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Allergic Rhinitis Quality of Life in Urban Children with Asthma

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Introduction

Asthma and allergic rhinitis (AR) are common, comorbid conditions in children. Epidemiological reports suggest that 60 to 80% of children with asthma experience rhinitis symptoms.[1,2] AR has been found to place a child at risk for poor asthma control,[3] and may further exacerbate risk for asthma morbidity (e.g., elevated healthcare utilization).[4] This is especially true of children living in urban environments, as stressors related to urban living (e.g., exposure to environmental allergens, lack of access to consistent provider) may complicate the co-management of both illnesses.[5,6] AR symptoms in children with asthma have the potential to increase the burden associated with managing both conditions, especially in urban families,[7] and negatively impact child quality of life (QOL).[8]

AR, Asthma, and QOL

QOL is often defined as the impact of a child's illness on the child's day-to-day physical, social, and emotional functioning. Child-related QOL has been highlighted as an important outcome variable in the study and treatment of pediatric illnesses.[9] Children with AR experience practical issues (e.g., blowing nose repeatedly), limitations in outdoor or group activities that expose them to allergens, feelings of isolation, missed days of school, and more problems with academic functioning.[8,10–12] Children with AR also experience

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disturbances in sleep due to nighttime symptoms,[13,14] which can impact daytime functioning and QOL specific to AR.[7,15] Children with AR who do not have asthma have also been found to experience better AR-related QOL than children with both conditions.[16]

Pediatric asthma research has focused more attention on asthma-related QOL as opposed to AR-related QOL,[17,18] when many children with asthma may have co-occurring AR symptoms that exacerbate asthma.[19] Clinical guidelines highlight the importance of co-managing AR and asthma in children with both illnesses[7,20] given that these children have higher rates of emergency department use than children with asthma only.[21] Research studies focused on AR QOL have often occurred in countries such as Canada[22] and the Netherlands[16] and have not included urban and ethnically diverse samples of children with both AR and asthma. Further work is needed to examine QOL specific to AR in urban children with both asthma and AR, and clarify which illness-related indicators may be important to target (e.g., report of control or symptoms) in order to improve AR-related QOL. It is also important to understand how poor AR QOL may increase morbidity risk in children from different ethnic groups.

Current Study

This study adds to the current literature by examining the contributions of AR control and asthma control on AR-specific QOL in an inner city sample of children (aged 7 to 9 years) with asthma and AR from African American, Latino, and non-Latino white backgrounds. We also examined the separate and combined contributions of daily rhinitis symptoms and asthma symptoms, examined across one 4-week period, on AR-specific QOL during that same period. Finally, we investigated ethnic differences in AR-related QOL.

Specifically, we hypothesized that children who were well controlled with regard to their asthma or AR would exhibit better AR QOL than children with poorly controlled asthma or AR. We hypothesized that AR control would emerge as a stronger predictor of AR QOL over and above asthma control. We also expected that higher levels of rhinitis and asthma symptoms (both independently and combined) would be associated with less optimal AR QOL in urban children. With respect to our final aim, we hypothesized that non-Latino white children would experience better AR QOL than African American and Latino children in our sample, based, in part, on the fact that AR in minority children is often undertreated. [7,23,24]

Methods

Participants

Families in this report were part of a larger study investigating the impact of asthma and AR on sleep and school performance in a sample of urban, school-aged children between 7 and 9 years.[24] The sample in the current study included 195 caregivers and their children with asthma (Table 1). Participants were recruited from 4 of the largest, adjacent and urban school districts in the Greater Providence area (Providence, East Providence, Central Falls, Pawtucket) that are also in environmentally similar areas. Families residing in these districts are demographically similar; approximately 50% Latino and African American children

attend schools in these districts and about 25–50% have asthma.[25] These districts were targeted because they are the largest urban school districts in the state and comprise the largest population of ethnically diverse, urban families. Each public, non-charter elementary school in these districts and each 1st to 4th grader were invited to participate. No further school district or school selection criteria were specified. Study flyers were distributed within schools and at school-based community events. Families who identified interest in participating after signing a Consent to Contact form, which described the study, needed to be eligible for the study according to inclusion criteria. Recruitment also occurred in hospital-based ambulatory pediatric clinics and asthma educational programs. The only children's hospital in the state, which provided these referrals, is located in an urban area of Providence and serves the surrounding and adjacent communities targeted for this study. Families on clinic and education referral lists were called if their child was 7–9 years and their home address was within one of the 4 targeted cities. Only one caregiver for each child participated in the study and multiple children with the same caregiver (e.g., siblings) did not participate in the study. Although infrequent, if the family had more than one child eligible for the study, caregivers enrolled their oldest child with asthma.

