Original Article

Bereavement in Early Life and Later Childhood Overweight

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Key Words

Stress • Bereavement • Overweight • Childhood obesity • Body mass index

Abstract

Objective: The rise in the occurrence of childhood obesity during the last decades in many populations indicates an important role of environmental exposures, which may operate very early in life. We aimed to examine the association between bereavement during the first 6 years of life, as a stress indicator, and subsequent risk of overweight in school-aged children.

Methods: We followed 46,401 singletons born in Denmark who underwent annual health examinations at 7–13 years of age in school of Copenhagen. A total of 492 children experienced bereavement by death of a parent during the first 6 years of life. We compared BMI levels, changes in BMI, and the prevalence of overweight at 7–13 years of age between bereaved and non-bereaved children. **Results:** Between bereaved children and non-bereaved children, there were no differences in average BMI levels at any age or changes in BMI at 7–13 years of age. Bereavement during the first 6 years of life was not associated with an increased risk of overweight at 7–13 years of age. **Conclusion:** This study did not support that stress induced by bereavement during the first 6 years of life has significant influence on overweight in later childhood.

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Introduction

One out of 10 school-aged children worldwide is overweight or obese, which decreases quality of life and increases the risk of several chronic diseases [1, 2]. The rise in the occurrence of childhood obesity during the last decades in many populations indicates an important role of environmental exposures, which may operate very early in life [3, 4]. However, little is known about the etiology [5, 6]. Breastfeeding has been associated with a lower risk [7, 8], while over- or undernutrition in infancy followed by overnutrition has been associated with increased risk of childhood or adulthood obesity [9]. Several other variables related to birth as well as to behavioral and social factors have been suggested to be associated with the risk of childhood obesity, but the evidence remains uncertain [10], providing limited clues for effective prevention [5, 6].

Animal studies have demonstrated that stress during the early period of life is associated with epigenetic and metabolic changes [11], which may have a programming effect on the development of overweight and obesity in the future [12–14]. Early life stress in humans can lead to pathophysiological changes in the neuroendocrine systems [15], psychological symptoms, and behavioral changes in children [16], which could influence the risk of overweight or obesity [17]. Maternal postpartum distress has been suggested to affect their children and increase the risk of childhood obesity [18–20].

The death of a parent is classified as one of the most stressful life events that a child can experience [21, 22], and loss of a father during the first postnatal years may stress mothers and influence feeding behaviors or child rearing [1, 19]. Bereavement during the early life period may also influence children via a direct metabolic influence of stress and behavioral mechanisms [17, 19]. In this study, we examined whether bereavement during the first 6 years of life was associated with an increased risk of overweight in school children at 7–13 years of age.

Material and Methods

Study Design and Population

This population-based cohort study was based on linkage of the Danish Civil Registration System [23], the Danish Medical Birth Register [24], the Integrated Database for Longitudinal Labor Market Research (IDA) [25], and the Copenhagen School Health Records Register (CSHRR) [26]. All live born children and new residents in Denmark since 1969 have been assigned a unique civil personal registration (CPR) number, allowing accurate linkage of data between registries [27]. Information on demographic, vital statistics, and family relationships is retrievable from the Danish Civil Registration System [23]. Thus, within this system, it is possible in a single study to follow all residents for decades and link data at an individual level on demographic, vital status, social and economic conditions, and health information [27].

We first identified all singletons born in Denmark from 1973 to 1989 through the Danish Civil Registration System [24]. By using their personal identification number and links to family members, we identified their parents, for whom information on the date and cause of death could also be retrieved [24]. Children were subsequently linked to the CSHRR [26], which holds data on health examinations of children enrolled in public or private schools in the municipality of Copenhagen. A total of 46,401 singletons who had ever resided in Copenhagen and had records in CSHRR were included in the study. Children who had lost a parent during the first 6 years of life were categorized as exposed. The remaining children were in the unexposed cohort.

