



Background and Objective

China has improved access to anti-cancer drugs through NRDL price negotiations and the “dual-channel” mechanism, which extends the supply of negotiated drugs from medical institutions to designated retail pharmacies. The 2025 NRDL includes 88 national price-negotiated anti-cancer drugs. Existing studies have mainly assessed accessibility using drug availability and utilization indicators, while spatial accessibility research has largely been limited to provincial or municipal settings, with limited nationwide evidence and few analyses of associated factors. Therefore, this study evaluates the geographical distribution, spatial accessibility, and associated factors of national price-negotiated anti-cancer drugs across China to support further optimization and implementation of the national drug price negotiation policy.

Methods

- Data sources:** Data on hospitals and retail pharmacies supplying national price-negotiated anti-cancer drugs were obtained from the official public platform of the National Healthcare Security Administration of China. Population data were obtained from the 2020 WorldPop dataset, and friction surface data were derived from the 2020 dataset provided by the Malaria Atlas Project. Drug price data were obtained from PharmCube.
- Spatial accessibility:** Spatial accessibility was assessed using ArcGIS Pro 3.4.2 for all 88 anti-cancer drugs included in the 2025 NRDL. Supplying institutions were geocoded to WGS-84 coordinates using the Amap API and Python 3.12.0. A $1 \times 1 \text{ km}^2$ population grid and the 2020 friction surface were used to estimate travel time from each residential grid cell to the nearest supplying hospital or retail pharmacy using a least-cost path approach, accounting for road networks, terrain, and transport resistance. For each drug, the national population-weighted mean travel time was calculated based on grid-level travel time and population.
- Statistical analysis:** Descriptive analyses summarized population coverage across travel-time intervals and the population-weighted mean travel time for each drug. Multiple linear regression was performed using SPSS 26.0, with population-weighted mean travel time as the dependent variable and guideline recommendation level, evidence category, number of approved indications, drug origin, and DDDc as independent variables. Sensitivity analyses assessed the robustness of ordinal variable coding.

Results

- Population-Weighted Travel Time:** Across all types of supplying facilities, the population-weighted mean travel time for the 88 drugs ranged from 28.77 minutes for camrelizumab to 205.15 minutes for zimberelimab, with a median of 59.86 minutes and a mean of 68.57 minutes (SD = 31.31). Most drugs (82/88) had a population-weighted mean travel time between 0.5 and 2 hours. Compared with access through hospitals alone, the combined availability through both hospitals and retail pharmacies was associated with a substantially shorter population-weighted mean travel time (68.57 vs. 126.90 minutes; Table 1).

Table 1 Comparison of Population-Weighted Average Travel Time: All Facilities vs. Hospital

Unit: minutes		Population-weighted mean travel time (all facilities)	Population-weighted mean travel time (hospitals)
Mean		68.57	126.90
Standard error of the mean		3.34	13.39
Median		59.86	85.82
Standard deviation		31.31	125.64
Minimum		28.77	29.20
Maximum		205.15	840.26
Percentile	25	48.02	58.26
	50	59.86	85.82
	75	85.26	121.39

- Population Coverage by Travel-Time Threshold:** The proportions of the population able to access drugs within different travel-time thresholds are presented in Table 2. The median proportions of the population able to access drugs within 5, 15, 30, 60, 120, 180, and 300 minutes were 15.13%, 30.02%, 44.26%, 69.47%, 89.06%, 94.58%, and 97.95%, respectively. For 29 drugs, more than 50% of the population could access the drug within 30 minutes, while for most drugs (70/89), more than 50% of the population could access the drug within 60 minutes. For 21 drugs, more than 20% of the population could access the drug within 5 minutes, indicating relatively high spatial accessibility. For three drugs, more than 10% of the population required over 300 minutes of travel, suggesting substantial variation in spatial accessibility across drugs.

