Supplementary Table S1. Detailed information of search strings applied in our meta-analysis.

Database	Search string	results
pubmed	("hypertension, pulmonary"[MeSH Terms] OR "pulmonary hypertension"[Text Word] OR ("pulmonary arterial hypertension"[MeSH Terms] OR "arterial hypertension pulmonary"[Text Word] OR "hypertension pulmonary arterial"[Text Word])) AND ("lupus erythematosus, systemic"[MeSH Terms] OR "systemic lupus erythematosus"[Text Word] OR "lupus erythematosus disseminatus"[Text Word] OR "libman sacks disease"[Text Word] OR "disease libman sacks"[Text Word] OR "libman sacks disease"[Text Word])	639
cochrane	("Hypertension, Pulmonary"[MESH] OR"Pulmonary Hypertension"OR "Pulmonary Arterial Hypertension"[mesh]OR"Hypertension, Pulmonary Arterial"OR"Arterial Hypertension, Pulmonary")AND("Lupus Erythematosus, Systemic"[mesh]OR"Libman-Sacks Disease"OR"Disease, Libman-Sacks"OR"Libman Sacks Disease"OR"Systemic Lupus Erythematosus"OR"Lupus Erythematosus Disseminatus")	32
web of science	TS= (pulmonary arterial hypertension OR arterial hypertension pulmonary OR hypertension pulmonary arterial) AND TS= (lupus erythematosus, systemic OR systemic lupus erythematosus OR lupus erythematosus disseminatus OR libman sacks disease OR disease libman sacks OR libman sacks disease) AND TS= (Incidence OR Incidences OR Secondary Attack Rate OR Attack Rate, Secondary OR Rate, Secondary Attack OR Secondary Attack Rates OR Incidence Proportion OR Incidence Proportions OR Proportion, Incidence OR Attack Rate OR Attack Rates OR Rate, Attack OR Cumulative Incidence OR Cumulative Incidences OR Incidence, Cumulative OR Incidence Rate OR Incidence Rates OR Rate, Incidence OR Person-time Rate OR Person time Rate OR Person-time Rates OR Rate, Person-time)	47
Embase	('pulmonary arterial hypertension':ab,ti OR 'arterial hypertension pulmonary':ab,ti OR 'hypertension pulmonary arterial':ab,ti) AND ('lupus erythematosus, systemic':ab,ti OR 'systemic lupus erythematosus':ab,ti OR 'lupus erythematosus disseminatus':ab,ti OR 'disease libman sacks':ab,ti OR 'libman sacks disease':ab,ti) AND (incidence:ab,ti OR incidences:ab,ti OR 'secondary attack rate':ab,ti OR 'attack rate, secondary':ab,ti OR 'rate, secondary attack':ab,ti OR 'secondary attack rates':ab,ti OR 'incidence proportion':ab,ti OR 'incidence proportions':ab,ti OR 'proportion, incidence':ab,ti OR 'attack rate':ab,ti OR 'attack rates':ab,ti OR 'rate, attack':ab,ti OR 'cumulative incidence':ab,ti OR 'cumulative incidences':ab,ti OR 'incidence, cumulative':ab,ti OR 'incidence rate':ab,ti OR 'incidence rates':ab,ti OR 'rate, incidence':ab,ti OR 'person-time rate':ab,ti OR 'person time rate':ab,ti OR 'person-time rates':ab,ti OR 'rate, person-time':ab,ti)	36

Supplementary Table S2. Mendelian Randomization analyses from Systemic Lupus Erythematosus to Pulmonary Hypertension.

outcome	exposure	method	nsnp	OR	95% CI		P-value
Pulmonary Hypertension	Systemic Lupus Erythematosus	MR Egger	86	1.51	0.97	2.36	0.072
Pulmonary Hypertension	Systemic Lupus Erythematosus	Weighted median	86	1.42	0.95	2.14	0.087
Pulmonary Hypertension	Systemic Lupus Erythematosus	Inverse variance weighted	86	1.33	1.04	1.69	0.023
Pulmonary Hypertension	Systemic Lupus Erythematosus	Simple mode	86	1.17	0.54	2.52	0.687
Pulmonary Hypertension	Systemic Lupus Erythematosus	Weighted mode	86	1.36	0.86	2.13	0.189
Pulmonary Hypertension	Systemic Lupus Erythematosus(Replication)	MR Egger	39	0.84	0.66	1.08	0.192
Pulmonary Hypertension	Systemic Lupus Erythematosus(Replication)	Weighted median	39	0.97	0.82	1.15	0.730
Pulmonary Hypertension	Systemic Lupus Erythematosus(Replication)	Inverse variance weighted	39	1.06	0.95	1.19	0.297
Pulmonary Hypertension	Systemic Lupus Erythematosus(Replication)	Simple mode	39	1.18	0.86	1.62	0.311
Pulmonary Hypertension	Systemic Lupus Erythematosus(Replication)	Weighted mode	39	0.99	0.79	1.24	0.949

Supplementary Table S3. Estimation of Wald ratio between individual SNP related to Systemic Lupus Erythematosus and risk of Pulmonary Hypertension.

