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Youth secrets are associated with poorer sleep and asthma symptoms via negative affect

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ABSTRACT

Objective: Among older children and adolescents, keeping secrets from parents is consistently associated with lower levels of psychological well-being. Further, concealing one's thoughts and emotions has been associated with poor physical health outcomes in adults. However, it remains an open question whether secret-keeping is associated with poorer health and health-related behaviors (such as sleep) among youth and, if those hypothesized links exist, what the psychological mechanisms might be. We investigated the associations among youth secrecy towards parents, daily asthma symptoms and daily sleep behaviors in a sample of low-income youth with asthma aged 10–17 and tested negative affect as a possible mediator of these associations.
Methods: One hundred and seventy two youths reported the extent to which they kept secrets towards parents over a period of four days. Asthma symptoms, nighttime awakenings, sleep onset latency, and subjective sleep quality were assessed with daily diaries completed by youths.
Results: More frequent secret-keeping was associated with more severe asthma symptoms, lower ratings of sleep quality and greater number of nighttime awakenings. Secrecy was also associated with increased negative affect, which accounted for the associations between secrecy and number of awakenings and daytime asthma symptoms. These findings remained significant after controlling for youth age and other relevant demographic factors.
Conclusions: Our findings suggest that secrecy towards parents can have consequential health outcomes for youth with asthma and point to the importance of investigating affective processes as mediators of the influence of secret-keeping on youth health.

1. Introduction

Asthma is the most prevalent childhood chronic illness in the United States, affecting primarily youth from minority and low-socioeconomic groups [1]. Asthma can influence developmental outcomes, increasing vulnerability for emotional and behavioral difficulties, which are exacerbated in youth facing socioeconomic adversity [2,3]. Research suggests that psychosocial stressors involving challenges in affiliating with others are associated with exacerbation of pediatric asthma symptoms and greater functional impairment [3]. For example, family conflict, youth oppositional behaviors, and difficulties in getting along with peers show robust associations with asthma severity, such as more frequent experiences of asthma attacks (e.g. Ref 2). Although these types of stressors represent clear manifestations of difficulties with interpersonal relationships, other subtler processes can also serve as important indicators of challenges in affiliating with others. Among these, the tendency to keep secrets from close others is often an indicator of interpersonal stress stemming from lack of intimacy, and low trust. Although research shows that secrecy and lack of disclosure among youth can have deleterious consequences for psychological well-being, their effects on physical well-being are poorly understood. In an attempt to bridge this gap, we investigated the link between secrecy from parents regarding one's thoughts and activities, and physical health among low-income youth with asthma. We also tested negative affect as a plausible psychological mechanism that may underlie this association.

During late childhood and adolescence youth increasingly assert greater independence in their social environments. While building autonomy is an adaptive goal, maintaining cohesive and intimate relationships with parents leads to better psychosocial adjustment throughout adolescence [4]. Moreover, youths' disclosure to parents regarding various aspects of their daily lives is associated with fewer internalizing and externalizing problems [5,6]. Recent evidence, however, suggests that the effects of disclosure and secrecy towards parents are not mere opposites of each other [7]. Unlike failure to self-disclose, secrets involve active concealment of information and are part of normative information-sharing strategies that youth employ in order to increase autonomy [8].

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Indeed, many studies have shown that youth may choose to disclose certain information about their daily activities to parents, while keeping other information secret [8,9]. Despite their normative prevalence, secrets towards parents show consistent links with maladaptive outcomes [10]. Secrecy often appears as a marker for behavioral problems [11,12], and may also be connected to youth physical health problems. For example, secrecy regarding daily activities has been associated with more frequent physical complaints (e.g. headaches, nausea, 13) and research among youth with diabetes reveals that greater secrecy regarding diabetes management is associated with poorer adherence and glycemic control, independently from the effects of disclosure [14,15]. In contrast, youths' written disclosure of their innermost emotions is associated with reduced asthma symptoms and decreased functional disability [16].

Past research indicates that secrecy is also a strong predictor of psychological outcomes with prominent ties to physical health problems such as loneliness and depression [13,17]. Studies show that secrecy predicts increased negative affect longitudinally, with more frequent secret-keeping in early adolescence leading to increased depressive symptoms and anxiety over time, but not vice versa [10,18,19].[1] These findings have particular relevance for low-income youth with asthma for several reasons. First, psychological conditions that involve dysregulation of negative affect (e.g., depression) are frequently associated with increased symptoms and asthma severity [3], and these links are stronger among low-income youth [1,2]. Second, because of the many stressors that surround them, low-SES parents experience more parenting difficulties and tend to engage in more punitive parenting practices, which can alienate youth from warm and responsive interactions with them [20,21] and potentially increase secrecy in order to avoid punishment. Therefore, developing in economically distressed environments may exacerbate the secrecy-health link, particularly for conditions such as asthma. Although studies show that minority youth tend to be similar to European American youth in most aspects of secret-keeping behaviors [22], research in this area is limited [9] and further work is needed to better understand the health consequences of secret-keeping among youth in low-income settings.

