

ORIGINAL ARTICLE

The Use of Synthetic Bedding in Children. Do Strategies of Change Influence Associations with Asthma?

THOMAS BEHRENS, M.D.,^{1,4} WASIM MAZIAK, PH.D.,^{1,2} STEPHAN K. WEILAND, M.D.,³ EDITH SIEBERT,¹ PETER RZEHAK, M.A.,³
AND ULRICH KEIL, M.D., PH.D.,^{1,*}

¹*Institute of Epidemiology and Social Medicine, University of Münster, Münster, Germany*

²*Syrian Center for Tobacco Studies, Aleppo, Syria*

³*Department of Epidemiology, University of Ulm, Ulm, Germany*

⁴*Bremen Institute of Prevention Research and Social Medicine, University of Bremen, Bremen, Germany*

Background. Epidemiological data suggest in contrast to clinical recommendations a negative effect of synthetic bedding on asthma and respiratory symptoms. **Objective.** To assess the effects of bedding filled with synthetic material on the risk of asthma and respiratory symptoms in 6- to 7-year-old children, taking into account allergy-related change of bedding material. **Methods.** We analyzed data from the ISAAC Phase III cross-sectional survey (1999/2000) in Münster, Germany. Data were collected by parental report from representative school-based samples of 6- to 7-year old children ($n = 3,529$). We calculated prevalence ratios with 95% confidence intervals for the association between respiratory symptoms suggestive of asthma and synthetic pillows and blankets and adjusting for potential confounders. **Results.** In the preliminary analyses, synthetic pillows and synthetic blankets were positively associated with the studied respiratory outcomes. For example, a high number of wheezing attacks was positively associated with synthetic pillows (PR = 4.44; 95% CI 2.84–6.94) and synthetic blankets (PR = 3.80; 95% CI 2.48–5.82). However, in the restricted analysis, excluding participants reporting allergy-related change of bedding (pillows $n = 440$; blankets $n = 437$), the positive associations disappeared for all studied outcomes. **Conclusions.** Our findings suggest that allergy-related choice of bedding is an important factor in the assessment of the relation between synthetic bedding and asthma symptoms. Ignoring those changes can lead to false-positive risk estimates. Prospective studies that allow to disentangle the temporal sequence of disease, exposure, and change of bedding should help to further clarify this issue.

Keywords asthma, allergen avoidance, bedding, cross-sectional, ISAAC

INTRODUCTION

Over the last decades, a rising trend of the prevalence of asthma has been observed in many Western countries, which has been accompanied by changes in lifestyle and environmental exposures. Heating and better insulation of homes have led to warmer and more humid houses which may favor the replication of some airborne allergens, such as house dust mites (1). House dust mites, as a suspected risk factor for the development of asthma, habitat in dust that accumulates in beddings, carpets, and upholstery furniture (2, 3).

Epidemiological data, which assess the association between symptoms and diagnoses of asthma and atopic disease and the presence of different types of bedding suggest—in contrast to clinical recommendations—a protective effect of feather bedding and a negative effect of synthetic bedding on asthma and respiratory symptoms. However, most studies that looked at this issue did not fully account for allergy-induced change of bedding, which may lead to bias in the estimated risk (4–9). This study uses data

from the International Study of Asthma and Allergies (ISAAC) Phase III survey to assess the relationship between synthetic bedding and symptoms of asthma.

MATERIALS AND METHODS

The ISAAC Phase III in Münster has been described elsewhere (10). Briefly, a cross-sectional survey was conducted among first and second graders from representative school-based samples in the city of Münster, Germany. Information was collected from parents of pupils after being briefed about the study and giving their written approval to participate. Respiratory symptoms were assessed by using the ISAAC core questions on respiratory symptoms and severity during the last 12 months: wheezing and whistling in the chest, speech-limiting wheeze, sleep disturbance due to wheezing, exercise-induced wheeze, a dry cough when not having a cold, and number of wheezing attacks (< 4 vs. ≥ 4) (11). The questionnaire also included a question on lifetime diagnosis of asthma.

