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Missed sleep and asthma morbidity in urban children

Lauren C. Daniel, PhD[*], **Julie Boergers, PhD**[*], **Sheryl J. Kopel, MSc**[*], and **Daphne Koinis-Mitchell, PhD**[*]

[*]Bradley/Hasbro Children's Research Center, Alpert Medical School, Brown University, Providence, Rhode Island

Abstract

Background—Children living in urban environments have many risk factors for disrupted sleep, including environmental disturbances, stressors related to ethnic minority status, and higher rates of stress and anxiety. Asthma can further disrupt sleep in children, but little research has examined the effects of missed sleep on asthma morbidity.

Objective—To examine the associations among missed sleep, asthma-related quality of life (QoL), and indicators of asthma morbidity in urban children with asthma from Latino, African American, and non-Latino white backgrounds. Given the importance of anxiety as a trigger for asthma symptoms and the link between anxiety and disrupted sleep, the associations among anxiety, asthma morbidity indicators, and missed sleep were also tested.

Methods—Parents of 147 children ages 6 to 13 years completed measures of asthma morbidity and missed sleep, parental QoL, and child behavior.

Results—Higher reports of missed sleep were related to more frequent school absences, more activity limitations, and lower QoL across the sample. The associations between missed sleep and asthma morbidity were stronger for Latino children compared with non-Latino white and African American children. For children with higher anxiety, the associations between missed sleep and asthma morbidity were stronger than for children with lower anxiety.

Conclusion—Results offer preliminary support for missed sleep as a contributor to daily functioning of children with asthma in urban neighborhoods. Missed sleep may be more relevant to Latino families. Furthermore, anxiety may serve as a link between sleep and asthma morbidity because higher anxiety may exacerbate the effects of disrupted sleep on asthma.

Introduction

Asthma prevalence rates are significantly higher for African American and Latino children compared with non-Latino White (NLW) children,[1] and children living in urban environments are at increased risk for multiple stressors that can affect asthma management and challenge asthma control.[2, 3] Multiple-risk models of asthma morbidity in minority children suggest that outcomes in this group are multidetermined. Processes related to an urban environment (eg, poverty and neighborhood disadvantage), cultural background (eg, acculturative stress and perceptions of discrimination[2]), and asthma status (eg, asthma severity and environmental tobacco smoke[4]) have been found to contribute to increased

Reprints: Lauren C. Daniel, PhD, The Children's Hospital of Philadelphia, 34th and Civic Center Blvd, CHOP North #1482, Philadelphia, PA 19107; daniell@email.chop.edu.

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functional limitation and more asthma-related emergency department (ED) visits in urban children.[5] Furthermore, ethnic minority children who reside in urban settings have been found to be less adherent to daily asthma medication use,[6] making this group particularly vulnerable to increased morbidity.

Frequency of missed sleep due to asthma symptoms is commonly used as an indicator of asthma morbidity.[7] Difficulty initiating or maintaining sleep related to asthma symptoms may reflect poorly controlled asthma.[8] A child with asthma may wake often during sleep because of more persistent asthma,[9] the child's asthma not being under appropriate medication control, or exposure to household environmental triggers.[10] Lower levels of sleep efficiency and more frequent night wakings have been found when comparing children with asthma to those without asthma.[11] In a sample of urban children with asthma, night wakings from asthma occurred in 40% of the sample during a 1-month period.[12] Several factors contribute to nocturnal worsening of asthma, including circadian variations of lung functioning, supine posture, air temperature, allergens in the bedroom, hormonal variations, and diurnal variations of lung inflammation (for a review see Atanasov[13]). In addition, children with asthma report more fatigue and less daytime alertness.[14] Poor sleep quality has also been found to predict higher levels of asthma symptoms the following day.[15] Night wakings and poor sleep quality put children with asthma at increased risk for developmentally salient indicators of asthma morbidity. For example, Diette and colleagues[12] demonstrated that missed sleep is related to more school absences among children with asthma.

Urban environment, ethnic minority status, and lower socioeconomic status are shown to contribute to poor sleep in healthy children, making missed sleep especially relevant to urban and ethnic minority children with asthma. Recent research examining sleep in children from both African American and Latino backgrounds found shorter sleep durations,[16, 17] more daytime sleepiness, [16] higher instances of sleep disordered breathing,[18 –20] and more daytime napping[21] compared with NLW children. In addition, lower socioeconomic status has been related to more bedtime and sleep behavior problems.[16] Furthermore, an emerging body of literature has described the effect of ethnic minority status, socioeconomic status, and urban residence on disrupted sleep in children with chronic health conditions (see Boergers and Koinis-Mitchell[22] for a review).

