



Air Pollution, housing and respiratory tract Infections in Children: National birth Cohort study (PICNIC)

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**Medical
Research
Council**



The Telegraph

More than 2,000 children die from pneumonia every day, charities warn

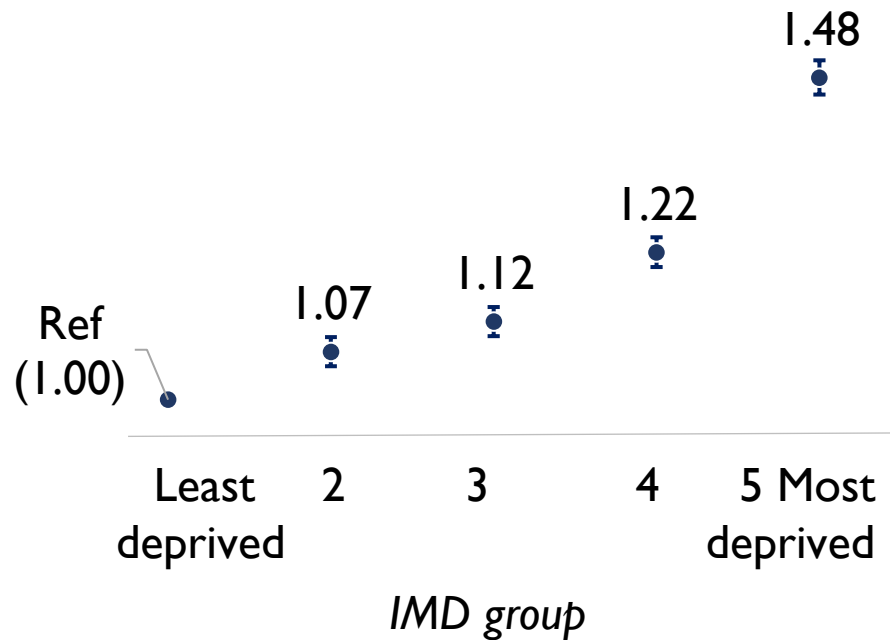


Childhood pneumonia cases up 50% in 10 years, NHS data shows



Poorest areas hardest hit by 'forgotten epidemic' of pneumonia putting a child in hospital every 10 minutes

Fig 3. Rate ratio of bronchiolitis admissions
<1 year: England, 2012-2016



Lewis, De Stavola & Hardelid (*J Epidemiol Comm Health*, 2020)

Slide courtesy of
Kate Lewis



EUROPEAN RESPIRATORY *journal*

FLAGSHIP SCIENTIFIC JOURNAL OF ERS

Risk factors for admission to hospital with laboratory-confirmed influenza in young children: birth cohort study

Pia Hardelid¹, Maximiliane Verfuenden¹, Jim McMenamin² and Ruth Gilbert¹

Risk factor and scenario [#]	Population-attributable fraction
Age group 1: <6 months	
Parity: first child	45.5 (33.5–55.3)
Maternal age: 30–39 years	18.5 (5.5–29.7)
High risk: no	4.5 (1.3–7.7)
Season of birth: April–June	65.8 (49.9–76.6)

RESEARCH ARTICLE

The contribution of child, family and health service factors to respiratory syncytial virus (RSV) hospital admissions in the first 3 years of life: birth cohort study in Scotland, 2009 to 2015

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Population attributable fraction (as a percentage of admissions prevented) by risk factor and scenario, birth cohort study, Scotland, 2009–2015

Risk factor and scenario	Population attributable fraction (95% CI)
Gestational age = post term	18.9 (13.8–23.7)
Season of birth = April–June	25.6 (21.0–30.0)
Chronic condition = No	6.5 (5.6–7.5)
Parity = 0	34.0 (31.0–36.9)
Maternal smoking during pregnancy = no	5.9 (4.2–7.7)
Maternal age = ≥ 40 years	31.4 (18.7–42.1)
Birth weight at gestational age = right for gestational age	1.6 (0.1–3.0)
Delayed infant vaccination = no ^a	2.5 (0.5–4.5)