Exposure was assessed by asking the following questions: “Which material was used for the child’s pillow?” (synthetic fiber or foam, feather, wool, other), and then by asking a second question about the filling material of the child’s blanket. We excluded participants who reported more than one type of pillow ($n = 163$) or more than one type of blanket ($n = 75$) (e.g., feather or wool pillows or blankets in addition to bedding from synthetic material).

*Corresponding author: Ulrich Keil, M.D., Ph.D., Institute of Epidemiology and Social Medicine, University of Münster, Domagkstr. 3, Münster 48149, Germany; Fax: +49 (251) 8356300; E-mail: keilu@uni-muenster.de

TABLE 1.—Descriptive statistics of the study population (6- to 7-year-old children, ISAAC Phase III data, collected 1999/2000 in Münster; Germany, $N = 3529$).

	<i>N</i>	%
Sex		
Male	1,863	52.8
Female	1,666	47.2
Synthetic pillows (use of multiple types of pillows)	(163)	(4.6)
Yes	1,061	31.5
Synthetic blankets (use of multiple types of blankets)	(75)	(2.1)
Yes	1,156	33.5
Change of pillow due to atopy		
Yes	440	13.1
Change of blanket due to atopy		
Yes	437	12.7
Wheezing during last 12 months		
Yes	466	13.2
Speech-limiting wheeze during last 12 months		
Yes	88	2.5
Sleep disturbance due to wheeze during last 12 months		
Yes	269	7.6
Exercise-induced wheeze during last 12 months		
Any	246	7.0
Nocturnal cough during last 12 months		
Yes	560	15.9
Number of wheeze attacks during last 12 months		
≥ 4	112	3.2
Asthma		
Yes	156	4.4

We also asked participants with synthetic bedding whether they had acquired synthetic pillows or blankets because of an existing atopic disease of the child or a family history of atopy, using the following two questions: “Was the (pillow or blanket) of the child changed to synthetic bedding out of one of the following reasons?” (asthma/asthmatic, spastic, or obstructive bronchitis/hay fever/respiratory symptoms such as cough, shortness of breath, breathing difficulties/atopic eczema).

Consistent with earlier reports from Münster, we included only students with known German nationality and known sex in the analysis (10).

Multivariate analyses were conducted to adjust for possible confounders of the relation between synthetic bedding and symptoms of asthma. Gender, parental atopy, and socioeconomic status were included in all of the analyses. Parental atopy was defined as a history of asthma, hay fever, or atopic eczema in either parent, whereas socioeconomic status was based on parents' education and was considered high when one parent had a formal school education of at least 12 years.

Additional variables that did not show a confounding effect were environmental tobacco smoke, heating with fossil fuels, frequency of trucks passing on streets next to the home, birds and furry animals as pets, number of older siblings, own bedroom, the presence of molds or wet stains in the child's bedroom, presence of a carpet in the bedroom, living on a farm, history of breastfeeding, and duration of living in the present dwelling. As recommended by several authors (12, 13), prevalence ratios were calculated to assess the relation between symptoms of asthma and synthetic bedding.

RESULTS

The overall response rate was 82%. Selected study characteristics of the study's population are presented in Table 1.

The use of synthetic pillows and blankets was positively associated with all studied outcomes (Table 2). All associations, adjusted for sex, socioeconomic status, and parental atopy, reached statistical significance at the 95% level.

Among children using synthetic bedding material, 440 of 3366 of parents (13.1%) and 437 of 3454 of parents (12.7%) reported that they had chosen synthetic pillows or blankets because of an allergic child or a family history of atopy. When these participants were excluded from the

TABLE 2.—Prevalence ratio, adjusted for sex, socioeconomic status, and parental atopy, and 95% confidence intervals for the association between synthetic pillows and blankets and respiratory symptoms in 6- to 7-year old pupils of German nationality and known sex (ISAAC Phase III): bedding change because of atopy of the child or in the family.

