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4 **The changing contexts of child health: an assessment of unmet physical, psychological, and**
5 **social needs of children with common chronic childhood illness.**

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25
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27 Biopsychosocial needs, social determinants of health inequality, paediatric chronic conditions,
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We declare no conflicts of interest to disclose.

1 **Authors' contributions**

2 All authors have access to and have verified the underlying data reported in the manuscript. All
3 authors accept responsibility to submit for publication. RL as co-PI and External Evaluation lead
4 conceptualised the work, developed the methodology and led the investigation and analyses, wrote,
5 reviewed, and edited the manuscript. NH carried out the analysis, wrote, reviewed, and edited the
6 manuscript. LC as trial coordinator, oversaw data collection, carried out data analysis, wrote,
7 reviewed, and edited the manuscript. JF as trial statistician carried out data analysis, wrote,
8 reviewed, and edited the manuscript. JN, as trial coordinator oversaw data collection reviewed, and
9 edited the manuscript. RS carried out data collection reviewed, and edited the manuscript. MSB, SC
10 and JFR advised on data collection, reviewed, and edited the manuscript. IW as Principle
11 Investigator, conceptualised the work, acquired funding, developed the methodology and oversaw
12 the investigation and analyses, and edited the manuscript.

13

14 **ABSTRACT**

15 **Background**

16 We assessed the biopsychosocial needs and key health drivers among children living with a common
17 chronic illness, as baseline for a cluster randomised controlled trial of a child health system
18 strengthening intervention.

19 **Methods**

20 Cross-sectional data were analysed from a large population sample of children from South London
21 with asthma, eczema, or constipation, as exemplar tracer conditions of a new integrated care
22 service. Descriptive and regression analyses, accounting for socio-demographic factors, investigated
23 social needs, psychosocial outcomes, and quality of life associated with poor symptom control.

24 **Results**

25 Among 7779 children, 4371 children (56%) had at least 1 uncontrolled physical health condition.
26 Across the three domains of physical health, mental health, and social needs, 77.5% of
27 children (n=4304/5554) aged 4-15 years had at least one unmet need, while 16.3% of children
28 had three unmet needs. Children from the most socio-economically disadvantaged quintile had a
29 20% increased risk of at least one poorly controlled physical condition (RR=1.20, 95% CI:1.11 to 1.31,
30 $p<0.001$) compared with those from the least disadvantaged quintile. There was an 85% increased
31 risk of clinically important mental health needs among children with uncontrolled asthma (RR=1.85,
32 95%CI:1.65 to 2.07, $p<.001$); 57% for active constipation (RR=1.57, 95% CI:1.12 to 2.20, $p<.01$); and
33 39% for uncontrolled eczema (RR=1.39, 95%CI:1.24 to 1.56, $p<.001$). Health-related quality of life
34 was associated with poor symptom control.

35 **Conclusions**

36 There is a large burden of unmet biopsychosocial needs among children with chronic illness,
37 signalling an urgent need for prevention, early intervention, and integrated biopsychosocial care.

38

39

1 **What is already known on this topic**

- 2 • Previous research has shown increased prevalence of asthma, eczema, and constipation in
3 children from lower socioeconomic groups. In addition, our team amongst others has
4 demonstrated the overlap between chronic illness and increased mental health difficulties in
5 children.
6 • No previous work has however shown the full biopsychosocial needs of a large UK child
7 population with primary care diagnosed chronic health needs.

8 **What this study adds**

- 9 • This study explores the active unmet biopsychosocial needs of nearly 8000 urban children
10 from the UK with one of three common chronic GP diagnosed health conditions: asthma,
11 eczema, and constipation.

12 **How this study might affect research, practice or policy**

- 13 • Across the three domains of physical, mental health, and social needs, 77.5% of
14 children diagnosed by their GP with a chronic illness had at least one active unmet need,
15 while 16.3% of children had three unmet needs.
16 • Health needs were socially mediated. This study highlights the importance of
17 integrated care and active follow up of children with known common childhood
18 diagnosis, especially those from lower socio-economic groups, to optimise the
19 physical, mental, and social health of children at a population level.

1 INTRODUCTION

2 Chronic conditions affect at least 1 in 5 children and account for 79% of all disability-adjusted life
3 years lost among children aged 1–14 years across Europe (1-3). The marked decrease in child
4 mortality over the last century, through improvements in public health and paediatric care, has been
5 mirrored by an increase in childhood chronic illness and disability (1). This increase in chronic disease
6 has placed a growing burden on the already strained public health systems (4).

7 Health systems in high-income countries were developed to deliver acute, inpatient, and specialist
8 services. Acute hospital based care, due to its siloed nature, was never set up to provide the holistic
9 care needed to meet the physical, psychological, and social needs of children and families (4).
10 Approximately 5.2 million children in the UK, more than 30% of the <18 year population, live in
11 poverty (5). Previous meta-analysis using data from 1991-2013 showed a 72% increased odds of
12 chronic disabling illness among children living in poverty (6). More recent longitudinal research from
13 the UK, Canada, and Australia has again shown the effect of poverty on chronic illness in childhood
14 (7, 8). The importance of comorbid physical and mental health conditions is increasingly recognised
15 (9). There is, however, limited literature assessing the association of childhood poverty with severity
16 of chronic illness, and the mental health and social needs of children with chronic illness.

