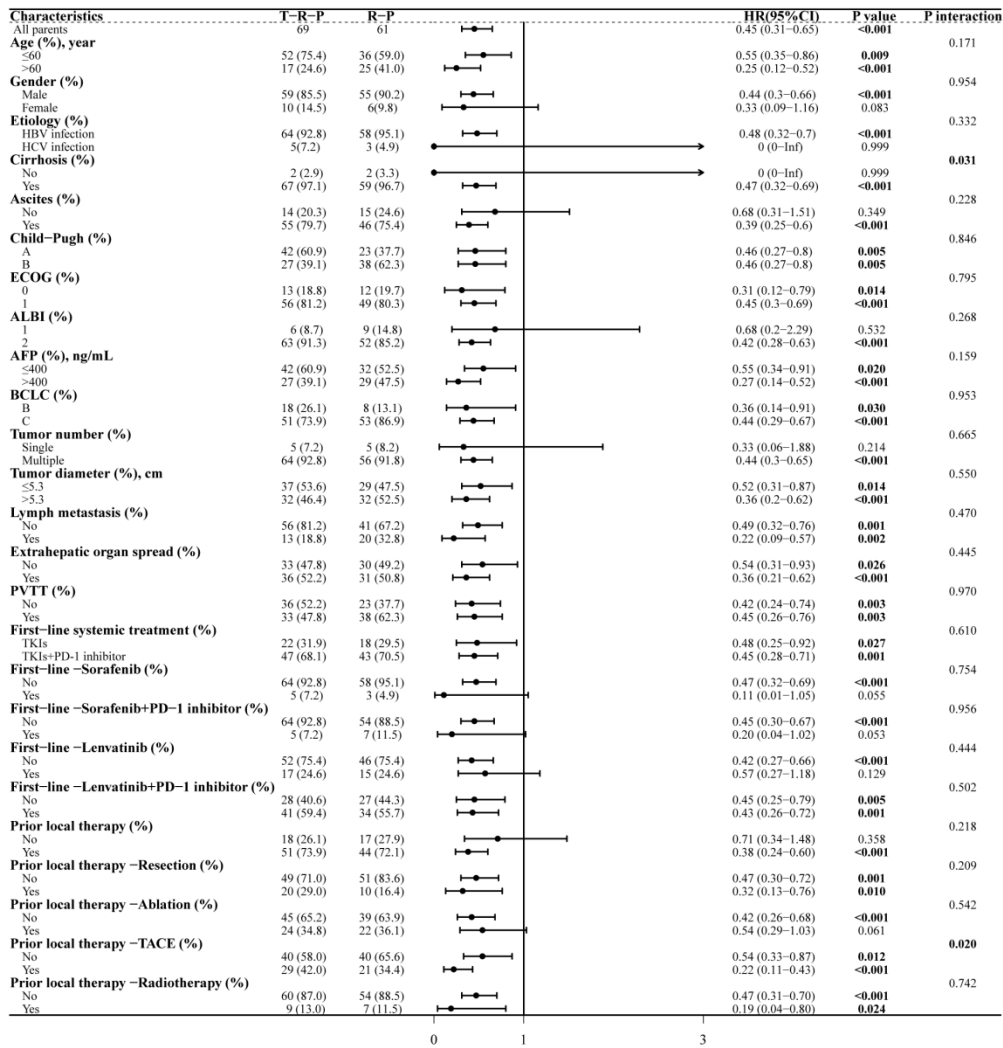


Supplementary Figure 1 Subgroup analysis of overall survival in the unmatched cohort.

Note: The hazard ratio (HR) and 95% confidence interval (CI) for each subgroup are shown. Bold values indicate statistical significance ($P < 0.05$) for the treatment comparison within that subgroup.

