

Does a Medical Home Mediate Racial Disparities in Unmet Healthcare Needs among Children with Special Healthcare Needs?

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Abstract

OBJECTIVES: This study extends mediation analysis techniques to explore whether and to what extent differential access to a medical home explains the black/white disparity in unmet healthcare needs among children with special healthcare needs (CSHCN). **METHODS:** Data were obtained from the 2007 National Survey of Children's Health, with analyses limited to non-Hispanic white and black CSHCN (n=14,677). The counterfactual approach to mediation analysis was used to estimate odds ratios for the natural direct and indirect effects of race on unmet healthcare needs. **RESULTS:** Overall, 43.0% of white CSHCN and 60.4% of black CSHCN did not have a medical home. Additionally, 8.8% of white CSHCN and 15.3% of black CSHCN had unmet healthcare needs. The natural indirect effect indicates that the odds of unmet needs among black CSHCN are elevated by approximately 20% as a result of their current level of access to the medical home rather than access at a level equal to white CSHCN ($OR_{NIE} = 1.2$, 95% CI = 1.1, 1.3). The natural direct effect indicates that even if black CSHCN had the same level of access to a medical home as white CSHCN, blacks would still have 60% higher odds of unmet healthcare needs than whites ($OR_{NDE} = 1.6$, 95% CI = 1.1, 2.4). **CONCLUSIONS:** The racial disparity in unmet healthcare needs among CSHCN is only partially explained by disparities in having a medical home. Ensuring all CSHCN have equal access to a medical home may reduce the racial disparity in unmet needs, but will not completely eliminate it.

Key Words: Child health services; medical home; healthcare disparities; mediation analysis; children with special healthcare needs (CSHCN)

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Despite a national focus on reducing health disparities in the US over the last two decades (1), racial and ethnic disparities in access to care do not appear to be improving (2). Racial and ethnic minorities receive poorer quality care and have more barriers to accessing care (2). While most studies of racial disparities in healthcare have been among adults (3), there are also well-established racial and ethnic disparities in healthcare access and utilization among children (4).

One important indicator of lack of access to care is having unmet healthcare needs, defined as needs for healthcare services that are not received or are delayed. Lack of access is particularly relevant for children with special healthcare needs (CSHCN), who by virtue of their health status require increased interaction with the healthcare system. These children experience higher rates of unmet needs than children without special healthcare needs, with approximately 16 -18% of CSHCN having at least one unmet healthcare need (5-6) compared to 5-7% of all children (6-7). Among CSHCN, black children are significantly more likely than white children to have unmet healthcare needs (8).

Organizing and delivering health services through the “medical home” has become central to child health policy since 1992, when the American Academy of Pediatrics (AAP) issued its first policy statement on the topic (9). According to the AAP, a medical home provides community-based primary care that is “accessible, continuous, comprehensive, family-centered, coordinated, compassionate, and culturally effective” (9). The AAP states that “every child deserves a medical home” (10) and *Healthy People 2020* includes an objective for increasing the proportion of CSHCN who have a medical home from 47.1% in 2007 to 51.8% (1). CSHCN who are older, , uninsured, and have more severe health conditions are less likely to have a medical home than their counterparts (6, 11-13). Black and Hispanic CSHCN are less likely to have a medical home than white CSHCN whether measured by the overall medical home or by distinct components of a medical home (6, 14).

There is evidence that having a medical come leads to improved health service outcomes for CSHCN. Compared to those without a medical home, CSHCN with a medical home have less delayed care, fewer unmet health and dental care needs, and fewer unmet needs for specialty and family support services (6, 15-16). Children without a usual source of care also have higher odds of unmet needs for

prescription medicines, mental health care, dental care, and eye care (17). There is also some evidence suggesting that having a medical home could reduce racial and ethnic disparities in access to care. One study showed that racial disparities in four types of unmet healthcare needs among CSHCN disappeared after controlling for having a personal doctor/nurse, having a usual source of care, and other variables (8). This suggests having a medical home, or factors closely related to it, may mediate, or explain, the racial/ethnic disparities in unmet needs among CSHCN. If this is true, then assuring equitable access to a medical home could contribute to reducing the racial disparities in unmet needs for care.

The study of racial disparities in health status or healthcare access often focuses on documenting inequalities in health status and health care, but not on explaining the pathways by which those inequalities arise and are maintained. In the absence of an explanatory theory, the ability to develop effective interventions is limited (18-19). Mediation analysis provides a conceptual framework and accompanying analytic methods that can improve our understanding of racial disparities in health care access by addressing the causal processes through which one variable is related to another (18, 20). The counterfactual approach to mediation analysis (21) is particularly useful because it produces direct and indirect effects on the odds ratio scale with interpretations that can advance our understanding of how intervening on a mediator may change the outcome.