17 We aimed to describe the concurrent physical, psychological, and social needs of a large population
18 of nearly 8000 children living in South London, who had selected tracer conditions: asthma,
19 constipation, or eczema. We assessed the association and clustering between social need, physical
20 and mental health, and health-related quality of life. This analysis of unmet need served as a
21 baseline assessment to inform a population-based biopsychosocial approach to paediatric
22 healthcare subsequently evaluated with a cluster randomised controlled trial (10, 11).

23

24 METHODS

25 Study population

26 This cross-sectional study was part of the Child and Young People's Health partnership (CYPHP)
27 programme whose model of care was designed to improve the health of children with general and
28 long-term health conditions (10). Data were collected from 1 April 2018 to 31 December 2020.

29 The study was based in Southwark and Lambeth, two boroughs in South London with high levels of
30 deprivation and ethnic diversity (11). Children with three common and long-term exemplar (tracer)
31 paediatric conditions: asthma, constipation, and eczema, were identified using primary care records.
32 Inclusion criteria are presented in Supplementary Table S1. These tracer conditions were selected as
33 exemplars of long-term conditions where effective self-management should be achieved in a
34 primary care setting to help reduce unnecessary use of and burden on secondary care services. The
35 parents/guardians of children meeting criteria for one of these diagnoses were invited to complete
36 the online health check assessment (HC) to identify their unmet biopsychosocial needs to
37 personalise care and health management. Ethics approval was obtained from Southwest Cornwall &
38 Plymouth Research Ethics Committee on 14 December 2017 (REC reference: 17/SW/0275).

39 Physical health

40 The Asthma Control Test (ACT) was used to identify children with uncontrolled asthma, indicated by
41 an ACT score < 20 and signifying need for clinical care (12). Eczema severity was determined using
42 the Patient-Oriented Eczema Measure (POEM), ranging from "clear to mild" (score ≤ 7) to "moderate
43 to very severe" (score of 8-28); the latter was considered uncontrolled eczema (13). The CYPHP
44 team developed a clinically accepted constipation symptoms checklist based on National Institute
45 for Health and Care Excellence guidelines and the Bristol stool chart (14). Children whose score was
46 ≥ 3 were considered to have active or uncontrolled constipation.

1 **Family's social concerns**

2 A questionnaire was derived from the validated instrument 'We Care' on a range of psychosocial
3 needs considered clinically relevant and common for low-income families, including concerns about
4 housing, food security and paying bills, parental mental health, having a smoker in the household,
5 and parental unemployment (15, 16) (Supplementary background).

6 **Emotional difficulties**

7 Emotional and behavioural difficulties of children aged 4-15 years were assessed using the parent-
8 reported scores of Strengths and Difficulties Questionnaire (SDQ), which is a widely used measure to
9 assess emotional and behavioural outcomes of children (17). We calculated the SDQ total score,
10 (range 0-40), the internalising problem score (sum of emotional and peer problems scales scores),
11 the externalising problem score (sum of conduct problems and hyperactivity scales scores), and the
12 impact supplement score. We followed SDQ guidelines to identify children with "abnormal" (SDQ
13 total score \geq 17) versus "normal or borderline" (SDQ total score $<$ 17) levels of emotional and
14 behavioural difficulties (17).

15 **Health-related quality of life**

16 Children who completed the HC were invited to participate in the CYPHP trial follow up for which
17 additional patient-reported outcomes were collected (11). Health-related quality of life (HRQoL) was
18 assessed using the parent-administered Paediatric Quality of Life Inventory (PedsQL) questionnaire.
19 The PedsQL has been widely used in child health research including children with a chronic illness
20 (18-20). We calculated both raw (sum of items divided by the number of items responded) and T-
21 score (the number of sample standard deviations from the sample mean, calculated separately for
22 each PedsQL age group). A higher PedsQL score indicates a better HRQoL.

23 **Socio-demographic factors**

24 Data on socio-demographic factors including sex, age, ethnicity, and postcode-level residential area
25 socioeconomic status (SES) were collected. SES quintiles were determined using the Indices of
26 Multiple Deprivation (2019 version). Due to small numbers, we combined the highest two quintile
27 categories (i.e., Q4 and Q5) to a single category (i.e., the least disadvantaged).

28 **Statistical analysis**

29 We described symptom status by socio-demographic factors. Modified Poisson regression analyses
30 were used to assess the risk of having uncontrolled tracer condition symptoms associated with the
31 socio-demographic factors. Linear regression analysis was used to examine the mean difference in
32 emotional and behavioural difficulties (SDQ score) and HRQoL (PedsQL T-score) between children
33 with and without a controlled tracer condition. Robust standard errors were used to calculate 95%
34 confidence intervals (95% CIs). Analyses controlled for socio-demographic factors (sex, age, ethnicity,
35 and residential area SES). We conducted a sensitivity analysis by further controlling for other two
36 tracer conditions to explore how comorbidity of the three tracer conditions impacted the association
37 related to a single tracer condition (Supplementary Table S2). The proportions of missing data were
38 generally $<$ 5% for variables examined except for PedsQL scores (10-16%). Thus, multiple imputations
39 for missing data were used in the regression analysis of PedsQL scores using the Fully Conditional
40 Method (FCS). We examined outliers by examining studentised residuals. We tested multicollinearity
41 of independent variables in the regression analysis by examining variance inflation factors. We also
42 tested normality of residuals for the linear regression analyses, using quantile-quantile plots. All the
43 analyses were conducted using SAS (Enterprise Guide) statistical software version 7.1 (SAS Institute
44 Inc., Cary, NC, USA).

