Ohio Family Health Survey

Access to and Utilization of Health Services by Rural-Dwelling Ohio Children: Are There Unique Challenges for Those in the Appalachia Region?

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OFHS

About the Ohio Family Health Survey

With more than 51,000 households interviewed, the Ohio Family Health Survey is one of the largest and most comprehensive state-level health and insurance surveys conducted in the country. The project was managed by The Ohio State University's Ohio Colleges of Medicine Government Resource Center, and the Health Policy Institute of Ohio and the survey was conducted by Macro International. The Ohio Departments of Insurance, Job and Family Services, Health, and Mental Health, the Cleveland State University, and the Ohio Board of Regents funded the project. This current project is the third in a series of statewide health surveys, following family health surveys in 1998 and 2004.

Ohio Family Health Survey Web site (all sponsored research reports are available for download here):

http://grc.osu.edu/ofhs

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Abstract

The objective of this study is to identify the differences in health status, access to health care and health care utilization between children living in the Appalachian region and children living in rural non-Appalachian counties. This study used the 2008-9 Ohio Family Health Survey[1] data and is designed around the *Framework for Understanding Access, Utilization & Health States*[2]. To address the specific aims, a mixed analysis strategy was used. Statistical analysis was performed using a Bayesian hierarchical modeling strategy, accounting for unequal sampling probabilities of the respondents. Continuous variables were modeled using normal distributions, dichotomous variables were modeled using logistic regression forms, and ordinal variables were modeled using proportional odds forms. Ohio is uniquely positioned to compare the health seeking patterns of children residing in rural areas, taking into account the impact that regional cultural area such as Appalachia may have on these outcomes. Differences in access to care and utilization patterns were found. The results of this study provide vital information about specific vulnerable groups in Ohio and should assist policy makers in changing systems to improve health outcomes in these populations.

I: Introduction and Background

Children living in rural Appalachia are shaped by a unique regional culture that is characterized as isolated and populated by a people who prefer to take care of their own[1]. Reduced educational opportunities and high unemployment in Appalachian counties have led to economic instability and persistent poverty, which has been associated with poorer health outcomes in children[3]. Furthermore, children living in counties that border the Ohio River are disproportionally exposed to adverse environmental conditions related to the industry such as coal mining, manufacturing and power generation plants, and pollution prevalent along the Ohio River [4.] Seven of Ohio's river-bordering Appalachian counties are subjected to some of the largest reported chemical releases in the state[4]. Furthermore, over 40% of all chemical releases in the state occur in this region[4]. These same seven river bordering counties are reported to have a high incidence of cancer diagnoses and cancer deaths[5]. Consequently, if available, access to and utilization of health care may provide one avenue to improving the life chances of these vulnerable children. Although health care alone cannot guarantee health, primary health care and early intervention may delay the onset of disease and improve the long-term health of these children. Appalachian counties share some of the same challenges facing other rural counties in Ohio such as the lack of health care providers[6]; however, the Appalachian region is recognized as distinct. Because of this distinctiveness it is unclear if there are different challenges in providing health care for children within this region. Furthermore, it is unclear if children in the Appalachian region experience greater disparities in health, access to and utilization of health care than children living in other rural areas throughout Ohio. To date, comparisons in health, access to and utilization of health care has focused primarily on differences between urban and rural living children and adolescents[7-9]. Furthermore, studies that have only examined rural children and adolescents generally have not considered culturally defined areas such as Appalachia. Such areas may further impact access to and utilization of health care and ultimately health outcomes. We expect that *a* greater understanding of access to and utilization of health care services, coupled with information about the health of these children will provide policy makers with additional knowledge to develop culturally relevant strategies to improve the health of children in each of these subsets.

The overall goal of this study was to examine if there were differences in access to and utilization of health care services between children living in rural areas and Appalachian areas of Ohio. Because it is well-known that the presence of health problems influences health services use, an important component of this study was to describe the underlying health of these children. By understanding these access and use patterns against the backdrop of overall health, recommendations for structuring services across these important geographical areas can be made. The ***specific aims include:***

A) Are there differences in the health of Appalachian children compared to non-Appalachian rural dwelling children?
B) Are there differences in health care access in Appalachian children when compared to other rural dwelling children?
C) Are there differences in health care utilization in Appalachian children when compared to other rural dwelling children?

D) What is the relationship between health, health care access, and health care utilization in Appalachian children compared to non-Appalachian rural dwelling children?
E) How do Appalachian children who live in a county that borders the Ohio River compare to other Appalachian and rural dwelling children in these outcomes (i.e., health, health care access, and health care utilization)?

Background

Geographic regions of interest

The two geographic areas under study in this project were the 29 designated Appalachian counties and the 30 rural counties, mainly located in western Ohio. While these two areas share some common problems in providing health care to its citizens, there are notable differences between the two areas. Household incomes within the Appalachian counties are lower, with the mean income across the 29 counties $35,955 with 16.55% of families living at or below the poverty line; the income in the rural counties is $43,955 with 10.4% of families living at or below the poverty line[10]. Data from the OFHS county web cite suggest that the poverty rates have increased with 33.8 percent of families in Appalachia now living below the poverty line and 19.3% of those residing within the rural counties now living below the poverty line. The number of pediatric providers[10-11] is greater in the rural area when compared to the Appalachian region and the number of counties without a pediatric provider is also greater in Appalachia (48% or 14 of 29 counties) when compared with the rural counties (42% or 13 of 30 counties). These system differences suggest that there will be differences in utilization and access across these regions. Furthermore, because of greater poverty in Appalachia, more of these children are likely to qualify for Medicaid.

Ohio is comprised of non-Appalachian and Appalachian rural areas which enable novel comparisons of the health seeking patterns of the children residing in a rural area and the regional cultural area such as Appalachia. Within the Appalachian counties there is a growing interest in the health of the citizens residing in the river bordering Appalachian counties because of adverse environmental exposures that occur in this area. The following map shows the rural and Appalachian regions of Ohio. All rural areas are shaded in blue and the Appalachian region is shaded in red.

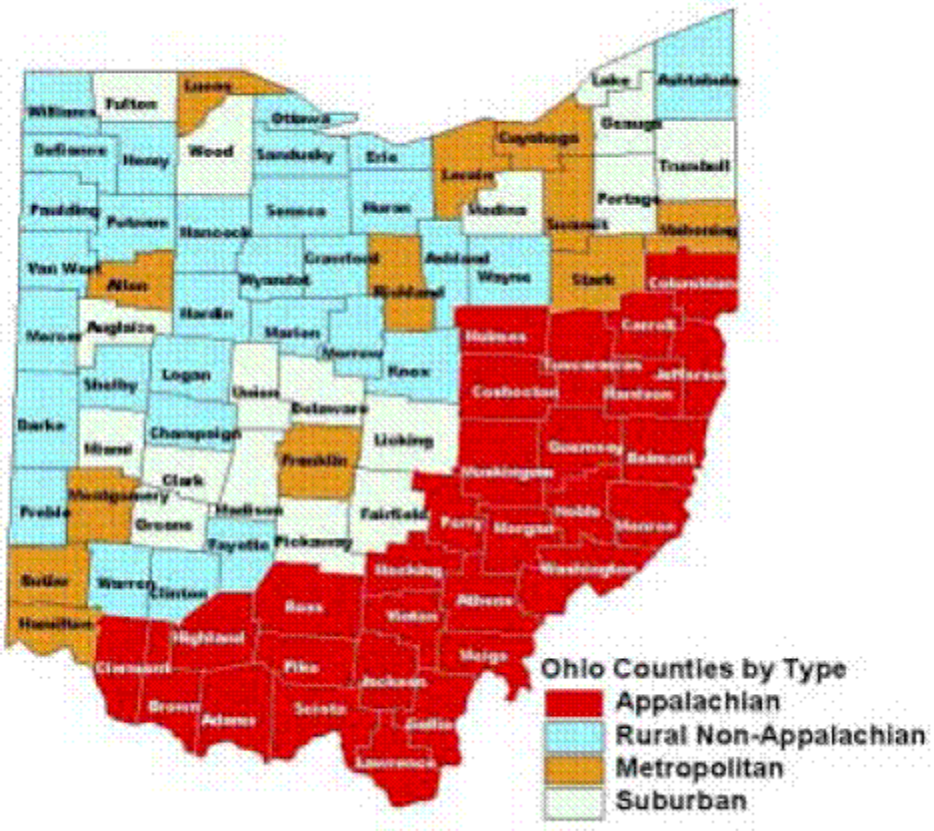

Figure 1. Map of Ohio with Rural and Appalachian Counties

Health

Nationally and within the state of Ohio, rural living persons generally have lower income, poorer educational achievement and less health care service availability[3,12] . These characteristics are generally seen as precursors to poorer health status. Residents of rural Appalachia Ohio are particularly vulnerable as recent national studies have identified high rates of cancer[13-14], heart disease[9] and premature mortality[7] among residents residing within this region. Yet, location as a precursor to poor health primarily has been reserved to states with little attention being paid to culturally- defined geographic areas such as Appalachia[2.] Of particular concern is the rapid increase in the prevalence of childhood obesity especially in Appalachia Ohio[3] that has alarmed health agencies, providers, researchers and the general public [15-17]. Obesity is a precursor to numerous chronic diseases since the condition affects nearly every organ in the body[13-17]. Appalachian culture impacts how health is defined and the health information is communicated. For example, beliefs about body weight, family norms, attitudes and behaviors concerning weight, eating and activity are culturally-determined [7,16]. Furthermore, Appalachian's sense of faith, fatalism, fear of outsiders, and caring for our own may impact their access to and utilization of health care services as well as their health [3,18].

Health care utilization patterns

Although young children and adolescents are generally healthy, variation in environments may lead to differences in health outcomes, and in access to and utilization of health care[15]. Specifically, differences in socioeconomic and environmental stressors between rural and non-rural communities may contribute to disparities in health care access and utilization[15-16]. Evidence suggests that non-rural children are more likely to seek routine/preventive health care and care for chronic conditions, such as asthma whereas rural living children are more likely to seek care for acute conditions such as ear infections, influenza and rhinitis[15-16]. What is not known is if there are differences in health care utilization between children living in rural areas and those living in culturally defined rural areas, such as Appalachia.

How a cultural group defines health impacts health care utilization. Rural families frequently define health as the "ability to work"[17]. Consequently, chronic health conditions such as asthma, diabetes, and childhood obesity are tolerated for longer periods of time, under-diagnosed and untreated in rural children and adolescents, as long as the child/adolescent can work or attend school[15-17]. What is not known is if the unique cultural factors found among Appalachian peoples further influences health care utilization beyond the challenges faced by rural living people, especially for children and adolescents.

Health care access

Access to care is limited in rural and Appalachia counties because of a shortage of providers and the distance to care centers[6,7,14]. In addition, because of the nature of the work (small employers or self-employment) family health insurance may be less accessible[19]. This is problematic because health insurance is a precursor for access to health care [20]. Furthermore, access to care in Appalachia may be limited by cultural aspects, such as "fear of outsiders" and the need to "care for our own". Consequently, access to care in rural Appalachia may be limited not only by the lack of health insurance, the shortage of providers and distance to care center that is prevalent among all rural communities, but also by the Appalachian cultural attitudes and beliefs that encourage self reliance and potentially to delays in accessing formal care and underutilization of services.

Summary

This study is the first step in understanding the unique differences in health and in access to and utilization of health care between Ohio residents living in non-Appalachian and Appalachian rural counties. A better understanding of health care access and utilization patterns between Ohio's rural residents in general and those living in the culturally-defined Appalachian rural areas will assist Ohio's policy makers with necessary information to understand the challenges making a meaningful impact on the health of these vulnerable residents. This project aimed to identify the differences of health care access and utilization of health care services between Appalachian children and other rural living children after adjusting for the impact of health insurance and health status.

Guiding Framework

The guiding framework for this study is Anderson & Aday's[2] *Framework for Understanding Access, Utilization & Health States* (see Figure 2). This model posits that access to and use of health services is a complex interplay of availability, individual need, individual resources, and the underlying proclivity to use services. In this study the focus is on assessing structure (delivery system, population at risk, environment) and process (realized access).

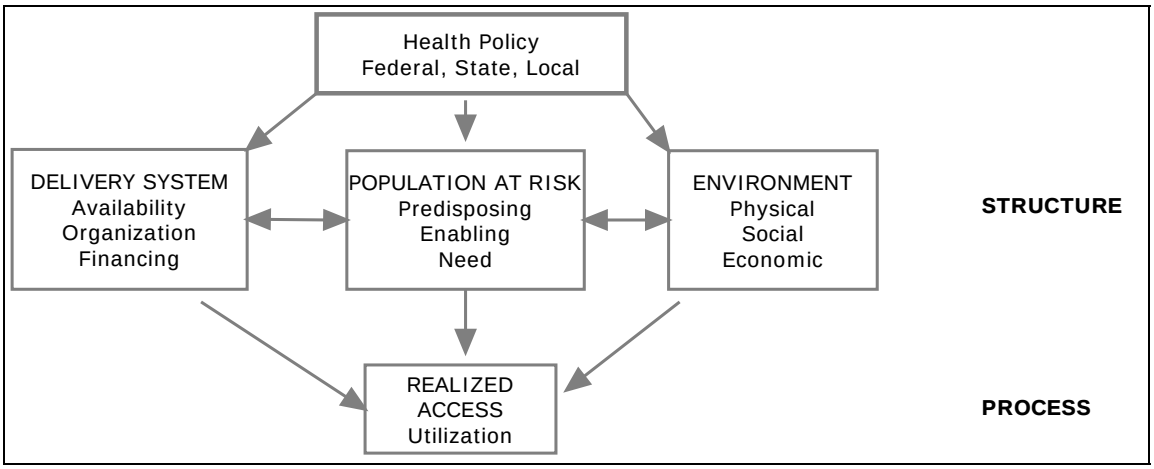

Figure 2. "Smith's" Adaptation of Aday's Framework for Understanding Access and Utilization (Aday et al, 1999)[2]

II: Methods

Data from the 2008 Ohio Family Health Survey (OFHS)[1] were used to generate findings in this report. This project used the Child Questionnaire and Parent Health Status data. OFHS is a statewide, random digit dial telephone survey of over 50,000 Ohio residents. OFHS used a stratified sampling frame that sampled respondents using random digit dialing computer assisted telephone interviewing (CATI) methods. The sample was stratified by county with several additional samples. The six largest metropolitan counties were sub-sampled to ensure greater representation of African Americans. Additional targeted supplemental samples were drawn to ensure good representation of Asian and Hispanic residents. Finally, a separate cell phone sample ensured good representation of younger people more often reached via cell phones. A detailed description of the survey methodology can be found in the 2008 OFHS Methodological Report (ref 2008). Child[ren] is defined as someone under the age of 18 years of age. Parent is defined as either the mother or father of said child. Table 1 displays the number of participants from each county (un-weighted).

