

Supplemental Materials for Short- and Long-term Chest CT Findings After Recovery from COVID-19: A Systematic Review and Meta-Analysis

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The tool consists of 10 items addressing four domains of bias. Items 1 to 4 assess the external validity of the study (domains are selection and nonresponse bias), and items 5 to 10 assess the internal validity (items 5 to 9 assess the domain of measurement bias, and item 10 assesses bias related to the analysis).	38
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Supplemental Table S1. Breakdown of Comorbidities.

NR: Not Reported

Author (year)	Comorbidities, n (%)
Bellan et al. (2021)	Arterial hypertension 82 (41) Diabetes 31 (15.5) Dyslipidemia 18 (9) COPD 12 (6) Obesity 22 (11) IBD 4 (2) Chronic liver disease 7 (3.6) Autoimmune disease 3 (1.5) Hematological disease 13 (6.5) Coronary artery disease 18 (9) Atrial fibrillation 13 (6.5) Other structural heart disease 3 (1.5) Other arrhythmogenic heart disease 6 (3) Endocrinological disease 22 (11) CKD 12 (6) Stroke/TIA 5 (2.5) VTE 4 (2) Anxiety and depression 8 (4) Active malignancy 18 (9)
Zhan et al. (2021)	Hypertension 31 (25.6) Diabetes 8 (6.6) Autoimmune diseases 2 (1.7) Cardiovascular diseases 3 (2.5) Cancer 1 (0.8)
Zhou et al. (2021)	Diabetes 6 (5) Hypertension 20 (16.7) Hyperlipidemia 4 (3.3) Coronary heart disease 3 (2.5)
Li et al. (2021)	Hypertension 55 (39.0) Diabetes 52 (36.9) Type 2 diabetes 50 (35.5) Type 1 diabetes 2 (1.4) Cardiovascular disease 13 (9.2) Coronary heart disease 12 (8.5) Heart failure 1 (0.7) Cerebrovascular disease 2 (1.4)

Author (year)	Comorbidities, n (%)
	Chronic pulmonary disease 14 (9.9) COPD 10 (7.1) Asthma 3 (2.1) Latent Tuberculosis 1 (0.7) Chronic renal failure 1 (0.7) Chronic liver disease 5 (3.5) Chronic hepatitis 2 (1.4) Cirrhosis 3 (2.1)
Chen et al. (2021)	Hypertension 10 (24.4) Type 2 diabetes 4 (9.7) Coronary artery heart disease 2 (4.9) COPD/emphysema 2 (4.9)
Zhao et al. (2021)	Hypertension 16 (17.0) Diabetes Mellitus 9 (9.6) Chronic heart disease 4 (4.3) Asthma 2 (2.1)
Gamberini et al. (2021)	Hypertension 88 (49.4) Chronic ischemic heart disease 13 (7.3) Chronic kidney disease 6 (3.4) COPD 13 (7.3) Diabetes 28 (15.7)
Han et al. (2021)	NR
Wu et al. (2021)	None
Eberst et al. (2022)	Obesity 28 (32.9) Ischemic heart disease 9 (10.6) Heart failure 1 (1.2) Atrial fibrillation 7 (8.2) Stroke 2 (2.4) COPD 7 (8.2) Asthma 6 (7.1) Sleep apnea 16 (18.8) Hypertension 44 (51.8) Diabetes 21 (24.7%) Dyslipidemia 27 (31.8) Deep vein thrombosis 4 (4.7) Pulmonary embolism 0 (0)

Author (year)	Comorbidities, n (%)
Lorent et al. (2022)	Arterial hypertension 143 (48) Hyperlipidemia 113 (38) Diabetes 75 (25) Ischemic heart disease 36 (12) Active malignancy 57 (19) Chronic lung disease 52 (17) Obstructive sleep apnea syndrome 32 (11) Immune suppression 32 (11) Chronic renal disease 45 (15) Heart failure 15 (5) Transplant (organ/other) 9 (3)
Zangrillo et al. (2021)	NR
Faverio et al. (2022)	Cardiovascular diseases 65 (22.6) Hypertension 82 (28.6) Cerebrovascular diseases 5 (1.7) Asthma 16 (5.6) Obstructive sleep apnea 6 (2.1) Chronic kidney diseases 9 (3.1) Liver diseases 4 (1.4) Diabetes 41 (14.3) Prior cancer 12 (4.2)
Rigoni et al. (2022)	Cardiovascular (including hypertension) 289 (61.5) Diabetes 82 (17.4) Gastrointestinal 73 (15.5) Autoimmune 62 (13.2) Obesity 55 (11.7) Pulmonary 57 (12.1) Renal 50 (10.6) Cancer 56 (11.9)
Liao et al. (2022)	Hypertension 15 (4.9) Hyperlipidemia 4 (1.3) Diabetes 2 (0.7) Heart disease 4 (1.3) Endocrine disease 4 (1.3) Liver disease 4 (1.3) Solid tumor 2 (0.7)
González et al. (2022)	Obesity 81 (45.5) Hypertension 78 (43.1)

Author (year)	Comorbidities, n (%)
	Diabetes mellitus (Type I/II) 42 (23.2) Chronic heart disease 22 (12.2) COPD/Bronchiectasis 14 (7.7) Chronic renal disease 11 (6.1) Asthma 10 (5.5) HIV 2 (1.1) Immunological disorders 1 (0.6)
Corsi et al. (2022)	Arterial hypertension 42 (66.8) Cardiovascular disease 14 (22.2) Obesity 20 (31.7) Diabetes 12 (19) Dyslipidemia 24 (38.1) Chronic renal failure 1 (1.6) Neoplasia (active history) 1 (1.6) Rheumatic pathology 5 (7.9) Immunodepression 3 (4.8) Epilepsy 1 (1.6)
Zhang et al. (2022)	NR
Liu et al. 2022	Hypertension 222 (37.4) Diabetes 103 (17.3) Cardiovascular disease 37 (6.2) Chronic lung diseases 50 (8.4) Malignancy 20 (3.4) Cerebrovascular disease 15 (2.5) Chronic hepatitis B 17 (2.9) Chronic kidney disease 2 (0.3) Gastrointestinal diseases 10 (1.7) Metabolic arthritis 7 (1.2) Autoimmune disease 6 (1.0)
Marando et al. 2022	Hypertension 14 (36.8) Diabetes 5 (13.1) Cardiovascular diseases 7 (18.4) Coronary heart disease 4 (10.5) Chronic respiratory diseases 8 (21) COPD 3 (7.9) Asthma 5 (13.1) Chronic kidney disease 3 (7.9) Malignancy 4 (10.5)

Author (year)	Comorbidities, n (%)
	Depression 4 (10.5)
Luger et al. 2022	NR
Pan et al. 2022	Hypertension 28 (13.4) Type 2 diabetes mellitus 13 (6.2) Coronary heart disease 11 (5.3)
Tarraso et al. 2022	Pulmonary disease 39 (18.7) Hypertension 82 (39.2) Diabetes 30 (14.4) Cardiovascular disease 21 (10.0)
Vijayakumar et al. 2022	Asthma 6 (18.8) COPD 2 (6.3) Hypertension 11 (34.4) Ischemic heart disease 3 (9.4) Hypercholesterolemia 4 (12.5) Type 2 diabetes mellitus 8 (25) Previous venous thromboembolism 1 (3.1) Anxiety and/or depression 4 (12.5)
Martino et al. 2022	Hypertension 33 (51.5) Diabetes 12 (18.7) Obesity 8 (12.5) Heart disease 16 (25) Lung disease 11 (17.2) Active cancer 4 (6.2) Rheumatic diseases 6 (9.4)
Bocchino et al. 2022	Type II diabetes 23 (27.4) Arterial systemic hypertension 55 (65.5) Cardiovascular diseases 17 (20.2) Chronic lung diseases 7 (8.3) Obesity 24 (28.6)
Huang et al. 2022	Hypertension 410 (34.4) Diabetes 164 (13.8) Coronary heart diseases 104 (8.7) Cerebrovascular diseases 66 (5.5) Chronic kidney disease 50 (4.2) Malignancy 31 (2.6)

Author (year)	Comorbidities, n (%)
	COPD 18 (1.5)
Barini et al. 2022	NR
van Raaij et al. 2022	Hypertension 18 (27.3) Diabetes mellitus 14 (21.2) Asthma 9 (13.6) Coronary artery disease 7 (10.6) Hypercholesterolemia 6 (9.1) Immunodeficiency 4 (6.1) Heart valve anomaly 4 (6.1) Chronic kidney disease 4 (6.1) Atrial fibrillation or flutter 3 (4.5) Cerebrovascular diseases 2 (3) Chronic obstructive pulmonary disease 2 (3) Pulmonary embolism (before COVID-19) 1 (1.5)
Lenoir et al. 2022	Interstitial lung disease 8 (2) Asthma 74 (15) Coronary artery disease 46 (9) Arterial hypertension 207 (40) Pulmonary hypertension 9 (2) Heart failure 29 (6) Pulmonary embolism/DVT 20 (4) GERD with PPI 45 (9) GERD without PPI 11 (2) Sleep apnea 68 (14) Lung cancer 4 (1) Other cancer 46 (9) Connective tissue disease or vasculitis 4 (1) Depression/anxiety 49 (11) Diabetes 94 (18) Chronic renal failure 31 (7) Solid organ transplant 5 (1) Other comorbidities 224 (47)
Guo et al. 2022	Hypertension 75 (36.1) Diabetes 23 (11.1) Cardiovascular disease 14 (6.7)
Bernardinello et al. 2023	Cardiovascular diseases 174 (50.1) Respiratory diseases 50 (14.5)

Author (year)	Comorbidities, n (%)
	Autoimmune diseases 52 (15) Metabolic diseases 158 (45.5) Oncologic diseases 57 (16.4)
Han et al. 2023	Type 2 diabetes 15 (10) Hypertension 60 (42) Cardiovascular disease 7 (5)
Bongiovanni et al. 2023	COPD 31 (13.3) Asthma 26 (11.2) Diabetes 76 (32.6) Cardiovascular 119 (51.1) Autoimmune 19 (8.2) Renal failure 21 (9)
Lerum et al. 2023	Diabetes mellitus 22 (8) Hypertension 80 (33) COPD 13 (5) Obesity 78 (31)
Sanna et al. 2023	Arterial hypertension 43 (43) COPD 7 (7) Asthma 14 (14) Interstitial lung disease 0 (0) Obesity/overweight 64 (64)
Núñez-Fernández et al. 2023	Chronic cardiopathy 36 (18.6) Diabetes 21 (10.8) Hypertension 71 (36.6) COPD 13 (6.7) Chronic kidney failure 6 (3.1)
Mulet et al. 2023	Pulmonary disease 23 (17) Hypertension 47 (34.8) Diabetes 28 (20.7) Cardiovascular disease 16 (11.9)
Nouredine et al. 2023	Obesity (BMI>30) 33 (55) Ischemic heart disease 5 (8.3) Hypertension 28 (46.7) Dyslipidemia 21 (35) Diabetes 15 (25)

Author (year)	Comorbidities, n (%)
	COPD 5 (8.3) Asthma 6 (10) Sleep apnea 12 (20) Deep vein thrombosis 3 (5) Pulmonary embolism 0 (0)
Sahanic et al. 2023	Metabolic disease 42 (45) Diabetes 15 (16) Hypercholesterolemia 21 (23) Cardiovascular disease 40 (43) Pulmonary disease 19 (20) Malignancy 9.3 (10) Immune deficiency 5.6 (6) Chronic kidney disease 6.5 (7) Gastrointestinal disease 13 (14)
van der Sar-van der Brugge et al. 2023	Diabetes mellitus 30 (19) Cardiovascular disease 41 (25) COPD 25 (16) Asthma 23 (14.3) Chronic kidney disease 11 (7) Malignancy 18 (11) Chronic hematologic disease 3 (2)
Schlemmer et al., 2023	Cardiovascular disease 244 (50.3) COPD 12 (2.5) Emphysema 17 (3.5) Asthma 32 (6.6) Interstitial lung disease 8 (1.6) Non-cystic fibrosis bronchiectasis 5 (1.0) Obstructive sleep apnea 46 (9.5) Diabetes 107 (22.1) Immune deficiency (all causes) 52 (10.7)
Flor et al., 2023	NR

Supplemental Table S2. Pooled Event Rates of Chest CT Findings Over Time For All Patients.

UE: Unable to estimate. *p < 0.05

	1-6 months		12-24 months	
Chest CT findings	Event rate (95% CI)	I ²	Event rate (95% CI)	I ²
Any Abnormality	0.75 (0.63-0.84)*	0.89	0.63 (0.49-0.75)*	0.95
Bronchiectasis	0.18 (0.11-0.29)*	0.95	0.17 (0.10-0.28)*	0.95
Consolidation	0.06 (0.03-0.09)*	0.93	0.03 (0.02-0.04)*	0.70
Fibrotic-like Changes	0.44 (0.3-0.59)*	0.9	0.38 (0.23-0.56)*	0.94
GGO	0.43 (0.32-0.55)*	0.94	0.25 (0.17-0.35)*	0.93
Honeycombing	0.03 (0.02-0.07)	UE	0.04 (0.02-0.07)	0.40
Reticulation	0.29 (0.17-0.45)*	0.93	0.28 (0.18-0.41)*	0.92
Interlobular Septal Thickening	0.25 (0.13-0.44)*	0.94	0.22 (0.06-0.55)*	0.92

Supplemental Table S3. Summary of Meta-Regression Models for the Pooled Event Rate Each Lung Abnormality Using Months Since Primary Infection as the Independent Predictor

Abnormality	Beta Coefficient (Months)	P-Value
Any Abnormality	-0.137	0.002
GGO	-0.169	<0.001
Fibrotic-Like Changes	0.047	0.265
Bronchiectasis	0.034	0.373
Reticulation	-0.002	0.955
Consolidation	-0.177	<0.001
Interlobular Septal Thickening	-0.118	0.096
Honeycombing	0.075	0.03

Supplemental Table S4. Pooled Event Rates for Chest CT findings with COVID-19 Severity as the Mediator.