Air Pollution, housing and respiratory tract Infections in Children: National birth Cohort study (PICNIC)



BMJ Open Air Pollution, housing and respiratory tract Infections in Children: National birth Cohort study (PICNIC): study protocol

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ABSTRACT

Introduction Respiratory tract infections (RTIs) are the most common reason for hospital admission among children <5 years in the UK. The relative contribution of ambient air pollution exposure and adverse housing conditions to RTI admissions in young children is unclear and has not been assessed in a UK context.

Methods and analysis The aim of the PICNIC study (Air Pollution, housing and respiratory tract Infections in Children: National birth Cohort Study) is to quantify the extent to which in-utero, infant and childhood exposures to ambient air pollution and adverse housing conditions are associated with risk of RTI admissions in children <5 years old. We will use national administrative data birth cohorts, including data from all children born in England in 2005–2014 and in Scotland in 1997–2020, created via linkage between civil registration, maternity and hospital admission data sets. We will further enhance these cohorts via linkage to census data on housing conditions and socioeconomic position and small area-level data on ambient air pollution and building characteristics. We will use time-to-event analyses to examine the association between air pollution, housing characteristics and the risk of RTI admissions in children, calculate population attributable fractions for ambient air pollution and housing characteristics, and use causal mediation analyses to explore the mechanisms through which housing and air pollution influence the risk of infant RTI admission.

Ethics, expected impact and dissemination To date, we have obtained approval from six ethics and information governance committees in England and two in Scotland. Our results will inform parents, national and local governments, the National Health Service and voluntary sector organisations of the relative contribution of adverse housing conditions and air pollution to RTI admissions in young children. We will publish our results in open-access journals and present our results to the public via parent groups and social media and on the PICNIC website. Code and metadata will be published on GitHub.

INTRODUCTION

Upper and lower respiratory tract infections (RTIs), including croup, bronchiolitis and pneumonia, are the most common reason for

Strengths and limitations of this study

- The PICNIC study will use national, administrative data birth cohorts from England and Scotland, linked to small area-level data on environmental exposures and census data on socioeconomic position, to examine the association between ambient air pollution and adverse housing exposures and respiratory tract infection admissions in children less than 5 years old.
- The national birth cohorts will include all children born in the two countries during specified time periods, thus minimising selection bias and allowing analyses of even relatively uncommon environmental exposures and infection outcomes.
- Data on air pollution and building characteristics will be linked to maternal and child postcode histories during pregnancy and early life, thus creating longitudinal environmental exposure data at a national scale.
- PICNIC will include an examination of the population-based risk factors for SARS-CoV-2 infection in Scottish children.
- A key weakness is that only infections requiring hospital admission will be the primary outcome, thus respiratory infections not requiring healthcare contact will not be considered.

hospital admission in children aged less than 5 years old in the UK, with 170 000 admissions in England alone in 2017.¹ RTI admission rates peak in winter months, contributing to the ‘winter crisis’ in the National Health Service (NHS).² Severe RTI symptoms in infancy and early childhood have been linked to adverse respiratory health outcomes in later childhood, including asthma.³ We have previously shown that 79% of annual admissions for RTIs in infants <1 year old can be attributed to respiratory syncytial virus (RSV) and other viral infections for which no vaccines are currently available.⁴ Thus, alternative



Fury as long-awaited UK environment bill is delayed for third time

Green campaigners attack further delay 'to most important piece of legislation for decades'



UK broke law by 'systematically and persistently' breaching air pollution limits, top court rules



