Received: 5 January 2024 | Revised: 9 May 2024 | Accepted: 30 May 2024

DOI: 10.1111/apa.17323

ACTA PÆDIATRICA NURTURING THE CHILD WILEY

ORIGINAL ARTICLE

Trends in overweight and obesity in Bergen, Norway, using data from routine child healthcare 2010–2022

Melissa R. Balthasar[1,2] | Mathieu Roelants[3] | Bente Brannsether-Ellingsen[1] | Ragnar Bjarnason[4,5] | Ingunn H. Bergh[6] | Liv G. Kvalvik[7] | Kristine M. Stangenes[7] | Astanand Jugessur[7,8] | Mette C. Tollånes[7,9] | Finn Markussen[9] | Petur B. Juliusson[2,10,11]

[1]Department of Pediatrics and Adolescents, Stavanger University Hospital, Stavanger, Norway

[2]Department of Clinical Science, University of Bergen, Bergen, Norway

[3]Department of Public Health and Primary Care, KU Leuven, University of Leuven, Leuven, Belgium

[4]Department of Pediatrics, Landspitali – The National University Hospital, Reykjavik, Iceland

[5]Department of Pediatrics, Faculty of Medicine, University of Iceland, Reykjavik, Iceland

[6]Department of Health and Inequality, Norwegian Institute of Public Health, Oslo, Norway

[7]Department of Global Public Health and Primary Care, University of Bergen, Bergen, Norway

[8]Centre for Fertility and Health, Norwegian Institute of Public Health, Oslo, Norway

[9]City Council Department for the Elderly Health and Care, Bergen Municipality, Bergen, Norway

[10]Department of Health Registry Research and Development, Norwegian Institute of Public Health, Bergen, Norway

[11]Children and Youth Clinic, Haukeland University Hospital, Bergen, Norway

Correspondence
Melissa R. Balthasar, Department of Pediatrics and Adolescents, Stavanger University Hospital, P. O. Box 8100, N-4068 Stavanger, Norway.
Email: melissa.rajini.balthasar@sus.no

Funding information
Helse Vest, Grant/Award Number: F-12594

Abstract

Aim: Trends in childhood overweight, obesity and severe obesity have been lacking in Norway. This study assessed pre-pandemic trends from 2010 to 2019 and evaluated differences in prevalence during the 2020–2022 pandemic years.

Methods: Routine height and weight measurements from child and school health centres were extracted retrospectively from children aged 2, 4, 6, 8 and 13 years. Overweight, obesity and severe obesity was classified according to the International Obesity Task Force cut-offs. Pre-pandemic trends were estimated using linear regression. The prevalence during the pandemic was compared to the 95% prediction interval of this model.

Results: We obtained 181 527 body mass index measurements on 78 024 children (51.0% boys). There was a decrease in the prevalence of overweight including obesity from 2010 to 2019 in boys and this was statistically significant at 4 and 13 years of age. We found no significant trends in girls during this period. During the pandemic, the prevalence of overweight including obesity exceeded the prediction intervals for boys aged 4, 6, and 8 years, and for 6-year-old girls.

Abbreviations: BMI, body mass index; COSI, The WHO European Childhood Obesity Surveillance Initiative; SD, standard deviation; WHO, World Health Organization.

Conclusion: From 2010–2019, overweight including obesity plateaued in girls and decreased in boys but increased during the pandemic among prepubertal boys. Routine healthcare data is useful for estimating the prevalence of different weight status.

KEYWORDS
body mass index, childhood obesity, lockdown, pandemic, sex differences

1 | INTRODUCTION

Trends in overweight and obesity remains a key focus in research. The 2018–2020 World Health Organization (WHO) European Childhood Obesity Surveillance Initiative (COSI) reported that approximately a third of European children aged 7–9 years had overweight including obesity according to WHO definitions. However, the prevalence varied significantly, ranging from 6% in Tajikistan to 43% in Cyprus.[1] A systematic review also highlighted a north-to-south gradient, with the highest prevalence of overweight including obesity in the Mediterranean region and the lowest in North and Central Europe.[2] Worldwide trends from 1975 to 2016 showed an accelerated increase in the body mass index (BMI) among children and adolescents in low-income and middle-income countries. High-income countries appeared to have reached a plateau since early 2000.[3]

Norwegian trends in overweight and obesity have been monitored through national samples of eight-year-old children as part of the COSI. These showed from 2008 to 2019, there was a relatively stable prevalence of overweight including obesity, which ranged from 15% to 18%. Obesity alone, ranged from 3% to 4%.[4,5] However, these surveys were limited to Norwegian children aged 8 years and did not provide insights into other age groups. The latest estimates of childhood overweight and obesity in the municipality of Bergen were reported in 2010[6] and more recent data are clearly needed.

Height and weight measurements are an integral part of healthcare assessments in Norwegian child and school health centres. The Norwegian Directorate of Health's guidelines for growth monitoring state that children should undergo frequent evaluations during the first year of life and two, four, six, eight and 13 years of age.[7] Growth monitoring can detect disease at an early stage and provide the basis for health promotion and parental support. The attendance rate at these centres is high, exceeding 95% for children below 5 years in Bergen.[8] No published studies have used routine Norwegian data to assess trends in different weight status.