UE: Unable to estimate. *p<0.05, **p≤0.01

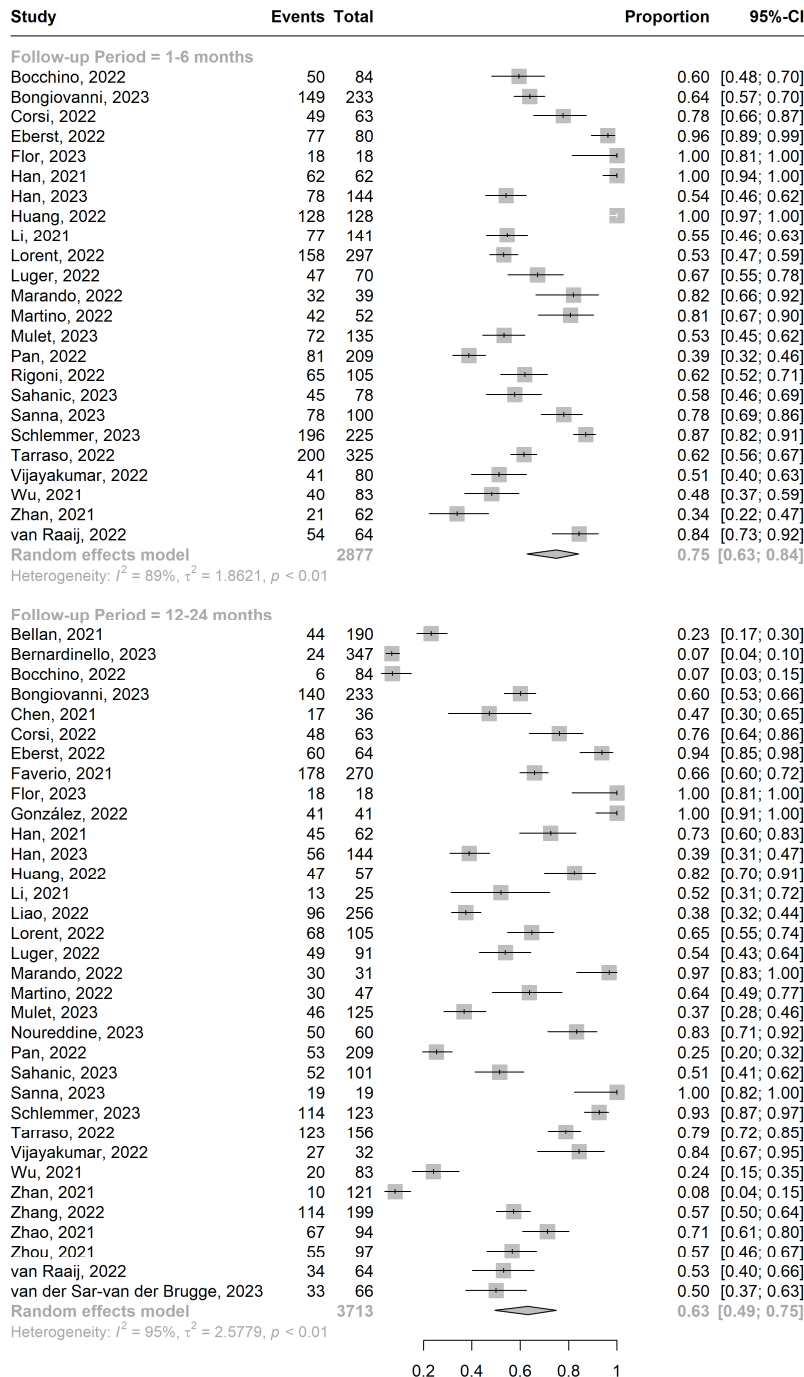
Chest CT Findings	Severe subgroup				Non-severe subgroup				Non-severe vs. severe	
	1-6 months		12-24 months		1-6 months		12-24 months			
	Event rate (95%CI)	I ²	Event rate (95%CI)	I ²	Event rate (95%CI)	I ²	Event rate (95%CI)	I ²	P (1-6 months)	P (12-24 months)
Any Abnormality	0.6 (0.39-0.78)	0.77	0.39 (0.21-0.6)	0.86	0.88 (0.75-0.95)**	0.92	0.75 (0.63-0.84)**	0.94	0.01	<0.001
Bronchiectasis	0.09 (0.06-0.14)**	0.56	0.09 (0.04-0.16)**	0.71	0.29 (0.16-0.46)**	0.96	0.24 (0.13-0.4)**	0.96	<0.001	0.02
Consolidation	0.04 (0.02-0.09)**	0	0.01 (0-0.05)**	0.64	0.1 (0.06-0.17)**	0.93	0.05 (0.03-0.07)**	0.61	0.06	0.07
Fibrotic-like Changes	0.35 (0.26-0.46)**	0.78	0.21 (0.11-0.34)**	0.93	0.5 (0.28-0.72)*	0.83	0.45 (0.27-0.65)**	0.92	0.27	0.03
GGO	0.34 (0.17-0.57)	0.9	0.17 (0.1-0.28)**	0.87	0.44 (0.29-0.6)*	0.93	0.26 (0.17-0.38)	0.88	0.50	0.21
Honeycombing	0 (0-1)	UE	UE	UE	0.06 (0.04-0.09)**	0	0.05 (0.03-0.09)**	0.60	1	UE
Reticulation	0.12 (0.06-0.23)**	0.84	0.07 (0.02-0.17)**	0.72	0.36 (0.2-0.56)*	0.93	0.33 (0.21-0.49)*	0.92	0.01	<0.001
Interlobular Septal Thickening	0.11 (0.08-0.16)**	0.53	0.07 (0.05-0.1)**	0	0.28 (0.1-0.57)	0.94	0.22 (0.05-0.63)	0.81	0.09	0.16

Supplemental Table S5. Summary of Meta-Regression Models for the Pooled Event Rate Each Lung Abnormality Stratified by Primary COVID-19 Infection Severity Using Months Since Primary Infection as the Independent Predictor

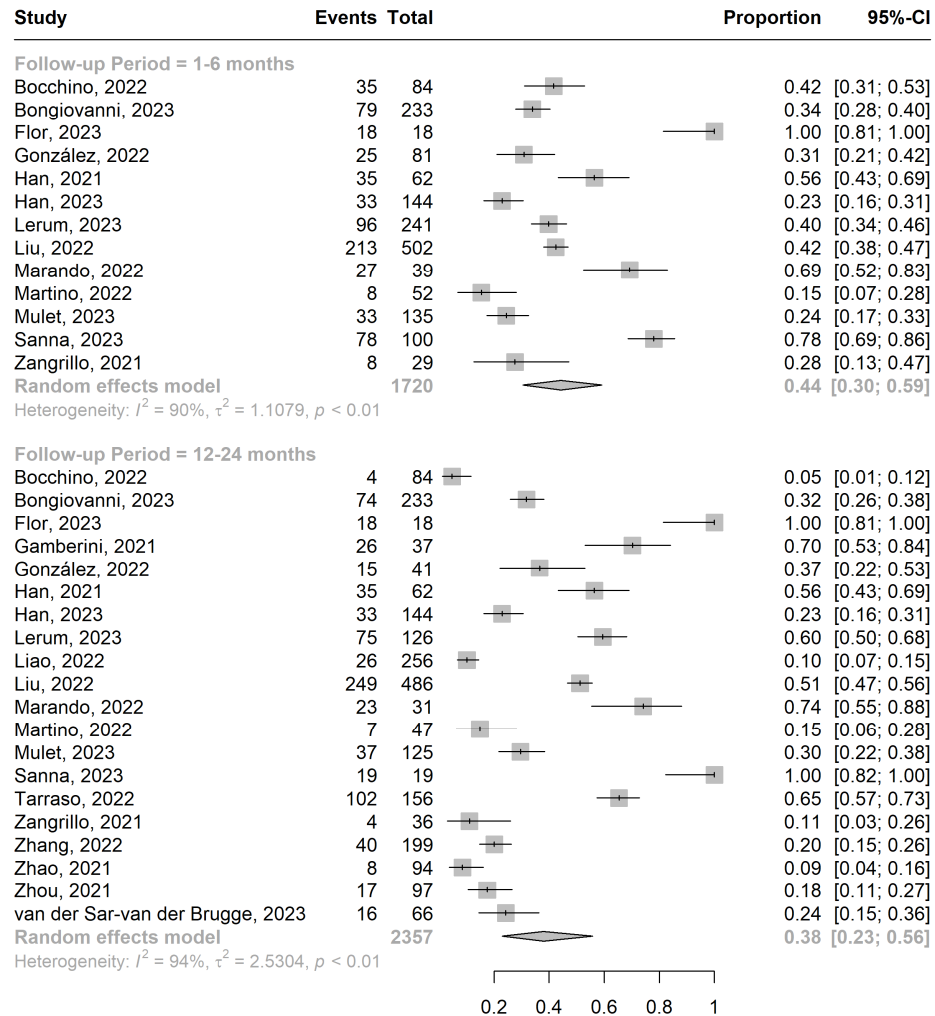
Abnormality	Non-Severe		Severe	
	Beta Coefficient (Months)	P-Value	Beta Coefficient (Months)	P-Value
Any Abnormality	-0.192	0.01	-0.11	0.032
GGO	-0.181	0.001	-0.148	<0.001
Fibrotic-Like Changes	0.016	0.793	0.087	0.109
Bronchiectasis	0.03	0.595	-0.006	0.901
Reticulation	-0.058	0.369	-0.04	0.324
Consolidation	-0.278	0.001	-0.145	0.001
Interlobular Septal Thickening	-0.069	0.004	-0.136	0.094
Honeycombing	Not Enough Effect Sizes		0.033	0.377

Supplemental Figure S1. Meta Analysis the Follow-up Chest CT Lung Abnormalities Over Time for the Entire Population

