Utilizing ArcGIS to Discover Geographic Disparities in Lung Cancer Screening

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Abstract

Lung cancer screening has the potential to discover cancer at early stages and reduce mortality. The American College of Radiology provides a locator tool for all lung cancer screening facilities within the country. For organizational purposes, we sought to see where ACR accredited Lung Cancer Facilities reside within our state. After mapping facilities within the state of Florida on ArcGIS, we recognized an uneven distribution of facilities within the state that visually coincided with incidence, mortality and the percentage of cases diagnosed at a late stage. After mapping the locations, a Florida counties GIS file was overlayed with the locations of the lung cancer screening facilities and the summarize within feature of ARC GIS was utilized to provide the count of facilities within each county. This was exported as an excel file and combined with data pulls from census and health organizations to provide sufficient data for statistical analysis. Univariate analysis was utilized to test the strengths of the correlation. However, a multiple variate model is being developed in order to account for other variables. After mapping the locations, a Florida counties GIS file was overlayed with the locations of the lung cancer screening facilities and the summarize within feature of ARC GIS was utilized to provide the count of facilities within each county. This was exported as an excel file and combined with data pulls from census and health organizations to provide sufficient data for statistical analysis. These findings could have significant implications for public health policy as well as institution-level administrative decisions around how lung cancer screening and care programs should be strategically developed as part of TGH CI outreach efforts. Among other efforts, a multivariate model is being refined to estimate the effect of lung cancer screening facilities on screening to assess the impact of LCSFs more precisely and determine how other demographic factors interact to influence lung cancer outcomes in our catchment.

Introduction

Lung cancer screening has the potential to discover cancer at early stages and reduce mortality. The American College of Radiology provides a locator tool for all lung cancer screening facilities within the country. For organizational purposes, we sought to see where ACR accredited Lung Cancer Facilities reside within our state. After mapping facilities within the state of Florida on ArcGIS, we recognized an uneven distribution of facilities within the state that visually coincided with incidence, mortality and the percentage of cases diagnosed at a late stage. The effects of this distribution were not studied academically specifically within our state; therefore, we began to investigate several demographic variables and outcomes related to lung cancer that could be potentially linked to the location of Lung Cancer Screening Facilities.

