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ORIGINAL ARTICLE

Nonattendance in preventive child health examinations associated with increased risk of school-aged obesity in Denmark

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Abstract

Aim: The aim of this study is to investigate associations between attending routine preventive child health examinations in general practice and the risk of obesity and overweight at age six, focusing on psychosocial risk factors.

Methods: Data from nationwide Danish registers on 725 926 children born between 2000 and 2012 were analysed. Information on examination attendance and BMI was obtained. Regression analyses assessed the association between examination attendance and obesity or overweight risk.

Results: Non-attendance in preventive child health examinations was associated with a risk of obesity of 18%–31% at age six. The highest risk was observed in children of parents with low educational attainment who missed all examinations, a four- to five-fold increase compared to children of parents with high educational attainment who attended all or missed only one exam. A smaller association of one to 2% was found between missing examinations and risk of overweight in the general population. However, children of parents with low educational attainment who did not attend were 8%–9% more likely to have overweight.

Conclusion: Associations were found between obesity and overweight and not attending preventive child health examinations in general practice. Further research is needed to understand the mechanisms and develop targeted interventions to address health disparities in childhood obesity.

KEYWORDS
general practice, obesity, overweight, preventive child health examination

Abbreviations: BMI, body mass index; CI, confidence interval; RR, risk ratios.

1 | INTRODUCTION

Childhood obesity has emerged as a global epidemic, presenting a significant public health challenge.[1,2] Even in Denmark, a country with a comparatively low prevalence, the rates remain concerning, with over 10% of children aged 6–7 classified with overweight and 3% with obesity.[3] Alarmingly, obesity rates are projected to escalate by 2030.[1] Moreover, there is a pronounced social inequality in distribution of overweight and obesity among children,[4,5] underscoring the urgency for effective preventive and early detection interventions.

Early identification and intervention are paramount since overweight-related complications are established already by school ages.[6] Moreover, persistent childhood obesity is closely linked to cardiovascular disease in adulthood.[7]

All children aged 0–5 years in Denmark are offered seven routine preventive child health appointments in general practice, ensuring comprehensive monitoring of their physical, mental, and social well-being.[8] The Danish tax-based healthcare system ensures that health services, including these examinations, are free of charge.[9] General practitioners play a pivotal role in the identification and management of childhood overweight and obesity.[8,10] The Danish Health Authority guideline specifies the assessment of overweight and obesity as a key aspect of the routine examinations conducted by general practitioners. This unique opportunity places general practice in an ideal position to identify and address overweight and obesity at an early stage.

Children attending preventive health examinations in general practice may benefit from early recognition and intervention, potentially averting the progression of overweight or obesity.[11] Furthermore, children of parents with psychosocial risk factors, including those with parents of low educational levels[12] or mental health conditions may particularly gain from these examinations, which encompass preventive healthcare, early detection and counselling tailored to the specific needs of both parents and children.

Despite the conceptualisation of these examinations as interventions to address health inequality,[13,14] their actual impact on child health remains poorly studied and largely unexplored. To bridge this gap, our study aims to investigate the association between attending preventive child health examinations and the risk of overweight and obesity at the age of six. We will explore this association within the broader paediatric population and specifically assess its implications for children of parents with psychosocial risk factors, including short length of education and mental health conditions. This research seeks to contribute to valuable insight to inform targeted interventions and policies aimed at reducing childhood obesity and health disparities.

Key note

- The impact of preventive health examinations on child obesity and overweight are poorly studied and largely unexplored.
- Nonattendance at routine preventive child health examinations in general practice were associated with a pronounced risk of obesity and an increased risk of overweight at age six.
- The highest obesity risk was found in children whose parents had low educational attainment and missed all exams.

2 | METHODS

2.1 | Study design

We conducted a population-based birth cohort using nationwide Danish registers.