45

1 RESULTS

2 A total 7779 individual children had a complete HC assessment (demographic characteristics in
3 Supplementary Table S3). There were slightly more children from white ethnic groups and fewer
4 children from the most disadvantaged area (i.e., IMD quintile 1) in the study population but
5 otherwise the study population was comparable with the total invited population (n=15945;
6 Supplementary Table S4).

7 Among 7779 participants, 5923 (76.1%) had one tracer condition; 1592 (20.5%) two conditions and
8 113 (1.5%) three conditions; 151 (1.9%) had a missing value on the status of at least one tracer
9 condition. There were 9609 person-conditions (considering comorbidity across the three tracer
10 conditions): 3616 children with asthma, 1502 children with constipation and 4491 children with
11 eczema. A total of 1412 (39.1%) were defined as having uncontrolled symptoms (by ACT score);
12 88.5% (n=1329) had active constipation symptoms; and 2278 (50.7%) had moderate, severe, or very
13 severe (i.e., uncontrolled) symptoms of eczema. In summary, of the 7779 children with at least 1
14 tracer condition, 4371 (56.2%) had at least 1 uncontrolled condition (Supplementary Table S3).

15 Compared to White children, there was an 8% increased risk of having at least one poorly controlled
16 tracer condition among Black (risk ratio or RR=1.08, 95% confidence interval or 95%CI:1.03 to 1.13,
17 $p<.001$) and Asian (RR=1.08, 95%CI:1.01 to 1.17, $p=.03$) children, after controlling for age, gender,
18 and socioeconomic status (Table 1). Compared to children from the least disadvantaged area,
19 children from the most socio-economically disadvantaged quintile had a 20% increased risk of having
20 at least one poorly controlled condition (RR=1.20, 95% CI:1.11 to 1.31, $p<0.001$). The risk ratios were
21 highest for children with asthma.

22 In general, children with at least one uncontrolled tracer condition had significantly more parent
23 reported social concerns compared with children with controlled symptoms (Figure 1 and
24 Supplementary Table S5). Of the three conditions, asthma control had the highest cross-sectional
25 overlap with social concerns: children with poorly controlled asthma, compared with those who had
26 controlled symptoms, had the increased risk ranging from 16% for parent smoking (RR=1.16,
27 95%CI:0.98 to 1.37, $p=0.09$) to over two-fold for having food concerns (RR=2.18, 95%CI:1.62 to 2.93,
28 $p<.001$) (Table 2). Results for children with eczema mirrored those for children with asthma (Table
29 2).

30 Among 5554 children aged 4-15 years, there was an 85% (95%CI:1.65 to 2.07, $p<.001$), 57% (95%
31 CI:1.12 to 2.20, $p<.01$), and 39% (95%CI:1.24 to 1.56, $p<.001$) increased risk of SDQ clinically
32 important mental health difficulties, among children with uncontrolled versus controlled asthma,
33 constipation, and eczema, respectively (Table 3). These increased risks were mirrored for the SDQ
34 impact supplement scale (Table 3) and across internalising and externalising behaviours
35 (Supplementary Table S6). Of the 5554 children aged 4-15 years, 77.5% (n=4304) had at least one
36 uncontrolled tracer condition, clinically important mental health difficulties, or family social
37 concerns, with 46.6% (n= 2005) having 1, 37.1% (n=1597) having 2, and 16.3% (n=702)
38 having three unmet needs.

39 In total, 1731 parents consented to further assessment including health-related quality of life
40 (HRQoL), measured using the PedsQL score. There was similar sociodemographic distribution
41 between children with a HC assessment and children consenting to the HRQoL assessment
42 (Supplementary Table S4). We report the results based on the complete case analysis in the main
43 text and the similar results from the multiple imputation analysis in Supplementary Table S7. The
44 PedsQL score was decreased by 11.75-point (95% CI:-14.72 to -8.77, $p<.001$), 4.75-point (95% CI:-
45 6.94 to -2.55, $p<.001$), and 5.54-point (95% CI:-11.99 to 0.90, $p=.09$) among children with poorly
46 controlled asthma, eczema, and constipation compared to those with controlled symptoms,

1 respectively. These magnitudes of decrease equate to adjusted mean difference for PedsQL T-score
2 of -0.66 (95% CI:-0.83 to -0.5, $p<.001$), -0.30 (95%CI:-0.43 to -0.17, $p<.001$), and -0.31 (95%CI:-0.71 to
3 0.08, $p=0.12$) (Table 4). The mean PedsQL score was significantly lower in both the PedsQL physical
4 and psychosocial scores for children with uncontrolled asthma and eczema than those with
5 controlled symptoms.

