

## ORIGINAL ARTICLE

# The prevalence of overweight among 4-year-olds during and after the COVID-19 pandemic was associated with socioeconomic burden

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**Abstract****Aim:** To assess the prevalence of overweight among Swedish 4 year olds in 2018, 2020 and 2022, taking socioeconomic variables into account.**Methods:** Aggregated regional data on children's body mass index were collected. The socioeconomic Care Need Index (CNI), foreign background, low education, being a single parent, low income and childhood poverty, were assessed. The differences in overweight, including obesity, were tested for Sweden and for regions.**Results:** Data were available for 303 843 children, representing 87% of children born in 2014, 2016 and 2018. Overweight or obesity were found in 11 177 (11.4%) of children in 2022, decreasing from 2020 (13.3%,  $p < 0.001$ ) but at the same level as in 2018. Regional low CNI, low level of foreign background, education and income as well as being a single parent were associated with a higher prevalence of overweight or obesity in all cohorts ( $p < 0.001$ ). In regions with high levels of childhood poverty, overweight or obesity were more prevalent during ( $p = 0.009$ ) and after the pandemic ( $p < 0.001$ ).**Conclusion:** Three national cohorts demonstrate that the increase in overweight during the COVID-19 pandemic has returned to pre-pandemic levels, but the inequalities in health associated with socioeconomic vulnerability of the regions remained.**KEYWORDS**

child health services, obesity, overweight, prevention, socioeconomy

## 1 | INTRODUCTION

The prevalence of obesity among children in the world has quadrupled from 1990 to 2022 according to a recent study in the Lancet,<sup>1</sup> now affecting 6.9% of girls and 9.3% of boys aged 5–19 years. Various studies from around the world report an increase during the COVID-19 pandemic.<sup>2–4</sup> Increased food intake<sup>5–7</sup> and sedentary

behaviour<sup>6,7</sup> as well as general lock down of society and thus change of daily routines during the pandemic<sup>5,6</sup> have been speculated as underlying causes for the increase.

Childhood obesity develops from a complex series of genetic, environmental and lifestyle risk factors.<sup>8</sup> Moreover, obesity in childhood is associated with obesity later in life since 90% of 3-year-old children with overweight or obesity had the same weight status

**Abbreviations:** CHP, Child Health Programme; CHS, Child Health Services; CNI, Care Need Index.

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during adolescence.<sup>9</sup> Childhood obesity is thus considered a chronic disease<sup>8</sup> and there is a need for both early detection and prevention.<sup>10</sup> Growth should be monitored throughout childhood and changes in growth trends should lead to action since high and increasing trajectories in body mass index (BMI) in early childhood are maintained.<sup>11</sup>

In Sweden, the Child Health Services (CHS), guided by the national Child Health Programme (CHP),<sup>12,13</sup> encompasses continuous health dialogues, growth surveillance and assessments of health-protective and risk factors for the child and their family. To identify an increasing BMI trajectory the BMI growth curve is used from 1 year of age while overweight and obesity are identified using BMIs widely accepted International Obesity Task Force (IOTF) definitions from 2 years of age.<sup>14</sup> The Swedish CHS has a broad uptake and enrolls 96% of Swedish 0–6-year old children<sup>15</sup> and was sustained during the COVID-19 pandemic.<sup>16</sup>

Comprehensive CHS national data on 4-year-old children's heights and weights from 2018 to 2020 showed that the prevalence of overweight or obesity among Swedish 4-year-olds was 11%<sup>4,17</sup> before and increased to 13% during the COVID-19 pandemic.<sup>4</sup> Recent data from three Swedish regions showed that the increased rates of overweight or obesity during early COVID-19 decreased to pre-pandemic levels afterwards in three and 4-year-old children.<sup>18</sup> However, the influence of socioeconomic risk factors for the development of overweight or obesity among young children during the COVID-19 pandemic is not known. It seemed that the pandemic influenced children's social or genetic vulnerability for obesity resulting in a higher prevalence when their support structures disappeared<sup>19</sup> or in less socially privileged areas.<sup>4</sup> Research suggests that lower parental socioeconomic status such as low parental education and income is related to higher levels of childhood adiposity.<sup>9</sup>

The aim of this study was to assess the prevalence of overweight or obesity among Swedish 4-year-olds 2022 and to compare these with the from 2018 to 2020, taking socioeconomic variables into account. No studies, to our knowledge, have used complete national cohort data, under and after the pandemic to understand the impact of the pandemic on overweight or obesity early in life.