Table 1. Un-weighted Sample of Ohio Children from Rural, Non-River Appalachian and Appalachian Counties (N = 5704)

Rural	**n**	**Appalachian Non-River**	**n**
Ashland	75	Carroll	60
Ashtabula	106	Coshocton	84
Champaign	74	Guernsey	73
Clinton	79	Highland	171
Crawford	63	Hocking	58
Darke	116	Holmes	95
Defiance	86	Jackson	78
Erie	93	Morgan	85
Fayette	83	Muskingum	101
Hancock	112	Noble	71
Hardin	65	Perry	77
Harrison	56	Pike	107
Henry	79	Ross	108
Huron	107	Tuscarawas	114
Knox	82	Vinton	64
Logan	70	**Appalachian River**	**n**
Marion	82	Adams	132
Mercer	83	Athens	94
Morrow	75	Belmont	69
Ottawa	67	Brown	183
Paulding	85	Clermont	322
Preble	74	Columbiana	113
Putnam	85	Gallia	79
Sandusky	103	Jefferson	74
Seneca	93	Lawrence	93
Shelby	101	Meigs	113
Van Wert	61	Monroe	47
Warren	261	Scioto	118
Wayne	147	Washington	85
Wyandot	70		
Total	**2750**	**Total**	**2954**

Measures

Table 2 delineates the variables used in this study and links these to the guiding framework (Figure 2), the level of measure, and the OFHS data element. Each of these are described further below.

Table 2. Measures

Framework	Construct/Variables	Measure	OFHS Data Element
	STRUCTURE		
Delivery system availability	Access		
	Regular place of care	Yes/No	N137, N137 Check
	Regular provider	Yes/No	N137b
	Difficulty accessing specialty care	No or small problem/Big problem	K4Q26
Populations -at-risk Predisposing	Age, ethnicity, gender	Age in years, Race/ethnicity (white, Black, Asian, Native American, Hispanic)	Age_c; race_c_imp i90,P150,P148
Enabling Need	Health Insurance Health	Private, Gov't, Uninsured Parent-reported health status; Weight state (under weight, normal weight, overweight, obese)	J100a-J100f; J120, H87 L125, BMI_C, BMI_c_CAT
Environments Physical, social, economic	Geographical Region	Appalachian River, Non-River Rural, non-Appalachian	County_A
	PROCESS		
Realized Access	Utilization		
	Well Care	Well child/baby visit	M130
	Sick Care	Preventive Dental Care ER visits; # days since non-preventive dental visits; Overnight hospital; Seen by specialist; # days since last MD visit	M130a K4Q24;M132;M135; M134;M131

Note: N137 (regular place for care) was recoded in such as way that it is the same as the created variable "usual_c" found in the final OFHS dataset

Structure

Delivery system availability: Access is defined as having entrée or admittance to a regular health care provider and place to obtain care. This was operationalized as access to a (regular) place for care, access to a (regular) health care provider such as a physician or nurse practitioner and the perceived degree of difficulty in accessing specialized care (when such care was needed). Items measuring access to place and access to provider were dichotomized to reflect either "yes" or "no". Degree of difficulty in accessing specialized care was measured dichotomized into either "no problem or small problem" or "big problem".

Population-at-risk: *Predisposing*: Demographic data describes the composition of the population at risk and includes age of the child, gender and race/ethnicity of the children as reported by the parent. Respondents who answered anything except "mother" or "father" had i90B (primary parent race) and S15 (gender) coded as missing. Additional information about variable construction and transformations can be found in Appendix A.

Enabling: Enabling is measured by the child's insurance status. Medicaid eligibility was measured using responses from J100C, H87, and J100A. Child's insurance status was measured by items J100A – J100F that ask parents to state whether or not the child is covered by various public and private insurance plans. Insurance status was then measured by: having government-based coverage (yes or no) or having private health insurance such as employer-based coverage or privately purchased plans. Children who were covered by both a government and private plan were placed in the government-based coverage group. Children who had neither a government-based or private insurance plan were classified as "uninsured".

***Need*:** Health, defined as the child's overall health, was measured by the parent's perception of the child's general health and for children older than 9 years and less than 18 years old, the child's Body Mass Index (BMI) Category based on the percentiles for age and gender as reported by the parent(s). BMI is a number calculated from the child's weight and height. BMI is a reliable indicator of body fatness for most children and teens [21]. BMI does not measure body fat directly, but research has shown that BMI correlates to direct measures of body fat such as underwater weighing[22]. Consequently, BMI is considered an alternative for direct measures of body fat. For children and teens, BMI is age and sex specific. After BMI is calculated, the BMI number is plotted on the Center for Disease Control's (CDC) BMI for Age growth charts (for either girls or boys) to obtain a percentile ranking. Percentiles are the most commonly used indicator to assess the size and growth patterns of individual children in the United States [21]. For the OFHS Survey, parents were asked to provide the child's current height in and weight. Child height was recorded in feet and inches. Child weight was recorded in pounds. Child weight and height measures were only asked of parents for children older than age 9 years. Consequently, BMI percentiles were only calculated for children between the ages of 10-17 years. BMI percentiles were not calculated for younger children for the Ohio Family Health Survey.

Based on the BMI percentiles for age and gender, children were classified into a weight status category, according to the Center for Disease Control recommendations as follows. Obese is classified as children's who's ht/wt percentile is ≥ the 95th percentile for age and gender. Overweight is classified as between the 85th and 94.9th percentile. Healthy weight is classified as between the 5th and 84.9th percentile. Underweight is classified as below the 5th percentile. The variable produced by these calculations (BMI_C) was used. Children with BMI_C_CAT equal to 5 were set to missing.

Child general health was measured by item L125. Item L125 asked parent's to describe their child's health, specifically whether [his/her] health is excellent, very good, good, fair, or poor. Item L125 was coded so that 1=excellent, 2=very good, 3=good, 4= fair and 5=poor. This item was asked for all children, regardless of age.

Environments: The region of residence (Appalachian and rural non-Appalachian) was a key variable of interest. For this project, children residing in the 29 clustered Appalachian counties were classified as "Appalachian". Children residing in the other 30 clustered rural counties were classified as "non-Appalachian rural". In addition, a sub-classification of the Appalachian counties was created by clustering the 13 counties bordering the Ohio River as "River Bordering Appalachian" and the remaining Appalachian Counties as "Non-River Bordering Appalachian". See Table 1 above.

Process (realized access)

Health care utilization (realized access) is defined as the type of care the child receives from a health care provider or the health care system, specifically either **wellness care or care due to an illness or injury**. *Wellness care* includes well baby and well child check-ups and dental visits for standard check-ups. Wellness care was measured by items M130 and M135a. Item M130 asks whether the baby has had a well baby check since birth or for other children receiving a well child checkup within the past 12 months. Item M135a asked about seeing a dentist for preventive dental care such as a dental check up or dental cleaning within the past 12 months. Item M131a was checked for those who answered "no" to M131 for consistency.

Sick care utilization was measured by 5 items. These items were coded so that a higher value indicates more sick care utilization. Wellness care use of services was measured by 2 items. These items were coded so that a higher value indicated more wellness care utilization. Sickness care includes: being seen by a specialist for care, being in the hospital overnight (within the past year), visits to the emergency room, and length of time since last doctor's visit, excluding well baby or well child check up. Illness care was measured by items M132 (overnight hospital stays), M134 (patient in an emergency room/emergency room visits), and seeing a specialist for care (K4Q24). We wanted to use M135DAYS as an indicator for non-preventive dental care such as other dental treatment but it was not possible to determine whether children who had seen a dentist in the past 12 months visited for the purpose of preventive care or other dental treatment. Consequently, we dropped M135DAYS from our analysis. Additional information about data measurements and transformations can be found in Appendix A.

Other Key Controls: Parent Health, defined as the parent's overall health, was measured by the parent's perception of their own general health (Item D30) and their Body Mass Index that was calculated from their self-reported height (in inches) and weight (in pounds) using the following formula: **BMI = weight (lbs)/[height(inches)]^2 x703.** Using the CDC recommendations, obese is defined as an index of $\geq$ 30.0. Overweight is an index between 25.0– 29.9; healthy weight is an index between 18.5-24.9; underweight is < 18.5. The variable produced by these calculations (BMI_A) was used. Parents with a BMI_A_CAT equal to 5 were set to missing. Respondents who answered anything except "mother" or "father" to i90B had D30 (indicating parent general health status) and BMI_A coded as missing. Child and Parent Health Status data can be found in Tables 4 and 5.

Analysis Plan

We began with a series of descriptive analyses comparing the geographic groupings across demographic, access, health insurance, health (parent and child), and utilization variables. Chi square tests were completed taking into account child weights to test for differences by group. Two sets of group comparisons were completed: rural compared with all Appalachian counties; and rural compared with river bordering Appalachian counties and non-river bordering counties. Next correlations were determined among the health, access and utilization variables.

To address the main research questions of this project, statistical analysis was performed using a Bayesian hierarchical modeling strategy[23]. A Bayesian hierarchical modeling approach is justified because we: a) have cross-sectional data with reasonable latent factors (unobserved variables), b) are not assuming a linear relationship with all observed variables, c) are not constrained to assume linear relationships between variables, d) are not constrained with assuming a normal distribution of variables, e) models for missing data rather than imputing or excluding ; and f) will be able to directly test the interactions between groups such as Appalachian children and rural children as well as other relationships between the variables. This strategy allowed us to model the complex relationships between health, insurance status, health care access, and health care utilization while testing for differences between rural Appalachian and rural non-Appalachian children. In addition, the modeling strategy allowed us to explicitly account for the stratified sampling design used in the survey.

Prior to the development of the full models, multiple, bi-variate and logistic regression analysis were conducted using the combined means of the observed variables representing each factor as predictors and criterion for each proposed path. Because the survey was conducted using a stratified design, the model for data analysis should account for the unequal sampling probabilities of the individual respondents. One solution that can be applied within the Bayesian modeling paradigm is to model the observed data conditional on the variables used to perform the stratification[20]. We applied this strategy by including a variable in each of the relevant equations to allow for county-specific effects.

The first step in the modeling process is the formulation of the model that is based on research findings and theory. The tested model is a representation of the theoretical relationships between the unobservable or latent concepts (see Figure 3) and the connections between the latent concepts and the measured indicator variables. The statistical model used a latent variable structure. For notational purposes, we indexed individuals by *i*, geography (Appalachia or non-Appalachia in the original model) by *j*, and counties (nested within geography) by *k*. Each individual has some latent (unobserved) health, parent's health, access level, well care utilization, and sick care utilization, which we denoted CHS_{ijk}, PHS_{ijk}, ACC_{ijk}, WCU_{ijk}, and SCU_{ijk}, respectively. Each of these latent variables was connected to several observed variables. For example, for the access variable we observe the answers to three access questions listed in the measurement table: N137, N137B, and NSCH KQ26. Our statistical model related these observed variables to the unobserved access level through statistical equations. For example, Question N137B asks if the child has a doctor or nurse he usually sees, so this can be modeled as a Bernoulli random variable conditional on ACC_{ijk}: $N137B_{ijk}|ACC_{ijk} \sim \text{Bin}(p_{N137B,ijk})$, $\text{logit}(p_{N137B,ijk}) = \beta_{N137B,0} + \beta_{N137B,1} \times ACC_{ijk}$. Similarly, we can establish equations to relate observed variables listed in the measurement table to utilization of well care, utilization of sick care, and health status. In our model, N137, N137B, K4Q26, K4Q24, M130, and M135A were modeled as Bernoulli random variables as described above. The remaining variables were modeled using ordinary linear regression equations. For example, for M134, the number of visits to an emergency room in the past 12 months, $M134_{ijk}|SCU_{ijk} \sim \text{Normal}(\mu_{M134}, \sigma^2_{M134})$, $\mu_{M134} = \beta_{M134,0} + \beta_{M134,1} \times SCU_{ijk}$. For identifiability purposes, the slope parameters were restricted to 1 for one variable connected to each latent variable. The chosen variables to have a restricted slope were parental general health status, child general health status, N137, M134, and M130.