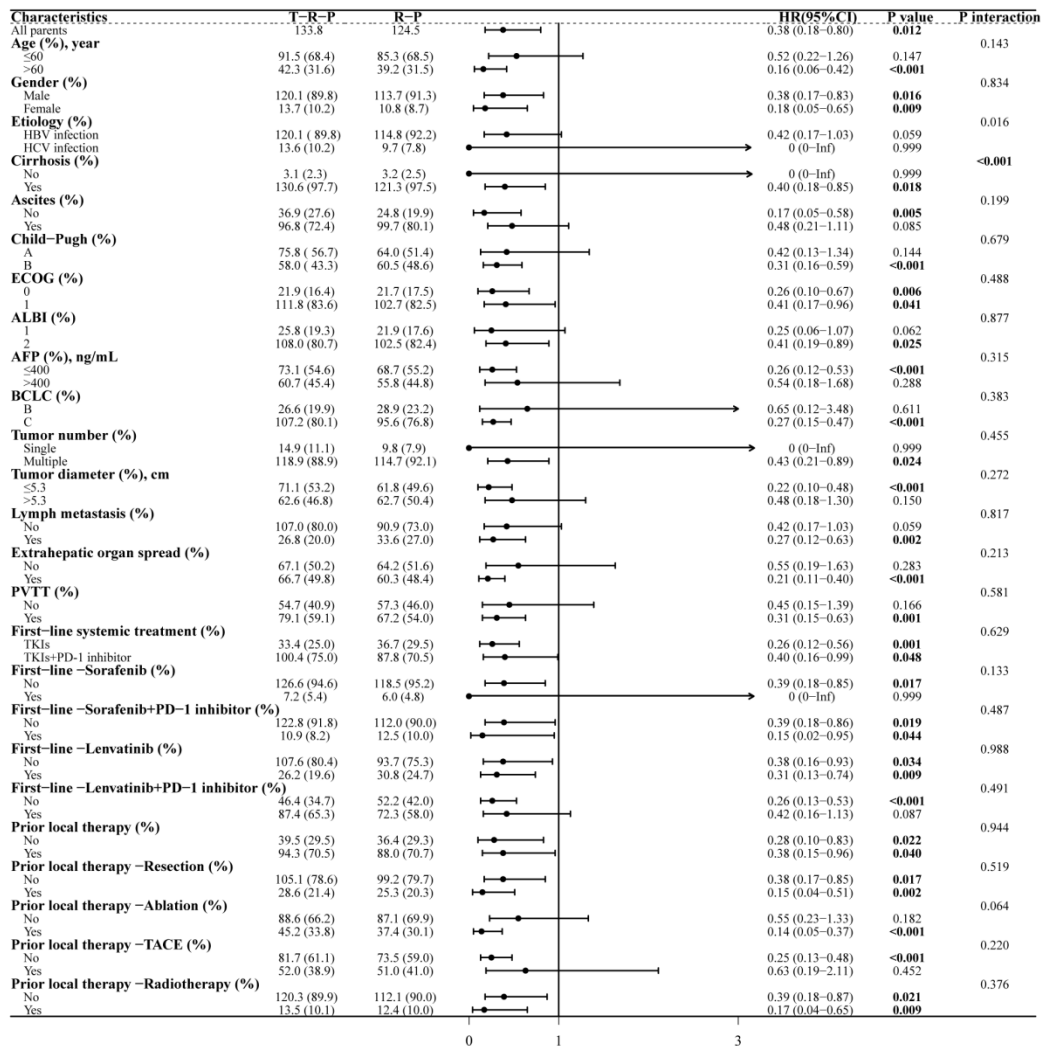
Abbreviations: PSM, propensity score matching; R-P, regorafenib plus PD-1 inhibitor; TACE, transarterial chemoembolization; T-R-P, TACE plus regorafenib plus PD-1 inhibitor; CI, confidence interval; HR, hazard ratio; ECOG, Eastern Cooperative Oncology Group; ALBI, albumin-bilirubin; AFP, alpha-fetoprotein; BCLC, Barcelona Clinic Liver Cancer; PVTT, portal vein tumor thrombosis.



Supplementary Figure 2 Subgroup analysis of progression-free survival in the unmatched cohort.

Note: The hazard ratio (HR) and 95% confidence interval (CI) for each subgroup are shown. Bold values indicate statistical significance ($P < 0.05$) for the treatment comparison within that subgroup.