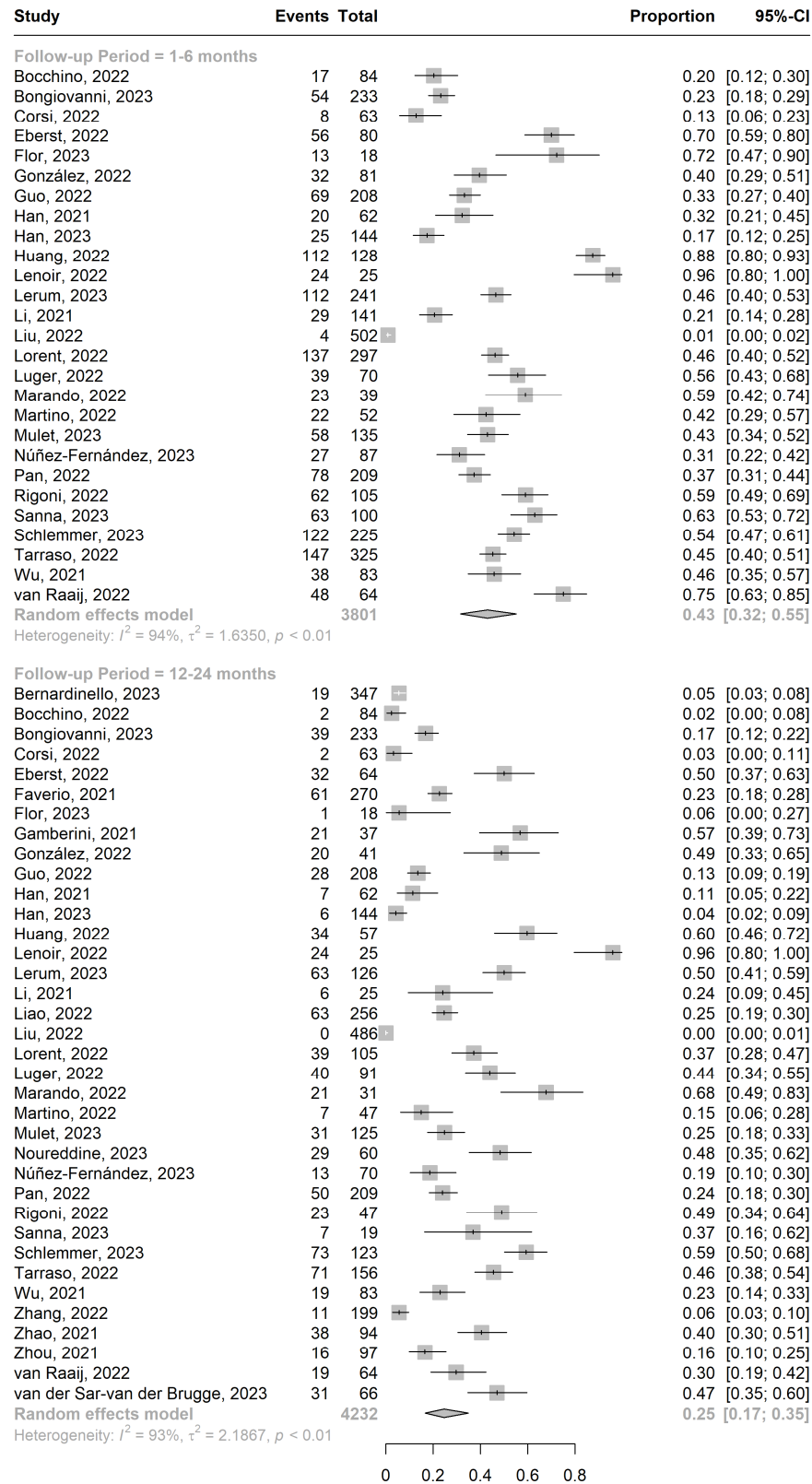
Any Abnormality



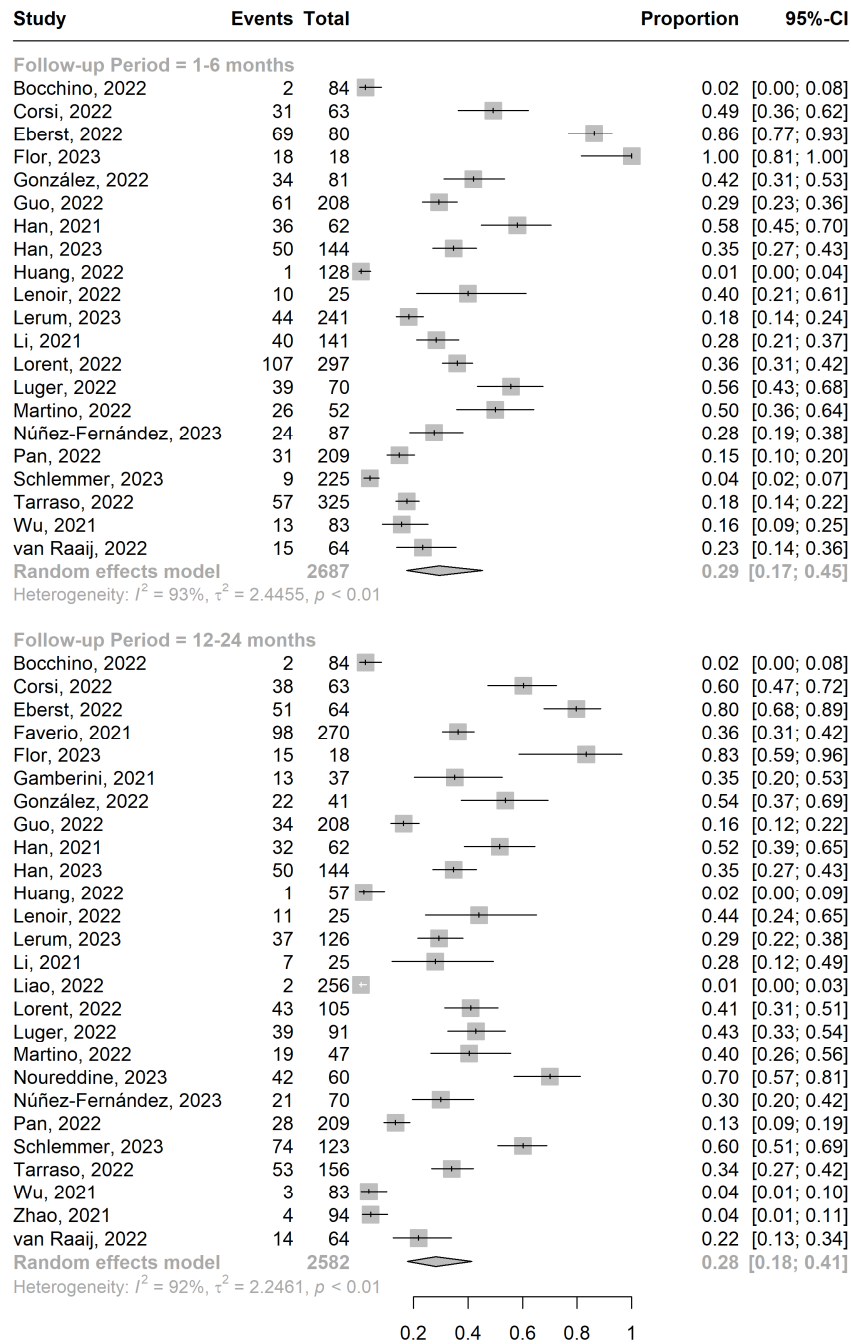
Fibrotic-like changes



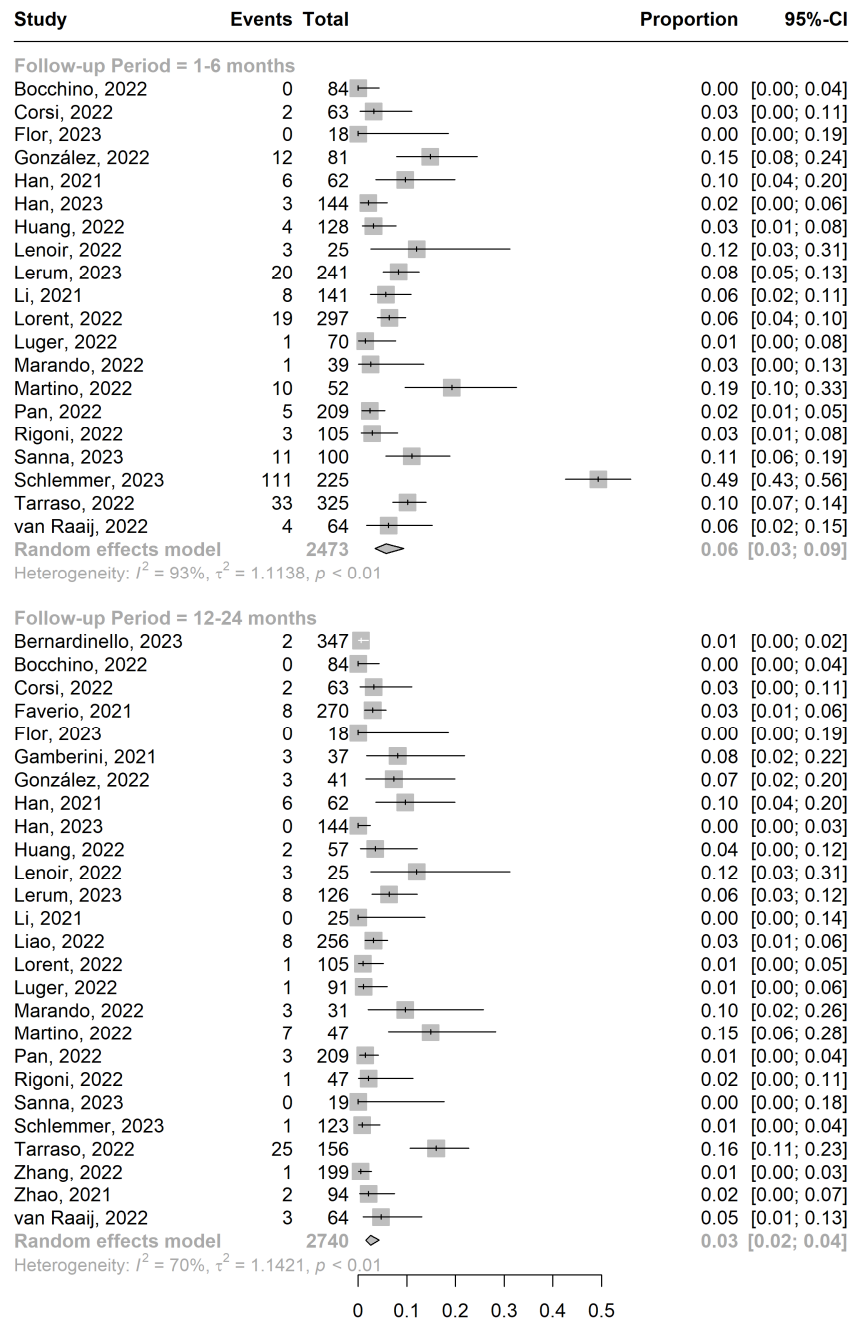
Ground Glass Opacities



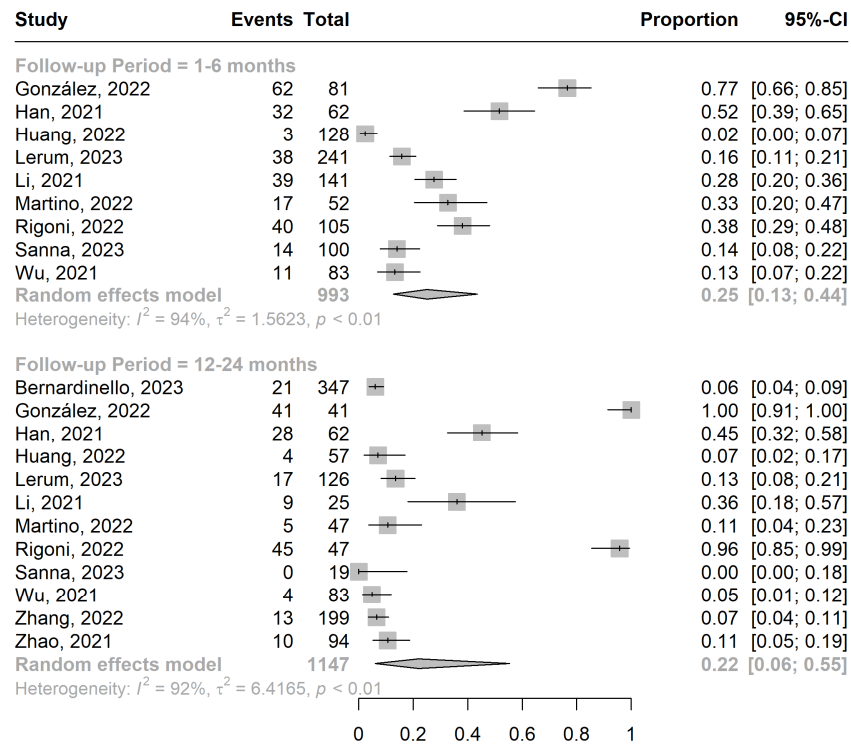
Reticulation



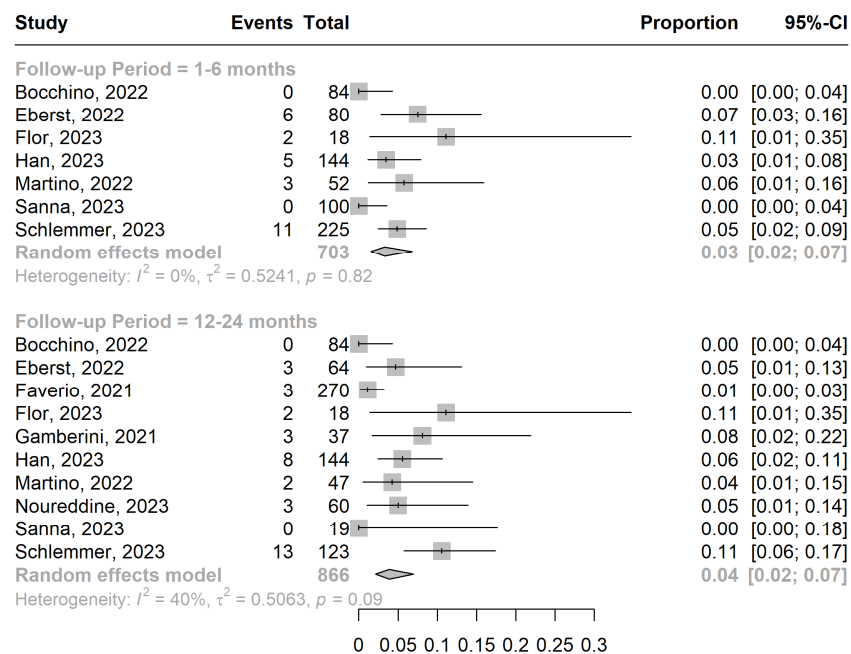
Consolidation



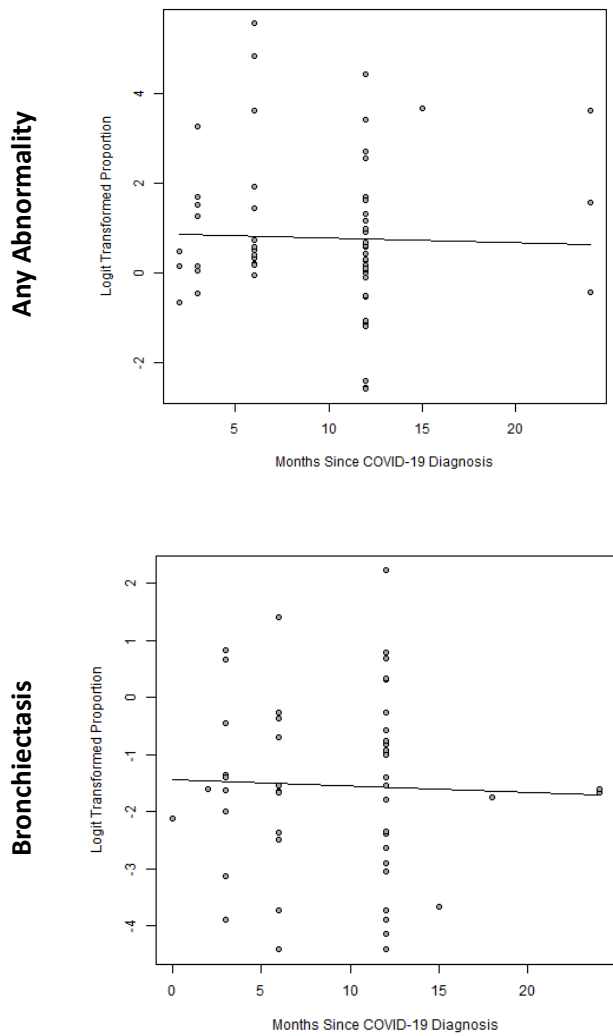
Interlobular Septal Thickening



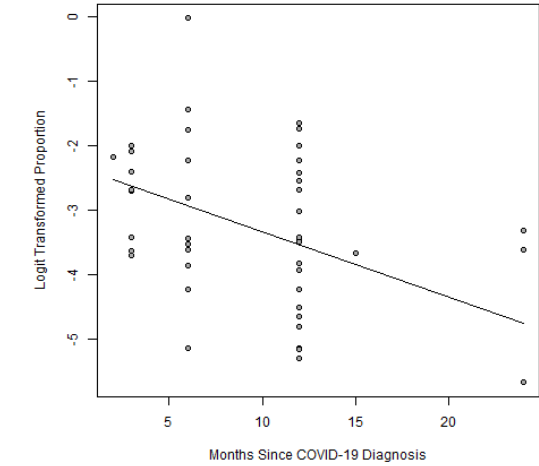
Honeycombing



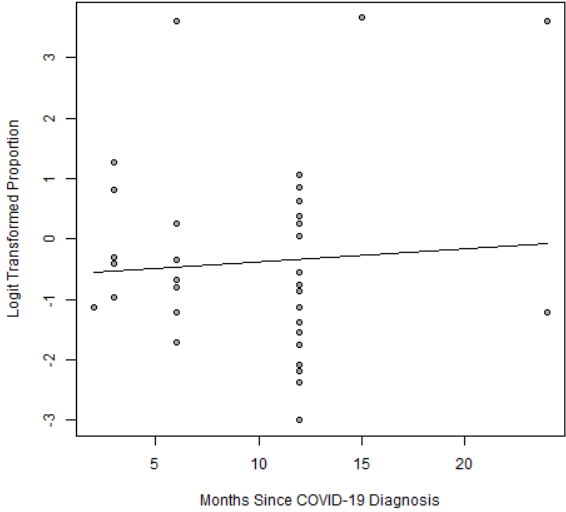
Supplemental Figure S2. Meta-Regression Plots for the Pooled Event Rate Each Lung Abnormality Using Months Since Primary Infection as the Independent Predictor



