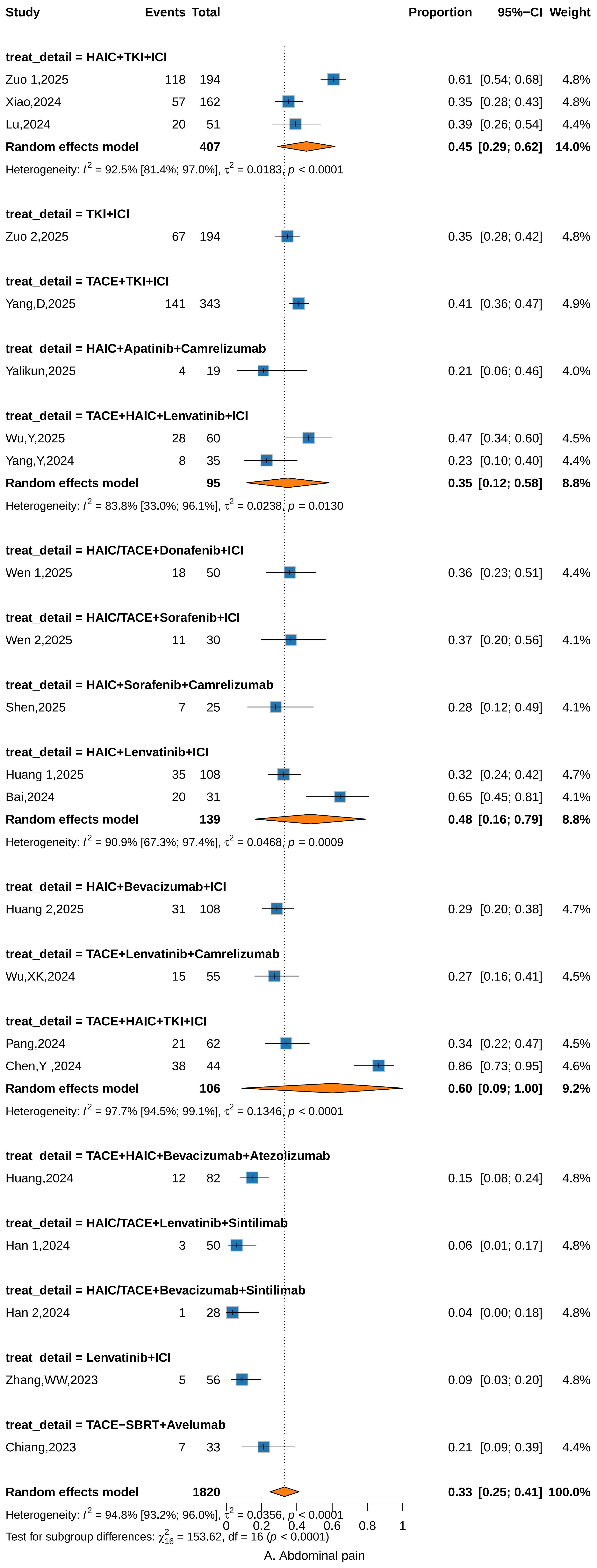
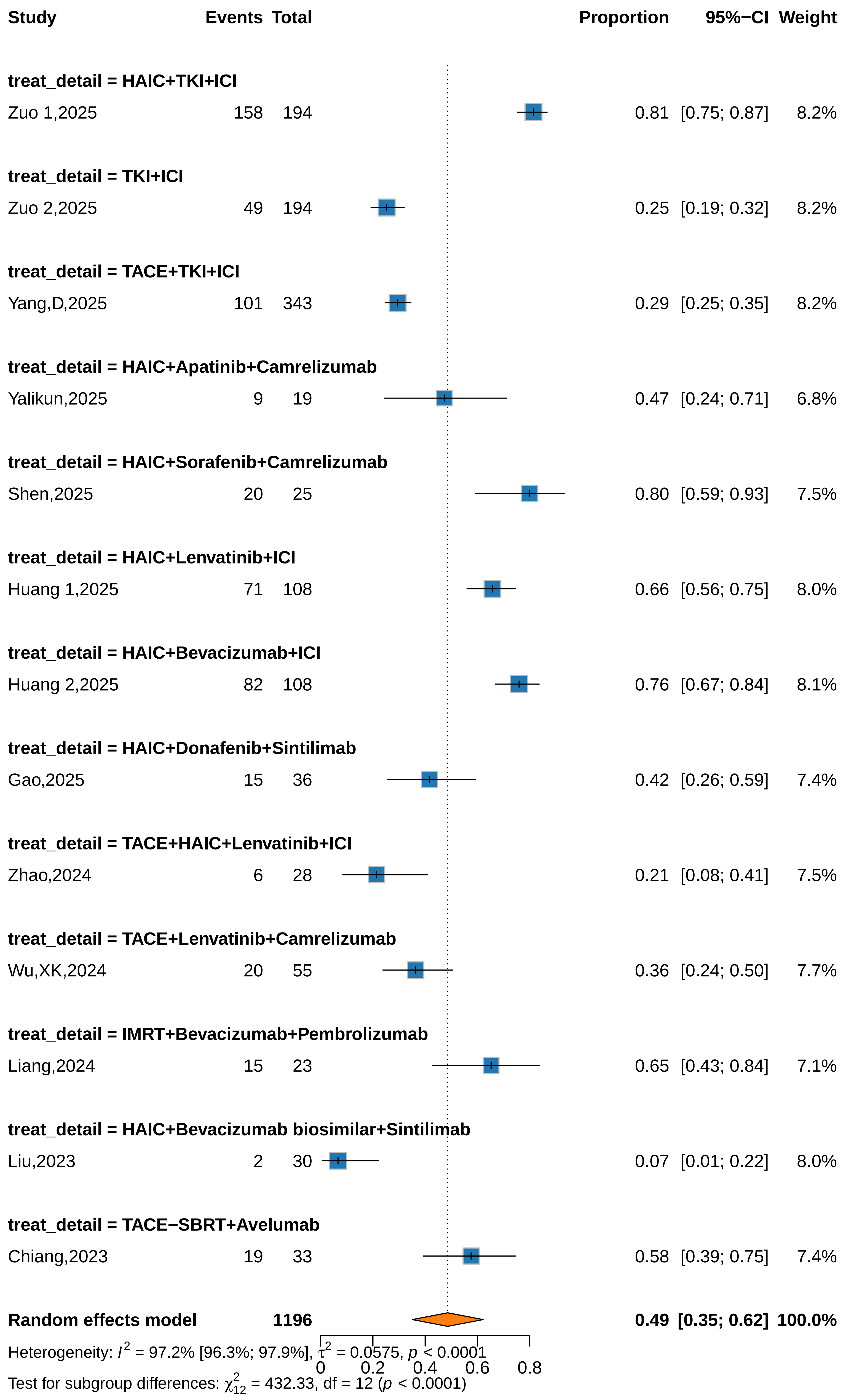
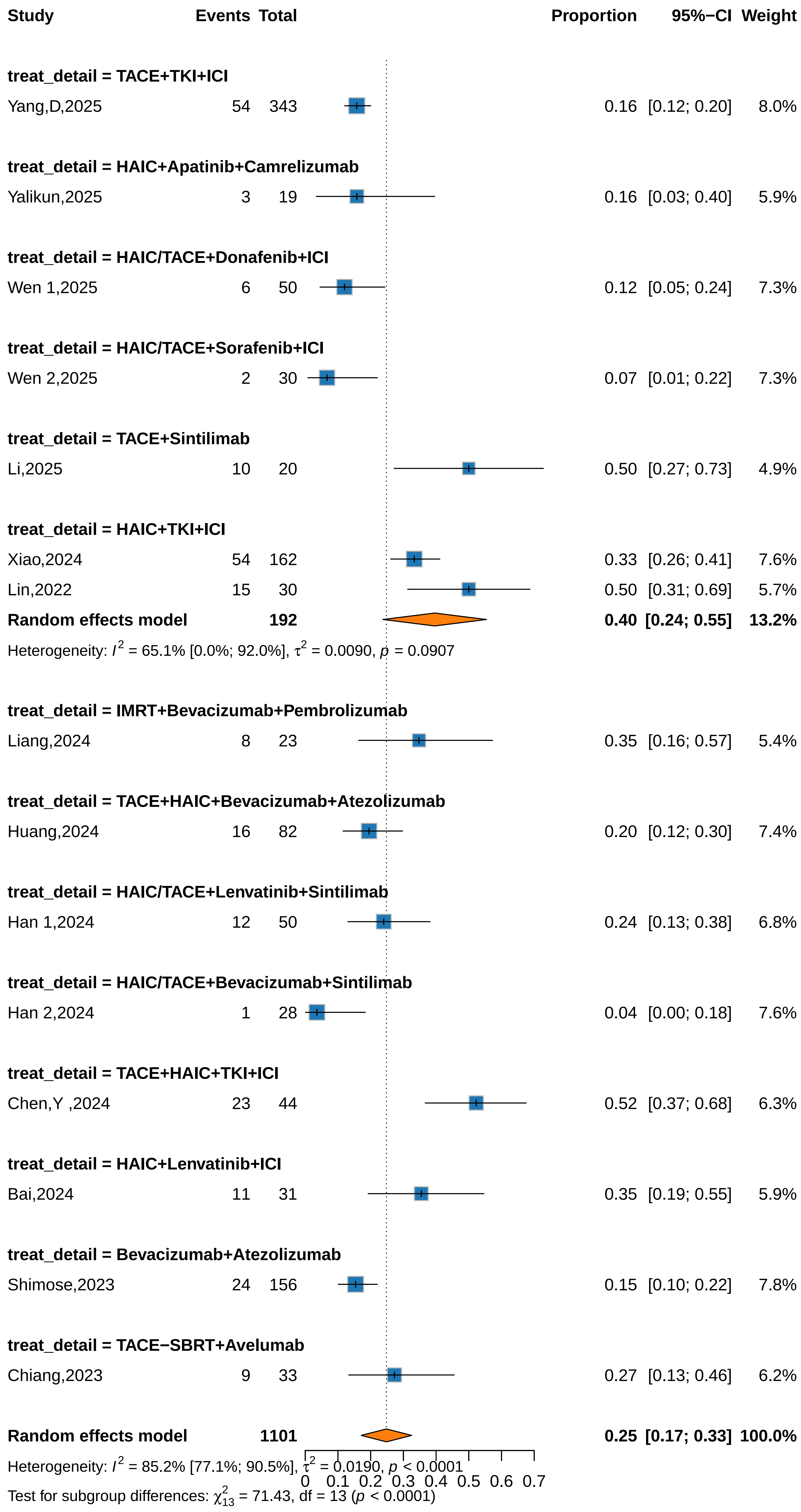


Study	Events	Total	Proportion	95%−CI	Weight
treat_detail = HAIC+TKI+ICI					
Zuo 1,2025	118	194	0.61	[0.54; 0.68]	4.8%
Xiao,2024	57	162	0.35	[0.28; 0.43]	4.8%
Lu,2024	20	51	0.39	[0.26; 0.54]	4.4%
Random effects model		**407**	**0.45**	**[0.29; 0.62]**	**14.0%**
Heterogeneity: $I^2 = 92.5\%$ [81.4%; 97.0%], $\tau^2 = 0.0183$, $p < 0.0001$					
treat_detail = TKI+ICI					
Zuo 2,2025	67	194	0.35	[0.28; 0.42]	4.8%
treat_detail = TACE+TKI+ICI					
Yang,D,2025	141	343	0.41	[0.36; 0.47]	4.9%
treat_detail = HAIC+Apatinib+Camrelizumab					
Yalikun,2025	4	19	0.21	[0.06; 0.46]	4.0%
treat_detail = TACE+HAIC+Lenvatinib+ICI					
Wu,Y,2025	28	60	0.47	[0.34; 0.60]	4.5%
Yang,Y,2024	8	35	0.23	[0.10; 0.40]	4.4%
Random effects model		**95**	**0.35**	**[0.12; 0.58]**	**8.8%**
Heterogeneity: $I^2 = 83.8\%$ [33.0%; 96.1%], $\tau^2 = 0.0238$, $p = 0.0130$					
treat_detail = HAIC/TACE+Donafenib+ICI					
Wen 1,2025	18	50	0.36	[0.23; 0.51]	4.4%
treat_detail = HAIC/TACE+Sorafenib+ICI					
Wen 2,2025	11	30	0.37	[0.20; 0.56]	4.1%
treat_detail = HAIC+Sorafenib+Camrelizumab					
Shen,2025	7	25	0.28	[0.12; 0.49]	4.1%
treat_detail = HAIC+Lenvatinib+ICI					
Huang 1,2025	35	108	0.32	[0.24; 0.42]	4.7%
Bai,2024	20	31	0.65	[0.45; 0.81]	4.1%
Random effects model		**139**	**0.48**	**[0.16; 0.79]**	**8.8%**
Heterogeneity: $I^2 = 90.9\%$ [67.3%; 97.4%], $\tau^2 = 0.0468$, $p = 0.0009$					
treat_detail = HAIC+Bevacizumab+ICI					
Huang 2,2025	31	108	0.29	[0.20; 0.38]	4.7%
treat_detail = TACE+Lenvatinib+Camrelizumab					
Wu,XK,2024	15	55	0.27	[0.16; 0.41]	4.5%
treat_detail = TACE+HAIC+TKI+ICI					
Pang,2024	21	62	0.34	[0.22; 0.47]	4.5%
Chen,Y ,2024	38	44	0.86	[0.73; 0.95]	4.6%
Random effects model		**106**	**0.60**	**[0.09; 1.00]**	**9.2%**
Heterogeneity: $I^2 = 97.7\%$ [94.5%; 99.1%], $\tau^2 = 0.1346$, $p < 0.0001$					
treat_detail = TACE+HAIC+Bevacizumab+Atezolizumab					
Huang,2024	12	82	0.15	[0.08; 0.24]	4.8%
treat_detail = HAIC/TACE+Lenvatinib+Sintilimab					
Han 1,2024	3	50	0.06	[0.01; 0.17]	4.8%
treat_detail = HAIC/TACE+Bevacizumab+Sintilimab					
Han 2,2024	1	28	0.04	[0.00; 0.18]	4.8%
treat_detail = Lenvatinib+ICI					
Zhang,WW,2023	5	56	0.09	[0.03; 0.20]	4.8%
treat_detail = TACE−SBRT+Avelumab					
Chiang,2023	7	33	0.21	[0.09; 0.39]	4.4%
Random effects model		**1820**	**0.33**	**[0.25; 0.41]**	**100.0%**
Heterogeneity: $I^2 = 94.8\%$ [93.2%; 96.0%], $\tau^2 = 0.0356$, $p < 0.0001$					
Test for subgroup differences: $\chi^2_{16} = 153.62$, df = 16 ($p < 0.0001$)					

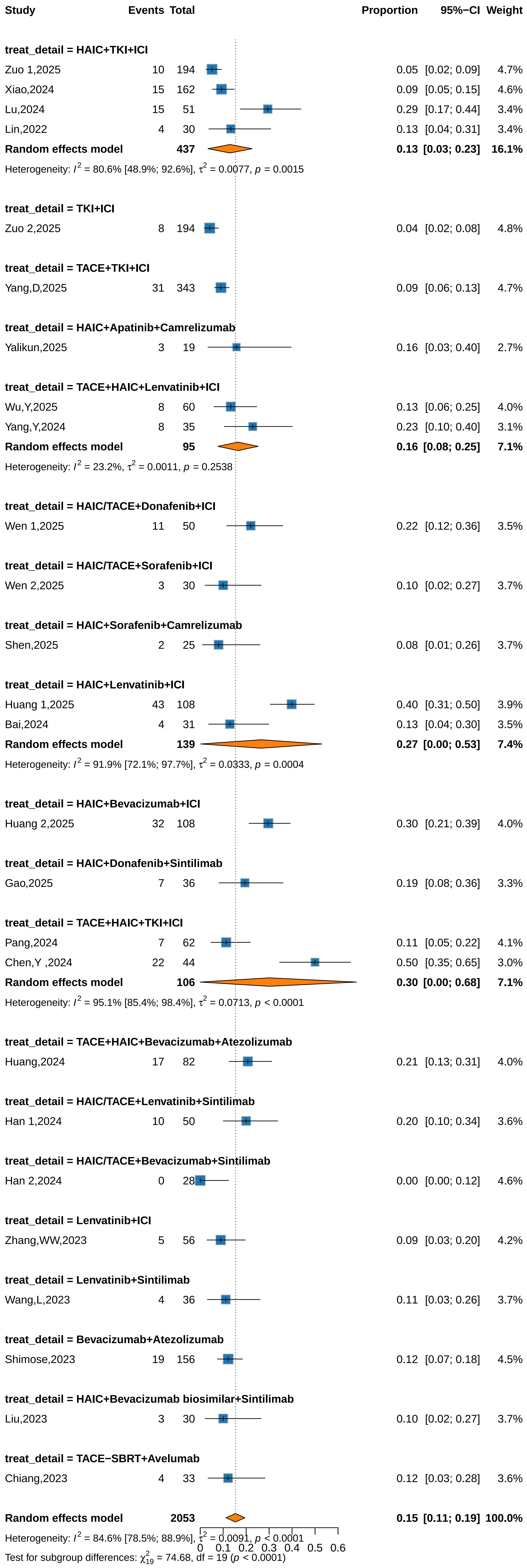
A. Abdominal pain


Study Events Total Proportion 95%−CI Weight
treat_detail = HAIC+TKI+ICI
Zuo 1,2025 158 194 0.81 [0.75; 0.87] 8.2%
treat_detail = TKI+ICI
Zuo 2,2025 49 194 0.25 [0.19; 0.32] 8.2%
treat_detail = TACE+TKI+ICI
Yang,D,2025 101 343 0.29 [0.25; 0.35] 8.2%
treat_detail = HAIC+Apatinib+Camrelizumab
Yalikun,2025 9 19 0.47 [0.24; 0.71] 6.8%
treat_detail = HAIC+Sorafenib+Camrelizumab
Shen,2025 20 25 0.80 [0.59; 0.93] 7.5%
treat_detail = HAIC+Lenvatinib+ICI
Huang 1,2025 71 108 0.66 [0.56; 0.75] 8.0%
treat_detail = HAIC+Bevacizumab+ICI
Huang 2,2025 82 108 0.76 [0.67; 0.84] 8.1%
treat_detail = HAIC+Donafenib+Sintilimab
Gao,2025 15 36 0.42 [0.26; 0.59] 7.4%
treat_detail = TACE+HAIC+Lenvatinib+ICI
Zhao,2024 6 28 0.21 [0.08; 0.41] 7.5%
treat_detail = TACE+Lenvatinib+Camrelizumab
Wu,XK,2024 20 55 0.36 [0.24; 0.50] 7.7%
treat_detail = IMRT+Bevacizumab+Pembrolizumab
Liang,2024 15 23 0.65 [0.43; 0.84] 7.1%
treat_detail = HAIC+Bevacizumab biosimilar+Sintilimab
Liu,2023 2 30 0.07 [0.01; 0.22] 8.0%
treat_detail = TACE−SBRT+Avelumab
Chiang,2023 19 33 0.58 [0.39; 0.75] 7.4%
Random effects model 1196 0.49 [0.35; 0.62] 100.0%
Heterogeneity: I^2 = 97.2% [96.3%; 97.9%], τ^2 = 0.0575, p < 0.0001
Test for subgroup differences: χ^2_{12} = 432.33, df = 12 (p < 0.0001)
0
0.2
0.4
0.6
0.8