Sensitivity to stress exposure is expected to vary with the age of the child and the type of bereavement [28]. The exposure was stratified by timing of exposure at different years of age (all, 0–2, 3–4, 5–6 years), and exposure was further categorized into two groups (loss of a father or loss of a mother). Finally, the exposure was categorized by the causes of death into two groups: unexpected death (unexpected causes, ICD8 codes 7950–7959, ICD 10 codes R95–R97, motor vehicle accidents, ICD8

Table 1. Exposure to bereavement by death of a parent at each age

Age of the child	Parents	Mother	Father
1st year	49	12	37
2nd year	60	12	48
3rd year	81	21	61
4th year	90	22	68
5th year	100	21	79
6th year	112	26	86
All ages (1–6 years)	492	114	379

codes 8100–8230, ICD10 codes V01–V89, suicide, ICD8 codes 950–959, ICD10 codes X60–X84, other accidents and violence, ICD8 codes 800–807, 825–949, 960–999, ICD10 codes V90–V99, W00–X59, X85–Y89) and death by other causes.

The definition of childhood overweight at specific ages (7, 8, 9, 10, 11, 12, and 13 years) was based on the International Obesity Task Force gender- and age-specific BMI references [29]. The measurements of weight and height were retrieved from the CSHRR [26]. BMI was calculated as weight (kg) / height (m)² at a given age. School doctors and nurses recorded heights to the nearest half-centimeter and weights to the nearest 100 g. When the data were computerized, the data entry program applied a series of range and consistency checks to minimize coding errors. Furthermore, as there were longitudinal measurements of the children, their growth curves were plotted and examined for unusual values. These values were verified in the original records which are stored in the municipal archive [26].

Information on birth outcomes, such as birth weight and gestational age, was obtained from the Danish Medical Birth Register [24], which was established in 1973. Information on socioeconomic factors (maternal age, maternal residential place, maternal education, maternal income, and maternal cohabitation status) was obtained from the Integrated Database for Longitudinal Labour Market Research (IDA), and these data were available from 1980 and onwards [25].

Statistical Analysis

The data were analyzed in SAS (version 9.1) and Stata (version 12). Chi-square (χ^2) test was used to determine whether the levels of overweight at each age (7, 8, 9, 10, 11, 12, 13 years) were similar between the exposed and the unexposed. The differences in mean BMI values between the exposed and unexposed groups at each age were analyzed using General Linear Model (GLM). The odds ratios (ORs) for overweight at each age between the exposed and the unexposed were analyzed using logistic regression. We adjusted for the following potential confounding variables: gender (male, female), birth year, (gestational age (<37, $\geq$ 37 weeks, unknown), birth weight (<3,000, 3,000–3,350, 3,350–3,700, $\geq$ 3,700 g, unknown), and maternal age (<27, 27–30, $\geq$ 31 years). Maternal characteristics of school education (0–9 years, 10–11 years, $\geq$ 12 years, unknown), income (lowest quartile, 2nd quartile, 3rd quartile, highest quartile in the calendar year, unknown), and marital status (yes, no, unknown) were included.

As maternal characteristics of school education, income, and marital status were available only for the period 1980–1989, we imputed the missing values for the period 1973–1979 using a multiple imputation technique [30].

In order to take into account repeated BMI measurements at different ages, we performed hierarchical linear analysis using SAS Proc Mixed procedure [31].

Ethics

The Danish Data Protection Agency approved the study (J.nr. 2008–41–2555, J.nr. 2008–41–2680). The study was based on secondary data, and no individuals were approached, nor did we have access to any personal identification of the participants. The study was thus exempted from obtaining written consent according to Danish law.

Table 2. Baseline characteristics of the study population

Variables	Exposed cohort (n = 492)		Unexposed cohort (n = 45,909)		P value*
	no.	%	no.	%	
Gender					0.60
Boys	245	50	23,404	51	
Girls	247	50	22,505	49	
Preterm birth					0.43
Yes	27	4	2,040	4	
No	423	86	40,273	88	
Unknown	42	9	3,596	8	
Birth year					0.96
1973–1978	184	37	17,104	37	
1979–1983	132	27	12,113	26	
1984–1989	176	36	16,692	36	
Maternal age, years					<0.01
≤23	106	22	10,540	23	
24–26	99	20	11,129	24	
27–30	118	24	11,995	26	
>30	169	34	12,245	27	
Birth weight, g					<0.01
<3,000	130	26	9,300	20	
3,000–3,350	122	25	11,324	25	
3,350–3,700	107	22	11,377	25	
>3,700	101	21	11,966	26	
Unknown	32	7	1,940	4	
Maternal education					0.04
Primary	124	25	10,013	22	
Secondary	41	8	4,001	9	
High	55	11	7,059	15	
Unknown	272	55	24,836	54	
Maternal income					0.18
≤0	32	7	2,130	5	
Low (1/3)	50	10	4,399	10	
Middle (1/3)	59	12	6,763	15	
High (1/3)	106	22	9,975	22	
Unknown	245	50	22,642	49	
Marital status					0.81
Single	121	25	11,838	26	
Cohabitation	127	26	11,469	25	
Unknown	244	50	22,602	49	