In March 2020, the WHO declared COVID-19 a pandemic[9] and global quarantine measures were put in place, as there was no effective treatment or vaccines available. These included travel restrictions, staying at home, home schooling, closing leisure facilities and workplaces and social distancing. Norway introduced strict measures in early 2020 as part of its initial response.[10] The stringency of these restrictions varied throughout 2020 and 2021, with a gradual return to normalcy in early 2022. While these measures were considered essential for controlling the spread of the virus, it is likely that they contributed to an increasingly obesogenic environment,[11] and an increased prevalence of overweight and obesity.[12] Studies from across the world and on different age groups, have documented increases in BMI following the first lockdown periods.[13–15] However, these studies had short follow-up periods and these were only up to 12 months. This limited the scope for a comprehensive assessment of the long-term impact of these COVID-19 measures on weight status.

Key notes

- Prevalence and trends of overweight, obesity and severe obesity among children and adolescents, including the impact of the COVID-19 lockdown were lacking in Norway.
- The prevalence of overweight including obesity significantly decreased among 4 and 13-year-old boys from 2010 to 2019 and increased during the pandemic period for boys at 4, 6 and 8 years of age in Bergen.
- Routine healthcare data are useful for estimating the prevalence of different weight status.

The primary aim of this study was to investigate trends in overweight, obesity and severe obesity in children from the municipality of Bergen in Norway, from 2010 to 2019. Secondly, to analyse possible deviations from the predicted trends during the pandemic years of 2020–2022. Given that the secular trends had already plateaued in high-income countries, we hypothesised a plateau in the prevalence of overweight, obesity and severe obesity in Norway during the last decade. However, we anticipated an increase during the COVID-19 pandemic.

2 | MATERIALS AND METHODS

2.1 | Study population

This was a retrospective study of anthropometric data collected on eligible children attending routine healthcare visits in the municipality of Bergen during 2010–2022. Bergen is Norway's second largest city and includes both urban and rural areas.

Data on height and weight were retrieved for the first time in the current study, from the HealthProfile 0-20 electronic medical record template (Visma, Bergen, Norway). This is used by all child and school health centres in Bergen to monitor the children's growth and development, by recording standardised health information. The roll-out of HealthProfile 0-20 started in 2010, with the youngest children and other age groups were subsequently added. The participation rates were provided by the City Council Department for Health and Care and were 95% and above for children aged 2, 4 and 6 years. The general participation rates of children aged 8 and 13 were 80–90%. The number of children measured during the pandemic years 2020–2022 was similar to the preceding years.

Figure 1 shows the process for selecting eligible records, by excluding records on missing data, outliers and repeated measurements. The age at the time of the measurements was calculated by subtracting the date of birth from the date of measurement. These were pooled by the scheduled age of contact and divided into five age groups: 2, 4, 6, 8 and 13 years. The children were periodically assessed at school throughout the academic year. Depending on their date of birth and when the measurements were taken, a child categorised as 6 years old could have been evaluated at 5, 6, or 7 years of age. We defined plausible intervals for each target age, according to the typical timing of the scheduled visits (Figure S1). These were 2 years (24–35 months), 4 years (47–59 months), 6 years (66–89 months), 8 years (90–114 months) and 13 years (150–174 months). Only one measurement per child was selected within the target age range and this was the measurement closest to the mode of the age distribution. A total of 181 527 height and weight measurements from 2010 to 2022 were included, from children born between 1995 and 2020, with a median birth year of 2009. We excluded 190 records with extreme value of height, weight or BMI, defined as an age- and sex-adjusted *z*-score of <− 5 or >+5, as these were probably due to registration errors or a severe disorder.[15] In addition, we excluded 2475 records with missing data on age, sex or BMI and 25 026 records of repeated measurements from the same child within a specific age interval.

2.2 | Anthropometric measures

The routine data collected included sex, height measured to the nearest 0.5 cm, weight measured to the nearest 100 g, date of birth and date of measurement. Height and weight were measured by trained staff, according to standardised procedures.[7] The BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2).

2.3 | Weight status

Age- and sex-adjusted BMI *z*-scores were calculated using the International Obesity Task Force (IOTF) reference curve.[16] The prevalence of overweight, obesity and severe obesity was estimated using age- and sex-specific cut-offs adopted by the IOTF. Overweight, obesity and severe obesity were defined as IOTF ≥ 25, IOTF ≥ 30 and IOTF ≥ 35, respectively, corresponding to adult BMIs of ≥25 kg/m^2, ≥30 kg/m^2 and ≥35 kg/m^2. Prevalence estimates of overweight always includes obesity and severe obesity and prevalence estimates of obesity always includes severe obesity. We refer to these three weight status categories as overweight, obesity and severe obesity.

2.4 | Statistical analyses

The distributions of the variables are presented as means and standard deviations (SD). Differences in the prevalence estimates between boys and girls were analysed within age groups and study years using the chi-square test or Fisher's exact test, as appropriate. Trends in the proportion of children with BMI equal to or above IOTF cut-offs of 25, 30 and 35, according to the year of measurement, were estimated using linear regression for the pre-pandemic years 2010–2019. Trends were estimated for boys and girls separately due to evidence of different directions in some age groups, even though joint linear regression models did not reveal any significant interactions.