Table 2 Cumulative Population Coverage Within Different Travel-Time Thresholds (%)

Drug	Proportion of Population Able to Access the Drug Within the Specified Travel Time (%)							
	<5	<15	<30	<60	<120	<180	<300	>300
Camrelizumab for Injection	35.72	54.96	72.84	88.05	95.76	97.92	99.27	0.73
Apatinib Mesylate Tablets	34.92	54.34	72.24	87.7	95.59	97.82	99.2	0.8
Pyrotinib Maleate Tablets	32.33	51.51	69.92	86.48	95.24	97.68	99.17	0.83
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Larotrectinib Sulfate Oral Solution	4.18	11.53	16.81	27.54	50.93	70.57	86.7	13.3
Larotrectinib Sulfate Capsules	4.14	12.1	18.04	28.77	51.06	71.13	86.71	13.29
Zimberelimab Injection	2.45	7.99	12.83	21.48	44.19	63.09	82.95	17.05

- Regional differences:** The spatial accessibility of all included drugs across China was visualized in Figure 1, with each panel representing a single drug. Pixel color indicates the minimum travel time required for residents in the corresponding $1 \times 1 \text{ km}$ grid cell to reach a facility supplying that drug, with darker colors representing shorter travel times.

Overall, national price-negotiated anti-cancer drugs showed a clear east–west gradient in spatial accessibility, with generally better accessibility in eastern China and poorer accessibility in western China. Notably, some drugs with relatively low overall accessibility remained accessible in and around major cities in central and eastern China.