*The p value is for the difference between the exposed and the unexposed.

Table 3. Mean BMI, differences in means of BMI, prevalence of overweight, and OR of overweight at age 7 according to type of relative and timing of exposure

Exposure	Number of children	Mean BMI	Differences in means of BMI*	Overweight cases	Overweight prevalence	OR of overweight†
Death of a parent						
No	33,882	15.92 ± 1.68	Ref.	3,744	11.0	Ref.
Yes – all 6 years	375	15.85 ± 1.74	–0.03 (–0.20 to 0.14)	38	10.1	0.93 (0.66–1.30)
Yes – 1–2 years	81	15.79 ± 1.75	–0.12 (–0.49 to 0.24)	7	8.6	0.74 (0.34–1.61)
Yes – 3–4 years	120	15.78 ± 1.61	–0.10 (–0.39, 0.19)	10	7.7	0.70 (0.36–1.36)
Yes – 5–6 years	164	15.95 ± 1.83	0.07 (–0.18, 0.32)	21	12.8	1.23 (0.67–1.96)
Death of a father						
No	33,966	15.93 ± 1.69	Ref.	3,753	11.1	Ref.
Yes – all 6 years	291	15.83 ± 1.67	–0.08 (–0.27 to 0.11)	29	10.0	0.89 (0.60–1.31)
Yes – 1–2 years	64	15.78 ± 1.65	–0.15 (–0.56 to 0.26)	5	7.8	0.65 (0.26–1.63)
Yes – 3–4 years	98	15.74 ± 1.37	–0.17 (–0.49 to 0.17)	7	7.1	0.63 (0.29–1.36)
Yes – 5–6 years	129	15.91 ± 1.88	0.02 (–0.27 to 0.30)	10	13.2	1.23 (0.73–2.06)
Death of a mother						
No	34,172	15.92 ± 1.67	Ref.	3,773	11.0	Ref.
Yes – all 6 years	85	15.95 ± 1.69	0.13 (–0.22 to 0.49)	9	10.6	1.06 (0.53–2.14)
Yes – 1–2 years	17	15.83 ± 2.13	–0.02 (–0.81 to 0.77)	2	11.8	1.02 (0.25–5.04)
Yes – 3–4 years	33	15.87 ± 2.19	0.07 (–0.50 to 0.63)	3	9.1	0.88 (0.26–2.92)
Yes – 5–6 years	35	16.08 ± 1.67	0.27 (–0.28 to 0.83)	4	11.4	1.20 (0.42–3.46)

*GLM regression, adjusted for gender, birth year (calendar year), gestational age, birth weight, and maternal characteristic (age, education, income, marital status).

†Logistic regression, adjusted for gender, birth year (calendar year), gestational age, birth weight, and maternal characteristic (age, education, income, marital status).

Results

We identified 492 children who experienced bereavement during the first 6 years of life (table 1). The exposed and unexposed children were comparable for most baseline characteristics. The exceptions were low birth weight, low maternal education, and high maternal age, which were slightly overrepresented in the exposed group (table 2).

The numbers of children who had measurements of BMI were 34,257 at age 7, 28,027 at age 8, 18,837 at age 9, 14,420 at age 10, 11,959 at age 11, 11,171 at age 12, and 9,532 at age 13.

Table 3 shows that there were no differences in mean BMI values and in the prevalence of overweight between the exposed and unexposed groups at age 7. Compared to children in the nonexposed group, the exposed children did not show significant differences in the means of BMI or in the odds of being overweight after adjusting for potential confounders. Similar results were observed for age 13 (table 4). Results from the other ages were also similar, and data are not shown.

