Supplementary Online Content

This supplementary material has been provided by the authors to give readers additional information about their work.

eTable 1. Atopic Dermatitis Disease Activity and Severity by Child Age

Time point	Total respondents **	Never reported AD [a]		Inactive AD [b]		Active AD [c], No problem		Active AD [c], Mild		Active AD [c], Quite bad		Active AD [c], Very bad		Number with data available for both AD and sleep
		Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	
30 months (2 y 6 m)	10,196	4,754	46.6	620	6.1	191	1.9	1,040	10.2	602	5.9	170	1.7	10,195
42 months (3 y 6 m)	9,972	4,357	43.7	1,155	11.6	182	1.8	1,065	10.7	513	5.1	149	1.5	9,979
57 months (4 y 9 m)	9,335	3,823	41.0	1,291	13.8	191	2.1	1,171	12.5	484	5.2	114	1.2	9,324
69 months (5 y 9 m)	8,544	3,323	38.9	1,579	18.5	177	2.1	1,039	12.2	376	4.4	87	1.0	8,532
81 months (6 y 9 m)	8,418	3,206	38.1	1,835	21.8	161	1.9	968	11.5	311	3.7	81	1.0	8,408
103 months (8 y 7 m)	7,893	2,868	36.3	1,824	23.1	173	2.2	928	11.8	299	3.8	72	0.9	-
128 months (10 y 8 m)	7,422	2,602	35.1	2,028	27.3	107	1.4	830	11.2	243	3.3	34	0.5	6,717
140 months (11 y 8 m)	7,043	2,359	33.5	1,940	27.6	137	2.0	862	12.2	229	3.3	50	0.7	6,608
166 months (13 y 10 m)	6,713	2,227	33.2	2,220	33.1	63	0.9	567	8.5	191	2.9	37	0.6	-
198 months (16 y 6 m)*	4,813	1,451	30.2	1,637	34.0	61	1.3	354	7.4	213	4.4	65	1.4	3,227

* Child-reported; ** Includes individuals with AD severity data not missing
Atopic dermatitis (AD), defined as ≥ 2 positive responses to the question: *"Has your child had an itchy, dry skin rash in the joints and creases of his body (e.g. behind the knees, elbows, under the arms) in the past year?"* [a] Never AD defined as never reporting a positive response to the question above; [b] Inactive AD defined as a history of ≥ 2 positive responses to the above question, but a current negative response at the specific time point considered; [c] Active AD defined as a history of ≥ 2 positive responses to the above question, including a current positive response at the specific time point considered

eTable 2. Unadjusted Odds of Sleep Disturbances for Children with Active Atopic Dermatitis by Child Age Compared to Children Who Never Reported Atopic Dermatitis

Child age	Regularly waking at least once in the night	Regularly waking early in the morning	Regularly having difficulty falling asleep	Regularly experiencing nightmares	Composite outcome [*]: Experiencing more sleep quality disturbances
	Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)
30 months	1.19 (1.04, 1.35)	1.26 (1.11, 1.44)	1.08 (0.94, 1.23)	1.15 (0.99, 1.34)	1.22 (1.09, 1.37)
42 months	1.14 (0.99, 1.31)	1.29 (1.12, 1.48)	1.28 (1.12, 1.47)	1.38 (1.20, 1.59)	1.40 (1.24, 1.58)
57 months	1.38 (1.19, 1.61)	1.32 (1.14, 1.52)	1.29 (1.12, 1.50)	1.28 (1.11, 1.49)	1.47 (1.29, 1.66)
69 months	1.36 (1.14, 1.63)	1.12 (0.95, 1.31)	1.40 (1.19, 1.64)	1.39 (1.19, 1.63)	1.45 (1.27, 1.67)
81 months	1.50 (1.23, 1.83)	1.09 (0.92, 1.28)	1.46 (1.23, 1.74)	1.42 (1.20, 1.68)	1.51 (1.30, 1.74)
115 months	1.23 (0.89, 1.69)	1.18 (0.93, 1.50)	1.32 (1.04, 1.67)	1.59 (1.23, 2.05)	1.49 (1.21, 1.84)

Results from unadjusted logistic and ordered logistic ([*]composite outcome measure of sleep quality that combines nighttime awakenings, early morning awakenings, difficulty going to sleep, and nightmares) regression models examining the association between active atopic dermatitis and different sleep quality outcomes at 6 time points between ages 2 and 10.

eTable 3. Subject-specific Odds of Waking at Least Once per Night According to Atopic Dermatitis Disease Activity and Severity Stratified by Comorbid Asthma or Allergic Rhinitis Compared to Children Who Never Reported Atopic Dermatitis

