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Association between maternal pre-pregnancy body mass index, gestational weight gain, and offspring atopic dermatitis: a prospective cohort study.

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Abstract

Background: Maternal weight status may contribute to the development of atopic disorders in children.

Objective: The objective of this study was to assess associations of maternal pre-pregnancy body mass index (BMI) and gestational weight gain (GWG) with risk of atopic dermatitis in children.

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Methods: Maternal pre-pregnancy BMI and GWG were assessed by questionnaire through the Growing Up Today Study (GUTS), a prospective cohort study of U.S. children. Mothers reported whether GUTS participants had ever been diagnosed with atopic dermatitis by a clinician in either 1997 or 1999, when GUTS participants were between 10–17 years old. We used multivariable logistic regression to estimate the association of BMI and GWG with atopic dermatitis in offspring (expressed as odds ratios (OR) with 95% confidence intervals).

Results: Among 13,269 GUTS participants, 2,058 (16%) had childhood atopic dermatitis. Higher maternal pre-pregnancy BMI was not associated with atopic dermatitis (p trend = 0.48). By contrast, GWG was associated with increased atopic dermatitis risk (p trend = 0.005). Compared to children of mothers who gained 25–34 lb, children of mothers who gained 35–44 lb (OR 1.11, 0.98–1.26) and 45 lbs (OR 1.23, 1.05–1.43) had an increased risk of atopic dermatitis. These associations appeared stronger with pre-pregnancy BMI >25 (GWG 35–44 lb: OR 1.20, 0.84–1.69; GWG 45 lb: OR 1.57, 1.07–2.31), but the statistical interaction between BMI and GWG was not significant.

Conclusion: In this study, increased GWG was associated with increased risk of atopic dermatitis in offspring. This supports existing evidence that prenatal exposures contribute to the development of atopic disorders.

Keywords

atopic dermatitis; weight status; pregnancy; perinatal; maternal BMI; gestational weight gain

Background

Atopic dermatitis (AD) is the most common chronic disease in childhood, with a prevalence of approximately 10–20% in children worldwide.(1) The condition is burdensome for patients and their families, particularly with respect to impaired quality of life.(2) Recent literature has found that while the majority of cases present before age five, AD persists into adolescence and adulthood more commonly than previously thought, thus extending morbidity across the lifespan.(3) This combination of early age of onset, chronicity and impaired quality of life make AD the leading cause of decreased disability-adjusted life-years among all skin diseases.(4) Understanding prenatal and early life risk factors for AD may lead to improved prevention strategies to decrease its burden.

Possible early contributors to AD pathogenesis are pro-inflammatory stimuli in utero, including those related to maternal obesity and weight-gain before and during pregnancy. Maternal weight status has been linked with the development of other atopic conditions in children.(5–7) However, few studies have examined associations with childhood AD. A national cohort of Danish children found no significant association between maternal body mass index (BMI) and gestational weight gain (GWG) and AD in early childhood(6) and in a birth cohort from Sweden there was no association between maternal BMI and AD up to age 16.(8)

The objective of this study is to determine the association between maternal pre-pregnancy BMI and GWG and the risk of AD in offspring through adolescence and young adulthood.

We hypothesized that increased maternal BMI and GWG would be associated with an increased risk of AD in offspring.

Methods

Study participants

The Growing Up Today Study (GUTS) is a longitudinal cohort that began with 9,039 girls and 7,842 boys aged 9 to 14 years at baseline (1996) living throughout the United States. Participants are children of women in the Nurses' Health Study II (NHSII), a prospective cohort study of female registered nurses. Details of the GUTS cohort recruitment have been published previously.⁽⁹⁾ Participants are mailed questionnaires approximately annually to collect a variety of information pertaining to risk factors and diseases. GUTS participant's mothers completed questionnaires related to their children and prenatal and early-life risk factors in 1997, 1999, and 2004; 99% of mothers completed one or more questionnaires.

This study was approved by the Research Ethics Boards at Harvard School of Public Health and Brigham and Women's Hospital, Boston, Massachusetts.