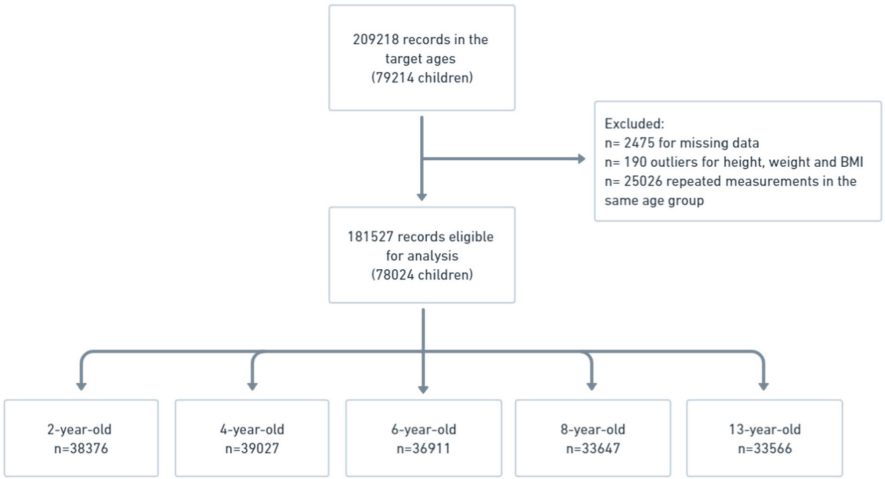

FIGURE 1 Flowchart showing the observations included in the final analyses for each age group from 2010 to 2022.

We estimated a prediction model based on the pre-pandemic trends from 2010 to 2019, which was then extrapolated to the years 2020–2022, to assess the potential effects of lockdown measures on weight status. This model compared the proportion of children with overweight, obesity and severe obesity in 2020–2022 against the 95% prediction interval for the pre-pandemic trend from 2010 to 2019. Prevalence estimates outside the 95% prediction interval were regarded as statistically significant ($p \leq 0.05$). The corresponding two-sided p values were obtained by comparing the differences between the observed and predicted prevalence estimates, divided by the standard deviation of the prediction at the respective year against a t-distribution with 8 degrees of freedom.

The statistical analyses were conducted using R software version 4.2.3 (R Foundation for Statistical Computing, Vienna, Austria).

3 | RESULTS

A total of 181 527 BMI measurements from 78 024 children (51.0% boys) were included in the analysis. Descriptive statistics for the total sample are presented in Table 1. The mean ages and SD were similar across both sexes. The overall prevalence estimates for overweight, obesity and severe obesity in different age groups from 2010 to 2019 are shown in Table S1. The smaller number of boys and girls aged eight and 13 years reflects the gradual implementation of the HealthProfile 0-20 electronic medical record template in 2010 and 2011 (Table S2).

3.1 | Overweight between 2010 and 2019

The overall prevalence of overweight in the boys was slightly higher at 2 years of age than 4 years of age. Between 4 years and 13 years of age it increased from 7.3% to 16.8%. In girls, there was an increase in the overall prevalence with age, starting from 9.1% at 2 years of age and rising to 22.3% at 13 years of age (Figure 2A, Table S1). The largest difference in the overall prevalence was observed between the 13-year-old girls and boys (Table S1). There were statistically significant differences in the prevalence between boys and girls, with a higher prevalence in girls from 4 years of age (Table S2).

We observed a tendency of decreasing prevalence by year in boys in all age groups, except at 8 years of age, but it was only statistically significant among boys aged 4 and 13 years (Figure 2A, Table S2). In girls, the trends were less prominent and non-significant.

3.2 | Obesity between 2010 and 2019

The overall prevalence of obesity in boys increased from 0.9% at 4 years of age to 3.4% at 13 years of age. In girls, it increased from 1.2% at 2 years of age to 4.2% at 13 years of age (Figure 2B, Table S1). Girls tended to have a higher prevalence of obesity across all age groups than boys, although significant differences were only observed in a few study years (Table S2).

There were no significant trends in obesity from 2010 to 2019 in any of the age groups (Figure 2B, Table S2). Similar trends were found for both sexes, except for a noticeable increasing trend in 6-year-old boys and 2-year-old girls.

3.3 | Severe obesity between 2010 and 2019

The overall prevalence of severe obesity varied between 0.2% and 0.7% in boys and between 0.3%–0.8% in girls and was highest in the six-year-old children (Figure 2C, Table S1). There were no significant differences in the prevalence between boys and girls in the different age groups in most study years (Table S2).

When we analysed the trends for severe obesity, we found a significant decreasing trend among the four-year-old boys. The other trends for severe obesity mirrored the trends for obesity in each sex (Figure 2C, Table S2).

3.4 | Weight status between 2020 and 2022

The prevalence of overweight for boys from 2020 to 2022 consistently exceeded the pre-pandemic predictions across all age groups, but it was only statistically significant at 4, 6 and 8 years of age (Figure 2A, Table S2). In 2021 the prevalence for the four-year-old boys was 8.6%, which was above the predicted prevalence of 6.2%. In 2022, the prevalence for the six-year-old boys was 11.0%,

TABLE 1 Descriptive statistics of age, height and BMI presented as means and standard deviations (SD) stratified by age group in boys and girls from 2010 to 2022 ($n = 181\,527$).

	Boys				Girls			
	N	Age (SD)	Height cm (SD)	BMI (kg/m^2) (SD)	*N*	Age (SD)	Height cm (SD)	BMI (kg/m^2) (SD)
2 years	19 728	2.3 (0.2)	90.6 (3.5)	16.5 (1.3)	18 648	2.3 (0.2)	89.2 (3.5)	16.3 (1.3)
4 years	20 045	4.2 (0.2)	106.0 (4.2)	15.7 (1.2)	18 982	4.2 (0.2)	105.0 (4.2)	15.7 (1.3)
6 years	18 879	6.3 (0.4)	121.0 (5.5)	15.7 (1.6)	18 032	6.3 (0.4)	119.0 (5.5)	15.7 (1.7)
8 years	17 145	8.7 (0.4)	135.0 (6.0)	16.7 (2.3)	16 502	8.7 (0.4)	133.0 (6.1)	16.8 (2.4)
13 years	17 100	13.5 (0.4)	165.0 (8.8)	19.6 (3.3)	16 466	13.5 (0.4)	162.0 (6.6)	20.1 (3.2)

