A 21st Century Census Curated Data Enterprise:

Demonstration Use Case on Skilled Nursing Facilities

Presentation to FCSM
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United States® Census Bureau

21st Century Census Curated Data Enterprise

The 21st Century Census Curated Data Enterprise (CDE) is a proposed shift of focus away from relying solely on individual surveys and towards creating statistical products defined by stakeholders' purposes and uses

The statistical product first process starts with research questions and ends with products that provide data-driven insights into these questions.

Demonstration Use Cases are being used to test this idea out and shed light on what capabilities will be needed to develop and deploy the Curated Data Enterprise (CDE)

Each Use Case follows the CDE Framework.

Curated Data Environment Framework

The **outer rectangle** identifies the guiding principles for ethical transparent and reproducible product development and dissemination.

The **inner rectangle** identifies the statistical product development steps.

Curated Data Environment Framework

One can think of this as the scientific method for research using multiple data sources and types that are discovered and wrangled rather than collected based on a statistical model like an experimental design.

Purpose & Use

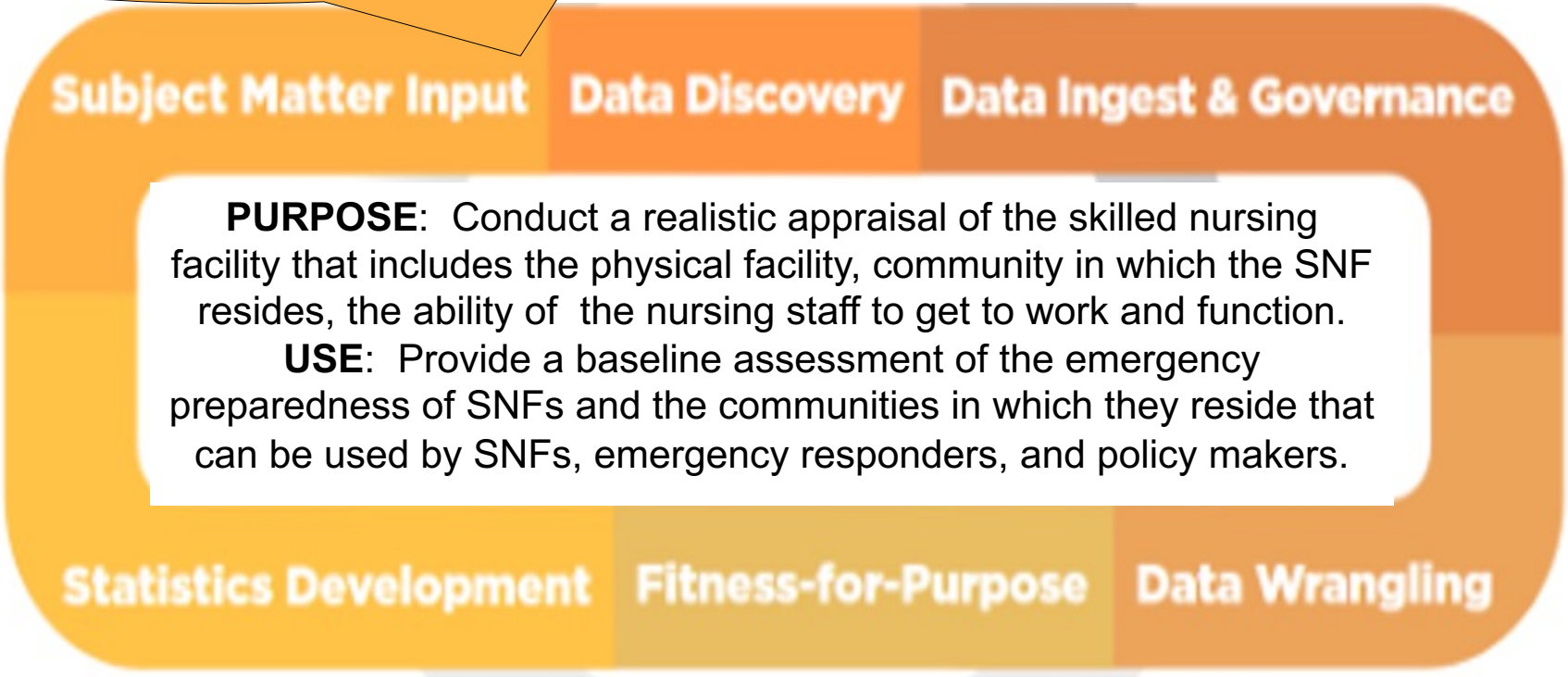
PURPOSE: Conduct a realistic appraisal of the skilled nursing facility that includes the physical facility, community in which the SNF resides, and the ability of the nursing staff to get to work and function.