Atopic dermatitis disease activity and severity	Unadjusted[1]	Adjusted[2]	
		No asthma or allergic rhinitis	Asthma or allergic rhinitis
	Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Never reported atopic dermatitis	Ref.	Ref.	Ref.
Overall active atopic dermatitis	0.96 (0.85, 1.08)	1.27 (1.08, 1.49)	1.53 (1.23, 1.90)
No problem	0.65 (0.53, 0.81)	1.02 (0.78, 1.32)	1.43 (0.85, 2.39)
Mild	0.62 (0.55, 0.70)	1.01 (0.88, 1.17)	0.96 (0.76, 1.21)
Quite bad	1.14 (0.99, 1.32)	1.40 (1.16, 1.70)	1.55 (1.17, 2.06)
Very bad	1.83 (1.42, 2.36)	1.80 (1.21, 2.69)	2.55 (1.60, 4.06)
Inactive atopic dermatitis	0.42 (0.38, 0.46)	1.06 (0.92, 1.22)	1.20 (0.96, 1.51)

Overall test for interaction: p = 0.228
Results from unadjusted and adjusted multivariable mixed effects logistic regression models examining the association between atopic dermatitis and nighttime awakening (≥ 1 awakening per night) at 6 time points between ages 2 and 10. The multivariable model adjusted for potential confounders including child gender, child age, child race/ethnicity, comorbid asthma or allergic rhinitis, household smoking exposure, maternal education, social class, crowding index, financial difficulties score, and maternal age at delivery, and included an interaction term between atopic dermatitis and comorbid asthma or allergic rhinitis. Although the test for interaction was not statistically significant, the interaction term was included on theoretical grounds, as it was statistically significant and included in the primary analysis with the composite sleep quality outcome.
[1] Model N = 11,446 individuals [mean of 4.5 observations per individual (range 1-6)]
[2] Model N = 9,089 individuals [mean of 4.5 observations per individual (range 1-6)]

eTable 4. Subject-specific Odds of Having Difficulty Falling Asleep According to Atopic Dermatitis Disease Activity and Severity Stratified by Comorbid Asthma or Allergic Rhinitis Compared to Children Who Never Reported Atopic Dermatitis

Atopic dermatitis disease activity and severity	Unadjusted[1]	Adjusted[2]	
		No asthma or allergic rhinitis	Asthma or allergic rhinitis
	Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Never reported atopic dermatitis	Ref.	Ref.	Ref.
Overall active atopic dermatitis	1.41 (1.28, 1.56)	1.37 (1.20, 1.56)	1.49 (1.24, 1.79)
No problem	1.27 (1.07, 1.52)	1.15 (0.93, 1.43)	1.37 (0.88, 2.12)
Mild	1.47 (1.34, 1.62)	1.34 (1.20, 1.50)	1.49 (1.24, 1.79)
Quite bad	1.41 (1.24, 1.60)	1.32 (1.12, 1.55)	1.66 (1.31, 2.12)
Very bad	1.50 (1.19, 1.88)	1.73 (1.22, 2.45)	1.44 (0.96, 2.16)
Inactive atopic dermatitis	1.85 (1.70, 2.03)	1.33 (1.19, 1.48)	1.51 (1.26, 1.81)

Overall test for interaction: p = 0.005
Results from unadjusted and adjusted multivariable mixed effects logistic regression models examining the association between atopic dermatitis and difficulty falling asleep at 6 time points between ages 2 and 10. The multivariable model adjusted for potential confounders including child gender, child age, child race/ethnicity, comorbid asthma or allergic rhinitis, household smoking exposure, maternal education, social class, crowding index, financial difficulties score, and maternal age at delivery, and included an interaction term between atopic dermatitis and comorbid asthma or allergic rhinitis.
[1] Model N = 11,459 individuals [mean of 4.6 observations per individual (range 1-6)]
[2] Model N = 9,102 individuals [mean of 4.5 observations per individual (range 1-6)]

eTable 5. Subject-specific Odds of Early Morning Awakening According to Atopic Dermatitis Disease Activity and Severity Stratified by Comorbid Asthma or Allergic Rhinitis Compared to Children Who Never Reported Atopic Dermatitis

