,000 person-year)	HR(95%CI)	P value
Total HPV-associated diseases	IMDs*	59003	450	0.63	1.91 (1.70,2.14)	<0.001	40786	266	0.54	1.82 (1.58,2.09)	<0.001
	Asthma	27194	194	0.59	1.79 (1.53,2.09)	<0.001	18168	115	0.52	1.76 (1.45,2.15)	<0.001
	Organ transplant	954	25	2.18	6.61 (4.44,9.84)	<0.001	1320	28	1.76	5.95 (4.07,8.68)	<0.001
	Acute rheumatic fever/Chronic rheumatic heart diseases	N/A					4479	33	0.61	2.06 (1.45,2.92)	<0.001
	Chronic nephritic syndrome						627	12	1.59	5.37 (3.03,9.50)	<0.001
	Ulcerative colitis	2496	24	0.79	2.41 (1.60,3.61)	<0.001	N/A				
	Crohns disease	1555	20	1.06	3.22 (2.06,5.01)	<0.001					
	Rheumatoid arthritis	4380	44	0.84	2.52 (1.86,3.42)	<0.001					
	Psoriasis	2400	35	1.21	3.66 (2.61,5.13)	<0.001					
	pernicious anaemia	973	12	1.02	3.09 (1.75,5.46)	<0.001					
	Lichen planus	760	12	1.31	3.97 (2.25,7.02)	<0.001					
	Endometriosis	5302	42	0.66	1.99 (1.46,2.71)	<0.001					
Benign HPV-associated diseases	IMDs*	59003	178	0.25	2.74 (2.25,3.32)	<0.001	40786	124	0.25	2.21 (1.78,2.73)	<0.001
	Asthma	27194	75	0.23	2.50 (1.93,3.24)	<0.001	18168	50	0.23	2.00 (1.48,2.70)	<0.001
	Organ transplant	954	17	1.48	16.3 (9.96,26.67)	<0.001	1320	21	1.32	11.63 (7.46,18.15)	<0.001
	Acute rheumatic fever/Chronic rheumatic heart diseases	N/A					4479	19	0.35	3.08 (1.94,4.91)	<0.001
	Rheumatoid arthritis	4380	15	0.28	3.11 (1.85,5.25)	<0.001	N/A				
	Psoriasis	2400	15	0.52	5.68 (3.37,9.57)	<0.001					
	Endometriosis	5302	19	0.30	3.26 (2.04,5.20)	<0.001					

Continued

Outcome	Disease	Women					Men				
		No. of participants with the disease	No.case	Incidence	HR(95%CI)	P value	No. of participants with the disease	No.case	Incidence	HR(95%CI)	P value
Malignant HPV-associated diseases	IMDs*	59003	276	0.39	1.61 (1.40,1.85)	<0.001	40786	145	0.29	1.60 (1.33,1.94)	<0.001
	Asthma	27194	120	0.37	1.52 (1.25,1.84)	<0.001	18168	66	0.30	1.64 (1.27,2.13)	<0.001
	Rheumatoid arthritis	4380	29	0.55	2.28 (1.57,3.31)	<0.001	N/A				
	Lichen planus	760	10	1.10	4.54 (2.43,8.49)	<0.001					
	Psoriasis	2400	20	0.69	2.87 (1.84,4.47)	<0.001					
Oropharyngeal HPV-associated diseases	IMDs*	59003	51	0.07	1.92 (1.37,2.70)	<0.001	N/A				
	Rheumatoid arthritis	4380	11	0.21	5.61 (3.01,10.47)	<0.001					
Anogenital HPV-associated diseases	IMDs*	59003	225	0.32	1.55 (1.33,1.81)	<0.001	40786	71	0.14	2.11 (1.59,2.79)	<0.001
	Asthma	27194	104	0.32	1.56 (1.26,1.92)	<0.001	18168	36	0.16	2.41 (1.68,3.46)	<0.001
	Crohns disease	1555	11	0.58	2.87 (1.58,5.22)	<0.001	N/A				
Cervical HPV-associated diseases	Endometriosis	5302	14	0.31	2.47 (1.44,4.23)	0.001	N/A				

“ * ” refers to compare the outcome risk between participants with at least one of 80 immune-mediated diseases and those without any immune-mediated diseases.