Abbreviations: PSM, propensity score matching; R-P, regorafenib plus PD-1 inhibitor; TACE, transarterial chemoembolization; T-R-P, TACE plus regorafenib plus PD-1 inhibitor; CI, confidence interval; HR, hazard ratio; ECOG, Eastern Cooperative Oncology Group; ALBI, albumin-bilirubin; AFP, alpha-fetoprotein; BCLC, Barcelona Clinic Liver Cancer; PVTT, portal vein tumor thrombosis.



Supplementary Figure 3 Subgroup analysis of overall survival after IPTW.

Note: The hazard ratio (HR) and 95% confidence interval (CI) for each subgroup are shown. Bold values indicate statistical significance ($P < 0.05$) for the treatment comparison within that subgroup.

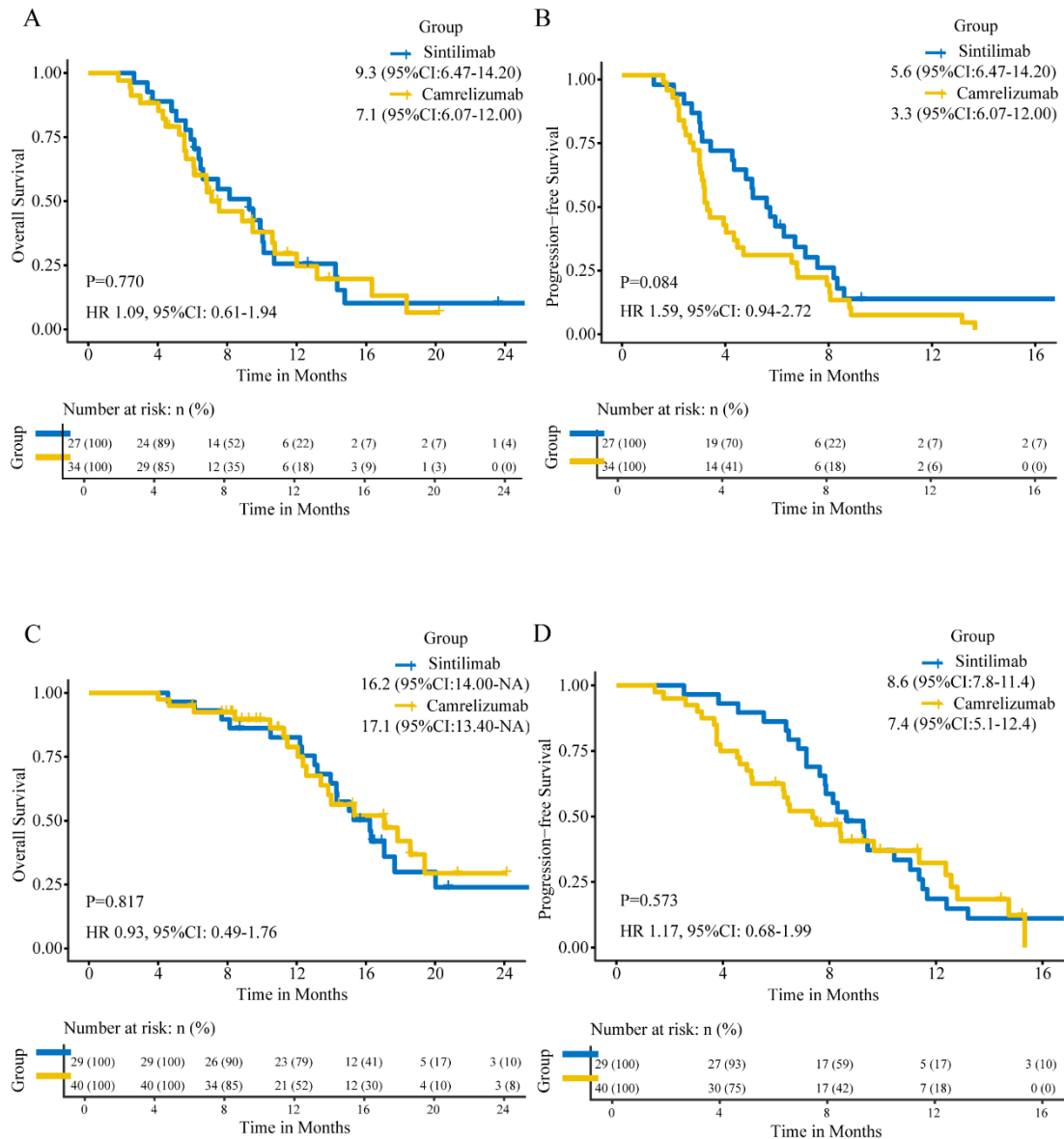
Abbreviations: PSM, propensity score matching; R-P, regorafenib plus PD-1 inhibitor; TACE, transarterial chemoembolization; T-R-P, TACE plus regorafenib plus PD-1 inhibitor; CI, confidence interval; HR, hazard ratio; ECOG, Eastern Cooperative Oncology Group; ALBI, albumin-bilirubin; AFP, alpha-fetoprotein; BCLC, Barcelona Clinic Liver Cancer; PVTT, portal vein tumor thrombosis.