Asthma shares a complex relation with sleep, a health behavior that may be significantly impacted by disclosure and secrecy [23,24]. Sleep is an important restorative behavior [25]. Research shows that asthma symptoms may lead to sleep disturbances [26,27], but also that poor sleep may influence subsequent asthma symptoms [28]. Negative affect and rumination may increase sleep difficulties, especially if experienced before bed-time [29,30]. Evidence also suggests that sleep is affected by social processes. For example, friendship quality was associated to sleep outcomes in college students [31,32], while greater attachment security to mothers predicted fewer sleep problems after two years among third grade children [33]. Such findings raise the possibility that the effects of secrecy among youth may extend to health outcomes and behaviors (e.g., sleep) relevant to asthma.

Generally, it is assumed that keeping secrets is an aversive process for the secret-keeper, since it requires increased monitoring and vigilance [34]. Active inhibition of one's thoughts and feelings may increase arousal, worry, and intrusive thoughts that may lead to increased experiences of stress over time [35]. Negative affect is often a consequence of stress and has been associated with poor physical health [36], including poor sleep outcomes [29], more frequent asthma symptoms and worse pulmonary functioning in youth with asthma [37]. Research with adolescents has shown that daily negative affect strongly predicts sleep disruptions and sleep quality [38,39]. Furthermore findings in adults suggest that negative affect may be a mechanism explaining the effects of self-disclosure processes on sleep [24]. Therefore, considering that secrecy may lead to exacerbation of negative affect over time, and that reductions in negative affect are associated with better sleep outcomes [18,24], we expected that greater negative affect would mediate the links among secrecy, asthma symptoms, and sleep. Another line of reasoning, however, is that secret-keeping promotes vulnerability to negative health outcomes *only* among youth who experience higher levels of negative affect in daily life. In order to test these competing hypotheses, we examined negative affect both as a mediator and moderator of the association between secrecy and health outcomes.

Thus, in the current study, we investigated the links among secrecy regarding one's daily activities, thoughts, and feelings, asthma symptoms and sleep in an urban sample of youth with asthma. Given that secrecy might increase strain in parent-child relationships and isolate youth from warm and responsive interactions with parents, we hypothesized that higher levels of secrecy from parents would be related to more severe asthma symptoms. In line with the notion that secrecy promotes vigilance and rumination, we hypothesized that higher levels of secrecy would also be associated with several indicators of poor sleep. Because of the bidirectional association between asthma and sleep [40], we conducted exploratory analyses to test whether sleep outcomes would mediate the links between secrecy and asthma symptoms. Finally, because negative affect has been associated with both asthma morbidity and sleep problems, we tested the role of negative affect as a proximal mechanism of these associations.

2. Method

2.1. Participants

Participants were part of a larger longitudinal project examining the effects of family environments on childhood asthma.[2] Youths and their primary caregivers were recruited through Metro-Detroit area hospitals and schools. This study focused on baseline daily diary assessments collected from the youth participants. Families were eligible to participate if their child was between the ages of 10 and 17 with a diagnosis of mild to severe asthma confirmed by medical report. Families were excluded if youth were using oral steroid medication(s), diagnosed with a chronic condition other than asthma (e.g., endocrine disorders), or diagnosed with a medical condition that may interfere with immune system functions (e.g., pregnancy in the past year). The overall sample ($N = 194$) included 82 female (*Mean age* = 13.03, $SD = 1.88$) and 112 male (*Mean age* = 12.62, $SD = 1.75$) youths ranging in age from 10 to 17 years. The sample was reduced to 172 youths after excluding participants with >50% of missing data on study variables (see "Analysis Plan"). This final sample included 72 female (*Mean age* = 13.07, $SD = 1.94$) and 100 male (*Mean age* = 12.63, $SD = 1.77$) youths. One hundred and twenty nine (75.0%) youths were African American, with the rest being European American and Hispanic. Parental education ranged from *no schooling completed* to *doctoral degree,* with 40.1% of parents having completed at least 12 years of education. Annual parental income ranged from $0–$7825 tax bracket to the $97,926–$174,850 tax bracket with a median range of $7826–$31,850. Asthma severity diagnosis ranged from mild intermittent to severe, with 34.3% of participants having mild to moderate asthma, 34.3% having moderate to severe asthma and 31.4% of participants having severe asthma.

2.2. Procedure

Participants visited the lab to complete baseline questionnaires. Following this visit, youths completed daily diaries and sleep diaries in paper for two weekdays and two weekend days. Written assent and consent were obtained from the participating youth and their parent, respectively. Families were paid up to $540 for their participation across

[1] The alternative hypothesis of negative affect leading to increased secrecy over time has been tested frequently but has not found strong support in the literature (e.g. [10,19]).

[2] Other papers from this project have investigated conflict and asthma symptoms [41], youth immune responses and affect [42], and youth positive behaviors and affect [43]. The present analyses do not overlap with these previous analyses.

all study waves. This study was approved by the institutional review board at Wayne State University.

2.3. Measures

Descriptive and reliability statistics for each measure are provided in Table 1.

2.3.1. Secrecy

Following Smetana and colleagues [22], youth were provided a list of 14 statements regarding their activities, thoughts, and feelings each day and rated on a scale from 1 (*not at all secret*) to 5 (*very secret*) the extent to which they concealed each of them from their parents. Items included problem behaviors (e.g., "Anything I did that might be risky or unsafe"), school-related topics (e.g., "My school-work, assignments, or grades"), personal feelings/behaviors (e.g., "My true feelings"), and multifaceted behaviors (e.g., "How I spent my free time"). These items have been frequently used in previous research (e.g., 9, 22) and show high reliability, with alphas ranging from 0.90 to 0.98. Responses were averaged across the 4 days to create an average secrecy score.