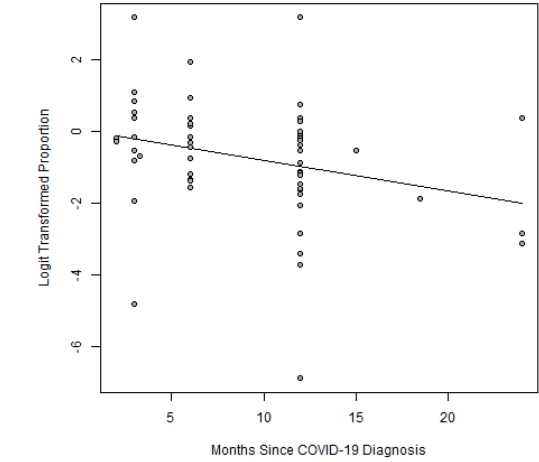
Consolidation



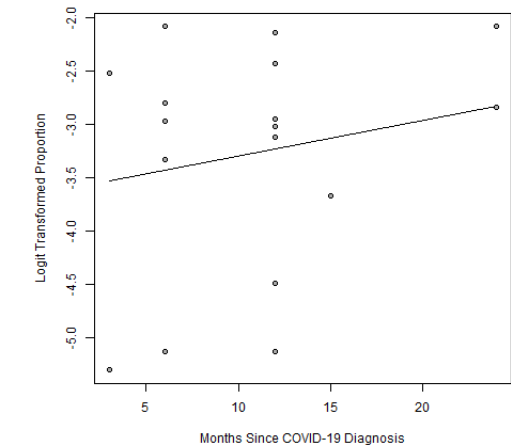
Fibrotic Like Changes



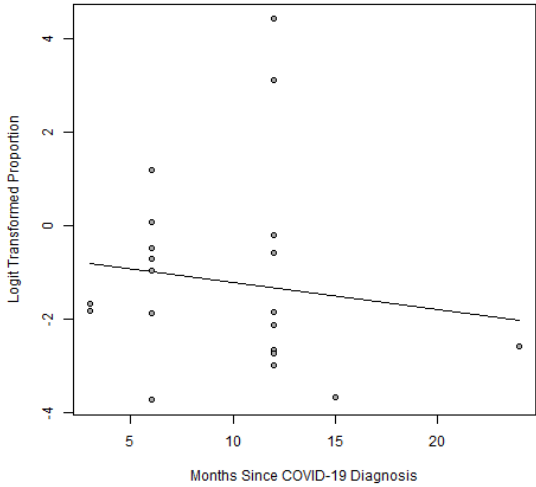
GGO



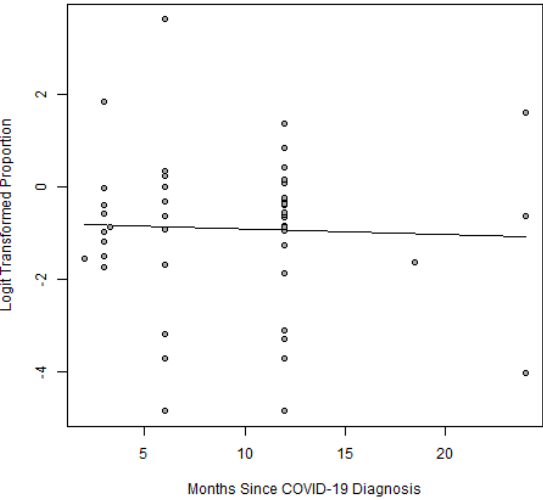
Honeycombing



Interlobular Septal Thickening



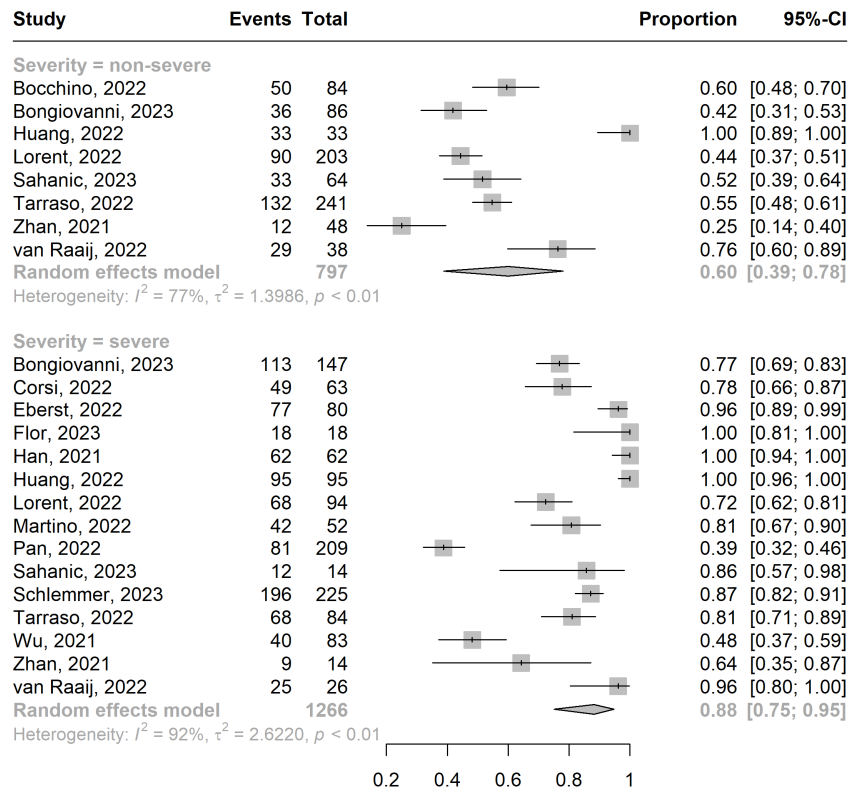
Reticulation



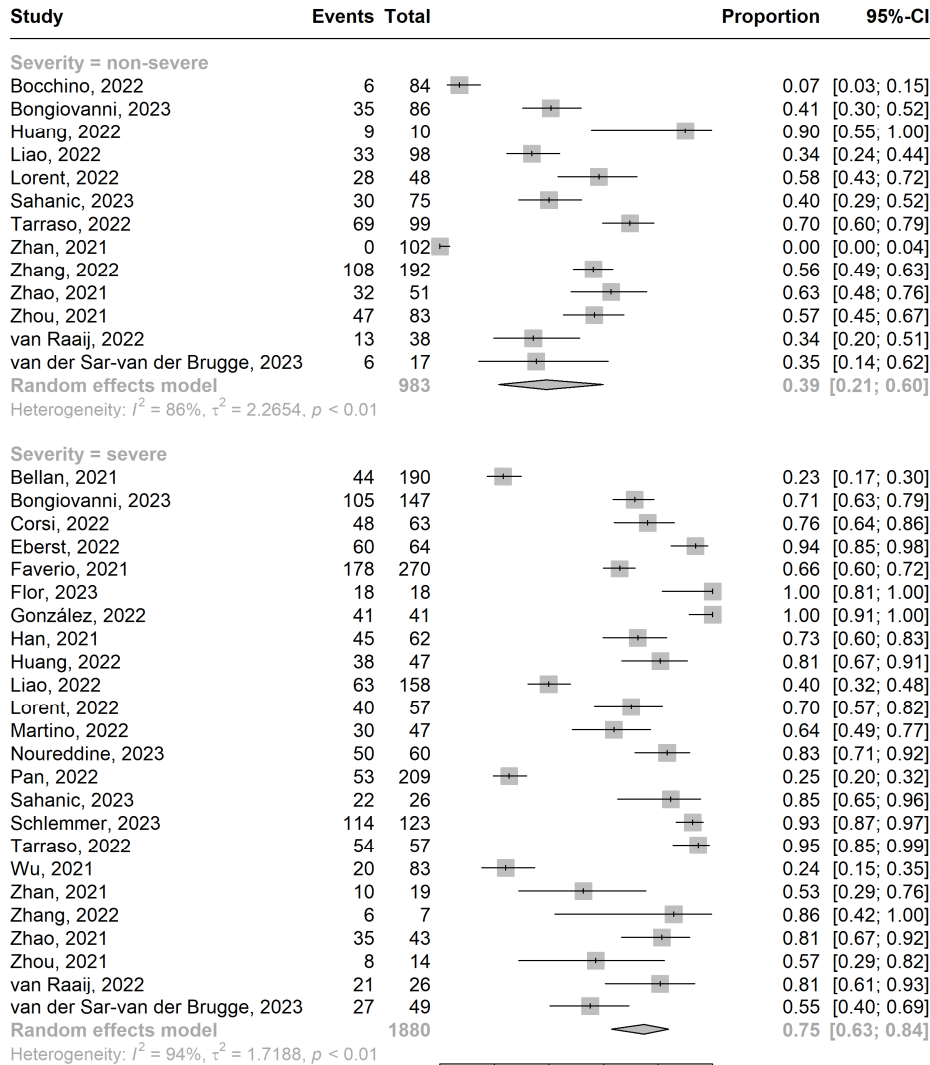
Supplemental Figure S3. Meta Analysis the Follow-up Chest CT Lung Abnormalities Over Time for the Entire Population Stratified by Primary COVID-19 Infection Severity

