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Original Article

Neighbourhood Deprivation, Individual-Level Familial and Socio-Demographic Factors and Diagnosed Childhood Obesity: A Nationwide Multilevel Study from Sweden

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What Is Already Known about This Subject?

- Childhood obesity is a major health risk in childhood.
- Childhood obesity is thought to be caused by environmental and inherited factors.
- Neighbourhood environments have been shown to be an important independent risk factor for many childhood health problems.
- Management of incidentally discovered adrenal masses in FAP patients should be the same as the one for the normal population.

What This Study Adds?

- Neighbourhood deprivation exerts an independent effect on childhood obesity.
- Maternal marital status, parental low level education, advanced paternal age, family history of obesity, diabetes, chronic obstructive pulmonary disease, alcoholism, individual age, female gender and comorbidity of diabetes were associated with higher odds of childhood obesity.
- Clinicians and decision-makers should take into account the potentially negative effect of neighbourhood deprivation on childhood obesity.

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Key Words

Childhood obesity · Neighbourhood-level deprivation · Incidence · Socio-demographic factors · Multilevel modelling

Abstract

Objectives: To examine whether there is an association between neighbourhood deprivation and diagnosed childhood obesity, after accounting for family- and individual-level socio-demographic characteristics. ***Methods:*** An open cohort of all children aged 0–14 years was followed between January 1, 2000 and December 31, 2010. Childhood residential locations were geocoded and classified according to neighbourhood deprivation. Data were analysed by multilevel logistic regression, with family- and individual-level characteristics at the first level and level of neighbourhood deprivation at the second level. ***Results:*** During the study period, among a total of 948,062 children, 10,799 were diagnosed with childhood obesity. Age-adjusted cumulative incidence for diagnosed childhood obesity increased with increasing level of neighbourhood deprivation. Incidence of diagnosed childhood obesity increased with increasing neighbourhood-level deprivation across all family and individual-level socio-demographic categories. The odds ratio (OR) for diagnosed childhood obesity for those living in high-deprivation neighbourhoods versus those living in low-deprivation neighbourhoods was 2.44 (95% confidence interval (CI) = 2.22–2.68). High neighbourhood deprivation remained significantly associated with higher odds of diagnosed childhood obesity after adjustment for family- and individual-level socio-demographic characteristics (OR = 1.70, 95% CI = 1.55–1.89). Age, middle level family income, maternal marital status, low level education, living in large cities, advanced paternal and maternal age, family history of obesity, parental history of diabetes, chronic obstructive pulmonary disease, alcoholism and personal history of diabetes were all associated with higher odds of diagnosed childhood obesity. ***Conclusions:*** Our results suggest that neighbourhood characteristics affect the odds of diagnosed childhood obesity independently of family- and individual-level socio-demographic characteristics.

Introduction

Childhood obesity is a major health risk in children [1]. Childhood obesity is thought to be caused by environmental and inherited factors in about equal proportions [2, 3]. Many environmental risk factors are known, including lack of physical activity, large birth weight, nutritional factors and maternal tobacco smoking during pregnancy [4, 5]. Family history is an important risk factor, which has been shown in twins and adoptees [3]. There is also a growing body of evidence that suggests that individual-level socio-economic status (SES) is a risk factor for obesity [4–7]. Low SES may influence the risk of obesity in multiple ways. For example, exposure to harmful agents may result from residential, lifestyle or occupational factors, all of which may be related to SES [6]. These individual-level socio-demographic characteristics do not, however, fully explain the disparities by SES in childhood obesity risk that exist between different population groups [4–6]. Efforts have therefore been made to study whether the socio-economic environment is associated with the risk of childhood obesity. Neighbourhood environments have been shown to be an important independent risk factor for many childhood health problems [4, 6, 8–15]. However, no previous studies have investigated whether neighbourhood deprivation is associated with diagnosed childhood obesity after accounting for family and individual factors.

The present study had the following two aims: i) to determine whether the relationship between neighbourhood deprivation and odds of diagnosed childhood obesity remains significant after adjusting for family- and individual-level socio-demographic factors; and ii) to examine possible cross-level interactions between individual-level socio-demographic factors and neighbourhood-level deprivation to determine whether neighbourhood-level deprivation has a differential effect on the odds of diagnosed childhood obesity across subgroups of families and individuals (effect modification).