2.3.2. Asthma symptoms

Youth reported both daytime and nighttime asthma symptoms on a 5-point scale, with higher scores indicating more severe symptoms. Daytime symptoms were reported before going to bed ($M = 1.34$, $SD = 0.38$), while nighttime symptoms were reported the following day right after wake-up ($M = 1.26$, $SD = 0.38$). Symptoms included wheezing, chest pain, chest tightness, and shortness of breath and were selected based on the National Asthma Education and Prevention Program, Expert Panel Report 2 [44]. Responses were aggregated across the four days.

2.3.3. Sleep outcomes

Upon waking up, participants answered items regarding aspects of their sleep overnight. Items were modified from the Pittsburgh Sleep Diary [45], and are commonly used to assess sleep outcomes [46]. Youth reported on sleep onset latency (SOL) as the number of minutes it took them to fall asleep; the time they went to bed and got out of bed, which were used to compute total time in bed; and the number of times they woke up during the night. Subjective sleep quality was measured with a single item ranging from 1 (*terrible*) to 4 (*great*).

2.3.4. Daily negative affect

Following previous studies (e.g. [47,48]), we used six adjectives to capture daily negative affect: *sad, mean, unhappy, tense, angry,* and *worried*. Youth rated on a scale from 1 (*not at all*) to 5 (*all of the day*) the extent to which each adjective described their emotional experiences over the day. These items have been well-validated by previous research with reliability indexes ranging from 0.77 to 90 (e.g. [47,48]).

Table 1
Descriptive statistics.

Variable	M or %	SD	Range	Internal consistency (α)
Female	42%	–	–	–
Non-White	78.50%	–	–	–
Some college (<1 year)*	40.10%	–	No schooling-Doctoral Degree	–
Age	12.82	1.85	10–18	–
Secrecy	1.41	0.60	1.00–4.33	0.94
Asthma symptoms (day)	1.34	0.38	1.00–3.00	0.89
Asthma symptoms (night)	1.26	0.38	1.00–3.27	0.90
Subjective sleep quality	3.38	0.47	2.25–4.00	–
Number of awakenings	0.77	1.00	0.00–7.50	–
SOL	20.40	26.00	0.00–178.33	–
Total time in bed	9.01	1.29	4.65–12.54	–
Negative affect	1.24	0.30	1.00–3.04	0.85
Sleep continuity	8.67	1.34	2.88–12.35	–

Note. *Indicates parental education; SOL = Sleep Onset Latency (reported in minutes); Sleep Continuity (reported in hours) was calculated as the difference between Total time in Bed (reported in hours) and SOL.

2.4. Analysis plan

Bivariate correlations were conducted to examine the relations among study variables (Table 2). Multiple regression analyses were conducted to assess the association between secrecy and asthma outcomes, as well as the association between secrecy and each sleep outcome. Because we did not assess the duration of nighttime awakenings, we were unable to calculate a measure of sleep duration; instead, we calculated the difference between total time in bed and SOL in order to obtain an approximate measure of sleep continuity. To determine the covariates for our analyses, we first tested if theoretically-relevant variables such as gender, ethnicity, age, and parental education were significantly associated with secrecy and the outcome variables [2]. Of these possible covariates, we selected only those that correlated with the outcome variables ($p < 0.10$; cf. Ref. 49). Age, which correlated with secrecy, was included in all models.

Nine out of the 12 variables included in the study had missing values. Participants with missing values on >50% of the study variables were excluded leaving a sample size of 172 individuals (41.9% females) out of the initial 194 youths enrolled in the study (42.3% females). This approach allowed us to reduce the amount of missing data from 16.5% to 5.8%. Although non-white individuals were overrepresented among the excluded subsample compared to the final sample ($\chi 2$ (1) = 5.85, $p = 0.02$), no other differences between the two subsamples emerged in any other demographic variables (lowest $p = 0.12$). The expectation maximization (EM) algorithm was used to replace missing values, which reduces the bias associated with list-wise deletion of missing data, provides unbiased parameter estimates, and improves statistical power [50]. Because EM does not allow value replacement for categorical data, mode replacement was used to replace missing parental education data. Indirect effect analyses using bootstrapping [51] were run to test whether secrecy showed the hypothesized indirect effects on the dependent variables via negative affect. To test the alternative hypothesis that negative affect would moderate the impact of secrecy on the dependent variables, we ran additional regression analyses including a negative affect by secrecy interaction term. To facilitate interpretation, all continuous variables were standardized, while dichotomous variables were coded as 0 and 1 (i.e., 0 = less than at least one year of college, 1 = one year of college or more).

3. Results

3.1. Secrecy and asthma symptoms

Regression analyses revealed a significant effect of secrecy on daytime asthma symptoms [$b = 0.324$, $SE = 0.072$, $p < 0.001$ after controlling for age and gender] and on nighttime asthma symptoms [$b = 0.302$, $SE = 0.075$, $p < 0.001$, after controlling for age]. Distribution of residuals for nighttime symptoms was strongly skewed and elimination of five observations associated with large standardized residuals significantly reduced skewness. The new pattern of results did not change, with secrecy being positively associated with nighttime symptoms [$b = 0.134$, $SE = 0.057$, $p = 0.02$].[3]

[3] Please see supplemental document for tables reflecting results from each regression analysis. In order to ensure that findings were not driven by a certain group of youth, we also repeated our analyses after winsorizing extreme observations associated with large standardized scores (>3 SD) for any of the variables of interest. The pattern of these results remained largely the same (with a few exceptions) and they are reported in the supplemental document.