2.2 | Setting

All children in Denmark are offered seven examinations in general practice during their first 5 years of life. The first three examinations are during the first year, followed by one examination annually at the ages of two, three, four and five. The examinations are performed by the physician or by another health professional delegated by the physician. Furthermore, all children are during their first year of life offered home visits from health nurses in the municipality. At school age, all children are offered health examinations at school by health nurses from the municipality.

2.3 | Participants

We included all Danish children born between 2000 and 2012. Children were included at age six, as health examinations at school ages are conducted by school health nurses. Most children undergo their 5-year examination during their sixth year and before they turn 6 years old,[15] thus providing a suitable follow-up period from the children's sixth to seventh birthday.

Children were excluded if information on parents' identification number was missing, blocking linkage to the parents, or if the children or parents were not residing in Denmark at baseline, being when the child turned 6 years old or during the exposure period.

2.4 | Variables

The outcome of interest was overweight and obesity based on body mass index (BMI) at school age, defined as the first registration and clinical measure of BMI by the school health nurse at the age of six or later. Overweight and obesity were defined based on The International Obesity Taskforce (IOTF) criteria,[16] using age- and gender-specific BMI centile corresponding to BMI at age 18 years, with a BMI ≥25 at age 18 years defining overweight and a BMI ≥30 at age 18 years defining obesity.

The exposure variable was attendance at preventive child health examinations, including the four examinations at ages 2, 3, 4 and 5 years, respectively, categorised as: attending all or missing one (reference), missing two or three and missing all four examinations. These four exams are performed in general practice and are therefore included in this study. The examinations and measures before the age of two are performed by the health visitor.

Parental psychosocial risk factors were low level of educational attainment and mental health conditions, categorised as maternal and paternal risk factors, respectively. *Parental education* was categorised based on the International Standard Classification of Education (2011)[17] and grouped into three categories according to the parent's highest educational attainment at the time where the child turned 6 years: levels 0–2 (10 years of mandatory education or below), levels 3–4 (10–14 years of education, such as high school) and levels 5–8 (more than 14 years of education, such as a bachelor's degree). *Mental health conditions* were categorised based on the level of mental healthcare received within 5 years prior to baseline and categorised in three mutually exclusive groups. Parents with minor mental health conditions had been treated solely at primary healthcare settings. These parents were identified via talk therapy and psychometric tests in general practice, contacts to psychologist and reimbursed prescriptions of antidepressants and anxiolytics. Moderate–severe mental health conditions required a higher level of mental healthcare and were defined by contact to psychiatrist practicing outside psychiatric hospital or any registered psychiatric diagnosis at psychiatric hospital. More detailed definitions of the mental health conditions are further described elsewhere.[18]

We included following covariates: parent's age at the time of the child's birth, parental cohabitation (living with a partner or not), parity (firstborn or not), country of origin (Nordic, Western European, and other) and calendar year. To account for geographic variation in access to healthcare services, municipality was categorised into four categories: outer, rural, intermediate and city based on a range of indicators such as population per square kilometre, population in rural areas and cities with less than 1000 inhabitants and part of population in specific age groups.[19] All covariates were extracted at baseline.

2.5 | Data sources

Data linkages were achieved using the personal identity number assigned to all Danish residents at birth or to individuals when they become residents. Register keepers at Statistics Denmark carried out data collection and register linkage. All data were deidentified before the researchers gained access.

Information on child participation in preventive health examinations at general practice and mental health-related contacts to primary healthcare were retrieved from the Danish Health Service Register.[20] Data on height and weight were obtained from the National Children's Database.[21] Information on parents' highest completed education was provided by the Population Education Register.[22] The National Patient Register provided information about psychiatric diagnoses and hospital contacts,[23] whereas the Danish National Prescription Registry provided data on reimbursed prescriptions on psychopharmaceuticals.[24] Information on the age of the child and parents, parental cohabitation status, country of origin and municipality were retrieved from the Danish Civil Registration System.[25]