Characteristics	T-R-P	R-P		HR(95%CI)	P value	P interaction
All patients	133.8	124.5		0.38 (0.25-0.59)	<0.001	
Age (%), year						
≤60	91.5 (68.4)	85.3 (68.5)		0.47 (0.29-0.76)	0.002	0.345
>60	42.3 (31.6)	39.2 (31.5)		0.23 (0.09-0.55)	0.001	
Gender (%)						
Male	120.1 (89.8)	113.7 (91.3)		0.38 (0.24-0.60)	<0.001	0.907
Female	13.7 (10.2)	10.8 (8.7)		0.26 (0.08-0.85)	0.026	
Etiology (%)						
HBV infection	120.1 (89.8)	114.8 (92.2)		0.41 (0.26-0.64)	<0.001	0.395
HCV infection	13.6 (10.2)	9.7 (7.8)		0 (0-Inf)	0.999	
Cirrhosis (%)						
No	3.1 (2.3)	3.2 (2.5)		0 (0-Inf)	0.999	0.002
Yes	130.6 (97.7)	121.3 (97.5)		0.40 (0.26-0.62)	<0.001	
Ascites (%)						
No	36.9 (27.6)	24.8 (19.9)		0.65 (0.30-1.39)	0.266	0.084
Yes	96.8 (72.4)	99.7 (80.1)		0.32 (0.18-0.57)	<0.001	
Child-Pugh (%)						
A	75.8 (56.7)	64.0 (51.4)		0.34 (0.19-0.59)	<0.001	0.708
B	58.0 (43.3)	60.5 (48.6)		0.44 (0.23-0.81)	0.009	
ECOG (%)						
0	21.9 (16.4)	21.7 (17.5)		0.28 (0.10-0.74)	0.010	0.771
1	111.8 (83.6)	102.7 (82.5)		0.39 (0.24-0.62)	<0.001	
ALBI (%)						
1	25.8 (19.3)	21.9 (17.6)		0.44 (0.17-1.17)	0.099	0.373
2	108.0 (80.7)	102.5 (82.4)		0.37 (0.23-0.60)	<0.001	
AFP (%), ng/mL						
≤400	73.1 (54.6)	68.7 (55.2)		0.46 (0.26-0.80)	0.006	0.219
>400	60.7 (45.4)	55.8 (44.8)		0.21 (0.11-0.42)	<0.001	
BCLC (%)						
B	26.6 (19.9)	28.9 (23.2)		0.27 (0.12-0.61)	0.002	0.513
C	107.2 (80.1)	95.6 (76.8)		0.41 (0.25-0.66)	<0.001	
Tumor number (%)						
Single	14.9 (11.1)	9.8 (7.9)		0.12 (0.01-0.97)	0.047	0.508
Multiple	118.9 (88.9)	114.7 (92.1)		0.38 (0.25-0.60)	<0.001	
Tumor diameter (%), cm						
≤5.3	71.1 (53.2)	61.8 (49.6)		0.40 (0.21-0.78)	0.007	0.927
>5.3	62.6 (46.8)	62.7 (50.4)		0.34 (0.19-0.60)	<0.001	
Lymph metastasis (%)						
No	107.0 (80.0)	90.9 (73.0)		0.43 (0.26-0.70)	0.001	0.259