Table 2
Bivariate correlations between study variables.

Descriptive variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Female	1	−0.015	−0.075	0.119	−0.002	0.198**	−0.033	−0.105	0.052	0.049	0.008	0.079	−0.07
2. Non-White		1	−0.226**	−0.182*	−0.019	−0.079	0.102	0.006	0.08	0.016	0.023	−0.045	0.017
3. Some college (<1 year)			1	−0.088	−0.034	0.045	0.001	−0.117	−0.018	−0.105	−0.223**	−0.021	−0.181*
4. Age				1.000	0.176*	0.161*	0.033	−0.209**	0.130	0.096	−0.199**	0.121	−0.222**
5. Secrets					1.000	0.338**	0.299**	−0.247**	0.271**	0.105	−0.124	0.508**	−0.152*
6. Asthma symptoms (day)						1.000	0.722**	−0.510**	0.391**	0.020	−0.051	0.317**	−0.056
7. Asthma symptoms (night)							1.000	−0.494**	0.355**	0.060	−0.041	0.223**	−0.058
8. Subjective sleep quality								1.000	−0.317**	−0.035	0.068	−0.235**	0.076
9. Number of awakenings									1.000	−0.003	−0.228**	0.268**	−0.218**
10. SOL										1.000	0.043	−0.018	−0.277**
11. Total time in bed											1.000	0.046	0.948**
12. Negative mood												1.000	0.050
13. Sleep continuity													1.000

* $p < 0.05$.
** $p < 0.01$.

Next, we tested whether negative affect mediated the link between secrecy and asthma symptoms. The bootstrap analyses revealed a significant indirect association between secrecy and daytime symptoms (95% CI: 0.0037, 0.2130) – but not nighttime symptoms (95% CI: −0.0172, 0.1323) – via negative affect (Fig. 1). We also tested the alternative moderating hypotheses (i.e., secrecy and negative affect would interact in predicting asthma symptoms) and found that the interaction term was not significant for either daytime [$b = -0.003$, $SE = 0.044$, $p = 0.94$] or nighttime symptoms [$b = 0.078$, SE = 0.045, $p = 0.09$; $b = 0.031$, $SE = 0.033$, $p = 0.34$, after removing five observations associated with large standardized residuals].

Finally, in order to ensure that the association between secrecy and asthma symptoms was not driven by those youth experiencing the most severe symptoms, we conducted additional analyses where we tested whether the effects of secrecy were moderated by asthma severity. These analyses also included parental income as an additional covariate in order to make sure that these effects remained even after accounting for this variable. For daytime symptoms, results indicated a significant effect for secrecy [$b = 0.313$, $SE = 0.072$, $p < 0.001$] and asthma severity [$b = 0.142$, $SE = 0.072$, $p = 0.049$], but no effect was found for the interaction term [$b = 0.073$, $SE = 0.08$, $p = 0.363$, after controlling for age, gender and parental income]. A similar pattern of results was also observed for nighttime symptoms, with secrecy remaining a significant predictor [$b = 0.289$, $SE = 0.075$, $p < 0.001$], while the effects of asthma severity [$b = 0.017$, $SE = 0.075$, $p = 0.821$] and the interaction term [$b = 0.100$, $SE = 0.084$, $p = 0.233$ after controlling for age and parental income] did not reach statistical significance.

3.2. Secrecy and sleep outcomes

All the regression analyses involving sleep outcomes included age as a covariate. Analyses for total time in bed and sleep continuity also controlled for parental education. Results revealed a significant association between secrecy and lower subjective sleep quality [$b = -0.216$, $SE = 0.075$, $p = 0.004$] and greater number of awakenings [$b = 0.256$, $SE = 0.075$, $p = 0.001$],[4] but not total time in bed [$b = -0.096$, $SE = 0.074$, $p = 0.19$], sleep continuity [$b = -0.121$, $SE = 0.074$, $p = 0.11$], or SOL [$b = 0.091$, $SE = 0.077$, $p = 0.24$],[5] though these effects were in the expected direction.

Bootstrap analyses revealed that secrecy had an indirect association with number of awakenings via negative affect (95% CI: 0.0175, 0.1691). Further, although secrecy was not directly associated with total time in bed or sleep continuity, analyses revealed a significant indirect pathway through which higher secrecy was linked to lower total time in bed (95% CI: 0.0083, 0.1874) and sleep continuity (95% CI: 0.0172, 0.2007) via negative affect. No evidence was found for an indirect effect linking secrecy to subjective sleep quality (95% CI: −0.1787, 0.031), or SOL (95% CI: −0.1450, 0.0156). We also tested the alternative moderating hypotheses (i.e., secrecy and negative affect would interact in predicting sleep outcomes) and found that the interaction term was not significant for subjective sleep quality [$b = 0.023$, $SE = 0.046$, $p = 0.62$], number of awakenings [$b = 0.040$, $SE = 0.046$, $p = 0.38$], total time in bed [$b = 0.009$, $SE = 0.045$, $p = 0.84$] or sleep continuity [$b = -0.024$, $SE = 0.045$, $p = 0.60$]. Distribution of residuals for number of awakenings was skewed and elimination of one observation associated with large standardized residuals significantly reduced skewness. Results remained the same, with the interaction term not being associated with number of awakenings [$b = 0.017$, $SE = 0.038$, $p = 0.65$].