USE: Provide a baseline assessment of the emergency preparedness of SNFs and the communities in which they reside that can be used by SNFs, emergency responders, and policy makers.

1. Are Skilled Nursing Facilities (SNF) prepared for extreme climate events?
2. Will the nursing staff be able to get to the facility in the event of an extreme climate event?
3. Will communities be able to provide support to SNFs?

Subject Matter Input

We met with SNF administrators, resident advocates, & researchers through discussions & listening sessions and conducted a library search.



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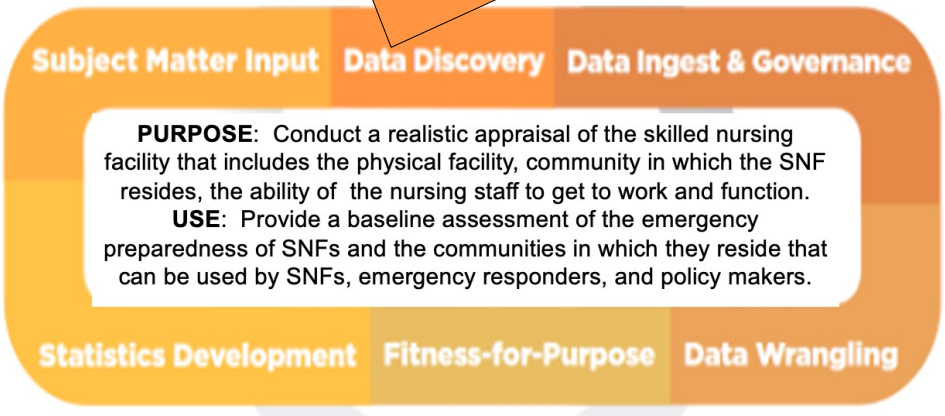
Data Discovery

Based on subject matter input & literature we made a wish list of variables for SNFs, climate threat, & community preparedness.



Data List

Baseline Skilled Nursing Facility

Skilled Nursing Facilities

- Type (profit, not for profit)
- Chain status
- Last sold
- Emergency deficiencies
- Fire Safety deficiencies
- Inspections dates

Residents

- Total # of Residents
- % > 65
- % Minority
- % on Medicaid
- Cognitive function
- Mobility
- Physical Health

Nursing Staff (NS)

- Total # of Nursing Staff
- Where NS live
- How NS get to work
- Composition of NS family

Climate Change Threat

Riverine Flooding

- # of events
- Annualized frequency
- Risk score

Coastal Flooding

- # of events
- Annualized frequency
- Risk score

Hurricanes

- # of events
- Annualized frequency
- Risk score

Preparedness

Skilled Nursing Facilities

- # Emergency deficiencies and Inspections over 4yrs
- # Fire safety deficiencies and Inspections over 4yrs

Community Built Environment

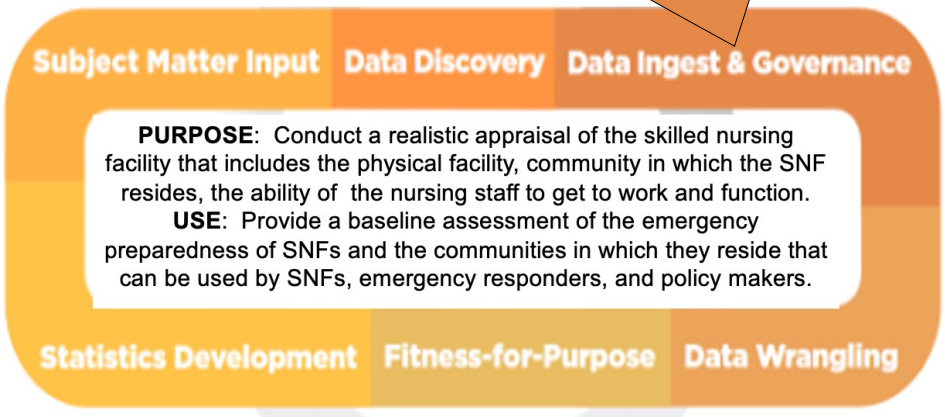
- # Hospitals
- # Fire Stations
- # Red Cross Chapters
- # National Shelter System Facilities
- # Urgent Care Facilities
- # Emergency Medical Service Stations
- # Primary care providers
- Transportation infrastructure

Community Population Resilience

- % < High School
- % Disabilities
- % Unemployed
- % No vehicle
- GINI Index

Data Ingest & Governance

Set up a GitHub repository to store public data, metadata, code, statistical products, data processes, & relevant literature on SNF resilience & regulations.



