Using enhanced two-stage catchment area analysis to plan mobile breast cancer screening placement: Oklahoma 2024

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Introduction

Breast cancer is the most common U.S. cancer, with 313,510 cases and 42,780 deaths estimated in 2024.[1]

In 2022, 30.7% of women in Oklahoma had not received a mammogram in the last two years compared to 23.7% in the US (BRFSS).

Unlike fixed methods, a floating catchment analysis (FCA) is a spatial analysis method that evaluates accessibility based on a specific radius or boundary across administrative boundaries.

Gravity is the concept that people further away of a location are less likely to visit that location.

This project identifies Oklahoma areas where women lack mammography access, guiding mobile screening van deployment.

Methods

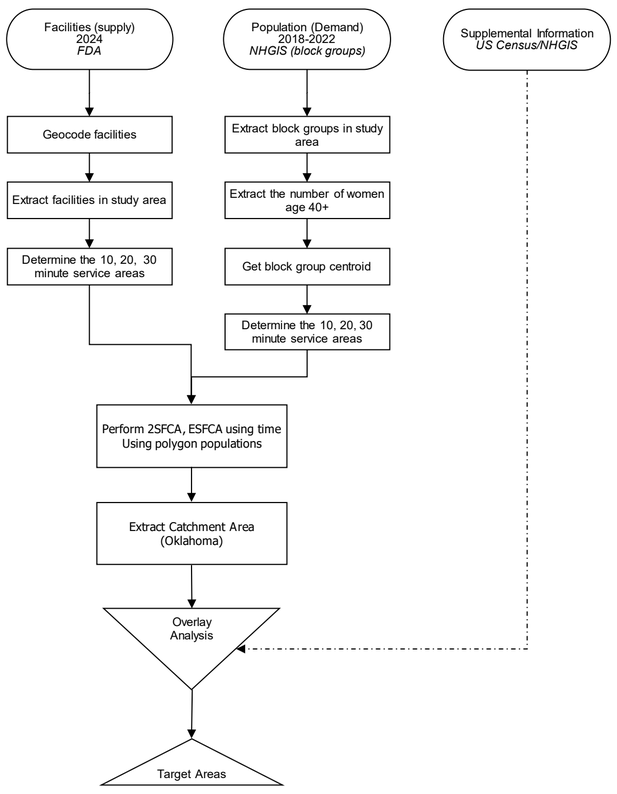
The study area is the catchment area for the Stephenson Cancer Center, Oklahoma.

For supply or mammography screening locations, we used the Federal Drug Administration (FDA) mammography facilities database (https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfmqsa/mqsa.cfm). We included any facility that had a 30-minute drive in the state.

We used 2018-2022 data from the National Historical Geographic Information System to find women 40+ eligible for mammography.[2]

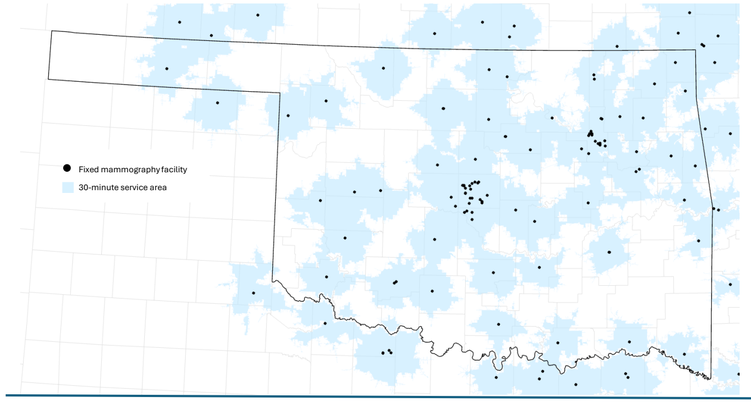
ArcGIS Pro 3.4 was used for this analysis.

Figure 1. Workflow for Oklahoma Mammography Screening 2SFCA and ESFCA using time 2024



Results

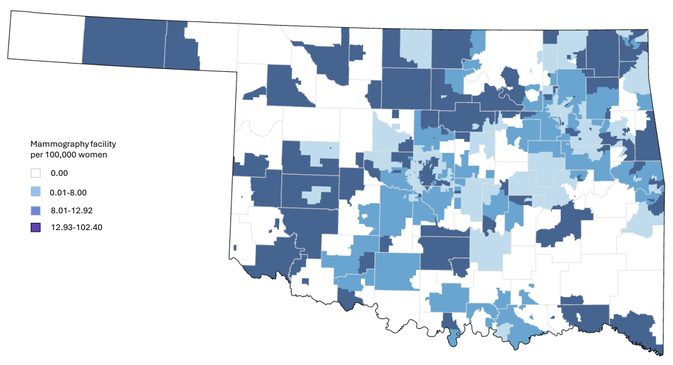
Figure 2. Fixed mammography locations and 30-minute service areas in and near Oklahoma 2024



We started with this map of fixed mammography locations in Oklahoma and their 30-minute service areas.

Limitations: It does not account for population, gravity, or traffic congestion.