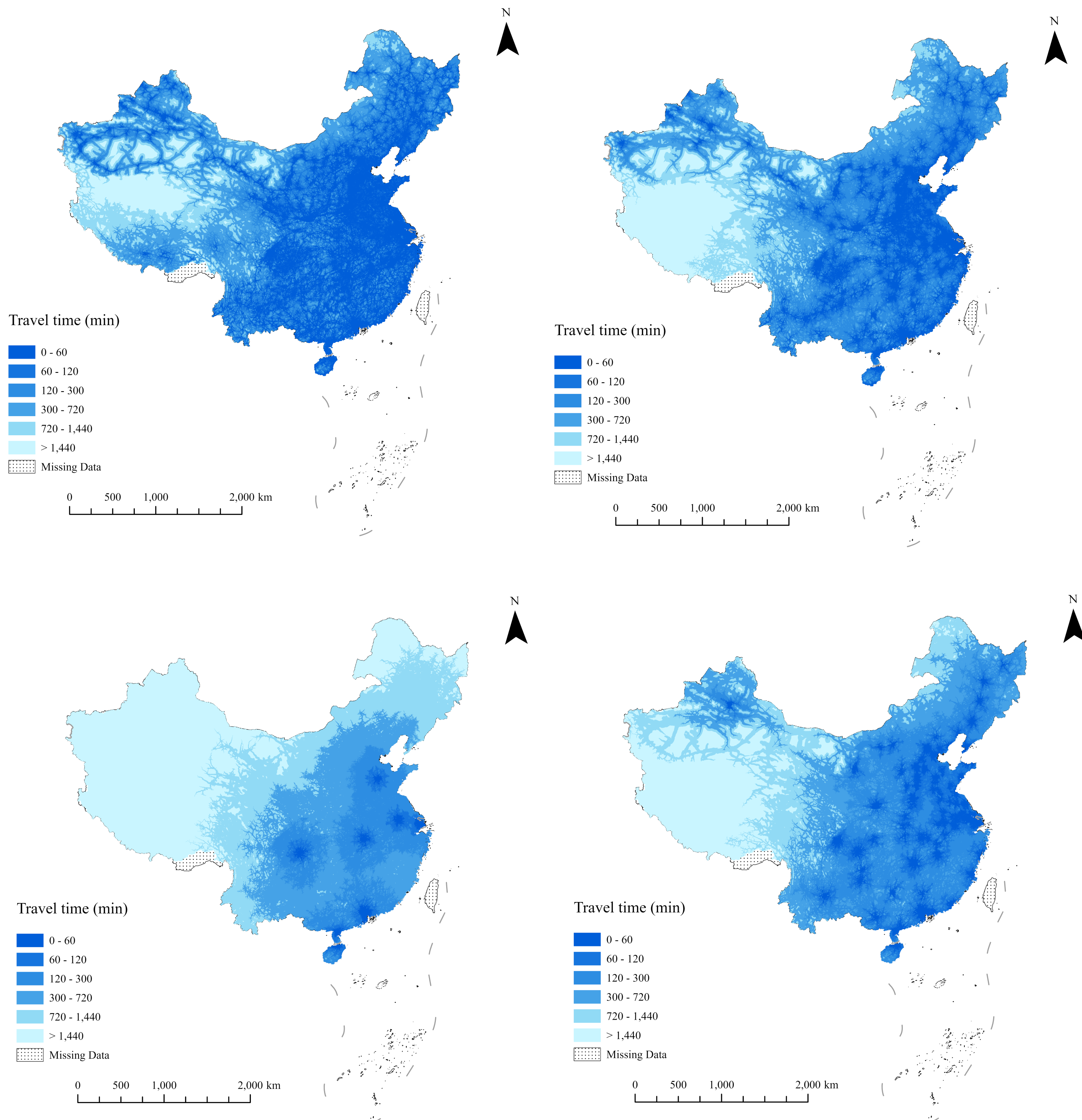


Figure 1. Examples of spatial accessibility maps for selected drugs. Upper left: accessibility of camrelizumab through hospitals; upper right: accessibility of fruquintinib capsules through both hospitals; lower left: accessibility of gumarontinib tablets through hospitals; lower right: accessibility of gumarontinib tablets through both hospitals and retail pharmacies.

- Factors Associated with Spatial Accessibility:** Multiple linear regression was performed with population-weighted mean travel time as the dependent variable and CSCO, ESMO, and NCCN guideline levels, DDDc, drug origin, and number of approved indications as independent variables. The overall model was statistically significant ($F = 8.123$, $p < 0.001$; adjusted $R^2 = 0.329$). Higher CSCO guideline levels were significantly associated with shorter population-weighted mean travel time ($\beta = -0.447$, $B = -8.377$, $p < 0.001$), as was a greater number of approved indications ($\beta = -0.299$, $B = -4.834$, $p = 0.004$). In contrast, ESMO and NCCN guideline levels, drug origin, and DDDc were not significantly associated with travel time. No substantial multicollinearity was observed (VIFs: 1.030–2.812). Additional Mann–Whitney U tests showed no significant differences in population-weighted mean travel time according to inclusion in the ESMO or NCCN guidelines or between domestic and imported drugs (all $p > 0.05$).

Table 3 Multiple linear regression of factors associated with population-weighted mean travel time

Variable	β	SE	Beta	t	p	VIF
Number of approved indications	-4.83	1.62	-0.30	-2.99	0.004	1.30
CSCO guideline level	-8.38	1.79	-0.45	-4.68	<0.001	1.18
ESMO guideline level	3.06	1.92	0.23	1.59	0.115	2.63
NCCN guideline level	-3.35	2.42	-0.20	-1.39	0.17	2.81
Drug origin	3.76	8.49	0.06	0.44	0.659	2.05
DDDc	0.00	0.00	-0.04	-0.46	0.649	1.03

Conclusion

- Spatial accessibility varied substantially across drugs, and the “dual-channel” policy improved the spatial accessibility of negotiated anti-cancer drugs. CSCO guideline evidence level and the number of approved indications were independent significant predictors of spatial accessibility: drugs supported by higher-level guideline evidence and covering a broader range of indications tended to have better spatial accessibility.
- This study established an evaluation framework for the accessibility of national price-negotiated anti-cancer drugs centered on travel time and quantified spatial accessibility using geographic information science techniques. By further exploring its determinants, the study suggests that a clinical value–oriented reimbursement access strategy may be guiding drug supply networks toward therapies with greater therapeutic value, thereby providing empirical support for value-based health insurance decision-making.
- It is recommended to establish a GIS-based routine monitoring platform for the spatial accessibility of “dual-channel” drugs. By integrating geocoded data on drug-supplying institutions nationwide with population raster data, the platform could automatically identify and flag spatial coverage gaps for each drug and each province on a quarterly or semiannual basis. For drugs with high clinical value but low spatial coverage, reliance on market forces alone may be insufficient, and proactive cross-sector interventions should be initiated.