Appendix C. Census Skilled Nursing Facility Use Case GitHub Repository

There are three main folders in the GitHub Repository,

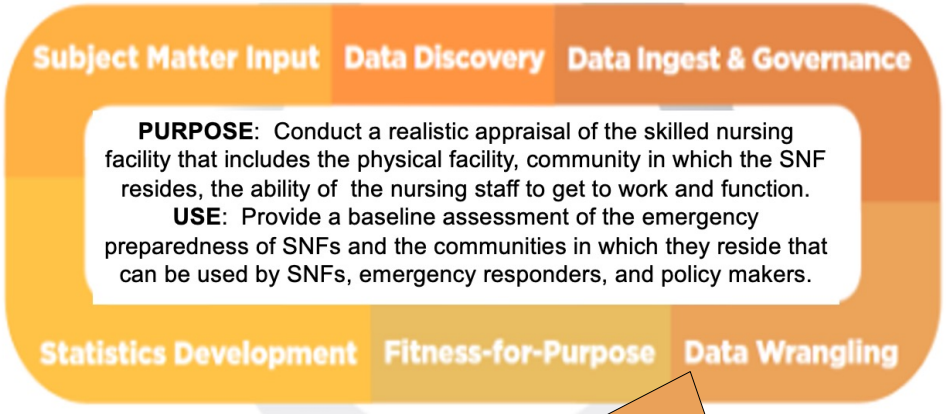
1. **Data** – Owners, Facility, Nursing Staff, Residents, Community, Resilience, Demographic + Meta Data for each folder
2. **Source Code**
   - Discovery (EDA-Exploratory Data Analysis (choropleths, box plots, isochrones)
   - Analysis (County Assets- Infrastructure and Workers, Deficiency Indexes, population resiliency, Probability of getting to SNF, and City of Richmond, VA example)
3. **Documents**
   - Literature and other Products (data tables, visualizations, presentations, and reports)
   - Processes (commute vulnerability) and derived variables (e.g., county resilience, shelter and emergency facilities, deficiency indices, average daily nursing staff, and probability of work not getting to work).

Table of Contents for the GitHub Repository
https://github.com/uva-bi-sdad/census_cde_demo_2

1. Data Folder

- Subfolder: **Virginia Skilled Nursing Facility**
  - Subfolder: **Owners**
    - File: va_cms_ownership_2022-08.csv
    - ✓ Subfolder: **Meta Data**
      - File: cms_five_star_users_guide_2022-01.pdf
      - File: cms_primary_data_dictionary.xlsx
  - Subfolder: **Facility**
    - File: us_cms_inspection_dates_2022-06.csv
    - File: va_cms_fire_safety_deficiencies_2022-12.csv
    - File: va_cms_provider_final_2022-07.csv
    - ✓ Subfolder: **Meta Data**
      - File: cms_deficiency_citation_descriptions_2022-07.xlsx

Data Wrangling



288 SNFs in Virginia, 283 had sufficient staffing data to be included in this Use Case.

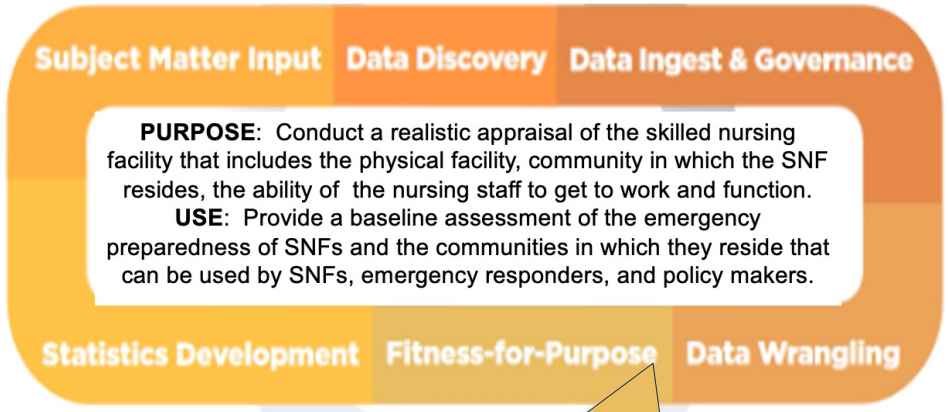
Data Wrangling Process

Profiling	Preparation	Linkage	Exploration
Quantity, Structure, Metadata, Provenance	Cleaning, Transforming, Restructuring,	Ontology, Selection & Alignment, Harmonization	Visualization, Exploratory Data Analyses, Characterization