## 2 | METHOD

### 2.1 | Data collection

Each year, data on overweight and obesity are summarised by the central CHS units in most Swedish regions, as part of regional child health surveillance and quality monitoring. Two national summaries on 4-year-olds were performed in 2018 and 2020.<sup>4,17</sup> A consecutive national summary of aggregated regional data on overweight or obesity was initiated in the spring 2023. The numbers of all 4-year-old girls and boys who were measured for height and weight within the Swedish CHS in 2022 were collected and each child's age-adjusted and sex-adjusted BMI categorised using the IOTF definitions.

### Key notes

- In total, 303 843 4-year-old children's weight and height status were gathered in three Swedish national cohorts 2018, 2020 and 2022.
- The prevalence of overweight including obesity increased during and decreased after the COVID-19 pandemic.
- There was an association between overweight or obesity and socioeconomic burden.

Overweight and obesity were defined by an IOTF-BMI of >25 and IOTF-BMI of >30, respectively.<sup>14</sup>

The data were requested from the central CHS units in each region in Sweden by e-mail in June 2023. Two reminders were sent, 2 and 3 months later, to those who had not responded to the first request. The regions were further contacted by e-mail if anything was unclear in the reported data. The previous summaries of 4-year-olds measured in 2018 and 2020 were used as comparisons in the present study.

### 2.2 | Study population

In 2022, the summary covered 98 397 children (51.2% boys), who attended their CHS 4-year health visit in 2022. This corresponded to 85% of all 115 832 children born in Sweden in 2018.<sup>20</sup> Similar data were collected from the 4-year health visits in 2018, when 105 445 children born in 2014 (50.2% boys) and from 2020, when 100 001 children born in 2016 (51.2% boys) were summarised.<sup>4</sup> In total, data were available from 303 843 children, representing 87% of the 348 164 children born in Sweden in 2014, 2016 and 2018.<sup>20</sup>

Data were reported by 18 of the 21 regions in Sweden 2022. Three smaller regions—Halland, Västmanland and Örebro (with a total of 9910 children born 2018)—had difficulties in accessing medical data and could thus not report the requested summary. One region could not specify data by gender.

Most regions used a measuring range of  $\pm 90$  days from the child's fourth birthday. Two regions, Västernorrland och Västerbotten, used a range of  $\pm 60$  days. One region, Stockholm, reported data from children 1350–1530 days and Värmland reported data from children aged 3 years and 10 months to 4 years and 3 months.

The number of children measured for height and weight in each region was compared to the number of children born in 2018 in the region. This was either reported by the regions or by Statistics Sweden.<sup>20</sup> Data were compiled from 73.9% to 98.1% of the children in each region. Missing data were reported to be caused by children being abroad, children moving into the region later than their 4-year health visit, children attending their 4-year health visit later than 3 months after their fourth birthday and parents declining CHS

or measurement. The number and percentage of children reported from each region is presented in [Table 1](#).

## 2.3 | Socioeconomic variables

Six different socioeconomic variables were used: The Swedish Care Need Index (CNI), foreign background, education level, single parents, economic situation and childhood poverty. Most of the variables were provided by Statistics Sweden.<sup>20</sup> The CNI is a measure of social deprivation based on sociodemographic information of the population in the area. It identifies the risk of health, moreover, it can be used by regions as support when calculating healthcare compensation in Sweden. The CNI includes the following components: Children under 5 years of age, having low education level, that is, completed maximum upper secondary school, being unemployed, being a single parent with children under the age of 17 years, being born outside Europe, having high mobility and being an elderly person living alone. The index value is 1 and an index above 1 is classified as increased risk of poor health. There are large differences in the index between Swedish regions.<sup>21</sup> Data from 2018, 2020 and 2021 were provided. Later index data were unavailable due to technical issues.

Specific information on foreign background, education level and single parents were provided by Statistics Sweden and assessed by region in 2018, 2020 and 2022.<sup>20</sup> Data on low-income levels in each region were available from 2018, 2020 and 2021. Foreign background was available for 4-year-olds and was categorised as Swedish

TABLE 1 Number and percentage of measured 4-year-old children in 2022, by region.