Once the relationships between latent and observed variables were established, we specified the models linking the latent variables to each other as shown in Figure 2. In this figure, observed quantities are shown in boxes, and unobserved, latent variables appear in circles. Note that some observed variables, such as gender and insurance status, were only introduced into the model as covariates impacting latent variables. Continuing with the example of access, the diagram shows that an individual's access level is a function of his insurance status, health, and geography, so

$$ACC_{ijk} = \beta_{ACC,0jk} + \beta_{ACC,1jk} CHS_{ijk} + \beta_{ACC,2jk}(Any\ Private\ Insurance)_{ijk} + \beta_{ACC,3jk}(Some\ Government\ But\ No\ Private\ Insurance)_{ijk} + \epsilon_{ACC,ijk},$$

where $\varepsilon_{ACC,ijk}$ is a random error term. Note that in this equation, the regression weights (the β parameters) vary by stratum (county) and the comparison group was the uninsured. The prior distributions on these parameters differ by geography: $\beta_{ACC,pjk} \sim \text{Normal}(\beta_{ACC,pj}, \sigma^2_{ACC,p})$. We present a full description of variable definitions and the formulas used in the appendix.

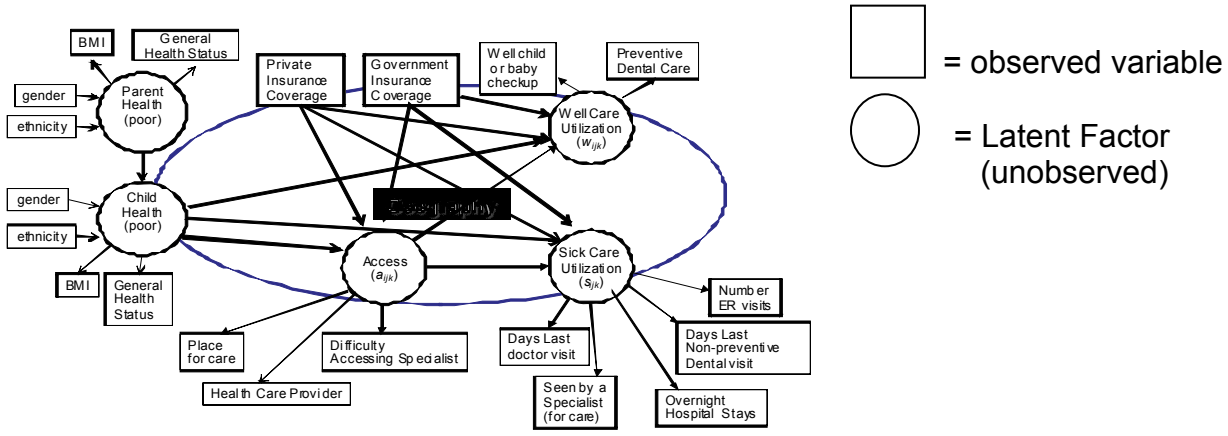

Figure 3. Diagram of Hypothesized Model

The statistical model uses gender, ethnicity, and answers to survey questions to provide information about individual parental and child health. The true values of health for each individual are unknown, but the observed factors provide information about the true value. The child's health is then tied to access, well-care utilization, and sick-care utilization, each of which is a latent variable similar to child and parent health; information is provided about each of these variables by several observed variables. One key element of our model is that the link between those latent variables differs between regions, so the impact of child health on access might be different between the rural region and the Appalachian region. It is these differences we were interested in testing.

One advantage of the statistical model specified is that it includes parameters that can be tested to address the research questions[23]. For example, to determine whether child health status has a different impact on access in rural areas than it does in Appalachia, our interest lies in the $\beta_{ACC,1j}$ parameters. The difference between $\beta_{ACC,11}$ and $\beta_{ACC,12}$ quantifies the difference in this effect between the rural and Appalachian areas. For all questions of interest, we examined the distribution of the parameters of interest conditional on the observed data, and significance was declared for a parameter if its 95% credible interval did not cross zero.

The point estimate is the best estimate of the parameter's true value, and the 95% interval is an interval that has a good probability of containing the parameter's true value. The estimate will be within the interval and is not used for determining significance of a parameter. Significance is determined by checking whether zero is inside the 95% interval. When zero is inside the interval, the parameter is not significant. When zero is outside the interval, the parameter is significant. When using a Bayesian approach for modeling, evidence for or against individual hypotheses are not quantified using p-values as is done in classical statistical modeling. Rather, the credible interval itself provides a measure of the amount of evidence that a parameter is not equal to zero.

Table 3. Missing, Don't Know and Refused Values for Study Measures

Measure	% Valid Observations		% Missing		% Don't Know/ Refused	
	R	A	R	A	R	A
Child Age	99.3	99.4	0.7	0.6	0	0
Child Ethnicity	98.5	98.9	0	0	1.5	1.1
Child Gender	100	100	0	0	0	0
Parent Ethnicity	99.5	99.5	0	0	0.5	0.5
Parent Gender	100	100	0	0	0	0
Unemployment	99.9	91.7	0	7.3	0.1	1.0
Child Health Status	94.7	94.3	5.1	5.6	0.2	0.1
Child BMI Category[1]	99.9	100	0.1[2]	0	0	0
Parent Health Status	100	99.8	0	0	0	0.2
Parent BMI Category	96.9	95.9	3.1	4.1	0	0
Regular Care Provider	91.9	92.3	8.0	6.6	0.1	1.1
Usual Place for Care	99.6	99.5	0	0	0.4	0.5
Difficulty Accessing Specialist[3]	99.4	99.0	0	0	0.6	1.0
Well baby/child care	94.1	92.3	5.8	6.6	0.1	1.1
Dental Check Up	89.1	88.9	10.4	10.2	0.5	0.9
Seen Specialist for Care	93.2	92.3	6.5	7.2	0.5	0.5
Mean Overnight Hospital Stays[4]	100	100	0	0	0	0
Mean ER visits[5]	100	100	0	0	0	0

R = Rural; A = Appalachian

[1] BMI Category only calculated for children between ages of 10-17 years. Percentage reported is for that age group. [2] Value reported is "out of range" BMI Category as determined by OFHS survey team.
[3] Percentage reported is for those respondents who reported having seen a specialist for care. [4] Percentage reported is for those children who were admitted to the hospital within past year [5] Percentage reported is for those children who visited an emergency room within past year

III: Results

Weighted values were applied to all model variables using the Weight_C variable provided by Macros. These weighted values are reflected in the following tables that describe the findings. Children living in Ohio's rural and Appalachian regions are demographically similar. See Tables 4 and 5 for demographic information. Most children and their parents are White (Caucasian), however the Rural region has more children with Hispanic heritage, compared to the Appalachian region. The children's average age was similar and most surveys were completed by the child's mother. Parent unemployment is significantly higher in the Appalachian region, particularly in the river-bordering counties in Appalachia and may be worsening. We found that over 14% of Appalachian parents are both unemployed, compared to the general unemployment rate in Appalachia of 6.2% for both 2006 and 2007[24]. Greater than 98% of children enrolled in governmental based insurance programs are enrolled in Medicaid. However, children living in Appalachia Ohio had the highest rate of Medicaid-eligibility (12.0%), i.e., eligible but nor enrolled, especially those children living in Appalachia areas that do not border the Ohio River (13.1%). Comparatively, 10.5% of children living in Ohio's rural areas were eligible for Medicaid but not enrolled. See Tables 11 and 12 for information about Medicaid-eligibility and other insurance information.

Table 4. Demographics- Rural and Appalachia

Demographics	Rural	Appalachia
Child		
Age		
Mean	9.13	9.12
SD	5.16	5.23
Gender (%)		
Male	51.1	49.6
Female	48.9	50.4
Ethnicity (%)		
White	93.6	95.4
Black	2.6	2.0
Asian	0.7	0.5
Native American	0.2	0.5
Hispanic	1.3	0.8
Parent/Guardian		
Gender (%)		
Male	32.7	30.9
Female	67.3	69.1
Ethnicity (%)		
White	94.1	94.5
Black	2.0	2.2
Asian	0.9	0.4
Native American	0.9	1.1
Hispanic	1.6	1.1
Unemployed (%) (Neither Parent Employed	**9.3**	**14.4**

Bolded values: statistically significant difference (χ^2 = 37.5, p = .000)

Table 5. Demographics: Rural, Non-River Appalachia and River Appalachia

Demographics	Rural	Non-River Appalachia	River Appalachia
Child			
Age			
Mean	9.13	9.29	9.09
SD	5.16	5.24	5.23
Gender (%)			
Male	51.1	48.6	51.6
Female	48.9	51.4	48.4
Ethnicity (%)			
White	94.0	95.9	95.0
Black	3.0	2.1	1.9
Asian	0.7	0.2	0.7
Native American	0.3	0.4	0.6
Hispanic	3.2	0.5	1.0
Parent/Guardian			
Gender (%)			
Male	32.7	29.8	31.7
Female	67.3	70.2	68.3
Ethnicity (%)			
White	94.1	95.6	93.6
Black	2.0	2.3	2.1
Asian	0.9	0.1	0.7
Native American	0.9	1.2	1.0
Hispanic	1.6	0.4	1.8
Unemployed (%)			
Neither parent Employed	**9.3**	**12.8**	**15.6**

Bolded values: statistically significant difference ($\chi 2$ = 40.83, p = .000)

Bi-variate Correlations

Results from bi-variate correlations between key indicators suggest no concerns with multi-collinearity. All correlations were less than r = .85. The largest correlations occurred between having a regular health care provider and having a place for care (r = .356). Based on the correlations, it appears that general wellness care and preventive dental care are not closely related. All bi-variate correlations between key indicators are presented in Table 6 below.

Table 6. Correlations between Latent Factor Indicators

Health Status				
	Parent Health	Child Health	Parent BMI	Child BMI
Parent Health	1.0	**.318**	**.226**	**.122**
Child Health		1.0	**.052**	**.183**
Parent BMI			1.0	**.202**
Child BMI				1.0
Access to Care				
	Regular Provider	Regular Place	Difficulty with Specialist Care	
Regular Provider	1.0	**.356**	**-.087**	
Regular Place		1.0	**-.099**	
Difficulty with Specialist Care			1.0	
Wellness Care Utilization				
	Well Baby/Child Checkup	Preventive Dental Care		
Well Baby/Child Checkup	1.0	.019		
Preventive Dental Care		1.0		
Sickness Care Utilization				
	Days since Last Doctor's Visit	Seen Specialist for Care	Overnight Hospital Stays	ER Visits
Days since Last Doctor's Visit	1.0	**-.192**	**.127**	**-.151**
Seen Specialist		1.0	**.167**	**.190**
Overnight Hospital Stays			1.0	**.243**
ER Visits				1.0

NOTE: All significant correlations at p< .01 are bolded
All bi-variate analyses excluded missing data

Regression Analysis between Indicators of Latent Factors

To test the proposed paths of the model, linear, non-linear and logistic regression analyses were conducted between the indicators of each factor. Results suggested support for the proposed model and proposed paths. A significant relationship was found between Child health status and (a) having a regular care provider ($F = 7.46$, $p = .006$), (b) having a regular place for care ($F = 4.13$, $p = .04$), and (c) difficulty seeing a specialist for care ($F = 25.53$, $p = .000$). Likewise, logistic regression analyses revealed a significant relationship between: (a) having a regular place for care and well baby/child check up (ExpB = 3.51) and having a regular care provider and well baby/child check up (ExpB = 1.63). These findings indicate that those children who had

a regular place for care were 3 ½ times more likely to have had a well baby/child check up within the past year, compared to children without a regular place for care. Children who had a regular care provider were more than 1 ½ times more likely to have had a well baby/child check up within the past year, compared to those children without a regular care provider. Logistic regression also revealed that those children in poorer general health were slightly less likely to have had a well baby/child check up (OR = .91) compared to children in good or excellent health.

Likewise, when testing the pathways impacting sickness care, the number of days since last doctor's visit was related to measures of Access to Care including: (a) having a regular care provider (F = 14.19, p = .000), and having a regular place for care (F = 28.58, p = .000). The number of days since last doctor's visit was not related to difficulty seeing a specialist for care (F = 3.5, p = .06). The number of overnight hospital stays was not related to either having a regular place for care (F = .70, p = .40), having a regular care provider (F = .58, p = .44), or difficulty seeing a specialist for care (F = .33, p = .57). Likewise, emergency room use was not related to all indicators of Access to Care including having a regular care provider (F = 1.31, p = .25) or having a regular place for care (F = .82, p = .36). However, difficulty accessing a specialist was related to emergency room use (F = 200, p =. 000). Logistic regression analysis revealed a significant relationship between (a) having a regular health care provider and receiving preventive dental care (ExpB = 1.40), and (b) having a regular place to receive care and receiving preventive dental care (ExpB = 2.64). These findings suggest that children who have regular health care providers are nearly 1 ½ times more likely to also receive preventive dental care within the past year, compared to those children without a regular provider. Also, children who have a regular place to receive health care are over 2 ½ times more likely to also receive preventive dental care, compared to children without a regular place for care. Based on these regression findings, initial support for the proposed model pathways was found.

Health

We found no differences in the health of Appalachian children compared to rural children. See Tables 7 and 8 for more information about both child and parent health measures. The majority of both rural and Appalachian parents feel that their children are in excellent health. Child body mass index classification was positively related to their general health. This indicates that for children aged 10 and older, body mass index (for age and gender) seems to reflect their general overall health and children who are underweight or obese have poorer health. Though not statistically significant, more Appalachian children were classified as underweight, compared to rural children, especially in the counties of Appalachia that do not border the Ohio River. Whereas, children in the Appalachian counties that border the river have the highest rates of obesity. Finally, the childhood obesity rates appear to slightly exceed the Ohio rates in both rural and Appalachian areas.

Gender and ethnic differences in child health exist. *Male children were found to have poorer health*, compared to females. Nearly 61% of the children classified as "obese" and 57% of the children classified as "overweight" were male. Compared to White (Caucasian) children's rate of obesity (19.9%), all other ethnic groups had disproportionally higher rates of obesity with Black children having the highest rate

(28.8%). Further, there were no significant differences in parent health based on gender. Ethnic differences in child health and parent health also were reported. Compared to Caucasians (Whites), *Black or African American and Hispanic children had poorer health.* No differences were found between Caucasian children's health compared to Asian, Native American or Native Hawaiian/Pacific Islanders.