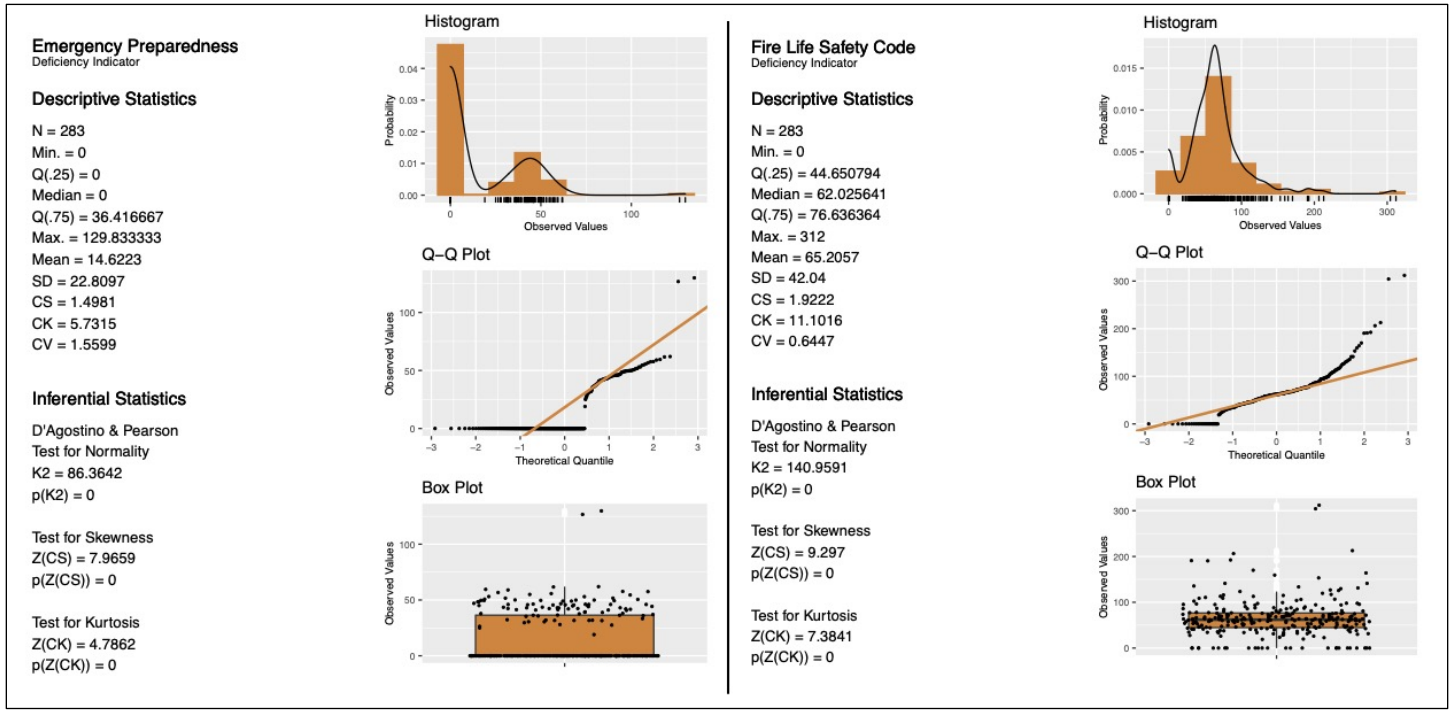
Data wrangling examples:

- Nonstandard names for hospitals and classification system
- Absence of data dictionaries that would allow users to compare variables across data sets
- Inconsistent geographic information

Fitness-for-Purpose



Exploratory data analyses were done to ensure the SNF Deficiency Indices had sufficient variability to discriminate between high and low-performing SNFs.



Emergency Preparedness
Deficiency Indicator

Descriptive Statistics

N = 283
Min. = 0
Q(.25) = 0
Median = 0
Q(.75) = 36.416667
Max. = 129.833333
Mean = 14.6223
SD = 22.8097
CS = 1.4981
CK = 5.7315
CV = 1.5599

Inferential Statistics

D'Agostino & Pearson
Test for Normality
K2 = 86.3642
p(K2) = 0

Test for Skewness
Z(CS) = 7.9659
p(Z(CS)) = 0

Test for Kurtosis
Z(CK) = 4.7862
p(Z(CK)) = 0

Histogram
Probability
Observed Values

Q–Q Plot
Observed Values
Theoretical Quantile

Box Plot
Observed Values

Fire Life Safety Code
Deficiency Indicator

Descriptive Statistics

N = 283
Min. = 0
Q(.25) = 44.650794
Median = 62.025641
Q(.75) = 76.636364
Max. = 312
Mean = 65.2057
SD = 42.04
CS = 1.9222
CK = 11.1016
CV = 0.6447