2.6 | Statistics

Descriptive statistics, including numbers and percentages, were calculated for groups of children of parents with psychosocial risk factors by categories of preventive child health examination attendance. Modified Poisson regression analyses were conducted to produce adjusted risk ratios (RRs) for overweight and obesity. RRs for overweight and obesity were calculated for the overall population and within subgroups of vulnerable children for maternal and paternal risk factors, respectively. The reference group comprised children with the expected lowest risk of overweight or obesity, namely those attending all or missing one examination, and for example, having mothers with the longest attained education. We adjusted for parent's age and calendar year using restricted cubic splines with three knots.[26] Siblings appear in the cohort and may not be independent. Therefore, we used a generalised estimating equation with an exchangeable correlation structure was used to fit a generalised linear model with log-link function, assuming a Poisson distribution and using robust variance estimation using Stata 18.0.

3 | RESULTS

We included 725 926 children in the analyses corresponding to 79.8% of all children born in Denmark from 2000 to 2012. This followed the exclusion of 25 826 (2.8%) children due to missing parental identification number, 79 351 (8.7%) due to non-residency of the child and/or the parents in Denmark at baseline or during the exposure period. Additionally, 78 962 (8.7%) were excluded due to missing information on BMI status at school age (Figure 1). Baseline sociodemographic characteristics by attendance at preventive child health examination are presented in Table 1. Overall, more than two-thirds (69%) of the children attended all four exams or missed only one. The proportion of children of parents with psychosocial risk factors was higher in groups missing two or three examinations and those missing all four examinations than the group of children attending all or missing one examination. For instance, 11% of the children attending all or missing one exam had mothers with 10 years of education or less; this percentage was 23% for children attending two or three examinations and 33% among those missing all four examinations.

Figure 2 illustrates the risk of overweight and obesity in the overall population. Attendance at preventive child health examinations,

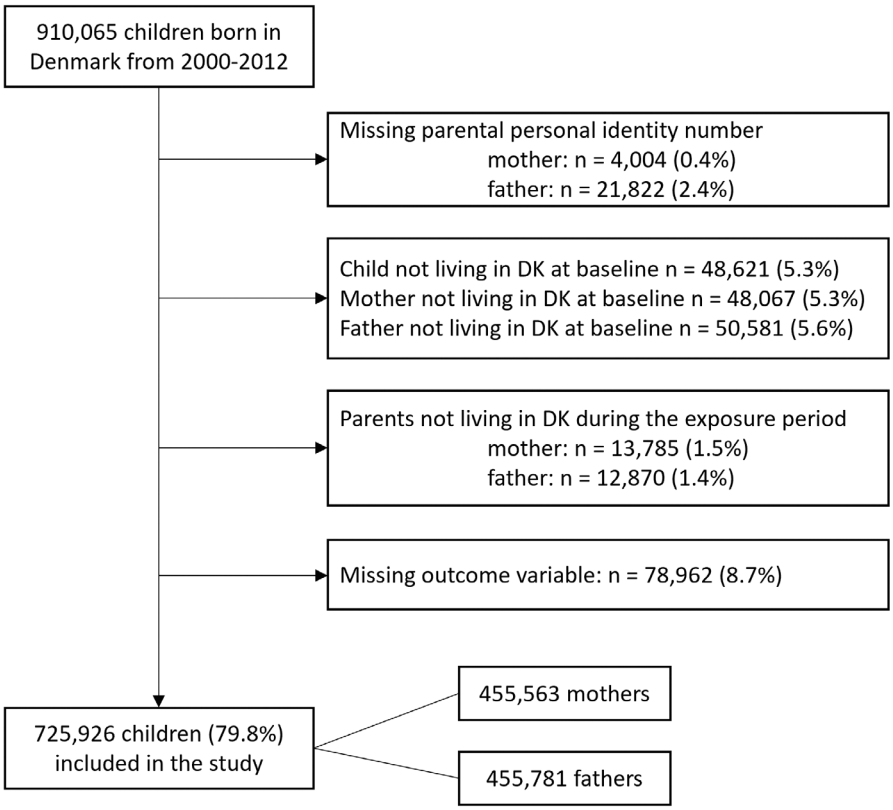


FIGURE 1 Flow chart of the study population.

compared to non-attendance, was associated with a small, but statistically significant reduced risk of overweight at age six in the overall population (RR 1.02, 95% CI 1.01–1.02, Figure 2).