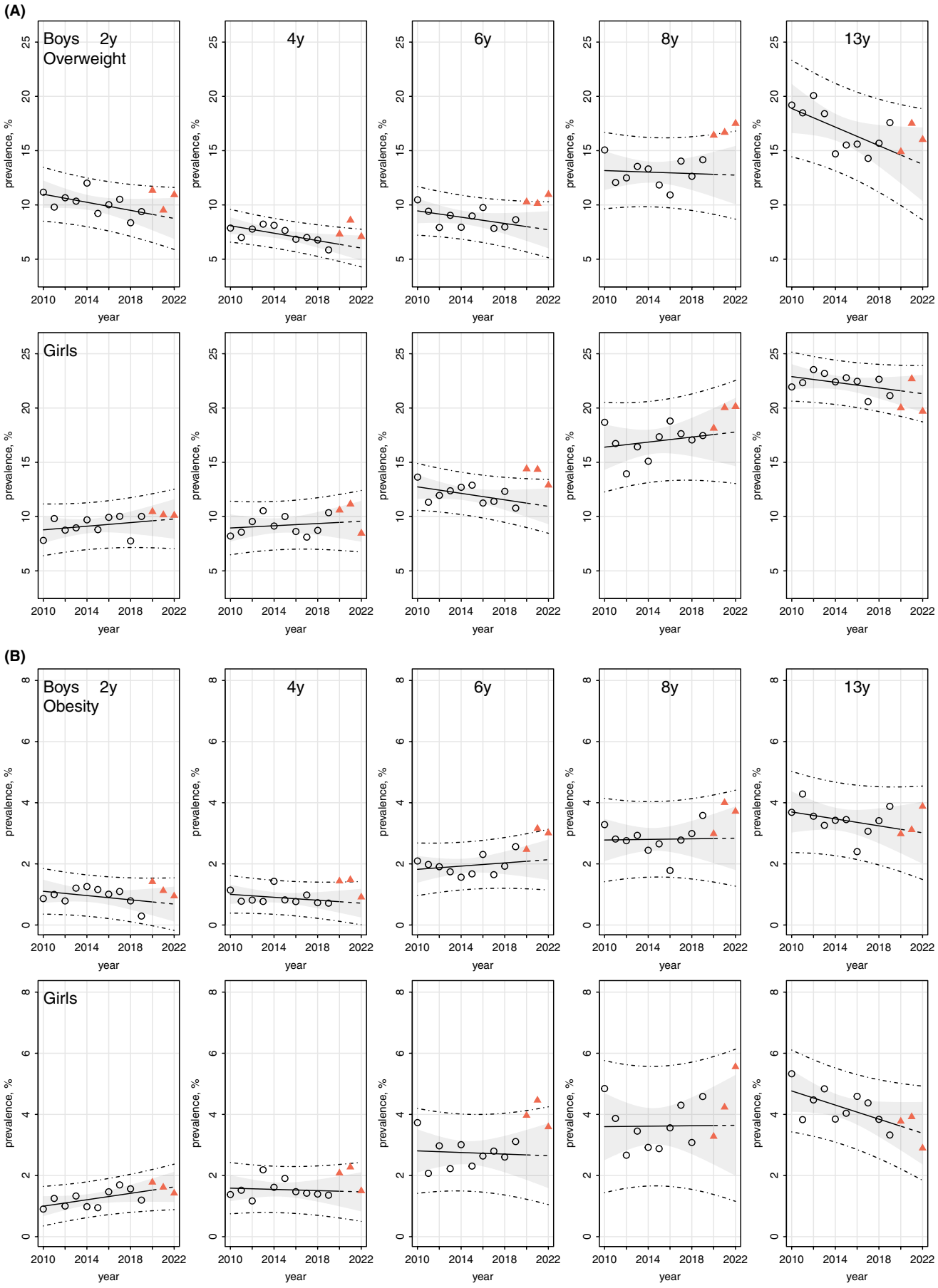

FIGURE 2 (Continued)

