[Title]

Preparation

- [Github link](#) *[Optional]*

- Number of words: ***

- Runtime: *** hours (*Memory 10 GB, CPU Intel i7-10700 CPU @2.90GHz*)

- Coding environment: SDS Docker

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- Additional library *[libraries not included in SDS Docker or not used in this module]*:

  - **watermark**: A Jupyter Notebook extension for printing timestamps, version numbers, and information.

  - To install required package:

    ```
    !pip install linearmodels
    pip install nbconvert weasyprint
    ```

Table of contents

Introduction

[go back to the top]

Childhood obesity remains a critical public health challenge in London, adversely affecting childre and causing significant economic costs. To address this, the UK government's *Childhood Obesity. Action* (Department of Health and Social Care, 2018) substantially expanded investments in physi infrastructure, including funding for school sports and community facilities. Public Health England'

Health Profiles report increased availability of parks, playgrounds, and sports centres across Lond
(Public Health England, 2023)↵. Nonetheless, reductions in childhood obesity have been limited a
especially among younger children, underscoring obesity's multifactorial nature and insufficient im
infrastructure expansion alone (Wyszyńska et al., 2020; Lieb, 2009)↵.

This study evaluates how different facility types influence childhood obesity rates across age grou
wards between 2009/10 and 2013/14. Using NCMP data from 2008 to 2014, it also examines the
roles of socioeconomic status (SES), green space, and public transport accessibility. By leveragin
temporal fixed effects, the research aims to uncover spatial heterogeneity and inform targeted, eq
health strategies (Titis, 2023; Yuan, 2024)↵.

Requirements to Run the Analysis

An overview of packages used to run the analysis with brief explanation of their role.

```python
import os
import requests
import zipfile
from functools import reduce

import pandas as pd
import geopandas as gpd
from shapely.geometry import Point

import numpy as np
import scipy.stats as stats

import matplotlib.pyplot as plt
from matplotlib.gridspec import GridSpec

import seaborn as sns

from sklearn.ensemble import RandomForestRegressor
from sklearn.preprocessing import StandardScaler

import statsmodels.api as sm
import statsmodels.formula.api as smf
from statsmodels.iolib.summary2 import summary_col
from statsmodels.stats.outliers_influence import variance_inflation_factor

from linearmodels.panel import PanelOLS
```

Literature Review

[go back to the top]

Increasing evidence challenges the notion that expanding physical activity facilities alone suffices
childhood obesity rates. While infrastructure is necessary, obesity results from complex interaction
behaviours, socioeconomic factors, and environmental contexts (Danielli et al., 2021)↵. Research
influences intervention responses: older children engage more independently with their surroundi
younger children's behaviours are more shaped by familial and cultural factors (Wyszyńska et al.,
et al., 2021)↵, indicating the need for age-specific approaches.

Socioeconomic disparities exacerbate risk, as children from lower SES backgrounds often face po
quality facilities and supportive environments (Lieb et al., 2009; Yuan, 2024)↵. Environmental fac
green space and public transport accessibility further modify physical activity opportunities and ok
outcomes (Danielli et al., 2021)↵. Additionally, spatial heterogeneity within London wards manifes
obesity prevalence and resources, warranting geographically targeted interventions (Titis et al., 20

This study's key innovation lies in integrating facility types, age, SES, and environmental factors w
spatial-temporal fixed effects framework. Unlike prior isolated or cross-sectional studies, this appr
captures how facility effects vary across age and SES groups and reveals spatial differences in ok
patterns. Using fixed effects controls unobserved confounders across space and time, enabling m
identification of heterogeneity. This comprehensive perspective supports the design of more targe
childhood obesity prevention policies.

Research questions

Considering that facility types affect physical activity differently by children's developmental stages
mobility, and that socioeconomic disparities influence facility access and use, it is essential to stud
factors separately. Environmental aspects like socioeconomic status, green space, and public tran
accessibility (PTAL), integrated through spatial and temporal fixed effects, also shape activity opp
may modify these effects. Therefore, this study addresses the following:

RQ1: How do various facility types impact obesity rates among children of different age groups?