In the subgroup of children of parents with 10 years of education of less, a slightly increased risk of overweight of eight to 9% regardless the level of attendance was seen compared to children of parents with more than 14 years of education attending all or missing one exam (Figure 3). For children of parents with 10–14 years of education, the risk of overweight was increased by 5%–8% with a slightly higher risk in the groups not attending the exams.

Overall, higher risks of obesity were associated with the number of missed examinations. In the overall population, the children with four missed examinations had a 31% increased risk of obesity compared to the children attending all or missing only one examination (Figure 2). Among the examined risk groups, the risk of obesity was markedly higher in children of parents with psychosocial risk factors with the highest risk, four- to five-fold increased, in children of parents with 10 years of education or less missing all exams, compared to children of parents with more than 14 years of education attending all or missing one exam (Figure 4). Children of parents with mental health conditions had 20%–42% increased risk of obesity regardless of the level of participation compared to children of parents without mental health conditions attending all examinations. Also, children of parents without mental health conditions who missed2–3 or all four exams had a 26% (RR 1.26, 95% CI 1.21–1.31) and 51% increased risk (RR 1.51, 95% CI 1.41–1.61) of obesity (Figure 4), respectively.

4 | DISCUSSION

This study aimed to investigate the association between attending preventive child health examinations in general practice and the risk of overweight and obesity in Danish children at age of six. We also aimed to assess the implications of these examinations for subgroups of children of parents with psychosocial risk factors being short length of education and mental health conditions. To our knowledge, this is the first study examining the association between attending preventive child health examinations and the risk of overweight and obesity within a Danish context.

Our findings suggest that not attending preventive child health examinations is associated with an increased risk of obesity and slightly increased risk of overweight at the age of six.

Preventive child health examinations in general practice hold significant potential for early identification and intervention of childhood overweight and obesity. This potential is supported by a UK study by Mason et al.,[11] which found that cuts to spending on government-funded facilities providing early education, healthcare and parenting support were associated with increased childhood obesity.[11] Furthermore, participation in these examinations may help reduce the inequality gap in the utilisation of specialised health care.[27] To meet this, an extended child health examination has been introduced in Denmark for children not attending the preventive examinations allowing for an outreach effort in general practice. Four times a year, a list of children not attending are made for the general practice. The children can then be contacted by general practice and offered the extended examination. The intervention has been

TABLE 1 Baseline sociodemographic characteristics. Numbers and percentages of the overall population and percentages of children by covariate and category of preventive child health examination attendance.

	Attending all/missing one	Attending two or three exams	Missing all exams
Number of children (%)	498 877 (68.7)	194 367 (26.8)	32 682 (4.5)
Parity			
First born	45.4	36.6	23.5
Not first born	50.7	57.0	65.0
Missing variable	3.9	6.4	11.5
Country of origin			
Nordic	94.7	84.9	82.9
Western Europe	0.3	0.5	0.8
Other	5.0	14.5	16.3
Missing	0.0	0.0	0.0
Municipality			
Outer	8.0	7.2	8.7
Rural	28.9	25.5	27.0
Intermediate	17.3	16.5	16.2
City	45.7	50.5	46.7
Missing variable	0.1	0.2	1.4
Maternal covariates			
Age			
<25	9.8	16.5	18.5
25–32	51.4	45.4	41.5
>32	38.8	38.1	39.9
Missing	0.0	0.0	0.1
Educational level			
< 10 years	10.8	22.7	32.7
10–14 years	37.8	37.9	36.8
>14 years	50.8	37.9	27.8
Missing	0.5	1.5	2.7
Mental health condition			
None	74.1	68.3	66.2
Minor	18.4	19.7	19.5
Moderate	6.7	10.4	12.1
Severe	0.9	1.6	2.2
Cohabitation status			
Living with partner	88.3	79.3	71.9
Not living with partner	11.7	20.4	26.7
Missing variable	0.1	0.2	1.4
Paternal covariates			
Age			
<25	4.5	8.0	9.3
25–32	39.4	36.3	33.4
>32	56.1	55.5	57.1
Missing	0.0	0.1	0.3
Educational level			
<10 years	13.9	22.5	29.8