Methods

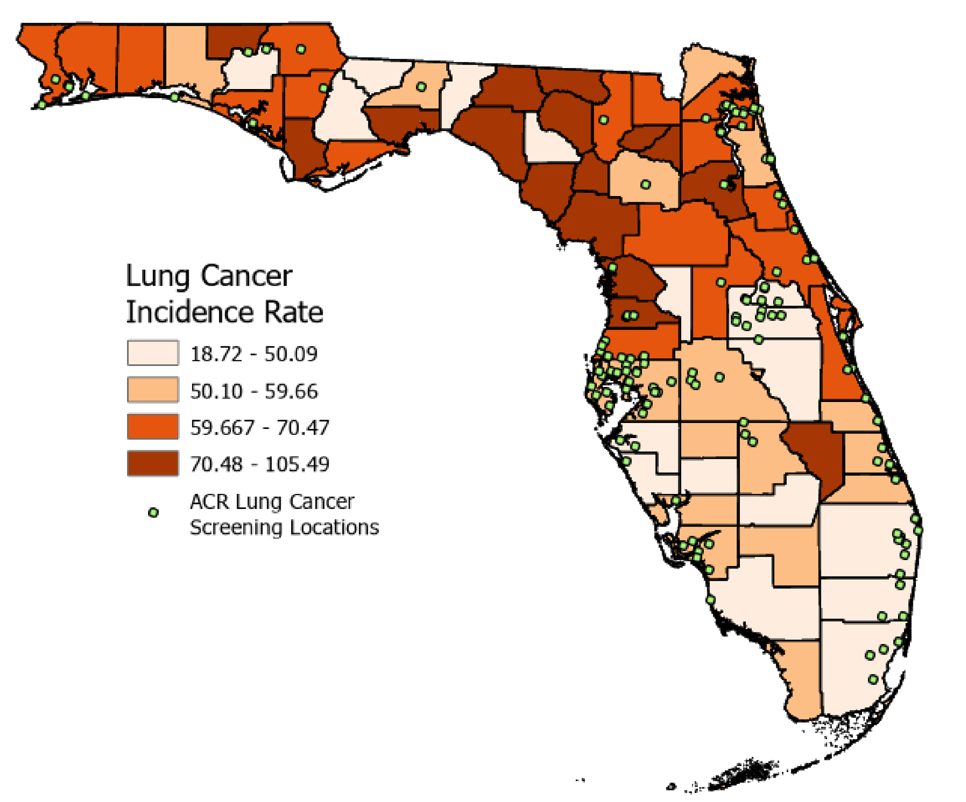
Data Abstraction and Map Generation

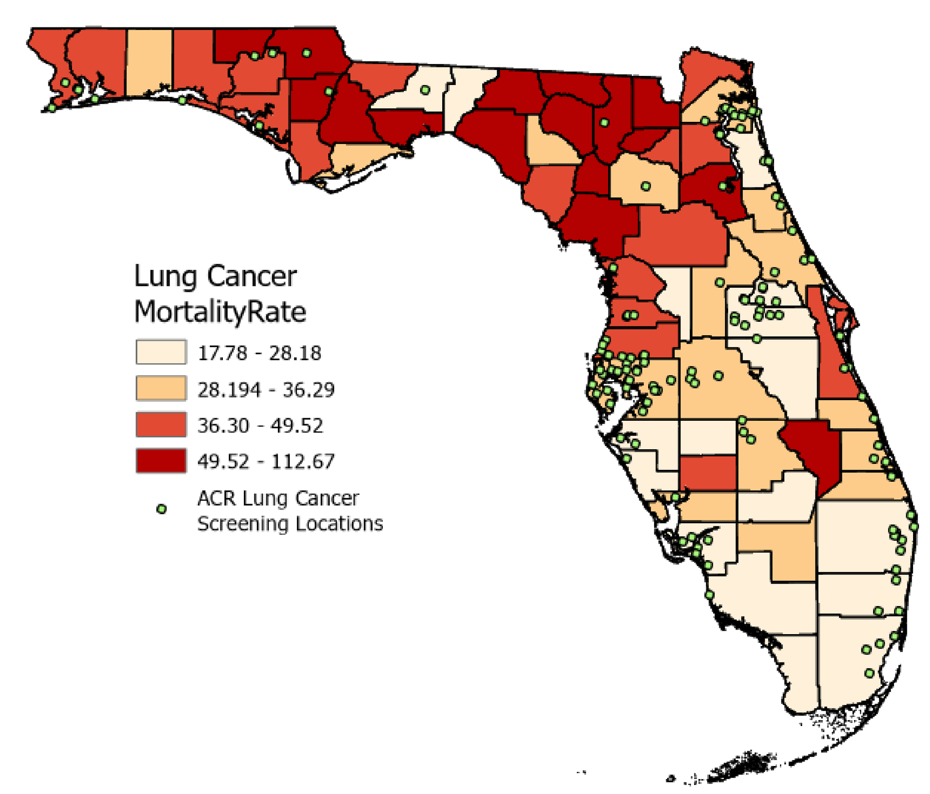
All data used for this project was retrieved from public sources. First, the American College of Radiology provides a list of all ACR registered Lung Cancer Screening facilities and provides the option to export the addresses to an excel file. Utilizing the Google Geocoder API, addresses were converted into XY coordinates. A map of the state of Florida and county borders was uploaded to ArcGIS and the Lung Cancer Screening facilities were added to the map of Florida. To accurately gauge locate lung cancer screening facilities, the summarize within feature of ArcGIS was used to generate a table with the number of facilities per county. Afterwards, outcome measures for Lung Cancer from the Florida Department of Health (incidence (2023), mortality (2022), and percent of late-stage diagnoses) were added to an excel sheet and uploaded to ArcGIS. This was joined with the Florida counties to create a new layer to visually demonstrate outcomes for each county.

Analytical Testing

An excel sheet with the county name, number of facilities, age-adjusted incidence rates, age-adjusted mortality rates, and the percentage of late diagnosis cases was uploaded to SPSS for statistical analysis. Liberty county was excluded from the analysis due to the lack of lung cancer cases during 2023. The correlation and significance between the number of facilities per county and outcome measures were analyzed using SPSS. For both incidence and percentage of late-stage diagnoses, Pearson Correlation was utilized. On the other hand, mortality data were analyzed utilized a Spearman Coefficient. Additionally, the association coefficient, standard error, 95% confidence interval and significance were also calculated using SPSS. For incidence, a normal distribution was assumed. For mortality, a log normal distribution was assumed. Finally, for late-stage diagnosis a gamma distribution was assumed.