Parent health was positively related to child health. This finding indicates that *parents with poorer overall health had children with poorer health.* Less than 25% of the parents think that their health is excellent. Appalachian parents significantly report higher levels of poorer health for themselves, compared to rural parents. Underweight, overweight, or obese parents report poorer general health, compared to parents with a healthy BMI classification. More than 60% of parents are classified as either overweight or obese and nearly 5% of Appalachian parents are underweight.

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Ethnic differences in parent health also were found. *Black (African American), Hispanic, and Native American parents reported poorer health*, compared to Whites (Caucasians). Only Asian Americans parents reported better general health, compared to White parents.

Table 7. Health – Rural and Appalachia Only

Child Health Status	Rural	Appalachia
Perceived General Health (%)		
Excellent	54.8	56.5
Very Good	28.2	27.6
Good	13.4	12.4
Fair	3.2	3.2
Poor	0.2	0.2
Don't Know/Refused	0.2	0.1
Body Mass Index[a] (%)		
Underweight	2.7	4.8
Normal weight	59.2	57.1
Overweight	18.2	15.7
Obese	19.7	22.4
Out of Range	0.1	0.0
Parent Health Status		
Perceived General Health (%)		
Excellent	**20.0**	**15.9**
Very Good	**36.1**	**34.2**
Good	**29.4**	**29.1**
Fair	**10.4**	**15.5**
Poor	**4.0**	**5.2**
Body Mass Index[b] (%)		
Underweight	1.6	2.1
Normal Weight	32.8	33.7
Overweight	34.8	33.3
Obese	30.9	30.9

[a] Body Mass Index (child) was calculated by age and gender using reported height and weight and is based on percentiles. Data collected only on children greater than age 9 years and less than 18 years old. Obese is classified as children's who's ht/wt percentile is $\geq$ the 95th percentile for age and gender. Overweight is classified as between the 85th and 94.9th percentile. Normal weight is classified as between the 5th and 84.9th percentile. Underweight is classified as below the 5th percentile. [b] Adult Body Mass Index was calculated from reported heights and weights. BMI = weight (lbs)/[height(inches)]^2 x703.Obese is defined as an index of $\geq$ 30.0. Overweight is an index between 25.0 – 29.9; normal weight is between 18.5-24.9; underweight is < 18.5.

Bolded values: statistically significant difference (χ^2 = 34.3, p = .000)

Table 8. Health – Rural and Appalachia Only

	Rural	Non-River Appalachia	River Appalachia
Child Health Status			
Perceived General Health (%)			
Excellent	54.8	57.1	56.1
Very Good	28.2	27.0	28.0
Good	12.4	12.3	12.4
Fair	3.2	3.3	3.1
Poor	0.2	0.1	0.2
Body Mass Index[a] (%)			
Underweight	2.7	5.1	4.5
Normal weight	59.2	60.4	54.1
Overweight	18.2	14.3	17.0
Obese	19.7	20.2	24.4
Out of Range	0.1	0.0	0.0
Parent Health Status			
Perceived General Health (%)			
Excellent	20.0	17.5	14.6
Very Good	36.1	34.4	33.9
Good	29.4	29.1	29.2
Fair	10.4	13.5	17.0
Poor	4.0	5.4	5.1
Body Mass Index[b] (%)			
Underweight	1.6	2.7	1.6
Normal Weight	32.8	32.3	34.9
Overweight	34.8	33.3	33.3
Obese	30.9	31.7	30.2

Body Mass Index (child) was calculated by age and gender using reported height and weight and is based on percentiles. Data collected only on children greater than age 9 years and less than 18 years old. Obese is classified as children's who's ht/wt percentile is $\geq$ the 95th percentile for age and gender. Overweight is classified as between the 85th and 94.9th percentile. Normal weight is classified as between the 5th and 84.9th percentile. Underweight is classified as below the 5th percentile.

[b] Adult Body Mass Index was calculated from reported heights and weights. BMI = weight (lbs)/[height(inches)]^2 x703.Obese is defined as an index of $\geq$ 30.0. Overweight is an index between 25.0 – 29.9; normal weight is between 18.5-24.9; underweight is < 18.5.

Access to Care

A*ccess to care is not uniform between rural and Appalachian children* though some similarities exist. See Tables 9 and 10 for Access to Care information. Nearly all children have a regular health care provider and a regular place to receive care. It is noteworthy that over 12% of children living in the Appalachian counties that border the Ohio River do not have access to a regular health care provider. Less than 10% of the children have seen a specialist for care, however, the parents of rural living children report slightly more difficulty in accessing such care, compared to parents of Appalachian children.

Table 9. Access to Health Care- Rural and Appalachia

	Rural	Appalachia
Provider Access		
Has Personal Doctor or Nurse		
(%) YES	91.5	90.1
(%) NO	8.3	9.7
Access to a Place for Care		
Child has a place for care		
(%) YES	96.7	97.3
(%) NO	3.1	2.3
Don't Know/Refused	0.2	0.5
Difficulty with Access – Specialist		
If Seen by Specialist, Perceived Difficulty (% for those who saw a specialist)		
No problem or Small problem	91.6	92.7
Large Problem or Much Difficulty	7.8	6.3

Table 10. Access to Care- Rural, Non-River Appalachia and River Appalachia

	Rural	Non-River Appalachia	River Appalachia
Provider Access			
Has Personal Doctor or Nurse			
(%) YES	91.5	92.5	88.2
(%) NO	8.3	7.2	11.7
Access to Place for Care			
Child has a place for care			
(%) YES	96.7	97.5	97.0
(%) NO	3.1	2.2	2.4
Difficulty with Access-Specialist			
If Seen by a Specialist, Perceived Difficulty (% for those who saw a specialist)			
No problem or Small problem	91.6	93.2	92.3
Large Problem or Much Difficulty	7.8	5.5	6.9

Insurance status and the type of insurance coverage are important factors for accessing care and care utilization. Tables 11 and 12 contain insurance information. Over 45% of Appalachian children are enrolled in Medicaid, compared to only 31% of rural children**. Approximately 99% of children enrolled in government type insurance plans are enrolled in Medicaid. Less than 1% of children are enrolled in other government type plans. I**n Appalachia, more children are covered by Medicaid than private insurance sources. Nearly, 5% of rural and Appalachian children are uninsured. Furthermore, 12% of Appalachia's children are eligible for Medicaid but not enrolled, with more children in the non-river bordering Appalachian counties eligible but not enrolled, compared to rural children and other Appalachian children.

Table 11. Child Insurance Status – Rural and Appalachia

Type of Insurance	Rural	Appalachia
(%) on Government	31.5	46.1
(%) on Private	58.3	43.3
(%) Insured – type unknown	5.3	5.8
(%) Uninsured	4.9	4.8
(%) Medicaid Eligible-not enrolled [d]	10.5	12.0

[d] Medicaid eligibility is defined as persons who do not have Medicaid as a source of health insurance but would qualify based on age, income and disability status. Income is based on the Federal Poverty Level (FPL). For children, the FPL is Up to 150% FPL or 151-200% FPL with no source of private health insurance. Some children classified as Medicaid-eligible may be enrolled in other plans.

Table 12. Child Insurance Status – Rural, Non-River Appalachia and River Appalachia

Type of Insurance	Rural	Non-River Appalachia	River Appalachia
(%) on Government Type	31.5	47.0	35.6
(%) on Private	58.3	42.8	54.8
(%) Insured – type unknown	5.3	5.6	4.7
(%) Uninsured	4.9	4.6	4.9
(%) Medicaid Eligible-not enrolled [d]	10.5	13.1	11.1

[d] Medicaid eligibility is defined as persons who do not have Medicaid as a source of health insurance but would qualify based on age, income and disability status. Income is based on the Federal Poverty Level (FPL). For children, the FPL is Up to 150% FPL or 151-200% FPL with no source of private health insurance. Some children classified as Medicaid-eligible may be enrolled in other plans.

Health Care Utilization

Differences in health care utilization exist between rural and Appalachian children. See Tables 13 and 14 for more information about health care utilization patterns. Significantly *fewer rural living children receive wellness care*, compared to Appalachian children. Overall, fewer than 10% of the children were hospitalized however; about 22% used the emergency room for care within the past year. Furthermore, nearly one-quarter of children were seen by a specialist for care.

Table 13. Health Care Utilization- Rural and Appalachia

Type of Utilization	Rural	Appalachia
Wellness Care		
Received well baby or well child checkup (within past year)		
%YES	**68.9**	**73.4**
%NO	**30.0**	**25.4**
Dental Visit for Standard Check Up (within past year)		
(%) YES	72.0	73.0
(%) NO	27.5	26.0
Sickness Care		
Has seen a Specialist for Care		
(%) YES	24.6	23.0
(%) NO	74.9	76.6
Average Number of Overnight Hospital Stays (within past year)- **total sample**	1.57	1.61
Standard Deviation	.15	.17
% of Total that were Users	7.0	5.5
Average Number of ER visits (within past year) –**total sample**	1.79	1.79
Standard Deviation	.15	.16
% of Total that were Users	21.9	21.8

Bolded values: statistically significant difference ($\chi 2$ =6.3, p = .01)

Table 14. Health Care Utilization- Rural Non-River Appalachia and River Appalachia

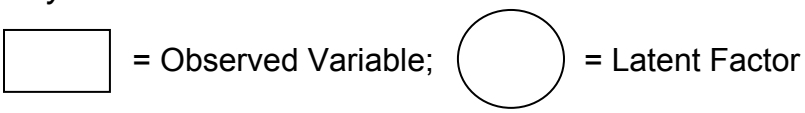
Type of Utilization	Rural	Non-River Appalachia	River Appalachia
Wellness Care			
Received well baby or well child checkup (within past year)			
%YES	68.9	70.7	75.7
%NO	30.0	28.1	23.2
Dental Visit for Standard Check Up (within past year)			
(%) YES	72.0	73.7	72.4
(%) NO	27.5	25.7	26.3
Sickness Care			
Has seen a Specialist for Care			
(%) YES	24.6	23.3	22.7
(%) NO	74.9	76.3	76.8
Average Number of Overnight Hospital Stays (within past year)	1.57	1.61	1.60
Standard Deviation	.15	.17	.16
(%) of Total that were Users	7.0	5.2	6.3
Average Number of ER visits (within past year)	1.79	1.76	1.80
Standard Deviation	.15	.10	.21
(%) of Total that were Users	21.9	19.9	20.3

Rural and Appalachian Comparisons using Bayesian Modeling Strategies

Our first models will compare rural children to all Appalachian children. These 2-group *comparisons reveal differences in access to care and health care utilization.* In addition the *impact of insurance type on both access to care and health care utilization are noted.* See Figures 4 and 5 below for a schematic diagram of the modeling results that accompany the modeling results narrative. See Appendix B for modeling parameter estimates with credible intervals.

The schematic key to aid interpretation is:

Key:



Latent Factors are measured by the observed variables that are denoted by an arrow leading from the latent factor to the observed variable.

Shapes shaded in **green** indicate a greater level of that factor, compared to other group.
Shapes shaded in **red** indicate less level of that factor, compared to the other group.
Thicker arrow lines indicate a greater impact, compared to the other group.