RQ2: To what extent do socioeconomic status, green space proportion, and public transport acce
(PTAL) moderate the effects of facilities on childhood obesity, after controlling for spatial and temp
differences?

Recognizing that obesity prevalence and environmental influences vary across geographic areas
time, a comprehensive spatial-temporal analysis is necessary. Consequently:

RQ3: How can spatial and temporal fixed effects reveal heterogeneous patterns to inform targeter
health interventions?

Data

*[Note: a table that describes the selected variables for analysis and modelling is required - see the
below.]*

| Variable	Type	Description
Burglary crime rate	Numeric	The burglary rate of MSOAs. Used as dependent variable regression.
Temperature	Numeric	The daytime temperature
Indicator of Inner or Outer London	Categorical	Whether the MSOA is in Inner London.

Variable	Type	Description
......	......	......

Methodology

[go back to the top]

[Note: a flow chart that describes the methodology is strongly encouraged - see the example belo chart can be made using Microsoft powerpoint or visio or other software]

Source: see link.
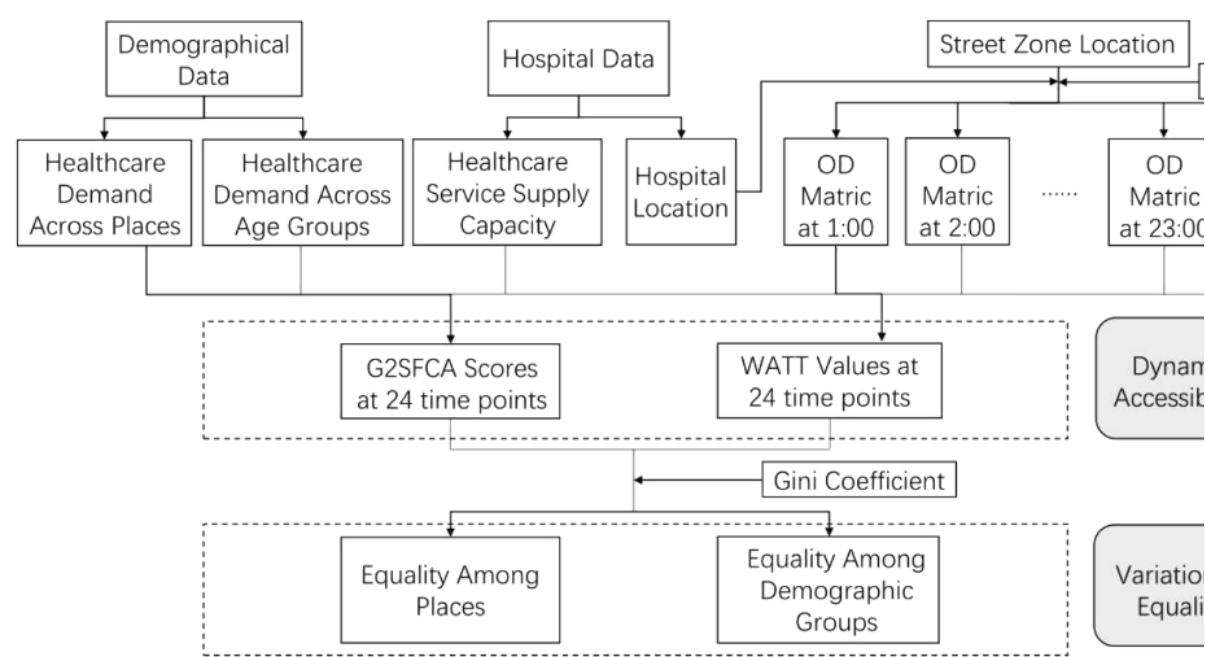
In [ ]:

Results and discussion

[go back to the top]

Conclusion

[go back to the top]

In [ ]:

References

[go back to the top]

- Ayala, G.X., et al., 2021. The social environment and childhood obesity. *International Journal Environmental Research and Public Health*. Available at: https://www.ncbi.nlm.nih.gov/pmc/a PMC8365653/ [Accessed 20 Apr 2025].

