The Impact of Access to Nature on Children's Healthy Weight in Reception and Year 6: Examining Changes Across London Boroughs Post-COVID Lockdown

1. Introduction

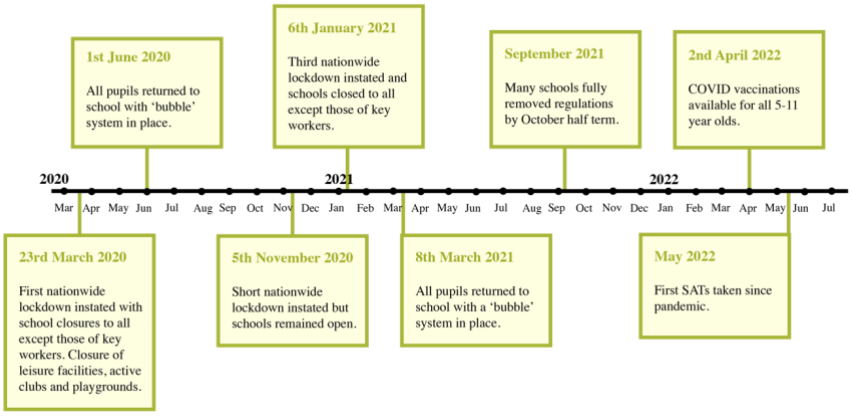

Figure 1 Timeline of COVID restriction impacting children in the UK

In 2020, the UK implemented stringent lockdowns in response to COVID-19, disrupting daily life and significantly altering children's physical activity patterns (Figure 1). While accelerometer-measured activity levels returned to near pre-pandemic levels by 2022, childhood obesity remains a critical global public health issue, with over 40 million obese children worldwide. In the UK, pre-pandemic obesity rates were already concerning, with 22% of children overweight by school entry (4–5 years) and 33% by ages 10–11 (Ziauddeen et al., 2017).

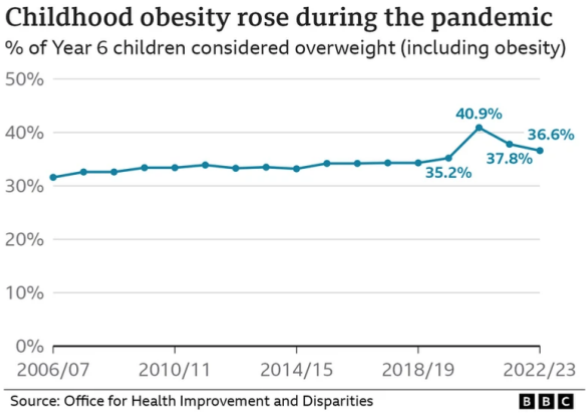

Figure 2 Graph of Year 6 childhood obesity levels
Source: Office for Health Improvement and Disparities (BBC, 24 January 2024)

A BBC report noted a sharp rise in obesity rates among 10- and 11-year-olds in England (Figure 2) but overlooked the role of reduced outdoor play during lockdowns. Research demonstrates significant links between residential green space and health outcomes (Mears et al., 2020). Lack of unstructured outdoor time, described as "nature deficit disorder" (McCurdy et al., 2010), has been identified as a key behavioural factor linked to childhood obesity. For example, greater street tree density is associated with lower obesity rates among 3–5-year-olds in New York City (Lovasi et al., 2013). However, UK studies suggest park access is less relevant for 7–8-year-olds, who often play in private gardens (Poole and Moon, 2017).

Green spaces were vital for health and wellbeing during the pandemic yet few studies examine age-specific health outcomes related to natural features. Children's limited independent mobility further underscores the importance of age-appropriate green spaces.

This study investigates the relationship between natural assets and childhood obesity pre- and post-pandemic, focusing on Reception (ages 4–5) and Year 6 (ages 10–11). Using logistic regression, it examines age-specific differences and identifies natural features most effective in promoting healthy weight.