Material and Methods

Data used in this study were retrieved from MigMed, a national database that contains information on the entire population of Sweden for a period of 40 years. The dataset we used contains nationwide information on parents and their offspring at the individual and neighbourhood level, including comprehensive demographic and socio-economic data. The information in MigMed comes from several Swedish national registers. The registers used in the present study were the Total Population Register, the Multi-Generation Register, the Hospital Discharge Register and the Outpatient Register. The Swedish nationwide population and health care registers have exceptionally high completeness and validity [16]. Individuals (children and their parents) were tracked using the personal identification numbers, which are assigned to each resident of Sweden. These identification numbers were replaced with serial numbers to provide anonymity. The follow-up period ran from January 1, 2000 until hospitalisation/out-patient treatment for obesity, death, emigration or the end of the study period on December 31, 2010.

Outcome Variable: Diagnosed Childhood Obesity

The outcome variable in this study was a hospital or out-patient diagnosis of childhood obesity (age at diagnosis 0–14 years) during the study period. Data on in-patient and out-patient diagnoses of obesity for 2000–2010 were retrieved from the Hospital Discharge Register and Out-Patient Register, which contain information on all hospital visits, including diagnoses. We searched these two registers for the International Classification of Diseases 10 (ICD-10) codes E65 and E66, denoting obesity as the main diagnosis during the study period. The serial numbers were used to ensure that each individual appeared only once in the dataset, for his or her first diagnosis of obesity during the study period.

Neighbourhood-Level Deprivation

The home addresses of all Swedish individuals have been geocoded to small geographic units with boundaries defined by homogeneous types of buildings. These neighbourhood areas, called small area market statistics or SAMS, each contain an average of 1,000 residents and were created by the Swedish Government-owned statistics bureau Statistics Sweden. SAMS were used as proxies for neighbourhoods, as they were in previous research [17, 18]. Neighbourhood of residence is determined annually using the Swedish mapping, cadastral and land registration authority.

A summary index was calculated to characterise neighbourhood-level deprivation. The neighbourhood index was based on information about female and male residents aged 20–64 years because this age group represents those who are among the most socio-economically active in the population (i.e. a population group that has a stronger impact on the socio-economic structure in the neighbourhood than children, younger women and men, and retirees do). The neighbourhood index was based on four items: low education level (<10 years of formal education), low income (income from all sources, including interest and dividends, that is <50% of the median individual income), unemployment (excluding full-time students, those completing military service and early retirees), and receipt of social welfare. The index of the year 2000 was used to categorise neighbourhood deprivation as low (more than 1 SD below the mean), moderate (within 1 SD of the mean), and high (more than 1 SD above the mean) [19].

Individual-Level Socio-Demographic Variables

Sex of child: male or female.

Age ranged from 0 to 14 years and was divided into three categories: 0–4, 5–9 and 10–14 years.

Marital status was defined according to maternal marital status, categorized as i) married/cohabitating or ii) never married, widowed or divorced.

Family income was calculated as annual family income divided by the number of people in the family. The family income measure took into consideration the ages of the family members and used a weighted system whereby small children were given lower weights than adolescents and adults. The sum of all family members' incomes was multiplied by the individual's consumption weight divided by the family members' total consumption weight. The final variable was calculated as empirical quartiles from the distribution.

Maternal and paternal education levels were categorised as completion of compulsory school or less (≤9 years), practical high school or some theoretical high school (10–11 years) and completion of theoretical high school and/or college (≥12 years).

Maternal and paternal country of birth was categorised as Sweden, Western country (Western Europe, USA, Canada, Oceania) and other.

Maternal urban/rural status: this variable was included because access to preventive antenatal care may vary according to urban/rural status. Mothers were classified as living in a large city, a middle-sized town or a small town/rural area. Large cities were those with a population of ≥200,000 (Stockholm, Gothenburg and Malmö); middle-sized towns were towns with a population of ≥90,000 but <200,000; small towns were towns with a population of ≥27,000 and <90,000; and rural areas were areas with populations smaller than those of small towns. This classification yielded three equally sized groups.

Mobility: children were classified as having 'not moved' or having 'moved' to another neighbourhood with the same or a different level of deprivation within 5 years.

Maternal age at childbirth was classified as <20, 20–24, 25–29, 30–34, 35–39, 40–44 and ≥45 years) and *paternal age at childbirth* was classified as <20, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49 and ≥50 years.