Any Abnormality

1-6 months

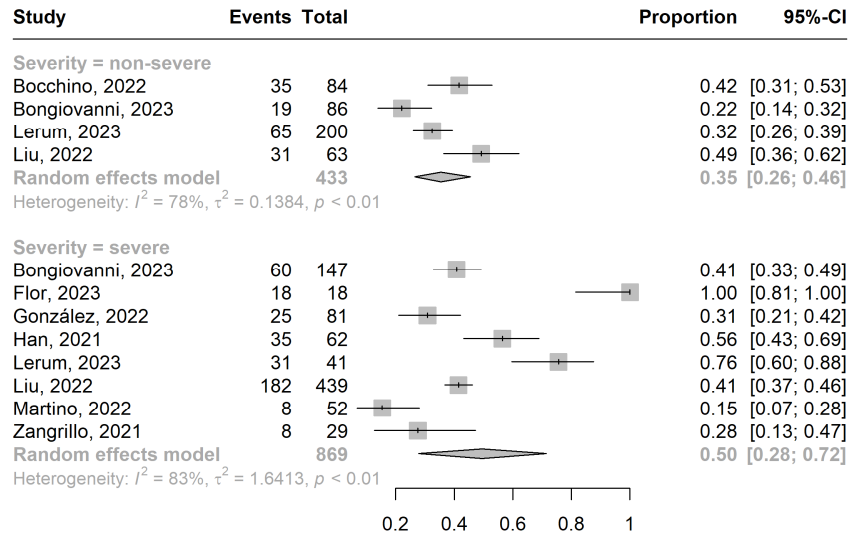


12-24 Months

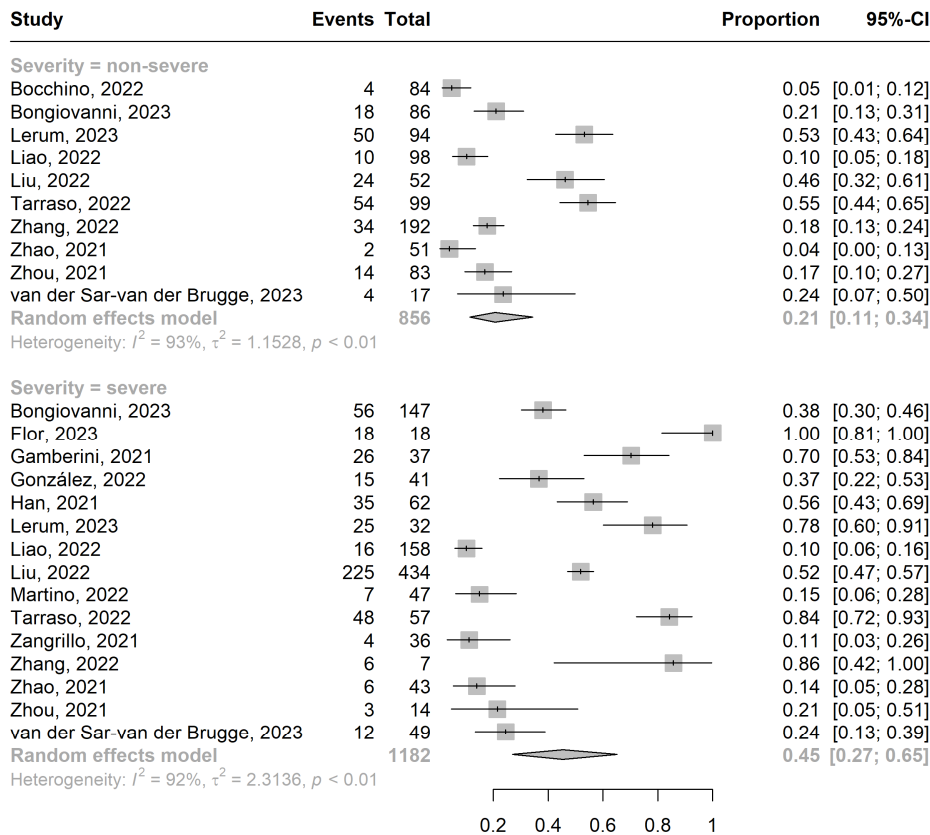


Fibrotic-like changes

1-6 Months

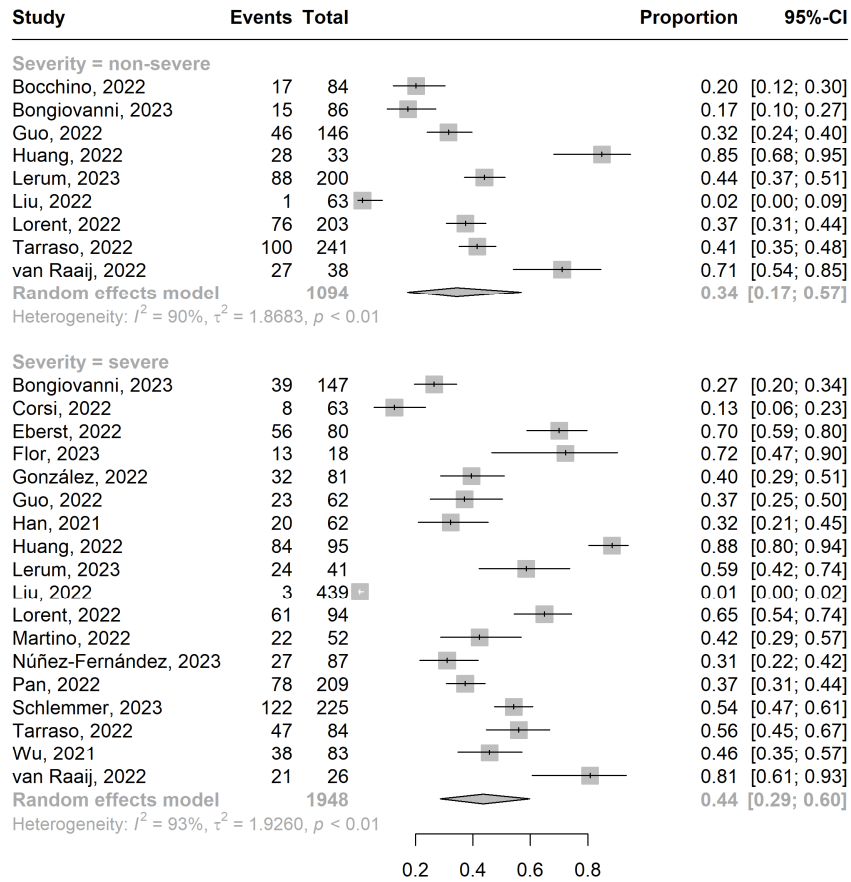


12-24 Months

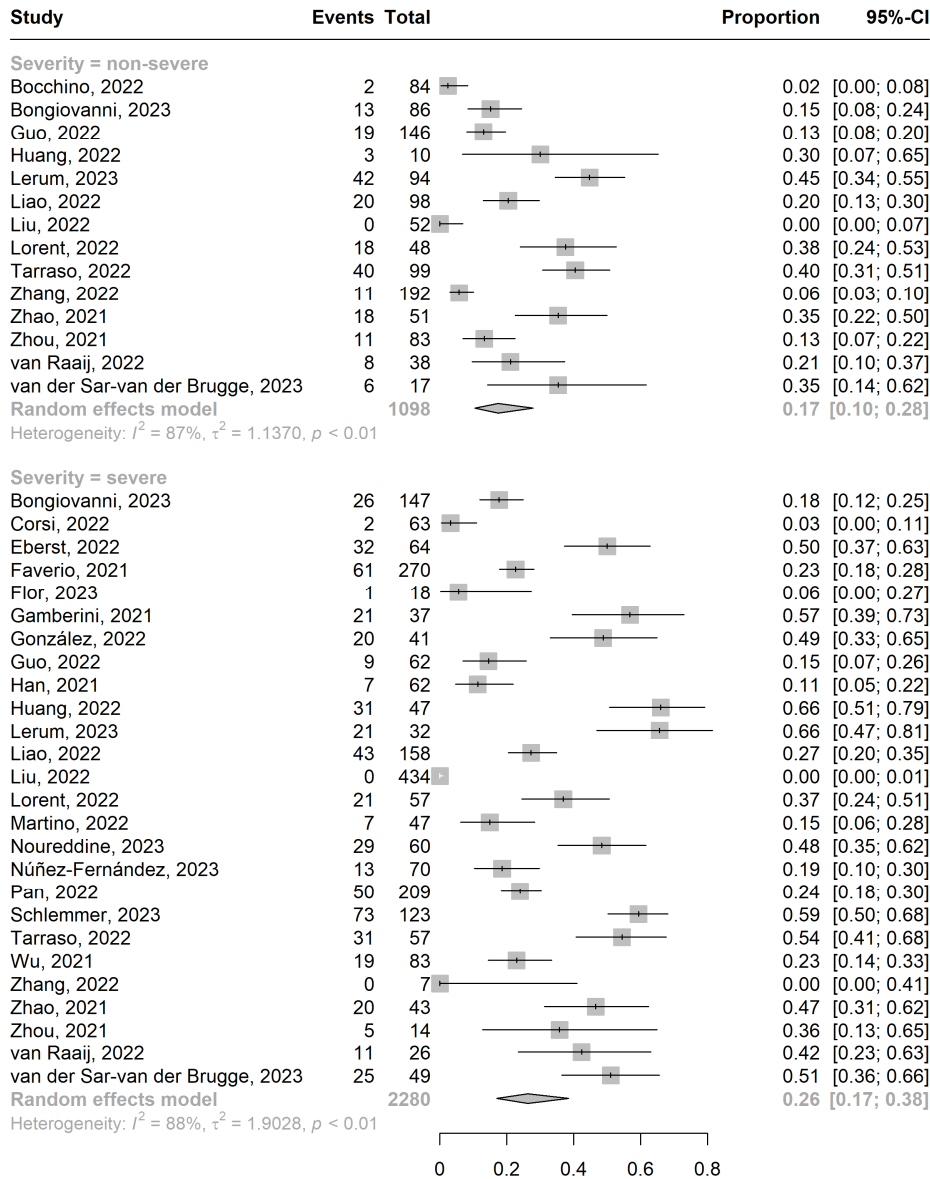


Ground Glass Opacities

1-6 Months

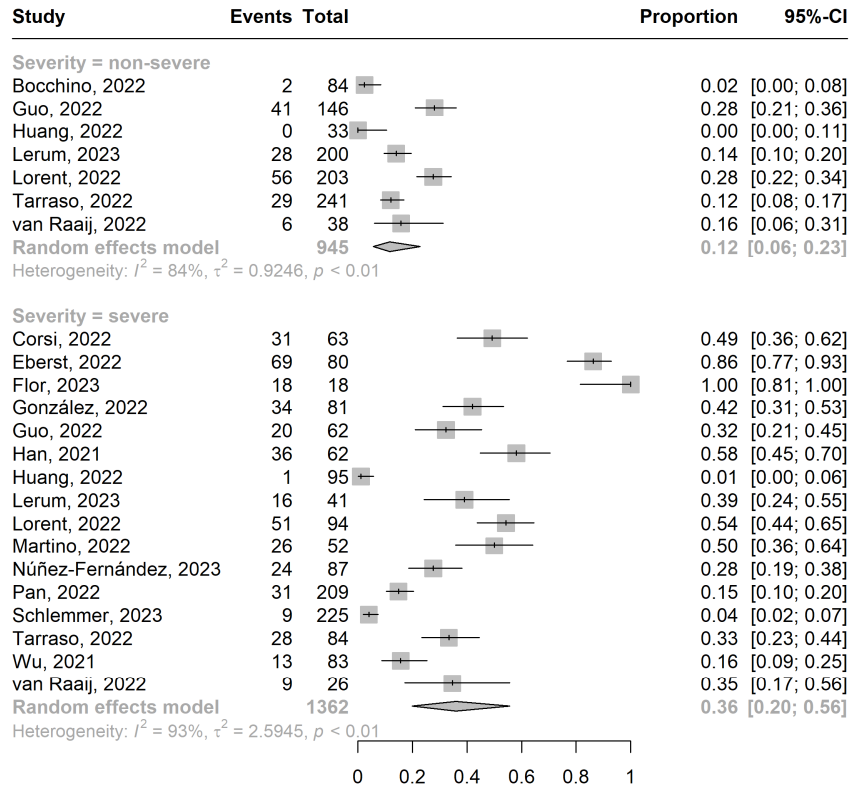


12-24 Months

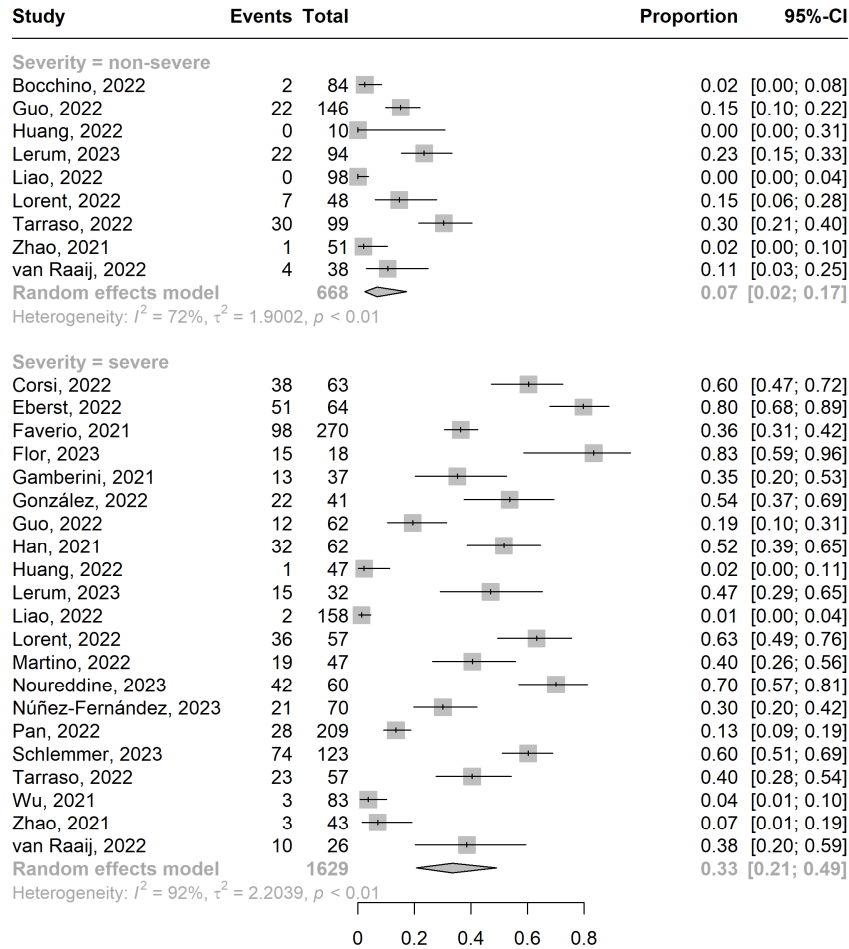


Reticulation

1-6 Months

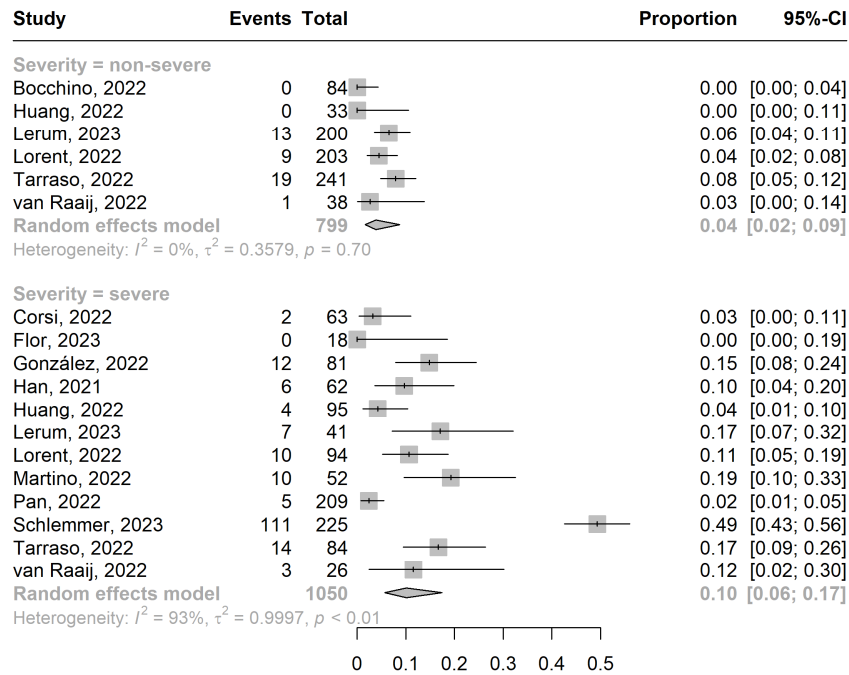


12-24 Months

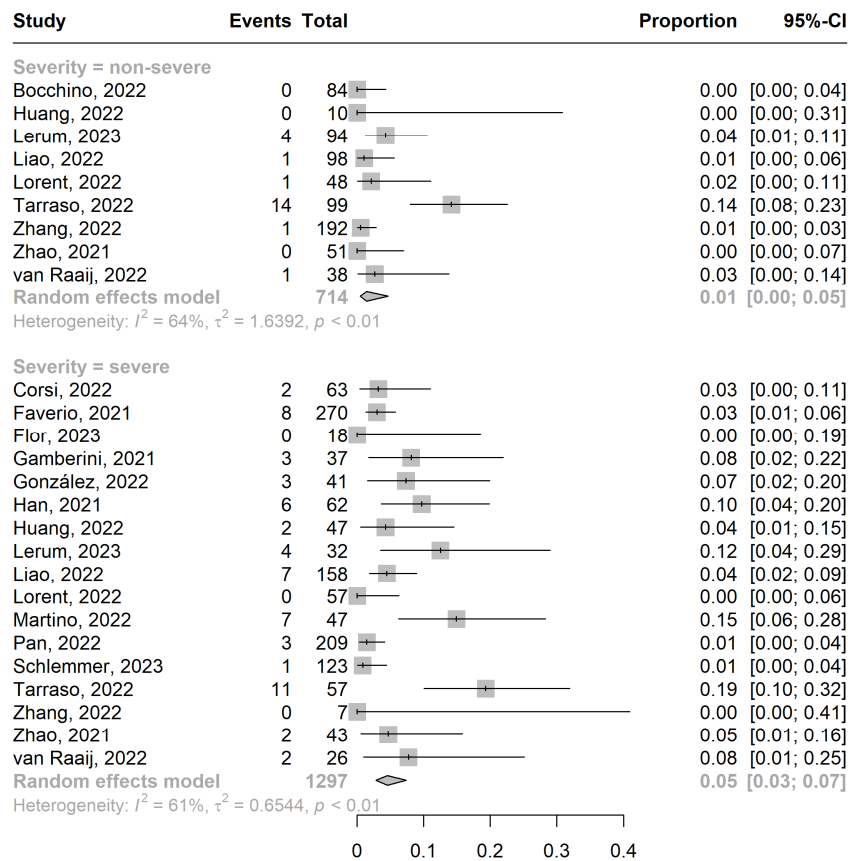


Consolidation

1-6 Months

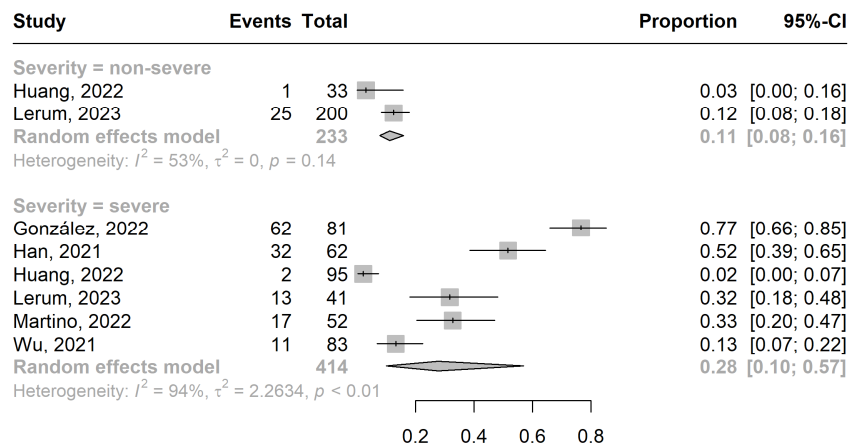


12-24 Months

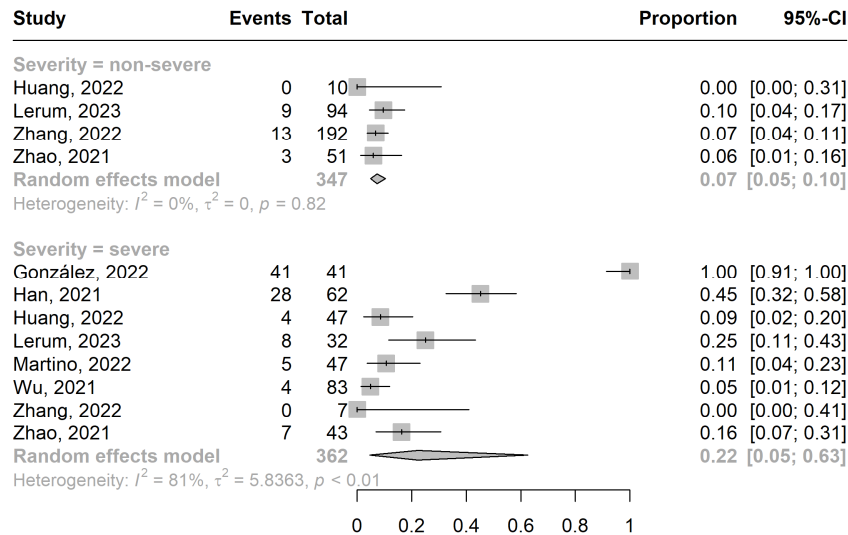


Interlobular Septal Thickening