Region	n	%
Blekinge	1612	97.0
Dalarna	2198	73.9
Gotland	579	98.1
Gävleborg	2963	95.3
Jämtland-Härjedalen	1320	87.5
Jönköping	4343	97.2
Kalmar	2570	95.2
Kronoberg	1341	92.4
Norrbottnen	2078	86.8
Skåne	15897	96.1
Stockholm	25041	90.7
Sörmland	3248	89.7
Uppsala	4237	91.3
Värmland	2516	81.8
Västerbotten	2559	85.0
Västernorrland	2624	96.0
Västra Götaland	18912	94.8
Östergötland	4359	92.5
SWEDEN	98397	85.0

or non-Swedish when the child and/or both parents were born outside Sweden. Education level was assessed among 25–64-year-olds in the population. It was categorised into low education level when completed maximum upper secondary school versus high education level when post-secondary school was completed. Data on single parents for children aged 0–4 years as well as income level were available. Low income was defined when the income of the family was 0–60 percentage of the median income in the region.

Prevalence of childhood poverty by region in 2019 was collected from the non-governmental organisation Save the Children.<sup>22</sup> It was defined as children 0–17 in a household with low income (disposable income not covering necessary expenses) and/or subsistence allowance.

## 2.4 | Statistical analyses

The difference between overweight or obesity in 2022 compared to 2020 and 2018 was tested for the country as a whole, for each region as well as by gender. All socioeconomic variables were compared to the Swedish average ([Table S1](#)) and prevalence below and above the national average was noted by region. Number of children with overweight or obesity was compared between regions with under versus over average in the different socioeconomic variables. Because aggregated data were presented, the first step was to weigh the cases. Then, chi-square tests were used to test for the differences between the groups. Statistical analyses were performed in SPSS version 22.0 (IBM Corp). Statistical significance was a *p*-value of  $\leq 0.05$ .

## 2.5 | Ethical considerations

Each year, CHS clinics in most Swedish regions compile data on overweight and obesity among four-year-old children. These unidentified, aggregated group data were reported from the regions. It was not possible to trace individual data and confidentiality was thus ensured throughout the entire study. Since only aggregated data were summarised and analysed and no personal data were used in the study, and there was no requirement for ethical approval.

## 3 | RESULTS

In 2022, overweight or obesity was found in 11 177 (11.4%) of the 98 397 children: 9.1% had overweight and 2.2% obesity. Among girls, 10.6% had overweight and 2.0% obesity and among boys 7.7% had overweight and 2.0% obesity. There was a significant difference in the prevalence of overweight between the sexes ( $p < 0.001$ ). The prevalence of overweight or obesity varied between the regions from 9.9% to 15.6%, with the lowest prevalence in Stockholm and the highest in Västernorrland ([Figure 1](#)). There was a significant decrease from 2020 (during the pandemic) when the prevalence of overweight or obesity was 13.3% ( $p < 0.001$ ). This decrease was

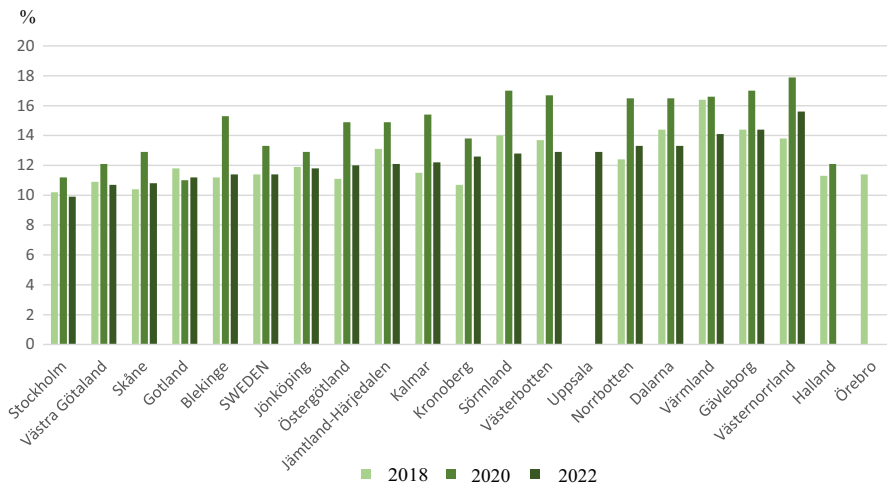


FIGURE 1 Prevalence of overweight or obesity among Swedish 4-year-olds in 2018, 2020 and 2022.

found in all but three regions. However, in Jönköping and Kronoberg there was a decrease in percentages, which did not reach significance (Table 2).

When comparing data from 2022 (after the pandemic) to data from 2018 (before the pandemic), there was no significant difference in overweight or obesity among the Swedish 4-year-olds. However, in two regions, Stockholm and Värmland the difference in prevalence between the years was significant. A tendency towards lower rates in 2022 compared to 2018 was also seen in other regions (Table 3).