Atopic dermatitis disease activity and severity	Unadjusted[1]	Adjusted[2]	
		No asthma or allergic rhinitis	Asthma or allergic rhinitis
	Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Never reported atopic dermatitis	Ref.	Ref.	Ref.
Overall active atopic dermatitis	1.15 (1.03, 1.28)	1.40 (1.21, 1.61)	1.56 (1.27, 1.91)
No problem	0.98 (0.81, 1.19)	1.22 (0.97, 1.54)	1.48 (0.92, 2.38)
Mild	1.03 (0.93, 1.14)	1.37 (1.21, 1.55)	1.39 (1.14, 1.70)
Quite bad	1.22 (1.06, 1.40)	1.25 (1.05, 1.49)	1.84 (1.41, 2.40)
Very bad	1.41 (1.09, 1.82)	1.81 (1.24, 2.66)	1.57 (1.00, 2.45)
Inactive atopic dermatitis	0.82 (0.75, 0.91)	1.34 (1.19, 1.51)	1.36 (1.12, 1.66)

Overall test for interaction: p = 0.078
Results from unadjusted and adjusted multivariable mixed effects logistic regression models examining the association between atopic dermatitis and early morning awakening at 6 time points between ages 2 and 10. The multivariable model adjusted for potential confounders including child gender, child age, child race/ethnicity, comorbid asthma or allergic rhinitis, household smoking exposure, maternal education, social class, crowding index, financial difficulties score, and maternal age at delivery, and included an interaction term between atopic dermatitis and comorbid asthma or allergic rhinitis. Although the test for interaction was not statistically significant, the interaction term was included on theoretical grounds, as it was statistically significant and included in the primary analysis with the composite sleep quality outcome.
[1] Model N = 11,459 individuals [mean of 4.6 observations per individual (range 1-6)]
[2] Model N = 9,102 individuals [mean of 4.5 observations per individual (range 1-6)]

eTable 6. Subject-specific Odds of Nightmares According to Atopic Dermatitis Disease Activity and Severity Stratified by Comorbid Asthma or Allergic Rhinitis Compared to Children Who Never Reported Atopic Dermatitis

Atopic dermatitis disease activity and severity	Unadjusted[1]	Adjusted[2]	
		No asthma or allergic rhinitis	Asthma or allergic rhinitis
	Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Never reported atopic dermatitis	Ref.	Ref.	Ref.
Overall active atopic dermatitis	1.56 (1.40, 1.74)	1.47 (1.28, 1.69)	1.71 (1.41, 2.07)
No problem	1.35 (1.12, 1.63)	1.28 (1.02, 1.60)	1.40 (0.89, 2.22)
Mild	1.59 (1.44, 1.76)	1.45 (1.29, 1.64)	1.56 (1.28, 1.89)
Quite bad	1.65 (1.44, 1.89)	1.53 (1.29, 1.81)	1.80 (1.40, 2.30)
Very bad	1.67 (1.31, 2.12)	1.63 (1.14, 2.34)	2.19 (1.45, 3.31)
Inactive atopic dermatitis	1.68 (1.53, 1.84)	1.46 (1.31, 1.63)	1.46 (1.22, 1.75)

Overall test for interaction: p = 0.873

Results from unadjusted and adjusted multivariable mixed effects logistic regression models examining the association between atopic dermatitis and nightmares at 6 time points between ages 2 and 10. The multivariable model adjusted for potential confounders including child gender, child age, child race/ethnicity, comorbid asthma or allergic rhinitis, household smoking exposure, maternal education, social class, crowding index, financial difficulties score, and maternal age at delivery, and included an interaction term between atopic dermatitis and comorbid asthma or allergic rhinitis. Although the test for interaction was not statistically significant, the interaction term was included on theoretical grounds, as it was statistically significant and included in the primary analysis with the composite sleep quality outcome.

[1] Model N = 11,457 individuals [mean of 4.6 observations per individual (range 1-6)]
[2] Model N = 9,100 individuals [mean of 4.5 observations per individual (range 1-6)]

eTable 7. Estimated Differences in Nighttime and Total Sleep Duration According to Atopic Dermatitis Disease Activity and Severity Compared to Children Who Never Reported Atopic Dermatitis Using Imputed Data

Nighttime duration	Unadjusted	Adjusted
Atopic dermatitis disease activity and severity	**Estimated difference in nighttime sleep duration in minutes (95% CI)**	**Estimated difference in nighttime sleep duration in minutes (95% CI)**
Never reported atopic dermatitis	Ref.	Ref.
Active atopic dermatitis		
No problem	-14 (-18, -9)	1 (-1, 4)
Mild	-13 (-15, -10)	1 (0, 3)
Quite bad	-12 (-16, -9)	1 (-1, 3)
Very bad	-14 (-21, -7)	2 (-3, 6)
Inactive atopic dermatitis	-41 (-43, -39)	3 (1, 4)
Total duration	**Unadjusted**	**Adjusted**
Atopic dermatitis disease activity and severity	**Estimated difference in total sleep duration in minutes (95% CI)**	**Estimated difference in total sleep duration in minutes (95% CI)**
Never reported atopic dermatitis	Ref.	Ref.
Active atopic dermatitis		
No problem	-15 (-20, -11)	-2 (-5, 1)
Mild	-15 (-17, -12)	-2 (-3, 0)
Quite bad	-12 (-15, -8)	-1 (-3, 1)
Very bad	-12 (-19, -4)	0 (-4, 4)
Inactive atopic dermatitis	-47 (-49, -45)	-1 (-2, 1)