A significant interaction term was found for SOL [$b = 0.103$, $SE = 0.047$, $p = 0.030$], such that higher secrecy was associated with greater sleep latency among participants reporting higher levels of negative affect. Again, distribution of residuals was strongly skewed and elimination of five observations associated with large standardized residuals did not significantly reduce skewness. For these reasons, analyses were repeated using bootstrapping to compute robust β estimates which yielded identical results, [$b = 0.103$, $SE = 0.058$, $p = 0.047$].

3.3. Secrecy, asthma symptoms and sleep outcomes

Given this pattern of results, we also explored whether subjective sleep quality and number of awakenings would mediate the effects of secrecy on asthma symptoms. Bootstrap analyses revealed that both sleep quality and number of awakenings mediated the link between secrecy and daytime asthma symptoms (95% CI: 0.0271, 0.1867 for sleep quality; 95% CI: 0.0130, 0.2222 for number of awakenings) as well as nighttime asthma symptoms (95% CI: 0.0319, 0.2046 for sleep quality; 95% CI: 0.0101, 0.2301 for number of awakenings). Significant indirect associations were also found when number of awakenings and sleep quality were introduced simultaneously as mediators in the model.

4. Discussion

Our findings showed that higher levels of secrecy from parents were associated with more severe daytime asthma symptoms, lower sleep quality, and greater number of awakenings over four days. Secrecy was also associated with increased negative affect, which accounted

[4] For analyses involving number of awakenings the distribution of residuals was strongly skewed and elimination of one observation associated with large standardized residuals significantly reduced skewness. Results did not change, with secrecy being positively associated with number of awakenings [$b = 0.290$, $SE = 0.063$, $p < 0.001$].

[5] Distribution of residuals was strongly skewed and elimination of observations associated with large standardized residuals did not reduce skewness. For these reasons, this model was run using bootstrapping to compute robust β estimates. This procedure yielded identical results, with secrecy not being associated with SOL [$b = 0.091$, $SE = 0.096$, $p = 0.37$].

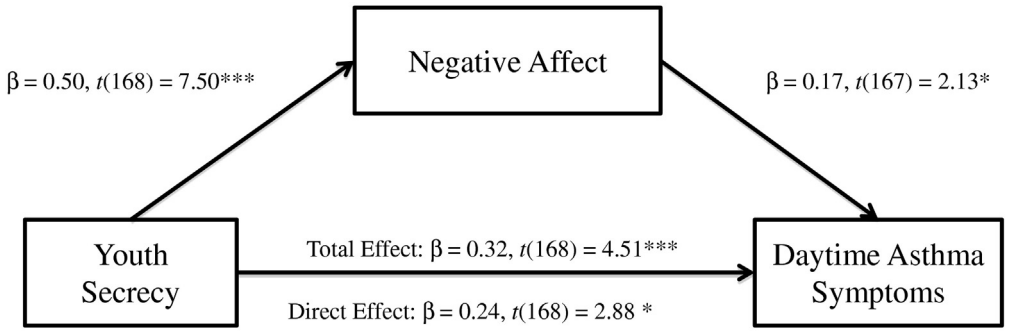

Fig. 1. Indirect effect of youth secrecy on daytime asthma symptoms via negative affect. *Note*: $^{*}p < 0.05$, $^{***}p < 0.001$.

for the links between secrecy, number of awakenings and daytime asthma symptoms.

Our study provides a novel extension of previous work on youth secrecy by showing that secrecy may have negative consequences on disease outcomes such as asthma symptoms, and that it may undermine restorative behaviors such as sleep, which can further influence physiological processes relevant to health over time. Another contribution was the investigation of negative affect as a proximal mechanism underlying the relation between secrecy and health. We observed that higher levels of secrecy were associated with higher levels of negative affect, which, in turn, explained the association of secrecy with nightly awakenings and daytime asthma symptoms. These findings support a large body of work on youth emotional adjustment and asthma severity [3] and highlight the idea that affective processes may serve as key mediators of youth social experiences on asthma outcomes [52].

It should be noted that our indirect effect findings were not uniform across all outcomes. For example, negative affect did not show an association with SOL. Perhaps, our results reflect the limitations of self-report for particular sleep outcomes such as SOL, especially among youth participants. Alternatively, these results may simply be due to the smaller effects of negative affect on SOL and sleep quality compared to number of awakenings. Future studies should use objective assessments of sleep, which may help to clarify the interpretation of our findings. Future studies should also continue to investigate whether negative affect should be conceptualized as a mediator or moderator of the relation between secrecy and SOL. As our findings show, greater negative affect led to larger SOL only among participants reporting higher secrecy, suggesting that negative affect may sometimes lead to deleterious outcomes only if levels of secrecy are also high.

Some of the reasons why youth keep secrets from parents may depend on characteristics of the parent-child relationship. Research shows that youth who perceive lower warmth and trust from their parents are more likely to keep secrets from them [53]. Because high levels of family connectedness are associated with lower levels of asthma-related functional limitation [54], fostering trust in parent-child relationships may constitute a mechanism for reducing secrecy and improving well-being in youth with asthma. Therefore, future research needs to clarify the extent to which family characteristics influence the association between youth secrecy and health, as these findings could lead to avenues for interventions that promote health among youth with asthma.