Table 5 presents the difference in BMI between the exposed and the unexposed when repeated measurements at each age were taken into account, and the analyses were based on 13,068 children who had at least 4 measurements between 7 and 13 years of age. The adjusted overall difference in BMI between the exposed and the unexposed was –0.01 (95% confidence interval (CI) –0.40 to 0.38).

Table 4. Mean BMI, differences in means of BMI, Prevalence of overweight, and OR of overweight at age 13 according to type of relative and timing of exposure

Exposure	Number of children	Mean BMI	Differences in means of BMI*	Overweight cases	Overweight prevalence	OR of overweight†
Death of a parent						
No	9,420	19.37 ± 3.23	Ref.	1,622	17.2	Ref.
Yes – all 6 years	112	19.57 ± 3.34	0.15 (–0.45 to 0.75)	20	17.9	1.01 (0.62–1.65)
Yes – 1–2 years	25	20.89 ± 3.83	1.41 (0.15 to 2.67)	6	24.0	1.44 (0.56–3.69)
Yes – 3–4 years	34	19.36 ± 3.25	–0.04 (–1.13 to 1.04)	6	17.7	1.03 (0.42–2.51)
Yes – 5–6 years	53	19.07 ± 3.05	–0.32 (–1.19 to 0.54)	8	15.1	0.82 (0.38–1.75)
Death of a father						
No	9,455	19.37 ± 3.25	Ref.	1,625	17.2	Ref.
Yes – all 6 years	77	19.88 ± 3.76	0.40 (–0.32 to 1.12)	17	22.1	1.27 (0.73–2.20)
Yes – 1–2 years	18	21.35 ± 3.76	1.80 (0.31 to 3.29)	5	28.8	1.63 (0.57–4.67)
Yes – 3–4 years	21	19.75 ± 3.33	0.25 (–1.13 to 1.63)	5	23.4	1.46 (0.53–4.04)
Yes – 5–6 years	38	19.23 ± 3.35	–0.18 (–1.20 to 0.85)	7	18.4	1.02 (0.44–2.33)
Death of a mother						
No	9,496	19.38 ± 3.25	Ref.	1,639	17.2	Ref.
Yes – all 6 years	36	18.95 ± 2.90	–0.33 (–1.39 to 0.72)	3	8.3	0.46 (0.82–1.51)
Yes – 1–2 years	7	19.71 ± 4.03	0.40 (–1.98 to 2.78)	1	14.3	0.52 (0.11–8.14)
Yes – 3–4 years	14	18.94 ± 3.11	–0.32 (–2.00 to 1.37)	1	7.1	0.38 (0.05–2.97)
Yes – 5–6 years	15	18.60 ± 2.14	–0.75 (–2.32 to 0.94)	1	6.7	0.35 (0.05–2.67)

*GLM regression, adjusted for gender, birth year (calendar year), gestational age, birth weight, and maternal characteristic (age, education, income, marital status).

†Logistic regression, adjusted for gender, birth year (calendar year), gestational age, birth weight, and maternal characteristic (age, education, income, marital status).

Table 5. Change in BMI (95%CI) between the exposed and the unexposed according to type of deceased relative and timing of exposure: hierarchical linear model*

Death of a relative	All 0–6 years	0–2 years	3–4 years	5–6 years
Parent				
Number exposed	157	33	50	74
Number unexposed	12,911	12,911	12,911	12,911
Difference in BMI	–0.01 (–0.40 to 0.38)	0.35 (–0.50 to 1.19)	0.10 (–0.59 to 0.79)	–0.27 (–0.84 to 0.29)
P value	0.96	0.41	0.78	0.74
Mother				
Number exposed	42	8	18	16
Number unexposed	13,026	13,026	13,026	13,026
Difference in BMI	0.35 (–0.40 to 1.10)	0.63 (–1.08 to 2.35)	0.34 (–0.81 to 1.49)	0.16 (–1.06 to 1.37)
P value	0.35	0.41	0.78	0.74
Father				
Number exposed	116	25	33	58
Number unexposed	12,952	12,952	12,952	12,952
Difference in BMI	0.15 (–0.60 to 0.31)	0.26 (–0.71 to 1.23)	0.05 (–0.89 to 0.80)	–0.40 (–1.04 to 0.24)
P value	0.53	0.60	0.92	0.23

*Adjusted for gender, birth year (calendar year), gestational age, birth weight, and maternal characteristic (age, education, income, marital status). The unexposed as reference group.