exposure	outcome	SNPs	beta	stand error	P-value
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs10028805	2.128285714	1.4566	0.143979061
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs10101368	-2.167730769	2.219884615	0.328813749
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs10168266	0.208445693	0.461329588	0.651386544
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs10488631	0.42180798	0.34080798	0.215838265
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs10760693	1.288022222	2.048396825	0.529483101
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs10905718	-0.207804839	1.647258065	0.899611635
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs10944479	-1.950842697	1.706168539	0.25287022
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs11217033	1.982259259	1.461814815	0.175090817
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs1128334	0.233629677	1.022316129	0.819234409
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs11644034	-0.545312245	1.107163265	0.622344003
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs11668616	-2.355144928	1.893478261	0.213566052
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs11724804	-1.325551282	1.265274359	0.294804773
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs12129787	-1.458550725	1.51657971	0.336181763
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs12148050	3.614148148	1.8855	0.055261879
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs12515884	-0.986221429	1.795321429	0.582779955
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs12529514	0.643097826	2.023923913	0.750676079
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs12627970	0.283450769	1.667476923	0.865019714
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs12663882	1.867217308	2.080923077	0.369557567
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs12742756	0.547545763	1.669186441	0.742887832
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs12783350	3.747932203	1.869135593	0.044945014
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs12872801	-3.620386364	2.335568182	0.121115243
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs12912487	-0.203916364	1.826681818	0.911115103
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs12992553	3.640891304	2.193	0.096867558

Systemic Lupus Erythematosus	Pulmonary Hypertension	rs13014122	-0.072631176	2.455529412	0.976403115
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs13132933	-1.130244444	1.616988889	0.48456393
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs13198474	-0.076074481	0.692590504	0.912535879
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs13277113	-0.099689326	0.633544944	0.874967737
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs1385374	0.920806723	1.377579832	0.503863304
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs1535271	-0.262402857	1.862371429	0.887951181
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs17027255	-0.351759016	1.785295082	0.843803042
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs17374749	-4.15079661	2.337101695	0.075725583
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs1790588	1.028117742	1.588232258	0.517415393
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs1867147	0.550391304	2.225304348	0.804650485
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs2111485	1.256268182	1.511866667	0.406008387
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs2233287	0.211777193	1.116339181	0.84953885
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs2288786	-2.313529412	2.064470588	0.262440906
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs2304256	-0.459541353	0.854481203	0.590714031
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs231804	2.456944444	1.464430556	0.093396437
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs2431697	1.097346939	1.028112245	0.285817622
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs244673	-0.472081081	1.551432432	0.760909071
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs2453044	0.393329688	2.050578125	0.847887868
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs2476601	0.957247093	0.398581395	0.016321978
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs2731783	2.2265625	1.9498625	0.253492495
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs2732547	0.208086567	1.471314925	0.887531063
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs2816316	-1.248987805	1.696914634	0.46170967
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs2847297	1.259778947	1.815561404	0.487758434
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs299629	0.282796721	1.654918033	0.864316067
Systemic Lupus	Pulmonary	rs301806	1.483556818	2.358	0.529244996

Erythematosus	Hypertension				
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs3024505	-1.019258889	1.507277778	0.498897813
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs35776863	0.013359662	1.885661972	0.994347142
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs3732421	-0.722842742	1.198733871	0.546505239
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs3761847	0.938511765	1.936488235	0.627927299
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs3784099	-0.170430159	1.690206349	0.919682287
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs3893660	1.411566667	1.115244444	0.205619939
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs427221	0.802864407	1.68060339	0.632846731
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs4542691	-0.251039063	2.027015625	0.901436707
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs4560769	0.278566292	1.833460674	0.879238442
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs4697651	2.324566038	2.105	0.269460028
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs4703116	-1.077048276	1.758293103	0.540171733
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs485499	-1.506614458	1.223433735	0.218149417
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs489574	1.417594643	1.959517857	0.469409277
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs4917014	0.160822581	1.149301075	0.888714692
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs4948496	-0.469960256	1.275988462	0.712641544
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs516124	0.595808696	1.445928986	0.680295853
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs548234	0.364825243	1.052291262	0.728819665
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs5754217	0.612440945	0.834559055	0.463040322
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs6445975	-2.002647059	1.514911765	0.186182723
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs653178	2.075053571	0.8387375	0.013360212
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs6602588	-0.0494025	2.373863636	0.983396415
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs6662618	1.228144578	1.725313253	0.476564724
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs6679356	-0.231045882	1.9492	0.905644797
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs6738087	3.113959184	2.05922449	0.130483002