Study inclusion criteria included: 1) physician-diagnosed child asthma as reported by the parent, 2) parent report of child breathing problems due to asthma in the past year, 3) confirmed asthma status met either by current prescription of an asthma controller medication, or endorsement of several items related to child daytime/nighttime symptoms, quick relief use, and activity limitations in the past 4 weeks, 4) self-identified parent ethnicity of Latino (Dominican or Puerto Rican), non-Latino white, or Black/African American, and 5) family resided in one of the targeted districts identified by zip code. Exclusion criteria included: 1) moderate to severe cognitive impairment as determined by school placement, 2) prescribed use of stimulant medication, 3) other pulmonary or chronic medical condition (e.g., cystic fibrosis), or 4) diagnosed sleep condition that would confound study questions (e.g., restless leg syndrome).

Procedures

Participants included in the current study were part of the larger, 5-year study focused on sleep and school performance in children with asthma and AR symptoms. Families participated in four research sessions (including interview-based and clinician-based assessments) and three, month-long monitoring periods over the course of one academic year. Repeated assessments of upper and lower airway symptoms using self-report measures of symptoms were tracked across monitoring periods. The current study included data from the first four years of the larger study including the baseline session, clinic visit that occurred 4 weeks later, and first four-week monitoring period (between August and December). The same recruitment, screening and enrollment procedures used for the larger study were applied to this sub-study, as families were part of the larger study.

Written informed consent and child assent were obtained by a trained research assistant during the initial research session, as well as demographic information, an assessment of AR QOL, and a review of asthma and AR medication use. At the clinical evaluation session, which occurred at our Asthma and Allergy Clinic on the hospital campus, study clinicians

confirmed child asthma and AR status using NIH-NHLBI (National Heart, Lung, and Blood Institute) guidelines[26] and determined asthma and AR severity from clinician interview, symptom report, physical exam, pulmonary function testing, and allergy testing. Participants received training in the use of daily diaries to track frequency of asthma and AR symptoms (morning and night) during the four-week monitoring period. Research assistants visited families' homes after two weeks and again after four weeks to update medication information and review diary data. All research materials and procedures were translated into Spanish using standard procedures.[27] Participants could complete the research protocol in English or Spanish with bilingual research assistants. The study was approved by the Institutional Review Board at Rhode Island Hospital in Providence, Rhode Island.

Measures

Demographics—Primary caregivers provided basic demographic information including child age and gender, family income, and parent and child race/ethnicity.

Income-to-needs ratio—Annual family income was divided by the poverty threshold for a family of that size during the year of study participation.[28] We used the actual value of this income-to-needs ratio, which is continuous in nature, to examine the impact of poverty on our main outcomes of interest.

AR severity—Study clinicians classified AR severity, according to the Allergic Rhinitis and its Impact on Asthma symptom classification,[20] and modified to distinguish mild, moderate, or severe.[29] The presence and severity of rhinitis symptoms (both allergic and non-allergic) during the previous four weeks were assessed at the clinic visit.[29]

Asthma severity—Study clinicians verified asthma diagnosis by obtaining a history from the child's caregiver and performing a physical examination at the clinic visit. The child's primary healthcare provider completed a review of current medications and a query of relevant medical information. The child's asthma was classified as intermittent, mild persistent, moderate persistent, or severe persistent based on parent-reported symptom frequency, current medication level, and pulmonary function according to Expert Panel Report-3 from the National Heart, Lung, and Blood Institute.[30]

AR control—Children completed the Rhinitis Control Assessment Test,[31] a well-validated, 6-item measure designed to identify patients whose nasal and ocular symptoms are not adequately controlled. Children were asked to recall frequency of nasal congestion, sneezing, watery eyes, sleep interference, activity avoidance, and self-assessed rhinitis control in the past week. Higher scores indicate better AR control.