This study explores whether and to what extent differential access to a medical home explains the black/white disparity in parent report of unmet healthcare needs among CSHCN in the United States. Our hypothesis is that the black/white disparity in unmet healthcare needs could be reduced if black CSHCN were to attain the same level of access to a medical home as white CSHCN. Though race/ethnicity and having a medical home are not “causal” factors in the traditional sense, this study aims to extend mediation methods to foster a better understanding of mechanisms underlying racial disparities in health care.

Methods

The 2007 National Survey of Children's Health (NSCH) was sponsored by the Health Resources and Services Administration, Maternal and Child Health Bureau (MCHB) to produce national and state-specific prevalence estimates of children's health and experiences with the health care system. The NCHS uses the State and Local Area Integrated Telephone Survey (SLAITS) mechanism to identify children for inclusion (www.cdc.gov/nchs/slaits/about_slaits.htm). The final national sample includes surveys for 91,642 children ages 0-17 that were conducted between April 2007 and June 2008. The respondent was the available parent or guardian who was most familiar with the child's health and the interview was conducted in English or Spanish. Each observation was weighted to account for stratification by state, non-response, probability of having a landline telephone, and probability of selecting a particular child in a household. A complete description of the sampling methodology and survey design can be found elsewhere (22).

MCHB defines CSHCN as those who have, or are at increased risk, for a chronic physical, developmental, behavioral, or emotional condition, and who also require healthcare-related services of a type or amount beyond that generally required by children (23). The 2007 NSCH includes a series of screening questions to identify CSHCN (24-25). This study was restricted to non-Hispanic white and black CSHCN aged 0-17 (n= 14,677), 14,269 (97.2%) of whom had non-missing responses regarding unmet healthcare needs and having a medical home. Black CSHCN made up 20.7% (95% CI: 19.0-22.3%) of the analytic sample.

The NSCH public use data set contains no identifying information, therefore this study was considered exempt by the University of Illinois at Chicago Institutional Review Board.

Dependent Variable:

For this study, a child had unmet healthcare needs if their parent reported any need for medical, mental health, or other types of healthcare services (excluding dental care) in the last 12 months, but these services had been delayed or not received. Unmet needs for dental care were not included in this analysis because the medical home may not be able to address this issue as readily as the other types of healthcare needs.

Independent Variables:

Because we are hypothesizing that the black/white disparity in unmet healthcare needs is mediated by having a medical home, the independent variables are separately labeled as: the main independent variable, the mediator, and the set of covariates. These distinctions are important because there will be a corresponding statistical approach for handling each variable type.

Main Independent Variable: The main independent variable was parent-reported race/ethnicity of the child, categorized as non-Hispanic white and non-Hispanic black.

Mediator (Intervening) Variable: The 2007 NSCH incorporates the latest consensus strategy for measuring the medical home. Nineteen questions are used to capture five components of the medical home concept: having a personal doctor or nurse, a usual place for sick/well care, access to needed referrals, family-centered care, and care coordination (24). In what has been termed the “on every” approach (26), to be classified as having a medical home, children must have received a score at or above a threshold level for each of the five individual components. More information about the medical home construct is available elsewhere (27).

Covariates: Child’s age, sex, highest parental education in the household, severity of chronic health conditions, type of special health care needs, region of the US, and urban-rural residence were included as potential confounders of the relationship between race and unmet healthcare needs. An index was created to score the severity of a child’s health conditions based on parent responses to questions about 15 specific medical conditions, such as diabetes, asthma, and depression. For any parent-reported diagnoses, parents rated the condition(s) as mild, moderate, or severe. We computed a total for each child (one, two, or three points, respectively, for each “mild”, “moderate”, and “severe” condition), then dichotomized the score into “low” (≤ 2 points) and “high” (≥ 3 points). For type of special healthcare needs, we used a previously developed composite measure, which classifies CSHCN into four categories: functional limitations, prescription medication use and increased service need or use, increased service need or use only, and prescription medication use only (24).

We did not consider socioeconomic status (SES) variables, such as insurance status and household income, as covariates in this study. This decision reflects a framing of racial disparities that considers SES differences as inextricably linked with the racial disparity of interest (28-29). Others have described the complex, intertwined nature of race/ethnicity and SES in the United States that supports this framework (30-31). From this vantage point, controlling for SES variables in a study of racial disparity would be "over-controlling", resulting in an underestimate of the disparity. Though not used as covariates, the distribution of insurance status and household income as a percentage of the federal poverty level (% FPL) are included in the description of the analysis sample.

The Mediation Framework

This study uses a mediation model to assess the hypothesis that the black/white disparity in unmet healthcare needs for CSHCN is the result of black CSHCN being less likely to receive care within a medical home. The hypothesized relationships among race (black/white), receiving care in a medical home, and parent report of unmet healthcare needs are depicted in Figure 1.