NA, not applicable. Only IMDs reaching statistical significance for the corresponding outcome were presented.

eTable 8. Multivariate adjusted associations between immune-mediated diseases and the risk of HPV-associated diseases in women.

Outcome	Diseases	Model 1		Model 2		Model 3	
		HR(95%CI)	P value	HR(95%CI)	P value	HR(95%CI)	P value
Total HPV-associated diseases	IMDs*	1.89 (1.68,2.12)	<0.001	1.85 (1.65,2.08)	<0.001	1.83 (1.63,2.05)	<0.001
	Asthma	1.78 (1.52,2.08)	<0.001	1.75 (1.49,2.04)	<0.001	1.71 (1.46,2.01)	<0.001
	Organ transplant	6.61 (4.44,9.85)	<0.001	6.51 (4.37,9.69)	<0.001	6.65 (4.47,9.9)	<0.001
	Ulcerative colitis	2.39 (1.59,3.59)	<0.001	2.35 (1.57,3.53)	<0.001	2.24 (1.48,3.4)	<0.001
	Crohn's disease	3.04 (1.93,4.79)	<0.001	2.99 (1.89,4.7)	<0.001	2.83 (1.79,4.46)	<0.001
	Rheumatoid arthritis	2.42 (1.78,3.29)	<0.001	2.34 (1.72,3.18)	<0.001	2.28 (1.67,3.1)	<0.001
	Psoriasis	3.60 (2.57,5.05)	<0.001	3.51 (2.50,4.93)	<0.001	3.33 (2.37,4.68)	<0.001
	pernicious anaemia	2.96 (1.67,5.24)	<0.001	2.87 (1.62,5.09)	<0.001	2.81 (1.58,4.97)	<0.001
	Lichen planus	3.88 (2.19,6.85)	<0.001	3.85 (2.18,6.82)	<0.001	3.82 (2.16,6.76)	<0.001
	Endometriosis	2.07 (1.51,2.84)	<0.001	2.01 (1.46,2.76)	<0.001	1.97 (1.43,2.73)	<0.001
Benign HPV-associated diseases	IMDs*	2.68 (2.20,3.26)	<0.001	2.65 (2.18,3.23)	<0.001	2.66 (2.18,3.24)	<0.001
	Asthma	2.46 (1.89,3.20)	<0.001	2.42 (1.86,3.15)	<0.001	2.42 (1.86,3.16)	<0.001
	Organ transplant	16.27 (9.94,26.62)	<0.001	16.11 (9.84,26.37)	<0.001	16.36 (9.99,26.8)	<0.001
	Rheumatoid arthritis	2.92 (1.73,4.94)	<0.001	2.84 (1.68,4.80)	<0.001	2.90 (1.72,4.92)	<0.001
	Psoriasis	5.47 (3.24,9.22)	<0.001	5.40 (3.20,9.11)	<0.001	5.49 (3.25,9.30)	<0.001
	Endometriosis	3.58 (2.21,5.83)	<0.001	3.57 (2.20,5.81)	<0.001	3.59 (2.21,5.84)	<0.001
Malignant HPV-associated diseases	IMDs*	1.60 (1.38,1.84)	<0.001	1.56 (1.35,1.80)	<0.001	1.52 (1.32,1.76)	<0.001
	Asthma	1.52 (1.25,1.85)	<0.001	1.49 (1.23,1.81)	<0.001	1.45 (1.19,1.77)	<0.001
	Rheumatoid arthritis	2.20 (1.50,3.21)	<0.001	2.12 (1.45,3.11)	<0.001	2.03 (1.38,2.97)	<0.001
	Lichen planus	4.51 (2.41,8.43)	<0.001	4.48 (2.40,8.38)	<0.001	4.41 (2.36,8.25)	<0.001
	Psoriasis	2.85 (1.83,4.45)	<0.001	2.77 (1.77,4.32)	<0.001	2.55 (1.63,3.99)	<0.001
Oropharyngeal HPV-associated diseases	IMDs*	1.92 (1.36,2.7)	<0.001	1.83 (1.3,2.58)	<0.001	1.78 (1.26,2.51)	<0.001
	Rheumatoid arthritis	5.82 (3.1,10.91)	<0.001	5.32 (2.83,10)	<0.001	5.17 (2.74,9.74)	<0.001
Anogenital HPV-associated diseases	IMDs*	1.54 (1.31,1.80)	<0.001	1.51 (1.29,1.77)	<0.001	1.48 (1.26,1.73)	<0.001
	Asthma	1.55 (1.26,1.92)	<0.001	1.53 (1.24,1.89)	<0.001	1.49 (1.2,1.84)	<0.001
	Crohn's disease	2.61 (1.39,4.88)	0.0027	2.57 (1.37,4.8)	0.003	2.39 (1.28,4.47)	0.007
Cervical HPV-associated diseases	Endometriosis	2.06 (1.20,3.56)	0.009	1.91 (1.09,3.35)	0.024	1.93 (1.10,3.39)	0.022