Results using imputed data, from unadjusted and adjusted multivariable generalized estimating equation (GEE) regression models examining the association between atopic dermatitis and nighttime and total sleep duration at 8 time points between ages 2 and 16. The multivariable model adjusted for potential confounders including child gender, child age, child race/ethnicity, comorbid asthma or allergic rhinitis, household smoking exposure, maternal education, social class, crowding index, financial difficulties score, and maternal age at delivery. Due to the extremely large size of the imputed dataset, mixed models were not computationally feasible and GEE models were used instead. Robust standard errors were used in the GEE models.

eTable 8. Subject-specific Odds of Individual Sleep Quality Disturbances According to Atopic Dermatitis Disease Activity and Severity Compared to Children Who Never Reported Atopic Dermatitis Using Imputed Data

Waking at least once per night	Unadjusted	Adjusted (AD alone)
Atopic dermatitis disease activity and severity	**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**
Never reported atopic dermatitis	Ref.	Ref.
Active atopic dermatitis		
No problem	0.92 (0.79, 1.06)	1.05 (0.92, 1.20)
Mild	0.90 (0.83, 0.98)	1.06 (0.97, 1.15)
Quite bad	1.25 (1.14, 1.38)	1.26 (1.13, 1.41)
Very bad	1.74 (1.49, 2.03)	1.38 (1.13, 1.68)
Inactive atopic dermatitis	0.78 (0.73, 0.83)	1.01 (0.93, 1.09)
Difficulty falling asleep	**Unadjusted**	**Adjusted (AD alone)**
Atopic dermatitis disease activity and severity	**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**
Never reported atopic dermatitis	Ref.	Ref.
Active atopic dermatitis		
No problem	1.25 (1.11, 1.42)	1.14 (1.00, 1.30)
Mild	1.36 (1.27, 1.25)	1.21 (1.12, 1.30)
Quite bad	1.32 (1.21, 1.44)	1.21 (1.09, 1.34)
Very bad	1.35 (1.16, 1.57)	1.34 (1.10, 1.63)
Inactive atopic dermatitis	1.56 (1.47, 1.66)	1.23 (1.15, 1.31)

eTable8. (continued)

Early morning awakening	Unadjusted	Adjusted (AD alone)
Atopic dermatitis disease activity and severity	**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**
Never reported atopic dermatitis	Ref.	Ref.
Active atopic dermatitis		
No problem	1.01 (1.00, 1.13)	1.18 (1.03, 1.35)
Mild	1.02 (1.00, 1.10)	1.22 (1.13, 1.32)
Quite bad	1.13 (1.03, 1.24)	1.22 (1.10, 1.35)
Very bad	1.25 (1.08, 1.46)	1.31 (1.08, 1.58)
Inactive atopic dermatitis	0.88 (0.82, 0.93)	1.20 (1.12, 1.29)
Nightmares	**Unadjusted**	**Adjusted (AD alone)**
Atopic dermatitis disease activity and severity	**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**
Never reported atopic dermatitis	Ref.	Ref.
Active atopic dermatitis		
No problem	1.27 (1.12, 1.45)	1.24 (1.08, 1.42)
Mild	1.41 (1.32, 1.52)	1.36 (1.26, 1.47)
Quite bad	1.45 (1.32, 1.59)	1.38 (1.24, 1.53)
Very bad	1.52 (1.30, 1.78)	1.34 (1.10, 1.62)
Inactive atopic dermatitis	1.39 (1.30, 1.49)	1.32 (1.23, 1.42)

Results using imputed data, from unadjusted and adjusted multivariable generalized estimating equation (GEE) regression models examining the association between atopic dermatitis and four individual sleep quality disturbances at 6 time points between ages 2 and 10. The multivariable model adjusted for potential confounders including child gender, child age, child race/ethnicity, comorbid asthma or allergic rhinitis, household smoking exposure, maternal education, social class, crowding index, financial difficulties score, and maternal age at delivery, and included an interaction term between atopic dermatitis and comorbid asthma or allergic rhinitis. Due to the extremely large size of the imputed dataset, mixed models were not computationally feasible and GEE models were used instead. Robust standard errors were used in the GEE models.