Exposures

The primary exposures of interest were maternal pre-pregnancy BMI and GWG. Height was assessed from the NHSII 1989 questionnaire and is assumed to be static thereafter). Pre-pregnancy weight was assessed retrospectively for each pregnancy on the 1999 GUTS mother's questionnaires. BMI was calculated as pre-pregnancy weight divided (kg) divided by the square of height (m) and classified into the following categories: <20, 20 to 22.4, 22.5 to 24.9, 25 to 29.9, and ≥ 30 kg/m².

Maternal GWG (lb) was ascertained from 1999 GUTS mother's questionnaires and was examined in two ways. First, we examined GWG in absolute terms in the following categories: <15, 15–24, 25–34, 35–44, and ≥ 45 lbs gained. Second, we classified GWG based on the Institute of Medicine recommendations for mothers with differing pre-pregnancy BMI (under recommended weight gain, meets recommended weight gain, over recommended weight gain).⁽¹⁰⁾

Outcomes

The primary outcome was the cumulative incidence of AD during childhood defined by maternal report in either 1997 or 1999. In 1997, when participants were aged 10–15, mothers were asked, “has this child ever had eczema (atopic dermatitis)?” and in 1999, when participants were aged 12–17, mothers were asked if their child “ever had doctor-diagnosed eczema (atopic dermatitis).” AD diagnoses in GUTS have not been validated but in other settings, parental report of childhood AD has been shown to be very accurate.⁽¹¹⁾ In a secondary analysis, we additionally required maternal or child report of comorbid atopic conditions (asthma or allergic rhinitis) in the child or maternal report of maternal, paternal or sibling AD, asthma, or hay fever to define cases of AD. In another secondary analysis we additionally included cases of doctor-diagnosed AD reported by the child in adolescence or

early adulthood on 2007 (when participants were aged 20–25) and 2013 (when participants were aged 26–31) questionnaires.

Covariates

Analyses were adjusted for maternal history of asthma or atopic dermatitis, race/ethnicity, smoking in child's early life; sociodemographic characteristics, including father's education level, household income, and US region of residence in child's early life); and pregnancy and post-natal factors such as maternal age at delivery, gestational diabetes, child's mode of delivery (C-section), child's birth order and weight, and breastfeeding duration.

Statistical analysis

All individuals who met the following criteria were included in analyses: GUTS participants with data on AD from 1997 or 1999 and whose mothers' pre-pregnancy BMI and GWG was available. To assess for selection bias, we compared characteristics of GUTS participants included and excluded from our analysis using the t-test and chi-square test for continuous and categorical variables, respectively. Multivariable logistic regression was used to estimate the association of maternal pre-pregnancy BMI and GWG with childhood AD in the offspring. Analyses were adjusted for maternal factors, sociodemographic factors and perinatal factors. Analyses with GWG as the outcome were further adjusted for maternal pre-pregnancy BMI. We created indicator variables for missing covariate data and included them in the models. Generalized estimating equations were used to address any familial dependence between children of the same mother.

To explore possible effect modification by pre-pregnancy BMI in the relationship between GWG and offspring AD, we examined the association between GWG and AD stratified by pre-pregnancy BMI ($<25 \text{ kg/m}^2$, $\geq 25 \text{ kg/m}^2$), and performed tests for interaction between pre-pregnancy BMI and GWG.

We performed a within-family analysis comparing the risk of AD associated with pre-pregnancy BMI and GWG between siblings born to the same mother. We used conditional logistic regression adjusted for the same covariates in which each group of siblings was considered a matched set.

In sensitivity analyses, we additionally adjusted models for gestational diabetes, a potential mediator in the association of maternal pre-pregnancy BMI and GWG with AD; and similarly, we further adjusted for GWG in the model examining the association of maternal pre-pregnancy BMI with AD. We also conducted the analysis for pre-pregnancy BMI excluding mothers with BMI $<18.5 \text{ kg/m}^2$. In other sensitivity analyses we excluded children whose mothers had a personal history of AD and we explored differences in the associations when limiting cases of AD to those reported in each of 1997 or 1999 or both.