More research is needed to identify factors that underlie the association between sleep and asthma. Because anxiety is independently related to sleep and asthma morbidity, anxiety may be one explanatory mechanism of this association. Previous research has described a bidirectional relationship between anxiety and disrupted sleep in children without chronic illness.[23] Furthermore, children living in urban environments are at high risk for frequent life stressors and symptoms of anxiety.[24] Several studies have documented higher prevalence of diagnosed anxiety disorders and anxiety symptoms in children and adolescents with asthma compared with healthy controls (for a review see Katon et al[25]). The associations among anxiety, sleep, and morbidity may be relevant to children living in urban neighborhoods who are at risk for disrupted sleep, higher rates of anxiety and stress, and greater asthma morbidity due to environmental and demographic risk factors. To date, anxiety and missed sleep have not been described in children with asthma.

The purpose of the current study was to examine associations among missed sleep, asthma-related QoL, and indicators of asthma morbidity (ie, functional limitation, school absences, and ED visits) in an urban sample of children with asthma from Latino (Dominican [DR] and Puerto Rican [PR]), African American, and NLW backgrounds. Our sample includes Latino families from DR and PR descent because of the high proportion of families from these backgrounds in urban areas in the Northeast United States and the high asthma

prevalence and morbidity rates in children from these Latino subgroups.[26] We refer to families of DR and PR descent as Latino with the understanding that there are differences in asthma prevalence and morbidity levels across Latino ethnic groups.[27]

We first sought to describe differences in missed sleep, QoL, and asthma morbidity among ethnic groups. Then we examined associations among missed sleep, QoL, and morbidity across the full sample and within each ethnic group to understand how these associations may differ between groups and to control for demographic differences. It was hypothesized that higher missed sleep would be related to lower QoL, greater activity limitation, more school absences, and more ED use during the past year. On the basis of the previous literature, we predicted a stronger association between missed sleep and asthma morbidity indicators in ethnic minority families compared with NLW families.

Given the importance of anxiety as a trigger for asthma symptoms and the link between anxiety and disrupted sleep, we also examined associations among anxiety, asthma morbidity indicators, and missed sleep. The associations are described across the sample and within ethnic groups. Next, the associations between missed sleep and morbidity indicators were compared by level of anxiety. We hypothesized an association between anxiety and missed sleep across the full sample and that this association would be stronger in Latino and African American children compared with NLW children of our sample. We also hypothesized a stronger association between missed sleep and asthma morbidity in children with higher anxiety compared with lower anxiety.

Methods

Procedures

After institutional review board approval by Rhode Island Hospital, families were recruited from a hospital-based ambulatory pediatric clinic, community primary care offices, asthma educational programs based in hospitals and schools, and community events. Caregivers signed a consent to contact form, indicating approval to be contacted by study staff to screen for eligibility. Inclusion criteria were children ages 6 to 13 years with a caregiver-reported asthma diagnosis from a physician, child breathing problems in the past 12 months, child currently receiving asthma treatment, living in an urban neighborhood (verified by zip code), and caregiver self-identified ethnicity of Latino (DR or PR), NLW, or African American. Caregivers provided written informed consent and children provided written assent when appropriate. Children with exercise-induced asthma, in foster care placements (because of informed consent limitations), and/or with moderate to low cognitive functioning as determined by school placement were excluded from the study. With bilingual research assistants, children and caregivers completed measures and a semistructured interview of asthma management during 2 sessions in either English or Spanish using established translating procedures.[28] Families were compensated for their participation.