We verified the relationships shown in Figure 1 by testing the following three criteria for determining mediation (32):

1. There must be a significant relationship between race (X) and unmet healthcare needs (Y);
2. There must be a significant relationship between race (X) and not having a medical home (M);
3. Not having a medical home (M) must be a significant predictor of unmet healthcare needs (Y) in an equation that includes race (X).

Statistical Analysis

All analyses were conducted using SAS survey procedures (Cary, NC: SAS 9.2) which accounted for the complex sample design and weighting of the NSCH.

The characteristics of black and white CSHCN in the sample were compared using chi-square statistics ($\alpha = 0.05$). The prevalence of unmet healthcare needs and not having a medical home were compared by child characteristics using chi-square statistics ($\alpha = 0.05$). Stratified analysis was carried out to assess confounding and effect modification of the race-unmet needs, race-medical home,

and medical home-unmet needs associations by covariates. Logistic regression was used to estimate crude and adjusted (for covariates) odds ratios (ORs) and 95% confidence intervals (CI) to assess the three mediation criteria outlined above. We then built the following two logistic regression models (33):

$$(1) \quad \text{logit} [\Pr(Y = 1|X = x, M = m, C = c)] = \theta_0 + \theta_1 X + \theta_2 M + \theta_3(X * M) + \theta_4 C$$

$$(2) \quad \text{logit} [\Pr(M = 1|X = x, C = c)] = \beta_0 + \beta_1 X + \beta_2 C$$

where: X , M , and Y notation is from Figure 1, C refers to the set of covariates described previously, θ s are the coefficients from modeling the association between race and unmet healthcare needs in the presence of medical home (the mediator) adjusting for covariates, and β s are the coefficients from modeling the association between race and medical home adjusting for covariates.

We used the coefficients from these models to estimate ORs for the natural direct effect (NDE) and natural indirect effect (NIE) (21). The definitions and calculations of the ORs for the NDE and NIE are shown in Table 1. The equations allow for interaction between the exposure and mediator, as estimated by θ_3 . In this study, however, statistical testing ruled out any such interaction (data not shown), so models were run without interaction terms and θ_3 was set to 0.

The NDE and NIE are based on the counterfactual framework in which, “contrary to fact”, each individual could be compared to him/herself under different conditions. The product of the NDE and NIE equals the total effect, or the racial disparity in unmet healthcare needs after adjusting for covariates (but not adjusting for the mediator) (21, 34). The decomposition of the total effect into the NDE and NIE makes this approach to mediation conceptually similar to other mediation approaches (34). The analysis was carried out using the mediation macro written by Valeri and Vanderweele with modification to account for the NSCH sample design and weighting (21).

Results

Table 2 shows the characteristics of white and black CSHCN in this study. Black CSHCN were significantly more likely than white CSHCN to have parents with low education, have high chronic

condition severity, live in an urban area, be uninsured or publicly insured, and to have a low household income. White and black CSHCN also had significantly different distributions of type of special healthcare needs and region of residence, but did not significantly differ by age or sex.

Table 3 shows the percent of CSHCN with unmet healthcare needs by certain child characteristics. Overall in our sample, 10.1% (95% CI: 8.7-11.6%) of black and white CSHCN had any unmet healthcare needs; 6.6% (95% CI: 5.4-7.8%) had unmet needs for medical care, 3.1% (95% CI: 2.3-4.0%) had unmet needs for mental health services, and 0.9% (95% CI: 0.6-1.2%) had unmet needs for other healthcare services (data not shown). Characteristics significantly associated with increased prevalence of unmet healthcare needs included: black race, not having a medical home, higher severity of chronic conditions, and functional limitations.

Table 3 also shows the percent of children who did not receive care consistent with the medical home model by child characteristics. Overall in our sample, 46.6% (95% CI: 44.7-48.5%) of black and white CSHCN did not have a medical home. Characteristics significantly associated with not having a medical home were: black race, low parent education, older age of the child, male sex, higher severity of chronic conditions, and functional limitations.

Table 4 reports the unadjusted and adjusted ORs to establish that the three mediation criteria have been met. Black CSHCN had significantly elevated odds of unmet healthcare needs and of not having a medical home compared to white CSHCN. After controlling for race, children without a medical home had five times the odds of unmet healthcare needs compared to those with a medical home. Adjusting for child age, child sex, parent education, chronic condition severity, type of special health care needs, region of residence, and urban-rural residence, slightly attenuated these relationships but 95% CIs still indicated statistical significance.

The results of the mediation analysis (Table 5) demonstrate that the racial disparity in unmet healthcare needs among CSHCN is partially explained by disparities in having a medical home. The NIE indicates the odds of unmet healthcare needs among black CSHCN are elevated by approximately 20% as a result of their current level of access to the medical home rather than access at a level equal to white

CSHCN ($OR_{NIE} = 1.2$, 95% CI = 1.1, 1.3). The NDE indicates that even if black and white CSHCN had equal levels of access to a medical home, blacks would still have 60% higher odds of unmet healthcare needs than whites ($OR_{NDE} = 1.6$, 95% CI = 1.1, 2.4). The product of the NDE and NIE, or total effect, ($OR_{TE} = 1.9$, 95% CI = 1.3, 2.9), is equivalent (with slight differences due to rounding) to the adjusted OR #1 in Table 4.