For all tests (including tests for interaction), a two-sided $P < 0.05$ was considered statistically significant. All analyses were run using SAS V.9 (SAS Institute, Cary, NC, USA).

Results

Of the 16,875 children enrolled in GUTS, we excluded 299 children without data on AD, and 3,307 children without information on maternal pre-pregnancy BMI and GWG. This yielded an analytic cohort of 13,269 GUTS participants, of whom 2,058 (16%) had AD at or before the age of 17 according to our primary definition. Based on pre-pregnancy BMI, 11% of women were classified as overweight, and 4% as obese. The mean GWG was 31.2 (sd: 10.6) lbs. Characteristics were generally balanced between participants with and without AD, with the expected exception that maternal AD and asthma were more common in children with AD (Table 1). There were a number of small but statistically significant differences between GUTS participants included and excluded from our analysis (Table E1).

In multivariable models, higher pre-pregnancy BMI was not associated with AD in offspring (p trend=0.48, Table 2). Increasing absolute GWG was associated with an increased risk of AD in offspring (p trend=0.005). There was a 11% increased risk with GWG 35–44 lbs (odds ratio [OR]: 1.11, 95% confidence interval [CI]: 0.98–1.26) and 23% increased risk with GWG ≥ 45 lbs (OR: 1.23, 1.05–1.43). When examining GWG according to the IOM recommendations, we did not see any significant associations.

Results were consistent when requiring a personal or family history of atopic conditions to define AD but were somewhat attenuated for the association of GWG with the expanded AD definition including GUTS participant self-report later in life. In the within-family analysis, estimates of the associations were similar to the primary analysis, but for GWG were no longer statistically significant, likely owing to reduced sample size ($n = 6,044$) (Table E2). There were no material changes in any of the sensitivity analyses, including adjusting for gestational diabetes. Results were similar when limiting AD cases to those reported in each of 1997 or 1999 and when limiting AD cases to those reported in both 1997 and 1999 (Table E3).

In stratified analyses, the association of GWG with childhood AD appeared stronger with higher pre-pregnancy BMI, with a 57% increased risk with GWG ≥ 45 lbs (OR: 1.57, 1.07–2.31) with pre-pregnancy BMI ≥ 25 kg/m² (Table 3) However, the interaction was non-significant ($p=0.46$).

Discussion

In this large longitudinal cohort study of children in the US, increasing GWG was associated with an increased risk for AD in childhood. A similar magnitude of association was seen in our within-family analysis, but with widening of the confidence intervals due to reduced power. However, when GWG was examined in relation to the IOM recommendations, GWG under or over the recommendation was not associated with AD. Additionally, there was no apparent relationship between pre-pregnancy BMI and AD risk. Our results were consistent when more stringent criteria were used to define cases of AD and in a number of sensitivity analyses.

The current IOM GWG guidelines (2009) recommend 12.5–18 kg (28–40 lb) of weight gain for underweight, 11.5–16 kg (25–35 lb) for normal weight, 7–11.5 kg (15–25 lb) for

overweight, and 5–9 kg (11–20 lb) for obese pregnant women.(10) Therefore, our results suggest that GWG well above of the recommended limits based on pre-pregnancy BMI drives the association between absolute GWG and AD.

These findings contribute to an increasing body of literature linking atopic conditions with maternal perinatal weight factors.(5–8) Our findings contrast with those of Harpsøe et al., who found no association between pre-pregnancy BMI or GWG with AD in the Danish National Birth Cohort.(6) In that study, there was a higher proportion of overweight and obese mothers pre-pregnancy who had generally lower GWG compared with our study; this may explain some of our discrepant results. Additionally, their study only examined the incidence of AD up to 7 years of age; while one might expect a prenatal exposure to exert its effect closest to birth, it is possible that our inclusion of AD cases with later onset may explain some of the differences in our results. Recent studies have shown a number of phenotypic differences between early and late-childhood onset AD.(12–14)

Interestingly, our results diverge from an analysis in the same cohort on the risk of asthma. (5) In that study, pre-pregnancy BMI but not GWG was associated with asthma risk in childhood. Importantly, the association with pre-pregnancy BMI appeared stronger for non-allergic asthma in that study. This suggests that pre-pregnancy BMI and GWG may act by separate mechanisms on the risk for non-allergic asthma and AD, respectively.