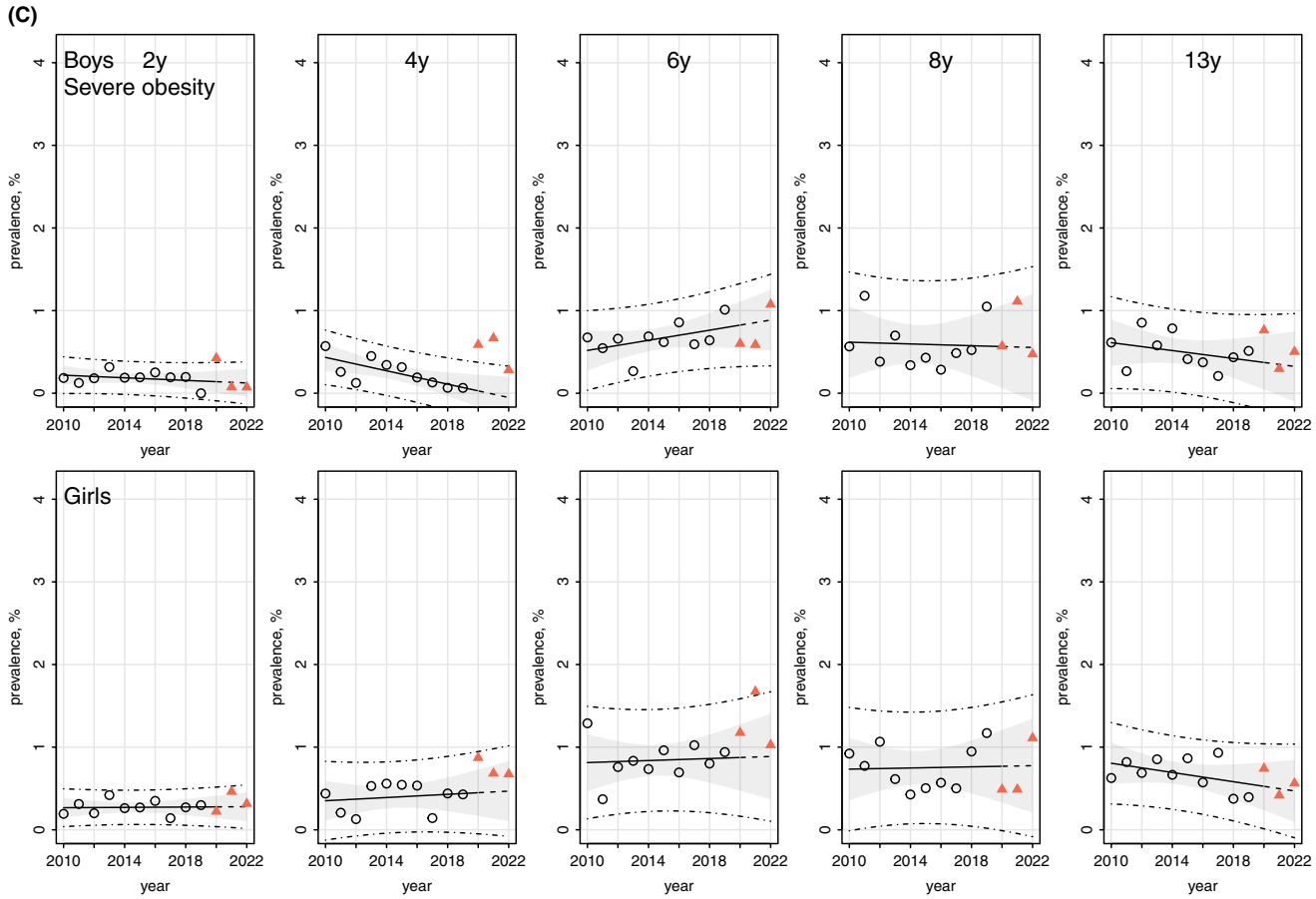

FIGURE 2 Prevalence of overweight (A), obesity (B) and severe obesity (C) in boys and girls from 2010 to 2022 according to International Obesity Task Force (IOTF) BMI cut-offs. Linear trends and corresponding prediction intervals were estimated with linear regression based on data from 2010 to 2019 and extrapolated to the years 2020 to 2022. Red triangles show the observed prevalence in 2020–2022. Grey areas show the confidence interval of the trend from 2010 to 2019 and dash-dot-dash lines the corresponding prediction intervals. Overweight was defined as IOTF ≥25, obesity as IOTF ≥30 and severe obesity as IOTF ≥35. Overweight includes obesity and severe obesity and obesity includes severe obesity.

compared to the predicted prevalence of 7.7% and for the eight-year-old boys it was 17.5%, compared to 12.7%. The observed prevalence of overweight for girls was only above the prediction interval at 6 years of age, at 14.4% against the predicted 11.2% in 2020 and 14.3% against the predicted 11.1% in 2021.

The prevalence estimates for obesity were above the prediction interval for 4-year-old boys in 2020 and 2021 and for 6-year-old boys and girls in 2021 (Figure 2B, Table S2). The prevalence estimates for severe obesity were higher than predicted for 2-year-old boys in 2020 and for 4-year-old boys in 2020 and 2021 (Figure 2C, Table S2). The prevalence of severe obesity was higher than predicted in 6-year-old girls in 2021.

4 | DISCUSSION

This study presents trends in the prevalence of children with overweight, obesity and severe obesity from 2010 to 2019, the decade before the COVID-19 was declared a pandemic in 2020. It provides the first comprehensive analysis of height and weight measurements collected in routine Norwegian child healthcare and incorporates data from most children in the Bergen municipality. We observed statistically significant decreasing trends in the prevalence of overweight among boys aged 4 and 13 years, which have not been previously documented among Norwegian children. However, there were no statistically significant changes in trends for overweight, obesity or severe obesity in girls. Furthermore, this study explored the potential impact of COVID-19 lockdown measures on weight status and found an increase in the prevalence of overweight, obesity and severe obesity from 2020 to 2022, mainly in boys.

The plateau in overweight and obesity rates has been evident since the early 2000s[3,17] and this was consistent with our hypothesis. A major unexpected finding was the significant decline in the prevalence of overweight among boys aged 4 and 13 during the pre-pandemic years from 2010 to 2019. The plateaued and

declining trends could be attributed to prevention and follow-up strategies endorsed by the Norwegian Directorate of Health.[18] A comparable study conducted in Sweden from 2004 to 2015 found plateaued trends in overweight including obesity in 7-year-old children and a decreasing trend in overweight including obesity in 4-year-old boys, in accordance with our findings.[19] In the current study the mean ages for the 4 and 6-year-old children were 4.2 years (±0.2 SD) and 6.3 years (±0.4 SD) respectively (Table 1). The comparable age groups in the Swedish study were 4.0 years (±0.1 SD) and 6.6 years (±0.3 SD). Although the age groups varied slightly between the two studies, the prevalence was almost double in the Swedish 4 and 7-year-old children. Factors such as socioeconomic status, ethnic background and population density have been reported to influence overweight and obesity.[6,20,21] These might explain these differences, but could not be explored in our study.