TABLE 1 (Continued)

	Attending all/missing one	Attending two or three exams	Missing all exams
10–14 years	46.1	43.8	42.7
>14 years	39.1	31.6	24.5
Missing	0.9	2.1	3.1
Mental health condition			
None	84.1	78.5	75.8
Minor	10.7	12.8	13.3
Moderate	4.4	7.3	9.1
Severe	0.8	1.4	1.8
Cohabitation status			
Living with partner	88.5	79.7	72.5
Not living with partner	11.3	19.9	25.9
Missing variable	0.1	0.4	1.5

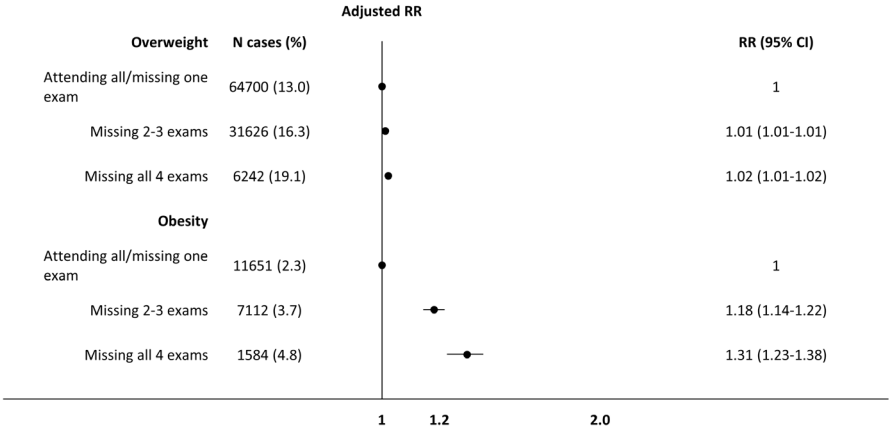


FIGURE 2 Numbers and risk ratios for overweight and obesity at school age for groups of attendance in examinations in the overall population.

