Proximity to radiotherapy centre, population, average income, and health insurance status as predictors of cancer mortality at the county level in the United States

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Introduction

Radiotherapy (RT) is indicated for approximately 50% of cancer patients, and thus RT capacity is essential for delivery of high quality, evidence-based cancer care.

In high-income settings, RT provides population-level local control and overall survival benefit.

Despite sufficient capacity, universal access is not always possible, even in high-income countries.

Barriers are complex and include geographic access, socioeconomic status, and insurance status.

This study aims to determine how geographic proximity to a RT-equipped cancer center, average income of a county population, and proportion of a county population without health insurance are associated with cancer mortality at the county level in the United States.

Methods

Data were obtained from the Center for Disease Control and Prevention (CDC), the International Atomic Energy Agency Directory of Radiotherapy Centres (DIRAC), the Environmental Systems Research Institute, the US Census Bureau, and the US Bureau of Economic Analysis.

RT-equipped cancer centres were mapped using Geographic Information Systems software QGIS v.3.16.9.

Univariate analysis was conducted to identify variables that predicted all-cancer mortality-to-incidence ratio (MIR)

Results

31% of US counties have one RT centre; 8.3% have 5 or more.

The median linear distance from county centroid to RT centre was 36 km.

The median county all-cancer MIR was 0.37.

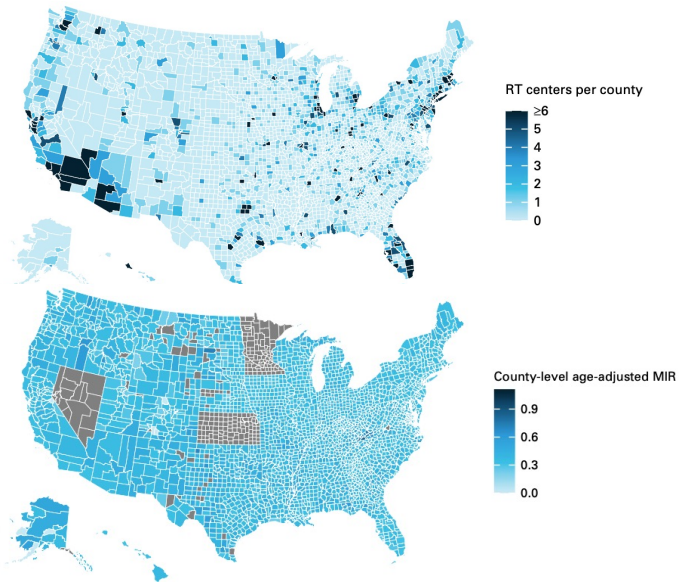
Greater distance to RT centre, lower county population, lower average income per county, and higher proportion of patients without health insurance were associated with increased all-cancer MIR (R-squared, 0.2113; F, 94.22; P < .001).

Variable	OLS	SE	*P*
Distance, km			
0.053-80	–	–	
80-1,176.5	0.0155	0.0030	<.001
County personal income, $			
19,472-36,294	–	–	
36,294-40,737	−0.0172	0.0031	<.001
40,737-45,207	−0.0267	0.0032	<.001
45,207-51,951	−0.0442	0.0033	<.001
51,951-229,825	−0.0612	0.0034	<.001
County population			
625-39,395	–	–	
39,395-103,240	0.0062	0.0026	<.05
103,240-10,039,107	0.0167	0.0028	<.001
County % uninsured			
2.4-15.8	–	–	
15.8-32.2	0.0144	0.0025	<.001

Abbreviation: OLS, ordinary least squares.

Results

(continued)



Variable	No. (%)	Median	Minimum	Maximum	*P*
Distance, km	2,824 (100)	36.14	0.053	1,176.5	<.001
0.053-80	2,433 (86.15)				
80-1,176.5	391 (13.85)				
County personal income, $	2,824 (100)	42,796	19,472	229,825	<.001
19,472-36,294	565 (20.01)	–	–	–	
36,294-40,737	565 (20.01)	–	–	–	
40,737-45,207	564 (19.97)	–	–	–	
45,207-51,951	565 (20.01)	–	–	–	
51,951-229,825	565 (20.01)	–	–	–	
County population	2,824 (100)	27,683	625	10,039,107	<.001
625-39,395	1,694 (59.98)	–	–	–	
39,395-103,240	565 (20.01)	–	–	–	
103,240-10,039,107	565 (20.01)	–	–	–	
County % uninsured	2,824 (100)	10.7	2.4	32.2	<.001
2.4-15.8	2,261 (80.06)	–	–	–	
15.8-32.2	563 (19.94)	–	–	–	
Radio therapy centers[a]	833 (29.50)	0.00	0.00	143.06	<.001
LINAC[a]	832 (29.46)	0.00	0.00	164.56	<.001
Brachy therapy[a]	336 (11.90)	0.00	0.00	109.71	<.001

Abbreviation: LINAC, linear accelerator.
[a]Ratio per 1,000,000 inhabitants.

Discussion

Distance to Radiotherapy Centre

- Travel burden is a known barrier to completion of RT.
- Patients living further from RT facilities are more likely to opt for surgery in place of RT when given the option, and to omit RT in deviation from standard of care.
- Distance from cancer centres may also infer distance from facilities for cancer screening, diagnostic workup, and survivorship.
- Geospatial mapping may assist in determining optimal locations for RT centres.
- Hypofractionated treatment courses and telemedicine follow-up may help to reduce travel burden.

Income

- Lower income patients are known to have higher cancer mortality than more affluent patients.
- Travel costs for a course of radiotherapy can be in excess of 1500 USD in both rural and urban settings.
- Low-income workers are less likely to receive accommodations such as sick leave, flexible schedules, or flexibility in tasks during treatment.
- Hypofractionation, specialized financial patient navigators, and subsidized accommodations may help to reduce financial burden.

Insurance

- Uninsured patients and those with Medicaid or Medicare are more likely to present with advanced disease and less likely to undergo radiotherapy or survivorship care.
- Large-scale interventions may include universal health insurance or national paid leave policies for cancer patients.
- Cancer patients in states with expanded Medicaid eligibility were more likely to present at earlier stages and undergo standard of care treatments.
- One solution may be through the use of value-based insurance design, where essential services such as cancer screening would not have an associated deductible

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