Pregnant mum 'living out of bags' in cramped house plagued by mould and mice

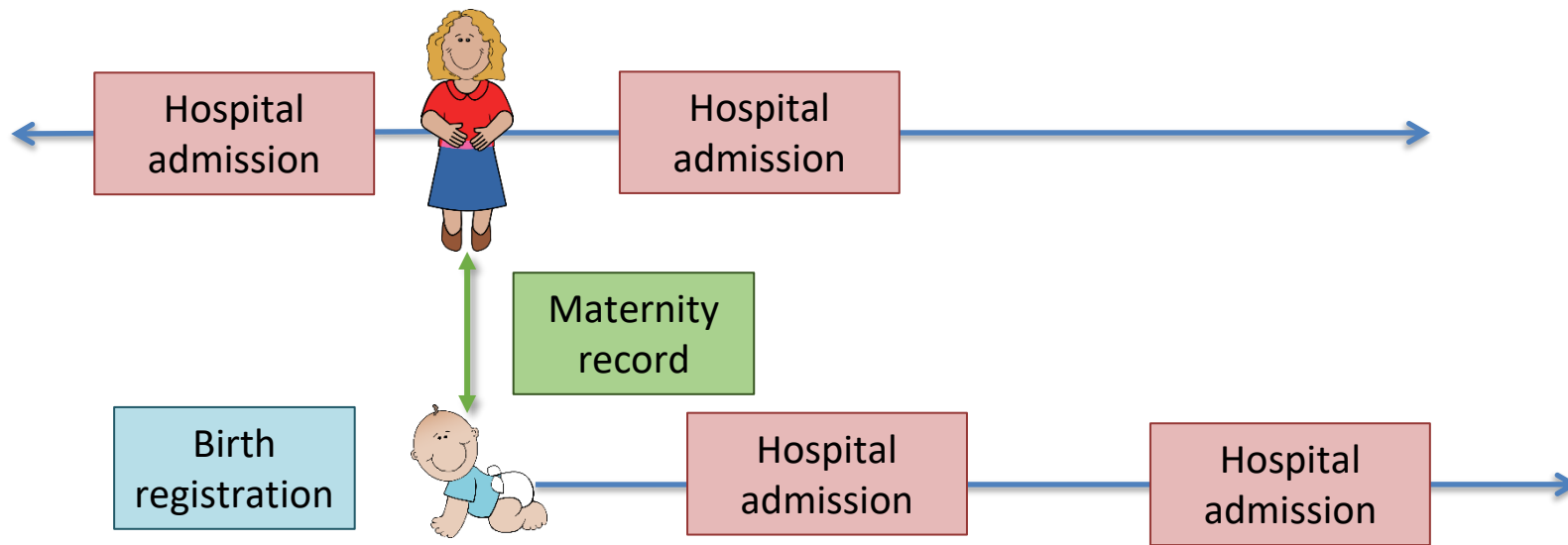
Cramped housing has helped fuel spread of Covid in England - study