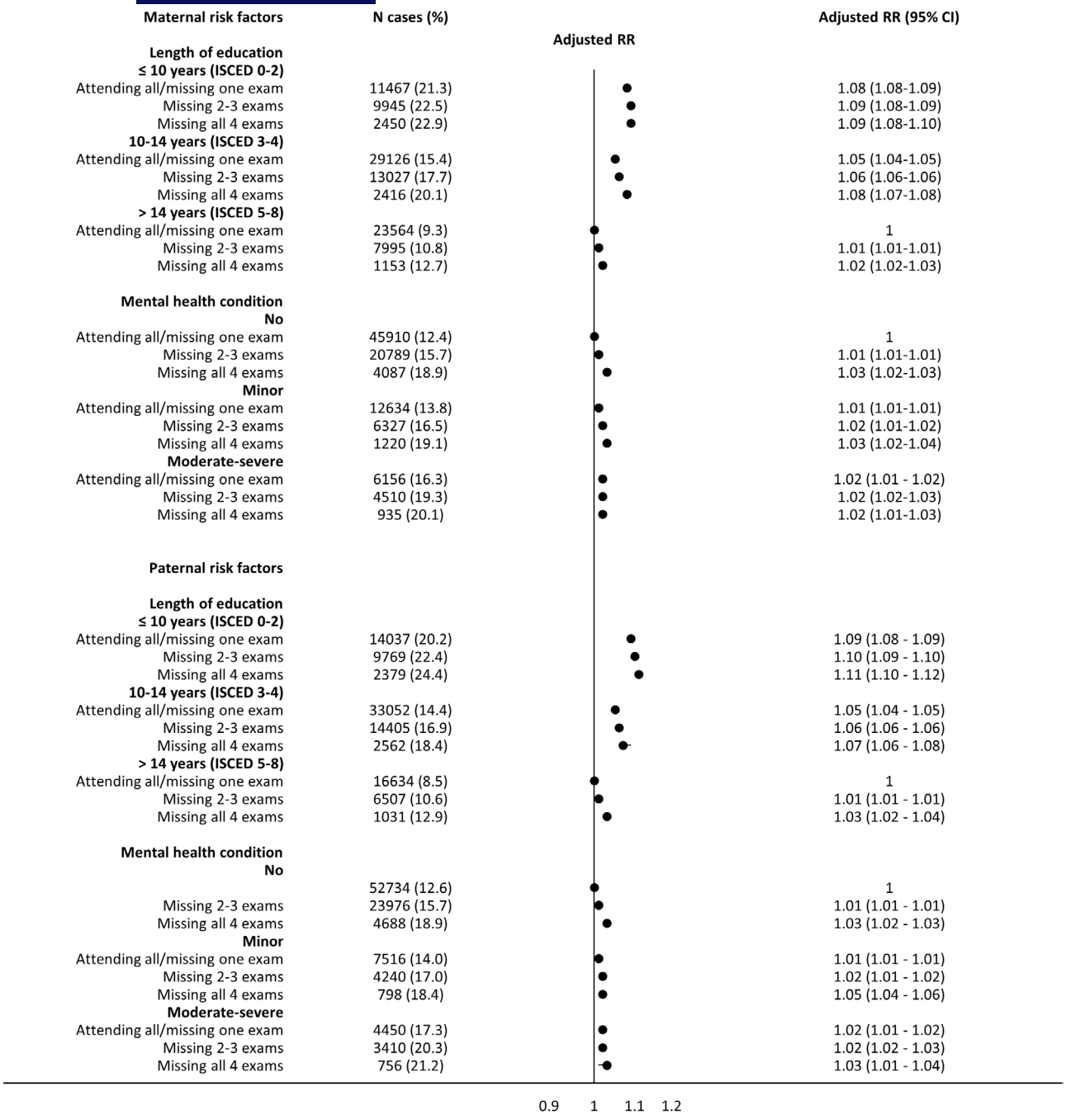
Adjusted for calendar year, country of origin, municipality, parental age, education, cohabitation, parental education and parental mental health

tested in a small-scale pilot study (not published), finding that more children attended the examinations. However, intervention has not been evaluated scientifically.

Our study examined the implications of attending preventive child health examinations for vulnerable subgroups. We found that children with parents of low educational levels or mental health conditions had a higher risk of obesity. This highlights the importance of targeted interventions and support for these vulnerable populations. Preventive child health examinations may provide an opportunity to identify and address the specific needs of these children and their parents.[28] A report by the Danish Health Authority highlights that a low maternal level of education is an important indicator of the necessity of extra support and concludes that a stronger focus on outreach and retention effort for families with low education and social vulnerability could reduce health inequality.[29] However, evidence on effective strategies for supporting these populations and reducing the risk of obesity are lacking.

Low levels of parental health literacy are associated with childhood obesity and parental attitudes about child weight.[30,31] Thus, effective communication between general practitioners and parents is crucial, particularly regarding the physician's ability to adapt information to the parents' health literacy level. General practitioners may often communicate in a traditional expert role, failing to consider the broader family context and the family's specific situation.[32] In Denmark, although there is a recommended focus on health literacy, it has not yet been fully implemented in general practice.[33] Interventions in primary care that target health literacy have shown promising results in preventing childhood obesity.[34] Enhancing health literacy competencies within general practice may therefore significantly improve the prevention of childhood obesity.