Asthma control—Parents and children completed the well-validated Asthma Control Test[32] to assess frequency of daytime asthma symptoms, nocturnal asthma symptoms, activity limitation, and patient perception of disease control. Children completed four items, with additional items completed by the parent including an assessment of healthcare utilization and perceived severity of asthma symptoms. Higher scores indicate better asthma control.

Rhinitis and asthma symptoms—Children used a standard daily diary format[33] to answer questions about the presence of breathing problems or nasal symptoms during the four-week monitoring period. Data from the daily diaries were summarized to yield a proportion score of number of morning or evening symptomatic days for each illness over the four-week period.

AR QOL—Children completed the Pediatric Rhinoconjunctivitis Quality of Life Questionnaire,[34] a 23-item measure designed to assess physical, emotional, and social difficulties associated with rhinoconjunctivitis in children. The questionnaire provides an overall QOL score and subscale scores across five domains: nose symptoms, eye symptoms, practical problems (e.g., rub nose and eyes, blow nose, carry tissues), other symptoms (e.g., thirst, irritable, tired), and activity limitations. Higher scores indicate more impaired levels of QOL. The measure has demonstrated strong validity and reliability properties.[34]

Statistical Analysis

Analyses were performed using SPSS version 20.0 software (Statistical Product and Service Solutions 20.0; SPSS Inc., Chicago, IL). We examined demographic and illness-related covariates that have been conceptualized previously to affect child health outcomes.[35,36] Specifically, race/ethnicity, asthma and AR severity, child gender and age, and the income-to- needs ratio were tested as potential covariates in associations with AR QOL. Analysis of variance (ANOVA) and t-tests were used to assess for differences in AR QOL across race/ethnicity, illness severity, and child gender. The F-test was used as the result obtained from the ANOVA to test the equality of a set of two or more means. Partial eta squared (η^2) was reported as the effect size of an ANOVA, which conveys the proportion of explained variance in a specific factor that is not accounted for by other variables in the model (such as controlled covariates). In further testing potential covariates, correlational analyses were used to determine whether AR QOL was significantly associated with continuous variables (e.g., child age and the income-to-needs ratio). An ANOVA was used to test for differences in the income-to-needs ratio across racial/ethnic group.

A series of hierarchical regression analyses were used to predict AR QOL from AR control, controlling for appropriate covariates, as well as from asthma control, again controlling for appropriate covariates. AR and asthma control were entered as continuous variables versus being dichotomized into “well controlled” and “not well controlled” AR/asthma subgroups.[37,38] For associations in which AR and asthma control each emerged as significant predictors of AR QOL, regression analyses were used to determine whether AR control predicted AR QOL beyond the effects of asthma control. Covariates were entered as the first step in the model, asthma control as the second step, and AR control as the final step. We repeated the process using AR control as the second step and asthma control as the final step to determine whether asthma control could predict AR QOL over AR control. Regression analyses were used to assess the contribution of rhinitis symptoms and the separate contribution of asthma symptoms, as well as the combined effect of rhinitis and asthma symptoms on AR-specific QOL. In testing the combined effect of rhinitis and asthma symptoms on AR QOL, rhinitis and asthma symptoms were entered together in a single step of the model predicting AR QOL. For all analyses, ΔR^2 was used to determine

whether the proportion of explained variability in the outcome variable by the model (R^2) significantly increased with the addition of a specific factor to the model. For example, ΔR^2 indicates whether the addition of a variable to the model, such as symptoms or control, is able to explain a significant amount of variability in AR QOL after controlling for covariates.

We used a series of ANOVAs to assess differences in total AR QOL and subscale scores across racial/ethnic group. Post hoc comparisons using Tukey's Honestly Significant Difference were used to pinpoint significant differences between groups and control for multiple testing. We used hierarchical regressions to test our study question predicting AR QOL from race/ethnicity and controlled for illness factors that emerged as strong predictors of AR QOL (e.g., AR or asthma control). Doing so allowed us to ensure that differences in AR QOL by race/ethnicity were not better accounted for by either AR or asthma control. Given the exploratory nature of our analyses, a p-value of .05 was used to assess the significance of results.