Despite its contributions, our study presents some limitations worth noting. First, we cannot pinpoint causality because of our cross-sectional design. For example, when testing the role of sleep as a mediator between secrecy and asthma outcomes, significant relations emerged for both daytime and nighttime symptoms. While this may indicate bidirectional associations between asthma and sleep [28], it is also possible that secrecy may lead to poorer sleep simply because of experiences of asthma symptoms. These questions may be clarified only through studies with prospective designs spanning over longer periods of time (i.e., more than four days, which are not ideal for robust lag analyses; [55]), which would allow us to control for previous day effects of sleep, asthma symptoms, and negative affect. Second, we note that the average level of secrecy in our sample is low. Therefore, future studies should continue to investigate youth secrecy and physical health in order to ensure that effects are not driven by other factors. Finally, most of our participants belonged to economically distressed, African American families; these findings should be replicated in samples of different socioeconomic backgrounds, and in other minority groups with high rates of asthma such as Hispanics [1]. In light of research showing that responsive relationships with parents are associated with better immune functioning among youth with asthma [42], promoting greater parental responsiveness in low-SES families may promote greater disclosure and less secrecy in the parent-child relationship.

In sum, our findings emphasize the notion that lower levels of secrecy in the parent-child relationship can lead to beneficial health outcomes during late childhood and adolescence, and, more broadly speaking, our findings support theoretical accounts emphasizing affective processes as important mechanisms through which social experiences influence physical health.

Conflicts of interest

The authors have no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jpsychores.2017.02.011.

References

[1] B. Bloom, L.I. Jones, G. Freeman, Summary health statistics for U.S. children: National Health Interview Survey, Vital Health Stat. 10 (2012) 1–75.
[2] J.A. Blackman, M.J. Gurka, Developmental and behavioral comorbidities of asthma in children, J. Dev. Behav. Pediatr. 28 (2007) 92–99, http://dx.doi.org/10.1097/DBP.0b013e3182396895.
[3] E.L. McQuaid, N. Weiss-Laxer, S.J. Kopel, D.K. Mitchell, J.H. Nassau, M.Z. Wamboldt, R.B. Klein, G.K. Fritz, Pediatric asthma and problems in attention, concentration, and impulsivity: disruption of the family management system, Fam. Syst. Health 26 (2008) 16–29, http://dx.doi.org/10.1037/1091-7527.26.1.16.
[4] J.G. Smetana, N. Campione-Barr, A. Metzger, Adolescent development in interpersonal and societal contexts, Annu. Rev. Psychol. 57 (2006) 255–284, http://dx.doi.org/10.1146/annurev.psych.57.102904.190124.
[5] M. Kerr, H. Stattin, What parents know, how they know it, and several forms of adolescent adjustment: further support for a reinterpretation of monitoring, Dev. Psychol. 36 (2000) 366–380, http://dx.doi.org/10.1037/0012-1649.36.3.366.