	Synthetic pillows				Synthetic blankets			
	All participants		Participants without change because of atopy of the child or in the family		All participants		Participants without change because of atopy of the child or in the family	
	<i>N</i>	PR (95% CI)	<i>N</i>	PR (95% CI)	<i>N</i>	PR (95% CI)	<i>N</i>	PR (95% CI)
Wheeze during last 12 months	2977	2.13 (1.77–2.55)	2540	0.95 (0.70–1.28)	3064	2.23 (1.86–2.68)	2618	1.23 (0.94–1.60)
Speech-limiting wheeze during last 12 months	2984	2.40 (1.52–3.80)	2544	0.46 (0.16–1.30)	3071	2.53 (1.60–4.0)	2622	0.96 (0.46–2.02)
Sleep disturbance due to wheeze during last 12 months	2981	2.33 (1.82–2.99)	2542	0.96 (0.64–1.45)	3067	2.33 (1.82–2.98)	2620	1.24 (0.87–1.77)
Wheeze after exercise during last 12 months	2947	2.98 (2.27–3.91)	2515	1.34 (0.89–2.03)	3036	2.81 (2.15–3.67)	2594	1.35 (0.92–1.99)
Nocturnal cough during last 12 months	2944	1.66 (1.41–1.96)	2511	1.01 (0.79–1.30)	3034	1.54 (1.31–1.81)	2590	0.94 (0.74–1.19)
Number of wheeze attacks (< 4 vs. ≥ 4) during last 12 months	2984	4.44 (2.84–6.94)	2544	1.39 (0.68–2.85)	2999	3.80 (2.48–5.82)	2622	1.53 (0.82–2.86)
Asthma	2981	3.73 (2.59–5.37)	2547	0.53 (0.23–1.24)	3071	3.78 (2.64–5.43)	2627	1.01 (0.54–1.86)

PR: prevalence ratio.

analysis, the positive associations for synthetic pillows and blankets were markedly reduced for all studied outcomes, rendering all prevalence ratios statistically nonsignificant. When analyses were restricted to participants who had avoided nonsynthetic material because of a positive family history alone, results did not differ from the preliminary analysis, which did not account for avoidance strategies (not shown), indicating that change of bedding because of an allergic child is an important factor influencing the relation between bedding and symptoms of asthma among the studied population.

Nocturnal symptoms (i.e., sleep disturbance due to wheeze and nocturnal cough during the last 12 months) likely to be most affected by type of bedding were also reduced after exclusion of participants who reported change of bedding. PRs for the relation between synthetic pillows became 0.96; 95% CI 0.64–1.45 for sleep disturbance due to wheeze and 1.01; 0.79–1.30 for nocturnal cough, whereas PRs for the relation between synthetic blankets became 1.24; 0.87–1.77 for sleep disturbance and 0.94; 0.74–1.19 for nocturnal cough, respectively (Table 2).

We also analyzed the associations between respiratory symptoms and synthetic bedding stratified according to physicians' diagnosis of asthma, and the results were nonsignificant after exclusion of subjects whose parents had reported allergy-related change of bedding (not shown). In fact, the associations between synthetic bedding and symptoms of asthma tended to be stronger in children not diagnosed with asthma, but were still reduced to nonsignificance in the restricted analysis.

However, in the analysis of cough, stronger PRs were observed for asthmatic children. It is also noteworthy that children without a diagnosis of asthma showed a statistically significant positive association of synthetic blankets with a high number of wheeze attacks after exclusion of children with atopy-related change of bedding material (PR = 2.30; 95% CI 1.10–4.78). However, this association was still reduced compared to the preliminary analysis without consideration of change of bedding (PR = 3.16; 95% CI 1.72–5.78).

Inclusion of other potential confounders did not change results. Likewise, we did not observe joint confounding effects.

DISCUSSION

Previous studies, including the ISAAC Phase I studies from Münster and Greifswald, reported positive associations between symptoms of asthma and synthetic bedding (4, 5, 7–9). Most of these studies, however, are cross-sectional or case-control studies and, therefore, rely on the retrospective assessment of exposures and do not fully account for the possibility of change of bedding because of allergy-motivated avoidance of exposure. A recent prospective study reported positive associations between symptoms of asthma and synthetic bedding, but the study did not preclude the effect of differential behavior of participants (6, 7). Several other studies tried to adjust for general changes in the indoor environment or excluded children who reported any change in the bedroom or bedding and still observed positive associations with the

use of synthetic bedding (4, 5, 8). Unlike our study, which inquired specifically about change of bedding because of allergy, most studies used proxies of change or unspecific questions about alterations in the bedroom (4–7).