Yes	26.8 (20.0)	33.6 (27.0)		0.18 (0.07-0.47)	<0.001	
Extrahepatic organ spread						
No	67.1 (50.2)	64.2 (51.6)		0.42 (0.22-0.78)	0.007	0.665
Yes	66.7 (49.8)	60.3 (48.4)		0.33 (0.19-0.59)	<0.001	
PVTT (%)						
No	54.7 (40.9)	57.3 (46.0)		0.33 (0.17-0.64)	0.001	0.365
Yes	79.1 (59.1)	67.2 (54.0)		0.44 (0.25-0.77)	0.004	
First-line systemic treatment (%)						
TKIs	33.4 (25.0)	36.7 (29.5)		0.39 (0.19-0.81)	0.011	0.973
TKIs+PD-1 inhibitor	100.4 (75.0)	87.8 (70.5)		0.39 (0.23-0.67)	0.001	
First-line -Sorafenib						
No	126.6 (94.6)	118.5 (95.2)		0.39 (0.25-0.61)	<0.001	0.768
Yes	7.2 (5.4)	6.0 (4.8)		0.12 (0.02-0.83)	0.031	
First-line -Sorafenib+PD-1 inhibitor						
No	122.8 (91.8)	112.0 (90.0)		0.39 (0.25-0.61)	<0.001	0.961
Yes	10.9 (8.2)	12.5 (10.0)		0.11 (0.02-0.51)	0.005	
First-line -Lenvatinib						
No	107.6 (80.4)	93.7 (75.3)		0.38 (0.23-0.64)	<0.001	0.864
Yes	26.2 (19.6)	30.8 (24.7)		0.45 (0.21-0.97)	0.041	
First-line -Lenvatinib+PD-1 inhibitor						
No	46.4 (34.7)	52.2 (42.0)		0.36 (0.19-0.70)	0.003	0.785
Yes	87.4 (65.3)	72.3 (58.0)		0.38 (0.21-0.67)	0.001	
Prior local therapy (%)						
No	39.5 (29.5)	36.4 (29.3)		0.61 (0.28-1.30)	0.201	0.267
Yes	94.3 (70.5)	88.0 (70.7)		0.30 (0.18-0.52)	<0.001	
Prior local therapy -Resection						
No	105.1 (78.6)	99.2 (79.7)		0.40 (0.25-0.66)	<0.001	0.229
Yes	28.6 (21.4)	25.3 (20.3)		0.29 (0.13-0.64)	0.002	
Prior local therapy -Ablation						
No	88.6 (66.2)	87.1 (69.9)		0.37 (0.21-0.66)	0.001	0.570
Yes	45.2 (33.8)	37.4 (30.1)		0.43 (0.21-0.89)	0.023	
Prior local therapy -TACE						
No	81.7 (61.1)	73.5 (59.0)		0.52 (0.31-0.87)	0.013	0.008
Yes	52.0 (38.9)	51.0 (41.0)		0.16 (0.08-0.32)	<0.001	
Prior local therapy -Radiotherapy						
No	120.3 (89.9)	112.1 (90.0)		0.39 (0.25-0.61)	<0.001	0.999
Yes	13.5 (10.1)	12.4 (10.0)		0.15 (0.04-0.63)	0.009	