Maternal, paternal and individual hospitalisations were defined as the first diagnosis from the Swedish Hospital Register during the follow-up period of i) diabetes (ICD-10 E10-E14), ii) chronic obstructive pulmonary disease (COPD) (ICD-10 J40-J47) and iii) alcohol-related liver disease (ICD-10 F10 and K70).

Because obesity is known to cluster in families, children were classified according to whether or not they had a *family history (parents or siblings) of hospitalization of obesity*.

Statistical Analysis

The cumulative rate of obesity was calculated for the total study population and for each subgroup after assessment of neighbourhood of residence for children. Multilevel (hierarchical) logistic regression models were used to estimate odds ratios (ORs) and 95% confidence intervals (95% CIs). The analyses were performed using MLwiN version 2.27 (University of Bristol, Bristol, UK). First, a null model was calculated to determine the variance among neighbourhoods. Then, to determine the crude odds of diagnosed childhood obesity by level of neighbourhood deprivation, a neighbourhood model that included only neighbourhood-level deprivation was calculated (model 1). Next, a full model that included neighbourhood-level deprivation, sex, age and the family- and individual-level socio-demographic variables, added simultaneously to the model, was calculated (aim 1). Finally, a full model tested for cross-level interactions between the family- and individual-level socio-demographic variables and neighbourhood-level deprivation to determine whether the effects of neighbourhood-level deprivation on diagnosed childhood obesity differed across the socio-demographic variables (aim 2).

Random effects: the between-neighbourhood variance was estimated both with and without a random intercept. It was regarded to be significant if it was more than 1.96 times the size of the standard error, which is in accordance with the precedent set in previous studies [20–22].

Ethical Considerations

This study was approved by the Ethics Committee at Lund University.

Results

In the total study population (948,062 children), 20%, 62%, and 18% of children aged 0–14 years lived in low-, moderate- and high-deprivation neighbourhoods, respectively. During the follow-up period (January 1, 2000 to December 31, 2010), 10,799 children were diagnosed with obesity (table 1). Cumulatively diagnosed childhood obesity rates increased from 0.6 per 100 in neighbourhoods with low deprivation to 1.2 per 100 in neighbourhoods

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Table 1. Distribution of population, number of diagnosed childhood obesity events, and age-standardized cumulative rates (per 100) by neighbourhood-level deprivation

	Population		Obesity events		Neighbourhood deprivation		
	no.	%	no.	%	low	moderate	high
Total population (%)	948,062				187,942 (20%)	590,306 (62%)	169,814 (18%)
Total obesity events			10,799		0.6	1.2	1.6
Gender							
Boys	486,690	51.3	5,565	51.5	0.6	1.2	1.6
Girls	461,372	48.7	5,234	48.5	0.7	1.1	1.6
Age, years							
0–4	261,589	27.6	3,102	28.7	0.6	1.2	1.7
5–9	340,657	35.9	4,437	41.1	0.7	1.3	1.9
10–14	345,816	36.5	3,260	30.2	0.6	1.0	1.3
Family income							
Low income	237,681	25.1	3,128	29.0	0.8	1.3	1.5
Middle–low income	237,772	25.1	3,065	28.4	0.7	1.3	1.8
Middle–high income	236,484	24.9	2,605	24.1	0.7	1.1	1.7
High income	236,125	24.9	2,001	18.5	0.5	1.0	1.5
Marital status							
Married/cohabiting	553,494	58.4	5,566	51.5	0.6	1.1	1.4
Never married, widowed, or divorced	394,568	41.6	5,233	48.5	0.7	1.3	1.9
Maternal educational attainment							
≤ 9 years	298,224	31.5	4,476	41.4	1.0	1.5	1.7
10–11 years	360,568	38.0	4,434	41.1	0.7	1.3	1.7
≥ 12 years	289,270	30.5	1,889	17.5	0.4	0.7	1.0
Paternal educational attainment							
≤ 9 years	314,863	33.2	4,661	43.2	1.0	1.5	1.7
10–11 years	357,220	37.7	4,354	40.3	0.8	1.2	1.6
≥ 12 years	275,979	29.1	1,784	16.5	0.4	0.7	1.2
Maternal immigrant status							
Sweden	818,028	86.3	8,955	82.9	0.6	1.1	1.7
Western countries	59,398	6.3	755	7.0	0.7	1.4	1.4
Other countries	70,636	7.5	1,089	10.1	1.0	1.5	1.6
Paternal immigrant status							
Sweden	817,772	86.3	8,907	82.5	0.6	1.1	1.7
Western countries	62,948	6.6	788	7.3	0.7	1.3	1.3
Other countries	67,342	7.1	1,104	10.2	1.2	1.7	1.6
Urban/rural status							
Large cities	280,040	29.5	3,541	32.8	0.6	1.3	2.1
Middle-sized towns	382,270	40.3	4,305	39.9	0.6	1.1	1.7
Small towns/rural areas	285,752	30.1	2,953	27.3	0.7	1.1	1.2
Mobility							
Not moved	578,542	61.0	6,155	57.0	0.6	1.1	1.6
Moved	369,520	39.0	4,644	43.0	0.7	1.3	1.6