6

7 **DISCUSSION**

8 This study provides a detailed analysis of psychological and social factors of health and unmet needs
9 among children with common chronic childhood illness. Even though all the children surveyed were
10 known to their GP and were diagnosed with either asthma, eczema, or constipation on GP records,
11 over half of these children had poorly controlled symptoms. As such, treatment has been sub-
12 optimal as the three conditions selected have clear evidence-based guidelines for optimal
13 monitoring and management which result in clear benefit and symptom reduction e.g., NICE
14 guidelines for asthma control (21). If half of the children with these diagnoses are in the community
15 with active symptoms, either the initial treatment was ineffective or monitoring and follow-up has
16 been inadequate. As per guidelines, asthma control should be checked at every review (at least
17 annually) (21). Our results suggest this frequent review is either not happening or not being
18 implemented effectively. The UK National Review of Asthma Deaths found that 46% of those who
19 died from asthma had received an inadequate standard of asthma care, with personal action plans
20 provided to only 23% of patients (22).

21 Children with poorly controlled physical health symptoms were significantly more likely to have
22 food, housing, financial, employment and parental mental health concerns, and were 39% to 85%
23 more likely to have clinically important mental health difficulties. We know that children from the
24 poorest families are more likely to have chronic illnesses and more than twice as likely to die before
25 they reach adulthood, compared with children from wealthier families (5). In addition, children who
26 have greater health needs are also less likely to access healthcare; known as the inverse care law
27 (23).

28 Countries with the highest asthma mortality rates for young people aged 10-24 years among 19 high
29 income countries (2016 data) were the US, New Zealand, Australia, and the UK (24). This additional
30 mortality may reflect the social determinants of health and health inequalities within these
31 countries. Fleegler et al. 2006 found that 54% of urban US families with children aged 0-6 years had
32 two or more unmet social needs and 49% needed referral to child health services (25). In total, 56%
33 of families had significant housing concerns and 28% were food insecure (25). Using a framework
34 based on Maslow's Hierarchy of Needs, Federico et al. describe a clinical screening tool for social
35 determinants of health in the context of childhood asthma (26). In essence, clinicians cannot expect
36 families to optimise a child's chronic health management unless they are safe and fed, i.e. their
37 physiological and safety needs are met.

38 The strengths of this study include detailed analyses of the biopsychosocial needs of a sample of
39 nearly 8000 urban UK children with GP-diagnosed and recorded chronic illness. Limitations include
40 the sample being based in one urban area, albeit highly diverse; and potential selection and recall
41 bias of participants. Children with poorly controlled symptoms could be more likely to
42 respond to the health check, and families may be more likely to report psychological or social
43 needs. However, this is unlikely as our findings replicate and support international literature in this
44 area (25, 26). Our sample was cross-sectional and as such we cannot prove causality. Further, our
45 data do not include information on health conditions other than the tracer conditions. However, we
46 were able to control for comorbidity between the three tracer conditions and this did not
47 significantly influence our results. The screener for psychosocial concerns used in this study, though

1 not validated in this sample, was derived from the validated We Care instrument that captures
2 common psychosocial needs of low-income families (15, 16).

3 Social determinants have been long recognised as a major cause for health inequity and child health
4 morbidity globally (27, 28). Our analysis highlights the need to address the social factors of health
5 through holistic and integrated interventions involving a range of health and care community
6 stakeholders (e.g., primary care practitioners, community-based services, social welfare). This
7 holistic view of child health needs can create a “safety net” within a value-based care framework
8 (29). In the United States, Australia, and the UK, community-based integrated care has been shown
9 to improve the quality of care, health-related quality of life and in some studies significantly reduce
10 hospital referrals (10, 30-32). Further high-quality experimental health services research is urgently
11 needed to assess integrated care solutions to provide care for unmet biopsychosocial needs and
12 improve health outcomes for children (33).

13

14 **CONCLUSION**

15 This study highlights the urgent and unmet biopsychosocial needs of children. The overlap between
16 the physical, psychological, and social needs of children highlights the need for an integrated health
17 and social welfare systems response to meet needs, reduce health inequalities, and improve child
18 health outcomes.

19

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- 4

1 **Table 1** Risk ratios (RRs) of having an uncontrolled or a severe tracer condition by socio-demographic factors (n=7779)