Discussion

In this cohort study, we observed that children who were bereaved by the death of a parent during the first 6 years of life had similar BMI value, similar prevalence of overweight or similar risk of overweight at 7–13 years of age, compared with those who were not exposed. The results were consistent across exposure strata by timing of exposure, relation of the child to the deceased relative, and cause of death.

Early stress in the form of maternal food insecurity in monkeys can result in peripubertal emergence of obesity [11]. Several studies in humans showed that maternal postpartum distress can lead to childhood overweight, but the retrospective collection of exposure data causes concerns about the validity of data [18–20]. Later and larger population-based studies of postpartum distress and depression did not indicate such effects [32, 33]. Findings in our study further suggest that stress following bereavement at a very early age might not be a strong independent risk factor of childhood overweight.

The observed similar risk between the exposed and the unexposed may be explained by several mechanisms. Firstly, an infant or a young toddler may not perceive bereavement as stressful as adolescents or adults because his/her cognitive capacities have not matured enough [34–36]. Secondly, grief reactions abate over time for most bereaved children, although a minority of the children have long-term difficulties. [37, 38]. Thirdly, children's understanding of death and their coping mechanisms would be closely related to the age-dependent developmental capacity [16, 39, 40]. To segregate children into developmentally more homogenous subgroups, for example by age group, might help to clarify whether different patterns of associations exist. However, the sample size in our study may be not sufficient enough, as illustrated by the wide confidence intervals of the estimates.

We have previously shown that exposure to maternal bereavement during the year before pregnancy was associated with an increased risk of overweight in offspring in early adolescence but not at 7–9 years of age [41]. We excluded individuals exposed to prenatal bereavement in the present study with the assumption that this exposure occurs independently of postnatal bereavement, as the size of the respective exposed groups did not allow a valid combined analysis. The lack of association with postnatal bereavement suggests that the previously demonstrated association with prenatal bereavement is not based on carry-over effects from the prenatal bereavement to the postnatal period.

However, our findings cannot rule out the possibility that early postnatal stress may contribute to an increased predisposition of overweight in late childhood or adulthood [12–14]. A few children do develop mood and physiological difficulties [38]. Bereavement during the early postnatal period potentially leads to stress in mothers or other family members, whose negative mood or changed behaviors may affect the infant's behavioral or psychological state for at least some children. Evidence from human studies has shown that psychological stress during late childhood, possibly involving emotional deprivation and parental neglect, may increase the risk of obesity in adulthood [42]. As mentioned previously, the effect of prenatal stress following bereavement cannot be observed until early puberty period; thus it could be possible that the effect following stress at an early age may become manifest after many years of follow-up, which can be confirmed by further studies.

The strengths of our study are its population-based longitudinal design, the objective measurement of exposure, a large exposure contrast, and the high-quality data on endpoints that are recorded independently of the exposure status. The CSHRR is a unique data source for obesity research with detailed data on growth with a high validity [26]. In particular, endpoint data from multiple time points reduce the possibility of a chance finding. Our study included virtually all school children in the Copenhagen municipality area, and selection bias is unlikely.

One of the limitations in the study is that children were not interviewed at any time point in order to determine the characteristics of their bereavement experience, which might represent different pathways from exposure to outcomes in either a negative developmental direction or positive developmental direction.[38] Secondly, we lack information on quality of the relationship to the lost parent, as it is more stressful to loss a parent with whom a child has the primary attachment than loss of an absent parent [43, 44] Thirdly, we lack the information on children's diet or nutrition, physical activities as well as other possibly mediating factors on the pathway to overweight or obesity. Lastly, the relatively modest size of the exposed cohort did not permit us to further categorize the exposure according to nature of the bereavement, such as cause of death [45].

We conclude that this study did not support that stress exposure following bereavement during the first 6 years of life influences the development of overweight in later childhood. However, it does not exclude a long-term effect or an effect of other type of stress exposure.

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Disclosure Statement

Conflicts of interest: None declared.

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