Results

Preliminary analyses to identify potential covariates indicated a difference in AR QOL total scores by AR severity level. Children with more severe AR (*Mean* [*M*]=2.51, *Standard Deviation* [*SD*]=1.44) had worse QOL than children with mild (*M*=1.68, *SD*=1.27) or moderate AR (*M*=1.73, *SD*=1.16; *F*(degrees of freedom=2, 169)=5.68, $p < .01$, partial $\eta^2 = .06$). AR QOL total scores also differed by family race/ethnicity with non-Latino white children experiencing better QOL than both Latino and African American children (Table 2). AR QOL total and subscale scores were significantly associated with the income-to-needs ratio (Table 2). AR QOL scores were not associated with child age, gender, or asthma severity. The income-to-needs ratio differed across family race/ethnicity ($F(2,192)=15.28$, $p < .01$, partial $\eta^2 = .14$), with non-Latino white families having higher income-to-needs ratios (*M*=1.68, *SD*=1.40) than both Latino (*M*=.68, *SD*=.71) and African American (*M*=.97, *SD*=.88) families. Race/ethnicity, the income- to-needs ratio, and AR severity were included as covariates where appropriate.

Associations between AR Control, Asthma Control, and AR QOL

First, we tested the predictive power of AR and asthma control on AR QOL while controlling for asthma severity, the income-to-needs ratio, and race/ethnicity (Table 3). Better AR control was associated with more optimal total AR QOL and all subscale scores. Better asthma control was associated with more optimal scores on the Nose Symptoms and Activity Limitations subscales. Controlling for covariates, AR control predicted total AR QOL (estimated $\beta = -.29$, $\Delta R^2 = .05$, $p < .01$), the Nose Symptoms (estimated $\beta = -.30$, $\Delta R^2 = .06$, $p < .01$) and the Activity Limitation subscales (estimated $\beta = -.24$, $\Delta R^2 = .04$, $p < .05$) over and above the effects of asthma control. Asthma control did not predict either total or subscale scores over and above AR control.

Associations between Rhinitis Symptoms, Asthma Symptoms, and AR QOL

Controlling for asthma severity, the income-to-needs ratio, and race/ethnicity, regression analyses were used to predict total AR QOL and subscale scores from rhinitis symptoms, asthma symptoms, and combined asthma and AR symptoms. Rhinitis symptoms were associated with the Nose Symptom subscale (Table 3). For the most part, asthma symptoms and combined asthma/AR symptoms were not associated with AR QOL (eTable 1). Although step 2 of the model predicting the Nose Symptoms subscale from asthma and AR symptoms was significant, the rhinitis symptoms variable was the only significant predictor (e.g., not asthma and rhinitis symptoms combined).

Mean Differences in Total AR QOL and Subscales by Child Race/Ethnicity

Results indicated ethnic differences in total AR QOL scores and two subscale scores, Eye Symptoms and Practical Problems (Table 2). Pairwise post-hoc analyses indicated significant differences in AR QOL and subscale scores between non-Latino white and both Latino and African American children. However, when controlling for AR control, race/ethnicity significantly predicted only the Practical Problems subscale (eTable 2).

Discussion

Associations between Illness Control, Symptoms, and AR QOL

The current study examined associations between AR control, asthma control, rhinitis symptoms, asthma symptoms and AR-related QOL in an inner city sample of children with asthma and AR from African American, Latino, and non-Latino white backgrounds. Results suggest that AR control may be more important to AR QOL, even when asthma control is taken into account. Families may find it more challenging to effectively control their children's AR in the context of factors related to urban living such as higher levels of allergens and irritants,[39] perceptions of neighborhood safety,[5] and psychological stress (e.g., related to violence).[40] For children with poorly controlled AR, health care providers may consider discussing with the family the importance of effective AR control. Health care providers may also wish to implement the Rhinitis Control Assessment Test in clinical practice, as it may be indicative of AR-related QOL.