Discussion

This study found that the black/white disparity in unmet healthcare needs among CSHCN may be partially mediated by differential access to a medical home. We estimated that unmet healthcare needs among black CSHCN could be reduced if their medical home access were increased. Additionally, assuring equal access to a medical home would result in a decrease in the black/white disparity in unmet healthcare needs.

Our findings both confirm and expand upon existing literature that demonstrates the improved healthcare access and reduced unmet needs that result from receiving care within a medical home (6, 15-16). Our study is unique in: 1) its focus on the medical home as a whole rather than separate components of care, 2) its examination of medical home as a mediator and not simply a confounder, and 3) its quantification of the indirect effect of race on unmet healthcare needs that operates specifically through the medical home. Additionally, we tested for, but did not find interaction between race and medical home and their association with unmet healthcare needs (exposure-mediator interaction). This suggests the effectiveness of the medical home in reducing unmet healthcare needs is equivalent for black and white CSHCN. The portion of the racial disparity in unmet healthcare needs explained by the medical home, therefore, is due to differential access rather than to differential effectiveness.

These findings point to the importance of improving access to the medical home as one strategy for decreasing the black/white disparity in unmet healthcare needs among CSHCN. On the other hand, the NDE shows that a significant black/white disparity would remain even when equitable medical home access is assured. Many other healthcare and social factors will need to be changed to fully eliminate the

black/white disparity in unmet healthcare needs. Future research should focus on identifying and mitigating these other factors.

It is important to understand the difference between how we have reported our findings compared to the usual approach of reporting an unconfounded (adjusted) estimate of effect. Had we chosen to treat medical home as a confounder rather than a mediator, we would only have reported the magnitude of the black/white disparity in unmet healthcare needs, controlling for all covariates, including medical home. This usual adjustment approach takes the focus off of the confounders —once controlled for, their values are immaterial. In contrast, mediation analysis calls attention to the role of any factor conceptualized as a mediator. The NIE and NDE respectively highlight the extent to which intervening on the mediator could improve the “exposed” group’s outcome and the strength of the exposure-outcome relationship after changing the level of the mediating factor among the exposed. For this study, then, the counterfactual mediation approach allowed us to describe the reduction in unmet healthcare needs among black CSHCN and the size of the black/white disparity in unmet healthcare needs remaining if the public health community ensures that black CSHCN have the same access to the medical home as white CSHCN.

The use of mediation analysis to describe racial disparities in health services outcomes is new and challenging conceptually. Determining “causal” pathways between health services variables is less straightforward than for health outcomes with proposed biologic mechanisms. Since the placement of variables in a conceptual model determines how they are handled statistically, results will vary depending on how the model is drawn. While mediation analysis forces us to explicitly articulate a conceptual model, there is currently no consensus on the approach for representing the complex interrelationships between health services outcomes, social determinants of health, and access to care. For instance, consistent with the IOM definition of racial disparities (28-29), we did not include income or insurance type as covariates in our analysis because we *a priori* conceptualized them as being inextricably linked with the racial disparity itself.

In contrast, we did include parent educational attainment as a covariate, even though it may be linked to socioeconomic status (SES) by affecting job potential and income level. We chose to adjust for

education to address potential reporting bias in unmet needs. By definition, a service must first be perceived as needed by an individual for it to subsequently be reported as “met” or “unmet”. Parents' education may affect their perception of what services are necessary for their child, preferences for care, and expectations of the healthcare system. Studies have shown that parents of CSHCN with lower educational attainment were less likely to report their child needed preventive services (35), specialist physician services (35-36) or prescription medications (36). Another study showed parents of black CSHCN were significantly less likely to report their child had a need for mental health counseling than parents of white CSHCN (37). Adjusting for educational attainment aimed to avoid an underestimate of the black/white disparity in unmet needs resulting from a systematic underreporting of unmet needs by black parents.

In general, decisions about which variables to include as covariates in a mediation analysis are even more critical than in other observational studies because the three criteria for mediation require strict assumptions regarding unmeasured confounding. For this study, no unmeasured confounding is assumed for the associations of race and unmet healthcare needs, medical home and unmet healthcare needs, and race and medical home. An additional assumption is required specifically for the estimation of NDEs and NIEs, namely that there is no unmeasured confounding of the medical home and unmet healthcare needs relationship by a factor that is "caused" by race (21). Whether these assumptions hold can be assessed by carrying out sensitivity analyses to estimate how findings might be affected if there is unmeasured confounding (21). We did not undertake these analyses at this time due to the difficulty in conceptualizing concrete examples of unmeasured factors that might be confounders within the complex model of social determinants, healthcare access and service delivery.