2. Methodology

Ordinal logistic regression was utilised to examine the relationship between natural assets and children's weight status, an ordered categorical variable. This method is particularly appropriate for public health research, as it explores how predictors such as green cover, tree cover, and outdoor space influence childhood obesity. The study focuses on Reception (ages 4–5) and Year 6 (ages 10–11) students, comparing the likelihood of being classified as healthy or unhealthy pre-COVID (2013–2019) and post-COVID (2021–2023). This enables robust insights into how environmental factors affect health outcomes over time.

London offers a diverse setting for investigating the impact of green space on childhood obesity. Its boroughs exhibit wide variability in green space availability, socio-economic contexts, and public health outcomes, making it a valuable case study. Additionally, the significant lifestyle changes experienced during the pandemic provide a unique opportunity to evaluate shifts in these relationships pre- and post-COVID.

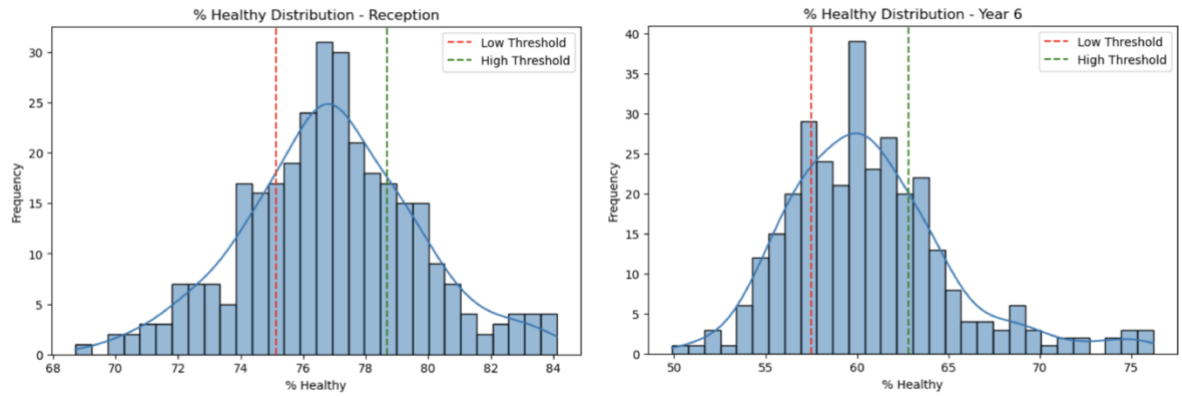

Figure 3 Reception and Year 6 healthy weight distribution histograms

Separate ordinal logistic regressions were performed for Reception and Year 6 students to account for age-specific differences (Figure 3). Boroughs with at least 63% of Year 6 children classified as healthy weight were categorised as "high health," 58–62.9% as "medium," and below 58% as "low." For Reception, "high health" was set at 79% or above, "medium" at 75–78.9%, and below 75% as "low."

The study included nine natural asset variables: Open Space, Regional Parks, Metropolitan Parks, District Parks, Local Parks, Green Cover, Blue Cover, Private Garden Access, and Tree Cover. To control for confounding factors, three socio-economic variables—income deprivation, crime deprivation, and employment deprivation—were incorporated, reflecting their significant association with child health and green space availability.

Statistical analyses were conducted using Python, ensuring population representativeness through data weighting. All code is available at https://github.com/Maheer-Maps/Research_Report. A significance level of $p < 0.05$ was applied, yielding robust conclusions about associations between natural assets, socio-economic factors, and childhood obesity. Socio-economic deprivation was

included due to its strong correlation with obesity rates and widening disparities with age (White, Rehkopf, and Mortensen, 2016).

The analysis focused on borough-level data as post-pandemic childhood weight data was unavailable at smaller scales. Boroughs provide robust population sizes, minimising statistical fluctuations and preserving anonymity. They also align with health interventions like walk-to-school programmes implemented by local councils.

This approach assumes proportional odds, meaning the relationship between predictors and the likelihood of moving between categories is consistent across outcome levels. However, it does not differentiate between types of unhealthy weight, such as underweight and overweight, which is a key limitation.