Although we expected associations between rhinitis and asthma symptoms (both independently and combined) and AR QOL in urban children with asthma, we found only an association between rhinitis symptoms and a specific domain of AR QOL related to nasal symptoms. Child asthma and rhinitis symptoms were measured through a daily diary that our research group has piloted and revised to enhance the ease of use with urban families. In the larger study, reports of asthma and AR symptoms have been correlated with objective measurements of upper and lower airway function. Preliminary data analyses from the larger study found that daily self-reported nighttime nose symptoms were associated with daily morning assessments on a peak flow nasal inspiratory flow meter ($F = 2.0$, $p < .001$, nested by case). Daytime, self-reported nose symptoms were associated with evening assessments on the peak flow nasal inspiratory flow meter ($F = 1.9$, $p < .001$). Self-reported breathing problems were marginally related to assessments of lung functioning, as measured by a hand-held spirometer ($F = 1.2$, $p = .07$). In the current study, we found only an association

between daily rhinitis symptoms and a specific component of AR QOL. Our findings are consistent with other studies suggesting that clinical symptoms do not consistently correlate with QOL measures.[41,42]

Racial/Ethnic Differences in AR QOL

As compared to African American and Latino children in our sample, we found that non-Latino white children experienced less impairment of their QOL due to practical problems related to AR (e.g., rub nose and eyes, blow nose, carry tissues). As this component of AR QOL (e.g., practical problems) is only one component of overall AR QOL, future research is needed in larger samples of diverse children to determine whether differences in overall AR QOL and other domains of AR QOL persist when accounting for AR control. Differences in AR QOL may reflect the fact that AR is more often underdiagnosed and undertreated in urban minority children.[23] Racial and ethnic minority families may face additional barriers (e.g., lack of knowledge for the need of a specialist) related to ensuring that their child with asthma receives the appropriate treatment for concomitant AR. This study, however, is a first step in documenting differences in AR QOL among urban children from African American, Latino, and non-Latino white backgrounds.

Limitations and Future Directions

Our study is limited in the use of a convenience sample and may not generalize to other samples of urban Latino, African American, and non-Latino white families. Data are also cross- sectional and do not allow for conclusions regarding causality between illness symptoms, control, and AR QOL. For purposes of this study, we have considered AR QOL as an outcome measure; however, it is likely that the association between AR control and AR QOL is bidirectional. It is also important to recognize that as AR-specific measures of QOL may not be assessing asthma-related issues, there is the potential need for AR-specific measures to be used in conjunction with asthma-specific measures in children with asthma and AR. Our study may be limited by informant bias in that we relied on child report of AR QOL and AR control. Given that our study clinicians did observe families and had some indication of minority status (although they did not ask families specifically about their race/ethnicity), it is possible that observer bias may have influenced AR and asthma severity level.

Future research is needed to consider associations between AR QOL and indicators of asthma morbidity (e.g., functional limitation) or other aspects of child functioning to further establish the clinical importance of AR QOL in urban children with asthma. Moreover, future research is needed that assesses the association between AR QOL and asthma QOL in urban samples. Although AR QOL and asthma QOL are measuring child QOL specific to each illness, it is unclear how AR and asthma QOL may be associated and whether interventions to improve QOL specific to one illness may also impact QOL related to other illnesses. The current study was focused on AR QOL and not designed to address issues related to both AR and asthma QOL.

Our findings related to racial/ethnic differences in AR QOL should also be replicated in larger, diverse samples of urban children with asthma, which would allow for associations

between AR/asthma control, illness symptoms, and AR QOL within groups and for other illness- related indicators to be conceptualized as covariates. We also recognize that multiple testing is a limitation in our study in that multiple testing may increase type I error rate. Researchers should use our reported effect sizes to guide future investigations of AR QOL in larger samples of urban children with asthma. We also recognize that Dominican and Puerto Rican families were combined into one Latino group despite research suggesting differences in level of acculturative stress and use of alternative medications between these Latino subgroups.[43,44] Future research with a larger sample should focus on Dominican and Puerto Rican children separately, as well as include children from non-Caribbean Latino families.

Finally, our findings highlight that treating AR likely has positive implications for child asthma outcomes as well. For example, nasal corticosteroid treatment of AR has been linked to improved asthma control in children with AR and asthma.[3] Increased awareness within families of the potential for AR control to impact child QOL across several domains of functioning may motivate families to effectively manage child AR in the context of child asthma. For healthcare providers and physicians, our study suggests the need to focus on AR control in urban children with asthma as enhancing AR control may assist in improving AR QOL in urban children. Clinical implications might include changing or reinforcing recommendations to improve AR control (e.g., medications, adherence, avoiding allergens) during clinic visits with children and their families. Focusing on AR control may serve to assist in improving child AR-related QOL in urban children, which has implications for child sleep, school functioning, and daytime activities.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Child and Family Characteristics (195 caregivers and their children)