[6] L. Keijsers, T. Frijns, S.J.T. Branje, W. Meeus, Developmental links of adolescent disclosure, parental solicitation, and control with delinquency: moderation by parental support, Dev. Psychol. 45 (2009) 1314–1327, http://dx.doi.org/10.1037/a0016693.
[7] T. Afifi, J. Caughlin, W. Afifi, The dark side (and light side) of avoidance and secrets, in: B.H. Spitzberg, W.R. Cupach (Eds.), The Dark Side of Interpersonal Communication, second ed.Erlbaum, Mahwah, NJ 2007, pp. 61–92.
[8] R.D. Laird, M.D. Marrero, J.A. Melching, E.S. Kuhn, Information management strategies in early adolescence: developmental change in use and transactional associations with psychological adjustment, Dev. Psychol. 49 (2013) 928–937, http://dx.doi.org/10.1037/a0028845.
[9] M. Villalobos Solis, J.G. Smetana, J. Comer, Associations among solicitation, relationship quality, and adolescents' disclosure and secrecy with mothers and best friends, J. Adolesc. 43 (2015) (193-05).
[10] T. Frijns, C. Finkenauer, Longitudinal associations between keeping a secret and psychosocial adjustment in adolescence, Int. J. Behav. Dev. 33 (2009) 145–154, http://dx.doi.org/10.1177/0165025408098020.
[11] N. Darling, P. Cumsille, L.L. Caldwell, B. Dowdy, Predictors of adolescents' disclosure to parents and perceived parental knowledge: Between- and within-person differences, J. Youth Adolesc. 35 (2006) 659–670, http://dx.doi.org/10.1007/s10964-006-9058-1.
[12] T. Frijns, C. Finkenauer, A.A. Vermulst, R.C.M.E. Engels, Keeping secrets from parents: Longitudinal associations of secrecy in adolescence, J. Youth Adolesc. 34 (2005) 137–148, http://dx.doi.org/10.1007/s10964-005-3212-z.
[13] C. Finkenauer, R.C.M.E. Engels, W. Meeus, Keeping secrets from parents: Advantages and disadvantages of secrecy in adolescence, J. Youth Adolesc. 31 (2002) 123–136, http://dx.doi.org/10.1023/A:1014069926507.
[14] A. Main, D.J. Wiebe, K. Van Bogart, S.L. Turner, C. Tucker, J.E. Butner, C.A. Berg, Secrecy from parents and type 1 diabetes management in late adolescence, J. Pediatr. Psychol. 40 (2015) 1075–1084.
[15] P. Osborn, C.A. Berg, A.E. Hughes, P. Pham, D.J. Wiebe, What mom and dad don't know CAN hurt you: adolescent disclosure to and secrecy from parents about type 1 diabetes, J. Pediatr. Psychol. 38 (2013) 141–150.
[16] L.J. Warner, M.A. Lumley, R.J. Casey, W. Pierantoni, R. Salazar, E.M. Zoratti, R. Enberg, M.R. Simon, Health effects of written emotional disclosure in adolescents with asthma: a randomized, controlled trial, J. Pediatr. Psychol. 31 (2006) 557–568.
[17] T. Frijns, L. Keijsers, S. Branje, W. Meeus, What parents don't know and how it may affect their children: qualifying the disclosure-adjustment link, J. Adolesc. 33 (2010) 261–270, http://dx.doi.org/10.1016/j.adolescence.2009.05.010.
[18] R.D. Laird, B.J. Bridges, M.A. Marsee, Secrets from friends and parents: longitudinal links with depression and antisocial behavior, J. Adolesc. 36 (2013) 685–693, http://dx.doi.org/10.1016/j.adolescence.2013.05.001.
[19] J. Kearney, K. Bussey, The impact of pressured information management on boys' and girls' psychological functioning, J. Appl. Dev. Psychol. 35 (2014) 234–244.
[20] R.D. Conger, M.B. Donnellan, An interactionist perspective on the socioeconomic context of human development, Annu. Rev. Psychol. 58 (2007) 175–199, http://dx.doi.org/10.1146/annurev.psych.58.110405.085551.
[21] V.C. McLoyd, Socioeconomic disadvantage and child development, Am. Psychol. 53 (1998) 185–204.
[22] J.G. Smetana, M. Villalobos, R.D. Rogge, M. Tasopoulos-Chan, Keeping secrets from parents: daily variations among poor, urban adolescents, J. Adolesc. 33 (2010) 321–331, http://dx.doi.org/10.1016/j.adolescence.2009.04.003.
[23] M. Vandekerckhove, J. Kestemont, R. Weiss, C. Schotte, V. Exadaktylos, B. Haex, J. Verbraecken, J.J. Gross, Experiential versus analytical emotion regulation and sleep: breaking the link between negative events and sleep disturbance, Emotion 12 (2012) 1415–1421, http://dx.doi.org/10.1037/a0028501.
[24] H.S. Kane, R.B. Slatcher, B.M. Reynolds, R.L. Repetti, T.F. Robles, Daily self-disclosure and sleep in couples, Health Psychol. 33 (8) (2014) 813–822, http://dx.doi.org/10.1037/hea0000077.
[25] K. Spiegel, R. Leproult, E. Van Cauter, Impact of sleep debt on metabolic and endocrine function, Lancet 354 (1999) 1435–1439, http://dx.doi.org/10.1016/S0140-6736(99)01376-8.
[26] K.N. Desager, V. Nelen, J.J.J. Weyler, W.A. De Backer, Sleep disturbance and daytime symptoms in wheezing school-aged children, J. Sleep Res. 14 (2005) 77–82, http://dx.doi.org/10.1111/j.1365-2869.2004.00432.x.
[27] D. Koinis-Mitchell, et al., Good sleep health in urban children with asthma: a risk and resilience approach, J. Pediatr. Psychol. 40 (9) (2015) 888–903, http://dx.doi.org/10.1093/jpepsy/jsv046.
[28] M.D. Hanson, E. Chen, The temporal relationships between sleep, cortisol, and lung functioning in youth with asthma, J. Pediatr. Psychol. 33 (3) (2008) 312–316, http://dx.doi.org/10.1093/jpepsy/jsm120.
[29] T. Åkerstedt, N. Orsini, H. Petersen, J. Axelsson, M. Lekander, G. Kecklund, Predicting sleep quality from stress and prior sleep—a study of day-to-day covariation across six weeks, Sleep Med. 13 (2012) 674–679, http://dx.doi.org/10.1016/j.sleep.2011.12.013.
[30] P.M. Zoccola, S.S. Dickerson, S. Lam, Rumination predicts longer sleep onset latency after an acute psychosocial stressor, Psychosom. Med. 71 (2009) 771–775, http://dx.doi.org/10.1097/PSY.0b013e3181ae58e8.