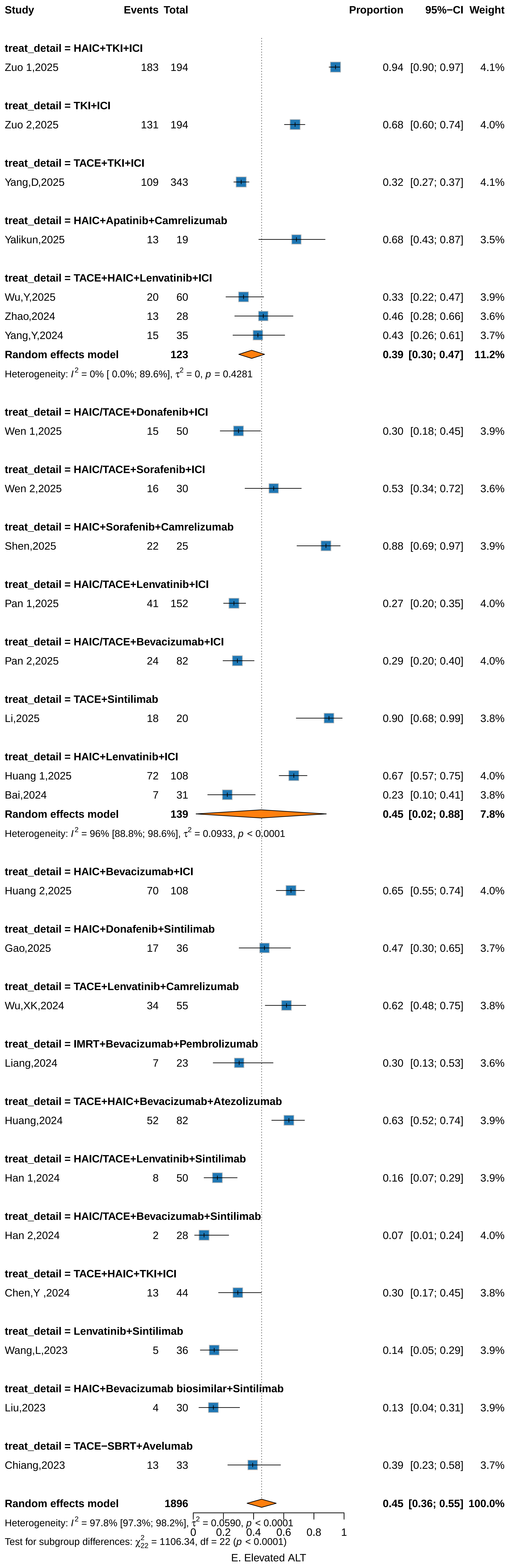
B. Anemia



C. Decreased appetite


Study Events Total Proportion 95%−CI Weight
treat_detail = HAIC+TKI+ICI
Zuo 1,2025 10 194 0.05 [0.02; 0.09] 4.7%
Xiao,2024 15 162 0.09 [0.05; 0.15] 4.6%
Lu,2024 15 51 0.29 [0.17; 0.44] 3.4%
Lin,2022 4 30 0.13 [0.04; 0.31] 3.4%
Random effects model 437 0.13 [0.03; 0.23] 16.1%
Heterogeneity: I^2 = 80.6% [48.9%; 92.6%], τ^2 = 0.0077, p = 0.0015
treat_detail = TKI+ICI
Zuo 2,2025 8 194 0.04 [0.02; 0.08] 4.8%
treat_detail = TACE+TKI+ICI
Yang,D,2025 31 343 0.09 [0.06; 0.13] 4.7%
treat_detail = HAIC+Apatinib+Camrelizumab
Yalikun,2025 3 19 0.16 [0.03; 0.40] 2.7%
treat_detail = TACE+HAIC+Lenvatinib+ICI
Wu,Y,2025 8 60 0.13 [0.06; 0.25] 4.0%
Yang,Y,2024 8 35 0.23 [0.10; 0.40] 3.1%
Random effects model 95 0.16 [0.08; 0.25] 7.1%
Heterogeneity: I^2 = 23.2%, τ^2 = 0.0011, p = 0.2538
treat_detail = HAIC/TACE+Donafenib+ICI
Wen 1,2025 11 50 0.22 [0.12; 0.36] 3.5%
treat_detail = HAIC/TACE+Sorafenib+ICI
Wen 2,2025 3 30 0.10 [0.02; 0.27] 3.7%
treat_detail = HAIC+Sorafenib+Camrelizumab
Shen,2025 2 25 0.08 [0.01; 0.26] 3.7%
treat_detail = HAIC+Lenvatinib+ICI
Huang 1,2025 43 108 0.40 [0.31; 0.50] 3.9%
Bai,2024 4 31 0.13 [0.04; 0.30] 3.5%
Random effects model 139 0.27 [0.00; 0.53] 7.4%
Heterogeneity: I^2 = 91.9% [72.1%; 97.7%], τ^2 = 0.0333, p = 0.0004
treat_detail = HAIC+Bevacizumab+ICI
Huang 2,2025 32 108 0.30 [0.21; 0.39] 4.0%
treat_detail = HAIC+Donafenib+Sintilimab
Gao,2025 7 36 0.19 [0.08; 0.36] 3.3%
treat_detail = TACE+HAIC+TKI+ICI
Pang,2024 7 62 0.11 [0.05; 0.22] 4.1%
Chen,Y ,2024 22 44 0.50 [0.35; 0.65] 3.0%
Random effects model 106 0.30 [0.00; 0.68] 7.1%
Heterogeneity: I^2 = 95.1% [85.4%; 98.4%], τ^2 = 0.0713, p < 0.0001
treat_detail = TACE+HAIC+Bevacizumab+Atezolizumab
Huang,2024 17 82 0.21 [0.13; 0.31] 4.0%
treat_detail = HAIC/TACE+Lenvatinib+Sintilimab
Han 1,2024 10 50 0.20 [0.10; 0.34] 3.6%
treat_detail = HAIC/TACE+Bevacizumab+Sintilimab
Han 2,2024 0 28 0.00 [0.00; 0.12] 4.6%
treat_detail = Lenvatinib+ICI
Zhang,WW,2023 5 56 0.09 [0.03; 0.20] 4.2%
treat_detail = Lenvatinib+Sintilimab
Wang,L,2023 4 36 0.11 [0.03; 0.26] 3.7%
treat_detail = Bevacizumab+Atezolizumab
Shimose,2023 19 156 0.12 [0.07; 0.18] 4.5%
treat_detail = HAIC+Bevacizumab biosimilar+Sintilimab
Liu,2023 3 30 0.10 [0.02; 0.27] 3.7%
treat_detail = TACE−SBRT+Avelumab
Chiang,2023 4 33 0.12 [0.03; 0.28] 3.6%
Random effects model 2053 0.15 [0.11; 0.19] 100.0%
Heterogeneity: I^2 = 84.6% [78.5%; 88.9%], τ^2 = 0.0091, p < 0.0001
Test for subgroup differences: χ^2_{19} = 74.68, df = 19 (p < 0.0001)
0 0.1 0.2 0.3 0.4 0.5 0.6

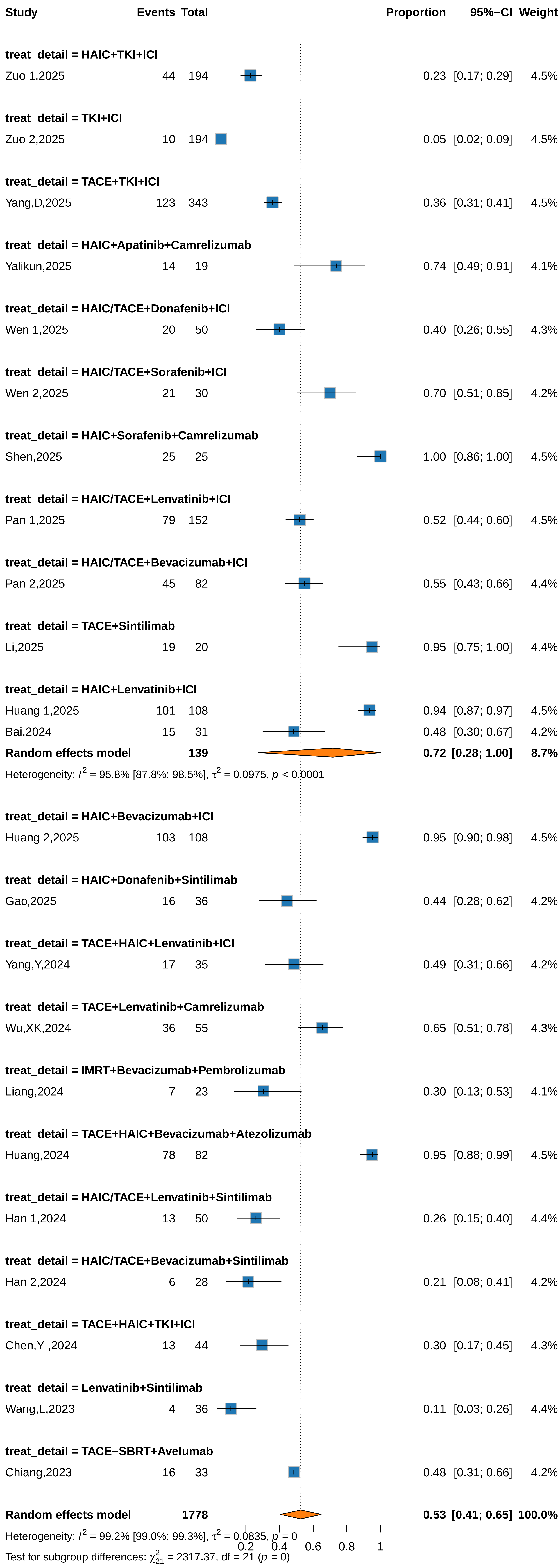
D. Diarrhea



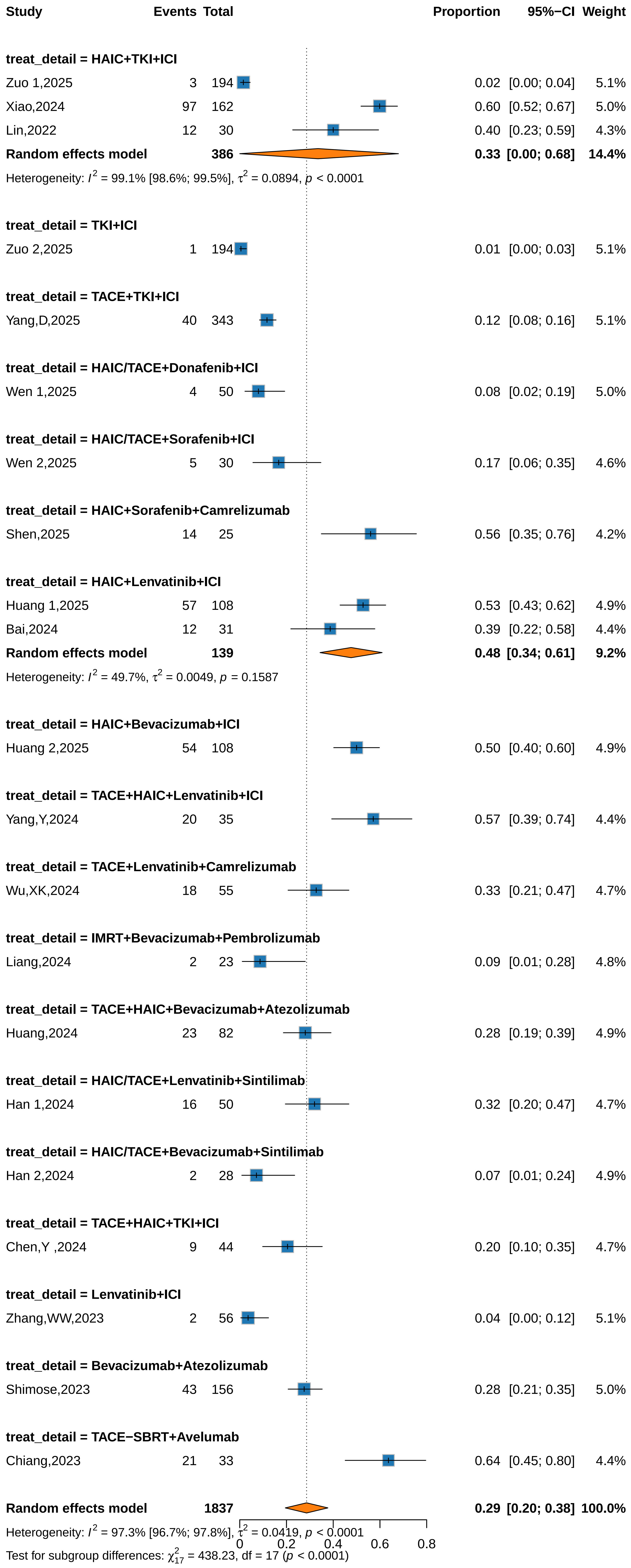
Study	Events	Total	Proportion	95%−CI	Weight
treat_detail = HAIC+TKI+ICI					
Zuo 1,2025	183	194	0.94	[0.90; 0.97]	4.1%
treat_detail = TKI+ICI					
Zuo 2,2025	131	194	0.68	[0.60; 0.74]	4.0%
treat_detail = TACE+TKI+ICI					
Yang,D,2025	109	343	0.32	[0.27; 0.37]	4.1%
treat_detail = HAIC+Apatinib+Camrelizumab					
Yalikun,2025	13	19	0.68	[0.43; 0.87]	3.5%
treat_detail = TACE+HAIC+Lenvatinib+ICI					
Wu,Y,2025	20	60	0.33	[0.22; 0.47]	3.9%
Zhao,2024	13	28	0.46	[0.28; 0.66]	3.6%
Yang,Y,2024	15	35	0.43	[0.26; 0.61]	3.7%
Random effects model		**123**	**0.39**	**[0.30; 0.47]**	**11.2%**
Heterogeneity: I^2 = 0% [0.0%; 89.6%], τ^2 = 0, p = 0.4281					
treat_detail = HAIC/TACE+Donafenib+ICI					
Wen 1,2025	15	50	0.30	[0.18; 0.45]	3.9%
treat_detail = HAIC/TACE+Sorafenib+ICI					
Wen 2,2025	16	30	0.53	[0.34; 0.72]	3.6%
treat_detail = HAIC+Sorafenib+Camrelizumab					
Shen,2025	22	25	0.88	[0.69; 0.97]	3.9%
treat_detail = HAIC/TACE+Lenvatinib+ICI					
Pan 1,2025	41	152	0.27	[0.20; 0.35]	4.0%
treat_detail = HAIC/TACE+Bevacizumab+ICI					
Pan 2,2025	24	82	0.29	[0.20; 0.40]	4.0%
treat_detail = TACE+Sintilimab					
Li,2025	18	20	0.90	[0.68; 0.99]	3.8%
treat_detail = HAIC+Lenvatinib+ICI					
Huang 1,2025	72	108	0.67	[0.57; 0.75]	4.0%
Bai,2024	7	31	0.23	[0.10; 0.41]	3.8%
Random effects model		**139**	**0.45**	**[0.02; 0.88]**	**7.8%**
Heterogeneity: I^2 = 96% [88.8%; 98.6%], τ^2 = 0.0933, p < 0.0001					
treat_detail = HAIC+Bevacizumab+ICI					
Huang 2,2025	70	108	0.65	[0.55; 0.74]	4.0%
treat_detail = HAIC+Donafenib+Sintilimab					
Gao,2025	17	36	0.47	[0.30; 0.65]	3.7%
treat_detail = TACE+Lenvatinib+Camrelizumab					
Wu,XK,2024	34	55	0.62	[0.48; 0.75]	3.8%
treat_detail = IMRT+Bevacizumab+Pembrolizumab					
Liang,2024	7	23	0.30	[0.13; 0.53]	3.6%
treat_detail = TACE+HAIC+Bevacizumab+Atezolizumab					
Huang,2024	52	82	0.63	[0.52; 0.74]	3.9%
treat_detail = HAIC/TACE+Lenvatinib+Sintilimab					
Han 1,2024	8	50	0.16	[0.07; 0.29]	3.9%
treat_detail = HAIC/TACE+Bevacizumab+Sintilimab					
Han 2,2024	2	28	0.07	[0.01; 0.24]	4.0%
treat_detail = TACE+HAIC+TKI+ICI					
Chen,Y ,2024	13	44	0.30	[0.17; 0.45]	3.8%
treat_detail = Lenvatinib+Sintilimab					
Wang,L,2023	5	36	0.14	[0.05; 0.29]	3.9%
treat_detail = HAIC+Bevacizumab biosimilar+Sintilimab					
Liu,2023	4	30	0.13	[0.04; 0.31]	3.9%
treat_detail = TACE−SBRT+Avelumab					
Chiang,2023	13	33	0.39	[0.23; 0.58]	3.7%
Random effects model		**1896**	**0.45**	**[0.36; 0.55]**	**100.0%**