This study is also limited by the cross-sectional nature of the NSCH data. Because of this, assumptions cannot be made about the direction of the relationship between having a medical home and unmet healthcare needs. Fundamental to mediation analysis are assumptions of causality; in our study, of particular importance is the assumption that not having a medical home is causally related to unmet healthcare needs. Therefore, a longitudinal study in which medical home was measured prior to the

measurement of unmet healthcare needs would strengthen the findings. Another limitation of this study is the reporting of ORs rather than relative risks for the NDE and NIE. It would have been preferable to use log binomial instead of logistic regression since the outcome of unmet healthcare needs is not rare, but procedures for performing log binomial regression with data from a complex sample survey are not yet available in SAS, the program in which the mediation macro is available. Finally, all data were parent-reported, potentially leading to misclassification. The medical home measure may be particularly vulnerable to misclassification given that parents may not accurately report information about their child's healthcare. In addition, the measure itself may not be sensitive and specific enough to fully capture the complexity of the medical home concept. We might have seen a stronger mediation effect (indicated by a smaller NDE and larger NIE) in the absence of misclassification of the medical home measure.

In summary, this study extends mediation analysis techniques to the problem of racial disparities in healthcare access. By identifying the medical home as a mediator of the black/white disparity in unmet healthcare needs among CSHCN, this study quantified the potential effect of improving medical home access for black CSHCN. If we hypothesize that a reduction in unmet healthcare needs can lead to better health status outcomes during childhood, then we might expect that improving access to medical homes for black CSHCN could reduce health disparities in those outcomes. The findings from this research are important for child health providers and policymakers as they work to configure a health care delivery system that promotes preventive services, timely care, appropriate management of health conditions, and care that is responsive to the needs of families. If a medical home is the foundation of such a system, it must be available for all children, regardless of race or ethnicity, health status, and developmental stage.

References

1. U.S. Department of Health and Human Services. *Healthy People 2020*. Accessed online on March 8, 2012 at <http://www.healthypeople.gov/2020/topicsobjectives2020/default.aspx>.
2. Agency for Healthcare Research and Quality. *2010 National Healthcare Disparities Report*. Rockville, MD: US Department of Health and Human Services, Agency for Healthcare Research and Quality; 2011: AHRQ Publication 11-0005.
3. Raphael JL, Beal AC. A review of the evidence for disparities in child vs. adult health care: a disparity in disparities. *J Natl Med Assoc*. 2010;102:684-91.
4. Flores, G, Committee on Pediatric Research. Technical report: Racial and ethnic disparities in the health and health care of children. *Pediatrics*. 2010 Apr;125(4):e979-e1020.
5. Van Dyck, PC, et al. Prevalence and characteristics of children with special healthcare needs. *Arch Pediat Adolesc Med*. 2004 Sept;158:884-890.
6. Strickland B, et al. Access to the medical home: New findings from the 2005-2006 National Survey of Children with Special Healthcare Needs. *Pediatrics*. 2009 June;123(6): e996-e1004.
7. Newacheck PW, et al. The unmet health needs of America's children. *Pediatrics*. 2000 Apr;105(4): 989-987.
8. Ngui EM, Flores G. Unmet needs for specialty, dental, mental, and allied health care among children with special health care needs: are there racial/ethnic disparities? *J Health Care Poor Underserved*. 2007 Nov;18(4):931-949.
9. American Academy of Pediatrics (AAP). The Medical Home: Medical Home Initiatives for Children with Special Needs Project Advisory Committee. Policy Statement. *Pediatrics*. 2002;110(1):184-186.
10. Sia C, et al. History of the medical home concept. *Pediatrics*. 2004 May;113(5 Supp):1473-1478.
11. Data Resource Center for Child and Adolescent Health. 2008; Available at: <http://childhealthdata.org/content/Default.aspx>.