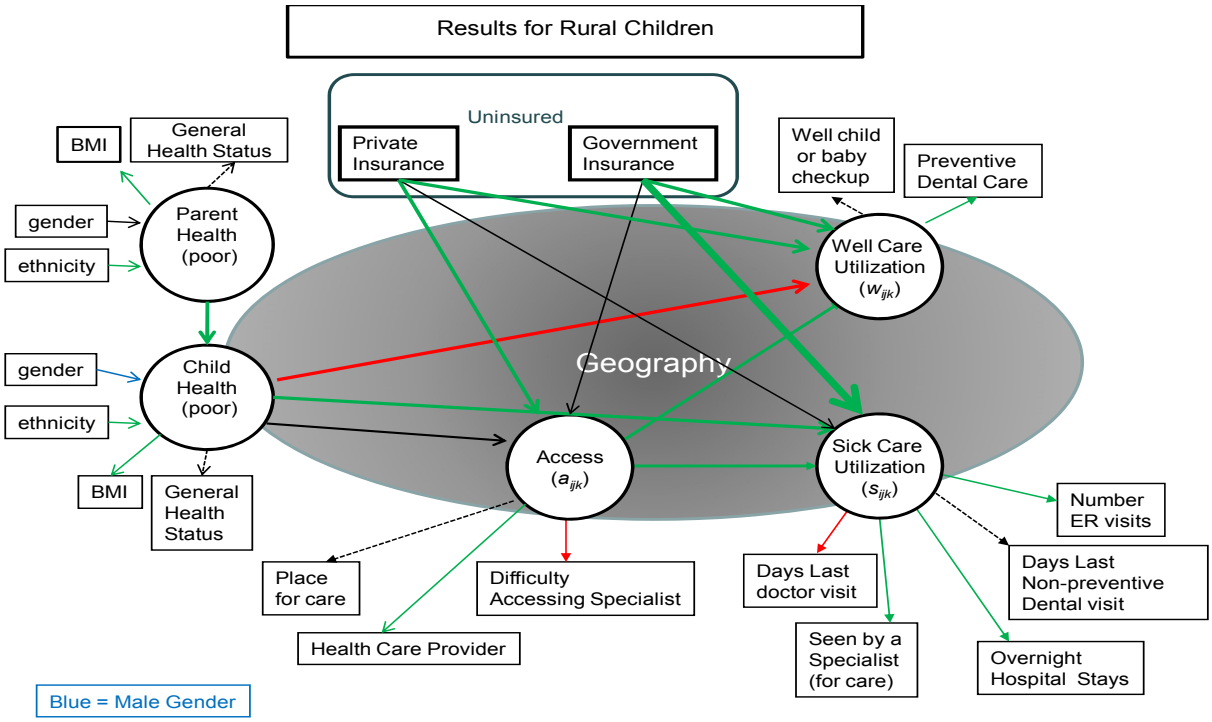


Figure 4. Modeling Results for Appalachian Children

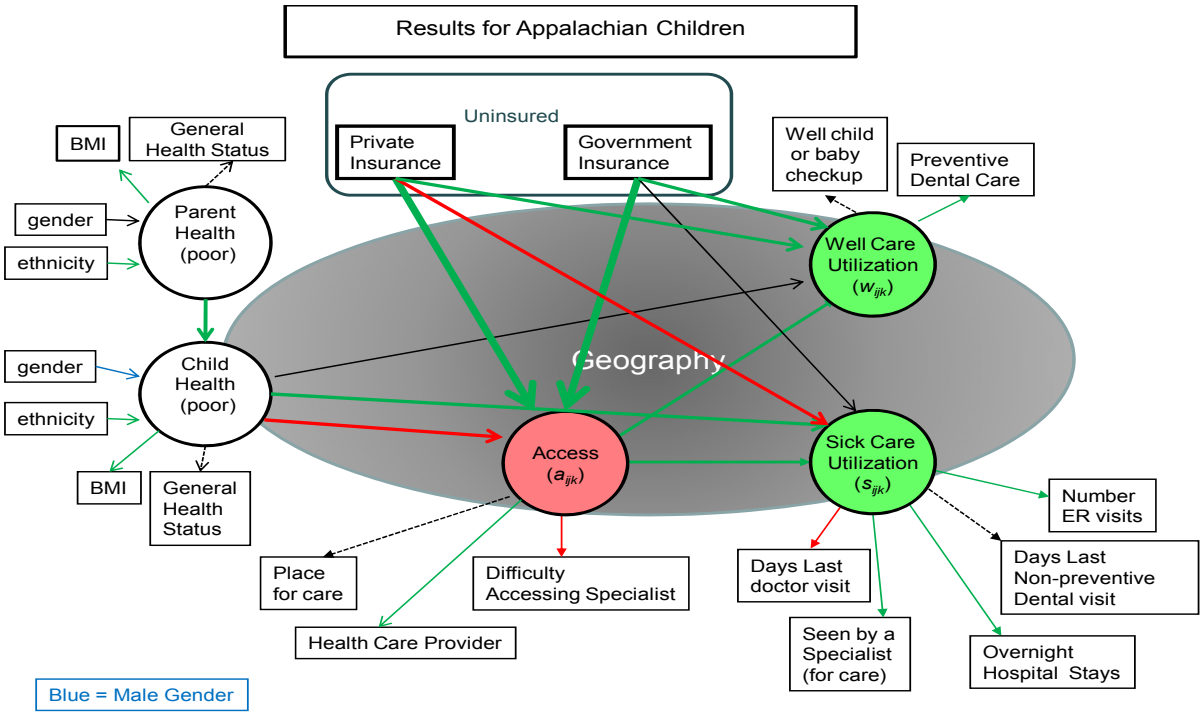


Figure 5. Modeling Results for Appalachian Children

Access to Care

Appalachian children have less access to care overall, compared to rural children. Further, *In Appalachia, children in poorer health had less access to care,* whereas, rural children in poorer health did not differ from the healthier rural children in access to care. However, having a regular health care provider improved access to general care for both groups.

Insurance status and the type of insurance coverage are important factors for accessing care and care utilization. All children who had *private insurance generally had better or greater access to care*, when compared to the uninsured. Insurance coverage (of any type) had a *larger impact on access to care for Appalachian children*, meaning that insurance coverage was more important for accessing care in Appalachia compared to the rural region. Appalachian children who are uninsured have less access to care than those children with either private or government insurance coverage.

Differences were found with the impact of governmental-based insurance on access to care. In Appalachia, having governmental-based insurance ***improved*** *access* to care*,* when compared to the uninsured. *In rural Ohio,* children with government-based insurance ***did not differ*** *from the uninsured in accessing care.* This means that rural children with government-based insurance did not have any greater access to care than the uninsured children.

Health Care Utilization

Differences were found in care utilization between rural and Appalachian children. Regardless of access, child health or insurance status, there was generally *more wellness and sickness care utilization in Appalachia,* compared to the rural regions. However, greater access to care and insurance coverage is similarly associated with greater wellness care utilization for both groups. Further, greater access regular care and poorer child health was related to more sickness care utilization in both groups.

H*aving private insurance was most important for wellness care utilization in the rural region. Having governmental-based insurance had a larger impact on wellness care in the Appalachia areas.* This finding indicates that the type of insurance impacts wellness care but is dependent on the region of residence. However, compared to the uninsured children, children with any type of insurance coverage received more preventive care.

The impact of child health on wellness care differed as well. *In rural Ohio, children in poorer health had less wellness care utilization,* meaning that children in poor health had less well child checkups and preventive dental care. However, child health was not related to wellness care utilization in Appalachia.

Differences emerged regarding the importance of insurance coverage and insurance type on sickness care utilization. In the *rural region*, compared to the uninsured, children with *government-based insurance had more sickness care* utilization. Children with private insurance coverage did not differ from the uninsured in sickness care utilization. In Appalachia, children with government-based insurance did not differ from the uninsured in sickness care utilization, whereas, children with private insurance coverage

had less sickness care utilization. Also*, in Appalachia*, the importance of insurance coverage on sickness care utilization was greater, compared to rural Ohio. This means that having insurance coverage of any type is more important for sickness care utilization in Appalachia, compared to the rural region.

Rural, Non-River Appalachian and River Appalachian Comparisons using Bayesian Modeling Strategies

Our final models compared rural children and two sub-groups of Appalachian children: those living in the counties that border the Ohio River and those living in the other Appalachian counties. *Other group differences did emerge.* These differences are discussed below. The modeling diagrams below follow the same key as noted above. See Appendices C and D for the models' significant estimates and credible intervals.

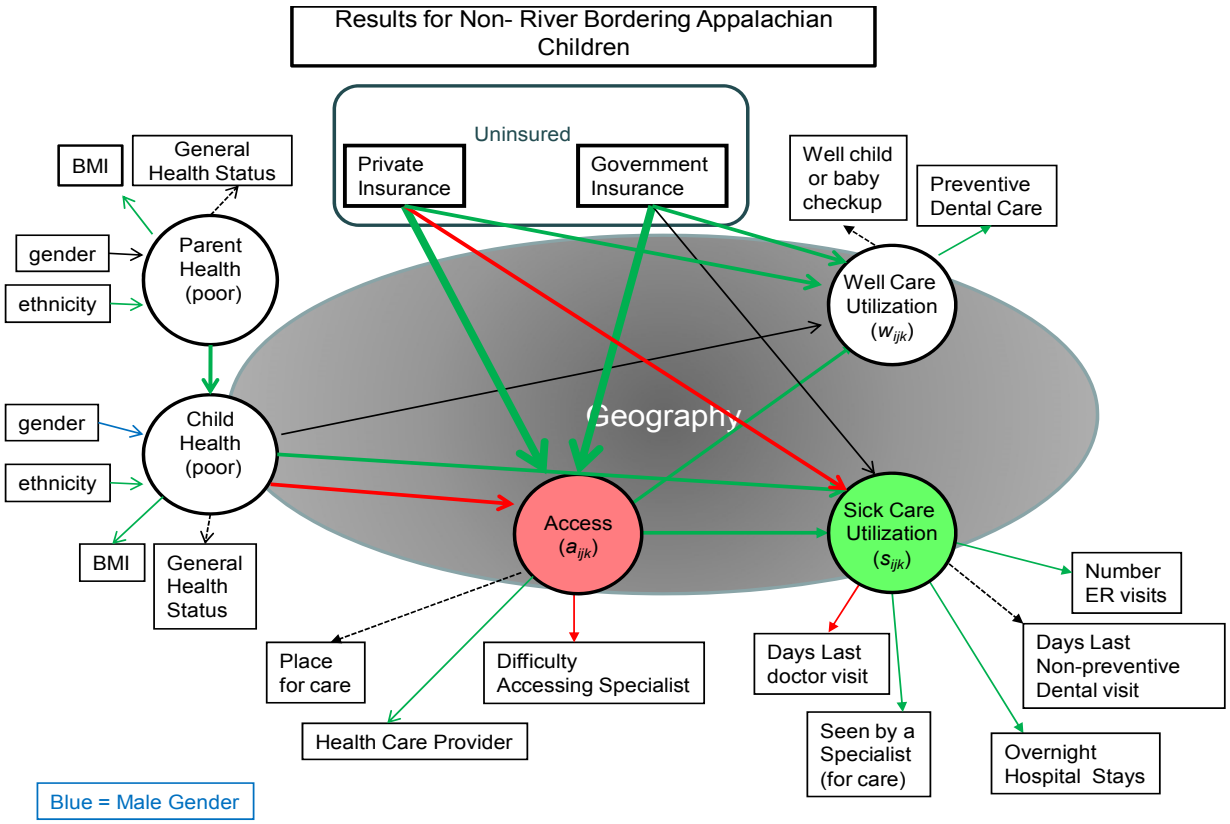


Figure 6. Modeling Results for Non-River Appalachian Children

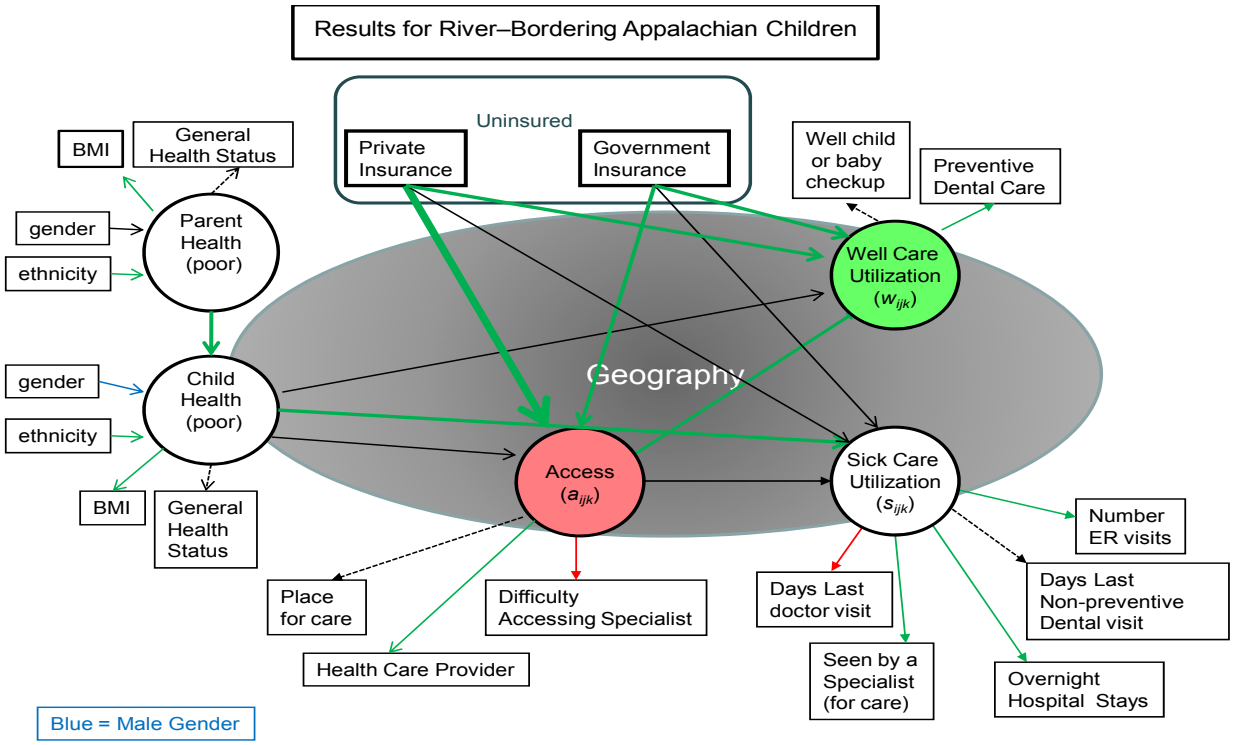


Figure 7. Modeling Results for River-Bordering Appalachian Children

Access to Care

Regardless of insurance status or health, *less overall access to care was found in the river-bordering counties of Appalachia,* compared to both the non-river bordering counties of Appalachia and the rural region. Further, *in the non-river counties, children in poorer health had less access to care* whereas in the river counties of Appalachia and the rural region, children in poorer health did not differ from healthier children in access to care. *The importance of having insurance differed by geographical region. The impact of having private insurance on access to care was greatest in the river-bordering counties of Appalachia*. This means that in the river counties, having private insurance was more important for accessing care, compared to the rural or other Appalachian areas.

Health Care Utilization

In the *river-bordering counties, wellness care was most prevalent*, regardless of health or insurance status. The *most sickness care utilization occurred in the Appalachian non-river counties,* regardless of child health and insurance status. In the *rural region children in poorer health receive less wellness care* whereas in Appalachia, child health was not related to wellness care utilization.

Insurance coverage is not uniformly important in these three regions for sickness care utilization. In the *rural region*, the importance of insurance coverage on sickness care was greatest, compared to the two Appalachian regions. Within the rural region children with governmental-based insurance utilized sickness care service more whereas, children with private insurance did not differ from the uninsured in sickness

care use. This means that rural children covered by governmental insurance programs used hospitals and emergency rooms more for care, compared to the uninsured or children covered by private plans.