3. Data

Table 1 Data and Sources

Data Type	Source	Year
Childhood Weight	NHS National Child Measurement Programme (NCMP)	2023-2013 [excluding 2020]
Open Space	London Datastore (Greater London Authority (GLA))	2018
Regional Parks	London Datastore (Greenspace Information for Greater London CIC (GiGL))	2015
Metropolitan Parks	London Datastore (Greenspace Information for Greater London CIC (GiGL))	2015
District Parks	London Datastore (Greenspace Information for Greater London CIC (GiGL))	2015
Local parks	London Datastore (Greenspace Information for Greater London CIC (GiGL))	2015
Green Cover	London Datastore (Greater London Authority (GLA))	2022
Blue Cover	London Datastore (Greater London Authority (GLA))	2022
Private Gardens	London Assembly	2020
Tree Cover	London Datastore (Greater London Authority (GLA))	2014
Deprivation	English Indices of Deprivation (ID)	2020
Income deprivation	London Assembly (Ministry of Housing, Communities & Local Government (MHCLG))	2019
Employment deprivation	London Assembly (Ministry of Housing, Communities & Local Government (MHCLG))	2019
Crime (Deprivation)	London Assembly (Ministry of Housing, Communities & Local Government (MHCLG))	2019

The study utilised data from the Government's National Child Measurement Programme (NCMP), which annually tracks the height and weight of children in Reception (ages 4–5) and Year 6 (ages 10–11) in England's state-maintained schools (Table 1). Weight is measured using digital scales and a stadiometer, with BMI classified using International Obesity Task Force categories (Cole et al., 2000). Aggregated NCMP data from 2013–2020 was used for robust analysis. Natural features data, derived from Ordnance Survey boundaries and Greater London Authority (GLA) datasets, included measures of open space access, green cover (e.g., parks, green roofs), and tree cover. Open space access was measured by walking distance, excluding farmland, while tree cover data originated from the Mayor's Street Tree Programme.

Certain constraints arose due to data limitations. The 2020/21 NCMP data was unavailable due to COVID-19 disruptions, and participation rates were affected by school closures. Additionally, data for the City of London was combined with Westminster to avoid disclosing small obesity estimates, and children in independent schools were excluded, limiting coverage. The analysis of green space also lacked consideration of quality or facilities, potentially underestimating its environmental impact on childhood obesity.

Despite these limitations, the NCMP holds UK National Statistics status, indicating high trustworthiness, quality, and public value. Its IT system incorporates data quality controls, requiring no more than 20% of recorded heights or weights to be rounded to the nearest whole or half unit. Approximately 10% of entries must be whole numbers and another 10% half numbers. With over one million children measured annually and a 95% participation rate, the NCMP provides robust data collection. This ensures data accuracy for the study while acknowledging inherent limitations.