- Danielli, A., Parker, L. and Swinburn, B., 2021. Systematic review into city interventions to ad *International Journal of Environmental Research and Public Health*, 18(12). Available at: https: www.ncbi.nlm.nih.gov/pmc/articles/PMC7910670/ [Accessed 20 Apr 2025].

- Lieb, D.C., 2009. Socioeconomic Factors in the Development of Childhood Obesity. *Current (Reports*. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5596457/ [Accessed 20

- Public Health England, 2023. London's Local Health Profiles. London: Public Health England https://fingertips.phe.org.uk/profile/health-profiles/data#page/4/gid/8000073/pat/15/par/E9200(are/E12000007/iid/90323/age/201/sex/4/cat/-1/ctp/-1/yrr/1/cid/4/tbm/1/page-options/car-do-0_ [Accessed 20 Apr 2025].

- Titis, E., 2023. Socio-economic correlates of childhood obesity in urban and rural England. *Pu Nutrition*. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10478054/ [Accessed 2

- Wyszyńska, J., et al., 2020. Physical Activity in the Prevention of Childhood Obesity. *Frontier: Pediatrics*. Available at: https://www.frontiersin.org/articles/10.3389/fped.2020.535705/full [Ac Apr 2025].

- Yuan, Y., 2024. Public health interventions against childhood obesity in China and globally. *Pi Medicine Reports*, 29. Available at: https://www.sciencedirect.com/science/article/pii/S246826([Accessed 20 Apr 2025].

In [10]:
```python
# Notebook to Interactive PDF Converter
# This script enables direct PDF conversion from the current notebook

# Import required libraries
import os
import nbconvert
from nbconvert.exporters import HTMLExporter
from weasyprint import HTML, CSS

def convert_notebook_to_interactive_pdf(notebook_path=None, css_path='print.css'):
    """
    Convert Jupyter Notebook to an interactive PDF with custom styling.

    Parameters:
    - notebook_path: Path to the current notebook (auto-detected if None)
    - css_path: Path to custom CSS file for styling

    Returns:
    - Path to the generated PDF file
    """
    # If no notebook path is provided, try to auto-detect
    if notebook_path is None:
        import inspect
        notebook_path = inspect.getfile(inspect.currentframe()).replace('.py', '.ipynb')

    # Configure HTML exporter
    html_exporter = HTMLExporter()
    html_exporter.template_name = 'classic'

    # Export notebook to HTML
    (body, resources) = html_exporter.from_filename(notebook_path)
```

```python
    # Generate temporary HTML file path
    html_path = notebook_path.replace('.ipynb', '.html')

    # Write HTML content
    with open(html_path, 'w', encoding='utf-8') as f:
        f.write(body)

    # Generate PDF path
    pdf_path = notebook_path.replace('.ipynb', '.pdf')

    # Convert HTML to PDF with optional CSS styling
    HTML(html_path).write_pdf(
        pdf_path,
        stylesheets=[css_path] if os.path.exists(css_path) else None
    )

    # Print confirmation message
    print(f"  Successfully converted {notebook_path} to interactive PDF: {pdf_path}")
    return pdf_path

# Optional: Create a default print.css if not exists
import os
if not os.path.exists('print.css'):
    with open('print.css', 'w') as f:
        f.write('''
@page {
    size: A4;
    margin: 2cm 1cm 2cm 1cm; /*              */
}

body {
    font-family: Arial, sans-serif;
    line-height: 1.6;
    width: 100%; /*       */
    max-width: none; /*             */
    margin: 0; /*        */
    padding-left: 0px; /*           */
}

.container {
    margin-left: 0;
    padding-left: 0;
}

pre {
    background-color: #f4f4f4;
    padding: 10px;
    overflow-x: auto;
    margin-left: 0; /*          */
}
''')

# Automatically convert current notebook to PDF when script runs
convert_notebook_to_interactive_pdf('24109799_submission_CASA0006.ipynb')
```

```
  Successfully converted 24109799_submission_CASA0006.ipynb to interactive PDF:
24109799_submission_CASA0006.pdf
```

Out[10]: '24109799_submission_CASA0006.pdf'

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