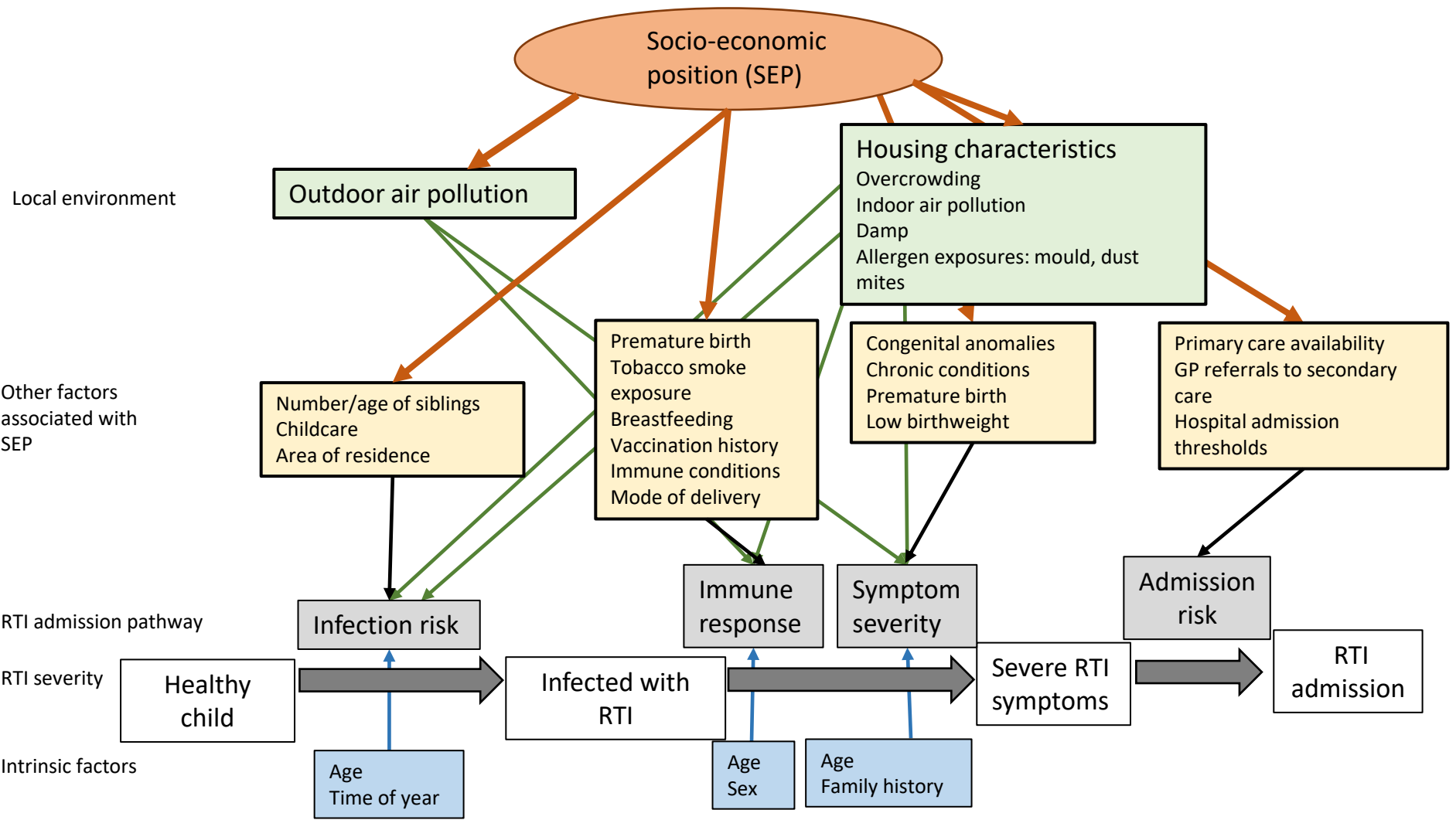


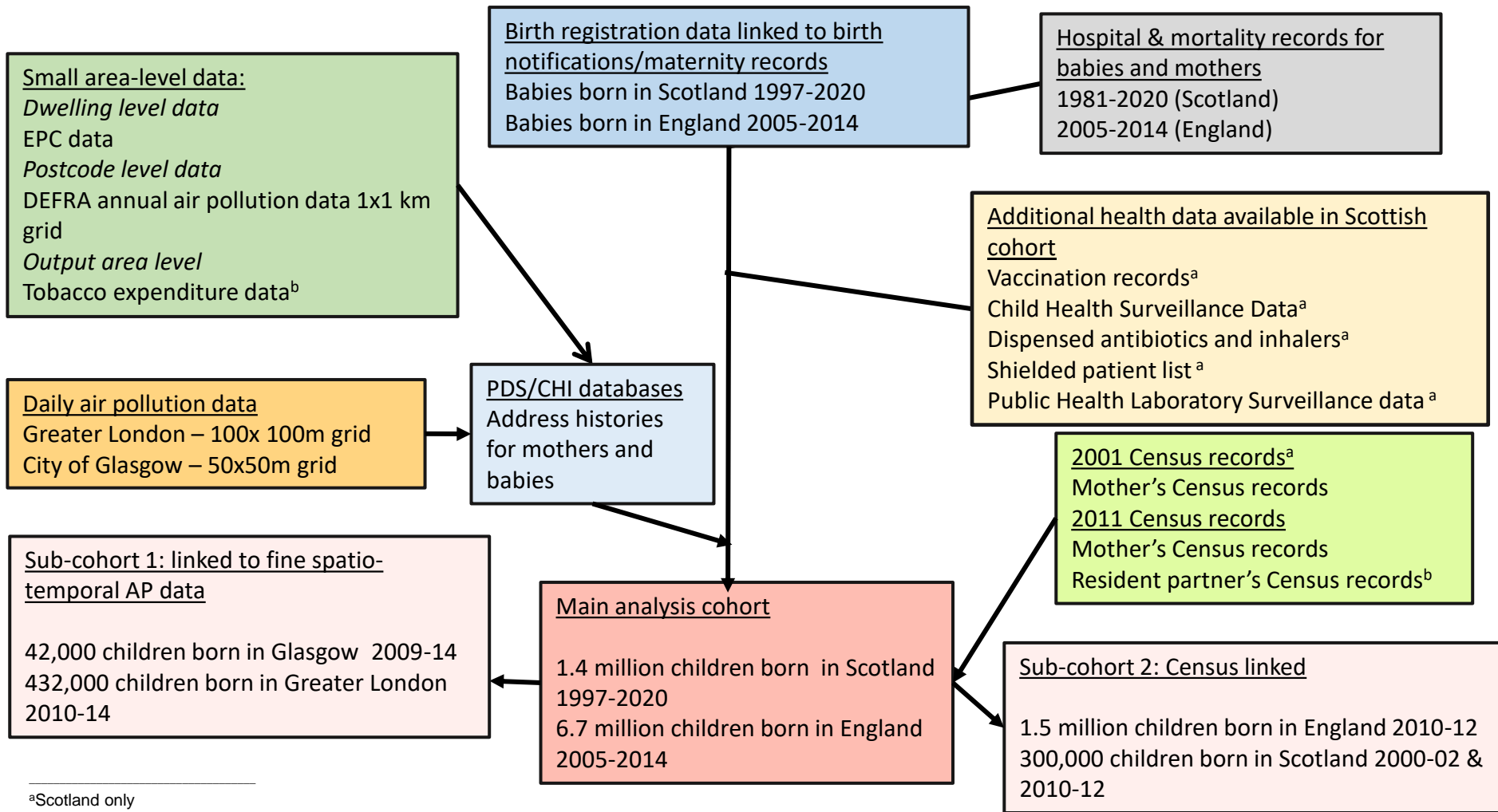
'The worst I've ever seen': The appalling and 'unliveable' council housing conditions some have endured during lockdown

PICNIC Aim:

‘To determine the contribution of exposure to air pollution and adverse housing