The importance of accounting for change of bedding in our data is evident from the reduction of risk spanning the whole spectrum of symptoms and severity levels of asthma, when we restricted the analysis to participants without change of bedding material. Notably, the risk of symptoms most likely to be affected by exposure to allergens in the bedding, such as sleep disturbance due to wheeze and nocturnal cough in the last 12 months, were also reduced to nonsignificance in the restricted analysis.

Because a diagnosis of asthma affects awareness and reporting as well as avoidance behavior, we conducted separate analyses stratified by a diagnosis of asthma. This relation was not proven according to our data because children without asthma diagnosis tended to show stronger associations between synthetic bedding and respiratory symptoms, except for cough. Still, when we excluded children with a reported change of pillows or blankets, the positive associations with cough or other respiratory symptoms tended to disappear (results not shown). Furthermore, these results do not lend support to the possibility that synthetic bedding material may aggravate respiratory symptoms in asthmatic children.

Notably, children without a diagnosis of asthma showed a statistically significant positive association of synthetic blankets with a high number of wheeze attacks after exclusion of children with atopy-related changes of bedding (PR = 2.30; 95% CI 1.10–4.78). Still, this observation does not contradict our overall results because the PR was still markedly lower than the association we observed in non-asthmatic children in the preliminary analysis without consideration of change of bedding (PR = 3.16; 95% CI 1.72–5.78).

Our results suggest that at least in our population the observed positive associations can largely be explained by bias due to altered behavior among families with a history of atopic disease.

Limitations of our study include the following. We did not ask participants about the type of bedding used before participants chose to change to synthetic bedding. We also did not ask whether parents had replaced synthetic bedding with feather bedding. Therefore, our analyses compare users of synthetic bedding with participants with present feather bedding, including those who had changed from synthetic to feather bedding.

However, although our study considered detailed information on the reasons for a change of bedding, it still has limitations. Excluding children who avoid nonsynthetic bedding due to atopy is one possibility to reduce bias. However, as long as a change of children from synthetic to feather bedding after the development of symptoms is not taken into account, this analysis is at risk of underestimating a possible harmful effect of synthetic bedding. Because clinical recommendations still advocate the use of synthetic bedding as a preventive measure for allergic subjects (1), this bias can be considered small compared with the opposite effect. Therefore, it is unlikely that we

missed crucial harmful effects of synthetic bedding due to this limitation.

Unfortunately, we also did not ask parents about other alterations in the bed, such as the use of mite-impermeable covers, which are also recommended as a measure of allergen avoidance (14). However, restriction to participants without change of bedding rather reflects past exposure and would, therefore, be independent from current use of bed covers, which argues against a major role of mite-impermeable covers on our results. In addition, two recent studies demonstrated that mite-impermeable covers were clinically ineffective as a single measure of allergen avoidance in adult asthma and allergic rhinitis (15, 16).

In summary, our results suggest that the observed positive associations between synthetic bedding and asthma symptoms may be explained by bias due to allergy-related altered behavior. To have a closer look at the potential harmful effects of bedding material, studies with detailed information about bedding and change in bedding are needed.

However, because of the cross-sectional nature of our study, results have to be interpreted with caution. On the one hand, the addition of objective markers of exposure to allergens in the bedroom and measures to assess their change in level of exposure due to change in bedding material accounting for other factors that can affect allergen levels in the bedroom, such as humidity, may help to clarify the role of bedding materials in the symptoms of asthma. Prospective studies, on the other hand, are capable of measuring exposure and change of bedding and their temporal relation precisely to allow clinical recommendations that are based on solid data.