### 3.1 | Overweight or obesity associated with socioeconomic burden

Regional under-average levels of CNI (i.e. higher socioeconomic status) as well as under average of foreign background were significantly associated with a higher prevalence of overweight or obesity both before (2018), during (2020) and after the pandemic (2022) ( $p < 0.001$ ). Regional under-average levels of education (low education), over average of single parents and under average of income (low income) were also associated with a higher prevalence of overweight or obesity in 2018, 2020 and 2022 ( $p < 0.001$ ).

There was no significant difference in overweight or obesity in regions with low versus high levels of childhood poverty before the pandemic ( $p = 0.967$ ) but the difference was significant during ( $p = 0.009$ ) and after the pandemic ( $p < 0.001$ ). Additionally, in regions with lower levels of education and income as well as a higher prevalence of single parents, overweight or obesity were more prevalent after the pandemic (2022) comparing to before the pandemic (2018). This was also found for lower levels of foreign background (Figure 2).

## 4 | DISCUSSION

Three national cohorts with nearly complete data on 4-year-old children in Sweden show an increase in overweight or obesity during

TABLE 2 Prevalence and comparison of overweight or obesity among Swedish 4-year-olds in 2022 and 2020, by region.

Region	2022, n (%)	2020, n (%)	p-Value
Blekinge	183 (11.4)	255 (15.3)	0.001
Dalarna	292 (13.3)	487 (16.5)	0.002
Gotland	65 (11.2)	66 (11.0)	0.712
Gävleborg	428 (14.4)	439 (17.0)	0.008
Jämtland-Härjedalen	159 (12.1)	171 (14.9)	0.042
Jönköping	511 (11.8)	573 (12.9)	0.116
Kalmar	314 (12.2)	396 (15.4)	0.001
Kronoberg	169 (12.6)	334 (13.8)	0.302
Norrbotten	277 (13.3)	381 (16.5)	0.004
Skåne	1706 (10.8)	2108 (12.9)	<0.001
Stockholm	2226 (9.9)	2794 (11.2)	<0.001
Sörmland	417 (12.8)	561 (17.0)	<0.001
Västra Götaland	2023 (10.7)	2363 (12.1)	<0.001
Värmland	354 (14.1)	467 (16.6)	0.012
Västerbotten	331 (12.9)	302 (16.7)	<0.001
Västernorrland	410 (15.6)	475 (17.9)	0.028
Östergötland	522 (12.0)	727 (14.9)	<0.001
SWEDEN	11 177 (11.4)	13 291 (13.3)	<0.001

and a decrease after the COVID-19 pandemic to pre-pandemic levels in 2022. There was no difference in prevalence before and after the pandemic in most regions. Notably, the prevalence was higher in regions with over-average level of single parents as well as under average of parental education and income, indicating inequalities in health associated with socioeconomic vulnerability.

A similar pandemic-driven increase<sup>2-4,23</sup> and a preceding decrease<sup>18</sup> in overweight or obesity among children have been described in other studies. The observed decrease after the pandemic is important and contrasts to earlier speculations that a fully reverse to pre-pandemic levels would be difficult to obtain.<sup>24</sup>

A recent article in the Lancet reported that the global age-standardised prevalence of obesity in school-aged children and

adolescents increased from 1.7% (1.5–2.0) in 1990 to 6.9% (6.3–7.6) in 2022 in girls and from 2.1% (1.9–2.3) to 9.3% (8.5–10.2) in boys, according to the WHO classification of obesity.<sup>1</sup> The Lancet highlights an urgent need for obesity prevention, supporting weight loss and reducing disease risk in those with obesity. It is also stated that prevention and management are especially important because the age of onset of obesity has decreased, which increases the duration of exposure. Although the prevalence of overweight or obesity

in 4-year-olds in Sweden has been stable over many years<sup>17,25</sup> and much lower in this Swedish national cohort compared to the report in the Lancet, there is still a need for prevention and early intervention in Sweden.

The higher prevalence of overweight or obesity in regions with under average of parental education and income and over average of single parents indicate an association to socioeconomic burden, not previously described for 4-year-old children in Sweden. Similar results were found in a Finnish study where lower parental socioeconomic status (SES) was related to higher levels of childhood adiposity in Europe.<sup>26</sup> The study stated that composite SES, parental education and parental occupation showed most frequently inverse associations with obesity levels.