Socio-demographics	Having an uncontrolled/severe tracer condition							
	Any tracer condition (Uncontrolled vs. controlled)		Asthma (Uncontrolled vs. controlled)		Eczema (Moderate to very severe vs. clear to mild)		Constipation (Actively constipated vs. not constipated)	
	Unadjusted RR (95%CI)	Adjusted RR (95%CI)	Unadjusted RR (95%CI) ¹	Adjusted RR (95%CI) ²	Unadjusted RR (95%CI)	Adjusted RR (95%CI)	Unadjusted RR (95%CI)	Adjusted RR (95%CI)
Sex								
Male (reference)	1	1	1	1	1	1	1	1
Female	1.1 (1.06, 1.14) ***	1.08 (1.04, 1.12) ***	1.11 (1.02, 1.2) *	1.11 (1.03, 1.21) **	1.07 (1.01, 1.14) *	1.08 (1.02, 1.15) *	1 (0.96, 1.03)	1 (0.97, 1.04)
Age group (year)								
0	1.22 (1.11, 1.33) ***	1.2 (1.09, 1.31) ***	1.19 (0.83, 1.7)	1.18 (0.83, 1.68)	1.17 (1.04, 1.33) *	1.2 (1.06, 1.36) **	0.81 (0.71, 0.92) **	0.82 (0.72, 0.93) **
1	1.16 (1.06, 1.28) **	1.16 (1.06, 1.27) ***	1.35 (0.85, 2.17)	1.36 (0.82, 2.25)	1.07 (0.94, 1.21)	1.11 (0.97, 1.26)	0.92 (0.83, 1.03)	0.94 (0.84, 1.05)
2-4	1.29 (1.21, 1.38) ***	1.26 (1.19, 1.34) ***	1.33 (1.16, 1.51) ***	1.4 (1.23, 1.6) ***	1.06 (0.96, 1.17)	1.08 (0.97, 1.19)	1.03 (0.96, 1.1)	1.04 (0.97, 1.12)
5-7	1.15 (1.07, 1.24) ***	1.15 (1.07, 1.23) ***	1.07 (0.94, 1.21)	1.12 (0.99, 1.27)	1.07 (0.96, 1.19)	1.08 (0.97, 1.2)	0.99 (0.92, 1.07)	1 (0.93, 1.08)
8-12	1.08 (1.01, 1.16) *	1.08 (1.01, 1.15) *	1.04 (0.94, 1.16)	1.06 (0.95, 1.18)	0.99 (0.89, 1.09)	0.99 (0.89, 1.1)	0.99 (0.92, 1.07)	1 (0.93, 1.08)
13-15 (reference)	1	1	1	1	1	1	1	1
Ethnicity								
White (reference)	1	1	1	1	1	1	1	1
Asian	1.11 (1.03, 1.2) **	1.08 (1.01, 1.17) *	1.24 (1.04, 1.48) *	1.19 (1, 1.42)	1.17 (1.04, 1.3) **	1.14 (1.02, 1.27) *	0.93 (0.86, 1.02)	0.94 (0.86, 1.03)
Black	1.13 (1.08, 1.18) ***	1.08 (1.03, 1.13) ***	1.41 (1.27, 1.55) ***	1.33 (1.2, 1.47) ***	1.06 (0.99, 1.14)	1.04 (0.96, 1.12)	1.05 (1.005, 1.09) *	1.05 (1.01, 1.1) *
Mixed	1.02 (0.96, 1.09)	1 (0.95, 1.06)	1.13 (1, 1.28)	1.08 (0.95, 1.22)	0.98 (0.89, 1.08)	0.97 (0.88, 1.06)	1.01 (0.96, 1.07)	1.01 (0.96, 1.07)
Other	1.09 (1.002, 1.19) *	1.07 (0.99, 1.16)	1.03 (0.83, 1.28)	0.98 (0.79, 1.22)	1.22 (1.09, 1.36) ***	1.21 (1.08, 1.35) ***	1.01 (0.91, 1.11)	1 (0.91, 1.11)
IMD quintiles 2019								
Q1 – Most disadvantaged	1.29 (1.18, 1.41) ***	1.2 (1.11, 1.3) ***	1.75 (1.43, 2.14) ***	1.55 (1.26, 1.91) ***	1.23 (1.08, 1.4) **	1.22 (1.07, 1.38) **	1.07 (0.99, 1.16) **	1.06 (0.97, 1.15) **

Socio-demographics	Having an uncontrolled/severe tracer condition							
	Any tracer condition (Uncontrolled vs. controlled)		Asthma (Uncontrolled vs. controlled)		Eczema (Moderate to very severe vs. clear to mild)		Constipation (Actively constipated vs. not constipated)	
	Unadjusted RR (95%CI)	Adjusted RR (95%CI)	Unadjusted RR (95%CI) ¹	Adjusted RR (95%CI) ²	Unadjusted RR (95%CI)	Adjusted RR (95%CI)	Unadjusted RR (95%CI)	Adjusted RR (95%CI)
	1.41 ^{***}	1.31 ^{***}	2.14 ^{***}	1.9 ^{***}	**	1.4 ^{**}	1.16	1.14
Q2	1.24 (1.14, 1.35) ^{***}	1.17 (1.08, 1.27) ^{***}	1.6 (1.31, 1.94) ^{***}	1.45 (1.19, 1.76) ^{***}	1.21 (1.06, 1.37) ^{**}	1.2 (1.06, 1.37) ^{**}	1.03 (0.96, 1.12)	1.02 (0.95, 1.11)
Q3	1.12 (1.02, 1.23) [*]	1.07 (0.99, 1.17)	1.31 (1.06, 1.62) [*]	1.22 (0.99, 1.51)	1.06 (0.92, 1.22)	1.06 (0.92, 1.22)	1.03 (0.95, 1.12)	1.04 (0.95, 1.13)
Q4 and Q5 - Least disadvantaged (reference)	1	1	1	1	1	1	1	1

1 ¹ Unadjusted risk ratios were derived from the univariable modified Poisson regression analyses, with tracer conditions as outcome and socio-demographic factors as
2 independent variables. ² Adjusted risk ratios were derived from the multivariable modified Poisson regression analyses, accounting for socio-demographic factors including
3 children's sex, age groups, ethnicity, and IMD score quintiles. * $p < .05$, ** $p < .01$, *** $p < .001$