Inferential Statistics

D'Agostino & Pearson
Test for Normality
K2 = 140.9591
p(K2) = 0

Test for Skewness
Z(CS) = 9.297
p(Z(CS)) = 0

Test for Kurtosis
Z(CK) = 7.3841
p(Z(CK)) = 0

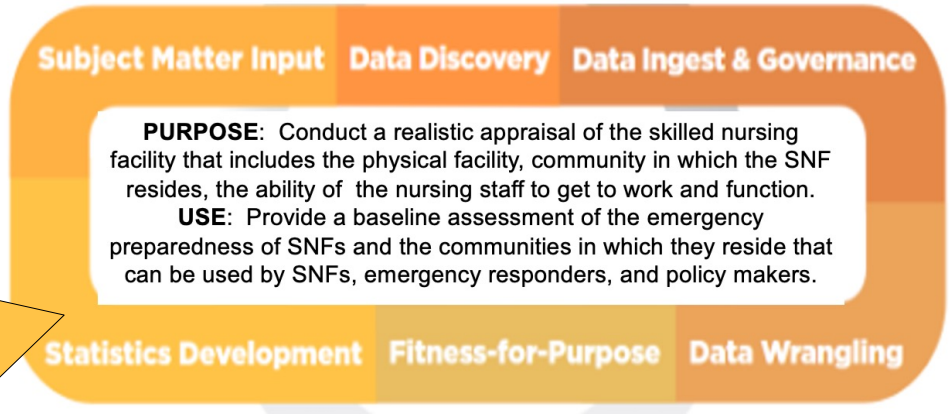
Histogram
Probability
Observed Values

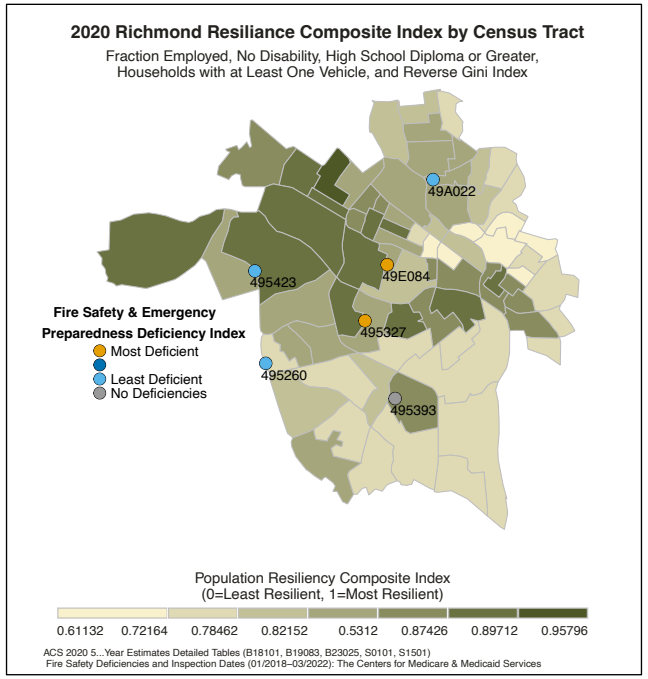
Q–Q Plot
Observed Values
Theoretical Quantile

Box Plot
Observed Values

Statistical Development

- Integrated Use Case Database
- Composite Indices
  - SNF Deficiency Indices
  - Community Resiliencies Indices
- Choropleth & Isochrone Maps
- Modeling Results
- Simulation Estimates
- R code use to
  - Download, clean & integrate multiple data sources
  - Produce the various statistical products





Are SNF prepared for emergencies?

CMS Skilled Nursing Home Deficiencies as a proxy for preparedness

Emergency Preparedness (EP)

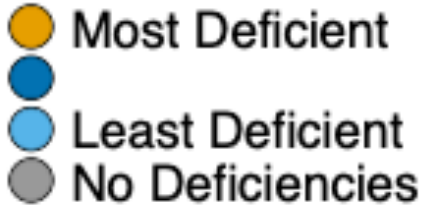
- Emergency plans
- Communication plan
- Training and testing
- Policies and procedures