12. Brachlow AE, et al. Comparison of indicators for a primary care medical home between children with autism or asthma and other special health care needs: National Survey of Children's Health. *Arch Pediatr Adolesc Med.* 2007 Apr;161(4):399-405.
13. Mulvihill BA, et al. Does access to a medical home differ according to child and family characteristics, including special-health-care-needs status, among children in Alabama? *Pediatrics.* 2007 Feb;119(Suppl 1):S107-13.
14. Raphael JL, et al. Racial and ethnic disparities in indicators of a primary care medical home for children. *Acad Pediatr.* 2009 July-August;9(4): 221-7.
15. Benedict RE. Quality medical homes: meeting children's needs for therapeutic and supportive services. *Pediatrics.* 2008 Jan;121(1):e127-34.
16. Lewis C, et al. Unmet dental care needs among children with special health care needs: implications for the medical home. *Pediatrics.* 2005 Sep;116(3):e426-31.
17. Hoilette LK, et al. Usual source of care and unmet need among vulnerable children, 1998-2006. *Pediatrics.* 2009 Feb;123(2):e214-219.
18. Hafeman DM, Schwartz S. Opening the black box: A motivation for the assessment of mediation. *Int J Epidemiol.* 2009;38: 838-845.
19. McKinlay JB, Marceau LD. To boldly go... *Am J Public Health.* 2000;90(1): 25-33.
20. MacKinnon DP, et al. Mediation analysis. *Annu Rev Psychol.* 2007;58: 593-614.
21. Valeri L, VanderWeele TJ. Mediation analysis allowing for exposure-mediator interactions and causal interpretation: Theoretical assumptions and implementation with SAS and SPSS macros. *Psychological Methods*, in press. (obtained via personal correspondence)
22. Blumberg, SJ, et al. Design and operation of the National Survey of Children's Health, 2007. National Center for Health Statistics. *Vital Health Statistics: Series 1.* 2009.
23. McPherson M, et al. A new definition of children with special healthcare needs. *Pediatrics.* 1998 July; 102 (1 Pt1): 137-140.

24. Child and Adolescent Health Measurement Initiative (CAHMI). *2007 National Survey of Children's Health: SAS codebook*. National Data Resource Center for Child and Adolescent Health, accessed online on April 20, 2012 at <http://childhealthdata.org/docs/nsch-docs/2007-nsch-sas-codebook-v1-2-december-2010-pdf.pdf>.
25. Bethell CD, et al. Identifying children with special health care needs: development and evaluation of a short screening instrument. *Ambul Pediatr*. 2002 Jan-Feb;2(1):38-48.
26. Bethell, CD. et al. Using existing population-based data sets to measure the American Academy of Pediatrics definition of medical home for all children and children with special health care needs. *Pediatrics*. 2004 May;113(5):1529-1537.
27. Child and Adolescent Health Measurement Initiative (CAHMI). *Measuring medical home for children and youth: Methods and findings from the National Survey of Children with Special Healthcare Needs and the National Survey of Children's Health*. National Data Resource Center for Child and Adolescent Health, May 2009. Accessed online on March 30, 2012 at http://childhealthdata.org/docs/medical-home/mhmanual-_body_sept2009-cb-edit-1-pdf.pdf.
28. Smedley BD, et al, eds. *Unequal treatment: Confronting racial and ethnic disparities in health care*. Institute of Medicine (IOM), 2003. Accessed online on March 30, 2012 at <http://www.nap.edu/catalog/10260.html>.
29. LeCook B, et al. Measuring racial/ethnic disparities in health care: Methods and practical issues. *Health Serv Res*. 2012 Feb; epub ahead of print.
30. Williams DR, et al. The concept of race and health status in America. *Public Health Rep*. 1994;109(1): 26-41.
31. LaVeist TA. Disentangling race and socioeconomic status: A key to understanding health inequities. *J Urban Health*. 2005;82(2 S3): iii26-iii34.
32. Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *J Pers Soc Psychol*. 1986;51(6):1173-1182.

33. Ananth CV, VanderWeele TJ. Placental abruption and perinatal mortality with preterm delivery as a mediator: Disentangling direct and indirect effects. *Am J Epidemiol.* 2011 Jul; 174(1):99-108.
34. VanderWeele TJ, Vansteelandt S. Odds ratios for mediation analysis for a dichotomous outcome. *Am J Epidemiol.* 2010 Dec;172(12):1339-1348.
35. Mayer ML, et al. The effects of rural residence and other social vulnerabilities on subjective measures of unmet need. *Med Care Res Rev.* 2005 Oct;62(5):617-628.
36. Porterfield SL, McBride TD. The effect of poverty and caregiver education on perceived need and access to health services among children with special health care needs. *Am J Public Health.* 2007;97(2):323-329.
37. Rose RA, et al. Suppression of racial disparities among children with special healthcare needs among families receiving Medicaid. *Soc Sci Med.* 2010;170:1263-1270.

Figure 1. Framework for Assessing Whether Not Having a Medical Home is a Mediator of the Racial Disparity in Unmet Healthcare Needs