The mixed results regarding the association between attending preventive child health examinations and the risk of overweight and obesity might be explained be a range of factors. Some of these factors may relate to the focus and competencies of general practitioners.[35] A report highlighted a lack of focus on overweight issues and insufficient knowledge among general practitioners regarding cross-sectional collaborators.[36] Similarly, a study that only one-fifth of the paediatricians felt competent in addressing childhood



Adjusted for calendar year, country of origin, municipality, parental age, cohabitation and the other risk factor (mental health or lenght of education)

FIGURE 3 Numbers and risk ratios for overweight at school age for groups of attendance in examinations in subgroups of maternal and paternal psychosocial risk factors.

obesity.[37] Moreover, research indicate that general practitioners often experience uncertainty in how to communicate their concerns, including those regarding obesity, to the parents, leading to a passive and hesitant approach.[32,35,38,39]

While the examinations may provide an opportunity for healthcare professionals to identify and counsel parents and children, it may not be sufficient to address the social and environmental factors that contribute to overweight and obesity. Future research should explore the specific component of these examinations and their effectiveness in addressing overweight and obesity.

The findings of the association between parental mental health conditions and obesity in children add to the literature of the wide-ranging health risks in children of parents with mental health conditions.[40–42] Worth noticing is that a Danish study reported that many general practitioners' knowledge on the impact of parental depression on the child were poor.[43] Thus, increasing