Differences in sickness care utilization based on insurance type were found between the two Appalachian groups. In *Appalachia's river-bordering counties*, children with insurance coverage (private or governmental-based) did not differ from the uninsured in the use of sickness care services. In *non-river Appalachia, only having private insurance was associated with less sickness care,* compared to the uninsured.

IV: Discussion

Thirty one of Ohio's rural and Appalachian counties are full or partial geographic, population or facility health professional shortage areas (HPSAs)[25]. Twenty-one of the facility HSPAs found in Ohio are located in the Appalachian counties that border the Ohio River. Additionally, a clustering of HSPAs classified as serving special populations, geographic, or corrections can be found in the Appalachian region. Federal designation as a HSPA serves to: increase access to additional health care providers and increase Medicare reimbursement. Despite this designation and clustering of facilities in Ohio's Appalachian region, our study found that regardless of insurance and health, Ohio's Appalachian children have lower general access to care. Specifically, Ohio's Appalachian children have less access to a regular care provider and place for care. Surprisingly, the children with the least access to care are Appalachian children living in the counties that border the Ohio River, the same area where most HPSAs are located.

One explanation for this finding may be the unique cultural characteristics of Appalachia. Perhaps the health care providers that serve in the Appalachian region and especially the river counties are not accessed for care by the community members because of a lack of trust of outsiders that is pervasive in the Appalachian culture or the preference to rely on family for care. Many care providers that serve in these critical need facilities are not "locals" and perceived as "outsiders" by the residents. Another explanation may be related to consistency and continuity of care. Turnover of health care providers that serve in the local clinics and facilities may be higher than normal thus impacting the perception that a provider is a "regular care provider".

Access to care is closely related to insurance coverage. In fact, many studies include insurance status as a measure of access[20,25]. We chose a different approach to specifically determine insurance's impact on other access measures. About 5% or more than 11,000 of Ohio's children remain uninsured. It appears that the rate of uninsured is improving slightly, compared to previous years[26-27]. Even at this level, a lack of insurance is concerning since a lack of insurance generally means a lack of preventive care[20]. Further, 10-13% of children included in this study qualifies for Medicaid coverage but are not enrolled. Reasons for this are not known but may be due to: lack of awareness, time constraints, the enrollment process, confusion about health insurance options or a lack of trust in the health care system, including formal health insurance.

Findings from this study indicate that insurance matters and most importantly, the type of insurance matters to accessing care. Compared to the uninsured, only rural children with private insurance had greater access to care. Rural children with governmental-based insurance did not differ from the uninsured in accessing care. However, Appalachian children on governmental insurance had greater access, compared to the uninsured. Further, the impact of private insurance on access to care was greatest for Appalachian children. One explanation could be that more Appalachian children rely on governmental insurance programs (45%) compared to rural children (31%) and the health care providers that service the Appalachian region may be more willing to accept Medicaid clients than in rural counties in general. The reasons for these differences;

however are not understood. Consequently, this finding demonstrates the need for further research to understand the impact of insurance type on access to care.

Health care utilization also is closely connected to insurance status. Uninsured Ohioans are more than twice as likely as insured Ohioans to have no regular care provider, no regular place for care or use emergency rooms as their usual source of care[25]. Our findings suggest that health care utilization patterns differ between rural and Appalachian children. Specifically, Appalachian children utilized both wellness care and illness care services more than rural children. Interestingly, illness care was greatest in the non-river Appalachian counties and wellness care was greatest in the Appalachian counties that border the Ohio River. The services provided by the HSPAs may partially explain this finding since a clustering of these facilities exists among the river counties. It appears that Medicaid's coverage of preventive care does not fully explain this finding since more children residing in the non-river counties are enrolled in Medicaid (46.6%) compared to the river-bordering counties of Appalachia (35.2%). Perhaps private insurance plans cover more wellness care. More river bordering children are enrolled in private plans (54.8%) compared to non-river bordering counties of Appalachia (42.8%).

Another explanation for the differences in health care utilization could be that safety net providers and services have historically targeted the Appalachian region and continue to cluster in this area. The Appalachian region has long been recognized as a vulnerable area due to pervasive poverty and disproportionate health burdens. Consequently, the Appalachian region has been designated as an area of critical need, thus the placement of HSPAs is justified. Our findings suggest that rural areas are vulnerable but may not be as readily recognized as such. Rural areas may lack the infrastructure and safety net of providers needed to ensure health care utilization.

It should be noted that children with any form of insurance had greater utilization of wellness care services, compared to the uninsured and children in poorer health were less likely to have a well baby/child checkup, compared to children in good or excellent health. This finding may be because parents who are visiting a health care provider frequently for sickness care believe that their child has seen a provider of care and do not need to seek any additional visits for preventive health care. However, when visiting a health care provider for sickness care, children are less likely to be offered immunizations, physical exams, counseling for growth and development or anticipatory guidance. More research is needed to understand this finding.

Illness or sickness care utilization patterns differ somewhat from wellness care. More Appalachian children use illness or sickness care services however Appalachian children residing in the non-river counties have the greatest use of illness/sickness care services. Sickness care does not seem as dependent on insurance coverage as wellness care. For example, regardless of the region, Appalachian children with private or government health insurance were not more likely than the uninsured to utilize sickness care. Only rural children with government insurance had greater illness/sickness care use, compared to the uninsured. These findings suggest that parents are more willing to use health care services for illness, sickness or injury for their children, whether they have insurance or not. For example, in all regions, children in poorer health utilized sickness care services more, compared to children in better

general health. It seems that facilities that offer illness or sickness care serve as a safety net for both rural and Appalachian children.

The prevalence of childhood overweight and obesity is daunting, especially in rural and Appalachian regions. While the prevalence of overweight and obesity is prevalent throughout the United States, the problem is especially severe in rural areas [28-29] and in Ohio, the problem is most severe in Appalachian counties [24,30]. Even though the majority of parents report that their children are in good or excellent health, the BMI percentiles for the children would indicate otherwise. Nearly 40% of the children aged 10-17 were classified as either overweight or obese. Further, the rates of children classified as "obese" in the OFHS Survey exceeds Ohio's estimates for third graders state-wide [24]. These results suggest that in Ohio, the childhood obesity epidemic is not confined to our youngest children; the rural and particularly the Appalachian regions seem to be "ahead of the curve" for the childhood obesity epidemic state-wide.

Not surprisingly, childhood obesity is related to adult obesity. Children who are obese by age 10 years have an 80% chance of being and obese adult[30]. This suggests that without intensive intervention at both the policy and community level, thousands of Ohio's rural and Appalachian children are destined to become obese adults. Further, obese children run the highest risk of co-morbidities while still in childhood, possibly impacting life expectancy and quality of life[21,30]. Overweight children face future health challenges as well. A BMI classification between the 85th and 95th percentile (overweight) in adolescence is associated with a 30% increase in adult death rates from all causes in both genders[30]. These statistics suggest that childhood obesity may be one of the most important public health issues impacting Ohio today.

A number of variables are related to the prevalence of overweight and obesity in children, including geography, culture, and socio-economic background. Geographical, cultural and economic factors do not cause obesity but rather societal trends and economic conditions create conditions that have accelerated the obesity epidemic state-wide. Cultural factors contributing to the problem in rural and Appalachian areas include higher dietary fat and caloric consumption, fewer fruits and vegetables are consumed, decreased daily physical activity, decreased compliance with dietary recommendations, and increased television viewing[28]. Other social issues impacting rural and Appalachian residents include the lack of nutrition education, lack of school-based health education and physical education, limited recreational opportunities, and fewer prevention and treatment facilities [28].

The economic impact of the childhood obesity epidemic on Ohio cannot be ignored. Within the pediatric health care system, obese children use more resources and are more likely to be hospitalized, compared to children of a healthy weight[30-32]. It costs billions of dollars yearly to treat obesity related illlnesses[30-32]. Not surprisingly, it has been estimated that by reducing obesity rates, Ohio could reduce health care expenditures by $1.4-1.6 billion however, these reductions would not occur for at least a decade because the root causes of obesity are deeply rooted in culture and difficult to address[30-32].

The results in this report indicate that parents are not aware of the health consequences of obesity on their children's overall health. Even though 40% of the children were overweight or obese, the overwhelming majority of parents considered these children in good or excellent health. However, the parents' perceived health more closely matched their BMI classification. Over 60% of parents were overweight and obese and only about 20% of parents considered them in excellent health and another 15-20% considered their health fair or poor. Another explanation could be that the parents lack understanding of body size on overall health or health risks. This finding is supported by a recent telephone survey conducted in Franklin County by Nationwide Children's Hospital that found that parents were misinformed about their child's body size and its impact on current and future health. More alarming, only 5% of parents in the survey thought that healthy weight was a primary concern to discuss with a health care provider and 13% felt that their child's nutritional status was a health concern[33]. Overall, misperceptions about weight and health are more prevalent in areas plagued by poverty, including rural and Appalachia Ohio where approximately 34% of the residents meet the Federal Poverty Level [34].

As important as the obesity epidemic is, one cannot ignore the impact of underweight and malnutrition on Ohio's children. Similar to overweight and obesity's impact on health, underweight in children is associated with poorer health in children, particularly chronic health conditions[23]. The findings in this report indicate that childhood underweight is a concern in Appalachia Ohio, especially the non-river counties of Appalachia where approximately 5% of children are underweight. Comparatively, the national average for childhood underweight is only 2% [35].The persistent poverty that plagues Appalachia is probably the explaining factor for this finding. In Appalachia Ohio, the Rate of Dependency on Income Supports is 6% higher than the state average, nearly 20% of the residents receive food stamps and 30 out of every 1,000 residents receive cash benefits through Ohio Works First Program (2007)[34].

V: Limitations

Though important to conduct, this study has several *limitations*. First, this study used only the 2008 OFHS data. Consequently, this study does not assess the longitudinal relationship between access, utilization and actual health outcomes. Furthermore, this study does not analyze other factors that may be important to health care access and utilization such as satisfaction with services, effectiveness of care, and environmental health risks such as lead exposure, tobacco use in the home or occupational hazards that are prevalent in agricultural areas. Though perceived health status is an important health need found in the guiding framework, this study relies on parent reported generalized health and parent reported heights and weights of the child. Actual health measures and height/weight measures were not collected. Though parent reported data is generally considered valid and reliable, this limitation should be noted. However, theoretically, *perceived* health status is an important factor that parents may consider when contemplating the need to access and utilize health care services.

This study is further limited by the variables used for measuring child and parent health. Lacking from the measures, were indicators of chronic disease such as asthma or diabetes. The decision to only include measures of general health and not chronic disease conditions was based on the study's focus, aims and hypotheses. Further, child height and weight information was only collected for children between the ages of 10-17 years for the OFHS Survey. Consequently, the relationship between BMI category and child health as well as BMI category and relationships to access to care and health care utilization is not known for younger children. This limitation should be noted when reviewing the results found in this report.

Next, though the OHFS asks about having a regular place for care, specific locations of these places for care are not known. For example, it is not known the distance traveled to access the place for care. Likewise, it is not known if the place used for care is in the respondent's local county or a nearby county or state. One could imagine that some respondents will cross county lines or even state lines to access a place for care. Mobile health clinics frequently serve rural and Appalachian communities. It is not known if these mobile clinics are considered a regular place for care by the survey respondents.

Finally, though we were able to compare children with governmental-based insurance, children with private insurance and the uninsured, this study did not analyze the under-insured. The lack of adequate health insurance or "underinsurance" is a concern for children, statewide[27]. Low to moderate income parents who have private health insurance with high deductibles or co-pays may be forced to ration care for their children thus impacting both access to care and health care utilization[27]. This study did not capture the impact of "under-insurance" on child health, access to care or health care utilization.

VI: Policy Implications

The findings from the study point to several policy implications regarding access to care, utilization of care, and the health of children and parents. To improve access, expanding current programs may be justified.

a) In Appalachian areas, additional *wrap-around services* are needed. These "one stop" centers could meet many needs at once such as preventive care, enrollment in services and programs, educational programming, consultation, resource referral, case management and follow up. With adequate funding, wrap-around services could be offered through mobile units, thus overcoming transportation issues. Schools and churches could serve as locations for these mobile units.

b) Consideration should be given to the expansion of the *"Help Me Grow"* program. An expansion of the program to include children older than 3 years of age could improve access to care providers that visit the home, early identification and intervention of children at risk for obesity or other health risks, health information and anticipatory guidance.

c) Efforts should be considered to recruit and retain *pediatric health care providers* particularly in the Appalachian region where nearly half of the counties lack a provider of this specialized care.

To impact wellness care utilization, overcoming barriers and improving the safety net of providers may be essential.

d) A better understanding of barriers to providing wellness care should be explored. Reimbursement mechanisms for providing wellness care to children that are accessing providers for other health care services (sickness care) should be supported. A reduction of "*missed opportunities*" is needed. Health care providers that provide care to children in times of illness or injury appear to be missing opportunities to provide more holistic and preventive care during such visits. This suggests that more innovative approaches to structure, reimbursement and delivery of care are needed.

e) Efforts to improve health care utilization, especially wellness care, among rural children seem warranted. Further exploration of the safety net of providers available to rural children is needed. Efforts used to improve services in Appalachia Ohio could serve as a model to reach out to rural children not living in the Appalachian region.

f) Tele-health or e-health may be one method worth exploring to deliver care to more rural and Appalachian residents. As Ohio aims to expand its broadband capabilities especially in rural and Appalachian regions, an opportunity exists to use such technology to improve the health of its citizens. Support for the establishments of innovative technological

approaches to deliver health care to remote and isolated citizens seems justified.