Heterogeneity: I^2 = 97.8% [97.3%; 98.2%], τ^2 = 0.0590, p < 0.0001

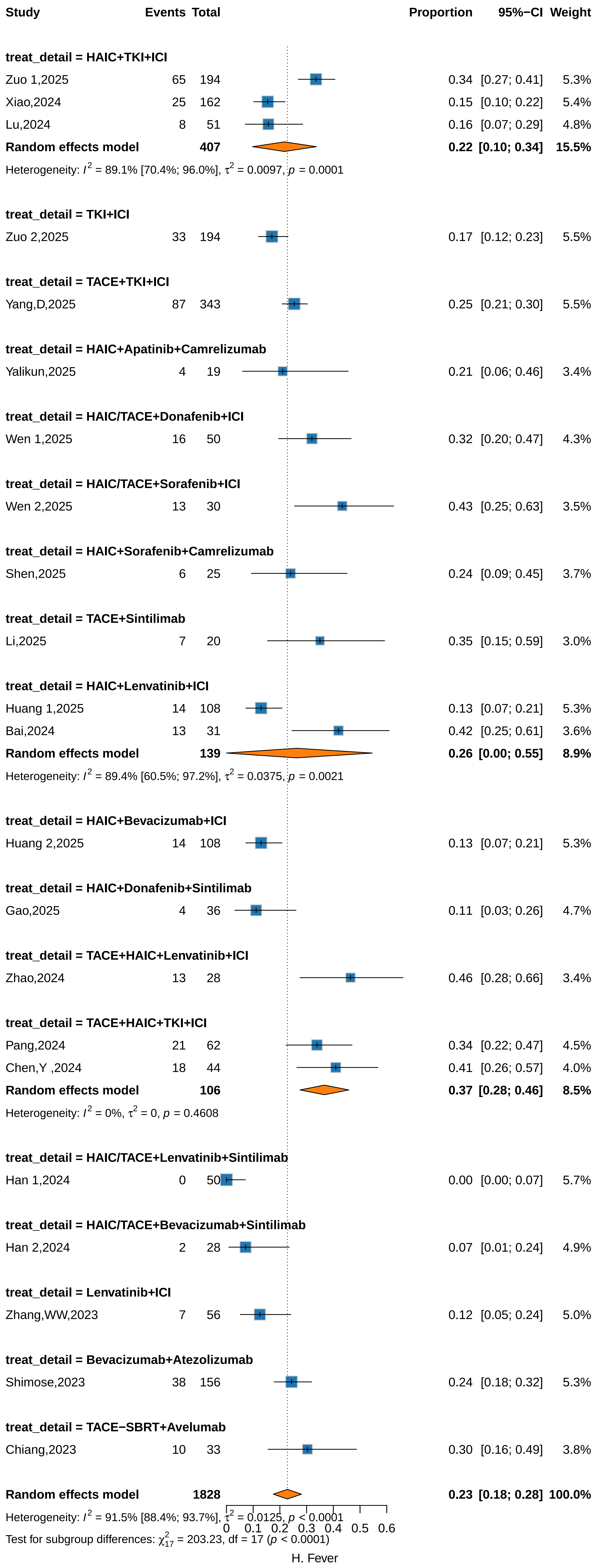
Test for subgroup differences: χ^2_{22} = 1106.34, df = 22 (p < 0.0001)



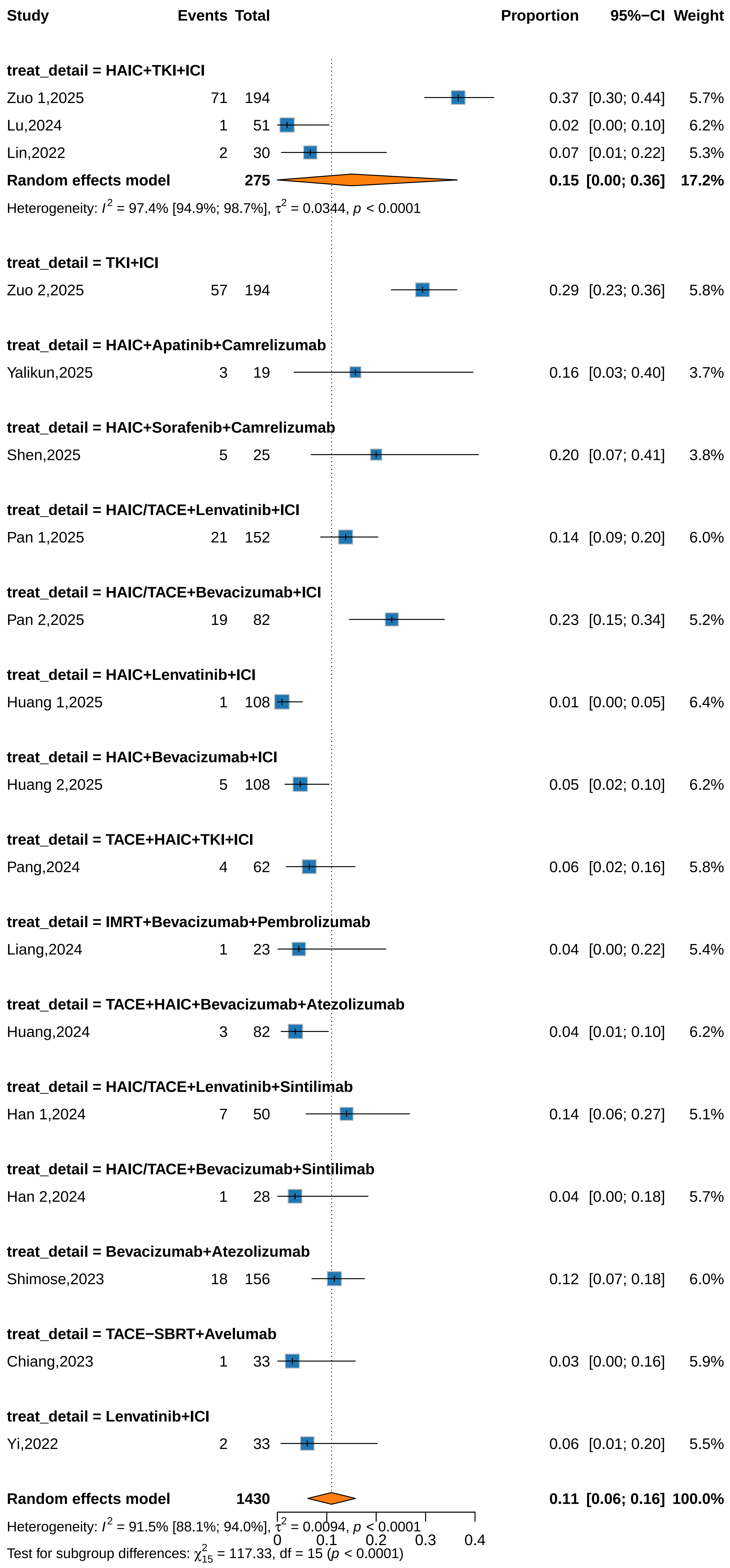
F. Elevated AST


Study Events Total Proportion 95%−CI Weight
treat_detail = HAIC+TKI+ICI
Zuo 1,2025 3 194 0.02 [0.00; 0.04] 5.1%
Xiao,2024 97 162 0.60 [0.52; 0.67] 5.0%
Lin,2022 12 30 0.40 [0.23; 0.59] 4.3%
Random effects model 386 0.33 [0.00; 0.68] 14.4%
Heterogeneity: I^2 = 99.1% [98.6%; 99.5%], τ^2 = 0.0894, p < 0.0001
treat_detail = TKI+ICI
Zuo 2,2025 1 194 0.01 [0.00; 0.03] 5.1%
treat_detail = TACE+TKI+ICI
Yang,D,2025 40 343 0.12 [0.08; 0.16] 5.1%
treat_detail = HAIC/TACE+Donafenib+ICI
Wen 1,2025 4 50 0.08 [0.02; 0.19] 5.0%
treat_detail = HAIC/TACE+Sorafenib+ICI
Wen 2,2025 5 30 0.17 [0.06; 0.35] 4.6%
treat_detail = HAIC+Sorafenib+Camrelizumab
Shen,2025 14 25 0.56 [0.35; 0.76] 4.2%
treat_detail = HAIC+Lenvatinib+ICI
Huang 1,2025 57 108 0.53 [0.43; 0.62] 4.9%
Bai,2024 12 31 0.39 [0.22; 0.58] 4.4%
Random effects model 139 0.48 [0.34; 0.61] 9.2%
Heterogeneity: I^2 = 49.7%, τ^2 = 0.0049, p = 0.1587
treat_detail = HAIC+Bevacizumab+ICI
Huang 2,2025 54 108 0.50 [0.40; 0.60] 4.9%
treat_detail = TACE+HAIC+Lenvatinib+ICI
Yang,Y,2024 20 35 0.57 [0.39; 0.74] 4.4%
treat_detail = TACE+Lenvatinib+Camrelizumab
Wu,XK,2024 18 55 0.33 [0.21; 0.47] 4.7%
treat_detail = IMRT+Bevacizumab+Pembrolizumab
Liang,2024 2 23 0.09 [0.01; 0.28] 4.8%
treat_detail = TACE+HAIC+Bevacizumab+Atezolizumab
Huang,2024 23 82 0.28 [0.19; 0.39] 4.9%
treat_detail = HAIC/TACE+Lenvatinib+Sintilimab
Han 1,2024 16 50 0.32 [0.20; 0.47] 4.7%
treat_detail = HAIC/TACE+Bevacizumab+Sintilimab
Han 2,2024 2 28 0.07 [0.01; 0.24] 4.9%
treat_detail = TACE+HAIC+TKI+ICI
Chen,Y ,2024 9 44 0.20 [0.10; 0.35] 4.7%
treat_detail = Lenvatinib+ICI
Zhang,WW,2023 2 56 0.04 [0.00; 0.12] 5.1%
treat_detail = Bevacizumab+Atezolizumab
Shimose,2023 43 156 0.28 [0.21; 0.35] 5.0%
treat_detail = TACE−SBRT+Avelumab
Chiang,2023 21 33 0.64 [0.45; 0.80] 4.4%
Random effects model 1837 0.29 [0.20; 0.38] 100.0%
Heterogeneity: I^2 = 97.3% [96.7%; 97.8%], τ^2 = 0.0419, p < 0.0001
Test for subgroup differences: χ^2_{17} = 438.23, df = 17 (p < 0.0001)
0
0.2
0.4
0.6
0.8

G. Fatigue



Study	Events	Total	Proportion	95%−CI	Weight
treat_detail = HAIC+TKI+ICI					
Zuo 1,2025	65	194	0.34	[0.27; 0.41]	5.3%
Xiao,2024	25	162	0.15	[0.10; 0.22]	5.4%
Lu,2024	8	51	0.16	[0.07; 0.29]	4.8%
Random effects model		**407**	**0.22**	**[0.10; 0.34]**	**15.5%**
Heterogeneity: I^2 = 89.1% [70.4%; 96.0%], τ^2 = 0.0097, p = 0.0001					
treat_detail = TKI+ICI					
Zuo 2,2025	33	194	0.17	[0.12; 0.23]	5.5%
treat_detail = TACE+TKI+ICI					
Yang,D,2025	87	343	0.25	[0.21; 0.30]	5.5%
treat_detail = HAIC+Apatinib+Camrelizumab					
Yalikun,2025	4	19	0.21	[0.06; 0.46]	3.4%
treat_detail = HAIC/TACE+Donafenib+ICI					
Wen 1,2025	16	50	0.32	[0.20; 0.47]	4.3%
treat_detail = HAIC/TACE+Sorafenib+ICI					
Wen 2,2025	13	30	0.43	[0.25; 0.63]	3.5%
treat_detail = HAIC+Sorafenib+Camrelizumab					
Shen,2025	6	25	0.24	[0.09; 0.45]	3.7%
treat_detail = TACE+Sintilimab					
Li,2025	7	20	0.35	[0.15; 0.59]	3.0%
treat_detail = HAIC+Lenvatinib+ICI					
Huang 1,2025	14	108	0.13	[0.07; 0.21]	5.3%
Bai,2024	13	31	0.42	[0.25; 0.61]	3.6%
Random effects model		**139**	**0.26**	**[0.00; 0.55]**	**8.9%**
Heterogeneity: I^2 = 89.4% [60.5%; 97.2%], τ^2 = 0.0375, p = 0.0021					
treat_detail = HAIC+Bevacizumab+ICI					
Huang 2,2025	14	108	0.13	[0.07; 0.21]	5.3%
treat_detail = HAIC+Donafenib+Sintilimab					
Gao,2025	4	36	0.11	[0.03; 0.26]	4.7%
treat_detail = TACE+HAIC+Lenvatinib+ICI					
Zhao,2024	13	28	0.46	[0.28; 0.66]	3.4%
treat_detail = TACE+HAIC+TKI+ICI					
Pang,2024	21	62	0.34	[0.22; 0.47]	4.5%
Chen,Y ,2024	18	44	0.41	[0.26; 0.57]	4.0%
Random effects model		**106**	**0.37**	**[0.28; 0.46]**	**8.5%**
Heterogeneity: I^2 = 0%, τ^2 = 0, p = 0.4608					
treat_detail = HAIC/TACE+Lenvatinib+Sintilimab					
Han 1,2024	0	50	0.00	[0.00; 0.07]	5.7%
treat_detail = HAIC/TACE+Bevacizumab+Sintilimab					
Han 2,2024	2	28	0.07	[0.01; 0.24]	4.9%
treat_detail = Lenvatinib+ICI					
Zhang,WW,2023	7	56	0.12	[0.05; 0.24]	5.0%
treat_detail = Bevacizumab+Atezolizumab					
Shimose,2023	38	156	0.24	[0.18; 0.32]	5.3%
treat_detail = TACE−SBRT+Avelumab					
Chiang,2023	10	33	0.30	[0.16; 0.49]	3.8%
Random effects model		**1828**	**0.23**	**[0.18; 0.28]**	**100.0%**
Heterogeneity: I^2 = 91.5% [88.4%; 93.7%], τ^2 = 0.0125, p < 0.0001					
Test for subgroup differences: χ^2_{17} = 203.23, df = 17 (p < 0.0001)					