conditions during pregnancy, infancy and early childhood to hospital admissions for respiratory tract infections (RTIs) in children less than 5 years old in England and Scotland’







^aScotland only

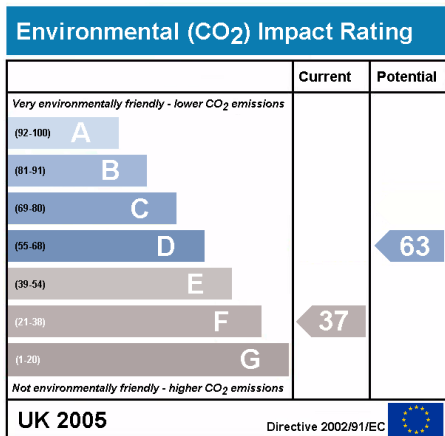
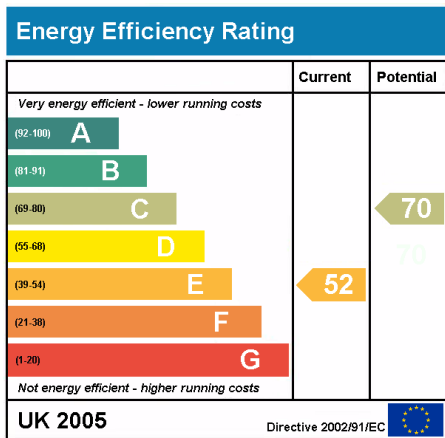
^bEngland only