The mechanism for the association between increased GWG and AD may be explained on the basis of an increased inflammatory state. Excessive GWG has been associated with a higher concentration of inflammatory markers, including C-reactive protein.(15) In other contexts, weight gain trajectories were associated with increased inflammation independent of baseline weight and smoking status, which may explain our divergent observations with regards to pre-pregnancy BMI and GWG.(16) Host-microbiome interaction is another potential mechanism give the myriad bidirectional relationships between atopic disease and the microbiome.¹⁷ Changes in the maternal gut microbiome during pregnancy are correlated with metabolic changes and may induce adiposity and insulin resistance.¹⁸

Our study has several limitations. First, the results of this study may have limited generalizability outside of this population, where all mothers are nurses living in the US. Participants are predominantly Caucasian and fairly homogenous in terms of socioeconomic status. Furthermore, this study relies heavily on self-report. However, both self and caregiver-report of AD have been validated against physician reports of AD in other contexts with excellent accuracy.(11) While we cannot rule-out misclassification of other skin diseases as AD, any misclassification is likely to bias our results towards the null. Despite GUTS being a prospective cohort study, pre-pregnancy weight and GWG were collected 12–17 years after pregnancy. The validity of recalled weight, pre-pregnancy weight, and other pregnancy-related events up to 30 years later has been demonstrated in the NHSII population, though.(17, 18) While GWG recall has not been specifically studied in NHSII participants, a moderate agreement between documented and recalled GWG has been shown elsewhere.(19) Additionally, any errors related to recall are likely to have been non-differential according to AD status as maternal weight status is not a well-known risk factor for atopy, therefore, the impact of recall bias is likely to be minimal. We found small but

statistically significant differences between GUTS participants included and excluded from our analysis; this selection bias may have impacted the results. However, absolute differences between those included and those excluded were small. We did not have data on the timing of GWG within pregnancy; this timing has been shown to impact other postnatal factors in offspring.(20, 21) As in most observational studies, we cannot rule-out the possibility of residual confounding. Lastly, the exposure data included in our analyses was collected before revised gestational weight gain guidelines were released by the Institute of Medicine in 2009.

In summary, this study is one of the first to examine the association between maternal weight status and the development of AD in offspring. An association was observed between increased GWG and risk of AD, particularly among women with higher pre-pregnancy BMI. These findings contribute to the literature on modifiable risk factors for AD and on the negative effects of excessive weight gain in pregnancy. As investigators explore potential means of primary prevention of AD,(22) children of mothers with excessive GWG may represent a higher-risk target population.

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Abbreviations:

AD	atopic dermatitis
BMI	body mass index
GUTS	Growing Up Today Study
GWG	gestational weight gain
IOM	Institute of Medicine
NHSII	Nurses' Health Study II
OR	odds ratio
sd	standard deviation

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Highlights

1. What is already known about this topic?

Maternal weight status has been linked to the development of atopic disorders. However, data on atopic dermatitis are limited. Two European studies found no association between maternal BMI or GWG and atopic dermatitis in offspring.

2. What does this article add to our knowledge?

This article supports the association between maternal weight status, particularly GWG, and the risk of atopic dermatitis in offspring.

3. How does this study impact current management guidelines?

As investigators explore potential means of primary prevention of atopic dermatitis, this work highlights mothers with excessive GWG as a higher-risk target population.

Table 1.