1-6 Months

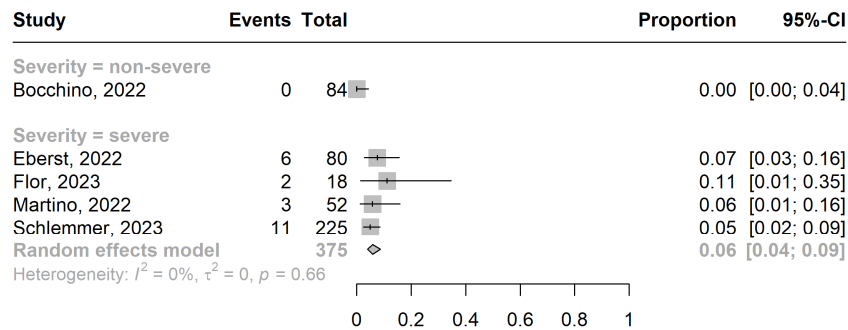


12-24 Months

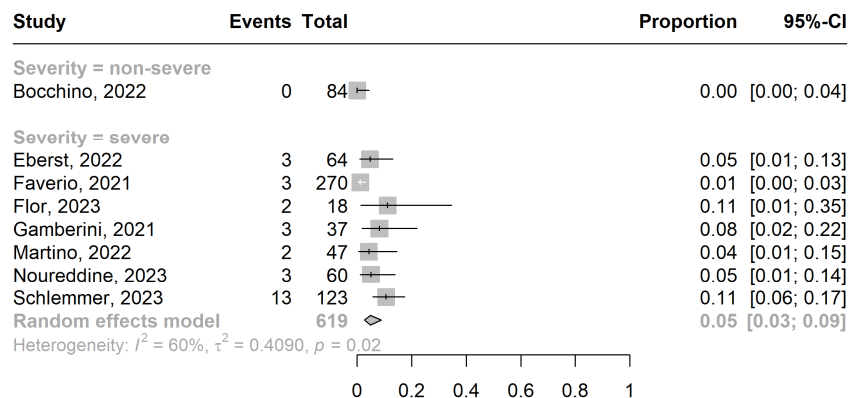


Honeycombing

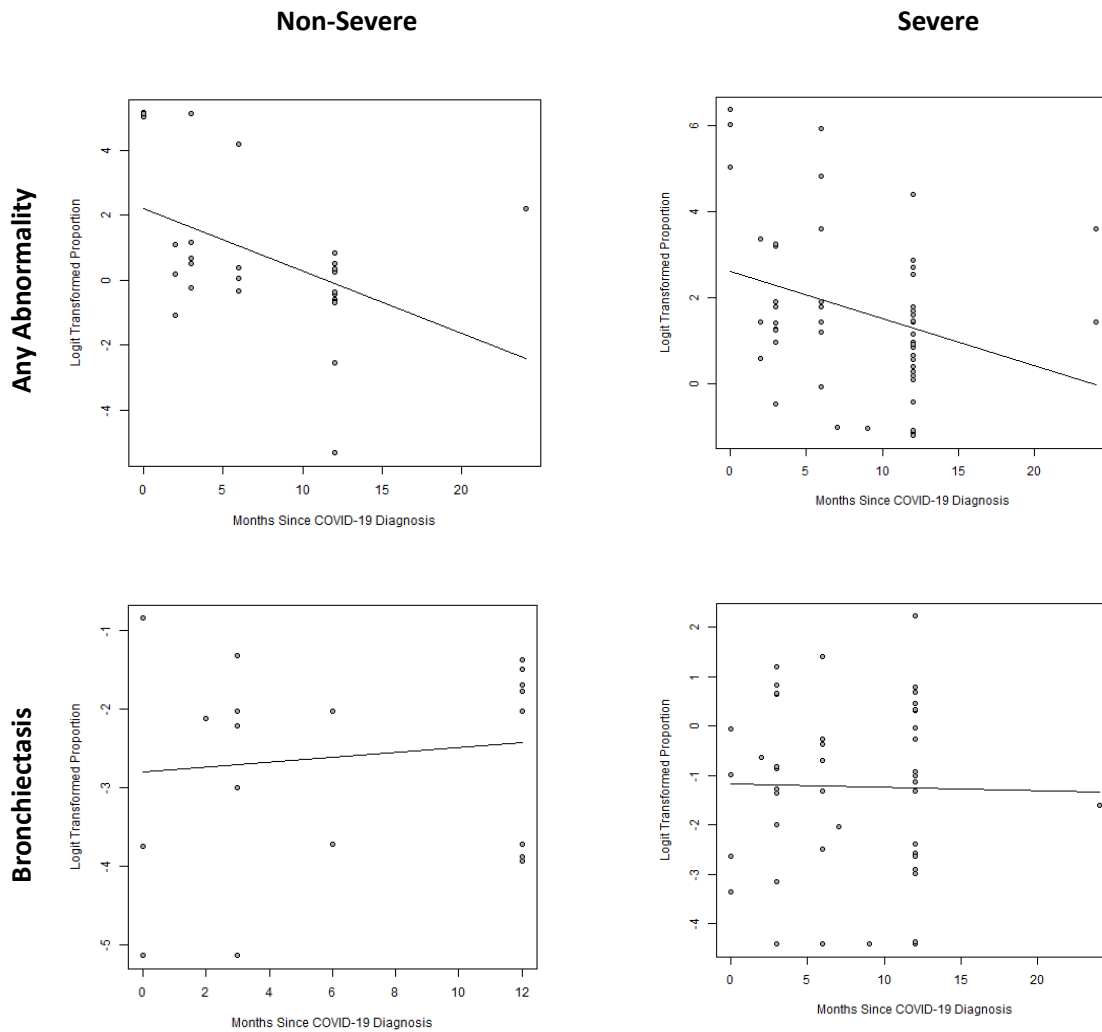
1-6 Months

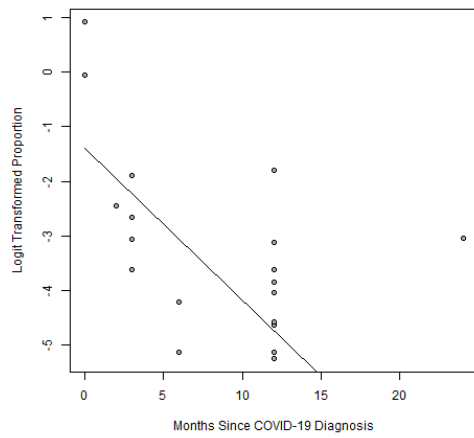
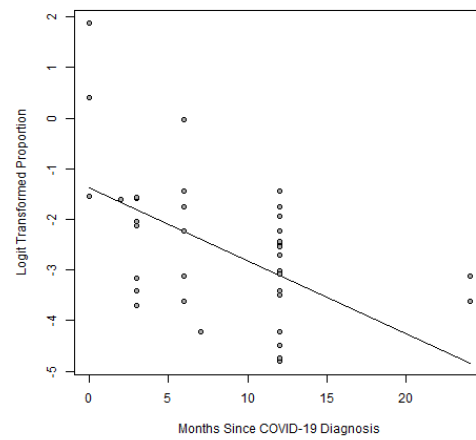
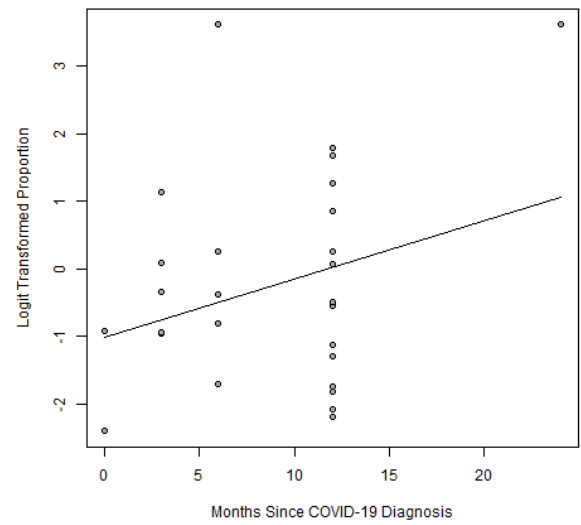
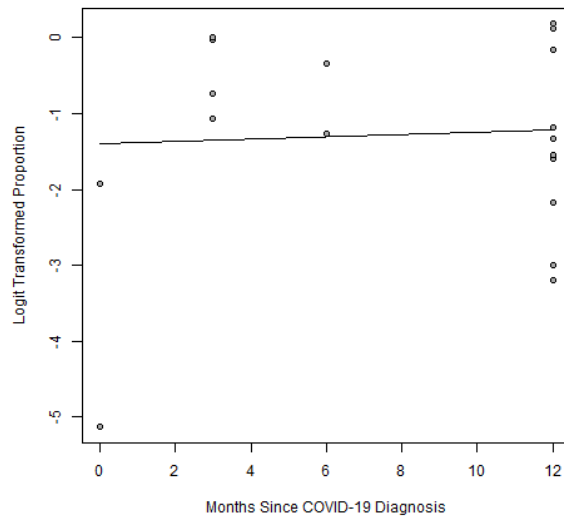
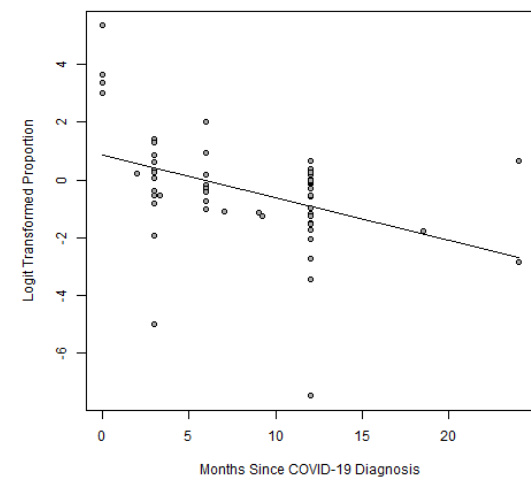
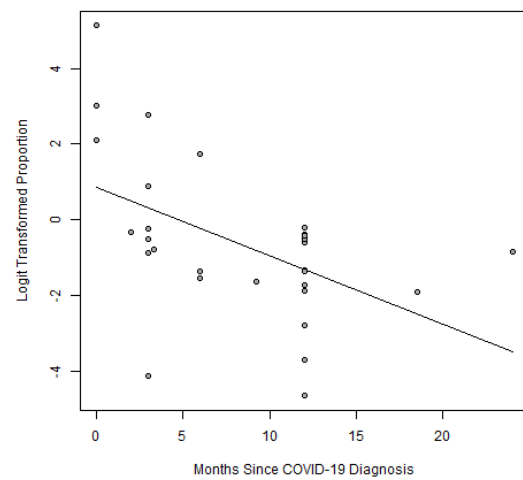


12-24 Months

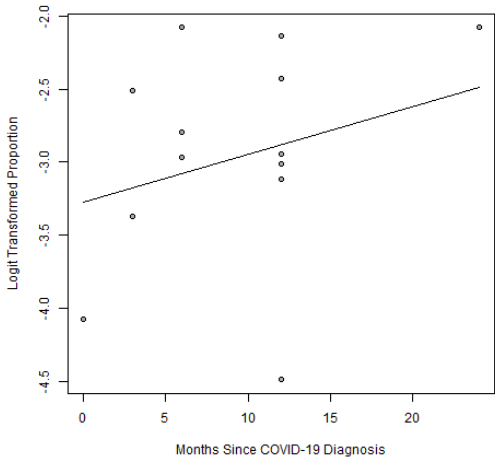


Supplemental Figure S4. Meta-Regression Plots for the Pooled Event Rate Each Lung Abnormality Stratified by Primary COVID-19 Infection Severity Using Months Since Primary Infection as the Independent Predictor