[31] R. Tavernier, T. Willoughby, Bidirectional associations between sleep (quality and duration) and psychosocial functioning across the university years, Dev. Psychol. 50 (2014) 674–682.
[32] R. Tavernier, T. Willoughby, A longitudinal examination of the bidirectional association between sleep problems and social ties at university: The mediating role of emotion regulation, J. Youth Adolesc. 44 (2015) 317–330.
[33] P. Keller, M. El-Sheikh, Children's emotional security and sleep: longitudinal relations and directions of effects, J. Child Psychol. Pychiatry. 52 (2011) 64–71.
[34] S. Petronio, Boundaries of Privacy: Dialectics of Disclosure, State University of New York Press, New York, 2012.
[35] R.B. Slatcher, J.W. Pennebaker, Emotional expression and health, in: S. Ayers, A. Baum, C. McManus, S. Newman, K. Wallston, J. Weinman, R. West (Eds.), Cambridge Handbook of Psychology, Health and Medicine, second ed.Cambridge University Press, Cambridge, UK 2007, pp. 84–86.
[36] D.S. Krantz, M.K. McCeney, Effects of psychological and social factors on organic disease: a critical assessment of research on coronary heart disease, Annu. Rev. Psychol. 53 (2002) 341–369, http://dx.doi.org/10.1146/annurev.psych.53.100901.135208.
[37] B.L. Wood, J. Lim, B.D. Miller, P.A. Cheah, S. Simmens, T. Stern, J. Waxmonsky, M. Ballow, Family emotional climate, depression, emotional triggering of asthma, and disease severity in pediatric asthma: examination of pathways of effect, J. Pediatr. Psychol. 32 (2007) 542–551, http://dx.doi.org/10.1093/jpepsy/jsl044.
[38] R. Tavernier, S.B. Choo, K. Grant, E.K. Adam, Daily affective experiences predict objective sleep outcomes among adolescents, J. Sleep Res. 25 (2016) 62–69.
[39] C.D. Kouros, M. El-Sheikh, Daily mood and sleep: reciprocal relations and links with adjustment problems, J. Sleep Res. 24 (2015) 24–31.
[40] Z. Ranjbaran, L. Keefer, E. Stephanski, A. Farhadi, A. Keshavarzian, The relevance of sleep abnormalities to chronic inflammatory conditions, Inflamm. Res. 56 (2007) 51–57.
[41] E.T. Tobin, H.S. Kane, D.J. Saleh, S. Naar-King, P. Poowuttikul, E. Secord, W. Pierantoni, V. Simon, R.B. Slatcher, Naturalistically-observed conflict and youth asthma symptoms, Health Psychol. 34 (2015) 622–631, http://dx.doi.org/10.1037/hea0000138.
[42] E.T. Tobin, H.S. Kane, D.J. Saleh, D.E. Wildman, E.C. Breen, E. Secord, R.B. Slatcher, Asthma-related immune responses in youth with asthma: Associations with maternal responsiveness and expressions of positive and negative affect in daily life, Psychosom. Med. 77 (2015) 892–902.
[43] L. Imami, E.T. Tobin, H.S. Kane, D.J. Saleh, T.H. Lupro, R.B. Slatcher, Effects of socioeconomic status on maternal and child positive behaviors in daily life among youth with asthma, J. Pediatr. Psychol. 40 (2015) 55–65.
[44] National Asthma Education and Prevention Program. Expert Panel Report 2: Guidelines for the diagnosis and management of asthma (NIH Publication No. 97–4051), U.S. Department of Health and Human Services; National Institutes of Health; National Heart, Lung, and Blood Institute; National Asthma Education and Prevention Program, Bethesda, MD, 1997.
[45] T.H. Monk, C.F. Reynolds, D.J. Kupfer, P.A. Coble, A.J. Hayes, M.A. Machen, S.R. Petrie, A.M. Ritenour, The Pittsburgh sleep diary, J. Sleep Res. 3 (1994) 111–120, http://dx.doi.org/10.1111/j.1365-2869.1994.tb00114.x.
[46] D.J. Buysse, S. Ancoli-Israel, J.D. Edinger, K.L. Lichstein, C.M. Morin, Recommendations for a standard resesarch assessment of insomnia, Sleep 29 (2006) 1155–1173.
[47] S. Cohen, C.M. Alper, W.J. Doyle, J.J. Treanor, R.B. Turner, Positive emotional style predicts resistance to illness after experimental exposure to rhinovirus or influenza a virus, Psychosom. Med. 68 (2006) 809–815, http://dx.doi.org/10.1097/01.psy.0000245867.92364.3c.
[48] P.D. Usala, C. Hertzog, Measurement of affective states in adults evaluation of an adjective rating scale instrument, Res. Aging 11 (1989) 403–426.
[49] M.A. Hernán, S. Hernández-Díaz, M.M. Werler, A.A. Mitchell, Causal knowledge as a prerequisite for confounding evaluation: an application to birth defects epidemiology, Am. J. Epidemiol. 155 (2002) 176–184.
[50] C.K. Enders, A primer on maximum likelihood algorithms available for use with missing data, Struct. Equ. Model. Multidiscip. J. 8 (1) (2001) 128–141, http://dx.doi.org/10.1207/S15328007SEM0801_7.
[51] K.J. Preacher, A.F. Hayes, Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models, Behav. Res. Methods 40 (2008) 879–891, http://dx.doi.org/10.3758/BRM.40.3.879.
[52] R.L. Repetti, S.E. Taylor, T.E. Seeman, Risky families: family social environments and the mental and physical health of offspring, Psychol. Bull. 128 (2002) 330–366, http://dx.doi.org/10.1037/0033-2909.128.2.330.
[53] J.G. Smetana, A. Metzger, D.C. Gettman, N. Campione-Barr, Disclosure and secrecy in adolescent-parent relationships, Child Dev. 77 (2006) 201–217, http://dx.doi.org/10.1111/j.1467-8624.2006.00865.x.
[54] D. Koinis-Mitchell, et al., Identifying individual, cultural, and asthma-related risk and protective factors associated with resilient asthma outcomes in urban children and families, J. Pediatr. Psychol. 37 (2012) 424–437.
[55] N. Bolger, A. Davis, E. Rafaeli, Diary methods: capturing life as it is lived, Annu. Rev. Psychol. 54 (2003) 579–616.