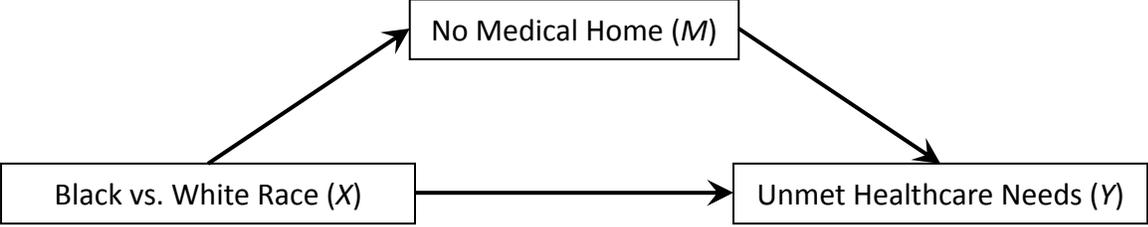


Table 1. Definitions and Equations for Natural Direct and Indirect Effects

Measure/Description	Equation*
<p>Natural Direct Effect: The odds ratio of unmet healthcare needs for black versus white CSHCN if blacks had the same prevalence of having a medical home what was observed for whites.^a</p>	$OR_{NDE} = \frac{\exp(\theta_1 a) \{1 + \exp(\theta_2 + \theta_3 a + \beta_0 + \beta_1 a^* + \beta_2' c)\}}{\exp(\theta_1 a^*) \{1 + \exp(\theta_2 + \theta_3 a^* + \beta_0 + \beta_1 a^* + \beta_2' c)\}}$
<p>Natural Indirect Effect: The odds ratio of unmet healthcare needs <u>among black CSHCN</u> under their observed prevalence of having a medical home versus if their prevalence of having a medical home were equal to that of white CSHCN.</p>	$OR_{NIE} = \frac{\{1 + \exp(\beta_0 + \beta_1 a^* + \beta_2' c)\} \{1 + \exp(\theta_2 + \theta_3 a + \beta_0 + \beta_1 a + \beta_2' c)\}}{\{1 + \exp(\beta_0 + \beta_1 a + \beta_2' c)\} \{1 + \exp(\theta_2 + \theta_3 a + \beta_0 + \beta_1 a^* + \beta_2' c)\}}$

* where the θ s and β s are as described in equations 1 and 2, a represents the exposure level set to 1 (race = black), and a^* represents the exposure level set to 0 (race = white)

^a Given the lack of statistical interaction between the exposure and mediator in this study, the natural direct effect is computationally equivalent to the controlled direct effect, in which the prevalence of no medical home is fixed at the level of blacks and whites combined (34)

Table 2. Characteristics of non-Hispanic White and Black Children with Special Healthcare Needs (CSHCN), NSCH 2007 (n=14,269)

Characteristic	Black CSHCN weighted percent (95% CI)	White CSHCN weighted percent (95% CI)
Child's Age		
0-5 years old	21.2 (17.1-25.3)	19.2 (17.5-20.9)
6-11 years old	40.2 (35.7-44.8)	37.4 (35.3-39.4)
12-17 years old	38.6 (34.2-42.9)	43.4 (41.4-45.5)
Child's Sex		
Female	43.5 (38.9-48.1)	40.0 (38.0-41.9)
Male	56.5 (51.9-61.1)	60.0 (58.1-62.0)
Parent Education †		
Low (\leq HS)	45.4 (40.7-50.0)	25.5 (23.7-27.3)
High ($>$ HS)	54.6 (50.0-59.3)	74.5 (72.7-76.3)
Chronic Condition Severity Index †		
High (\geq 3 points)	66.7 (62.5-70.0)	53.9 (51.8-56.0)
Low ($<$ 3 points)	33.3 (29.1-37.5)	46.1 (44.0-48.2)
Type of Special Healthcare Needs †		
Functional Limitations	25.9 (21.9-29.8)	20.4 (18.6-22.2)
Medication & Increased Service Use	19.1 (15.6-22.7)	24.4 (22.5-26.2)
Increased Service Use only	37.7 (33.2-42.3)	41.1 (39.1-43.1)
Medication Use only	17.2 (13.5-21.0)	14.1 (12.6-15.5)
Region of Residence †		
Midwest	19.0 (16.0-22.0)	28.2 (26.9-29.5)
North	14.3 (11.3-17.2)	18.5 (17.4-19.7)
South	58.4 (53.9-62.8)	37.3 (35.7-39.0)
West	8.4 (4.4-12.3)	15.9 (14.1-17.7)
Urban-Rural Residence †		

Rural	10.3 (8.2-12.4)	20.1 (18.6-21.5)
Urban	89.7 (87.6-91.8)	79.9 (78.5-81.4)
Insurance Type †		
No Insurance	7.5 (3.8-11.1)	4.2 (3.4-5.0)
Public Insurance	62.9 (58.4-67.3)	24.8 (23.2-26.5)
Private Insurance	29.7 (25.9-33.5)	71.0 (69.2-72.7)
Household Income †		
Low Income (\leq 200% FPL)	64.5 (60.4-68.7)	30.2 (28.3-32.0)
Middle Income (201-400% FPL)	23.6 (20.0-27.2)	33.0 (31.0-35.0)
Higher Income ($>$ 400% FPL)	11.9 (9.5-14.4)	36.8 (34.8-38.8)

† Black and white CSHCN have significantly different distributions at $p < 0.05$ (χ^2 test)