Life Safety Code (LSC) Deficiencies

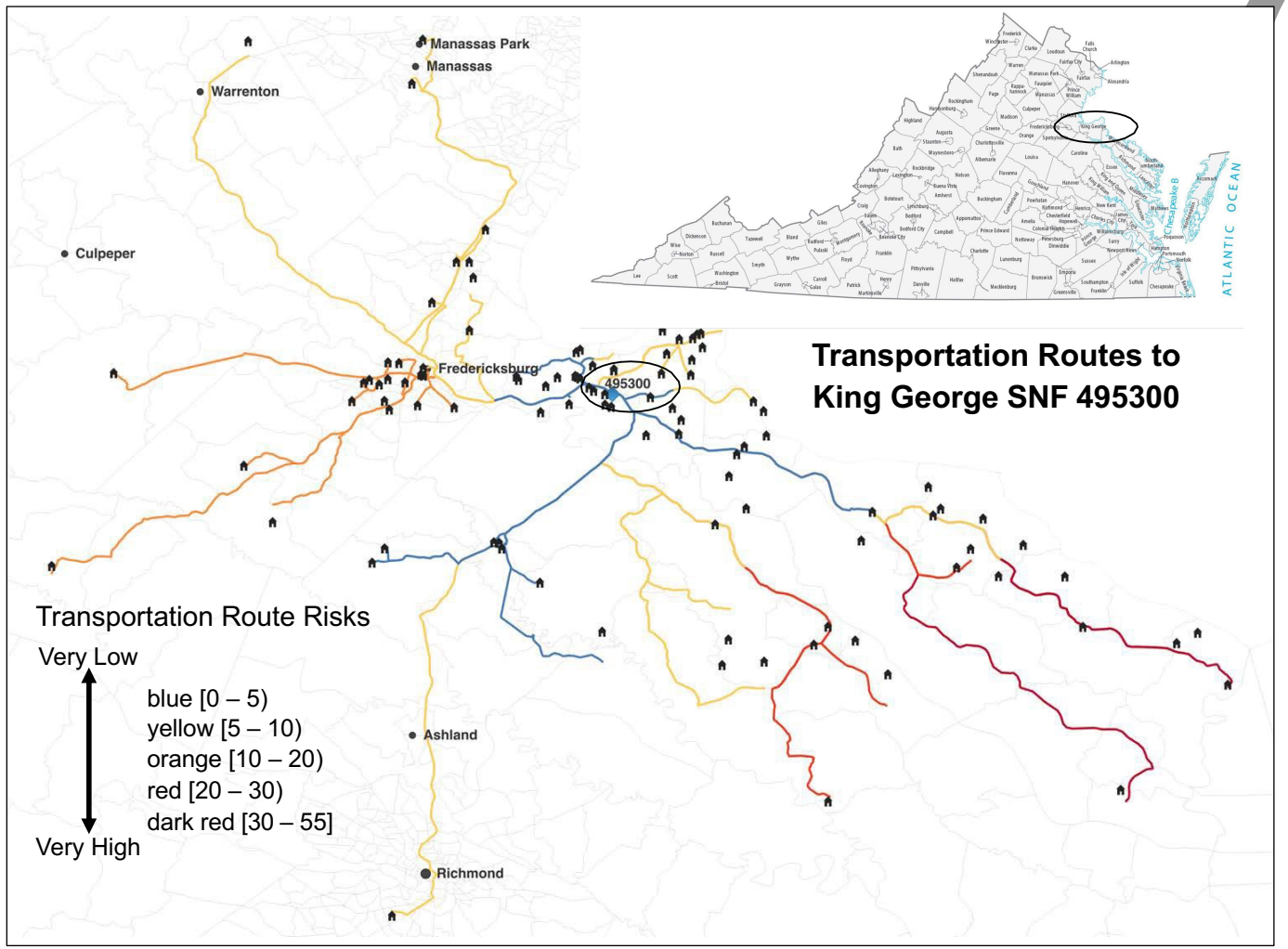
Fire protection requirements

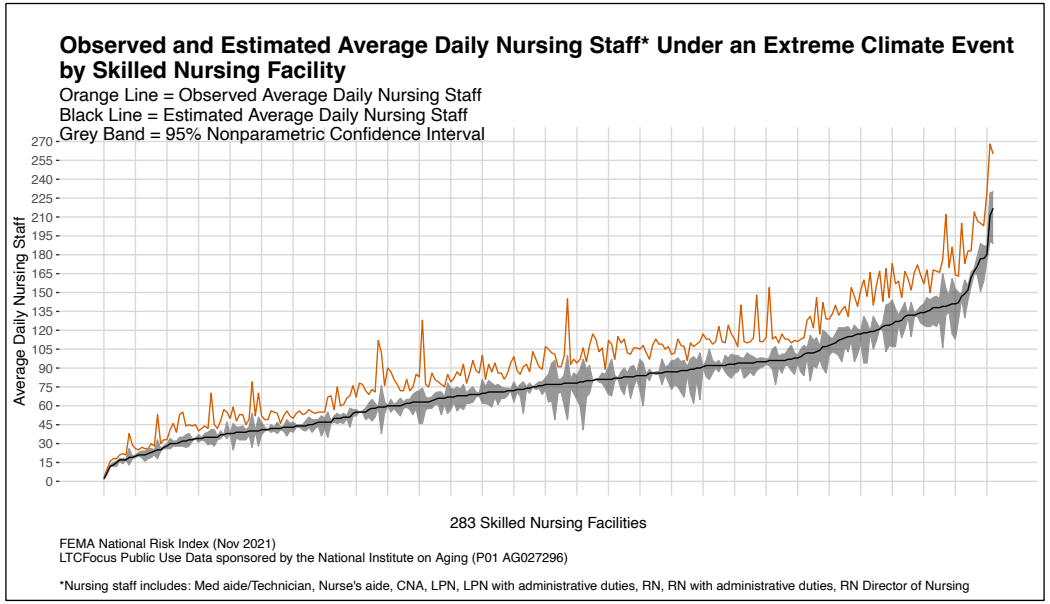
- Designed to provide a reasonable degree of safety from fire, smoke, and panic
- Construction
- Protection
- Operational features