Maternal and child's characteristics according to the child's atopic dermatitis status, among 13,269 mother-child pairs in the Growing Up Today Study

	All (n=13,269)	Child with atopic dermatitis		P
	No (n=11,211)	Yes (n=2,058)		
Maternal characteristics				
Pre-pregnancy BMI, kg/m ² , %				
< 20.0	24	24	26	0.34
20.0–22.4	41	41	39	
22.5–24.9	20	20	20	
25–29.9	11	11	11	
30	4	4	4	
GWG, lb, %				
<15	3	3	3	0.01
15–24	21	21	19	
25–34	41	41	39	
35–44	22	22	23	
45	14	13	15	
GWG relative to recommendations, %				
Under recommended weight gain	21	21	19	0.06
Meets recommended weight gain	48	48	47	
Over recommended weight gain	32	31	34	
Gestational diabetes, %	3	3	4	0.03
C-section, %				
Yes	19	19	20	0.45
Missing	7	6	7	
Age at delivery, mean (SD)	29.4 (3.5)	29.4 (3.5)	29.3 (3.5)	0.20
White, %	97	98	96	<0.001
Hispanic, %	2	2	2	0.87
Maternal asthma, %	19	18	23	<0.001
Maternal atopic dermatitis, %				
Yes	8	6	22	<0.001
Missing	23	23	24	
Smoking in child's early life [†] , %				
Never	70	70	69	0.09
Past	21	21	23	
Current	9	9	8	
US region in child's early life [†] , %				
West	14	14	16	<0.001
Midwest	35	36	32	
South	14	14	13	

	All (n=13,269)	Child with atopic dermatitis		
		No (n=11,211)	Yes (n=2,058)	P
Northeast	37	36	39	
Breast feeding duration, %				
Never	9	9	9	0.38
<3 months	20	20	19	
4–6 months	20	21	20	
7 months	47	47	49	
Missing	3	3	3	
Household income				
\$44,500	11	11	10	0.30
> \$44,500	72	72	72	
Missing	18	18	19	
Husband education				
High school or less	16	17	16	0.49
College graduate	46	46	46	
Graduate degree	30	30	31	
Missing	7	7	7	
Child's characteristics				
Female, %	54	54	53	0.73
Birth weight, lb, %				
<5.5	3	4	3	0.08
5.5–6.9	20	20	19	
7.0–8.4	53	53	51	
8.5–9.9	22	22	24	
10	2	2	2	
Birth order				
1	44	44	45	0.10
2	34	34	34	
3+	16	16	14	
Missing	7	6	7	

BMI – Body Mass Index; GWG – Gestational Weight Gain

$\bar{x}$ (age 2–7 years).

% missing values is displayed for variables with >3% missing values

Table 2.

Associations of prenatal and perinatal exposures with incidence of atopic dermatitis in offspring

	Child with atopic dermatitis					
	Primary definition [*]		Secondary definition 1 [^]		Secondary definition 2 [#]	
	No of cases	OR (95% CI)	No of cases	OR (95% CI)	No of cases	OR (95% CI)
Maternal pre-pregnancy BMI, kg/m ²						
< 20.0	530	1.12 (0.99–1.27)	450	1.14 (1.00–1.31)	647	1.07 (0.96–1.20)
20.0–22.4	812	1	677	1	1,023	1
22.5–24.9	417	1.11 (0.97–1.26)	344	1.11 (0.96–1.29)	506	1.06 (0.94–1.20)
25–29.9	226	1.02 (0.86–1.20)	198	1.07 (0.89–1.29)	272	0.97 (0.83–1.14)
30	73	0.99 (0.75–1.30)	61	0.99 (0.74–1.34)	90	0.98 (0.76–1.26)
<i>p trend</i>		<i>0.48</i>		<i>0.61</i>		<i>0.40</i>
Maternal GWG (lb) [*]						
<15	58	1.07 (0.78–1.47)	50	1.11 (0.79–1.57)	76	1.16 (0.87–1.54)
15–24	391	0.96 (0.84–1.10)	329	0.97 (0.84–1.12)	474	0.91 (0.81–1.03)
25–34	810	1	680	1	1,022	1
35–44	483	1.11 (0.98–1.26)	400	1.10 (0.96–1.27)	593	1.08 (0.96–1.21)
45	316	1.23 (1.05–1.43)	271	1.26 (1.07–1.49)	373	1.14 (0.99–1.31)
<i>p trend</i>		<i>0.005</i>		<i>0.008</i>		<i>0.02</i>
GWG relative to recommendations, %						
Under recommendations	397	0.94 (0.82–1.07)	334	0.96 (0.83–1.10)	487	0.91 (0.81–1.03)
Meets recommendations	970	1	810	1	1,218	1
Over recommendations	961	1.08 (0.96–1.20)	586	1.10 (0.98–1.24)	833	1.03 (0.93–1.14)

BMI – Body Mass Index; GWG – Gestational Weight Gain; OR – Odds Ratio; CI – Confidence Interval

Analyses were adjusted for maternal age at delivery, asthma, atopic dermatitis, race, ethnicity, smoking in child's early life, household income, husband's education, US region in child's early life, mode of delivery (C-section), child's birth order, and breast feeding duration.