Measures

Asthma history and background questionnaire—Caregivers reported demographic information, disease characteristics, asthma symptoms, and asthma controller use. Poverty was determined by dividing the family's annual income by the poverty threshold for a household of that size, according to US Census data for the year of study participation.[29]

Missed sleep—Caregiver report of the frequency of child missed sleep due to asthma symptoms during the past 12 months was determined using an item from a standard questionnaire of asthma-related functional limitation (The Asthma Functional Severity Scale

[AFSS][30]). The item reads, "In the last 12 months, how often did your child wake at night with cough or wheeze?" Higher scores indicated less frequent missed sleep. This item has been used in previous research, including that of urban children with asthma.[31] The AFSS has good reliability and internal consistency,[30] and these indicators of morbidity have been used with diverse samples of children with asthma.[2, 32, 33]

Asthma morbidity—The current study examined 3 indicators of asthma morbidity reported on the AFSS during the prior 12 months: functional limitation due to asthma (sports limitation and other activity limitation), number of school absences due to asthma, and ED visits due to asthma (examined dichotomously). A subscale of the AFSS[30] was used to assess the degree of functional impairment caused by asthma symptoms (Cronbach α = 0.70). Higher scores on the AFSS indicated less morbidity.

Quality of life—Caregivers completed the Pediatric Asthma Quality of Life Questionnaire, [34] a 13-item questionnaire that measures the effect of caring for a child with asthma on caregiver QoL (Cronbach α = 0.91). The total score was used as an indicator of QoL for the current study. The measure has been validated in caregivers of children and adolescents with asthma, has been shown to have good reliability and internal consistency,[35] and has been validated for use with Spanish-speaking families.[36] This measure is especially relevant to a discussion of missed sleep and asthma morbidity because it indicates the extent to which taking care of the child's asthma affects caregiver functioning.

Anxiety—The Behavioral Assessment System for Children, Second Edition (BASC-II), is a caregiver-report measure of child emotions and behavior. This measure has been validated in English and Spanish and has been shown to demonstrate good reliability and validity.[37] The BASC-II yields *t* scores relative to normative data for this measure. The *t* score for the anxiety subscale was examined for the current study.

Statistical analysis

The percentage of families living in poverty as classified by zip code was examined as a possible covariate using Pearson correlations to understand the associations between the percentage in poverty and outcome variables due to associations between sleep and socioeconomic status.[22] Differences in missed sleep and morbidity indicators among ethnic groups were described using 1-way analysis of covariance, controlling for poverty. The associations among morbidity indicators and missed sleep were examined across the full sample using single-entry linear regressions to include poverty as a covariate. Analyses involving ED use used logistical regressions due to the dichotomous nature of the dependent variable. The associations among missed sleep and asthma morbidity indicators were then examined within ethnic groups, again using separate single-entry regressions or logistical regressions controlling for poverty.

The association between anxiety and sleep with morbidity indicators was tested in the full sample and within ethnic groups using single-entry linear regression and logistic regressions controlling for poverty. Sleep and asthma morbidity relationships were then compared by level of anxiety by splitting the sample into higher and lower anxiety using a median split for the BASC-II anxiety subscale. Single-entry linear regressions and logistic regressions examining the association between missed sleep and asthma morbidity were conducted within the high and low anxiety groups, all controlling for poverty.

Results

Covariate analyses

Full sample demographics and demographics by ethnicity are presented in Table 1. Higher percentage in poverty was related to more missed sleep ($r = -0.20$, $P = .021$), greater activity limitation ($r = -0.27$, $P < .001$), more frequent sports limitation ($r = -0.19$, $P = .026$), and lower caregiver-reported QoL ($r = 0.24$, $P = .004$). Percentage in poverty was included in all subsequent analyses as a covariate.

Differences in missed sleep and asthma morbidity indicators by ethnicity

Missed sleep and asthma morbidity indicators were examined for group differences by ethnicity, controlling for poverty (Table 2). No differences were found by ethnic group in reports of missed sleep, sports limitation, other activity limitation, school absences, or ED use. QoL differed significantly by ethnic group, with NLW families having significantly higher QoL than both African American families and Latino families.

Associations among missed sleep and asthma morbidity indicators

Full sample—Controlling for poverty, more frequent missed sleep during the past 12 months was significantly related to more frequent school absences, more sports limitation, higher other activity limitation, more frequent ED use during the past 12 months, and lower levels of caregiver QoL (Table 3).

Within ethnic groups—Within the Latino group, missed sleep during the past 12 months was significantly related to higher levels of sports limitation and other activity limitation due to asthma and lower caregiver QoL when controlling for poverty. The models examining missed sleep with school absences and ED use were not significant when controlling for poverty (Table 3). For the NLW children, higher missed sleep was related to more sports activity limitations and lower caregiver QoL but not school absences, other activity limitation, or ED use when controlling for poverty (Table 3). For African American children, more missed sleep was only related to lower caregiver QoL when controlling for poverty. The model predicting other activity limitations was also significant, but missed sleep was not a significant predictor (Table 3).