Model 1 was adjusted for age and ethnicity. Model 2 was adjusted for age, ethnicity and socioeconomic status (Townsend deprivation score). Model 3 was adjusted for age, ethnicity, socioeconomic status (Townsend deprivation score), smoking status and alcohol drinker status. “ * ” refers to compare the outcome risk between participants with at least one of 80 immune-mediated diseases and those without any immune-mediated diseases.

eTable 9. Multivariate adjusted associations between immune-mediated diseases and the risk of HPV-associated diseases in men.

Outcome	Diseases	Model 1		Model 2		Model 3	
		HR(95%CI)	P value	HR(95%CI)	P value	HR(95%CI)	P value
Total HPV-associated diseases	IMDs*	1.74 (1.51,2.01)	<0.001	1.69 (1.46,1.95)	<0.001	1.68 (1.46,1.94)	<0.001
	Asthma	1.72 (1.41,2.09)	<0.001	1.66 (1.36,2.02)	<0.001	1.67 (1.37,2.04)	<0.001
	Organ transplant	5.72 (3.9,8.41)	<0.001	5.60 (3.81,8.23)	<0.001	5.62 (3.83,8.27)	<0.001
	Acute rheumatic fever/Chronic rheumatic heart diseases	1.82 (1.28,2.59)	<0.001	1.74 (1.22,2.48)	0.002	1.73 (1.22,2.46)	0.002
	Chronic nephritic syndrome	4.75 (2.68,8.42)	<0.001	4.49 (2.53,7.97)	<0.001	4.38 (2.47,7.78)	<0.001
Benign HPV-associated diseases	IMDs*	2.08 (1.67,2.58)	<0.001	2.06 (1.66,2.56)	<0.001	2.07 (1.66,2.57)	<0.001
	Asthma	1.92 (1.41,2.60)	<0.001	1.90 (1.40,2.58)	<0.001	1.92 (1.41,2.61)	<0.001
	Organ transplant	11.06 (7.01,17.43)	<0.001	11.05 (7.01,17.43)	<0.001	11.27 (7.14,17.78)	<0.001
	Acute rheumatic fever/Chronic rheumatic heart diseases	2.64 (1.65,4.23)	<0.001	2.62 (1.64,4.20)	<0.001	2.64 (1.65,4.23)	<0.001
Malignant HPV-associated diseases	IMDs*	1.57 (1.29,1.89)	<0.001	1.49 (1.23,1.80)	<0.001	1.48 (1.22,1.79)	<0.001
	Asthma	1.62 (1.25,2.10)	<0.001	1.54 (1.18,1.99)	0.001	1.54 (1.19,2.00)	0.001
Anogenital HPV-associated diseases	IMDs*	1.94 (1.46,2.57)	<0.001	1.85 (1.39,2.45)	<0.001	1.86 (1.4,2.47)	<0.001
	Asthma	2.29 (1.59,3.29)	<0.001	2.18 (1.52,3.14)	<0.001	2.18 (1.51,3.15)	<0.001

Model 1 was adjusted for age and ethnicity. Model 2 was adjusted for age, ethnicity and socioeconomic status (Townsend deprivation score). Model 3 was adjusted for age, ethnicity, socioeconomic status (Townsend deprivation score), smoking status and alcohol drinker status. “ * ” refers to compare the outcome risk between participants with at least one of 80 immune-mediated diseases and those without any immune-mediated diseases.