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15 **Table 2** Risk ratios (RRs) of exposure to a social concern by tracer condition status (n=7779)

Tracer condition as exposure	Exposure to family social concerns								
	Housing concern			Food concern			Struggle to pay bills		
	n (%) ¹	Unadjusted RR (95%CI) ²	Adjusted RR (95%CI) ³	n (%)	Unadjusted RR (95%CI)	Adjusted RR (95%CI)	n (%)	Unadjusted RR (95%CI)	Adjusted RR (95%CI)
Any tracer condition⁴									
All controlled (reference)	694 (21.89)	1	1	132 (4.16)	1	1	511 (16.11)	1	1
Any uncontrolled	1454 (33.26)	1.55 (1.43, 1.67) ^{***}	1.43 (1.33, 1.54) ^{***}	303 (6.93)	1.71 (1.4, 2.08) ^{***}	1.51 (1.23, 1.85) ^{***}	1049 (24)	1.55 (1.41, 1.7) ^{***}	1.45 (1.32, 1.6) ^{***}
Missing status	90 (37.97)			16 (6.75)			51 (21.52)		
Asthma control									
Controlled (reference)	469 (21.85)	1	1	77 (3.59)	1	1	355 (16.54)	1	1
Uncontrolled	598 (42.35)	1.99 (1.8, 2.19) ^{***}	1.74 (1.57, 1.92) ^{***}	118 (8.36)	2.41 (1.82, 3.18) ^{***}	2.18 (1.62, 2.93) ^{***}	412 (29.18)	1.87 (1.65, 2.11) ^{***}	1.69 (1.49, 1.92) ^{***}
Missing status	19 (32.76)			4 (6.9)			13 (22.41)		
Eczema severity									
Clear to mild (reference)	582 (26.8)	1	1	122 (5.62)	1	1	413 (19.01)	1	1
Moderate to very severe	767 (33.67)	1.28 (1.17, 1.39) ^{***}	1.22 (1.12, 1.33) ^{***}	174 (7.64)	1.4 (1.12, 1.75) ^{**}	1.31 (1.04, 1.65) [*]	569 (24.98)	1.35 (1.21, 1.51) ^{***}	1.31 (1.18, 1.46) ^{***}
Missing status	19 (46.34)			2 (4.88)			11 (26.83)		
Constipation status									
Not constipated (reference)	45 (26.01)	1	1	15 (8.67)	1	1	27 (15.61)	1	1
Actively constipated	389 (29.27)	1.14 (0.88, 1.49)	1.02 (0.81, 1.28)	71 (5.34)	0.62 (0.36, 1.05)	0.56 (0.33, 0.95) [*]	251 (18.89)	1.26 (0.88, 1.8)	1.15 (0.81, 1.63)
Missing status	0 (0.00)			0 (0.00)			0 (0.00)		

- 1 ¹ n represents the numerator. ² Unadjusted risk ratios were derived from the univariable modified Poisson regression analyses, with social concerns (binary) as outcome and tracer conditions as independent variables. ³ Adjusted risk ratios were derived from the multivariable modified Poisson regression analyses, accounting for socio-demographic factors including children's sex, age (continuous), ethnicity, and IMD score (continuous). ⁴ Any tracer condition was identified among all 7779 participants and specific tracer condition was identified only among those with the tracer condition. * $p < .05$, ** $p < .01$, *** $p < .001$

5 **Table 2 (cont'd)** Risk ratios (RRs) of exposure to a social concern by tracer condition status (n=7779)

Tracer condition as exposure	Exposure to social concerns								
	Parental mental health			Smoking in household			Parental unemployment or long-term sickness or disability		
	n (%) ¹	Unadjusted RR (95%CI) ²	Adjusted RR (95%CI) ³	n (%)	Unadjusted RR (95%CI)	Adjusted RR (95%CI)	n (%)	Unadjusted RR (95%CI)	Adjusted RR (95%CI)
Any tracer condition³									
All controlled (reference)	270 (8.51)	1	1	358 (11.29)	1	1	262 (8.26)		
Any uncontrolled	578 (13.22)	1.61 (1.41, 1.85) ^{***}	1.59 (1.38, 1.84) ^{***}	550 (12.58)	1.13 (0.99, 1.27)	1.12 (0.99, 1.27)	632 (14.46)	1.77 (1.55, 2.03) ^{***}	1.62 (1.41, 1.87) ^{***}
Missing status	32 (13.5)			29 (12.24)			32 (13.5)		
Asthma control									
Controlled (reference)	195 (9.09)	1	1	276 (12.86)	1	1	169 (7.88)		
Uncontrolled	223 (15.79)	1.83 (1.53, 2.18) ^{***}	1.8 (1.49, 2.17) ^{***}	213 (15.08)	1.19 (1.01, 1.4) [*]	1.16 (0.98, 1.37)	243 (17.21)	2.23 (1.86, 2.68) ^{***}	2.03 (1.66, 2.47) ^{***}
Missing status	8 (13.79)			6 (10.34)			5 (8.62)		
Eczema severity									
Clear to mild (reference)	215 (9.9)	1	1	265 (12.2)	1	1	251 (11.56)		
Moderate to very severe	318 (13.96)	1.45 (1.23, 1.7) ^{***}	1.43 (1.21, 1.68) ^{***}	270 (11.85)	0.98 (0.84, 1.15)	0.98 (0.83, 1.15)	316 (13.87)	1.22 (1.04, 1.42) [*]	1.14 (0.98, 1.33)
Missing status	7 (17.07)			5 (12.2)			9 (21.95)		
Constipation status									
Not constipated (reference)	22 (12.72)	1	1	18 (10.4)	1	1	19 (10.98)		
Actively constipated	159 (11.96)	0.97 (0.64, 1.47)	0.89 (0.59, 1.33)	157 (11.81)	1.12 (0.71, 1.78)	1.06 (0.68, 1.67)	193 (14.52)	1.33 (0.86, 2.07)	1.21 (0.77, 1.89)
Missing status	0 (0.00)			0 (0.00)			0 (0.00)		