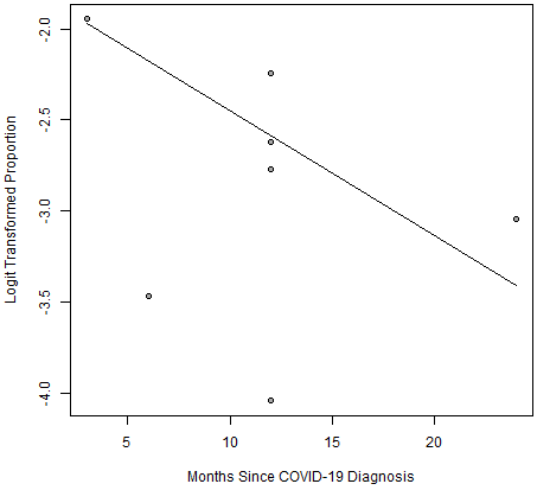
Consolidation**Non-Severe****Severe****Fibrotic Like Changes****GGO**

Honeycombing

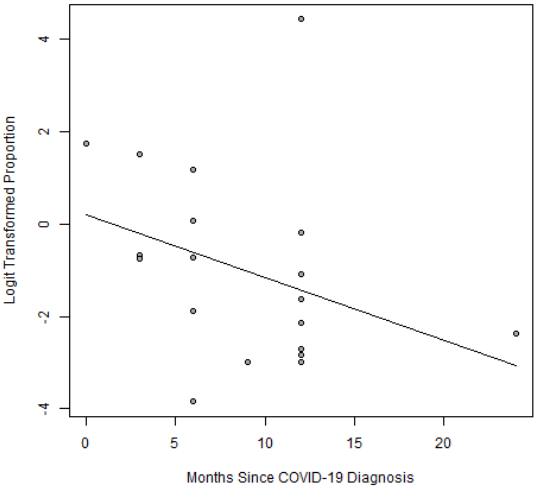


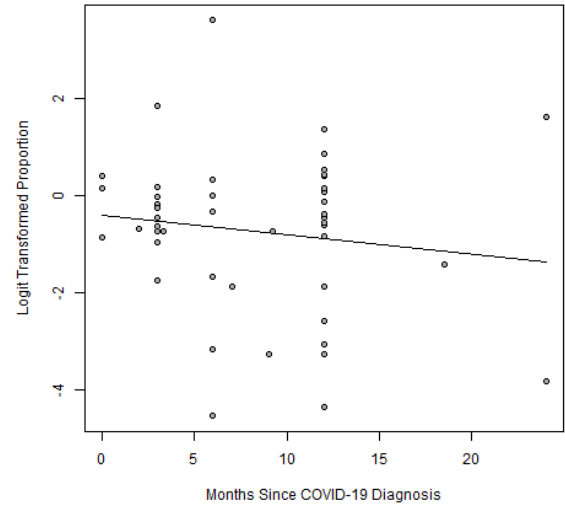
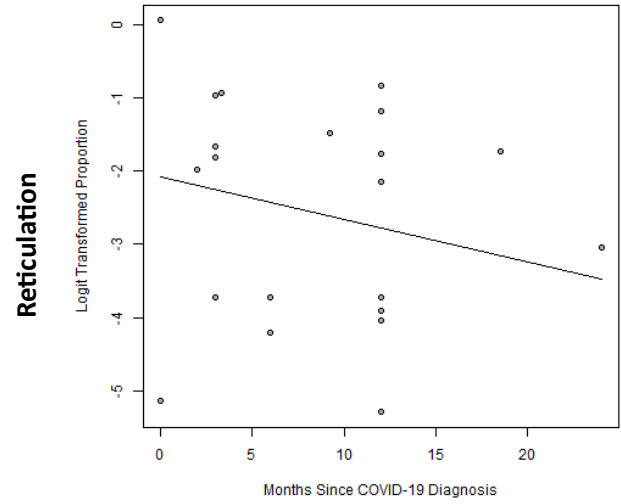
Non-Severe

Interlobular Septal Thickening



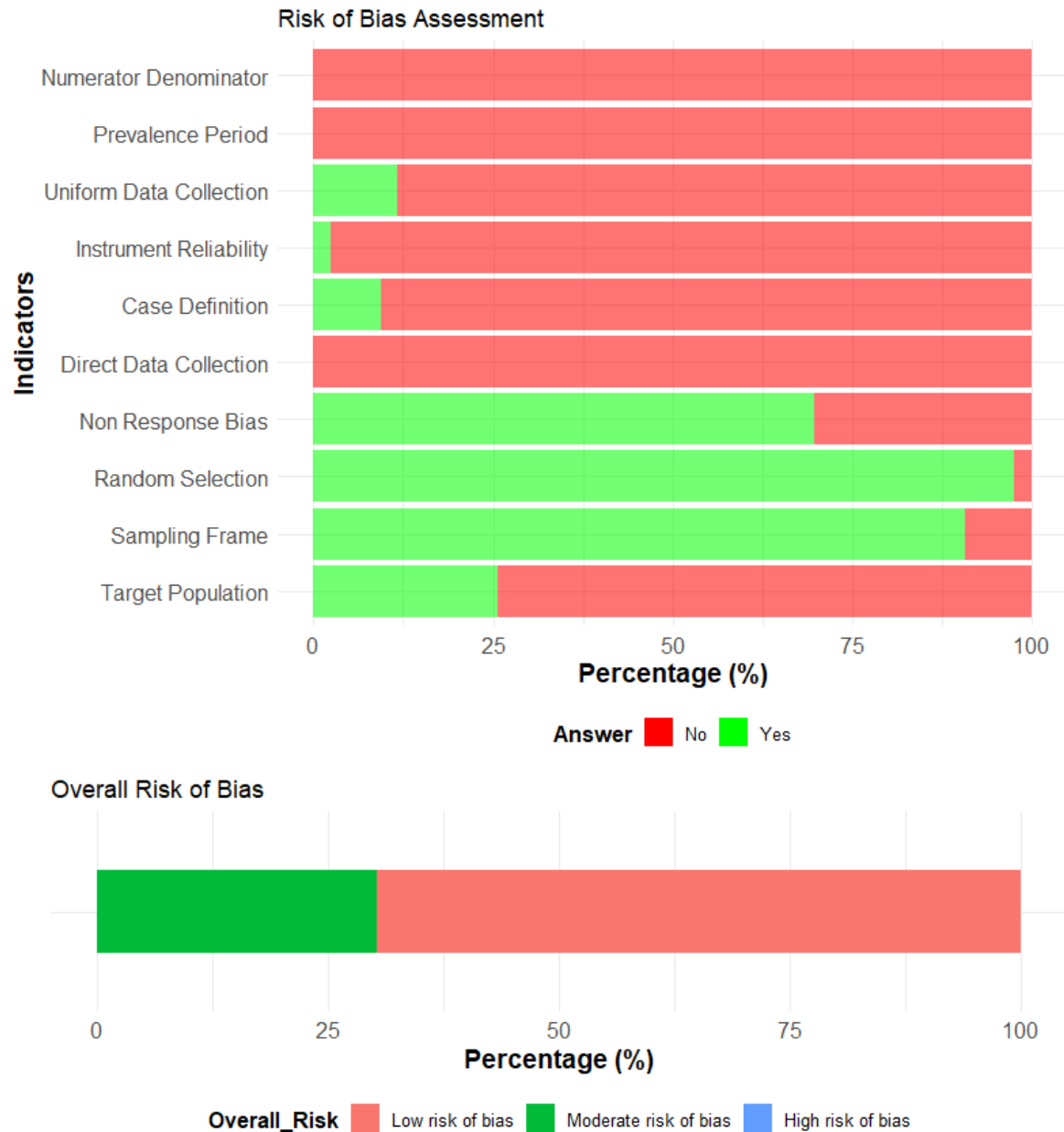
Severe



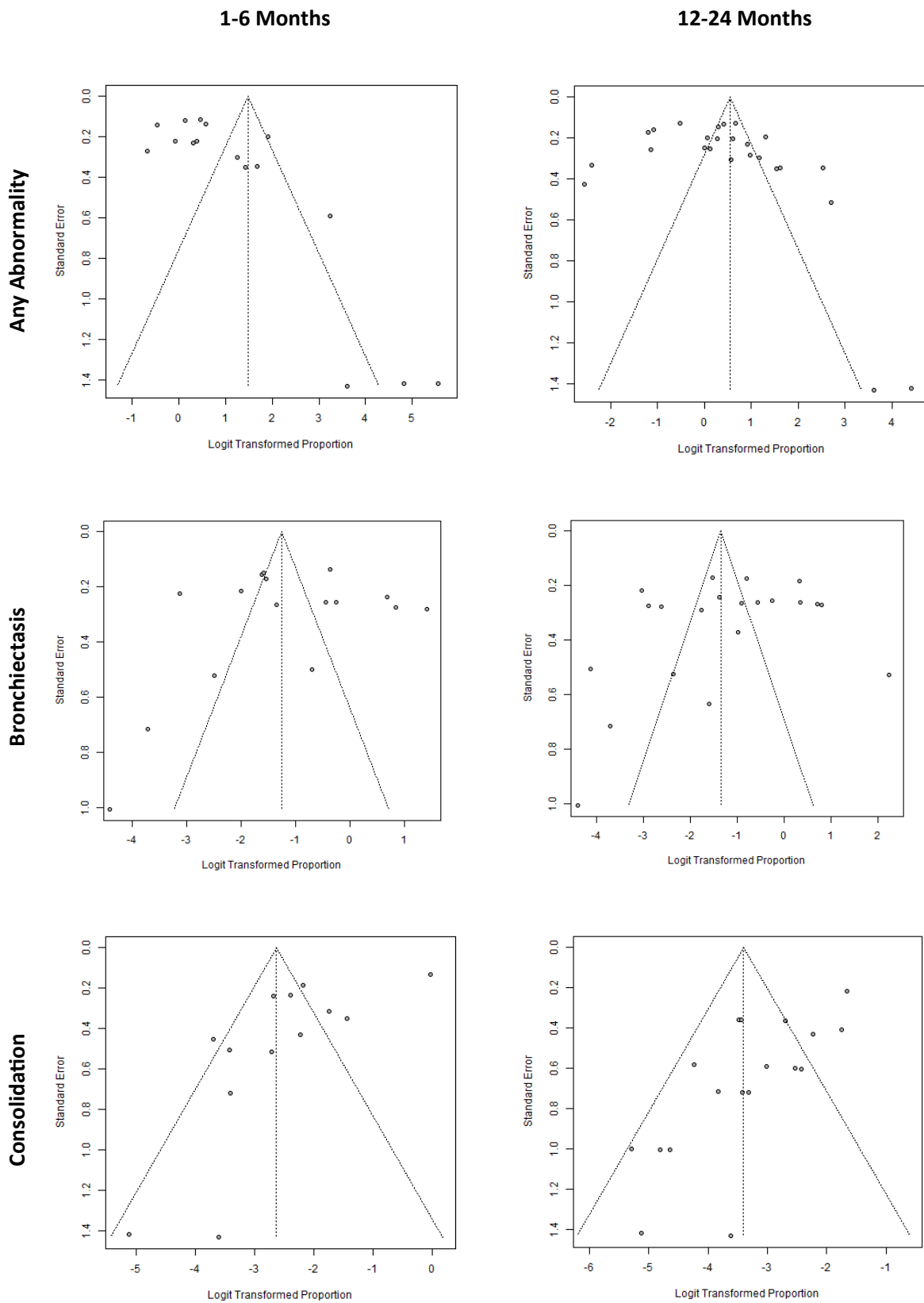


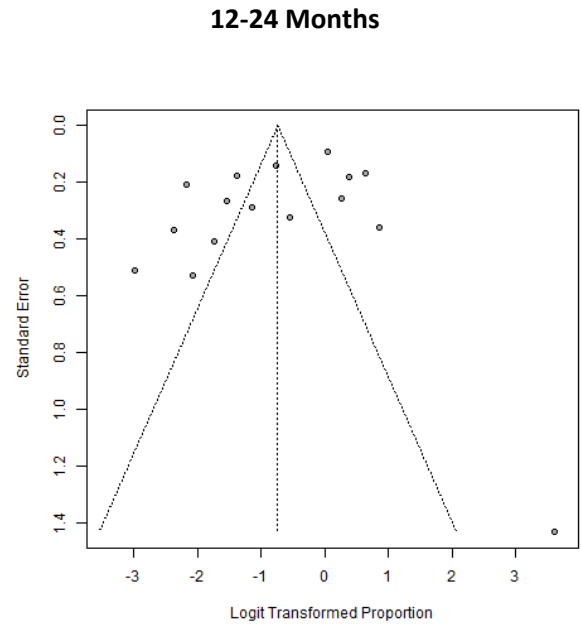
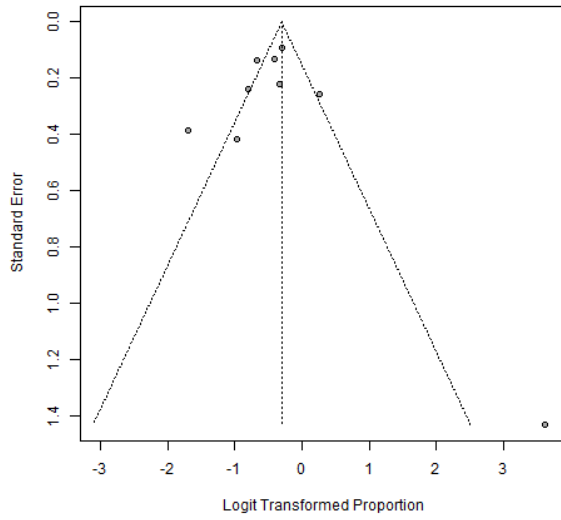
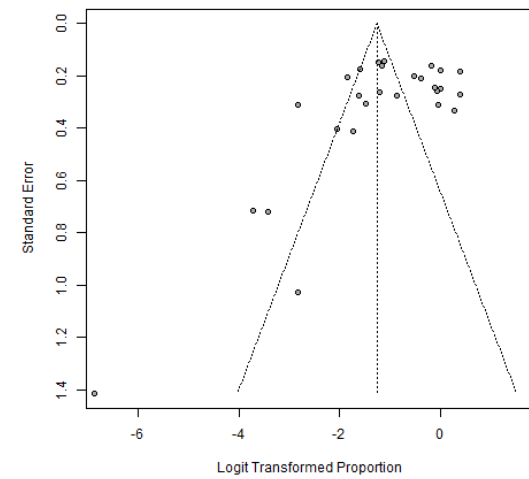
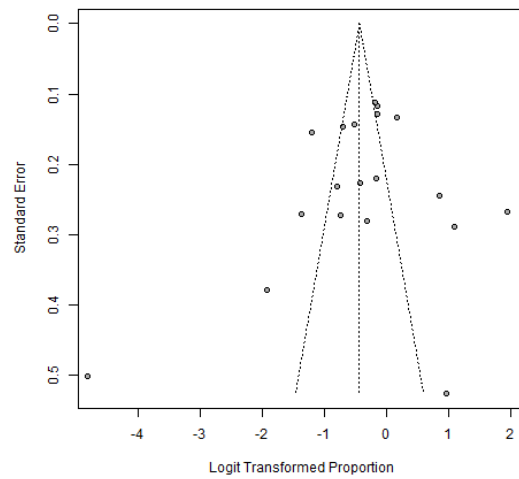
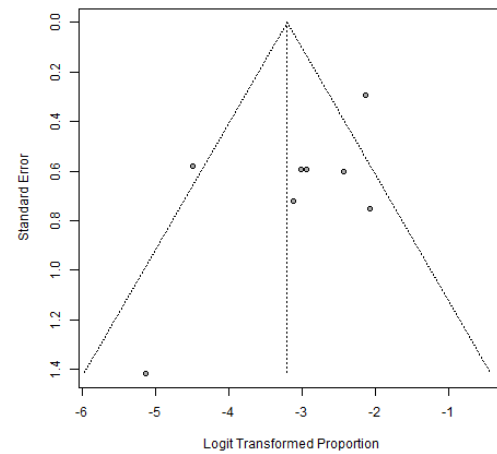
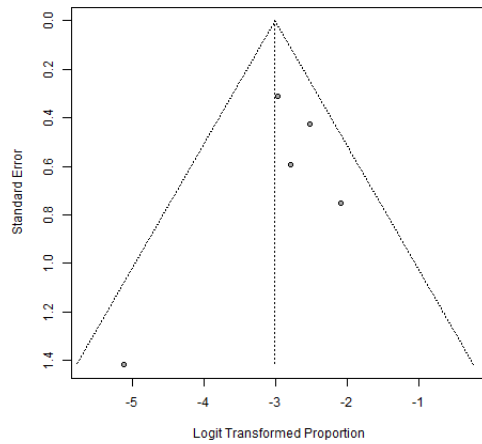
Supplemental Figure S5. Risk of Bias Assessment Summary Plot Using Hoy et al. Tool