To impact the health of children and parents:

g) We recommend that Ohio explore options to expand its *BMI screening program and surveillance of childhood obesity*. The State of Arkansas serves as a model of the effectiveness of comprehensive screening. To truly impact the obesity epidemic, Ohio needs to identify children at risk for overweight and obesity early in childhood. Implementing a formal screening program starting in kindergarten and continuing throughout the school years would be an important tool to help address the epidemic. Similar to Arkansas, we recommend BMI screening every two years in grades: K, 2, 4, 6, 8, and 10.

h) *Social marketing and educational* efforts should be undertaken to better inform parents, health care providers and the communities of the meaning of BMI, obesity's impact on overall health, factors that influence body size, and resources available to help parents and families. Health care providers often avoid discussing a child's weight status with a parent because of concerns of offending or alienating parents. Efforts to support and educate providers on approaches used to discuss child BMI results should be explored.

i) Funding programs that are *community-based* and use the *community participatory* approach are suggested, especially in Appalachia where there may be a lack of trust of "outsiders". To impact the health of a community, community members must be stakeholders and partners of public health. Through effective collaboration, coalition building and community organizing, public health officials and community members can work together to develop multifaceted community initiatives to address obesity, promote wellness and fitness.

VII: Conclusion

Rural and Appalachian children have unique barriers to obtaining health care. This study is the beginning of understanding the factors that impact the general health of Ohio's more remote and isolated children, health care access and health care utilization in these geographic locales. Regardless of insurance or health, differences exist between rural and Appalachian children with access to care and health care utilization. Though Ohio has undertaken many initiatives and efforts to impact the health of its youngest citizens, many challenges and much work remains. Through an organized, coordinated and committed effort, Ohio and its greatest asset- its citizens, can overcome these barriers and improve the health of its rural and Appalachian children.

Appendix A
Variable Transformations Modeling Plan and Equations

Before modeling could be performed, several transformations were made to the variables in the dataset. The following list details these transformations.

- Respondents who answered 1 (YES) to J96A (verifying that their child's insurance is exactly the same as their own) had the following modifications:
    - Parental values for B4A – B4E were copied into the corresponding responses for J100A – J100E.
    - J100F (asking about state-sponsored insurance programs) was set to 2 (NO).
- Respondents who answered 2 (NO) to I95A (asking if the child is covered by any health insurance) had J100A – J100F set to 2 (NO, not covered).
- Each child was categorized into one of three insurance groups:
    - Any private insurance – J100A or J100E = 1 (Yes)
    - Any Government insurance but no private insurance – J100A and J100E = 2 (No) and at least one of J100B, J100C, J100D, or J100F = 1 (Yes)
    - Uninsured – J100A through J100F = 2 (No)
    - Note, all others were classified as missing values. For example, individuals with missing values for J100A and J100E had an unknown insurance group classification.

  In the modeling, the insurance group variable was dummy coded into two indicator variables, one indicating if the child had any private insurance and one indicating if the child had some government but no private insurance.
- Respondents who answered 1 (YES) to M135A (asking if the child had seen a dentist for preventive care in the last 12 months) had M135DAYS (number of days since last dentist visit) coded as missing. We wanted to use M135DAYS only as an indicator of dental sick care utilization, and it is not possible to determine whether children who had seen a dentist for preventive care in the past 12 months had their most recent dentist visit for sick care or well care.
- Respondents who answered 2 (SMALL PROBLEM) or 3 (NOT A PROBLEM) to K4Q26 (asking about difficulty accessing a specialist) were grouped into a single group (recoded as 0).
- Respondents who answered 2 (MORE THAN ONE PLACE) to N137CHECK (checking that there is no place the child usually goes when sick) had N137 (asking if there is a place the child usually goes when sick) recoded to 1 (YES). Respondents who answered 1 (YES) or 3 (YES, VOLUNTEERED THAT THERE IS MORE THAN ONE PLACE) to N137 were grouped into a single group (coded as 1).

- Respondents who answered 1 (YES, ONE PERSON) or 2 (YES, MORE THAN ONE PERSON) to N137B (asking if the child has a personal doctor or nurse) were grouped into a single group (recoded as 1).
- Respondents who answered 2 (NO) to N137 (asking if there is a place the child usually goes when sick) had N137B (asking if the child has a personal doctor or nurse) recoded to 3 (NO).
- The child's primary race was coded using a combination of P150_A (first race specified), P150_B (second race specified), and P150A (specification of primary race). If P150_B was missing, 97 (OTHER), 98 (DK), or 99 (REFUSED), the child's primary race was set to the answer for P150_A (i.e., the respondent only gave one race). If P150_B had any other answer, the child's primary race was set to one of the following:
    - The answer to P150A, if P150A was not 97 (OTHER), 98 (DK), or 99 (REFUSED).
    - The answer to P150_A, if 150A was 97 (OTHER), 98 (DK), or 99 (REFUSED).

  In our modeling, we denote the new variable CRACE.
- The parent's primary race was coded similarly to the child's primary race using responses to S17_A, S17_B, and S17A. In our modeling, we denote the new variable PRACE.
- Respondents who answered anything except 1 (MOTHER) or 2 (FATHER) to I90B (relationship to child) had D30 (parental health status), I90B (used as a surrogate for gender of parent answering the health questions), primary parental race, and parental BMI coded as missing.
- Parents with BMI_A_CAT (parent BMI categorization) equal to 5 (BMI/age out of range: BMI_A_PCT/BMI_A_Z not computed) and children with BMI_C_CAT (child BMI categorization) equal to 5 (BMI/age out of range: BMI_C_PCT/BMI_C_Z not computed) were set to missing.
- Parents with BMI_A_CAT (parent BMI categorization) equal to 1 (underweight) and children with BMI_C_CAT (child BMI categorization) equal to 1 (underweight) had the respective values reset to 3, equivalent to overweight. Since BMI is only used as a dependent variable for parental and child health statuses, this essentially makes the health status of being underweight equivalent to the health status of being overweight. In our modeling, we denote the new variables New Parent BMI and New Child BMI.
- M135DAYS (number of days since last dentist visit) and M131DAYS (number of days since last doctor visit) were log transformed since the values were observed to be right skewed upon initial investigation.

The following equations give the full form of the statistical model.

<u>Parental Health</u>

$$(New\ Parent\ BMI)_{ijk} \sim N(\beta_{PBMI,0} + \beta_{PBMI,1} PHS_{ijk}, \sigma^2_{PBMI})$$

$$(D30)_{ijk} \sim N(\beta_{D30,0} + PHS_{ijk}, \sigma^2_{D30})$$

$$PHS_{ijk} \sim N(\beta_{PHS,1}(I90B)_{ijk} + \beta_{PHS,2}\mathbf{I}_{\{PRACE=2\}} + \beta_{PHS,3}\mathbf{I}_{\{PRACE=3\}} + \beta_{PHS,4}\mathbf{I}_{\{PRACE=4\}} + \beta_{PHS,5}\mathbf{I}_{\{PRACE=5\}} + \beta_{PHS,6}\mathbf{I}_{\{PRACE=6\}}, \sigma^2_{PHS})$$

In these equations, *N* denotes the normal distribution with mean and variance arguments, D30 denotes the general parental health status, I90B denotes the parental gender equal to male, and **I** denotes the indicator function, which takes a value of 1 if its argument is true and 0 otherwise.

Child Health

$$(New\ Child\ BMI)_{ijk} \sim N(\beta_{CBMI,0} + \beta_{CBMI,1}CHS_{ijk}, \sigma^2_{CBMI})$$
$$(L125)_{ijk} \sim N(\beta_{L125,0} + CHS_{ijk}, \sigma^2_{L125})$$
$$CHS_{ijk} \sim N(\beta_{CHS,1}(P148)_{ijk} + \beta_{CHS,2}\mathbf{I}_{\{CRACE=2\}} + \beta_{CHS,3}\mathbf{I}_{\{CRACE=3\}} + \beta_{CHS,4}\mathbf{I}_{\{CRACE=4\}} + \beta_{CHS,5}\mathbf{I}_{\{CRACE=5\}} + \beta_{CHS,6}\mathbf{I}_{\{CRACE=6\}} + \beta_{CHS,7}PHS_{ijk}, \sigma^2_{CHS})$$

In these equations, L125 denotes the general child health status, and P148 denotes the child's gender equal to male.

Access

$$(N137)_{ijk} \sim Ber(p_{N137,ijk}); \quad logit(p_{N137,ijk}) = \beta_{N137,0} + ACC_{ijk}$$
$$(N137B)_{ijk} \sim Ber(p_{N137B,ijk}); \quad logit(p_{N137B,ijk}) = \beta_{N137B,0} + \beta_{N137B,1}ACC_{ijk}$$
$$(K4Q26)_{ijk} \sim Ber(p_{K4Q26,ijk}); \quad logit(p_{K4Q26,ijk}) = \beta_{K4Q26,0} + \beta_{K4Q26,1}ACC_{ijk}$$
$$ACC_{ijk} \sim N(\beta_{ACC,0jk} + \beta_{ACC,1jk}CHS_{ijk} + \beta_{ACC,2jk}(Any\ Private\ Insurance)_{ijk} + \beta_{ACC,3jk}(Some\ Government\ But\ No\ Private\ Insurance)_{ijk}, \sigma^2_{ACC})$$
$$\beta_{ACC,pjk} \sim N(\beta_{ACC,pj}, \sigma^2_{ACC,p})$$

In these equations, *Ber* denotes the Bernoulli distribution with probability of success argument, N137 denotes whether a child has a place he regularly goes for care, *logit* is the logit function (*i.e.*, $logit(x) = \log(x/(1-x))$), N137 denotes whether the child has a regular doctor or nurse, and K4Q26 denotes whether the child has had a problem seeing a specialist.

Sick-care Utilization

$$(\log(M131DAYS))_{ijk} \sim N(\beta_{M131DAYS,0} + \beta_{M131DAYS,1}SCU_{ijk}, \sigma^2_{M131DAYS})$$
$$(\log(M135DAYS))_{ijk} \sim N(\beta_{M135DAYS,0} + \beta_{M135DAYS,1}SCU_{ijk}, \sigma^2_{M135DAYS})$$
$$(M134)_{ijk} \sim N(\beta_{M134,0} + SCU_{ijk}, \sigma^2_{M134})$$
$$(M132)_{ijk} \sim N(\beta_{M132,0} + \beta_{M132,1}SCU_{ijk}, \sigma^2_{M132})$$
$$(K4Q24)_{ijk} \sim Ber(p_{K4Q24,ijk}); \quad logit(p_{K4Q24,ijk}) = \beta_{K4Q24,0} + \beta_{K4Q24,1}SCU_{ijk}$$
$$SCU_{ijk} \sim N(\beta_{SCU,0jk} + \beta_{SCU,1jk}ACC_{ijk} + \beta_{SCU,2jk}CHS_{ijk} + \beta_{SCU,3jk}(Any\ Private\ Insurance)_{ijk} + \beta_{SCU,4jk}(Some\ Government\ But\ No\ Private\ Insurance)_{ijk}, \sigma^2_{SCU})$$
$$\beta_{SCU,pjk} \sim N(\beta_{SCU,pj}, \sigma^2_{SCU,p})$$

In these equations, M131DAYS denotes the number of days since the child's last dental visit, M135DAYS denotes the number of days since the child's last non-

hospital/emergency doctor visit, M134 denotes the number of times in an emergency room, M132 denotes the number of overnight hospital stays, and K4Q24 denotes whether the child has seen a specialist.

Well-care Utilization

$$(M130)_{ijk} \sim Ber(p_{M130,ijk}); \quad logit(p_{M130,ijk}) = \beta_{M130,0} + WCU_{ijk}$$
$$(M135A)_{ijk} \sim Ber(p_{M135A,ijk}); \quad logit(p_{M135A,ijk}) = \beta_{M135A,0} + \beta_{M135A,1} WCU_{ijk}$$
$$WCU_{ijk} \sim N(\beta_{WCU,0jk} + \beta_{WCU,1jk} ACC_{ijk} + \beta_{WCU,2jk} CHS_{ijk} + \beta_{WCU,3jk}(Any\ Private\ Insurance)_{ijk} + \beta_{WCU,4jk}(Some\ Government\ But\ No\ Private\ Insurance)_{ijk}, \sigma^2_{WCU})$$
$$\beta_{WCU,pjk} \sim N(\beta_{WCU,pj}, \sigma^2_{WCU,p})$$

In these equations, M130 indicates whether the child received a well-child or well-baby checkup and M135A denotes whether the child has had a dental visit for a standard checkup.

Other Distributional Assumptions

In order for the model to be identifiable, some coefficients were set to fixed values. These restrictions were as follows:

$\beta_{ACC,01} = 0$ (Intercept for access in the rural region)
$\beta_{SCU,01} = 0$ (Intercept for sick-care utilization in the rural region)
$\beta_{WCU,01} = 0$ (Intercept for well-care utilization in the rural region)

In addition, prior distributions had to be chosen for some missing values. This assumption was necessary for variables that appeared as independent variables in the equations for the latent variables. All prior distributions for the missing values were derived empirically from the data. The following distributional assumptions were used for missing values:

$$(P148)_{ijk} \sim Ber(0.511)$$
$$(P150)_{ijk} \sim MultiNom(0.963, 0.022, 0.005, 0.005, 0.001, 0.014)$$
$$(I90B)_{ijk} \sim Ber(0.318)$$
$$(S17)_{ijk} \sim MultiNom(0.945, 0.023, 0.008, 0.009, 0.0004, 0.015)$$
$$(Insurance\ Status)_{ijk} \sim MultiNom(0.075, 0.236, 0.649)$$

In these expressions, P148 is the child's gender, P150 is the child's ethnicity, I90B is the parent's gender, and S17 is the parent's ethnicity. For P148 and I90B the probability given is the probability of being male. For P150 and S17 the order of races is Caucasian, Black, Asian, Native American, Native Hawaiian/Pacific Islander, and Hispanic. For insurance status, the order of statuses is uninsured, some government but no private insurance, and any private insurance.