- 1 ¹ n represents the numerator. ² Unadjusted risk ratios were derived from the univariable modified Poisson regression analyses, with social concerns (binary) as outcome and tracer conditions as independent variables. ³ Adjusted risk ratios were derived from the multivariable modified Poisson regression analyses, accounting for socio-demographic factors including children's sex, age (continuous), ethnicity, and IMD score (continuous). ⁴ Any tracer condition was identified among all 7779 participants and specific tracer condition was identified only among those with the tracer condition. * $p < .05$, ** $p < .01$, *** $p < .001$

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1 **Table 3** Association between tracer conditions and SDQ categories, among children aged 4-15 years (n=5554)

	Total	Strengths and Difficulties Questionnaire (SDQ) categories					
		Normal	Borderline	Abnormal	Missing	Risk ratio (RR) for “Abnormal” versus “Normal and borderline combined”	
		n (Row %)	n (Row %)	n (Row %)	n (Row %)	Unadjusted RR (95%CI) ¹	Adjusted RR (95%CI) ²
SDQ Total problems							
Any tracer condition⁴							
All controlled (reference)	2383 (100)	1402 (58.83)	477 (20.02)	431 (18.09)	73 (3.06)	1	1
Any uncontrolled	3004 (100)	1177 (39.18)	633 (21.07)	1083 (36.05)	111 (3.7)	2.01 (1.82, 2.21) ***	2.01 (1.82, 2.22) ***
Missing status	167 (100)	59 (35.33)	37 (22.16)	52 (31.14)	19 (11.38)		
Asthma control							
Controlled (reference)	1987 (100)	1133 (57.02)	380 (19.12)	412 (20.73)	62 (3.12)	1	1
Uncontrolled	1260 (100)	444 (35.24)	279 (22.14)	490 (38.89)	47 (3.73)	1.89 (1.69, 2.11) ***	1.85 (1.65, 2.07) ***
Missing status	46 (100)	18 (39.13)	10 (21.74)	14 (30.43)	4 (8.7)		
Eczema severity							
Clear to mild (reference)	1455 (100)	743 (51.07)	309 (21.24)	359 (24.67)	44 (3.02)	1	1
Moderate to very severe	1467 (100)	628 (42.81)	297 (20.25)	488 (33.27)	54 (3.68)	1.36 (1.21, 1.52) ***	1.39 (1.24, 1.56) ***
Missing status	21 (100)	7 (33.33)	4 (19.05)	6 (28.57)	4 (19.05)		
Constipation status							
Not constipated (reference)	96 (100)	41 (42.71)	24 (25)	25 (26.04)	6 (6.25)	1	1
Actively constipated	788 (100)	254 (32.23)	165 (20.94)	340 (43.15)	29 (3.68)	1.61 (1.15, 2.27) **	1.57 (1.12, 2.2) **
Missing status	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)		
SDQ impact supplement³							
Any tracer condition⁴							
All controlled (reference)	716 (100)	288 (40.22)	119 (16.62)	305 (42.6)	4 (0.56)	1	1
Any uncontrolled	1273 (100)	335 (26.32)	196 (15.4)	729 (57.27)	13 (1.02)	1.35 (1.23, 1.49) ***	1.38 (1.25, 1.52) ***
Missing status	58 (100)	17 (29.31)	9 (15.52)	28 (48.28)	4 (6.9)		
Asthma control							
Controlled (reference)	639 (100)	232 (36.31)	124 (19.41)	279 (43.66)	4 (0.63)	1	1
Uncontrolled	542 (100)	139 (25.65)	82 (15.13)	312 (57.56)	9 (1.66)	1.33 (1.19, 1.49) ***	1.35 (1.2, 1.52) ***
Missing status	18 (100)	5 (27.78)	4 (22.22)	6 (33.33)	3 (16.67)		
Eczema severity							
Clear to mild (reference)	518 (100)	183 (35.33)	84 (16.22)	250 (48.26)	1 (0.19)	1	1