Associations among anxiety, missed sleep, and asthma morbidity

No differences were found in anxiety by ethnic group ($F_{2,139} = 0.41$, $P = .664$). The model controlling for poverty with anxiety predicting missed sleep in the full sample was significant ($R^2 = 07$, $F_{2,130} = 4.67$, $P = .011$), but anxiety did not reach significance ($\beta = .15$, $P = .070$). An examination of these associations by ethnic group, controlling for poverty, revealed that higher anxiety was related to less missed sleep in Latino children ($R^2 = 0.19$, $\beta = .30$, $F_{2,48} = 5.78$, $P = .006$). This association, however, was not significant for NLW children ($R^2 = 0.08$, $\beta = .16$, $F_{2,42} = 1.88$, $P = .165$) or African American children ($R^2 = 0.01$, $\beta = .01$, $F_{2,34} = 0.03$, $P = .967$).

Missed sleep and asthma morbidity by level of anxiety

The mean *t* score for caregiver-reported anxiety was 48.61 (range, 34–70; SD, 9.65) for the current sample. The sample was split at the median anxiety *t* score (49) to compare missed sleep and morbidity relationships between children with higher and lower caregiver-reported anxiety. Regressions controlling for poverty are presented in Table 4. A stronger association was found between missed sleep and school absences and missed sleep and other activity limitations for children with higher caregiver-reported anxiety compared with children with lower anxiety. For children with lower caregiver-reported anxiety, the association between

missed sleep and ED use was stronger than for children with higher anxiety. No differences were found between the anxiety groups for the association between missed sleep and sports limitation or missed sleep with caregiver QoL.

Discussion

Children living in urban environments may be exposed to risk factors that disrupt sleep, including stressors related to socioeconomic status,[16, 17] neighborhood stress and crowded living conditions, [22] and higher rates of anxiety.[24] Asthma can further disrupt sleep in children,[14] but there has been little research regarding the effects of missed sleep on asthma morbidity. The results of the present study demonstrate preliminary evidence that more frequent missed sleep due to asthma symptoms is related to several indicators of asthma morbidity in our sample of urban children, including school absences, sports limitation, other activity limitation, and more ED visits due to asthma. More frequent missed sleep was also found to be associated with lower caregiver QoL. The results offer preliminary support that missed sleep may be related to daily functioning of children with asthma living in urban neighborhoods. A comprehensive assessment of sleep hygiene and sleep quality may help identify children with more asthma morbidity overall. Likewise, increased awareness of the importance of appropriate and preventative management of asthma (adherence to medication, trigger control, and symptom identification) may minimize the risk of urban children's experience of nighttime asthma symptoms that may disrupt sleep.

Despite similarities in missed sleep and morbidity indicators among ethnic groups, missed sleep appears to be more relevant to asthma morbidity for the Latino families. Missed sleep was related to sports and other activity limitation and lower QoL in the DR and PR families. Missed sleep was only related to sports limitation and caregiver QoL in NLW children and caregiver QoL in African American children of this sample. Previous research has found that Latino children are more likely to cosleep with caregivers than NLW or African American children.[38] Although we did not assess cosleeping in this study, caregivers who cosleep may be more aware of their children's sleep disruptions or more affected by their child's nighttime awakenings, resulting in greater restriction of daytime activities. This differential association between missed sleep and morbidity by ethnicity may also be due to differences in parental worry with regard to asthma symptoms, given previous work showing that the level of asthma severity in Latino children tends to be higher than children from NLW background.[4] Further research that explores the variability in sleep, asthma morbidity, and daytime functioning in children from different ethnic groups is warranted to develop culturally tailored interventions that meet the needs of children and families.