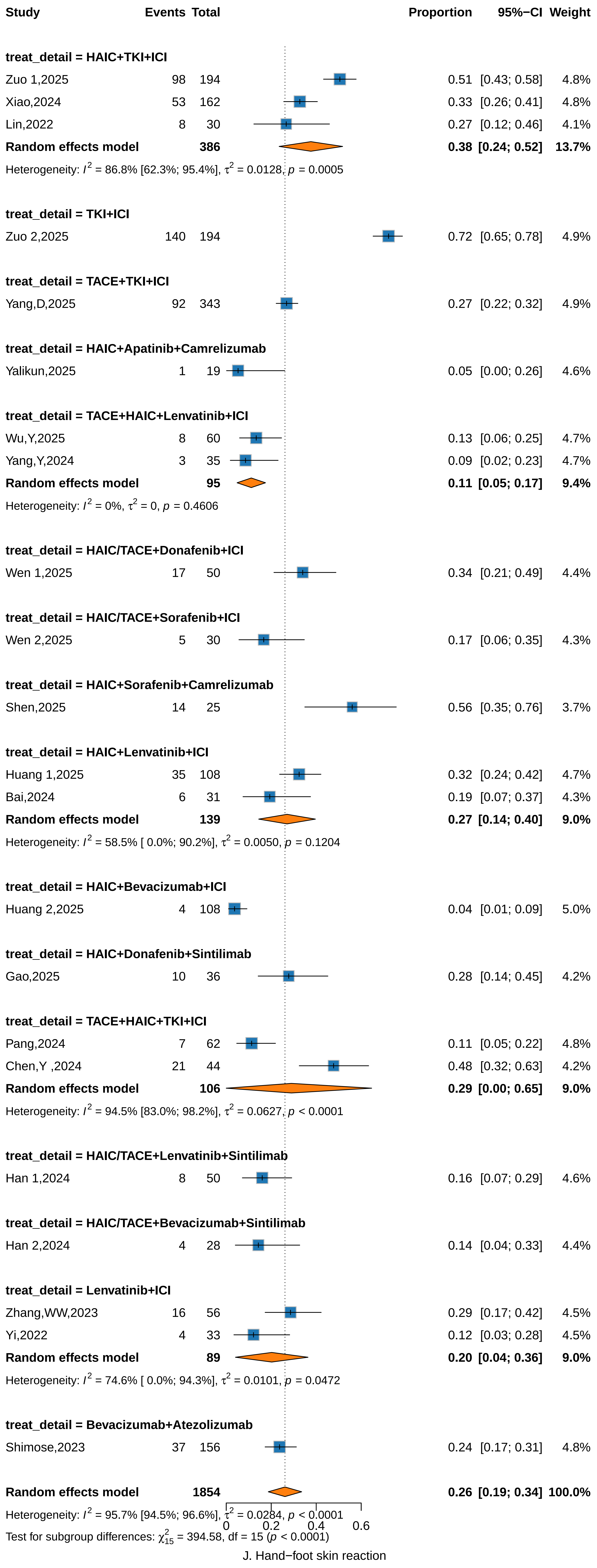


Study	Events	Total	Proportion	95%−CI	Weight
treat_detail = HAIC+TKI+ICI					
Zuo 1,2025	71	194	0.37	[0.30; 0.44]	5.7%
Lu,2024	1	51	0.02	[0.00; 0.10]	6.2%
Lin,2022	2	30	0.07	[0.01; 0.22]	5.3%
Random effects model		**275**	**0.15**	**[0.00; 0.36]**	**17.2%**
Heterogeneity: $I^2 = 97.4\%$ [94.9%; 98.7%], $\tau^2 = 0.0344$, $p < 0.0001$					
treat_detail = TKI+ICI					
Zuo 2,2025	57	194	0.29	[0.23; 0.36]	5.8%
treat_detail = HAIC+Apatinib+Camrelizumab					
Yalikun,2025	3	19	0.16	[0.03; 0.40]	3.7%
treat_detail = HAIC+Sorafenib+Camrelizumab					
Shen,2025	5	25	0.20	[0.07; 0.41]	3.8%
treat_detail = HAIC/TACE+Lenvatinib+ICI					
Pan 1,2025	21	152	0.14	[0.09; 0.20]	6.0%
treat_detail = HAIC/TACE+Bevacizumab+ICI					
Pan 2,2025	19	82	0.23	[0.15; 0.34]	5.2%
treat_detail = HAIC+Lenvatinib+ICI					
Huang 1,2025	1	108	0.01	[0.00; 0.05]	6.4%
treat_detail = HAIC+Bevacizumab+ICI					
Huang 2,2025	5	108	0.05	[0.02; 0.10]	6.2%
treat_detail = TACE+HAIC+TKI+ICI					
Pang,2024	4	62	0.06	[0.02; 0.16]	5.8%
treat_detail = IMRT+Bevacizumab+Pembrolizumab					
Liang,2024	1	23	0.04	[0.00; 0.22]	5.4%
treat_detail = TACE+HAIC+Bevacizumab+Atezolizumab					
Huang,2024	3	82	0.04	[0.01; 0.10]	6.2%
treat_detail = HAIC/TACE+Lenvatinib+Sintilimab					
Han 1,2024	7	50	0.14	[0.06; 0.27]	5.1%
treat_detail = HAIC/TACE+Bevacizumab+Sintilimab					
Han 2,2024	1	28	0.04	[0.00; 0.18]	5.7%
treat_detail = Bevacizumab+Atezolizumab					
Shimose,2023	18	156	0.12	[0.07; 0.18]	6.0%
treat_detail = TACE−SBRT+Avelumab					
Chiang,2023	1	33	0.03	[0.00; 0.16]	5.9%
treat_detail = Lenvatinib+ICI					
Yi,2022	2	33	0.06	[0.01; 0.20]	5.5%
Random effects model		**1430**	**0.11**	**[0.06; 0.16]**	**100.0%**

Heterogeneity: $I^2 = 91.5\%$ [88.1%; 94.0%], $\tau^2 = 0.0094$, $p < 0.0001$

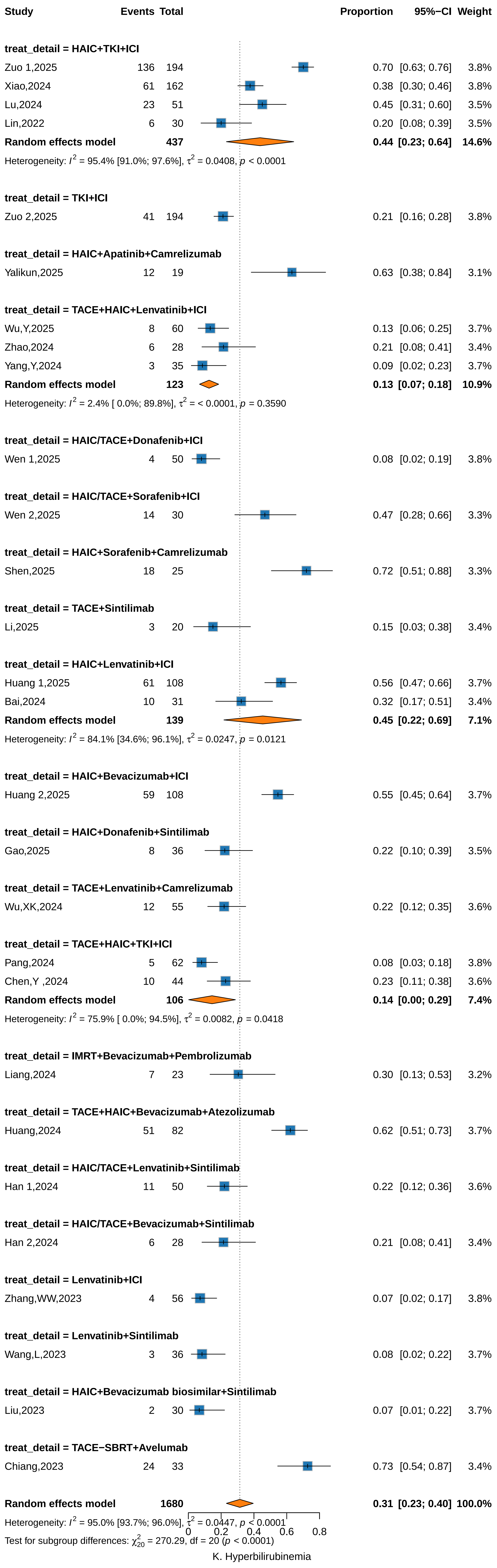
Test for subgroup differences: $\chi^2_{15} = 117.33$, df = 15 ($p < 0.0001$)

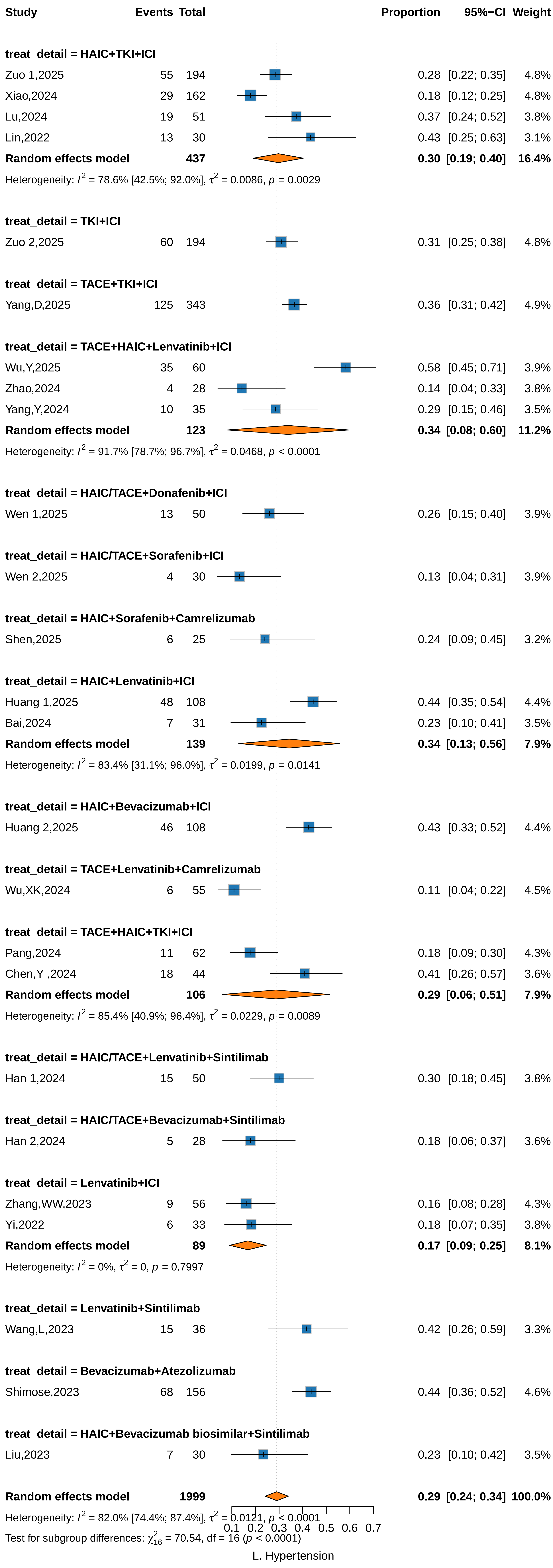
I. Gastrointestinal bleeding



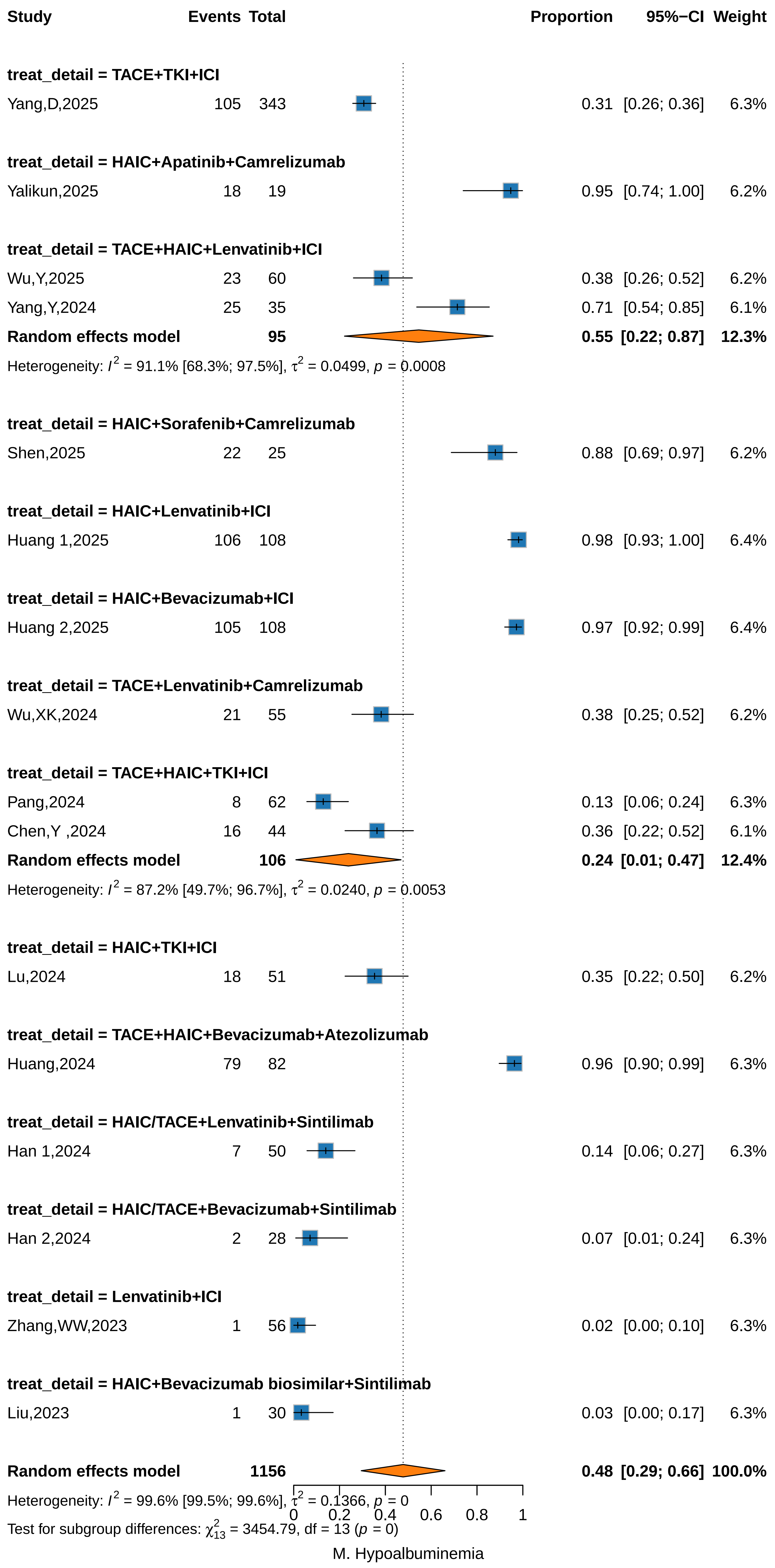
Study	Events	Total	Proportion	95%−CI	Weight
treat_detail = HAIC+TKI+ICI					
Zuo 1,2025	98	194	0.51	[0.43; 0.58]	4.8%
Xiao,2024	53	162	0.33	[0.26; 0.41]	4.8%
Lin,2022	8	30	0.27	[0.12; 0.46]	4.1%
Random effects model		**386**	**0.38**	**[0.24; 0.52]**	**13.7%**
Heterogeneity: I^2 = 86.8% [62.3%; 95.4%], τ^2 = 0.0128, p = 0.0005					
treat_detail = TKI+ICI					
Zuo 2,2025	140	194	0.72	[0.65; 0.78]	4.9%
treat_detail = TACE+TKI+ICI					
Yang,D,2025	92	343	0.27	[0.22; 0.32]	4.9%
treat_detail = HAIC+Apatinib+Camrelizumab					
Yalikun,2025	1	19	0.05	[0.00; 0.26]	4.6%
treat_detail = TACE+HAIC+Lenvatinib+ICI					
Wu,Y,2025	8	60	0.13	[0.06; 0.25]	4.7%
Yang,Y,2024	3	35	0.09	[0.02; 0.23]	4.7%
Random effects model		**95**	**0.11**	**[0.05; 0.17]**	**9.4%**
Heterogeneity: I^2 = 0%, τ^2 = 0, p = 0.4606					
treat_detail = HAIC/TACE+Donafenib+ICI					
Wen 1,2025	17	50	0.34	[0.21; 0.49]	4.4%
treat_detail = HAIC/TACE+Sorafenib+ICI					
Wen 2,2025	5	30	0.17	[0.06; 0.35]	4.3%
treat_detail = HAIC+Sorafenib+Camrelizumab					
Shen,2025	14	25	0.56	[0.35; 0.76]	3.7%
treat_detail = HAIC+Lenvatinib+ICI					
Huang 1,2025	35	108	0.32	[0.24; 0.42]	4.7%
Bai,2024	6	31	0.19	[0.07; 0.37]	4.3%
Random effects model		**139**	**0.27**	**[0.14; 0.40]**	**9.0%**
Heterogeneity: I^2 = 58.5% [0.0%; 90.2%], τ^2 = 0.0050, p = 0.1204					
treat_detail = HAIC+Bevacizumab+ICI					
Huang 2,2025	4	108	0.04	[0.01; 0.09]	5.0%
treat_detail = HAIC+Donafenib+Sintilimab					
Gao,2025	10	36	0.28	[0.14; 0.45]	4.2%
treat_detail = TACE+HAIC+TKI+ICI					
Pang,2024	7	62	0.11	[0.05; 0.22]	4.8%
Chen,Y ,2024	21	44	0.48	[0.32; 0.63]	4.2%
Random effects model		**106**	**0.29**	**[0.00; 0.65]**	**9.0%**
Heterogeneity: I^2 = 94.5% [83.0%; 98.2%], τ^2 = 0.0627, p < 0.0001					
treat_detail = HAIC/TACE+Lenvatinib+Sintilimab					
Han 1,2024	8	50	0.16	[0.07; 0.29]	4.6%
treat_detail = HAIC/TACE+Bevacizumab+Sintilimab					
Han 2,2024	4	28	0.14	[0.04; 0.33]	4.4%
treat_detail = Lenvatinib+ICI					
Zhang,WW,2023	16	56	0.29	[0.17; 0.42]	4.5%
Yi,2022	4	33	0.12	[0.03; 0.28]	4.5%
Random effects model		**89**	**0.20**	**[0.04; 0.36]**	**9.0%**
Heterogeneity: I^2 = 74.6% [0.0%; 94.3%], τ^2 = 0.0101, p = 0.0472					
treat_detail = Bevacizumab+Atezolizumab					
Shimose,2023	37	156	0.24	[0.17; 0.31]	4.8%
Random effects model		**1854**	**0.26**	**[0.19; 0.34]**	**100.0%**
Heterogeneity: I^2 = 95.7% [94.5%; 96.6%], τ^2 = 0.0284, p < 0.0001					
Test for subgroup differences: χ^2_{15} = 394.58, df = 15 (p < 0.0001)					