It has been shown that socioeconomic vulnerable groups, especially children whose parents lacked social network, have poorer dietary habits.<sup>27</sup> In our study, the highest prevalence of overweight or obesity, especially during the COVID-19 pandemic, was found in regions with over average prevalence of single parents. This finding indicates that the health of vulnerable groups, such as children to single parents, was affected the most by the restrictions during the pandemic. Even though pre-schools and schools remained mainly open, social distancing with the elderly was encouraged.<sup>28</sup> The social network was thus limited for single parents. The same study concludes that socioeconomically deprived groups suffered more from loss of income and unemployment due to the pandemic, which is also in line with the poorer health related to socioeconomic burden described here and in line with conclusions from the qualitative study from three countries including Sweden.<sup>6</sup> The latter study concludes that resilient households, where parents had secure housing and employment, were better able to adapt to the pandemic challenges, whereas parents who experienced household insecurity found it more difficult to cope. This also coincides with our finding that childhood

TABLE 3 Prevalence and comparison of overweight or obesity among Swedish 4-year-olds 2022 and 2018, by region.

Region	2022, n (%)	2018, n (%)	p-Value
Blekinge	183 (11.4)	184 (11.2)	0.934
Dalarna	292 (13.3)	404 (14.4)	0.261
Gotland	65 (11.2)	72 (11.8)	1.000
Gävleborg	428 (14.4)	253 (14.4)	0.994
Jämtland-Härjedalen	159 (12.1)	164 (13.1)	0.469
Jönköping	511 (11.8)	519 (11.9)	0.829
Kalmar	314 (12.2)	284 (11.5)	0.455
Kronoberg	169 (12.6)	259 (10.7)	0.083
Norrbottnen	277 (13.3)	290 (12.4)	0.394
Skåne	1706 (10.8)	1675 (10.4)	0.328
Stockholm	2226 (9.9)	2623 (10.2)	<0.001
Sörmland	417 (12.8)	477 (14.0)	0.160
Västra Götaland	2023 (10.7)	2092 (10.9)	0.594
Värmland	354 (14.1)	492 (16.4)	0.020
Västerbotten	331 (12.9)	273 (13.7)	0.470
Västernorrland	410 (15.6)	325 (13.8)	0.070
Östergötland	522 (12.0)	514 (11.1)	0.206
SWEDEN	11 177 (11.4)	12 028 (11.4)	0.729

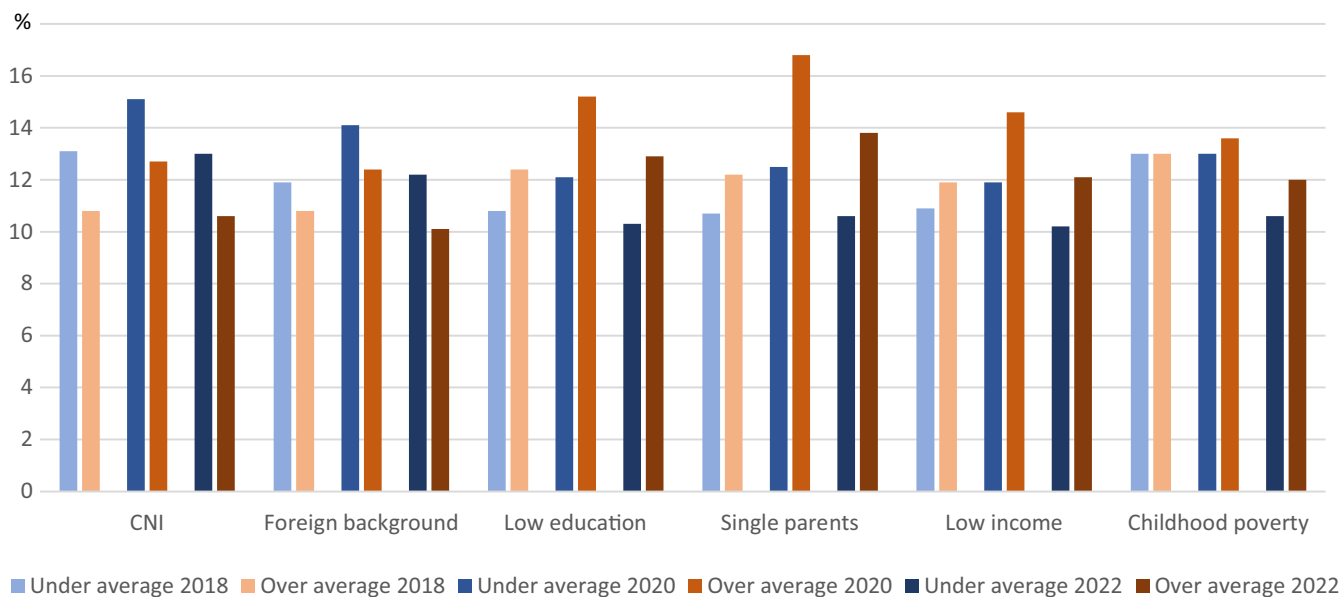


FIGURE 2 Prevalence of overweight or obesity per socioeconomic variable in 2018, 2020 and 2022.