4. Results

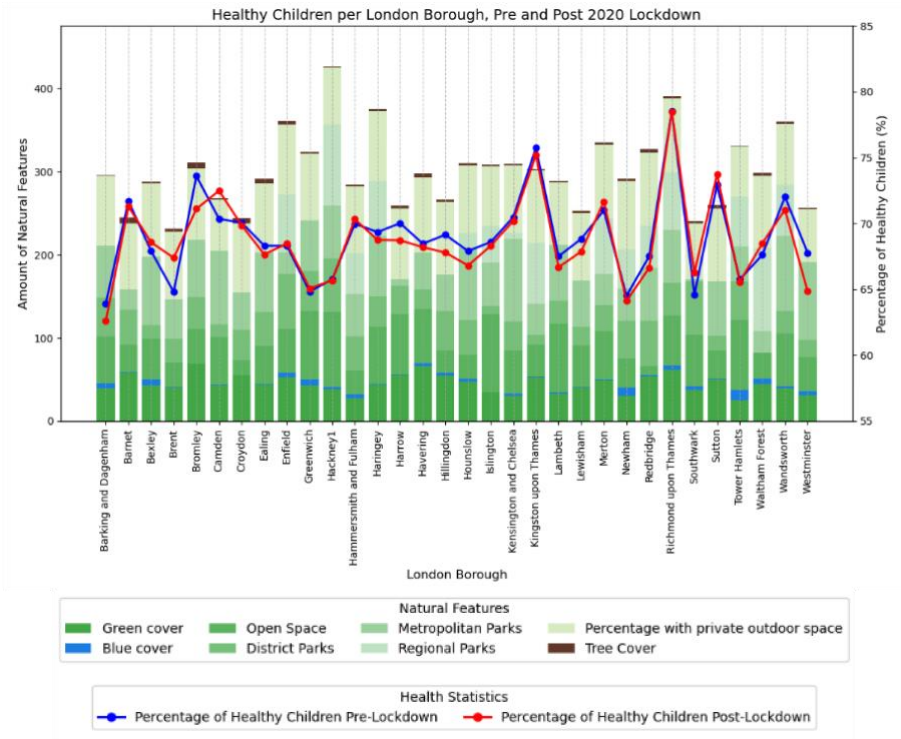

Figure 4 Stacked bar chart showing natural features and healthy weight prevalence by borough pre- and post-COVID.

Figure 4 highlights borough-level descriptive statistics, linking the amount of natural assets per borough and healthy weight prevalence among children both pre COVID Lockdown (2013-2019) and post COVID Lockdown (2021-2023). Southwark averaged the best healthy weight rates across ages pre- and post-COVID and ranked second for nature access. Looking into the split by age groups we discovered that Bromley exhibited the highest tree cover and strong healthy weight outcomes, with a 6% drop in Year 6 and a 1% increase in Reception post-COVID. Kensington and Chelsea, with the highest number of Local and Metropolitan Parks, saw minimal changes (1% decrease in Year 6 and 0.5% increase in Reception). Richmond upon Thames, with the second-best access to nature, had the highest healthy weight rates in Year 6 pre- and post-COVID and a 1% post-COVID improvement in Reception.

Table 2 Regression Results

	Year 6				Reception			
	Coefficient		P value		Coefficient		P value	
	Pre Covid	Post Covid	Pre Covid	Post Covid	Pre Covid	Post Covid	Pre Covid	Post Covid
Open Space	-0.0281	-0.0012	0.006	0.922	-0.0249	-0.0170	0.013	0.274
Green Cover	0.2101	0.0159	0.000	0.465	0.1554	0.0501	0.000	0.370
Blue Cover	-0.1855	-0.1269	0004	0.131	-0.0821	-0.0692	0.166	0.508
Local Parks	0.0914	0.0194	0.000	0.345	0.1052	0.0236	0.000	0.346
District Parks	-0.0154	-0.0181	0.251	0.284	-0.0008	0.0006	0.950	0.975
Metropolitan Parks	-0.0208	0.0014	0.017	0.897	-0.0068	-0.0041	0.402	0.757
Regional Parks	-0.0018	-0.0063	0.711	0.339	0.0028	-0.0143	0.552	0.059
Tree Cover	-1.9646	-0.5714	0.000	0.016	-0.8453	-0.5169	0.001	0.157
Private outdoor space	0.1253	0.0679	0.000	0.052	0.0359	0.0340	0.170	0.441

The regression analysis results (Table 2) revealed that for Year 6, open space and tree cover significantly impacted unhealthy weight status pre-COVID, but their effects weakened post-COVID. Green cover showed a strong positive association with healthier weight pre-COVID (0.2101, p-value <0.001) but lost significance post-COVID. Reception results indicated similar trends, with open space (-0.0249, p-value = 0.013), green cover (0.1554, p-value <0.001), and local parks (0.1052, p-value <0.001) significantly contributing to healthier weight pre-COVID. Across both groups, post-COVID impacts diminished, suggesting broader in the relationship to nature and green space.

5. Discussion

The regression analysis identifies significant, time-sensitive links between green spaces and children's healthy weight status. Pre-COVID, Green Cover and Local Parks positively correlated with healthier weight, though effects weakened post-COVID. Open Space and Tree Cover showed negative pre-COVID impacts but became insignificant after COVID, revealing the dynamic nature-health relationship.