J. Hand−foot skin reaction

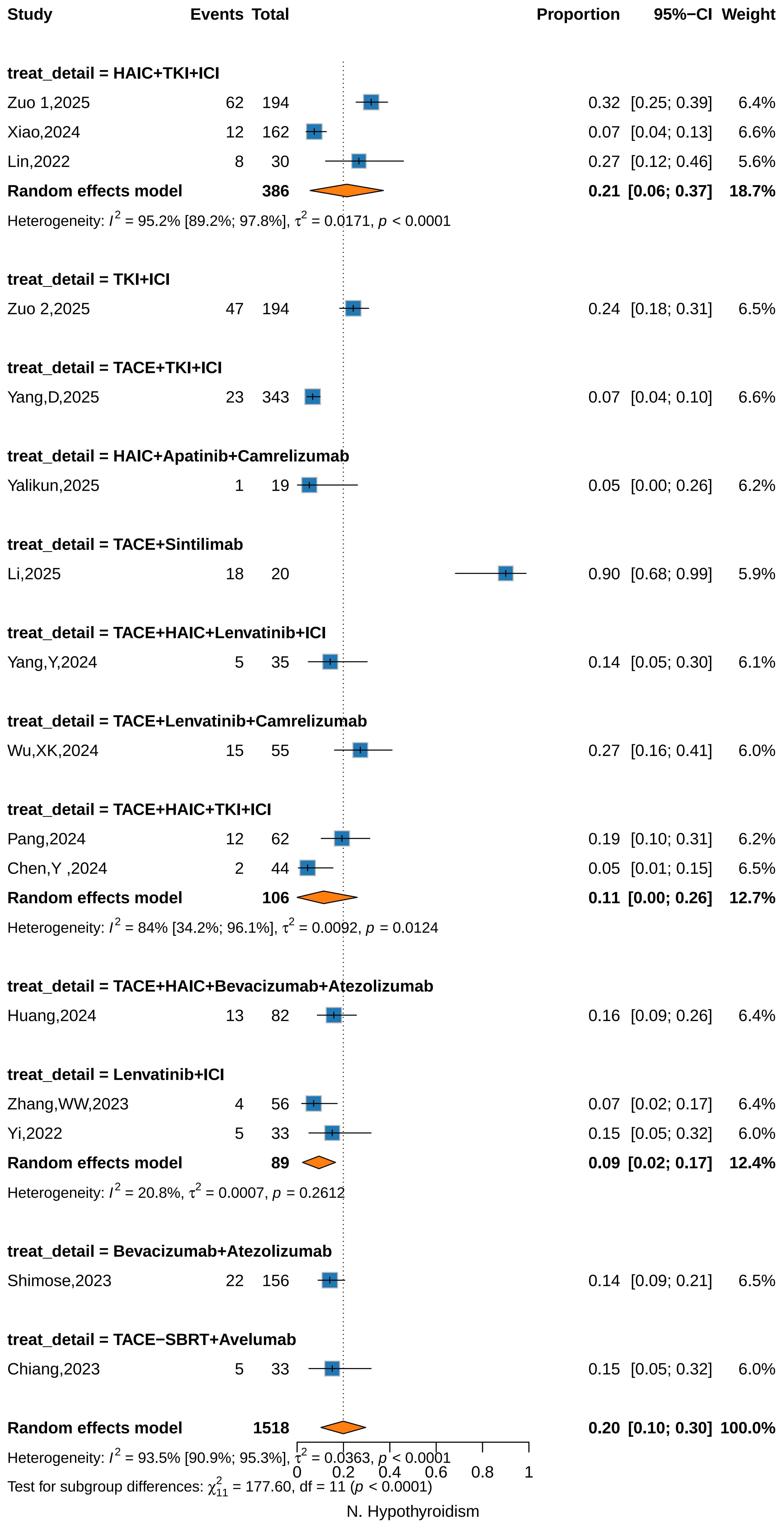

Study Events Total Proportion 95%−CI Weight
treat_detail = HAIC+TKI+ICI
Zuo 1,2025 136 194 0.70 [0.63; 0.76] 3.8%
Xiao,2024 61 162 0.38 [0.30; 0.46] 3.8%
Lu,2024 23 51 0.45 [0.31; 0.60] 3.5%
Lin,2022 6 30 0.20 [0.08; 0.39] 3.5%
Random effects model 437 0.44 [0.23; 0.64] 14.6%
Heterogeneity: I^2 = 95.4% [91.0%; 97.6%], τ^2 = 0.0408, p < 0.0001
treat_detail = TKI+ICI
Zuo 2,2025 41 194 0.21 [0.16; 0.28] 3.8%
treat_detail = HAIC+Apatinib+Camrelizumab
Yalikun,2025 12 19 0.63 [0.38; 0.84] 3.1%
treat_detail = TACE+HAIC+Lenvatinib+ICI
Wu,Y,2025 8 60 0.13 [0.06; 0.25] 3.7%
Zhao,2024 6 28 0.21 [0.08; 0.41] 3.4%
Yang,Y,2024 3 35 0.09 [0.02; 0.23] 3.7%
Random effects model 123 0.13 [0.07; 0.18] 10.9%
Heterogeneity: I^2 = 2.4% [0.0%; 89.8%], τ^2 = < 0.0001, p = 0.3590
treat_detail = HAIC/TACE+Donafenib+ICI
Wen 1,2025 4 50 0.08 [0.02; 0.19] 3.8%
treat_detail = HAIC/TACE+Sorafenib+ICI
Wen 2,2025 14 30 0.47 [0.28; 0.66] 3.3%
treat_detail = HAIC+Sorafenib+Camrelizumab
Shen,2025 18 25 0.72 [0.51; 0.88] 3.3%
treat_detail = TACE+Sintilimab
Li,2025 3 20 0.15 [0.03; 0.38] 3.4%
treat_detail = HAIC+Lenvatinib+ICI
Huang 1,2025 61 108 0.56 [0.47; 0.66] 3.7%
Bai,2024 10 31 0.32 [0.17; 0.51] 3.4%
Random effects model 139 0.45 [0.22; 0.69] 7.1%
Heterogeneity: I^2 = 84.1% [34.6%; 96.1%], τ^2 = 0.0247, p = 0.0121
treat_detail = HAIC+Bevacizumab+ICI
Huang 2,2025 59 108 0.55 [0.45; 0.64] 3.7%
treat_detail = HAIC+Donafenib+Sintilimab
Gao,2025 8 36 0.22 [0.10; 0.39] 3.5%
treat_detail = TACE+Lenvatinib+Camrelizumab
Wu,XK,2024 12 55 0.22 [0.12; 0.35] 3.6%
treat_detail = TACE+HAIC+TKI+ICI
Pang,2024 5 62 0.08 [0.03; 0.18] 3.8%
Chen,Y ,2024 10 44 0.23 [0.11; 0.38] 3.6%
Random effects model 106 0.14 [0.00; 0.29] 7.4%
Heterogeneity: I^2 = 75.9% [0.0%; 94.5%], τ^2 = 0.0082, p = 0.0418
treat_detail = IMRT+Bevacizumab+Pembrolizumab
Liang,2024 7 23 0.30 [0.13; 0.53] 3.2%
treat_detail = TACE+HAIC+Bevacizumab+Atezolizumab
Huang,2024 51 82 0.62 [0.51; 0.73] 3.7%
treat_detail = HAIC/TACE+Lenvatinib+Sintilimab
Han 1,2024 11 50 0.22 [0.12; 0.36] 3.6%
treat_detail = HAIC/TACE+Bevacizumab+Sintilimab
Han 2,2024 6 28 0.21 [0.08; 0.41] 3.4%
treat_detail = Lenvatinib+ICI
Zhang,WW,2023 4 56 0.07 [0.02; 0.17] 3.8%
treat_detail = Lenvatinib+Sintilimab
Wang,L,2023 3 36 0.08 [0.02; 0.22] 3.7%
treat_detail = HAIC+Bevacizumab biosimilar+Sintilimab
Liu,2023 2 30 0.07 [0.01; 0.22] 3.7%
treat_detail = TACE−SBRT+Avelumab
Chiang,2023 24 33 0.73 [0.54; 0.87] 3.4%
Random effects model 1680 0.31 [0.23; 0.40] 100.0%
Heterogeneity: I^2 = 95.0% [93.7%; 96.0%], τ^2 = 0.0447, p < 0.0001
Test for subgroup differences: χ^2_{20} = 270.29, df = 20 (p < 0.0001)
0
0.2
0.4
0.6
0.8
K. Hyperbilirubinemia

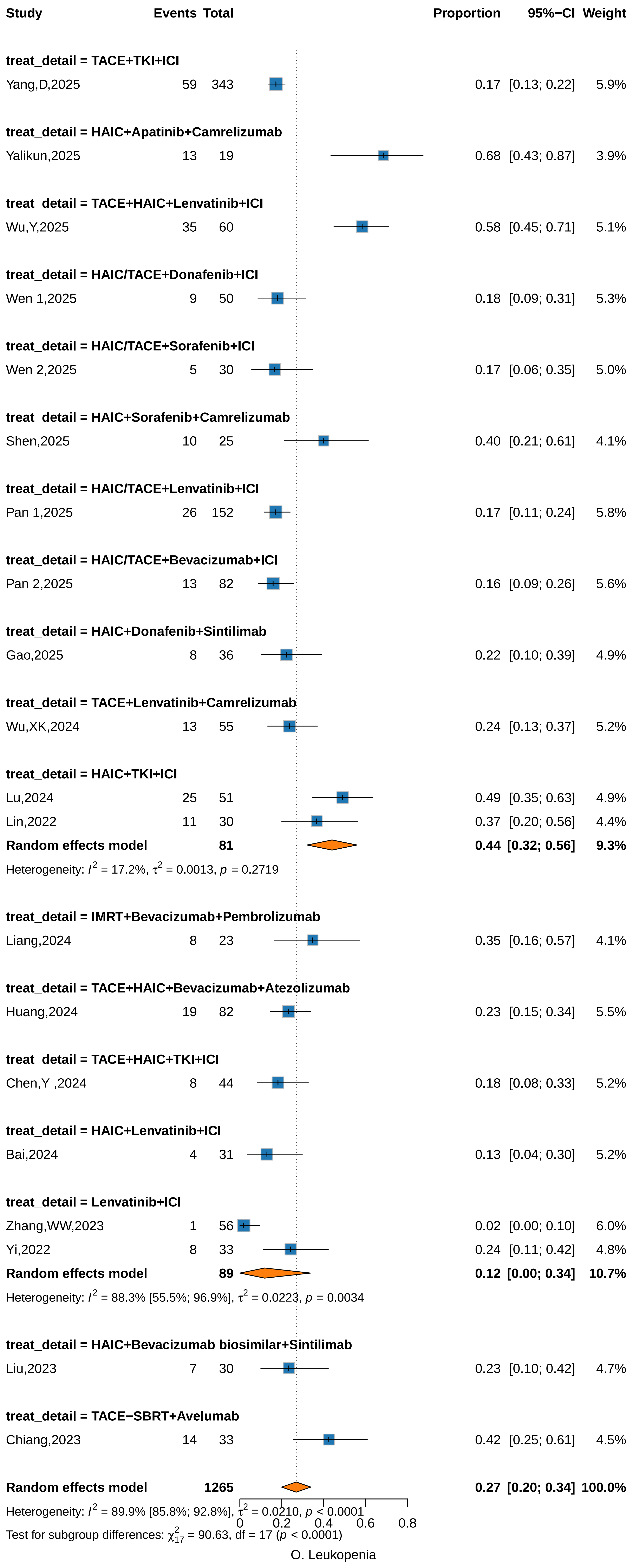


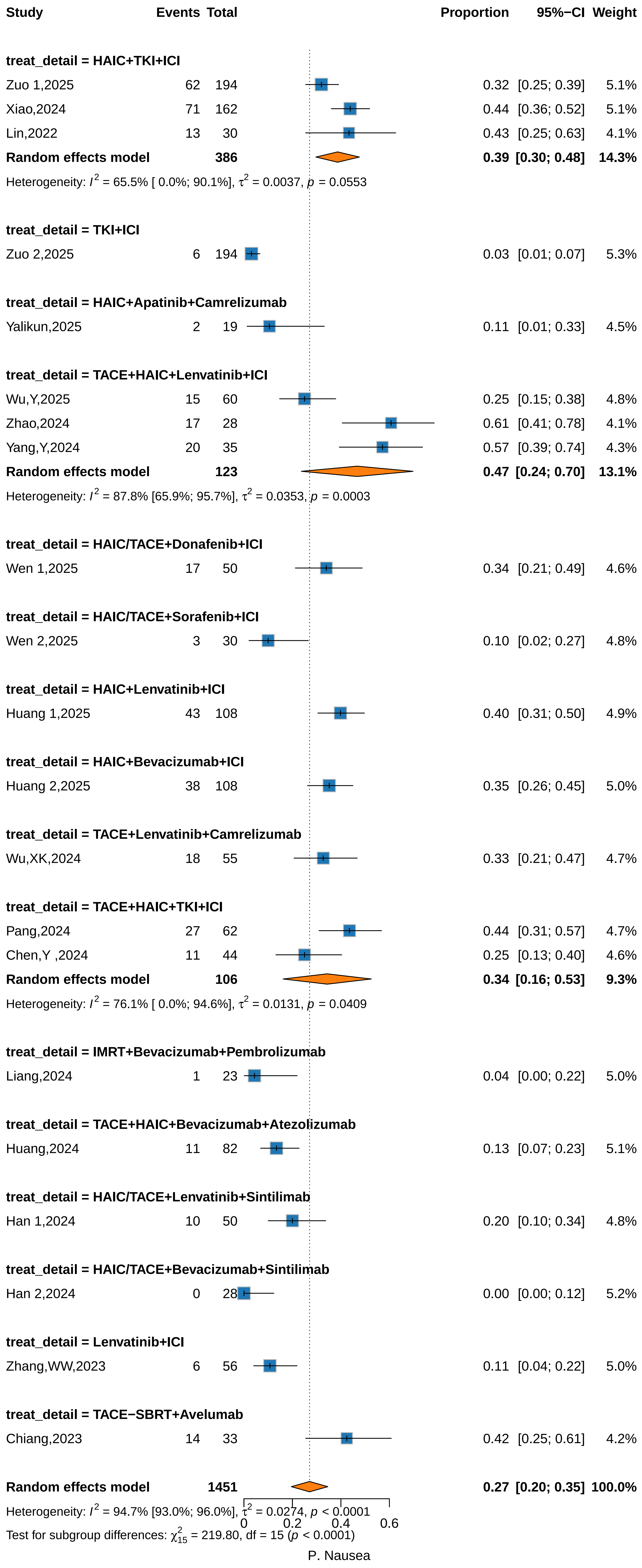
Study	Events	Total	Proportion	95%−CI	Weight
treat_detail = HAIC+TKI+ICI					
Zuo 1,2025	55	194	0.28	[0.22; 0.35]	4.8%
Xiao,2024	29	162	0.18	[0.12; 0.25]	4.8%
Lu,2024	19	51	0.37	[0.24; 0.52]	3.8%
Lin,2022	13	30	0.43	[0.25; 0.63]	3.1%
Random effects model		**437**	**0.30**	**[0.19; 0.40]**	**16.4%**
Heterogeneity: I^2 = 78.6% [42.5%; 92.0%], τ^2 = 0.0086, p = 0.0029					
treat_detail = TKI+ICI					
Zuo 2,2025	60	194	0.31	[0.25; 0.38]	4.8%
treat_detail = TACE+TKI+ICI					
Yang,D,2025	125	343	0.36	[0.31; 0.42]	4.9%
treat_detail = TACE+HAIC+Lenvatinib+ICI					
Wu,Y,2025	35	60	0.58	[0.45; 0.71]	3.9%
Zhao,2024	4	28	0.14	[0.04; 0.33]	3.8%
Yang,Y,2024	10	35	0.29	[0.15; 0.46]	3.5%
Random effects model		**123**	**0.34**	**[0.08; 0.60]**	**11.2%**
Heterogeneity: I^2 = 91.7% [78.7%; 96.7%], τ^2 = 0.0468, p < 0.0001					
treat_detail = HAIC/TACE+Donafenib+ICI					
Wen 1,2025	13	50	0.26	[0.15; 0.40]	3.9%
treat_detail = HAIC/TACE+Sorafenib+ICI					
Wen 2,2025	4	30	0.13	[0.04; 0.31]	3.9%
treat_detail = HAIC+Sorafenib+Camrelizumab					
Shen,2025	6	25	0.24	[0.09; 0.45]	3.2%
treat_detail = HAIC+Lenvatinib+ICI					
Huang 1,2025	48	108	0.44	[0.35; 0.54]	4.4%
Bai,2024	7	31	0.23	[0.10; 0.41]	3.5%
Random effects model		**139**	**0.34**	**[0.13; 0.56]**	**7.9%**
Heterogeneity: I^2 = 83.4% [31.1%; 96.0%], τ^2 = 0.0199, p = 0.0141					
treat_detail = HAIC+Bevacizumab+ICI					
Huang 2,2025	46	108	0.43	[0.33; 0.52]	4.4%
treat_detail = TACE+Lenvatinib+Camrelizumab					
Wu,XK,2024	6	55	0.11	[0.04; 0.22]	4.5%
treat_detail = TACE+HAIC+TKI+ICI					
Pang,2024	11	62	0.18	[0.09; 0.30]	4.3%
Chen,Y ,2024	18	44	0.41	[0.26; 0.57]	3.6%
Random effects model		**106**	**0.29**	**[0.06; 0.51]**	**7.9%**
Heterogeneity: I^2 = 85.4% [40.9%; 96.4%], τ^2 = 0.0229, p = 0.0089					
treat_detail = HAIC/TACE+Lenvatinib+Sintilimab					
Han 1,2024	15	50	0.30	[0.18; 0.45]	3.8%
treat_detail = HAIC/TACE+Bevacizumab+Sintilimab					
Han 2,2024	5	28	0.18	[0.06; 0.37]	3.6%
treat_detail = Lenvatinib+ICI					
Zhang,WW,2023	9	56	0.16	[0.08; 0.28]	4.3%
Yi,2022	6	33	0.18	[0.07; 0.35]	3.8%
Random effects model		**89**	**0.17**	**[0.09; 0.25]**	**8.1%**
Heterogeneity: I^2 = 0%, τ^2 = 0, p = 0.7997					
treat_detail = Lenvatinib+Sintilimab					
Wang,L,2023	15	36	0.42	[0.26; 0.59]	3.3%
treat_detail = Bevacizumab+Atezolizumab					
Shimose,2023	68	156	0.44	[0.36; 0.52]	4.6%
treat_detail = HAIC+Bevacizumab biosimilar+Sintilimab					
Liu,2023	7	30	0.23	[0.10; 0.42]	3.5%
Random effects model		**1999**	**0.29**	**[0.24; 0.34]**	**100.0%**
Heterogeneity: I^2 = 82.0% [74.4%; 87.4%], τ^2 = 0.0121, p < 0.0001					
Test for subgroup differences: χ^2_{16} = 70.54, df = 16 (p < 0.0001)					