Characteristic	
Child age (mean ± SD years)	8.39 ± .87
Sex of the child, n (%)	
Female	91 (47)
Race/Ethnicity, n (%)	
Non-Latino white	34 (17)
African American	60 (31)
Latino	101 (52)
Income-to-needs ratio (mean, SD)	.95 (.98)
	Range (0–4.49)
AR severity, n (%)	
Mild	45 (26)
Moderate	92 (54)
Severe	35 (20)
AR treatment appropriateness, n (%)	
No treatment	67 (39)
Undertreated	46 (26)
Reasonable treatment	57 (33)
Overtreated	2 (1)
Asthma severity, n (%)	
Mild intermittent	10 (5)
Mild persistent	72 (41)
Moderate persistent	65 (37)
Severe persistent	28 (16)
Prescribed inhaled corticosteroid for asthma, n (%)	118 (61)

Table 2

Associations between AR QOL, Race/Ethnicity, and Income-to-Needs Ratio

	Full sample n = 195	Non-Latino white n = 34	Latino n = 101	African American n = 60	Group differences	Effect sizes (partial η^2)	Correlation with income-to-needs ratio (*r*)
Total QOL Mean (*SD*)	1.84 (1.30)	1.32 (1.08)^{a,b}	1.91 (1.35)^{a}	2.03 (1.28)^{b}	F(2, 192) = 3.61*	.04	−.22**
Nose Symptoms	2.07 (1.46)	1.59 (1.37)	2.15 (1.46)	2.22 (1.47)	F(2, 192) = 2.35	.02	−.16*
Eye Symptoms	1.50 (1.54)	.81 (1.17)^{a,b}	1.53 (1.57)^{a}	1.85 (1.56)^{b}	F(2, 192) = 5.26*	.05	−.16*
Practical Problems	1.71 (1.45)	1.01 (.94)^{a,b}	1.85 (1.56)^{a}	1.87 (1.39)^{b}	F(2, 192) = 5.04*	.05	−.17*
Other Symptoms	2.01 (1.54)	1.60 (1.12)	2.07 (1.68)	2.13 (1.48)	F(2, 192) = 1.50	.02	−.20**
Activity Limitations	1.86 (1.79)	1.51 (1.77)	1.86 (1.72)	2.07 (1.92)	F(2, 192) = 1.05	.01	−.20**

Note. Sample size includes 195 caregivers and their children. Higher scores indicate impaired levels of QOL. In the three columns labeled non-Latino white, Latino, and African American, “a” represents a statistically significant comparison ($p < .05$) between non-Latino white and Latino children and “b” represents a statistically significant comparison ($p < .05$) between non-Latino white and African American children. In the column labeled “group differences”, entries marked * indicate that at least two of the ethnicities are significantly different (at $p < .05$) in a given row.

* p <. 05,

** p < .01

Table 3

AR Control, Asthma Control, and Rhinitis Symptoms Predicting AR QOL

		Total AR QOL		Nose Symptoms Subscale		Eye Symptoms Subscale		Practical Problems Subscale		Other Symptoms Subscale		Activity Limitations Subscale	
		β	**Δ*R*²**	***β***	**Δ*R*²**	***β***	**Δ*R*²**	***β***	**Δ*R*²**	***β***	**Δ*R*²**	***β***	**Δ*R*²**
Model 1	Rhinitis control	−.32**	.07**	−.36**	.09**	−.21*	.03*	−.26**	.05**	−.22*	.03*	−.28**	.06**
Model 2	Asthma control	−.15	.02	−.20*	.03*	−.09	.01	−.10	.01	−.08	.01	−.17*	.03*
Model 3	Rhinitis symptoms	.11	.01	.21*	.04*	−.05	.00	.12	.01	.06	.00	.12	.01

Note. β = estimated β. Sample size included 195 caregivers and their children. Results displayed are for the final step of each model. ΔR2 represents the significance of the illness variable in predicting AR QOL while controlling for AR severity, race/ethnicity, and the income-to-needs ratio. Estimated β values indicate the strength and direction of the association between the illness factor and outcome variable in the final step of the model.

* p < .05,

** p <.01