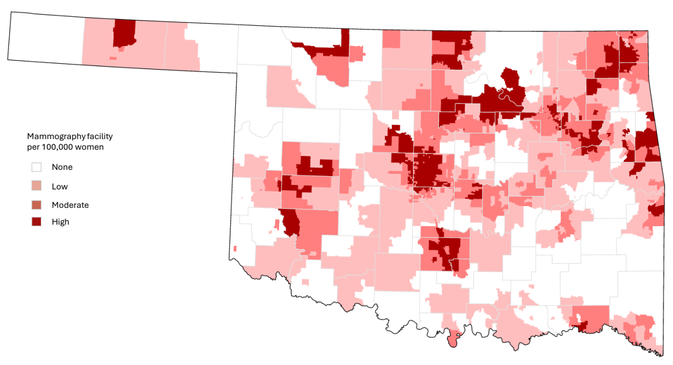
Figure 3. Classic Two-Step Floating Catchment Analysis (2SFCA) results in Oklahoma and surrounding locations Oklahoma 2024



To account for population, we employed a floating catchment analysis, which creates an estimate of eligible women in block groups. We used a 30-minute service area.

Limitations: It does not account for gravity. It does not account for traffic congestion.

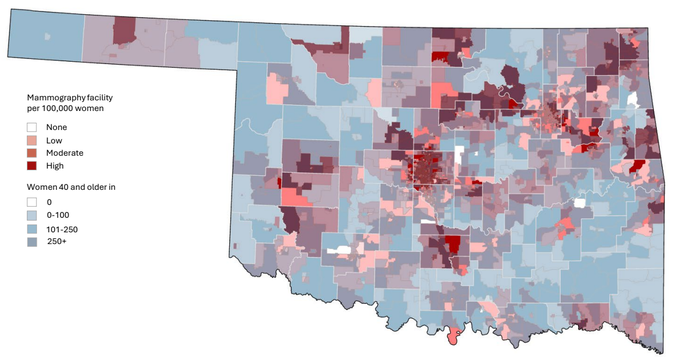
Figure 4. Enhanced Two-Step Floating Catchment Analysis (E2SFCA) Oklahoma 2024



To account for population and gravity, we employed an enhanced two-step floating catchment analysis, which creates an estimate of eligible women in block groups. We made a 10-, 20-, 30-minute service area (not accounting for traffic patterns or congestion). The classic and enhanced results were very similar, with the enhanced having a particular impact at the high end of access.

Limitations: Gravity weights were unknown; we assumed those used by Hashtarkhani (2024).[3] The results are more difficult to interpret.

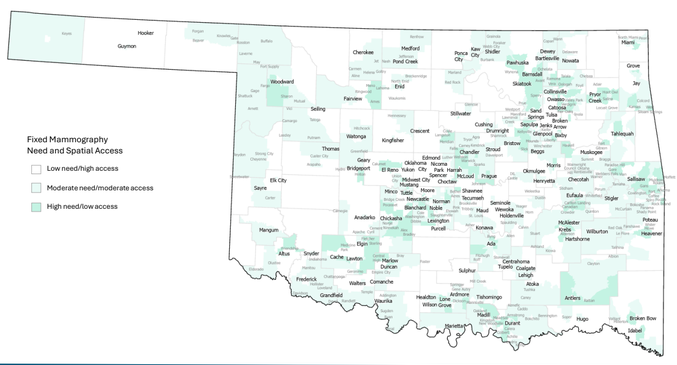
Figure 5. E2SFCA area by zero, low, moderate, and high spatial coverage for fixed mammography and population estimates of women eligible for mammography Oklahoma 2024



This map shows zero, low, moderate, and high spatial coverage and population counts for each block group.

Limitations: The map is difficult to read and interpret, so it may not be helpful to leadership, community stakeholders, or the public.

Figure 6. E2SFCA area by zero, low spatial coverage for fixed mammography and population estimates and at least 250 women in the block group Oklahoma 2024



This is the current "GO" Map. We deleted block groups that have moderate or high fixed mammography coverage. We eliminated areas without less than 250 eligible women in the block group. This will allow us to focus initially on the area most likely to support mobile van visits. We added cities and towns to the map to make planning easier.

ArcGIS Tools

We used the Classic and Enhanced Two Step Floating Catchment Area using the Travel Time tool in ArcGIS Pro developed by Hashtarkhani (2024) to run our FCA analysis.[3]

Tools are available on ArcGIS online

Case Study article

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Conclusions

- 2SFCA provides improved characterization over simple service area analysis.
- E2SFCA provides a more refined understanding of high, moderate, and low spatial access to mammography services.
- Both methods can now be completed in ArcGIS Pro.
- Sensitivity analysis revealed that excluding 50% of American Indian or Alaska Native women from the demand pool had no measurable effect.

Future Direction

- Account for the current mobile screening locations.
- Find partner within high-need locations for mobile mammography visits.

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Strengths

- E2SFCA accounts for distance, population, and gravity.
- We used the smallest geographic unit available (block group).

Limitations

- Ecological Fallacy.
- Modifiable Area Unit Problem.
- Travel time uncertainty.
- Expensive if you don't have ESRI Streetmap® added to ArcGIS Pro or another routing service. But you can use TIGER files.
- Urban Areas are too compact for this method .

References

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