Study	Events	Total	Proportion	95%−CI	Weight
treat_detail = TACE+TKI+ICI					
Yang,D,2025	105	343	0.31	[0.26; 0.36]	6.3%
treat_detail = HAIC+Apatinib+Camrelizumab					
Yalikun,2025	18	19	0.95	[0.74; 1.00]	6.2%
treat_detail = TACE+HAIC+Lenvatinib+ICI					
Wu,Y,2025	23	60	0.38	[0.26; 0.52]	6.2%
Yang,Y,2024	25	35	0.71	[0.54; 0.85]	6.1%
Random effects model		**95**	**0.55**	**[0.22; 0.87]**	**12.3%**
Heterogeneity: I^2 = 91.1% [68.3%; 97.5%], τ^2 = 0.0499, p = 0.0008					
treat_detail = HAIC+Sorafenib+Camrelizumab					
Shen,2025	22	25	0.88	[0.69; 0.97]	6.2%
treat_detail = HAIC+Lenvatinib+ICI					
Huang 1,2025	106	108	0.98	[0.93; 1.00]	6.4%
treat_detail = HAIC+Bevacizumab+ICI					
Huang 2,2025	105	108	0.97	[0.92; 0.99]	6.4%
treat_detail = TACE+Lenvatinib+Camrelizumab					
Wu,XK,2024	21	55	0.38	[0.25; 0.52]	6.2%
treat_detail = TACE+HAIC+TKI+ICI					
Pang,2024	8	62	0.13	[0.06; 0.24]	6.3%
Chen,Y ,2024	16	44	0.36	[0.22; 0.52]	6.1%
Random effects model		**106**	**0.24**	**[0.01; 0.47]**	**12.4%**
Heterogeneity: I^2 = 87.2% [49.7%; 96.7%], τ^2 = 0.0240, p = 0.0053					
treat_detail = HAIC+TKI+ICI					
Lu,2024	18	51	0.35	[0.22; 0.50]	6.2%
treat_detail = TACE+HAIC+Bevacizumab+Atezolizumab					
Huang,2024	79	82	0.96	[0.90; 0.99]	6.3%
treat_detail = HAIC/TACE+Lenvatinib+Sintilimab					
Han 1,2024	7	50	0.14	[0.06; 0.27]	6.3%
treat_detail = HAIC/TACE+Bevacizumab+Sintilimab					
Han 2,2024	2	28	0.07	[0.01; 0.24]	6.3%
treat_detail = Lenvatinib+ICI					
Zhang,WW,2023	1	56	0.02	[0.00; 0.10]	6.3%
treat_detail = HAIC+Bevacizumab biosimilar+Sintilimab					
Liu,2023	1	30	0.03	[0.00; 0.17]	6.3%
Random effects model		**1156**	**0.48**	**[0.29; 0.66]**	**100.0%**
Heterogeneity: I^2 = 99.6% [99.5%; 99.6%], τ^2 = 0.1366, p = 0					
Test for subgroup differences: χ^2_{13} = 3454.79, df = 13 (p = 0)					


Study Events Total Proportion 95%−CI Weight
treat_detail = HAIC+TKI+ICI
Zuo 1,2025 62 194 0.32 [0.25; 0.39] 6.4%
Xiao,2024 12 162 0.07 [0.04; 0.13] 6.6%
Lin,2022 8 30 0.27 [0.12; 0.46] 5.6%
Random effects model 386 0.21 [0.06; 0.37] 18.7%
Heterogeneity: I^2 = 95.2% [89.2%; 97.8%], τ^2 = 0.0171, p < 0.0001
treat_detail = TKI+ICI
Zuo 2,2025 47 194 0.24 [0.18; 0.31] 6.5%
treat_detail = TACE+TKI+ICI
Yang,D,2025 23 343 0.07 [0.04; 0.10] 6.6%
treat_detail = HAIC+Apatinib+Camrelizumab
Yalikun,2025 1 19 0.05 [0.00; 0.26] 6.2%
treat_detail = TACE+Sintilimab
Li,2025 18 20 0.90 [0.68; 0.99] 5.9%
treat_detail = TACE+HAIC+Lenvatinib+ICI
Yang,Y,2024 5 35 0.14 [0.05; 0.30] 6.1%
treat_detail = TACE+Lenvatinib+Camrelizumab
Wu,XK,2024 15 55 0.27 [0.16; 0.41] 6.0%
treat_detail = TACE+HAIC+TKI+ICI
Pang,2024 12 62 0.19 [0.10; 0.31] 6.2%
Chen,Y ,2024 2 44 0.05 [0.01; 0.15] 6.5%
Random effects model 106 0.11 [0.00; 0.26] 12.7%
Heterogeneity: I^2 = 84% [34.2%; 96.1%], τ^2 = 0.0092, p = 0.0124
treat_detail = TACE+HAIC+Bevacizumab+Atezolizumab
Huang,2024 13 82 0.16 [0.09; 0.26] 6.4%
treat_detail = Lenvatinib+ICI
Zhang,WW,2023 4 56 0.07 [0.02; 0.17] 6.4%
Yi,2022 5 33 0.15 [0.05; 0.32] 6.0%
Random effects model 89 0.09 [0.02; 0.17] 12.4%
Heterogeneity: I^2 = 20.8%, τ^2 = 0.0007, p = 0.2612
treat_detail = Bevacizumab+Atezolizumab
Shimose,2023 22 156 0.14 [0.09; 0.21] 6.5%
treat_detail = TACE−SBRT+Avelumab
Chiang,2023 5 33 0.15 [0.05; 0.32] 6.0%
Random effects model 1518 0.20 [0.10; 0.30] 100.0%
Heterogeneity: I^2 = 93.5% [90.9%; 95.3%], τ^2 = 0.0363, p < 0.0001
Test for subgroup differences: χ^2_{11} = 177.60, df = 11 (p < 0.0001)
0
0.2
0.4
0.6
0.8
1
N. Hypothyroidism

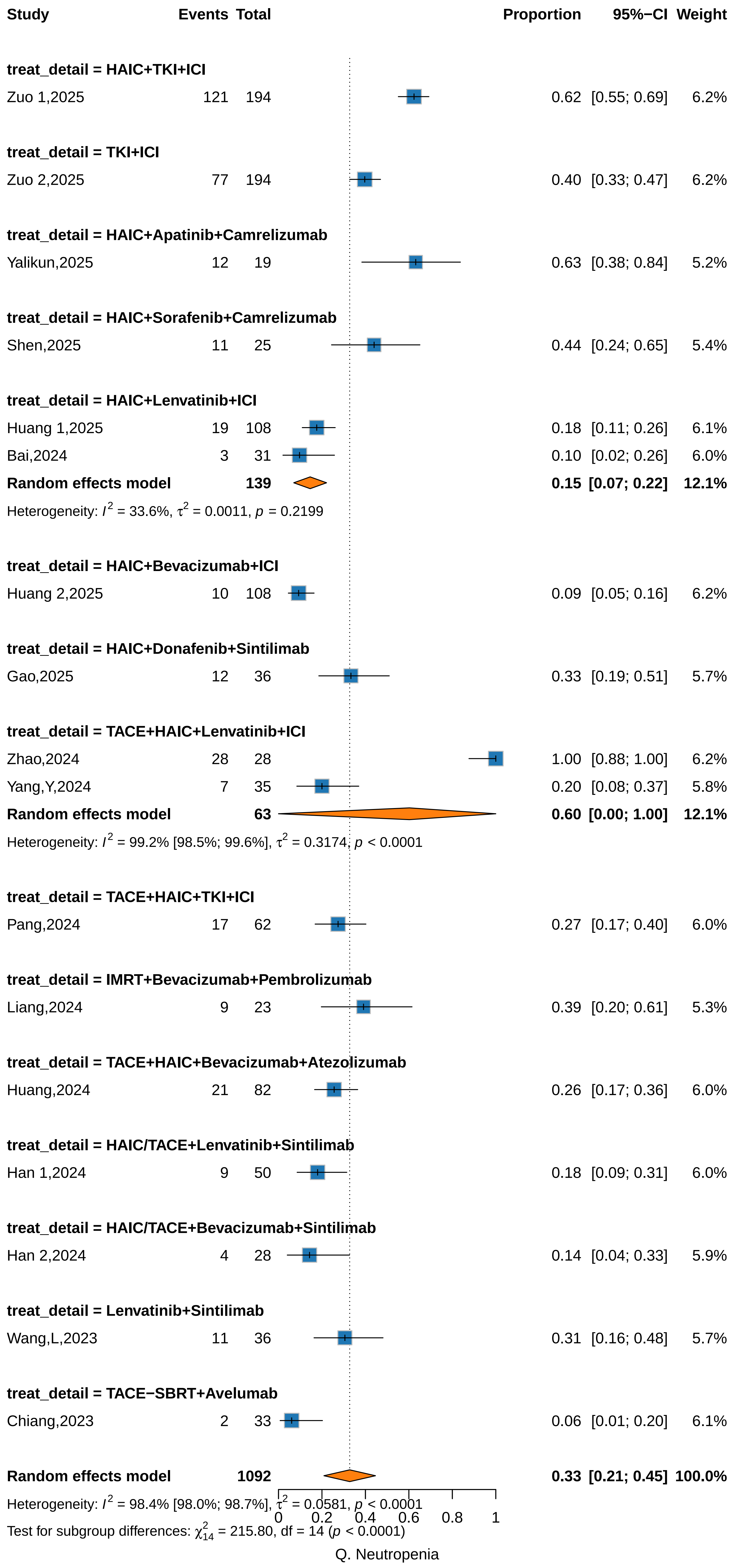

Study Events Total Proportion 95%−CI Weight
treat_detail = TACE+TKI+ICI
Yang,D,2025 59 343 0.17 [0.13; 0.22] 5.9%
treat_detail = HAIC+Apatinib+Camrelizumab
Yalikun,2025 13 19 0.68 [0.43; 0.87] 3.9%
treat_detail = TACE+HAIC+Lenvatinib+ICI
Wu,Y,2025 35 60 0.58 [0.45; 0.71] 5.1%
treat_detail = HAIC/TACE+Donafenib+ICI
Wen 1,2025 9 50 0.18 [0.09; 0.31] 5.3%
treat_detail = HAIC/TACE+Sorafenib+ICI
Wen 2,2025 5 30 0.17 [0.06; 0.35] 5.0%
treat_detail = HAIC+Sorafenib+Camrelizumab
Shen,2025 10 25 0.40 [0.21; 0.61] 4.1%
treat_detail = HAIC/TACE+Lenvatinib+ICI
Pan 1,2025 26 152 0.17 [0.11; 0.24] 5.8%
treat_detail = HAIC/TACE+Bevacizumab+ICI
Pan 2,2025 13 82 0.16 [0.09; 0.26] 5.6%
treat_detail = HAIC+Donafenib+Sintilimab
Gao,2025 8 36 0.22 [0.10; 0.39] 4.9%
treat_detail = TACE+Lenvatinib+Camrelizumab
Wu,XK,2024 13 55 0.24 [0.13; 0.37] 5.2%
treat_detail = HAIC+TKI+ICI
Lu,2024 25 51 0.49 [0.35; 0.63] 4.9%
Lin,2022 11 30 0.37 [0.20; 0.56] 4.4%
Random effects model 81 0.44 [0.32; 0.56] 9.3%
Heterogeneity: I^2 = 17.2%, τ^2 = 0.0013, p = 0.2719
treat_detail = IMRT+Bevacizumab+Pembrolizumab
Liang,2024 8 23 0.35 [0.16; 0.57] 4.1%
treat_detail = TACE+HAIC+Bevacizumab+Atezolizumab
Huang,2024 19 82 0.23 [0.15; 0.34] 5.5%
treat_detail = TACE+HAIC+TKI+ICI
Chen,Y ,2024 8 44 0.18 [0.08; 0.33] 5.2%
treat_detail = HAIC+Lenvatinib+ICI
Bai,2024 4 31 0.13 [0.04; 0.30] 5.2%
treat_detail = Lenvatinib+ICI
Zhang,WW,2023 1 56 0.02 [0.00; 0.10] 6.0%
Yi,2022 8 33 0.24 [0.11; 0.42] 4.8%
Random effects model 89 0.12 [0.00; 0.34] 10.7%
Heterogeneity: I^2 = 88.3% [55.5%; 96.9%], τ^2 = 0.0223, p = 0.0034
treat_detail = HAIC+Bevacizumab biosimilar+Sintilimab
Liu,2023 7 30 0.23 [0.10; 0.42] 4.7%
treat_detail = TACE−SBRT+Avelumab
Chiang,2023 14 33 0.42 [0.25; 0.61] 4.5%
Random effects model 1265 0.27 [0.20; 0.34] 100.0%
Heterogeneity: I^2 = 89.9% [85.8%; 92.8%], τ^2 = 0.0210, p < 0.0001
Test for subgroup differences: χ^2_{17} = 90.63, df = 17 (p < 0.0001)
0
0.2
0.4
0.6
0.8
O. Leukopenia



Study	**Events**	**Total**	**Proportion**	**95%−CI**	**Weight**
treat_detail = HAIC+TKI+ICI					
Zuo 1,2025	62	194	0.32	[0.25; 0.39]	5.1%
Xiao,2024	71	162	0.44	[0.36; 0.52]	5.1%
Lin,2022	13	30	0.43	[0.25; 0.63]	4.1%
Random effects model		**386**	**0.39**	**[0.30; 0.48]**	**14.3%**
Heterogeneity: I^2 = 65.5% [0.0%; 90.1%], τ^2 = 0.0037, p = 0.0553					
treat_detail = TKI+ICI					
Zuo 2,2025	6	194	0.03	[0.01; 0.07]	5.3%
treat_detail = HAIC+Apatinib+Camrelizumab					
Yalikun,2025	2	19	0.11	[0.01; 0.33]	4.5%
treat_detail = TACE+HAIC+Lenvatinib+ICI					
Wu,Y,2025	15	60	0.25	[0.15; 0.38]	4.8%
Zhao,2024	17	28	0.61	[0.41; 0.78]	4.1%
Yang,Y,2024	20	35	0.57	[0.39; 0.74]	4.3%
Random effects model		**123**	**0.47**	**[0.24; 0.70]**	**13.1%**
Heterogeneity: I^2 = 87.8% [65.9%; 95.7%], τ^2 = 0.0353, p = 0.0003					
treat_detail = HAIC/TACE+Donafenib+ICI					
Wen 1,2025	17	50	0.34	[0.21; 0.49]	4.6%
treat_detail = HAIC/TACE+Sorafenib+ICI					
Wen 2,2025	3	30	0.10	[0.02; 0.27]	4.8%
treat_detail = HAIC+Lenvatinib+ICI					
Huang 1,2025	43	108	0.40	[0.31; 0.50]	4.9%
treat_detail = HAIC+Bevacizumab+ICI					
Huang 2,2025	38	108	0.35	[0.26; 0.45]	5.0%
treat_detail = TACE+Lenvatinib+Camrelizumab					
Wu,XK,2024	18	55	0.33	[0.21; 0.47]	4.7%
treat_detail = TACE+HAIC+TKI+ICI					
Pang,2024	27	62	0.44	[0.31; 0.57]	4.7%
Chen,Y ,2024	11	44	0.25	[0.13; 0.40]	4.6%
Random effects model		**106**	**0.34**	**[0.16; 0.53]**	**9.3%**
Heterogeneity: I^2 = 76.1% [0.0%; 94.6%], τ^2 = 0.0131, p = 0.0409					
treat_detail = IMRT+Bevacizumab+Pembrolizumab					
Liang,2024	1	23	0.04	[0.00; 0.22]	5.0%
treat_detail = TACE+HAIC+Bevacizumab+Atezolizumab					
Huang,2024	11	82	0.13	[0.07; 0.23]	5.1%
treat_detail = HAIC/TACE+Lenvatinib+Sintilimab					
Han 1,2024	10	50	0.20	[0.10; 0.34]	4.8%
treat_detail = HAIC/TACE+Bevacizumab+Sintilimab					
Han 2,2024	0	28	0.00	[0.00; 0.12]	5.2%
treat_detail = Lenvatinib+ICI					
Zhang,WW,2023	6	56	0.11	[0.04; 0.22]	5.0%
treat_detail = TACE−SBRT+Avelumab					
Chiang,2023	14	33	0.42	[0.25; 0.61]	4.2%
Random effects model		**1451**	**0.27**	**[0.20; 0.35]**	**100.0%**