Results





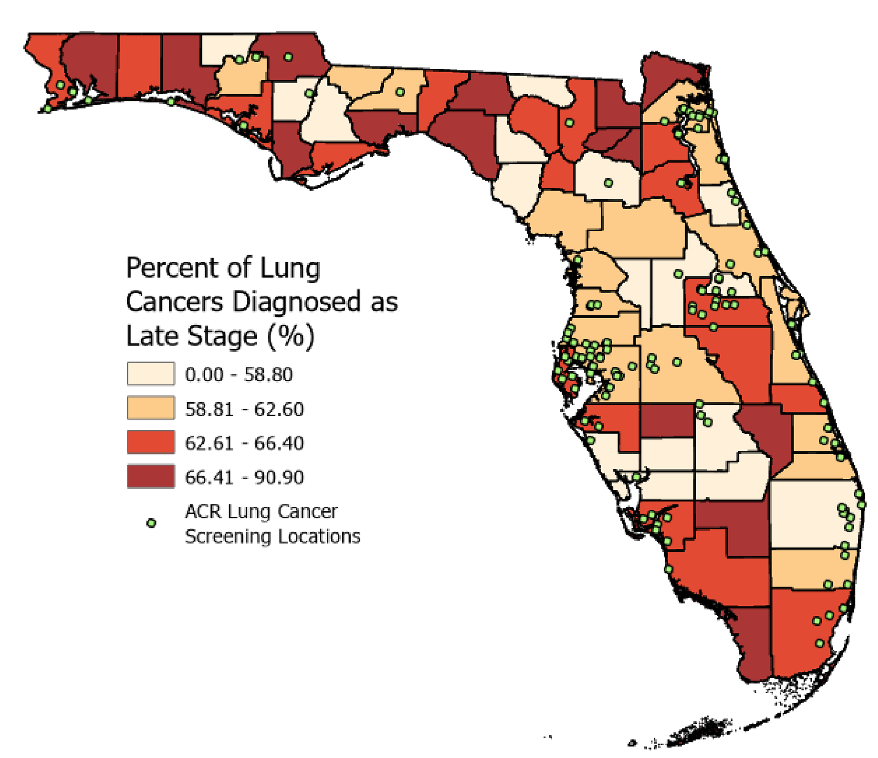


Figure 1: Locations of Lung Cancer Screening in Florida Overlayed with Age-Adjusted Incidence (A), Age-Adjusted Mortality (B), and the Percent of Lung Cancers Diagnosed as Late Stage (C).

Results

Table 1. Correlation between facility and lung cancer incidence, mortality and late-stage

	Incidence	Mortality*	Late-Stage
Facility	-0.24 p=.049	-0.37 p=0.002	-0.11 p=0.39

*Spearman correlation, otherwise Pearson correlation

Table 2. Association between facility and lung cancer incidence, mortality and stage. Generalized linear mixed method using appropriate distribution.

	Coefficient	SE	95% CI	p
Incidence*	-1.16	0.56	-2.31, -0.004	.049
Mortality**	-0.033	0.013	-0.06, -0.008	.010
Late Stage+	-0.004	0.005	-0.013 0.005	.391

*using normal distribution **using lognormal distribution +using gamma distribution

A robust negative correlation between the number of lung cancer screening facilities and both incidence (r=-0.24, p=0.04) and mortality (r=-0.37, p=0.002) specifically associated with lung cancer was observed. In other words, as the number of Lung Cancer Facilities increased, the incidence and mortality decreased, suggesting that access to early detection interventions provided by these facilities help to improve outcomes. However, no association was observed between number of screening facilities and stage at diagnosis (Fig 1C). It is possible that lung cancer screening facilities are placed in counties with better outcomes due to other factors such as better access to care. We are currently working to develop a multivariate model to account for other factors that might explain this discrepancy.

Conclusions

- The distribution of lung cancer screening Facilities in Florida is significantly correlated with both incidence and mortality.
- A multivariate model needs to be developed in order to account for other variables and determine the true impact of Lung Cancer Screening on outcomes.
- Counties with no lung cancer Screening Facilities have worse outcomes suggesting that adding Lung Cancer Screening Facilities could potentially improve outcomes within these counties.

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