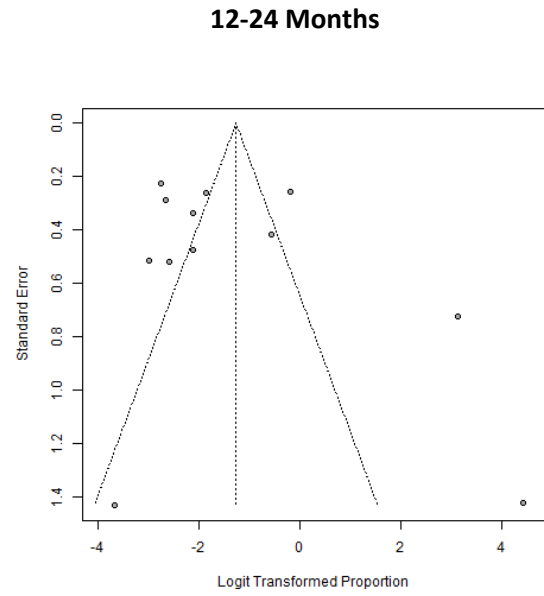
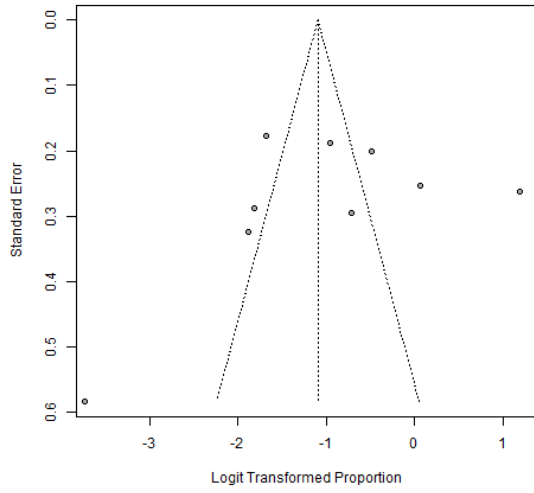
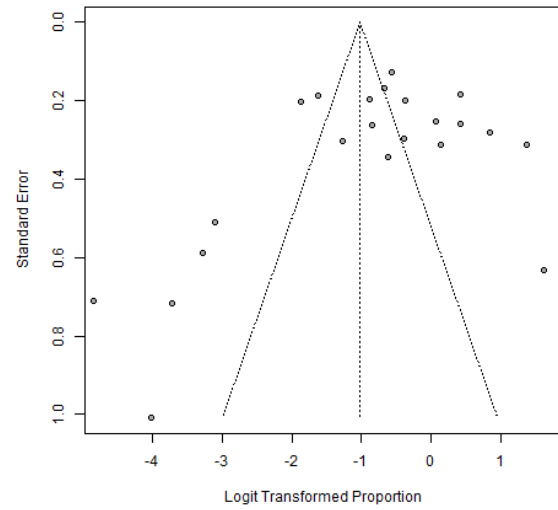
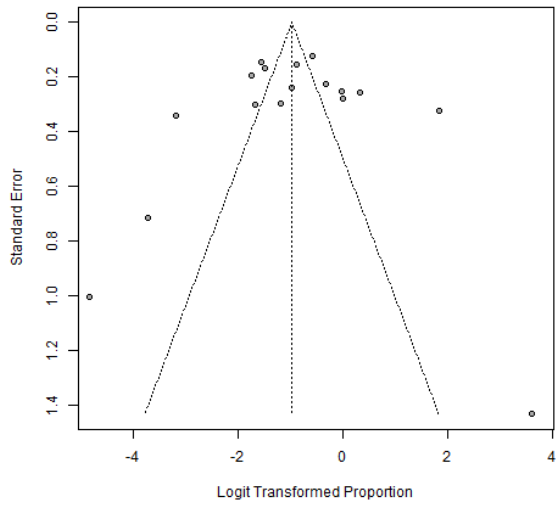
The tool consists of 10 items addressing four domains of bias. Items 1 to 4 assess the external validity of the study (domains are selection and nonresponse bias), and items 5 to 10 assess the internal validity (items 5 to 9 assess the domain of measurement bias, and item 10 assesses bias related to the analysis).



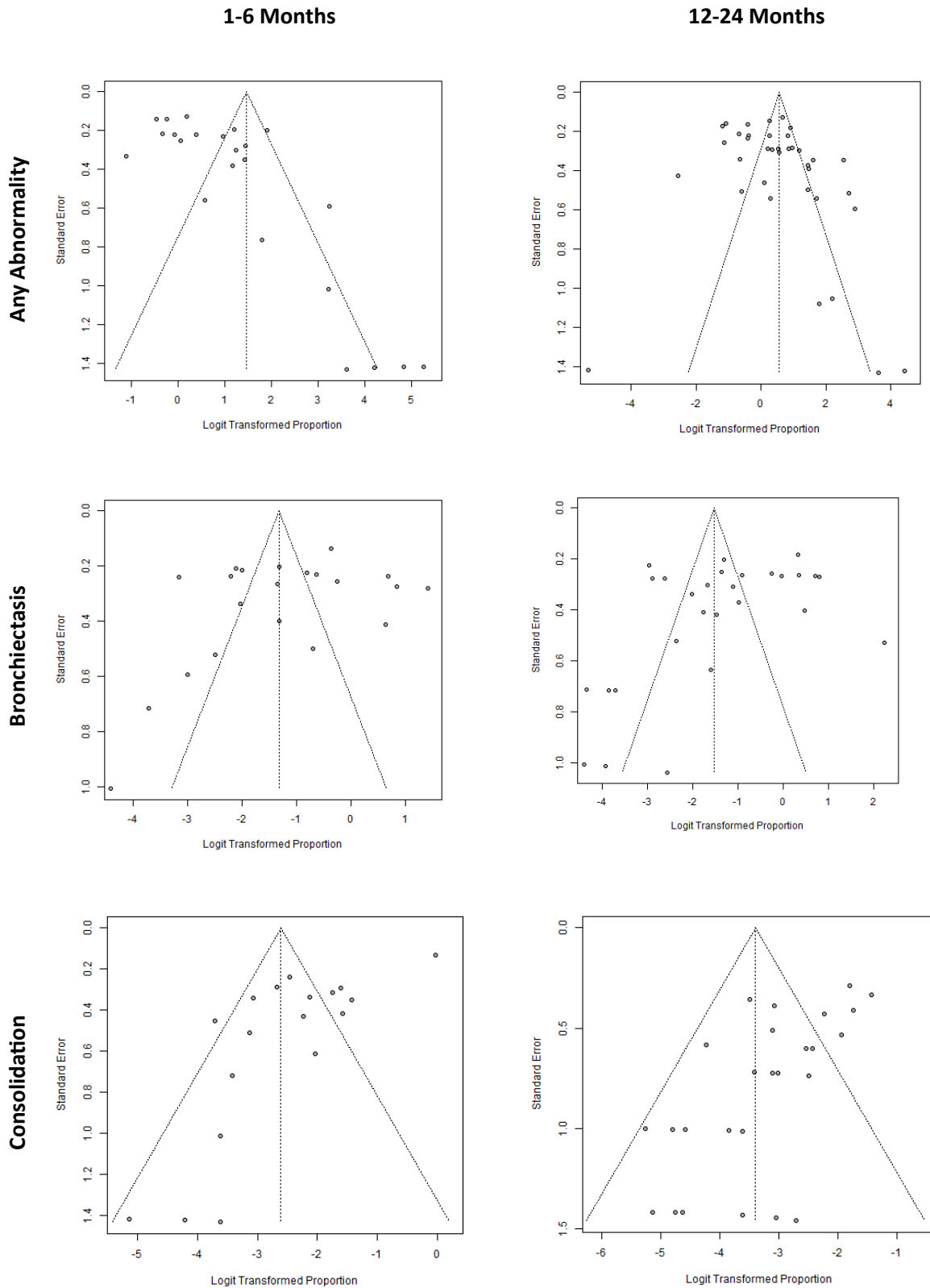
Supplemental Figure S6. Funnel Plots for the Pooled Meta-Analysis

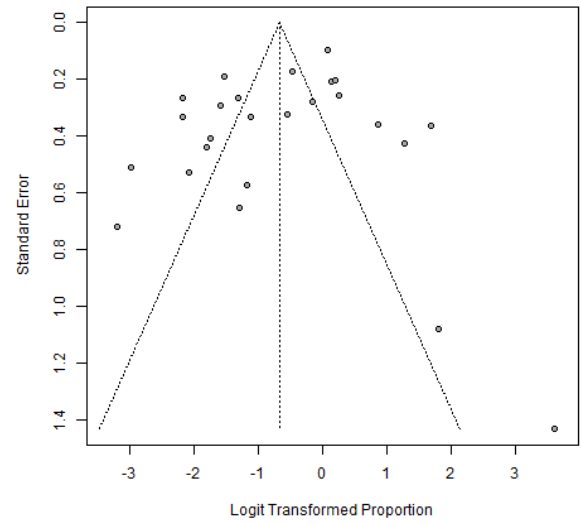
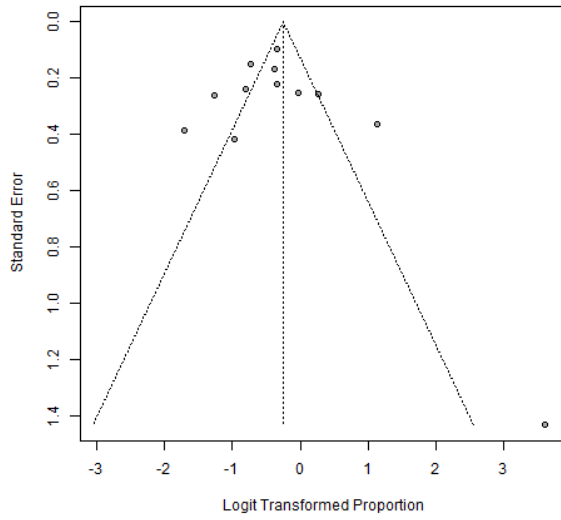
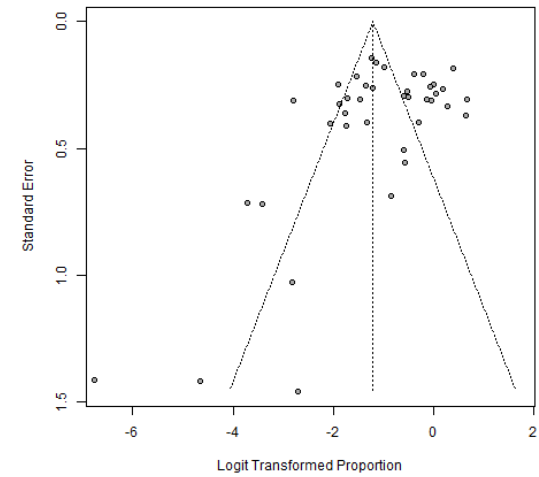
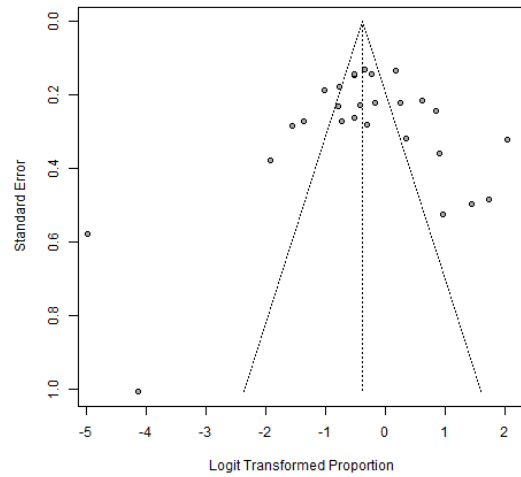


Fibrotic Like Changes**GGO****Honeycombing**

Interlobular Septal Thickening**Reticulation**

Supplemental Figure S7. Funnel Plots for the Stratified Meta-Analysis by Severity



Fibrotic Like Changes**GGO****Honeycombing**