Table 1 continued on next page

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Table 1. Continued

	Population		Obesity events		Neighbourhood deprivation		
	no.	%	no.	%	low	moderate	high
Maternal age at child birth, years							
<30	545,120	57.5	6,217	57.6	0.7	1.1	1.6
30–39	380,422	40.1	4262	39.5	0.6	1.2	1.6
≥40	22,520	2.4	320	3.0	0.8	1.4	2.1
Paternal age at child birth, years							
<30	365,427	38.5	4,229	39.2	0.6	1.2	1.6
30–39	485,142	51.2	5,175	47.9	0.6	1.1	1.6
≥40	97,493	10.3	1,395	12.9	0.9	1.4	2.0
Maternal hospitalization of diabetes							
No	939,772	99.1	10,493	97.2	0.6	1.1	1.6
Yes	8,290	0.9	306	2.8	2.3	3.6	4.7
Maternal hospitalization of chronic lower respiratory disease							
No	938,197	99.0	10,556	97.7	0.6	1.2	1.6
Yes	9,865	1.0	243	2.3	1.7	2.4	3.5
Maternal hospitalization of alcoholism and related liver disease							
No	938,744	99.0	10,631	98.4	0.6	1.2	1.6
Yes	9,318	1.0	168	1.6	1.7	1.5	2.8
Paternal hospitalization of diabetes							
No	932,296	98.3	10,411	96.4	0.6	1.1	1.6
Yes	15,766	1.7	388	3.6	1.5	2.4	3.2
Paternal hospitalization of chronic lower respiratory disease		0.0		0.0			
No	941,246	99.3	10,642	98.5	0.6	1.2	1.6
Yes	6,816	0.7	157	1.5	1.9	2.2	2.9
Paternal hospitalization of alcoholism and related liver disease							
No	927,070	97.8	10,400	96.3	0.6	1.2	1.6
Yes	20,992	2.2	399	3.7	1.3	1.8	2.3
Hospitalization of diabetes							
No	941,835	99.3	10,614	98.3	0.6	1.2	1.6
Yes	6,227	0.7	185	1.7	2.1	3.0	3.6
Family history of obesity							
No	911,546	96.1	8,749	81.0	0.5	1.0	1.3
Yes	36,516	3.9	2,050	19.0	4.2	5.6	6.4

with moderate deprivation and 1.6 per 100 in neighbourhoods with high deprivation. A similar pattern of higher rates with increasing neighbourhood deprivation was observed across all family- and individual-level socio-demographic categories.

The OR for diagnosed childhood obesity for children living in high- versus low-deprivation neighbourhoods in the crude neighbourhood-level model was 2.44 (95% CI = 2.22–2.68) (table 2). High neighbourhood-level deprivation remained significantly associated with the odds of diagnosed childhood obesity after adjustment for age, gender, and the family- and individual-level socio-demographic variables (OR = 1.70, 95% CI = 1.55–1.87; $p < 0.001$), compared to low-deprivation neighbourhoods. The odds of diagnosed childhood obesity was highest in children in the following subgroups among the included variables: advanced

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Table 2. OR and 95% CI for diagnosed childhood obesity; Results of multi-level logistic regression models