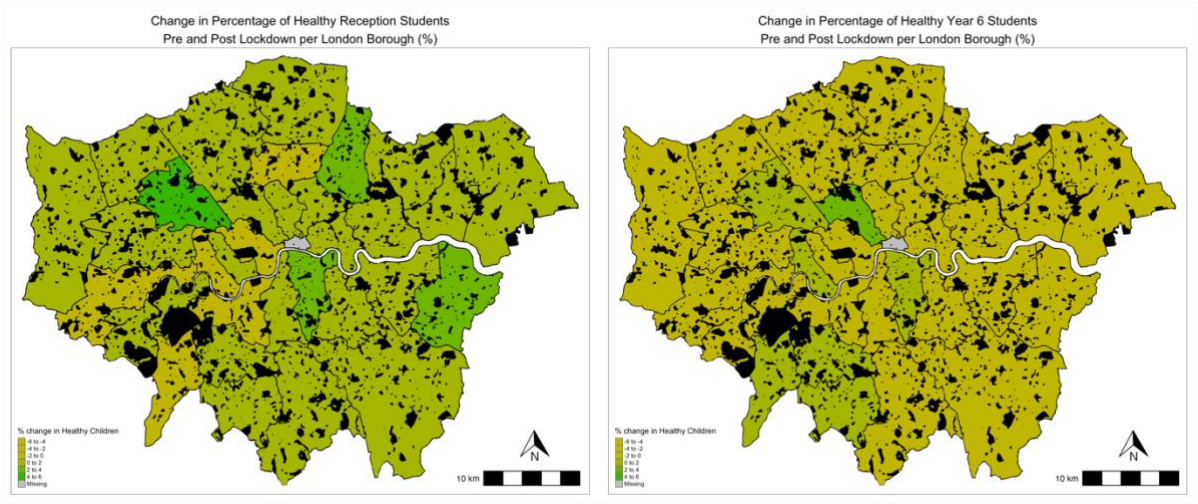

Figure 5 Spatial distribution of healthy weight changes in Reception and Year 6 children pre- and post-COVID, mapped against green cover per borough.

Access to local green spaces appears crucial for supporting healthier weight outcomes, with local parks outperforming non-green open spaces. Boroughs such as Bromley, with high tree cover, and Richmond upon Thames, with excellent access to nature (Figure 5), exhibited consistently strong

health outcomes pre- and post-COVID. Conversely, boroughs like Tower Hamlets and Barking and Dagenham, characterised by low access to private outdoor spaces, reported poorer health outcomes. Hackney, despite being among the greenest boroughs, underperformed in health metrics, suggesting that access alone is insufficient without addressing broader socio-economic and environmental factors.

Policy recommendations include integrating well-maintained local parks with age-appropriate play facilities into residential developments, improving green space quality in deprived areas, and ensuring accessibility to reduce health inequalities exacerbated by COVID-19 lockdowns. Tackling deprivation alongside these measures could more effectively enhance childhood health outcomes than focusing on diet alone.

The study is notable for being the first to examine associations between natural features and childhood obesity in two age groups before and after COVID-19. Strengths include the use of longitudinal data with baseline well-being measures, minimising recall and selection biases. Limitations include the cross-sectional design, which restricts causal inference and may reflect residual confounding or reverse causation. Nature usage, a key determinant of health benefits, was not assessed due to data unavailability. Borough-level analysis, while socially homogeneous, risks ecological fallacy by masking intra-borough variation. Additionally, London's high population density limits generalisability to rural settings, and the lack of demographic stratification, such as gender or ethnicity, constrains understanding of nature-health interactions.

6. Conclusion

Our findings indicate that the COVID-19 pandemic significantly impacted children's health and their interaction with nature. Access to well-maintained, well-designed local green spaces, especially parks, plays a vital role in promoting healthier weight outcomes in children. However, these benefits are shaped by socio-economic factors, green space quality, and broader environmental and temporal contexts, highlighting the need for integrated urban planning and public health strategies to reduce health inequalities. Post-pandemic shifts in healthy weight patterns emphasise the importance of prioritising greenspace access in urban planning to support children's health and well-being, potentially mitigating the effects of sedentary lockdown habits.

Future research should adopt multi-model inference approaches to enhance robustness, including examining quadratic relationships where nature impacts may vary at different levels. Investigating residential proximity, time spent in greenspaces, gender differences, and distinctions between underweight and overweight correlations would further clarify these associations.

Word Count

Word Count	1741

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