ACKNOWLEDGMENTS

This study was funded by the Ministry for Women, Youth, Family, and Health of the State of North Rhine-Westphalia, Düsseldorf. We thank all parents, children, teachers, and other school staff who participated in the surveys, and the field workers and funding agencies who supported data collection. Dr. Maziak is supported by USPHS Grant R01 TW 05962.

REFERENCES

1. Jones AP. Asthma and the home environment. *J Asthma* 2000; 37(2):103–124.
2. Sporik R, Holgate ST, Platts-Mills TA, Cogswell JJ. Exposure to house-dust mite allergen (Der p I) and the development of asthma in childhood: a prospective study. *N Engl J Med* 1990; 323(8):502–507.
3. Peat JK, Tovey E, Gray EJ, Mellis CM, Woolcock AJ. Asthma severity and morbidity in a population sample of Sydney schoolchildren. Part II. Importance of house dust mite allergens. *Aust N Z J Med* 1994; 24(3):270–276.
4. Strachan DP, Carey IM. Home environment and severe asthma in adolescence: a population based case-control study. *BMJ* 1995; 311(7012):1053–1056.
5. Duhme H, Weiland SK, Rudolph P, Wienke A, Kramer A, Keil U. Asthma and allergies among children in West and East Germany: a comparison between Munster and Greifswald using the ISAAC phase I protocol. *International Study of Asthma and Allergies in Childhood. Eur Respir J* 1998; 11(4):840–847.
6. Ponsonby AL, Kemp A, Dwyer T, Carmichael A, Couper D, Cochrane J. Feather bedding and house dust mite sensitization and airway disease in childhood. *J Clin Epidemiol* 2002; 55(6):556–562.
7. Ponsonby AL, Dwyer T, Kemp A, Cochrane J, Couper D, Carmichael A. Synthetic bedding and wheeze in childhood. *Epidemiology* 2003; 14(1):37–44.
8. Butland BK, Strachan DP, Anderson HR. The home environment and asthma symptoms in childhood: two population based case-control studies 13 years apart. *Thorax* 1997; 52(7):618–624.
9. Nafstad P, Nystad W, Jaakkola JJ. The use of a feather quilt, childhood asthma and allergic rhinitis: a prospective cohort study. *Clin Exp Allergy* 2002; 32(8):1150–1154.
10. Maziak W, Behrens T, Brasky TM, Duhme H, Rzehak P, Weiland SK, Keil U. Are asthma and allergies in children and adolescents increasing? Results from ISAAC phase I and phase III surveys in Munster, Germany. *Allergy* 2003; 58(7):572–579.
11. Asher MI, Keil U, Anderson HR, Beasley R, Crane J, Martinez F, Mitchell EA, Pearce N, Sibbald B, Stewart AW, Strachan D, Weiland SK, Williams HC. International Study of Asthma and Allergies in Childhood (ISAAC): rationale and methods. *Eur Respir J* 1995; 8(3):483–491.
12. Zocchetti C, Consonni D, Bertazzi PA. Relationship between prevalence rate ratios and odds ratios in cross-sectional studies. *Int J Epidemiol* 1997; 26(1):220–223.
13. McNutt LA, Wu C, Xue X, Hafner JP. Estimating the relative risk in cohort studies and clinical trials of common outcomes. *Am J Epidemiol* 2003; 157(10):940–943.
14. Fitzharris P, Siebers R, Crane J. Pillow talk: have we made the wrong beds for our patients to lie in? *Clin Exp Allergy* 1999; 29(4):429–432.
15. Woodcock A, Forster L, Matthews E, Martin J, Letley L, Vickers M, Britton J, Strachan D, Howarth P, Altmann D, Frost C, Custovic A. Control of exposure to mite allergen and allergen-impermeable bed covers for adults with asthma. *N Engl J Med* 2003; 349(3):225–236.
16. Terreehorst I, Hak E, Oosting AJ, de Monchy JG, Bruijnzeel-Koomen CA, Aalberse RC, van Wijk RG. Evaluation of impermeable covers for bedding in patients with allergic rhinitis. *N Engl J Med* 2003; 349(3):237–246.