All of the remaining parameters were assigned vague priors. All parameters defined on the real line (β parameters) were assigned normal distributions with a mean of zero and a variance of 1000. All parameters defined on the positive real

line (σ^2 parameters) were assigned an inverse gamma distribution with a mean of 1 and variance of 1000. The full list is as follows:

$\beta_{PBMI,0} \sim N(0, 1000)$
$\beta_{PBMI,1} \sim N(0,1000)$
$\beta_{D30,0} \sim N(0, 1000)$
$\beta_{PHS,p} \sim N(0, 1000)$ for $p = 1, \dots, 6$
$\beta_{CBMI,0} \sim N(0, 1000)$
$\beta_{CBMI,1} \sim N(0,1000)$
$\beta_{L125,0} \sim N(0, 1000)$
$\beta_{CHS,p} \sim N(0, 1000)$ for $p = 1, \dots, 7$
$\beta_{N137,0} \sim N(0, 1000)$
$\beta_{N137B,0} \sim N(0, 1000)$
$\beta_{N137B,1} \sim N(0, 1000)$
$\beta_{K4Q26,0} \sim N(0, 1000)$
$\beta_{K4Q26,1} \sim N(0, 1000)$
$\beta_{ACC,pj} \sim N(0,1000)$ for $p = 0, \dots, 3$ and all *j* except $p = 0$ and $j = 1$
$\beta_{M131DAYS,0} \sim N(0, 1000)$
$\beta_{M131DAYS,1} \sim N(0, 1000)$
$\beta_{M135DAYS,0} \sim N(0, 1000)$
$\beta_{M135DAYS,1} \sim N(0, 1000)$
$\beta_{M134,0} \sim N(0, 1000)$
$\beta_{M132,0} \sim N(0, 1000)$
$\beta_{M132,1} \sim N(0, 1000)$
$\beta_{K4Q24,0} \sim N(0, 1000)$
$\beta_{K4Q24,1} \sim N(0, 1000)$
$\beta_{SCU,pj} \sim N(0,1000)$ for $p = 0, \dots, 4$ and all *j* except $p = 0$ and $j = 1$
$\beta_{M130,0} \sim N(0, 1000)$
$\beta_{M135A,0} \sim N(0, 1000)$
$\beta_{M135A,1} \sim N(0, 1000)$
$\beta_{WCU,pj} \sim N(0,1000)$ for $p = 0, \dots, 4$ and all *j* except $p = 0$ and $j = 1$

$\sigma^2_{PBMI} \sim IG(0.001, 0.001)$
$\sigma^2_{D30} \sim IG(0.001, 0.001)$
$\sigma^2_{PHS} \sim IG(0.001, 0.001)$
$\sigma^2_{CBMI} \sim IG(0.001, 0.001)$
$\sigma^2_{L125} \sim IG(0.001, 0.001)$
$\sigma^2_{CHS} \sim IG(0.001, 0.001)$
$\sigma^2_{ACC} \sim IG(0.001, 0.001)$
$\sigma^2_{ACC,p} \sim IG(0.001, 0.001)$ for $p = 0, \dots, 3$
$\sigma^2_{M131DAYS} \sim IG(0.001, 0.001)$
$\sigma^2_{M135DAYS} \sim IG(0.001, 0.001)$
$\sigma^2_{M134} \sim IG(0.001, 0.001)$

$\sigma^2_{M132} \sim IG(0.001, 0.001)$
$\sigma^2_{SCU} \sim IG(0.001, 0.001)$
$\sigma^2_{SCU,p} \sim IG(0.001, 0.001)$ for $p = 0, \ldots, 4$
$\sigma^2_{WCU} \sim IG(0.001, 0.001)$
$\sigma^2_{WCU,p} \sim IG(0.001, 0.001)$ for $p = 0, \ldots, 4$

Appendix B: Model Estimates, Credible Intervals and Parameters for Rural and Appalachian Children

	Factor or Parameter (Model Pathway)	Estimate	Credible Interval
Rural			
	Child Health and Access to Care	-1.5	(-3.73,0.68)
	Private Insurance and Access to Care	+1.09	(0.49,1.88)
	Government Insurance and Access to Care	+0.09	(-0.93,1.1)
	Access to Care and Sick Care Utilization	+0.06	(0.02, 0.1)
	Child Health and Sick Care Utilization	+1.04	(0.63,1.49)
	Private Insurance and Sick Care Utilization	+0.01	(-0.11,0.014)
	Government Insurance and Sick Care Utilization	+0.24	(.0.1,0.39)
	Access to Care and Wellness Care Utilization	+0.05	(0.02,0.7)
	Child Health and Wellness Care Utilization	-0.28	(-0.46,-0.1)
	Private Insurance and Wellness Care Utilization	+1.08	(0.95,1.22)
	Government Insurance and Wellness Care Utilization	+0.89	(0.73,1.06)
Appalachian			
	Child Health and Access to Care	-2.4	(-4.29,-0.58)
	Private Insurance and Access to Care	+4.09	(3.02,5.08)
	Government Insurance and Access to Care	+3.32	(2.1,4.36)
	Access to Care and Sick Care Utilization	+0.07	(0.03,0.11)
	Child Health and Sick Care Utilization	+1.33	(0.92,1.78)
	Private Insurance and Sick Care Utilization	-0.24	(-0.39,-0.12)
	Government Insurance and Sick Care Utilization	-0.12	(-0.27,0.02)
	Access to Care and Wellness Care Utilization	+0.06	(0.04,0.09)
	Child Health and Wellness Care Utilization	-0.17	(-0.34,0.03)
	Private Insurance and Wellness Care Utilization	+0.89	(0.69,1.1)
	Government Insurance and Wellness Care Utilization	+0.79	(0.55,1.02)
All Children			
	Non-healthy BMI (%ile) and Health	+0.43	(0.33,0.52)
	Male Health and Female Health	+0.06	(0.03,0.09)
	Ethnicity- Health: Black (AA)*	+0.15	(0.03,0.28)
	Ethnicity- Health: Asians*	-0.02	(-0.28,0.24)
	Ethnicity – Health: Native Americans*	+0.08	(-0.16,0.32)
	Ethnicity- Health: Native Hawaiians/Pac. Isl.*	-0.16	(-0.87,0.53)
	Ethnicity- Health: Hispanics*	+0.21	(.0.19,0.56)

	Ethnicity- Parent Health: Blacks (AA)*	+0.38	(0.18,0.53)
	Ethnicity- Parent Health: Asian*	-0.29	(-0.62,0.02)
	Ethnicity- Parent Health: Native American*	+0.57	(0.27,0.87)
	Ethnicity- Parent Health: Native Hawaiian/Pac. Islander*	+5.33	(4.3,6.42)
	Ethnicity- Parent Health: Hispanic*	+0.32	(0.09,0.55)
	Parent Health and Child Health	+0.37	(0.27,0.4)
	Non-healthy BMI: Parent and Parent Health	+0.36	(0.29,0.43)
	Male Parent Health and Female Parent Health	-0.01	(-0.07,0.05)
Group Differences in Model			
Appalachian Children	Less Overall Access to Care	-2.75	(-3.71.-1.64)
	Impact of Child Health on Access to Care	-0.9	(-3.44,1.78)
Appalachian Children	More Overall Sickness Care Utilization	+0.23	(0.07,0.4)
Appalachian Children	More Overall Wellness Care Utilization	+0.31	(0.09,0.54)
Appalachian Children	Impact of Private Health Insurance and Access to Care	+2.99	(1.71,4.15)
Appalachian Children	Impact of Government Insurance and Access to Care	+3.22	(1.66,4.65)
	Impact of Access to Care on Sickness Care Utilization	+0.003	(-0.051,0.05)
	Impact of Child Health on Sickness Care Utilization	+0.29	(-0.28,0.86)
Appalachian Children	Impact of Private Health Insurance on Sickness Care Utilization	-0.25	(-0.44,-0.07)
Appalachian Children	Impact of Government Insurance on Sickness Care Utilization	-0.36	(-0.57,-0.16)
	Impact of Access to Care on Wellness Care Utilization	+0.01	(-0.01,0.04)
	Impact of Child Health on Wellness Care Utilization	+0.11	(-0.11,0.43)
	Impact of Private Insurance on Wellness Care Utilization	-0.19	(-0.46,0.06)
	Impact of Government Insurance on Wellness Care Utilization	-0.1	(-0.34, 0.19

*Comparisons are to White (Caucasians)

Shaded (gray) estimates indicate significance at 95% Credible Interval

Appendix C: *Significant* Findings for All Groups: Rural, non-River Appalachian and River-Bordering Appalachian Counties

Factor or Parameter (Model Pathway)	Estimate	Credible Interval
Non-Healthy BMI (%ile) and Child Health	+0.43	(0.33,0.53)
Non Healthy Parent BMI and Parent Health	+2.96	(2.93,2.98)
Parent Health and Child Health	+0.36	(0.3,0.42)
Male Gender and Child Health	+0.06	(0.03,0.09)
Black Ethnicity and Child Health	+0.15	(0.03,0.27)
Hispanic Ethnicity and Child Health	+0.25	(0.09,0.4)
Black Ethnicity and Parent Health	+0.37	(0.19,0.55)
Native American Ethnicity and Parent Health	+0.56	(0.26,0.87)
Native Hawaiian/Pacific Isl. and Parent Health	+5.36	(4.3,6.46)
Hispanic Ethnicity and Parent Health	+0.33	(0.1,0.55)
Regular Health Care Provider and Access to Care	+3.22	(2.84,3.7)
Difficulty Accessing Specialized Care and Access to Other Care	-2.85	(-3.18,-2.58)
Sick Care Utilization and Emergency Room Utilization	-0.22	(-0.27,-0.18)
Sick Care Utilization and Overnight Hospital Stays	+0.07	(0.05,0.09)
Sick Care Utilization and Specialist Care Utilization	+0.54	(0.43,0.67)
Child Health and Access to Care-Appalachia Non-River	-3.76	(-7.49.-0.77)
Child Health and Wellness Care Utilization Rural	-0.34	(-0.54,-0.06)
Child Health and Sick Care Utilization Rural	+1.2	(0.69,1.74)
Child Health and Sick Care Utilization-Appalachian Non-River	+1.55	(0.93,2.22)
Child Health and Sick Care Utilization-Appalachian River	+1.28	(0.61,1.99)
Private Insurance and Wellness Care Utilization-Rural	+1.15	(0.98,1.31)
Private Insurance and Wellness Care Utilization-Appalachian Non-River	+0.99	(0.54,1.46)
Private Insurance and Wellness Care Utilization-Appalachian River	+0.58	(0.22,1.0)
Government Insurance and Wellness Care Utilization- Rural	+1.0	(0.72,1.17)
Government Insurance and Wellness Care	+1.06	(0.72,1.5)

Utilization – Appalachian Non-River		
Government Insurance and Wellness Care Utilization- Appalachian River	+0.43	(0.09,0.87)
Private Insurance and Sick Care Utilization Appalachian Non-River	-0.33	(-0.52,-0.16)
Government Insurance and Sick Care Utilization Rural	+0/25	(0.1,0.4)
Access to Care and Wellness Care Utilization Rural	+0.05	(0.02,0.08)
Access to Care and Wellness Utilization Appalachian Non- River	+0.07	(0.03.0.12)
Access to Care and Wellness Utilization Appalachian River	+0.05	0.02,-0.06)

Significance determined by a 95% Credible Interval

Appendix D: *Significant* Differences between Rural, non-River Appalachian, and River-Bordering Appalachian Counties

Factor or Parameter (Model Pathway)	Estimate	Credible Interval
Appalachian (Non River)		
Access to Care Compared to Rural	-2.23	(-3.99,-0.62)
Sick Care Utilization (compared to Rural)	+0.29	(0.08,0.52)
Impact of Private Insurance on Access to Care Compared to Rural	+2.54	(0.64,4.74)
Impact of Government Insurance on Access to Care Compared to Rural	+3.57	(1.38,6.62)
Impact of Government Insurance on Wellness Care Utilization Compared to Appalachian River	-0.63	(-1.16,-0.05)
Rural		
Impact of Private Insurance on Sick Care Utilization Compared to Non-River Appalachia	-0.36	(-0.59,-0.14)
Impact of Private Insurance on Wellness Care Utilization Compared to Appalachian River	-0.58	(-0.94.-0.11)
Impact of Government Insurance on Sick Care Utilization Compared to Non River Appalachia Compared to River Appalachia	-0.43 -0.28	(-0.71,-0.18) (-0.53,-0.04)
Impact of Government Insurance on Wellness care Utilization Compared to Appalachian River	-0.56	(-0.98,-0.03)
Appalachian (River)		
Wellness Care Utilization Compared to Rural Compared to Non-River Appalachian	+0.77 +0.6	(0.34,1.11) (0.11,1.07)
Access to Care Compared to Rural Compared to Non-River Appalachia	-4.86 -2.63	(-8.08,-2.62) -5.18,-0.44)
Impact of Private Insurance on Access to Care Compared to Rural Compared to Non-River Appalachia	+5.45 +2.91	(2.88.9.52) (0.34,6.16)
Impact of Government Insurance on Access to Care Compared to Rural	+4.09	(1.75,7.44)

Significance determined by a 95% Credible Interval