overweight or obesity, after the pandemic, was higher in regions with over average frequency of poverty.

The association with socioeconomic vulnerability indicates that the entire society needs to be targeted in the prevention of overweight and obesity among children. This is in line with the Lancet publication that states that society must act and urgently provide programs that enhance healthy nutrition, such as free healthy school meals and primary care-based nutritional interventions.<sup>1</sup>

It has also been highlighted that there is a need to shift from a governmental approach focused on personal responsibility to an approach that recognises the influence of environmental, cultural and socioeconomic factors that contribute to childhood overweight and obesity. This is of extra importance for children who have little or no control over these factors. A whole-society approach whereby parents, businesses, schools, local authorities, health organisations and national government cooperate to tackle the situation has been advocated. This strategy requires sustained commitment from all and considerable resources for success.<sup>24</sup>

In contrast with earlier studies on dietary patterns in vulnerable groups,<sup>27</sup> our study did not find an association with migration and overweight as the prevalence was higher in regions with more children of Swedish origin. Explanations for this finding are speculative. There might be a higher percentage of underweight in children with foreign background, or a larger extent of families with foreign background do not bring their children with overweight or obesity to the health visits or possibly the health dialogues in the child health services are better targeted to parents with foreign background. However, a majority of the children with foreign background were born in the EU or in Asia<sup>20</sup> where the prevalence of childhood obesity is relatively low,<sup>1</sup> which also might explain this finding.

Our finding that regions with high CNI (i.e. poorer socioeconomic status) had a lower prevalence of overweight or obesity also contrasts with another Swedish study,<sup>23</sup> where the highest prevalence was found in areas with the highest CNI. Also, in the study from Finland, composite SES showed the most frequent inverse associations with obesity.<sup>26</sup> Our conclusion is that CNI at the regional level is a poor predictor of socioeconomic status. Possibly, the CNI is a better predictor for child health at the local level as a study from Hjert et al.<sup>29</sup> found that the percentage of children with a poorer mental health increased with the CNI at the local level. Our findings suggest that the components of CNI, such as low family income, being a single parent and lower education level, are strongly associated with the health and weight development of young children at the regional level.

A strength of the current study is the high-quality data from three consecutive almost complete national cohorts of 4-year-olds. The socioeconomic variables from different sources (Statistics Sweden and Save the Children) showed similar associations to childhood overweight or obesity. However, all data were summarised on regional level and no individual data were used. This limits the ability to investigate how socioeconomic burden correlates to and affects the development of overweight or obesity in young children. In order to make more advanced analyses of correlations between

socioeconomic burden and overweight or obesity, health data at individual level need to be used. The Swedish Child Health Services Register<sup>30</sup> will enable future and more detailed studies. Health registries also have standardised measuring ranges, which will eliminate the possible differences in prevalence of overweight and obesity due to the age of children. However, these health registries need to be developed to further encompass socioeconomic variables, now displayed by Statistics Sweden.

## 5 | CONCLUSION

Three national cohorts with nearly complete data on 4-year-old children's weight and heights in Sweden show an increase in overweight or obesity during the COVID-19 pandemic and a decrease to pre-pandemic levels in 2022. Overweight or obesity was associated with socioeconomic burden at the regional level. Prevention using a whole-society approach and early intervention are important, especially in socioeconomic vulnerable groups.

### AUTHOR CONTRIBUTIONS

**Charlotte Nylander:** Conceptualization; investigation; funding acquisition; writing – original draft; methodology; validation; visualization; writing – review and editing; software; formal analysis; project administration; data curation; resources. **Paulina Nowicka:** Conceptualization; investigation; writing – original draft; methodology; validation; visualization; writing – review and editing; supervision; data curation. **Mariette Derwig:** Conceptualization; investigation; writing – original draft; methodology; validation; visualization; writing – review and editing; project administration; data curation.

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### CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to declare.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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