	Model 1		Model 2		Model 3		Model 4		p value
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	
Neighbourhood-level variable (ref. low)									
Moderate	1.84	1.70–2.00	1.85	1.70–2.00	1.56	1.44–1.69	1.51	1.39–1.63	<0.001
High	2.44	2.22–2.68	2.43	2.21–2.67	1.80	1.64–1.99	1.70	1.55–1.87	<0.001
Age			0.98	0.98–0.98	0.99	0.99–0.99	0.99	0.98–0.99	<0.001
Gender to boys (ref. girls)			1.01	0.97–1.05	1.01	0.97–1.05	1.01	0.97–1.05	0.764
Family income (ref. high income)									
Middle-high income					1.07	1.01–1.14	1.05	0.99–1.12	0.110
Middle-low income					1.15	1.09–1.22	1.10	1.03–1.17	0.002
Low income					1.04	0.97–1.10	0.97	0.91–1.03	0.368
Marital status (ref. married/co-habiting)									
Never married, widowed, or divorced					1.16	1.11–1.21	1.15	1.11–1.20	<0.001
Maternal immigrant status (ref. born in Sweden)									
European countries					1.00	0.92–1.09	1.02	0.94–1.12	0.617
Others					0.95	0.86–1.05	0.98	0.89–1.08	0.689
Paternal immigrant status (ref. born in Sweden)									
European countries					0.96	0.88–1.04	0.97	0.89–1.06	0.549
Others					1.23	1.12–1.35	1.21	1.10–1.34	<0.001
Maternal education attainment (ref. ≥12 years)									
≤9 years					1.67	1.57–1.78	1.55	1.45–1.65	<0.001
10–11 years					1.58	1.49–1.67	1.49	1.41–1.58	<0.001
Paternal education attainment (ref. ≥12 years)									
≤9 years					1.66	1.56–1.77	1.58	1.48–1.68	<0.001
10–11 years					1.57	1.48–1.67	1.50	1.42–1.60	<0.001
Urban/rural status (ref. large cities)									
Middle-sized towns					0.84	0.80–0.89	0.85	0.81–0.90	<0.001
Small towns/rural areas					0.71	0.67–0.75	0.74	0.69–0.78	<0.001
Mobility (ref. not moved)					1.07	1.02–1.11	1.04	1.00–1.09	0.072
Maternal age at child birth, years (ref. <30 years)									
30–39					1.14	1.09–1.20	1.15	1.09–1.20	<0.001
≥40					1.29	1.14–1.45	1.30	1.15–1.47	<0.001
Paternal age at child birth, years (ref. <30 years)									
30–39					1.05	1.00–1.10	1.04	1.00–1.10	0.072
≥40					1.32	1.23–1.42	1.26	1.17–1.36	<0.001
Maternal hospitalization of type 2 diabetes (ref. no)							1.95	1.72–2.21	<0.001
Maternal hospitalization of chronic lower respiratory disease (ref. no)							1.47	1.28–1.68	<0.001
Maternal hospitalization of alcoholism and related liver disease (ref. no)							1.14	0.97–1.33	0.110
Paternal hospitalization of diabetes (ref. no)							1.50	1.35–1.67	<0.001
Paternal hospitalization of chronic lower respiratory disease (ref. no)							1.51	1.28–1.78	<0.001
Paternal hospitalization of alcoholism and related liver disease (ref. no)							1.27	1.14–1.41	<0.001
Hospitalization of diabetes (ref. no)							2.60	2.23–3.02	<0.001
Family history of obesity (ref. without family history)							4.71	4.46–4.96	<0.001
Variance (S.E.)	*0.355 (0.018)*		*0.355 (0.018)*		*0.319 (0.017)*		*0.253 (0.015)*		
Explained variance (%)	*22*		*22*		*30*		*44*		

parental age at birth, living in large cities, hospitalisation for diabetes, parents who were never married, widowed or divorced, parental low educational level, family moved within 5 years, advanced paternal age at childbirth, a family history of obesity, mothers hospitalised for type 2 diabetes or chronic lower respiratory disease, fathers with non-European country immigration background, fathers hospitalised for diabetes, chronic lower respiratory disease or alcohol-related liver disease.

A test for cross-level interactions between the individual-level socio-demographic variables and neighbourhood-level deprivation in the context of odds of diagnosed childhood obesity showed no meaningful cross-level interactions or effect modification.

The between-neighbourhood variance (i.e. the random intercept) was more than 1.96 times the size of the standard error in all models, indicating that there were significant differences in diagnosed childhood obesity between neighbourhoods after accounting for neighbourhood deprivation and the individual-level variables. Neighbourhood deprivation explained 22% of the between-neighbourhood variance in the null model (table 2). After inclusion of the family- and individual-level variables, the explained variance was 44%.