Supplementary Figure 4 Subgroup analysis of progression-free survival after IPTW.

Note: The hazard ratio (HR) and 95% confidence interval (CI) for each subgroup are shown. Bold values indicate statistical significance ($P < 0.05$) for the treatment comparison within that subgroup.

Abbreviations: PSM, propensity score matching; R-P, regorafenib plus PD-1 inhibitor; TACE, transarterial chemoembolization; T-R-P, TACE plus regorafenib plus PD-1 inhibitor; CI, confidence interval; HR, hazard ratio; ECOG, Eastern Cooperative Oncology Group; ALBI, albumin-bilirubin; AFP, alpha-fetoprotein; BCLC, Barcelona Clinic Liver Cancer; PVTT, portal vein tumor thrombosis.



Supplementary Figure 5 Overall survival and progression-free survival according to PD-1 inhibitor type in different treatment groups.

(A) Overall survival in the R-P group comparing sintilimab versus camrelizumab.

(B) Progression-free survival in the R-P group comparing sintilimab versus camrelizumab.

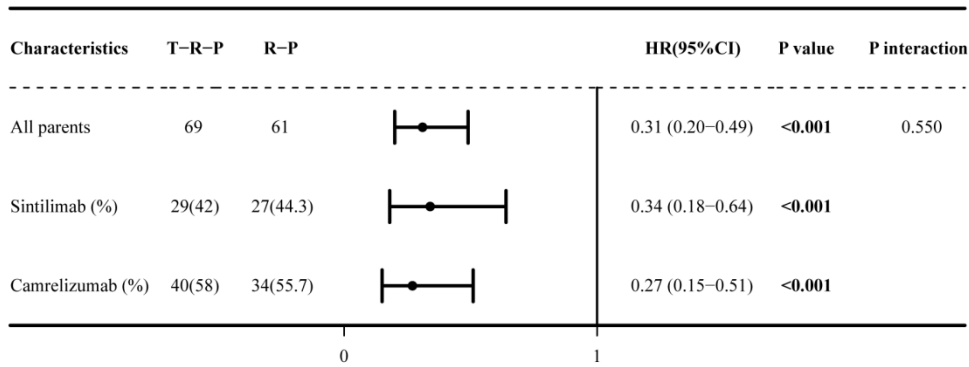
(C) Overall survival in the T-R-P group comparing sintilimab versus camrelizumab.

(D) Progression-free survival in the T-R-P group comparing sintilimab versus camrelizumab.

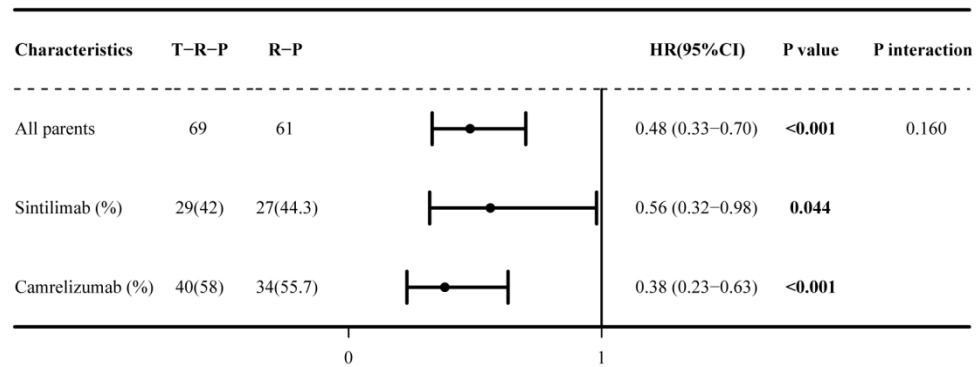
Abbreviations: R-P, regorafenib plus PD-1 inhibitor; TACE, transarterial chemoembolization;

T-R-P, TACE plus regorafenib plus PD-1 inhibitor; HR, hazard ratio; CI, confidence interval.

A



B



Supplementary Figure 6 Forest plots for subgroup analysis comparing T-R-P versus R-P stratified by PD-1 inhibitor type.

(A) Forest plot for overall survival. (B) Forest plot for progression-free survival.

Note: The hazard ratio (HR) and 95% confidence interval (CI) for each subgroup are shown. Bold values indicate statistical significance ($P < 0.05$) for the treatment comparison within that subgroup.

Abbreviations: CI, confidence interval; HR, hazard ratio; R-P, regorafenib plus PD-1 inhibitor; TACE, transarterial chemoembolization; T-R-P, TACE plus regorafenib plus PD-1 inhibitor.