Latino caregiver-reported anxiety was related to missed sleep due to asthma, consistent with research linking disrupted sleep and anxiety in children without asthma[23] ; however, the relationship suggests that greater anxiety is related to less missed sleep in this subsample. These results warrant more study in larger samples to fully understand the relationship between anxiety and missed sleep in asthma. Children with higher levels of anxiety had stronger associations between missed sleep with sports limitations and school absences. Anxiety has been previously described as a trigger for asthma.[39] It is possible that nocturnal worsening of asthma may disrupt sleep, and children with higher anxiety may have more difficulty returning to sleep due to asthma-specific anxiety and general worries, affecting the child's daily functioning. Anxiety could be an important target for intervention, especially around asthma-specific anxiety. Developing family-based interventions that address anxiety with a focus on the relationship between anxiety and asthma could reduce night waking frequency, length of night wakings, and overall asthma morbidity for children of specific ethnic groups.

Interestingly, the association between missed sleep and ED use was stronger in children with lower anxiety than for those with higher anxiety. Children with higher anxiety and more missed sleep are less likely to use the ED than children with lower anxiety. It is possible that higher levels of anxiety served as a motivator for increased accuracy and control with asthma management (eg, accurately identifying symptoms and using medications effectively when needed to avoid the need for urgent care). On the other hand, it is possible that families of children with lower anxiety in this sample may have been more relaxed with preventative management or may have been less knowledgeable about how to respond to symptoms.

The current study is limited in the use of a convenience sample of children with asthma that represents the urban demographic of Providence, Rhode Island. Because of the convenience nature of the sample, the demographics of this sample may not generalize to other urban areas; however, rates of asthma and poverty in this sample are similar to other urban areas. Latino families had higher rates of poverty than African American or NLW families, which is reflective of Providence's demographic. Furthermore, our Latino sample only included those of DR and PR decent, again because of the demographics of our urban area. We recognize that prior research has shown variation in asthma prevalence rates and morbidity across Latino ethnic groups and that by including only those of DR and PR decent our sample may be at greater risk for asthma morbidity than other Latino subgroups. The cross-sectional nature of this study based on retrospective parent reports does not allow for the examination of the temporal relationship between disrupted sleep and asthma morbidity. Further understanding of the day-to-day variations in sleep and morbidity can help understand targets for interventions to improve child functioning. The study is also limited by relying on caregiver reports of ED use and school absences.

This study was also limited by the assessment of sleep from a single-item caregiver report question that does not quantify number of wakings per night administered to caregivers retrospectively using a questionnaire designed to capture asthma morbidity. Future research should use both objective (eg, actigraphy) and caregiver- report measures (eg, daily sleep diaries) of sleep and the sleeping environment in children with persistent and nonpersistent asthma to better understand how sleep and sleep behaviors are affected by asthma. Also, sleep-disordered breathing should be examined because it is known to occur more frequently in children living in urban environments[18–20] and children with asthma[40, 41]

The findings from this study suggest that missed sleep is an important factor to consider when examining asthma morbidity and child functioning, particularly for Latino children from DR and PR backgrounds. Future research should focus on describing the frequency of sleep disruption from asthma and the effect on the child's daily functioning and asthma care. A study is currently under way at our center to examine the co-occurrence of asthma and allergic rhinitis symptoms, sleep quality, and academic functioning in urban children during the academic year using a multi-method approach (eg, diary of symptoms and sleep patterns, actigraphy, and spirometry). Such descriptive research can begin to illuminate areas for future behavioral and medical interventions to improve both sleep and daytime functioning. Clinically, health care professionals should be especially attuned to the effects of missed sleep and anxiety on asthma morbidity in Latino children because they are more susceptible to disruptions in daily functioning when experiencing disrupted sleep.

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Table 1

Child and family characteristics

Characteristic	Total sample (N = 147)	African American (n = 39 [25.6%])	Latino (n = 59 [40.1%])	Non-Latino white (n = 49 [33.3%])
Child age, mean (SD), y[a]	9.79 (1.60)	9.64 (1.60)	10.09 (1.56)	9.57 (1.70)
Family income, mean (SD), $[a,b]	30,439 (25,740)	24,636 (16,044)	20,699 (16,160)	46,236 (32,968)
Female child, No. (%)[c]	61 (41.5)	16 (41.02)	23 (38.98)	22 (44.89)
Child controller use, No. (%)[a]	89 (60.5)	20 (51.2)	35 (59.3)	34 (69.3)
Neighborhood below poverty threshold, No. (%)[a,d]	69 (48.2)	21 (53.8)	34 (61.8)	14 (28.5)

[a] Group comparisons among ethnicities conducted using 1-way analyses of variance.