Discussion

We found that living in a deprived neighbourhood increased the odds of diagnosed childhood obesity by 70%. It is noteworthy that we found this effect in a country with a comparatively strong system of universal health care and social welfare. Our finding that neighbourhood deprivation exerts an independent effect on odds of diagnosed childhood obesity is consistent with the findings of a small but growing number of studies that have provided evidence of an association between neighbourhood-level socio-economic factors and diagnosed childhood obesity [9, 10, 12, 14, 15]. Maternal marital status, parental education, paternal age, family history of obesity, co-morbidities, age and living in large cities were associated with higher odds of diagnosed childhood obesity.

Family and individual environments such as parental educational level have been reported to be associated with diagnosed childhood obesity, due to a potential influence on children's food intake and physical activity [7, 23]. Furthermore, parental smoking and alcohol consumption are associated with higher levels of BMI [24]. However, the causal pathways linking neighbourhood socio-economic deprivation and poor health in childhood are not completely understood [4, 6, 8–12, 14]. One possible mediator could be psychological stress due to isolation/alienation, littered and unsafe environments, vandalism, and violent crime in deprived neighbourhoods [20, 25]. It is possible that the lack of safe environments reduces residents' ability to exercise, thereby aggravating an unhealthy lifestyle. Additionally, socio-cultural norms regarding diet, smoking and physical activity could vary between neighbourhoods and affect the health of the residents and the risk of disease [15]. For instance, a Swedish study showed that cardiovascular disease risk factors including physical inactivity, obesity and smoking were more common among individuals living in deprived neighbourhoods than among those living in affluent neighbourhoods [26].

Living in deprived neighbourhoods can cause isolation from health-promoting milieus (e.g. safe places to exercise, safe side walks, bike paths, safe parks and decent housing) and services. In comparisons of wealthy nations, associations between neighbourhood characteristics and different health outcomes were inconsistent [27]. This implies that neighbourhood determinants of health are complex. Such determinants may include access to health care, education, and social services. Access to these services is uneven in the USA, where the effects of income inequalities on health are more pronounced [28]. For example, low community income is associated with higher risk of childhood obesity [12]. However, in the present study, no large associations with family income were observed. Children with parents who were never married, widowed or divorced, with parents with lower level of education, living in large cities, with family history of obesity, with advanced paternal age, with parental co-morbidities and with a history of diabetes had higher odds of obesity. It has been reported previously that neighbourhood socio-economic change (families who moved into different level of neighbourhoods) is associated with the risk of childhood obesity [13].

Level of neighbourhood deprivation may influence risk of childhood obesity through other general mechanisms, including unfavourable health-related behaviours of women during pregnancy [5], neighbourhood social disintegration (i.e. criminality, high mobility or unemployment) [20], low social capital [18, 19, 29], and neighbourhood stress mediated by factors that can influence immunological and/or hormonal stress reactions [30–32]. Consistent with this hypothesis are the results of a US study, which found that neighbourhood socio-economic disparities were associated with childhood and adolescent obesity [9].

The present study has several limitations. These include the possibility that some selective factors operate in the process of hospitalisation to favour certain children being hospitalised. Affordability of health care is not a selective factor in Sweden, nor is the likelihood of seeking medical advice important because of equal access to primary and hospital care [33]. It is, however, possible that residual confounding exists because socio-economic status cannot be fully measured by family income and education level. The Swedish Hospital Discharge Register contains no information about diagnostic procedures, which is a limitation, but any bias this may have caused would most likely be non-differential. However, with respect to childhood obesity, the overall diagnostic validity of the Hospital Discharge Register is close to 90% [34, 35].

The limitations of the study are countered by its strengths, which include: i) the ability to analyse data on a large national cohort of children aged 0–14 years; ii) the prospective design; iii) the completeness of the data (for example, only 1% of the data on maternal education level and family income were missing); iv) the use of small, well-defined neighbourhoods with an average of 1,000 residents; and v) the ability to adjust for a set of family- and individual-level socio-demographic factors (age, sex, family income, maternal marital status, parental country of birth, parental education level, urban/rural status, mobility, parental age, maternal and paternal hospitalisation, and family history of obesity). Accounting for family SES is particularly important, as it is a major confounder that can affect an individual's choice of neighbourhood. Another strength is the possibility to generalise our results to other populations (external validity), particularly to populations in industrialised societies.

Conclusions

This prospective nationwide study showed that, after accounting for family- and individual-level socio-demographic factors, neighbourhood deprivation was independently associated with increased odds of diagnosed childhood obesity. This finding represents valuable knowledge for health care professionals who work in socially deprived neighbourhoods.

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Disclosure Statement

There are no competing interests.

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