^{*} Analyses were further adjusted for maternal pre-pregnancy BMI.^{*} Primary case definition is maternal self-report of atopic dermatitis during childhood.[^] Secondary definition 1 is more stringent, with the additional requirement for a comorbid atopic condition in the GUTS participant or any of atopic dermatitis, asthma or hayfever in a first degree family member.[#] Secondary case definition expands on the primary case definition, adding cases of atopic dermatitis self-reported by GUTS participants in later childhood or early adulthood.

Table 3.

Associations of maternal GWG with incidence of atopic dermatitis in childhood, according maternal pre-pregnancy BMI

	Maternal pre-pregnancy BMI, kg/m2				p-interaction
	< 25 (n=11,276)		25 (n=1,968)		
	No of cases	OR (95% CI)	No of cases	OR (95% CI)	
Maternal GWG (lb)					Overall: 0.46
<15	32	1.16 (0.78–1.73)	26	0.98 (0.60–1.62)	0.67
15–24	324	0.92 (0.80–1.06)	67	1.18 (0.84–1.67)	0.18
25–34	720	1	90	1	-
35–44	419	1.07 (0.94–1.22)	64	1.20 (0.84–1.69)	0.77
45	264	1.13 (0.96–1.33)	52	1.57 (1.07–2.31)	0.17

BMI – Body Mass Index; GWG – Gestational Weight Gain; OR – Odds Ratio; CI – Confidence Interval

Analyses were adjusted for maternal age at delivery, asthma, atopic dermatitis, race, ethnicity, smoking in child's early life, household income, husband's education, US region in child's early life, mode of delivery (C-section), child's birth order, and breast feeding duration.

Table E1.

Comparison of maternal and child's characteristics of the 13,269 mother-child pairs included in the analyses with excluded mother-child pairs

	Included (n=13,269)	Missing value for atopic dermatitis, maternal BMI or GWG (n=3,606)	P
Maternal characteristics			
Age at delivery, mean (SD)	29.4 (3.5)	29.1 (3.5)	<0.001
White, %	97.5	97.0	0.07
Hispanic, %	1.7	1.3	0.17
Maternal asthma, %	18.6	20.9	0.001
C-section, %	20.8	19.2	0.07
Smoking in child's early life, %			
Never	70.1	66.6	<0.001
Past	21.3	23.2	
Current	8.6	10.2	
US region in child's early life, %			
West	14.3	12.3	0.02
Midwest	35.4	35.9	
South	13.8	13.7	
Northeast	36.5	38.1	
Breast feeding duration, %			
Never	9.6	12.9	<0.001
<3 months	20.8	21.0	
4–6 months	21.1	21.8	
7 months	48.6	44.3	
Household income > \$44,500, %	87.2	85.2	0.009
Husband education			
High school or less	17.7	18.2	0.003
College graduate	49.7	52.4	
Graduate degree	32.6	29.4	
Child's characteristics			
Female, %	53.7	52.9	0.40
Birth weight, lb, %			
<5.5	3.4	3.4	0.21
5.5–6.9	19.7	20.9	
7.0–8.4	52.5	51.0	
8.5–9.9	22.2	22.0	
10	2.2	2.6	
Birth order			
1	47.1	40.4	<0.001
2	36.4	39.0	
3+	16.6	20.6	

BMI – Body Mass Index; GWG – Gestational Weight Gain

Table E2.