Heterogeneity: I^2 = 94.7% [93.0%; 96.0%], τ^2 = 0.0274, p < 0.0001

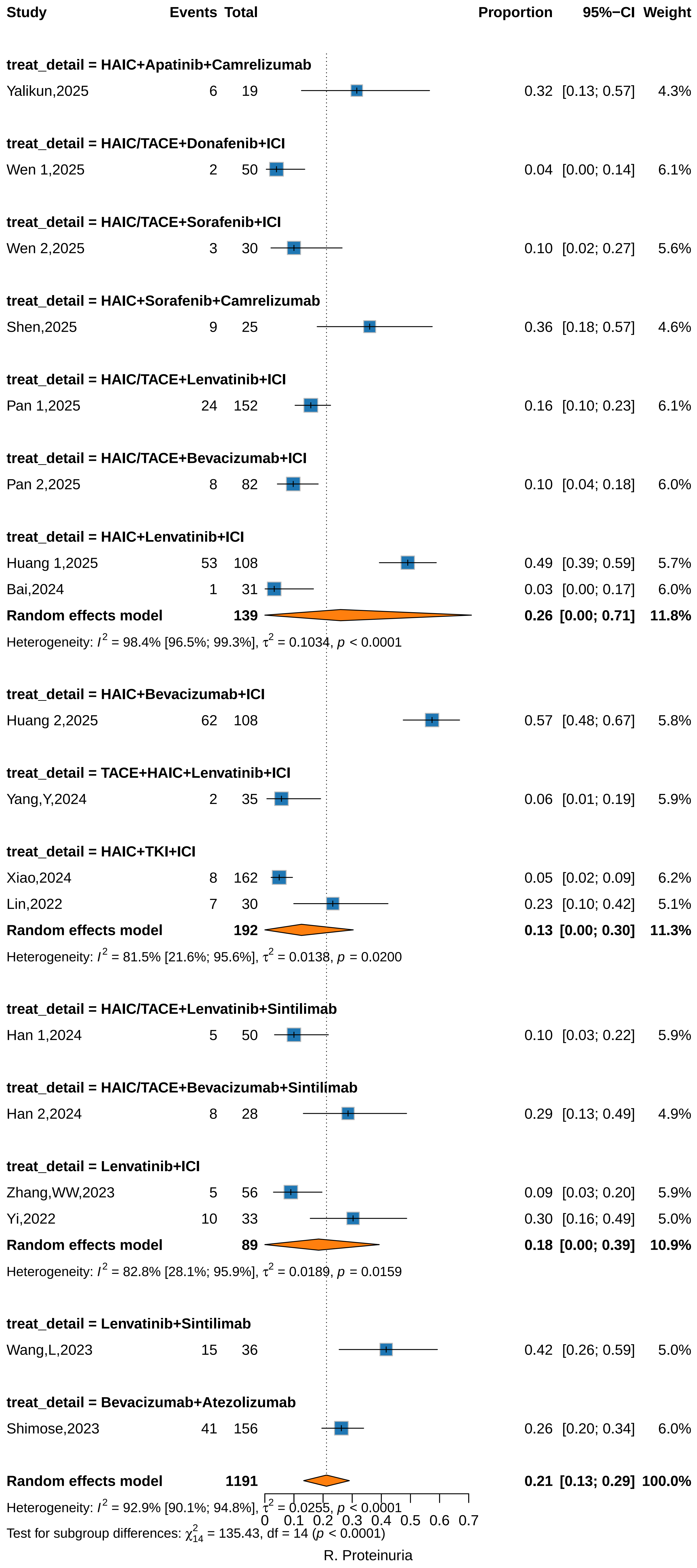
Test for subgroup differences: χ^2_{15} = 219.80, df = 15 (p < 0.0001)

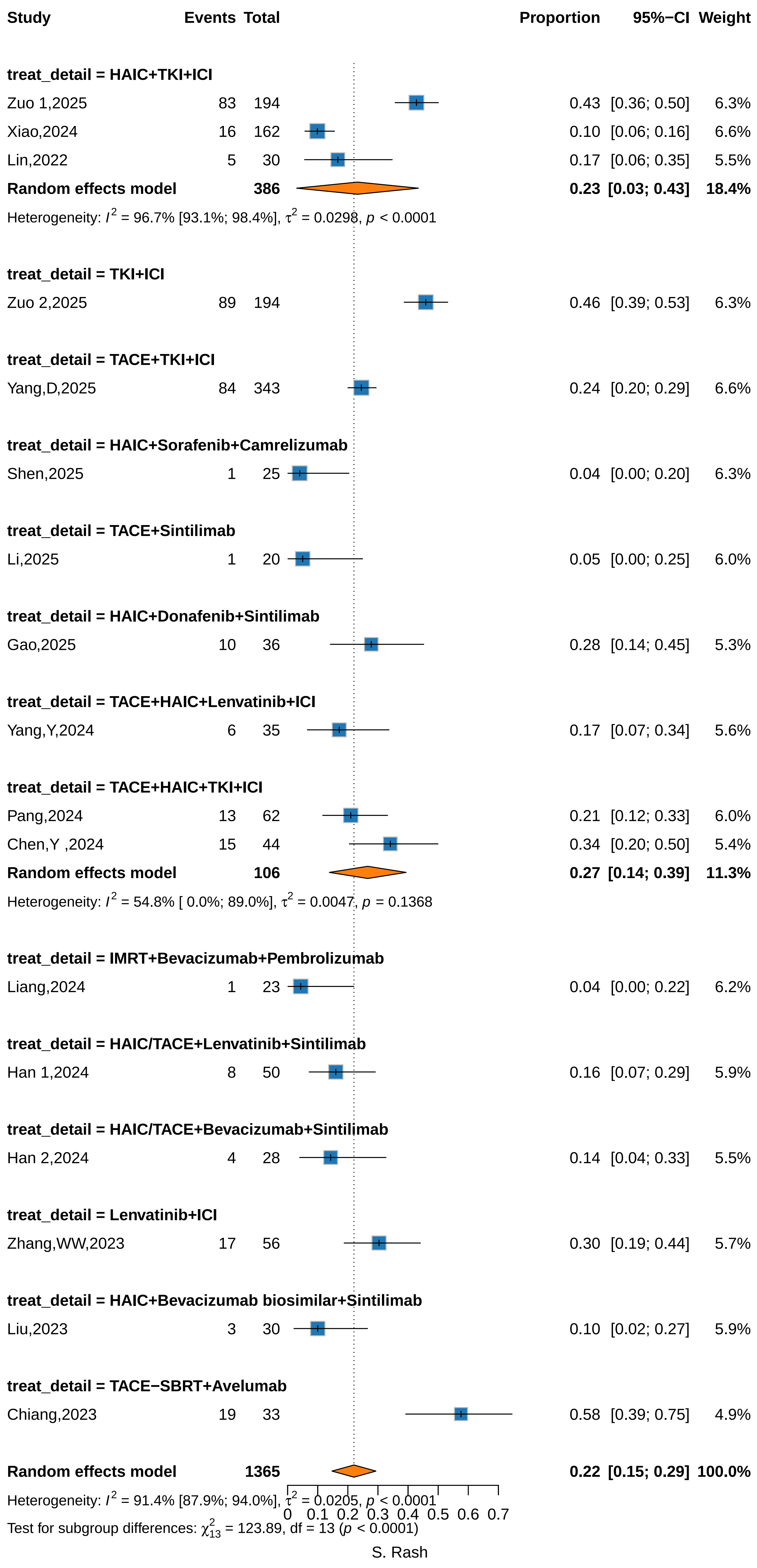


Study	Events	Total	Proportion	95%−CI	Weight
treat_detail = HAIC+TKI+ICI					
Zuo 1,2025	121	194	0.62	[0.55; 0.69]	6.2%
treat_detail = TKI+ICI					
Zuo 2,2025	77	194	0.40	[0.33; 0.47]	6.2%
treat_detail = HAIC+Apatinib+Camrelizumab					
Yalikun,2025	12	19	0.63	[0.38; 0.84]	5.2%
treat_detail = HAIC+Sorafenib+Camrelizumab					
Shen,2025	11	25	0.44	[0.24; 0.65]	5.4%
treat_detail = HAIC+Lenvatinib+ICI					
Huang 1,2025	19	108	0.18	[0.11; 0.26]	6.1%
Bai,2024	3	31	0.10	[0.02; 0.26]	6.0%
Random effects model		**139**	**0.15**	**[0.07; 0.22]**	**12.1%**
Heterogeneity: $I^2 = 33.6\%$, $\tau^2 = 0.0011$, $p = 0.2199$					
treat_detail = HAIC+Bevacizumab+ICI					
Huang 2,2025	10	108	0.09	[0.05; 0.16]	6.2%
treat_detail = HAIC+Donafenib+Sintilimab					
Gao,2025	12	36	0.33	[0.19; 0.51]	5.7%
treat_detail = TACE+HAIC+Lenvatinib+ICI					
Zhao,2024	28	28	1.00	[0.88; 1.00]	6.2%
Yang,Y,2024	7	35	0.20	[0.08; 0.37]	5.8%
Random effects model		**63**	**0.60**	**[0.00; 1.00]**	**12.1%**
Heterogeneity: $I^2 = 99.2\%$ [98.5%; 99.6%], $\tau^2 = 0.3174$, $p < 0.0001$					
treat_detail = TACE+HAIC+TKI+ICI					
Pang,2024	17	62	0.27	[0.17; 0.40]	6.0%
treat_detail = IMRT+Bevacizumab+Pembrolizumab					
Liang,2024	9	23	0.39	[0.20; 0.61]	5.3%
treat_detail = TACE+HAIC+Bevacizumab+Atezolizumab					
Huang,2024	21	82	0.26	[0.17; 0.36]	6.0%
treat_detail = HAIC/TACE+Lenvatinib+Sintilimab					
Han 1,2024	9	50	0.18	[0.09; 0.31]	6.0%
treat_detail = HAIC/TACE+Bevacizumab+Sintilimab					
Han 2,2024	4	28	0.14	[0.04; 0.33]	5.9%
treat_detail = Lenvatinib+Sintilimab					
Wang,L,2023	11	36	0.31	[0.16; 0.48]	5.7%
treat_detail = TACE−SBRT+Avelumab					
Chiang,2023	2	33	0.06	[0.01; 0.20]	6.1%
Random effects model		**1092**	**0.33**	**[0.21; 0.45]**	**100.0%**

Heterogeneity: $I^2 = 98.4\%$ [98.0%; 98.7%], $\tau^2 = 0.0581$, $p < 0.0001$

Test for subgroup differences: $\chi^2_{14} = 215.80$, df = 14 ($p < 0.0001$)

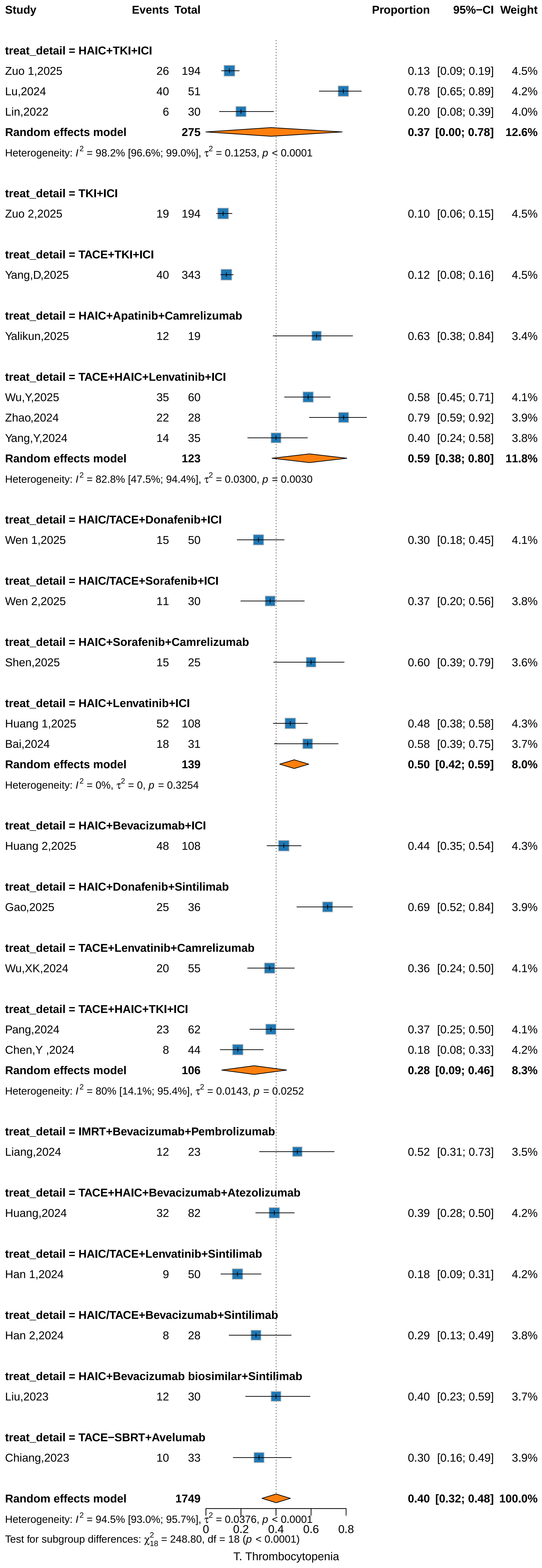

Study Events Total Proportion 95%−CI Weight
treat_detail = HAIC+Apatinib+Camrelizumab
Yalikun,2025 6 19 0.32 [0.13; 0.57] 4.3%
treat_detail = HAIC/TACE+Donafenib+ICI
Wen 1,2025 2 50 0.04 [0.00; 0.14] 6.1%
treat_detail = HAIC/TACE+Sorafenib+ICI
Wen 2,2025 3 30 0.10 [0.02; 0.27] 5.6%
treat_detail = HAIC+Sorafenib+Camrelizumab
Shen,2025 9 25 0.36 [0.18; 0.57] 4.6%
treat_detail = HAIC/TACE+Lenvatinib+ICI
Pan 1,2025 24 152 0.16 [0.10; 0.23] 6.1%
treat_detail = HAIC/TACE+Bevacizumab+ICI
Pan 2,2025 8 82 0.10 [0.04; 0.18] 6.0%
treat_detail = HAIC+Lenvatinib+ICI
Huang 1,2025 53 108 0.49 [0.39; 0.59] 5.7%
Bai,2024 1 31 0.03 [0.00; 0.17] 6.0%
Random effects model 139 0.26 [0.00; 0.71] 11.8%
Heterogeneity: I^2 = 98.4% [96.5%; 99.3%], τ^2 = 0.1034, p < 0.0001
treat_detail = HAIC+Bevacizumab+ICI
Huang 2,2025 62 108 0.57 [0.48; 0.67] 5.8%
treat_detail = TACE+HAIC+Lenvatinib+ICI
Yang,Y,2024 2 35 0.06 [0.01; 0.19] 5.9%
treat_detail = HAIC+TKI+ICI
Xiao,2024 8 162 0.05 [0.02; 0.09] 6.2%
Lin,2022 7 30 0.23 [0.10; 0.42] 5.1%
Random effects model 192 0.13 [0.00; 0.30] 11.3%
Heterogeneity: I^2 = 81.5% [21.6%; 95.6%], τ^2 = 0.0138, p = 0.0200
treat_detail = HAIC/TACE+Lenvatinib+Sintilimab
Han 1,2024 5 50 0.10 [0.03; 0.22] 5.9%
treat_detail = HAIC/TACE+Bevacizumab+Sintilimab
Han 2,2024 8 28 0.29 [0.13; 0.49] 4.9%
treat_detail = Lenvatinib+ICI
Zhang,WW,2023 5 56 0.09 [0.03; 0.20] 5.9%
Yi,2022 10 33 0.30 [0.16; 0.49] 5.0%
Random effects model 89 0.18 [0.00; 0.39] 10.9%
Heterogeneity: I^2 = 82.8% [28.1%; 95.9%], τ^2 = 0.0189, p = 0.0159
treat_detail = Lenvatinib+Sintilimab
Wang,L,2023 15 36 0.42 [0.26; 0.59] 5.0%
treat_detail = Bevacizumab+Atezolizumab
Shimose,2023 41 156 0.26 [0.20; 0.34] 6.0%
Random effects model 1191 0.21 [0.13; 0.29] 100.0%
Heterogeneity: I^2 = 92.9% [90.1%; 94.8%], τ^2 = 0.0255, p < 0.0001
Test for subgroup differences: χ^2_{14} = 135.43, df = 14 (p < 0.0001)
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
R. Proteinuria