	DEFRA	CERC
Air pollutants	PM10, PM2.5, NO2, NOx, CO, SO2, O3, benzene	PM10, PM2.5, NO2, O3
Spatial resolution	1x1km grid*	100x100m grid*
Temporal resolution	Annual	Daily
Coverage (years)	2001-2018	2010-2014
Coverage (geography)	England & Scotland	Greater London
Geographical identifier in dataset	x & y co-ordinates of each grid cell	x & y co-ordinates of each grid cell
Linking variable (to mother-birth cohorts)	Postcode*	Postcode*
*All based on the Ordnance Survey (OS) National Grid reference system (also known as British National Grid)		

Ambient air pollution data sources: Cambridge Environmental Research Consultants (CERC): ADMS-Urban



	DEFRA	CERC
Air pollutants	PM10, PM2.5, NO2, NOx, CO, SO2, O3, benzene	PM10, PM2.5, NO2, O3
Spatial resolution	1x1km grid*	100x100m grid* / 50x50m grid
Temporal resolution	Annual	Daily
Coverage (years)	2001-2018	2010-2014 / 2009-2014
Coverage (geography)	England & Scotland	Greater London / Glasgow
Geographical identifier in dataset	x & y co-ordinates of each grid cell	x & y co-ordinates of each grid cell
Linking variable (to mother-birth cohorts)	Postcode*	Postcode*
*All based on the Ordnance Survey (OS) National Grid reference system (also known as British National Grid)		



- Data collected by surveyor when a property is let, sold or constructed in the UK (valid for 10 years)
- EPC data for PICNIC includes:
 - directly observed variables e.g. property type, number of rooms, number of heated rooms, total floor area, mains gas connection..
 - Inferred variables: infiltration rate
 - Modelled variable: indoor/outdoor ratio for PM_{2.5} and NO₂
- EPC data linked at postcode level in England, UPRN (dwelling level) in Scotland.



WARNING: A CERTIFICATE IS NOT EVIDENCE OF IDENTITY.

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FREEPOST 2011 Census, Processing Centre, UK

Help is available in large print and Braille

Indices of Deprivation

Multiple Deprivation 2020

H1

Examples of public, parent and charity engagement

- Parents in Bradford consulted on the prevention of respiratory infections in children
- Parents' & Carers' Advisory Group (PCAG) at Great Ormond Street Hospital/UCL Institute of Child Health
- Shelter Birmingham (Visit to coffee morning)
- National Children's Bureau Parents Research Advisory group
- Conversations with British Lung Foundation & Clean Air Parents' Network / Mums for Lungs



Credit Alexander Drummer (unsplash)

England

1. NHS London Queen's Square Ethics Committee (reference: 18/LO/1514)
2. Confidentiality Advisory group (reference: 18/CAG/0159)
3. Administrative Data Research Network (reference PROJ-194 – note committee is now defunct)
4. ONS Research Accreditation Panel (reference 2019/020)
5. National Statistician's Data Ethics Advisory Committee (reference: 18(07))
6. Independent Group Advising on Release of Data (NHS Digital, reference DARS-NIC-234656)