While no significant decrease was observed in other prepubertal age groups, a decreasing trend in overweight among adolescent boys from 2010 to 2019 was reassuring. This trend was also seen in French adolescents from 2008 to 2018.[22] Further studies are needed to investigate the reasons behind these downward trends.

Few studies in Norway have reported the prevalence of overweight in preschool children. The pre-pandemic prevalence among children aged two and four in this study was 9.7% and 8.2%, respectively (data not shown). Another study from the municipality of Bergen conducted between 2003 and 2006, reported that the prevalence of overweight including obesity was 16.6% in 2-year-old children and 11.8% in 4-year-old children.[6] A study conducted in the municipality of Tromsø during the 2010/2011 school year, reported a prevalence of overweight including obesity to 11.5% in children aged 2–4 years.[23] The current study, which was characterised by its large sample size and low selection bias, enhances the reliability of the results.

Our study reports the prevalence and trends of severe obesity among Norwegian children for the first time. There was a significant decreasing trend in the 4-year-old boys, but no such trend was apparent in the other age groups for boys and girls. A study consisting of a national sample of Norwegian 13-year-old children recruited in 2017, reported an overall prevalence of severe obesity of 0.3%,[20] which was slightly lower than our findings of 0.5% in boys and 0.7% in girls (Table S1). This difference could have been due to geographical differences and the smaller sample size than our study. Furthermore, while the previous study found no strong evidence of sex differences, our study observed a higher prevalence of overweight among girls in all age groups from 4 to 13 years of age. Our findings concur with previous findings regarding the higher prevalence among young girls than boys,[2,19] but disagrees those reporting a higher prevalence in adolescent boys.[19,22] Differences in sexual development, lifestyle behaviours and sociocultural factors might explain this difference, but further research is warranted to provide more definitive answers.

4.1 | COVID-19 pandemic years

After the onset of the COVID-19 pandemic in 2020, we observed an increased prevalence of overweight and obesity, predominantly among prepubertal boys. This was consistent with two international studies published in 2021, which compared the first pandemic year with pre-pandemic years and reported the highest increases among young children compared to adolescents.[24,25] The lockdown period has often been compared to the school summer holidays, when daily routines change, such as regular mealtimes, structured physical activity and consistent sleep habits. These have all been reported to contribute to increased weight gain.[26] Even though weight gain has been reported in those with an initial normal weight, those already experiencing overweight or obesity appeared to face an elevated risk of accelerated weight gain during COVID-19.[14,15,25] We noted a lower prevalence of obesity and severe obesity, which might explain why we did not observe a consistent increase in the prevalence across all weight groups during the pandemic years.

There was no increase in the prevalence of overweight, obesity and severe obesity during the pandemic years among the 13-year-old adolescents in our study. Also a Danish study from 2023, did not find a tendency of increasing overweight and obesity among adolescents aged 14–15 years.[27] A study on physical activity and sedentary time reported that younger children had tended to be more active and had more adult-supervised screen time than adolescents, who often exhibited a more sedentary lifestyle.[28] Therefore, a decline in physical activity and increased screen time during lockdown might have had a more pronounced impact on younger children. In contrast, Sweden, a high-income neighbouring country, pursued a different pandemic strategy, avoiding a formal lockdown and keeping nurseries and schools open. Despite this, overweight and obesity still increased in Swedish children aged 3 and 4 years when comparing weight status before and during the COVID-19 pandemic period 2020/2021.[29,30] Several possible reasons were cited for disrupted attendance at nurseries and lifestyle changes in Swedish families during the pandemic. These included increased hygiene awareness, fewer children attending due to anxiety about catching the severe acute respiratory syndrome coronavirus-2 and a shortage of staff due to sick leave.

After the initial lockdown in Norway, restrictions were eased for the youngest children, with nurseries and schools reopening from late April to mid-May 2020.[10] However, due to the absence of vaccine coverage, practices such as social distancing, suspending school activities and staying at home if disease was suspected, were maintained until late September 2020. Our study found that the COVID-19 measures had a particular impact on prepubertal boys. Boys tend to exhibit higher levels of activity than girls.[28] Reduced physical activity following the closure of sports facilities may have exacerbated obesogenic behaviour more in boys than girls. However, specific data confirming these links are lacking. An increase in the consumption of unhealthy food among children during the COVID-19 lockdown has been discussed in previous review

papers.[12,13] We were unable to find reports on the eating behaviours of young Norwegian children during the pandemic. Further studies need to provide more information about sex differences in weight gain among children during the COVID-19 lockdown.

4.2 | Strengths and limitations

The strength of our study is that we used population-based data that represented nearly the entire child population in the municipality of Bergen, which is Norway's second-largest city. This provided unbiased trends at various ages from 2 to 13 years. We believe these results are generalisable to the Norwegian population as the large sample size included both urban and rural areas. Also, the proportion of citizens with an immigrant background in the municipality of Bergen was 17.8% in 2019, which was about the national average.[31]

The children's height and weight were measured by healthcare nurses, reducing the risk of bias associated with self-reported measurements. In addition, the prevalence estimates of overweight and obesity were similar to the COSI reports from Norway, which provides national data for 8-year-old children approximately every 3 years. These national data reported plateaued trends in overweight including obesity, ranging from 14%–16% in boys and 16%–20% in girls between 2008 and 2019.[5] Our study also included a longer follow-up period than other studies[14,15,29,30] after the initial COVID-19 lockdown, enabling us to explore long-term effects.