	Total	Strengths and Difficulties Questionnaire (SDQ) categories					
		Normal	Borderline	Abnormal	Missing	Risk ratio (RR) for “Abnormal” versus “Normal and borderline combined”	
		n (Row %)	n (Row %)	n (Row %)	n (Row %)	Unadjusted RR (95%CI) ¹	Adjusted RR (95%CI) ²
Moderate to very severe	584 (100)	164 (28.08)	90 (15.41)	326 (55.82)	4 (0.68)	1.16 (1.04, 1.3) *	1.18 (1.05, 1.32) **
Missing status	7 (100)	2 (28.57)	0 (0.00)	5 (71.43)	0 (0.00)		
Constipation status							
Not constipated (reference)	40 (100)	7 (17.5)	7 (17.5)	24 (60)	2 (5)	1	1
Actively constipated	387 (100)	80 (20.67)	60 (15.5)	245 (63.31)	2 (0.52)	1.01 (0.78, 1.3)	1.02 (0.8, 1.31)
Missing status	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)		

1 ¹ Unadjusted risk ratios were derived from the univariable modified Poisson regression analyses, with SDQ dichotomous status (abnormal versus “normal
2 and borderline combined”) as outcome and tracer conditions as independent variables. ² Adjusted risk ratios were derived from the multivariable modified
3 Poisson regression analyses, accounting for socio-demographic factors including children’s sex, age (continuous), ethnicity, and IMD score (continuous). ³
4 SDQ impact supplement outcomes were only analysed for children who were reported to have minor to severe difficulties in emotions, concentration,
5 behaviour or being able to get on with other people. ⁴ Any tracer condition was identified among all 5554 participants aged 4-15 years and specific tracer condition
6 was identified only among those with the tracer condition.

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1 **Table 4** Association between tracer condition and PedsQL outcome, among consented population
 2 (n=1731) (complete case analysis)

	PedsQL raw scores		Mean difference for PedsQL T-scores	
	Number ₁	Mean (SD)	Unadjusted RD (95%CI) ²	Adjusted RD (95%CI) ₃
PedsQL total score				
Any tracer condition				
All controlled (reference)	590	83.81 (14.41)	1	1
Any uncontrolled	882	75.84 (18.37)	-0.51 (-0.61, -0.42) ***	-0.52 (-0.62, -0.41) ***
Missing status	29			
Asthma control				
Controlled (reference)	370	81.17 (15.58)	1	1
Uncontrolled	234	68.96 (18.73)	-0.69 (-0.85, -0.54) ***	-0.66 (-0.83, -0.5) ***
Missing status	16			
Eczema severity				
Mild or moderate (reference)				
Moderate to very severe	449	77.54 (17.64)	-0.29 (-0.42, -0.16) ***	-0.3 (-0.43, -0.17) ***
Missing status	16			
Constipation status				
Not constipated (reference)				
Actively constipated	307	75.9 (19.03)	-0.31 (-0.69, 0.06)	-0.31 (-0.71, 0.08)
Missing status	4			
PedsQL physical score				
Any tracer condition				
All controlled (reference)	590	85.82 (16.69)	1	1
Any uncontrolled	883	77.43 (20.96)	-0.48 (-0.58, -0.38) ***	-0.47 (-0.57, -0.37) ***
Missing status	30			
Asthma control				
Controlled (reference)	370	82.9 (17.86)	1	1
Uncontrolled	235	69.29 (20.86)	-0.67 (-0.82, -0.51) ***	-0.62 (-0.78, -0.46) ***
Missing status	17			
Eczema severity				
Mild or moderate (reference)				
Moderate to very severe	449	79.83 (20.21)	-0.23 (-0.37, -0.1) ***	-0.23 (-0.36, -0.1) ***
Missing status	16			
Constipation status				
Not constipated (reference)				
Actively constipated	307	77.89 (21.25)	-0.15 (-0.57, 0.26)	-0.14 (-0.57, 0.29)
Missing status	4			
PedsQL psychosocial score				
Any tracer condition				
All controlled (reference)	590	82.64 (15.15)	1	1
Any uncontrolled	882	74.89 (19.08)	-0.47 (-0.57, -0.38) ***	-0.48 (-0.58, -0.38) ***
Missing status	29			
Asthma control				
Controlled (reference)	370	80.23 (16.16)	1	1
Uncontrolled	234	68.75 (20.07)	-0.63 (-0.79, -0.47) ***	-0.61 (-0.78, -0.45) ***
Missing status	16			
Eczema severity				
Mild or moderate (reference)				
Moderate to very severe	449	76.18 (18.43)	-0.29 (-0.42, -0.16) ***	-0.31 (-0.44, -0.17) ***
Missing status	16			
Constipation status				
Not constipated (reference)				
Actively constipated	35	81.02 (17.76)	1	1

	PedsQL raw scores		Mean difference for PedsQL T-scores	
	Number ₁	Mean (SD)	Unadjusted RD (95%CI) ²	Adjusted RD (95%CI) ₃
Actively constipated	307	74.76 (20)	-0.39 (-0.73, -0.04) [*]	-0.4 (-0.76, -0.04) [*]
Missing status	4			

1 ¹ These numbers refer to the numbers of children with a PedsQL score (i.e., non-missing SDQ
2 outcomes). ² Unadjusted mean difference was derived from the univariable linear regression
3 analyses with robust standard errors estimates, with the PedsQL *T-scores* (continuous) as outcome
4 and tracer conditions as independent variables. ³ Adjusted mean difference was derived from the
5 multivariable linear regression analyses with robust standard errors estimates, accounting for socio-
6 demographic factors including children's sex, age (continuous), ethnicity, and IMD quintiles.