Scotland

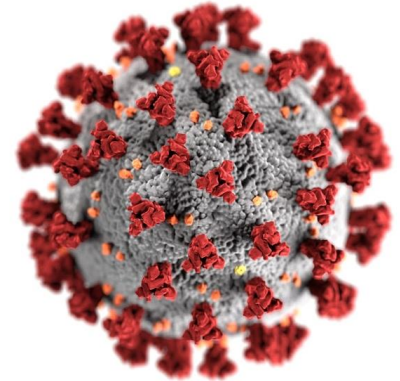
1. Public Benefit and Privacy Committee- Health and Social Care (reference 1819-0049)
2. Public Benefit and Privacy Committee- Statistics (reference 1819-0049)
3. University of Edinburgh School of Geosciences Ethics Committee (reference 2020-401)

Objectives

- 1) determine the population-based risks of:
 - a) SARS-CoV-2 test
 - b) SARS-CoV-2 infection
 - c) COVID19-related hospital admission
 - d) Multisystem Inflammatory Syndrome in Children
 - e) COVID-related intensive care unit stay

In children and young people in Scotland

- 2) establish how these risks vary according to clinical, family and socio-demographic risk factors

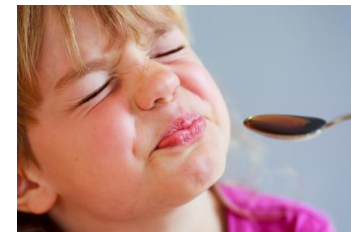


- All approvals are now in place
- Air pollution data downloaded and mapped to postcodes
- EPC data mapped to postcodes for England & uploaded to ONS SRS
- Comparison of air pollution exposures during pregnancy according to different spatio-temporal resolution work in progress
- Cleaning and validation of English & Scottish birth cohorts
- Epidemiology of SARS-CoV-2 in children and young people in Scotland study in write up phase



Factors associated with amoxicillin prescribing in primary care among young children in Bradford, England: cohort study

- One third of children <5 years old are prescribed at least one antibiotic annually
- 75% of antibiotics prescribed to children in primary care in the UK are for respiratory infections (pneumonia, tonsillitis, sinusitis)
- What child, family and environmental factors are associated amoxicillin prescribing in young children?



- **Born in Bradford Allergy and Infection (ALL-IN) study**

- **Data from ~2500 children from:**

- Maternity records
- Baseline questionnaire during pregnancy
- Congenital anomaly register
- Parental questionnaires at age 12 and 24 months
- Electronic primary care records
- DEFRA air pollution modelled PM_{2.5} annual averages at 1x1km grid linked to child LSOA at birth/1 year of age



<https://borninbradford.nhs.uk/>

Exposure variables

Child: Sex, annual quarter of birth, prematurity, mode of delivery, congenital anomalies, prematurity, ethnic group

Maternal/family: socio-economic status, maternal smoking during pregnancy, formal childcare, breastfeeding

Environment: overcrowding, mould/damp, gas cooking, quartile of PM2.5 exposure (in relation to Bradford annual average)

Outcome variables

- One or more amoxicillin prescription (by year of age)
- One or more consultations for lower respiratory infections (by year of age)
- One or more consultations for upper respiratory infections (by year of age)

Results – amoxicillin (odds ratios & 95% CI)

	Age 1	Age 2
	Mutually adjusted: n=2,450	Mutually adjusted: n=2,476
Mother's ethnicity		
White British	1	1
Pakistani, UK born	1.44 (1.06-1.94)	1.46 (1.10-1.94)
Pakistani, not UK born	1.42 (1.07-1.90)	1.56 (1.19-2.04)
Other	0.70 (0.52-0.96)	0.98 (0.74-1.31)
Socio-economic position		
Least deprived and most educated	1	1
Employed not materially deprived	0.79 (0.59-1.06)	1.13 (0.85-1.50)
Employed no access to money	0.92 (0.69-1.22)	1.11 (0.85-1.46)
Benefits but coping	0.92 (0.70-1.21)	1.26 (0.97-1.64)
Most deprived	1.36 (1.00-1.86)	1.26 (0.93-1.70)

$n_{age\ 1} = 2450$

$n_{age\ 2} = 2476$

Overall rates of amoxicillin prescribing:

Age 1: 710/1000 child years

Age 2: 780/1000 child years

Results – amoxicillin: (odds ratios & 95% CI) environment variables

	Age 1	Age 2
Quartile of PM2.5 in relation to Bradford level		
1 st /2nd quartile of PM2.5		1
3rd quartile of PM2.5		0.94 (0.76-1.16)
4th quartile of PM2.5		0.97 (0.75-1.26)
Mould or visible damp spots		
No mould or damp	1	
Mould or damp	0.98 (0.80-1.21)	
Number of people in household		
2-5 people	1	
6 or more people	1.41 (1.14-1.74)	

Results – lower respiratory infections (odds ratios & 95% CIs)



	Age 1	Age 2
Mother's ethnicity		
White British	1	1
Pakistani, UK born	1.21 (0.88-1.65)	1.40 (1.01-1.95)
Pakistani, not UK born	1.43 (1.06-1.91)	1.61 (1.17-2.21)
Other	0.76 (0.54-1.06)	1.15 (0.83-1.61)
Socio-economic position		
Least deprived and most educated	1	1
Employed not materially deprived	1.27 (0.91-1.76)	1.41 (1.02-1.95)
Employed no access to money	1.55 (1.13-2.12)	1.01 (0.73-1.39)
Benefits but coping	1.42 (1.06-1.91)	1.19 (0.88-1.60)
Most deprived	1.84 (1.32-2.58)	1.47 (1.05-2.08)

Overall rates of LRI consultations:

Age 1: 458/1000 child years

Age 2: 409/1000 child years

Results – lower respiratory infections

Environment variables (odds ratios & 95% CIs)

	Age 1	Age 2
Quartile of PM2.5 in relation to Bradford level		
1st-2nd quartile of PM2.5		1
3rd quartile of PM2.5		1.06 (0.83-1.35)
4th quartile of PM2.5		1.09 (0.81-1.46)
Mould or visible damp spots		
No mould or damp	1	
Mould or damp	0.84 (0.67-1.06)	

Summary – factors associated with amoxicillin prescribing in BiB ALL-IN



- 43% and 47% of children were prescribed amoxicillin in their 1st / 2nd year of life respectively
- Ethnic group was consistently associated with amoxicillin prescribing and lower respiratory infection consultations; socio-economic status associated with lower respiratory infection consultations and amoxicillin prescriptions during first year
- Overcrowding was only environmental variable associated with amoxicillin prescribing
- Study limited to one specific area of England with particular ethnic group composition; need national studies with more variation in environmental exposures across different families in order to detect these effects

- To examine questions about the impact of ambient air pollution and child health, we need national administrative data linked to environmental data: they are inclusive, large and geographically varied
- These datasets are extremely difficult to access, with applications to multiple data providers take years
- This is despite low risk of disclosure and evidence of public support



Photo credit: Kiana Bosman, unsplash

PICNIC project partners

UCL GOS ICH: Pia Hardelid, Graziella Favarato, Linda Wijlaars,
Bianca De Stavola



London School of Hygiene and Tropical Medicine: Ai Milojevic



University of Edinburgh: Steve Cunningham, Chris Dibben, Tom Clemens



Tampere University: Jonathon Taylor



City, University of London: Alison Macfarlane



Charity collaborators: Shelter, British Lung Foundation/Clean Air Parents Network

Public Health Scotland: Rachael Wood, Lynda Fenton, Jim McMenamin



Funding: Medical Research Council

ALL-IN Amoxicillin study: team



UCL GOS ICH: Faith Miller, Graziella Favarato

Bradford Institute for Health Research: Dan Mason, John Wright

London School of Hygiene and Tropical Medicine: Lucy Pembrey

UCL Institute of Health Informatics: Laura Shallcross

University of Edinburgh: Imad Adamestam

Funding: Medical Research Council (via Studentship to FM)





<https://www.ucl.ac.uk/child-health/picnic-study>