Our study had some limitations. While the age distribution within each age group varied slightly across the study years, the differences were small, at most by a single decimal. These differences were insufficient to account for the changes in prevalence observed during the pandemic. In addition, we used age-adjusted *z*-scores to determine weight status. We did not have information on factors that could impact weight gain, such as parental socioeconomic status, ethnicity, food consumption and physical activity levels. This hindered a detailed description of the probable causes of the observed trends. It is also possible that children with underweight or overweight might have opted out of height and weight measurements, potentially skewing the data. However, due to the high participation rate, we believe the impact was small and did not change the overall estimates.

5 | CONCLUSION

This study systematically analysed the height and weight measurements collected during routine healthcare visits attended by most of the children in the municipality of Bergen from 2010 to 2022. The prevalence of overweight, obesity and severe obesity in children aged 2–13 years in 2010–2019 indicated a pre-pandemic plateau in girls and a decreasing trend in 4- and 13-year-old boys. During pandemic years 2020–2022, the prevalence of overweight was higher than anticipated in boys aged 4, 6 and 8 years. The overall accelerated weight gain reported by international studies during lockdown periods, was not seen in girls and 13-year-old boys in our study. The study highlights that routine measurements of height and weight enable monitoring and evaluation of different weight status throughout childhood and adolescence. These data may be valuable for collection on a national basis.

AUTHOR CONTRIBUTIONS

Melissa R. Balthasar: Conceptualization; writing – original draft; formal analysis; methodology; data curation. **Mathieu Roelants:** Methodology; visualization; formal analysis; supervision; conceptualization; data curation. **Bente Brannsether-Ellingsen:** Writing – review and editing; supervision. **Ragnar Bjarnason:** Writing – review and editing. **Ingunn H. Bergh:** Writing – review and editing. **Liv G. Kvalvik:** Writing – review and editing. **Kristine M. Stangenes:** Writing – review and editing. **Astanand Jugessur:** Writing – review and editing. **Mette C. Tollånes:** Writing – review and editing. **Finn Markussen:** Writing – review and editing. **Petur B. Juliusson:** Conceptualization; writing – review and editing; project administration; supervision; methodology.

ACKNOWLEDGEMENTS

We thank Grethe Almenning for providing information on the participation rate.

FUNDING INFORMATION

The Western Norway Regional Health Authority, Grant number F-12594, supported this study.

CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to declare.

ETHICS STATEMENT

The project was approved by the Regional Committee for Medical and Health Research Ethics in Western Norway (ref. 2010/3276/REK vest).

REFERENCES

1. Report on the fifth round of data collection, 2018–2020: WHO European Childhood Obesity Surveillance Initiative (COSI). 2022 Accessed May 16, 2023. https://www.who.int/europe/publications/i/item/WHO-EURO-2022-6594-46360-67071#
2. Garrido-Miguel M, Cavero-Redondo I, Álvarez-Bueno C, et al. Prevalence and trends of overweight and obesity in European children from 1999 to 2016: a systematic review and meta-analysis. JAMA Pediatr. 2019;173(10):e192430. doi:10.1001/jamapediatrics.2019.2430
3. NCD Risk Factor Collaboration. Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults. Lancet. 2017;390(10113):2627-42. doi:10.1016/s0140-6736(17)32129-3
4. Meyer HE, Bergh IH. Overvekt og fedme i Noreg [Overweight and obesity in Norway]. Norwegian Institute of Public Health 2023. Updated 31.08.2022. Accessed October 02, 2023. https://www.fhi.no/he/folkehelserapporten/ikke-smittsomme/overvekt-og-fedme/?term=