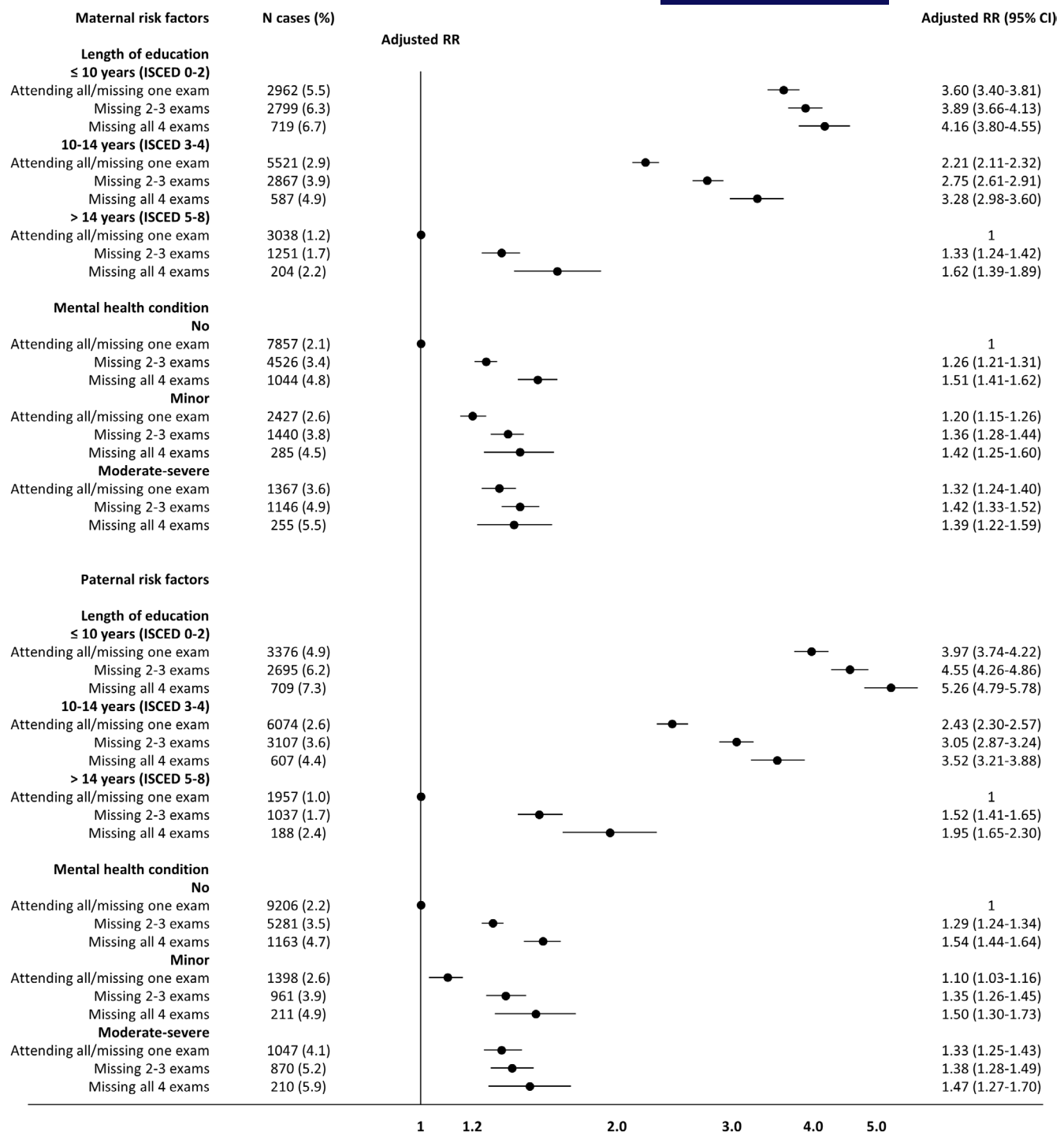


FIGURE 4 Numbers and risk ratios for obesity at school age for groups of attendance in examinations in subgroups of maternal and paternal psychosocial risk factors.

this knowledge in general practitioners may be an area needing focus and intervention.

It is important to note that our findings do not imply causation. Other factors may contribute to both attending these examinations and a lower risk of obesity. For example, higher levels of parental health literacy are associated with a lower risk of obesity and greater likelihood of following recommendations such as attending child health examinations. Future research should explore the mechanisms through which attending these examinations may reduce the risk of obesity.

It is worth noting that our study has some limitations. First, the missing data of the outcome variable in 9% of the population

may lead to selection bias. Second, we cannot rule out confounding. Attending child health examinations might be associated with healthier lifestyle and higher level of health literacy. However, we did handle covariates known to be associated with not attending preventive child health examinations, such as maternal depression,[15] young and single parents[44] and older siblings[44] by controlling. Finally, our study focused on the Danish context, and the findings may not be generalisable to other countries with different healthcare systems and social contexts.

The large cohort constituting 13 birthyears and the large percentage of children included is a noteworthy strength of this study. Also is the high quality of the Danish nationwide registers.[9]

In conclusion, we found that not attending the preventive child health examinations in general practice is associated with an increased risk of obesity at age of six. The highest risk of obesity was seen in children of parents with 10 years of education or less. Regarding overweight, our study only found an association of 8%–9% between attending preventive child health examinations and the risk of overweight in children of parents with 10 years of education or less. Further research is needed to understand specific components of these examinations and their effectiveness in addressing overweight and obesity. Additionally, targeted interventions and support should be developed for vulnerable populations to reduce the risk of obesity.

AUTHOR CONTRIBUTIONS

Signe Heuckendorff: Conceptualization; formal analysis; funding acquisition; project administration; writing – original draft; writing – review and editing; methodology; investigation; visualization. **René Børge Korsgaard Brund:** Conceptualization; writing – review and editing; supervision; formal analysis; investigation. **Charlotte Nørkjær Eggertsen:** Conceptualization; supervision; writing – review and editing; investigation. **Janus Laust Thomsen:** Conceptualization; supervision; writing – review and editing; investigation. **Kirsten Fonager:** Conceptualization; methodology; formal analysis; supervision; writing – review and editing; funding acquisition; project administration; investigation; resources.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study is available from the Statistics Denmark, but restrictions apply to the availability of these data, which were used under licence for the current study, and so are not publicly available. Questions or requests concerning these data are directed to the corresponding author Signe Heuckendorff.

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