[b] $P < .001$.

[c] Group comparisons among ethnicities conducted using the χ^2 test.

[d] $P < .05$.

Table 2

Missed sleep and asthma morbidity indicators by ethnicity, controlling for percentage in poverty

Indicator	African American	Latino	Non-Latino white	Group differences	Effect size
Missed sleep, mean (SE)	1.85 (0.18)	1.77 (0.18)	1.68 (0.16)	$F_{2,132} = 0.26$	Partial $\eta^2 = 0.004$
Sports limitation, mean (SE)	1.78 (0.17)	1.28 (0.15)	1.35 (0.17)	$F_{2,133} = 2.61$	Partial $\eta^2 = 0.038$
Other activity limitation, mean (SE)	1.51 (1.67)	1.09 (1.01)	0.78 (0.73)	$F_{2,134} = 2.45$	Partial $\eta^2 = 0.035$
School absences, mean (SE)	4.02 (1.03)	4.71 (0.92)	3.99 (1.01)	$F_{2,135} = 0.17$	Partial $\eta^2 = 0.003$
≥1 Emergency department visits in prior 12 months, %	43.59	33.33	24.49	$\chi^2_2 = 3.58$	Cramer V = 0.16
Quality of life, mean (SE)	5.82 (1.29)	5.63 (1.21)	6.48 (0.60)	$F_{2,135} = 5.43$[a]	Partial $\eta^2 = 0.066$

[a]Tukey least significant difference test indicated that quality of life was significantly higher for the non-Latino white group ($P < .05$) than the African American ($P < .05$) and Latino groups ($P < .05$). The African American and Latino group did not differ significantly.

Table 3

Regressions examining the association between missed sleep and asthma morbidity indicators controlling for poverty

Dependent variable	R^2	Missed sleep β	*F*
Sports limitation	0.18	.38[a]	14.12[a]
African American	0.14	.28	2.78
Latino	0.23	.46[a]	7.18[b]
Non-Latino white	0.17	.39[c]	4.20[c]
Other activity limitation	0.16	.28[a]	12.69[a]
African American	0.16	.17	3.29[c]
Latino	0.22	.45[a]	7.04[b]
Non-Latino white	0.12	.17	2.92
School absences	0.08	.26[b]	5.50[b]
African American	0.04	.15	0.69
Latino	0.10	.31[c]	2.80
Non-Latino white	0.10	.32[c]	2.39
Quality of life	0.17	−.33[a]	9.75[a]
African American	0.17	−.39[c]	3.40[c]
Latino	0.13	−.35[c]	3.88[c]
Non-Latino white	0.14	−.33[c]	3.37[c]
Emergency department use[d]	0.06	.51[b](χ^2 = 8.51)[c]	1.67
African American	0.11	.60(χ^2 = 4.66)	1.83
Latino	0.08	.56(χ^2 = 4.38)	1.75
Non-Latino white	0.02	.22(χ^2 = 1.07)	1.25

[a] $P \leq .001$.

[b] $P < .01$.

[c] $P < .05$.

[d] For emergency department use, the data in the R^2 column are the Cox Snell R^2 values and the data in the *F* column are odds ratios.

Table 4

Regressions controlling for poverty predicting asthma morbidity indicators from missed sleep in the whole sample

Dependent variable	R^2	Missed sleep β	F
Sports activity limitation			
Higher anxiety	0.20	.33[a]	6.57[b]
Lower anxiety	0.14	.36[c]	5.89[b]
Other activity limitation			
Higher anxiety	0.19	.32[a]	6.30[b]
Lower anxiety	0.12	.20	4.89[a]
Missed school			
Higher anxiety	0.11	.34[a]	3.45[a]
Lower anxiety	0.06	.22	2.32
Quality of life			
Higher anxiety	0.16	−.36[a]	5.12[b]
Lower anxiety	0.19	−.33[b]	8.76[c]
Emergency department visits[d]			
Higher anxiety	0.07	.48($\chi^2 = 4.41$)	1.62
Lower anxiety	0.07	.55[b]($\chi^2 = 6.18$)	1.73

[a] $P < .05$.

[b] $P < .01$.

[c] $P \leq .001$.

[d] For emergency department use, the data in the R^2 column are the Cox Snell R^2 values and the data in the F column are odds ratios.