5. Norwegian Institute of Public Health. Overweight and obesity, 8-year-olds-percent. Accessed October 02, 2023. http://www.norgeshelsa.no/norgeshelsa/index.jsp?headers=AAR&stubs=GEO&stubs=VEKTKATEGORI&stubs=KJONN&measure=common&virtualslice=RATE_value&layers=virtual&GEOsubset=0&VEKTKATEGORIsubset=overvektOgFedme_ukal%2Cfedme_ukal+-+renOvervekt_ukal&study=http%3A%2F%2F10.1.5.31%3A80%2Fobj%2FfStudy%2Fovervekt-8aar&mode=cube&KJONNsubset=0%2C1+-+2&virtualsubset=RATE_value&v=2&AARsubset=2008+-+2019&measuretype=4&cube=http%3A%2F%2F10.1.5.31%3A80%2Fobj%2FfCube%2Fovervekt-8aar_C1&language=en&top=yes
6. Júlíusson PB, Eide GE, Roelants M, Waaler PE, Hauspie R, Bjerknes R. Overweight and obesity in Norwegian children: prevalence and socio-demographic risk factors. Acta Paediatr. 2010;99(6):900-5. doi:10.1111/j.1651-2227.2010.01730.x
7. The Norwegian Directorate of Health. Nasjonal faglig retningslinje for det forebyggende arbeidet i helsestasjon, skolehelsetjeneste og helsestasjon for ungdom [National guideline for health promotion and preventive work in the child- and school health centres, and youth health service]. Accessed October 10, 2023. https://www.helsedirektoratet.no/retningslinjer/helsestasjons-og-skolehelsetjenesten
8. Statistics Norway. Kommunehelsetjeneste [Municipal health service]. Accessed December 10, 2023. https://www.ssb.no/statbank/table/11993/
9. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19. Accessed September 05, 2023. https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020
10. The ministries' security and service organisation. Tidslinje: myndighetenes håndtering av koronasituasjonen [Timeline: the authorities' handling of the corona situation]. Accessed November 06, 2023. https://www.regjeringen.no/no/tema/Koronasituasjonen/tidslinje-koronaviruset/id2692402/
11. Storz MA. The COVID-19 pandemic: an unprecedented tragedy in the battle against childhood obesity. Clin Exp Pediatr. 2020;63(12):477-82. doi:10.3345/cep.2020.01081
12. Nour TY, Altintaş KH. Effect of the COVID-19 pandemic on obesity and it is risk factors: a systematic review. BMC Public Health. 2023;23(1):1018. doi:10.1186/s12889-023-15833-2
13. Stavridou A, Kapsali E, Panagouli E, et al. Obesity in children and adolescents during COVID-19 pandemic. Children (Basel). 2021;8(2):135. doi:10.3390/children8020135
14. Brooks CG, Spencer JR, Sprafka JM, et al. Pediatric BMI changes during COVID-19 pandemic: an electronic health record-based retrospective cohort study. EClinicalMedicine. 2021;38:101026. doi:10.1016/j.eclinm.2021.101026
15. Vogel M, Geserick M, Gausche R, et al. Age- and weight group-specific weight gain patterns in children and adolescents during the 15 years before and during the COVID-19 pandemic. Int J Obes (Lond). 2022;46(1):144-52. doi:10.1038/s41366-021-00968-2
16. Cole TJ, Lobstein T. Extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity. Pediatr Obes. 2012;7(4):284-94. doi:10.1111/j.2047-6310.2012.00064.x
17. Wabitsch M, Moss A, Kromeyer-Hauschild K. Unexpected plateauing of childhood obesity rates in developed countries. BMC Med. 2014;12:17. doi:10.1186/1741-7015-12-17
18. The Norwegian Directorate of Health. Forebygging, Utredning Og Behandling Av Overvekt Og Fedme Hos Barn Og Unge -Nasjonale Faglige Retningslinjer for primærhelsetjenesten [Prevention, Assessment and Treatment of Overweight and Obesity in Children and Adolescents - National Guidelines for Primary Health Care] (IS-1734).
19. Eriksson M, Lingfors H, Golsäter M. Trends in prevalence of thinness, overweight and obesity among Swedish children and adolescents between 2004 and 2015. Acta Paediatr. 2018;107(10):1818-25. doi:10.1111/apa.14356
20. Øvrebø B, Bergh IH, Stea TH, et al. Overweight, obesity, and thinness among a nationally representative sample of Norwegian adolescents and changes from childhood: associations with sex, region, and population density. PLoS One. 2021;16(8):e0255699. doi:10.1371/journal.pone.0255699
21. Øvrebø B, Kjøllesdal M, Stea TH, et al. The influence of immigrant background and parental education on overweight and obesity in 8-year-old children in Norway. BMC Public Health. 2023;23(1):1660. doi:10.1186/s12889-023-16571-1
22. Vanhelst J, Baudelet JB, Thivel D, Ovigneur H, Deschamps T. French youth trends in prevalence of overweight, obesity and underweight from 2008 to 2018. BMC Res Notes. 2022;15(1):208. doi:10.1186/s13104-022-06091-3
23. Evensen E, Wilsgaard T, Furberg AS, Skeie G. Tracking of overweight and obesity from early childhood to adolescence in a population-based cohort - the Tromsø study, fit futures. BMC Pediatr. 2016;16:64. doi:10.1186/s12887-016-0599-5
24. Woolford SJ, Sidell M, Li X, et al. Changes in body mass index among children and adolescents during the COVID-19 pandemic. JAMA. 2021;326(14):1434-6. doi:10.1001/jama.2021.15036
25. Lange SJ, Kompaniyets L, Freedman DS, et al. Longitudinal trends in body mass index before and during the COVID-19 pandemic among persons aged 2-19 years - United States, 2018-2020. MMWR Morb Mortal Wkly Rep. 2021;70(37):1278-83. doi:10.15585/mmwr.mm7037a3
26. Baranowski T, O'Connor T, Johnston C, et al. School year versus summer differences in child weight gain: a narrative review. Child Obes. 2014;10(1):18-24. doi:10.1089/chi.2013.0116
27. Berg SK, Birk NM, Thorsted AB, et al. Risk of body weight changes among Danish children and adolescents during the COVID-19 pandemic. Pediatr Obes. 2023;18(4):e13005. doi:10.1111/ijpo.13005
28. Cooper AR, Goodman A, Page AS, et al. Objectively measured physical activity and sedentary time in youth: the International Children's Accelerometry Database (ICAD). Int J Behav Nutr Phys Act. 2015;12:113. doi:10.1186/s12966-015-0274-5
29. Fäldt A, Nejat S, Edvinsson Sollander S, Durbeej N, Holmgren A. Increased incidence of overweight and obesity among preschool Swedish children during the COVID-19 pandemic. Eur J Public Health. 2023;33(1):127-31. doi:10.1093/eurpub/ckac181
30. Miregård J, Nowicka P, Nylander C. National data showed an increased prevalence of overweight and obesity among four-year-old Swedish children during the first year of COVID-19. Acta Paediatr. 2023;112(6):1269-74. doi:10.1111/apa.16707
31. Statistics Norway. Innvandrere og norskfodte med innvandrerforeldre [Immigrants and Norwegian-born to immigrant parents]. Accessed October 05, 2023. https://www.ssb.no/en/statbank/table/09817/

SUPPORTING INFORMATION

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

How to cite this article: Balthasar MR, Roelants M, Brannsether-Ellingsen B, Bjarnason R, Bergh IH, Kvalvik LG, et al. Trends in overweight and obesity in Bergen, Norway, using data from routine child healthcare 2010–2022. Acta Paediatr. 2024;113:2098–2106. https://doi.org/10.1111/apa.17323