Associations of prenatal and perinatal exposures with incidence of atopic dermatitis in offspring, within-family analysis

Primary definition*		
	No of cases	OR (95% CI)
Maternal pre-pregnancy BMI, kg/m ²		
< 20.0	252	0.93 (0.57–1.50)
20.0–22.4	376	1
22.5–24.9	178	0.85 (0.54–1.34)
25–29.9	99	0.81 (0.41–1.61)
30	24	0.67 (0.17–2.61)
<i>p trend</i>		0.67
Maternal GWG (lb)*		
<15	18	0.50 (0.19–1.29)
15–24	175	0.90 (0.59–1.38)
25–34	381	1
35–44	228	1.06 (0.73–1.55)
45	127	1.20 (0.73–1.99)
<i>p trend</i>		0.21
GWG relative to recommendations, %		
Under recommendations	172	0.74 (0.48–1.15)
Meets recommendations	457	1
Over recommendations	300	0.94 (0.65–1.35)

BMI – Body Mass Index; GWG – Gestational Weight Gain; OR – Odds Ratio; CI – Confidence Interval Analyses were adjusted for maternal age at delivery, mode of delivery (C-section), child's birth order, and breast feeding duration.

* Analyses were further adjusted for maternal pre-pregnancy BMI.

* Primary case definition is maternal self-report of atopic dermatitis during childhood.

Analysis performed in 6,044 children with one or more sibling in GUTS, of which 15.4% had atopic dermatitis in childhood. Conditional logistic regression in which each group of siblings was considered a matched set, adjusted for the same covariates expect time invariant maternal characteristics (taken into account by matching).

Table E3.

Associations of prenatal and perinatal exposures with incidence of atopic dermatitis in offspring

	Child with atopic dermatitis					
	Maternal report of atopic dermatitis in 1997 and 1999 (n=1,131)		Maternal report of atopic dermatitis in 1997 (n=1,604)		Maternal report of atopic dermatitis in 1999 (n=1,585)	
	No of cases	OR (95% CI)	No of cases	OR (95% CI)	No of cases	OR (95% CI)
Maternal pre-pregnancy BMI, kg/m ²						
< 20.0	306	1.23 (1.05–1.45)	434	1.23 (1.08–1.41)	402	1.08 (0.94–1.25)
20.0–22.4	436	1	613	1	635	1
22.5–24.9	238	1.19 (1.00–1.42)	326	1.15 (0.99–1.33)	329	1.13 (0.97–1.31)
25–29.9	115	0.96 (0.77–1.42)	174	1.03 (0.85–1.25)	167	0.95 (0.79–1.15)
30	36	0.90 (0.61–1.32)	57	1.03 (0.76–1.39)	52	0.91 (0.66–1.26)
<i>p trend</i>		<i>0.11</i>		<i>0.20</i>		<i>0.40</i>
Maternal GWG (lb) *						
<15	24	0.94 (0.59–1.48)	41	0.97 (0.66–1.41)	41	1.07 (0.75–1.52)
15–24	224	1.06 (0.89–1.26)	303	0.97 (0.83–1.12)	312	1.05 (0.90–1.47)
25–34	416	1	621	1	605	1
35–44	298	1.37 (1.16–1.61)	395	1.22 (1.06–1.40)	386	1.21 (1.04–1.39)
45	169	1.31 (1.07–1.59)	244	1.24 (1.05–1.47)	241	1.24 (1.05–1.47)
<i>p trend</i>		<i>0.001</i>		<i>0.001</i>		<i>0.02</i>
GWG relative to recommendations, %						
Under recommendations	221	0.96 (0.81–1.13)	304	0.92 (0.79–1.07)	314	0.98 (0.85–1.14)
Meets recommendations	530	1	756	1	744	1
Over recommendations	380	1.11 (0.96–1.29)	544	1.11 (0.96–1.29)	527	1.07 (0.94–1.21)

BMI – Body Mass Index; GWG – Gestational Weight Gain; OR – Odds Ratio; CI – Confidence Interval

Analyses were adjusted for maternal age at delivery, asthma, atopic dermatitis, race, ethnicity, smoking in child's early life, household income, husband's education, US region in child's early life, mode of delivery (C-section), child's birth order, and breast feeding duration.

* Analyses were further adjusted for maternal pre-pregnancy BMI.