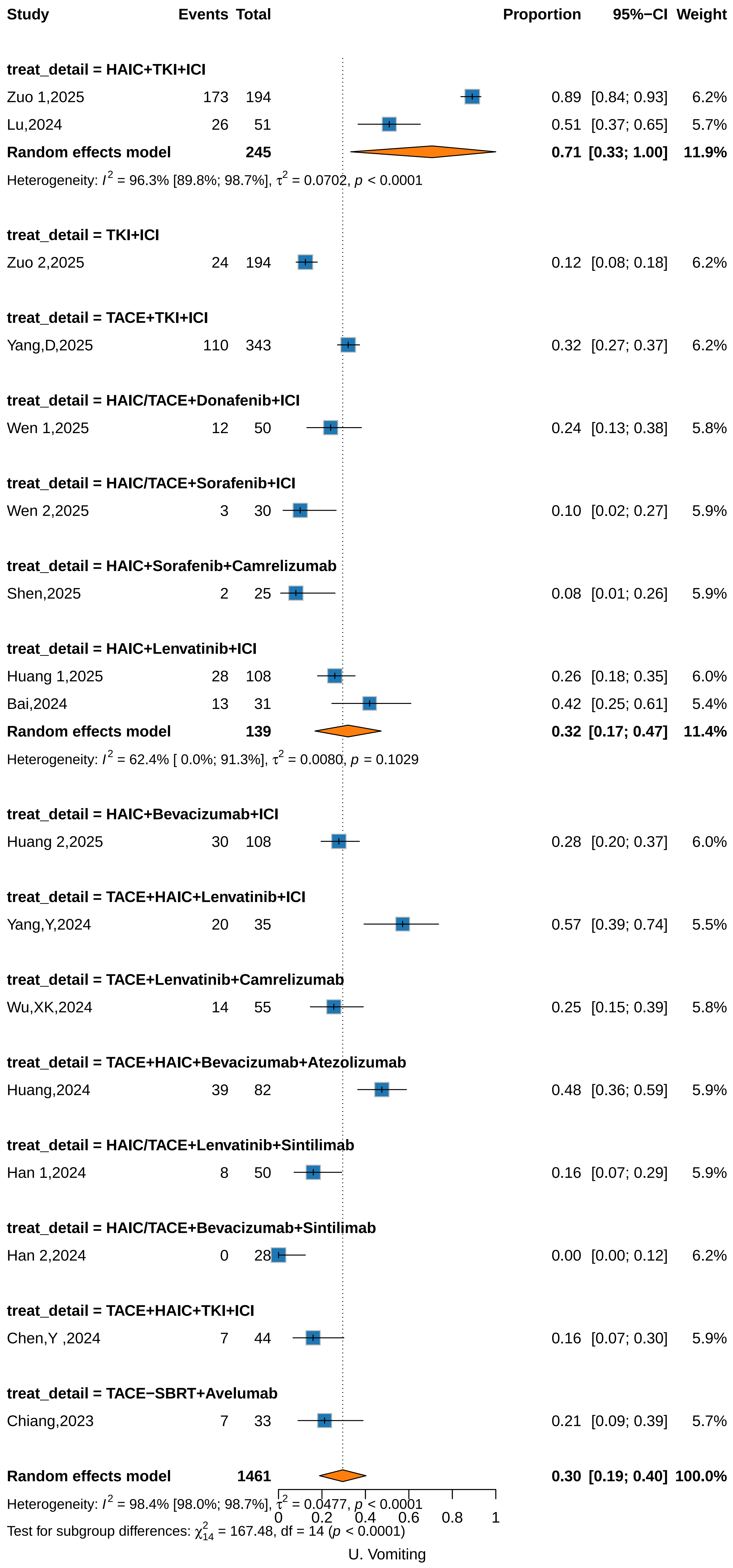
Study	Events	Total	Proportion	95%−CI	Weight
treat_detail = HAIC+TKI+ICI					
Zuo 1,2025	83	194	0.43	[0.36; 0.50]	6.3%
Xiao,2024	16	162	0.10	[0.06; 0.16]	6.6%
Lin,2022	5	30	0.17	[0.06; 0.35]	5.5%
Random effects model		**386**	**0.23**	**[0.03; 0.43]**	**18.4%**
Heterogeneity: I^2 = 96.7% [93.1%; 98.4%], τ^2 = 0.0298, p < 0.0001					
treat_detail = TKI+ICI					
Zuo 2,2025	89	194	0.46	[0.39; 0.53]	6.3%
treat_detail = TACE+TKI+ICI					
Yang,D,2025	84	343	0.24	[0.20; 0.29]	6.6%
treat_detail = HAIC+Sorafenib+Camrelizumab					
Shen,2025	1	25	0.04	[0.00; 0.20]	6.3%
treat_detail = TACE+Sintilimab					
Li,2025	1	20	0.05	[0.00; 0.25]	6.0%
treat_detail = HAIC+Donafenib+Sintilimab					
Gao,2025	10	36	0.28	[0.14; 0.45]	5.3%
treat_detail = TACE+HAIC+Lenvatinib+ICI					
Yang,Y,2024	6	35	0.17	[0.07; 0.34]	5.6%
treat_detail = TACE+HAIC+TKI+ICI					
Pang,2024	13	62	0.21	[0.12; 0.33]	6.0%
Chen,Y ,2024	15	44	0.34	[0.20; 0.50]	5.4%
Random effects model		**106**	**0.27**	**[0.14; 0.39]**	**11.3%**
Heterogeneity: I^2 = 54.8% [0.0%; 89.0%], τ^2 = 0.0047, p = 0.1368					
treat_detail = IMRT+Bevacizumab+Pembrolizumab					
Liang,2024	1	23	0.04	[0.00; 0.22]	6.2%
treat_detail = HAIC/TACE+Lenvatinib+Sintilimab					
Han 1,2024	8	50	0.16	[0.07; 0.29]	5.9%
treat_detail = HAIC/TACE+Bevacizumab+Sintilimab					
Han 2,2024	4	28	0.14	[0.04; 0.33]	5.5%
treat_detail = Lenvatinib+ICI					
Zhang,WW,2023	17	56	0.30	[0.19; 0.44]	5.7%
treat_detail = HAIC+Bevacizumab biosimilar+Sintilimab					
Liu,2023	3	30	0.10	[0.02; 0.27]	5.9%
treat_detail = TACE−SBRT+Avelumab					
Chiang,2023	19	33	0.58	[0.39; 0.75]	4.9%
Random effects model		**1365**	**0.22**	**[0.15; 0.29]**	**100.0%**

Heterogeneity: I^2 = 91.4% [87.9%; 94.0%], τ^2 = 0.0205, p < 0.0001

Test for subgroup differences: χ^2_{13} = 123.89, df = 13 (p < 0.0001)



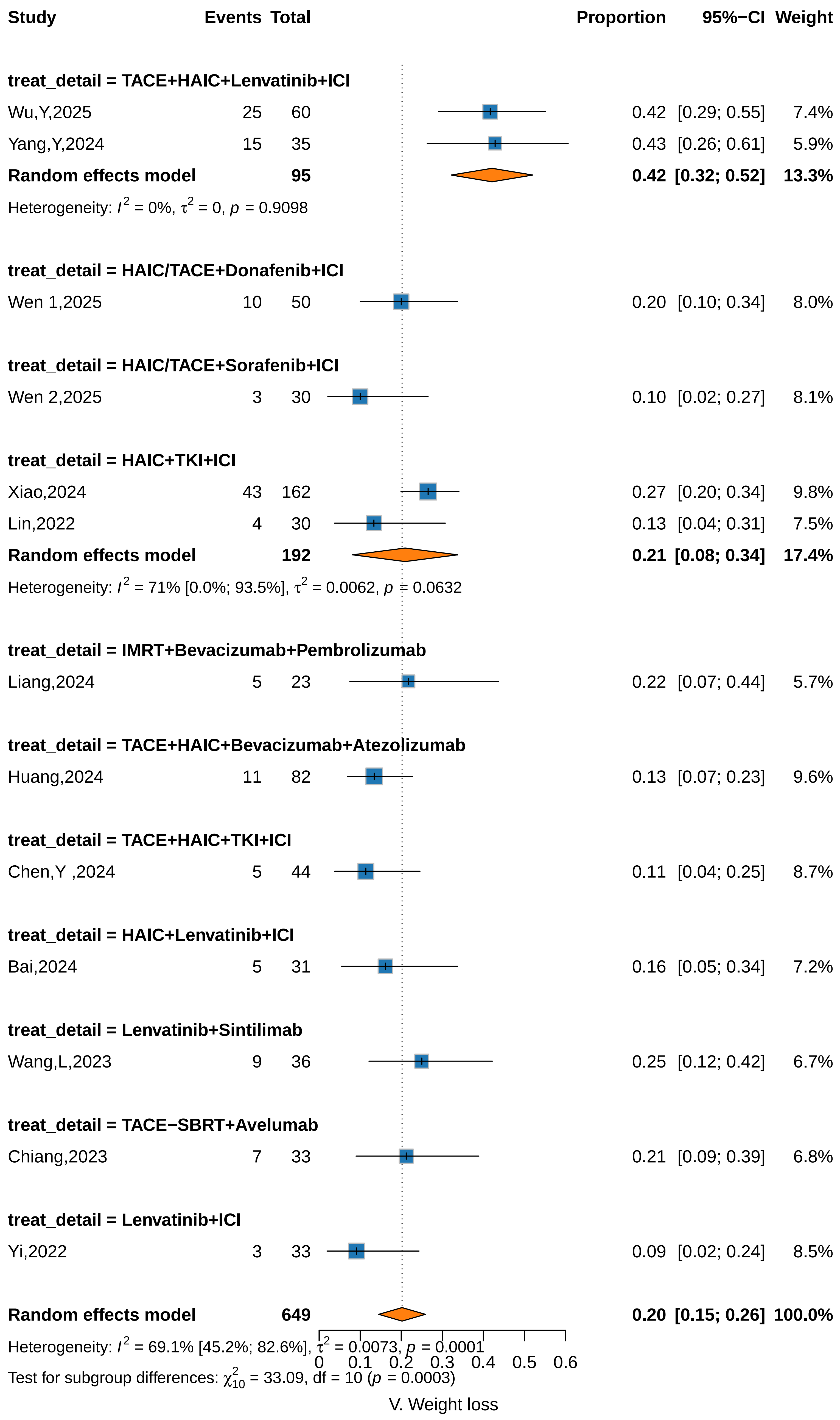
Study	Events	Total	Proportion	95%−CI	Weight
treat_detail = HAIC+TKI+ICI					
Zuo 1,2025	26	194	0.13	[0.09; 0.19]	4.5%
Lu,2024	40	51	0.78	[0.65; 0.89]	4.2%
Lin,2022	6	30	0.20	[0.08; 0.39]	4.0%
Random effects model		**275**	**0.37**	**[0.00; 0.78]**	**12.6%**
Heterogeneity: I^2 = 98.2% [96.6%; 99.0%], τ^2 = 0.1253, p < 0.0001					
treat_detail = TKI+ICI					
Zuo 2,2025	19	194	0.10	[0.06; 0.15]	4.5%
treat_detail = TACE+TKI+ICI					
Yang,D,2025	40	343	0.12	[0.08; 0.16]	4.5%
treat_detail = HAIC+Apatinib+Camrelizumab					
Yalikun,2025	12	19	0.63	[0.38; 0.84]	3.4%
treat_detail = TACE+HAIC+Lenvatinib+ICI					
Wu,Y,2025	35	60	0.58	[0.45; 0.71]	4.1%
Zhao,2024	22	28	0.79	[0.59; 0.92]	3.9%
Yang,Y,2024	14	35	0.40	[0.24; 0.58]	3.8%
Random effects model		**123**	**0.59**	**[0.38; 0.80]**	**11.8%**
Heterogeneity: I^2 = 82.8% [47.5%; 94.4%], τ^2 = 0.0300, p = 0.0030					
treat_detail = HAIC/TACE+Donafenib+ICI					
Wen 1,2025	15	50	0.30	[0.18; 0.45]	4.1%
treat_detail = HAIC/TACE+Sorafenib+ICI					
Wen 2,2025	11	30	0.37	[0.20; 0.56]	3.8%
treat_detail = HAIC+Sorafenib+Camrelizumab					
Shen,2025	15	25	0.60	[0.39; 0.79]	3.6%
treat_detail = HAIC+Lenvatinib+ICI					
Huang 1,2025	52	108	0.48	[0.38; 0.58]	4.3%
Bai,2024	18	31	0.58	[0.39; 0.75]	3.7%
Random effects model		**139**	**0.50**	**[0.42; 0.59]**	**8.0%**
Heterogeneity: I^2 = 0%, τ^2 = 0, p = 0.3254					
treat_detail = HAIC+Bevacizumab+ICI					
Huang 2,2025	48	108	0.44	[0.35; 0.54]	4.3%
treat_detail = HAIC+Donafenib+Sintilimab					
Gao,2025	25	36	0.69	[0.52; 0.84]	3.9%
treat_detail = TACE+Lenvatinib+Camrelizumab					
Wu,XK,2024	20	55	0.36	[0.24; 0.50]	4.1%
treat_detail = TACE+HAIC+TKI+ICI					
Pang,2024	23	62	0.37	[0.25; 0.50]	4.1%
Chen,Y ,2024	8	44	0.18	[0.08; 0.33]	4.2%
Random effects model		**106**	**0.28**	**[0.09; 0.46]**	**8.3%**
Heterogeneity: I^2 = 80% [14.1%; 95.4%], τ^2 = 0.0143, p = 0.0252					
treat_detail = IMRT+Bevacizumab+Pembrolizumab					
Liang,2024	12	23	0.52	[0.31; 0.73]	3.5%
treat_detail = TACE+HAIC+Bevacizumab+Atezolizumab					
Huang,2024	32	82	0.39	[0.28; 0.50]	4.2%
treat_detail = HAIC/TACE+Lenvatinib+Sintilimab					
Han 1,2024	9	50	0.18	[0.09; 0.31]	4.2%
treat_detail = HAIC/TACE+Bevacizumab+Sintilimab					
Han 2,2024	8	28	0.29	[0.13; 0.49]	3.8%
treat_detail = HAIC+Bevacizumab biosimilar+Sintilimab					
Liu,2023	12	30	0.40	[0.23; 0.59]	3.7%
treat_detail = TACE−SBRT+Avelumab					
Chiang,2023	10	33	0.30	[0.16; 0.49]	3.9%
Random effects model		**1749**	**0.40**	**[0.32; 0.48]**	**100.0%**
Heterogeneity: I^2 = 94.5% [93.0%; 95.7%], τ^2 = 0.0376, p < 0.0001					
Test for subgroup differences: χ^2_{18} = 248.80, df = 18 (p < 0.0001)					



Study	Events	Total	Proportion	95%−CI	Weight
treat_detail = HAIC+TKI+ICI					
Zuo 1,2025	173	194	0.89	[0.84; 0.93]	6.2%
Lu,2024	26	51	0.51	[0.37; 0.65]	5.7%
Random effects model		**245**	**0.71**	**[0.33; 1.00]**	**11.9%**
Heterogeneity: I^2 = 96.3% [89.8%; 98.7%], τ^2 = 0.0702, p < 0.0001					
treat_detail = TKI+ICI					
Zuo 2,2025	24	194	0.12	[0.08; 0.18]	6.2%
treat_detail = TACE+TKI+ICI					
Yang,D,2025	110	343	0.32	[0.27; 0.37]	6.2%
treat_detail = HAIC/TACE+Donafenib+ICI					
Wen 1,2025	12	50	0.24	[0.13; 0.38]	5.8%
treat_detail = HAIC/TACE+Sorafenib+ICI					
Wen 2,2025	3	30	0.10	[0.02; 0.27]	5.9%
treat_detail = HAIC+Sorafenib+Camrelizumab					
Shen,2025	2	25	0.08	[0.01; 0.26]	5.9%
treat_detail = HAIC+Lenvatinib+ICI					
Huang 1,2025	28	108	0.26	[0.18; 0.35]	6.0%
Bai,2024	13	31	0.42	[0.25; 0.61]	5.4%
Random effects model		**139**	**0.32**	**[0.17; 0.47]**	**11.4%**
Heterogeneity: I^2 = 62.4% [0.0%; 91.3%], τ^2 = 0.0080, p = 0.1029					
treat_detail = HAIC+Bevacizumab+ICI					
Huang 2,2025	30	108	0.28	[0.20; 0.37]	6.0%
treat_detail = TACE+HAIC+Lenvatinib+ICI					
Yang,Y,2024	20	35	0.57	[0.39; 0.74]	5.5%
treat_detail = TACE+Lenvatinib+Camrelizumab					
Wu,XK,2024	14	55	0.25	[0.15; 0.39]	5.8%
treat_detail = TACE+HAIC+Bevacizumab+Atezolizumab					
Huang,2024	39	82	0.48	[0.36; 0.59]	5.9%
treat_detail = HAIC/TACE+Lenvatinib+Sintilimab					
Han 1,2024	8	50	0.16	[0.07; 0.29]	5.9%
treat_detail = HAIC/TACE+Bevacizumab+Sintilimab					
Han 2,2024	0	28	0.00	[0.00; 0.12]	6.2%
treat_detail = TACE+HAIC+TKI+ICI					
Chen,Y ,2024	7	44	0.16	[0.07; 0.30]	5.9%
treat_detail = TACE−SBRT+Avelumab					
Chiang,2023	7	33	0.21	[0.09; 0.39]	5.7%
Random effects model		**1461**	**0.30**	**[0.19; 0.40]**	**100.0%**

Heterogeneity: I^2 = 98.4% [98.0%; 98.7%], τ^2 = 0.0477, p < 0.0001

Test for subgroup differences: χ^2_{14} = 167.48, df = 14 (p < 0.0001)



Study	Events	Total	Proportion	95%−CI	Weight
treat_detail = TACE+HAIC+Lenvatinib+ICI					
Wu,Y,2025	25	60	0.42	[0.29; 0.55]	7.4%
Yang,Y,2024	15	35	0.43	[0.26; 0.61]	5.9%
Random effects model		**95**	**0.42**	**[0.32; 0.52]**	**13.3%**
Heterogeneity: $I^2 = 0\%$, $\tau^2 = 0$, $p = 0.9098$					
treat_detail = HAIC/TACE+Donafenib+ICI					
Wen 1,2025	10	50	0.20	[0.10; 0.34]	8.0%
treat_detail = HAIC/TACE+Sorafenib+ICI					
Wen 2,2025	3	30	0.10	[0.02; 0.27]	8.1%
treat_detail = HAIC+TKI+ICI					
Xiao,2024	43	162	0.27	[0.20; 0.34]	9.8%
Lin,2022	4	30	0.13	[0.04; 0.31]	7.5%
Random effects model		**192**	**0.21**	**[0.08; 0.34]**	**17.4%**
Heterogeneity: $I^2 = 71\%$ [0.0%; 93.5%], $\tau^2 = 0.0062$, $p = 0.0632$					
treat_detail = IMRT+Bevacizumab+Pembrolizumab					
Liang,2024	5	23	0.22	[0.07; 0.44]	5.7%
treat_detail = TACE+HAIC+Bevacizumab+Atezolizumab					
Huang,2024	11	82	0.13	[0.07; 0.23]	9.6%
treat_detail = TACE+HAIC+TKI+ICI					
Chen,Y ,2024	5	44	0.11	[0.04; 0.25]	8.7%
treat_detail = HAIC+Lenvatinib+ICI					
Bai,2024	5	31	0.16	[0.05; 0.34]	7.2%
treat_detail = Lenvatinib+Sintilimab					
Wang,L,2023	9	36	0.25	[0.12; 0.42]	6.7%
treat_detail = TACE−SBRT+Avelumab					
Chiang,2023	7	33	0.21	[0.09; 0.39]	6.8%
treat_detail = Lenvatinib+ICI					
Yi,2022	3	33	0.09	[0.02; 0.24]	8.5%
Random effects model		**649**	**0.20**	**[0.15; 0.26]**	**100.0%**

Heterogeneity: $I^2 = 69.1\%$ [45.2%; 82.6%], $\tau^2 = 0.0073$, $p = 0.0001$

Test for subgroup differences: $\chi^2_{10} = 33.09$, df = 10 ($p = 0.0003$)