Fire Safety & Emergency Preparedness Deficiency Index

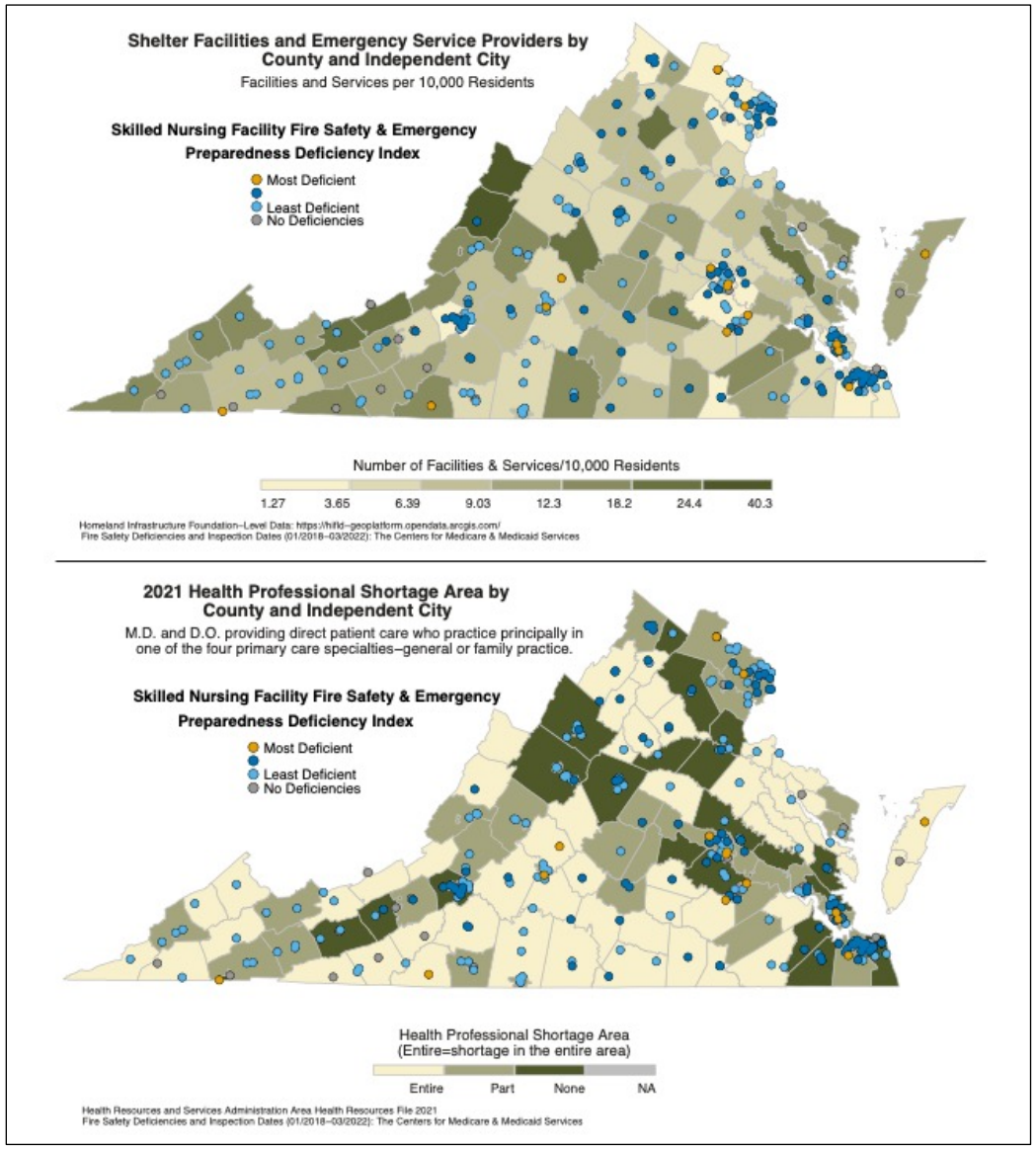


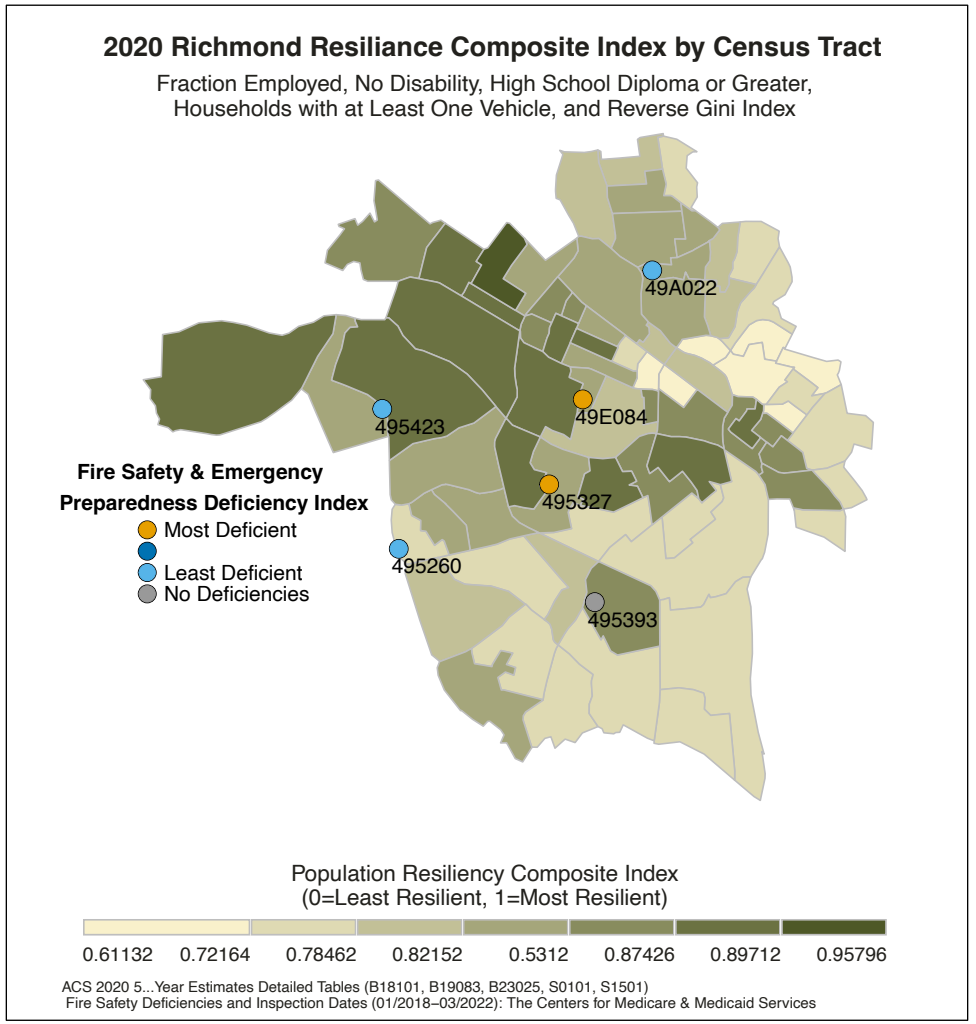
Will nursing staff reach the facility?





Can communities provide support?





What CDE capabilities are identified?

CDE Capabilities developed:

- Identify the home location of SNF workers.
- SNF workers' transportation routes + risk of flooding by route
  - Monte Carlo simulation to estimate the average probability of getting to work and the percentage loss in nursing staff based on the average daily skilled nursing staff numbers from CMS.
- SNF combined deficiency index
  - SNF Emergency Preparedness deficiencies metric
  - SNF Life Safety Code (fire) deficiencies metric
- Community resilience indicators
  - Number of shelter facilities and emergency service providers per 10,000 people.
  - Mapping health professional shortage areas.

What are the gaps to be filled in future use cases?

- Provide crosswalks that link location variables such as lats & long, FIPS codes, ZIP codes, addresses, etc.
- Resolve inconsistencies and omissions observed across data sources on the same topic. In this Use Case, three data sets on hospitals had different names and federal IDs such as Medical Provider Number.
- Provide private-equity ownership data, there is no definitive source that is publicly available (GAO 2023).

Technical Report: Lancaster V, Shipp S, Keller S, Schroeder A, Mortveit H, Swarup S, Xie D, (2023), Census Curated Data Enterprise Use Case Demonstration: Climate Resiliency of Skilled Nursing Facilities. Proceedings of the Biocomplexity Institute, Technical Report. TR# 2023-53. University of Virginia. https://doi.org/10.18130/ce97-sp05