Systemic Lupus Erythematosus	Pulmonary Hypertension	rs6897932	-1.740348485	1.580863636	0.270946871
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs6939565	-3.8865	2.367909524	0.100730766
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs7010390	4.064476923	1.914769231	0.033779162
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs704840	0.887114754	0.881221311	0.314084821
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs7749323	0.494929638	0.793420043	0.532763729
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs7922169	0.473103896	1.289441558	0.713689106
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs8032939	0.859112329	1.501465753	0.567198387
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs8067378	-1.620605263	1.300572368	0.212738401
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs849141	-1.924469697	1.613909091	0.233093635
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs906868	-0.106661324	1.459870588	0.941756639
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs936469	-0.995892857	1.194535714	0.404446079
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs9469857	-0.035290614	0.923605263	0.969520544
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs9782955	1.595633962	2.297792453	0.487418602
Systemic Lupus Erythematosus	Pulmonary Hypertension	rs9888739	-0.154402459	0.621565574	0.803818
Systemic Lupus Erythematosus	Pulmonary Hypertension	All - Inverse variance weighted	0.283696438	0.124446652	0.022627678
Systemic Lupus Erythematosus	Pulmonary Hypertension	All - MR Egger	0.413117963	0.226979514	0.072310649
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs10048743	0.409137994	0.551935858	0.458524805
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs10200680	-0.353482438	0.52841291	0.503526623
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs1078324	0.111172216	0.34393916	0.746519387
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs10912578	0.329457182	0.42893948	0.442443333
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs1143679	-0.101813588	0.263079338	0.698750906
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs12094036	0.152240764	0.521725763	0.770437806
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs12524498	0.027340368	0.526278505	0.958568232
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs13019891	-0.071582708	0.176036569	0.684275764

Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs13136219	0.800445074	0.584498116	0.170856447
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs13332649	-0.227446451	0.348154338	0.513568036
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs1464446	-0.574336994	0.395066727	0.146009494
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs150180633	-1.084636277	0.883599668	0.219627204
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs17849501	-0.038520834	0.31165822	0.901632302
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs2431697	0.48193095	0.451524576	0.285817622
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs2459611	0.999716871	0.850500258	0.239816449
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs2573219	0.132025206	0.3038975	0.663969013
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs268124	0.162724736	0.547330006	0.766232565
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs34703115	-0.209193328	0.440524452	0.634877238
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs35000415	0.28777091	0.232512798	0.21584356
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs35251378	-0.140177412	0.476595311	0.768664286
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs353608	0.441744754	0.529269575	0.403925546
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs3747093	0.295242869	0.406404842	0.467547762
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs389884	-0.068449256	0.183203533	0.708683997
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs4274624	0.207401147	0.209180938	0.321445584
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs4388254	-0.518272574	0.406628862	0.202465291
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs4661543	0.416755029	0.72219125	0.563892052
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs4916215	0.968486717	0.571258918	0.090008079
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs58688157	-0.450820995	0.547063779	0.409897556
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs58721818	0.337509125	0.564372186	0.549822722
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs597808	1.570050271	0.615053624	0.010689008
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs6671847	-0.139706112	0.497044521	0.77865392
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs6679677	0.965696997	0.409632897	0.018399974
Systemic Lupus	Pulmonary	rs6889239	0.287153498	0.393038266	0.465023915

Erythematosus (Replication)	Hypertension				
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs7097397	0.301140986	0.550517898	0.584369128
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs73050535	0.063777529	0.976823439	0.947942512
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs73068668	0.594373886	0.571966026	0.298722468
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs7768653	-0.478387452	0.481827799	0.320778283
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs7823055	-0.001925437	0.282970253	0.994570932
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	rs9852014	-0.389340888	0.29105816	0.181002782
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	All - Inverse variance weighted	0.061524865	0.058993877	0.296993432
Systemic Lupus Erythematosus (Replication)	Pulmonary Hypertension	All - MR Egger	-0.168435293	0.126716224	0.191909788

Supplementary Table S4. Effect estimates from MR-Egger regression for Systemic Lupus Erythematosus.

Exposures	MR-Egger regression		
	Intercept	Standard error	P-value
Systemic Lupus Erythematosus	-0.0154	0.0225	0.4972
Systemic Lupus Erythematosus (Replication)	0.0305	0.0835	0.7173

Supplementary Table S5. MR-PRESSO analyses from Systemic Lupus Erythematosus to Pulmonary Hypertension.

outcome	exposure	OR(95%CI)	P-Value	Outlier number	Global Test P-value
Pulmonary Hypertension	Systemic Lupus Erythematosus	1.33(1.06-1.67)	0.016	0	0.805
Pulmonary Hypertension	Systemic Lupus Erythematosus (Replication)	1.06(0.95-1.18)	0.308	0	0.586

Supplementary Table S6. Heterogeneity analysis using Cochran's Q test.

outcome	exposure	method	Cochran's Q test	Degree of Freedom	p-value
Pulmonary Hypertension	Systemic Lupus Erythematosus	MR Egger	73.0827	84.0000	0.7967
Pulmonary Hypertension	Systemic Lupus Erythematosus	Inverse variance weighted	73.5476	85.0000	0.8077
Pulmonary Hypertension	Systemic Lupus Erythematosus (Replication)	MR Egger	32.4424	37.0000	0.6826
Pulmonary Hypertension	Systemic Lupus Erythematosus (Replication)	Inverse variance weighted	36.6471	38.0000	0.5320