Table 3. Prevalence of Unmet Healthcare Needs and Not Having a Medical Home for non-Hispanic White and Black Children with Special Healthcare Needs (CSHCN), By Child Characteristics, NSCH 2007 (n=14,269)

Characteristic	Has Unmet Needs weighted percent (95% CI)	No Medical Home weighted percent (95% CI)
Overall	10.1 (8.7-11.6)	46.6 (44.7-48.5)
Child's Race/Ethnicity † ‡		
Black	15.3 (11.0-19.6)	60.4 (56.0-64.8)
White	8.8 (7.3-10.2)	43.0 (40.9-45.1)
Medical Home †		
No Medical Home	17.5 (15.0-20.1)	-
Medical Home	3.7 (2.2-5.2)	-
Child's Age ‡		
0-5 years old	10.3 (6.8-13.8)	41.9 (37.5-46.4)
6-11 years old	10.3 (8.0-12.7)	48.7 (45.5-51.9)
12-17 years old	9.9 (7.7-12.1)	46.9 (44.1-49.7)
Child's Sex ‡		
Female	10.5 (8.0-13.0)	43.9 (41.1-46.7)
Male	9.9 (8.1-11.7)	48.4 (45.8-51.1)
Parent Education ‡		
Low (\leq HS)	9.3 (7.5-11.2)	54.2 (50.6-57.8)
High ($>$ HS)	10.5 (8.6-12.4)	43.4 (41.2-45.7)
Chronic Condition Severity Index † ‡		
High (\geq 3 points)	13.6 (11.3-15.9)	53.6 (50.9-56.2)
Low ($<$ 3 points)	5.6 (4.3-7.0)	37.5 (34.8-40.3)
Type of Special Healthcare Needs † ‡		
Functional Limitations	17.7 (13.9-21.4)	62.0 (57.8-66.2)

Medication & Increased Service Use	9.4 (7.3-11.5)	48.1 (44.1-52.1)
Increased Service Use only	12.7 (8.9-16.5)	55.1 (50.1-60.2)
Medication Use only	5.7 (3.3-8.1)	34.4 (31.5-37.2)
Region of Residence † ‡		
Midwest	7.8 (6.2-9.5)	44.1 (41.3-46.9)
North	7.7 (5.3-10.1)	45.9 (41.8-49.9)
South	10.5 (8.5-12.5)	45.4 (42.4-48.3)
West	16.3 (9.3-24.4)	55.7 (48.7-62.8)
Urban-Rural Residence		
Rural	10.3 (7.6-12.9)	44.1 (40.5-47.7)
Urban	10.1 (8.4-11.8)	47.1 (44.9-49.3)

† proportion of CSHCN with unmet needs is significantly different across subgroups at $p < 0.05$ (χ^2 test)

‡ proportion of CSHCN with no medical home significantly different across subgroups at $p < 0.05$ (χ^2 test)

Table 4: Unadjusted and Adjusted Odds Ratios Logistic Regression Models for Each of the Criteria for Mediation Analysis (n = 14,242)

Criteria for Mediation	Model	Unadjusted* OR (95% CI)	Adjusted** OR (95% CI)
1. There must be a significant relationship between race and unmet healthcare need	Unmet Need = Black vs. White	1.9 (1.3, 2.7)	1.9 (1.2, 2.8)
2. There must be a significant relationship between race and not having a medical home (MH);	No MH = Black vs. White	2.0 (1.7, 2.5)	1.9 (1.5, 2.3)
3. Not having a medical home must be a significant predictor of unmet healthcare need in an equation that includes race	Unmet Needs = No MH vs. MH ; controlling for Race (Black vs. White)	5.3 (3.4, 8.3)*	4.2 (2.7, 6.8)

* For the first two assumptions, the unadjusted OR is the crude OR of the association. For the third assumption, the unadjusted OR is the association of unmet healthcare needs (outcome) and medical home (mediator), controlling only for race (exposure)

** Adjusted models additionally control for covariates: child age (0-5 vs. 6-17), child sex (male vs. female), parent education level (\leq HS vs. $>$ HS), chronic condition severity index (continuous), type of special healthcare needs (4 categories), region of the U.S. (North, South, Midwest, West), and urban vs. rural residence

Table 5. Estimates of the Natural Direct, Natural Indirect, and Total Effects of the Association between Race and Unmet Healthcare Needs for CSHCN (Mediated through Medical Home) (n = 14,242)

Adjusted* Odds Ratios					
Natural Direct Effect**		Natural Indirect Effect**		Total Effect	
OR _{NDE}	95% CI	OR _{NIE}	95% CI	OR _{TE}	95% CI
1.6	1.1, 2.4	1.2	1.1, 1.3	1.9	1.3, 2.9

*Adjusted for parent education level (\leq HS vs. $>$ HS), child age (0-5 vs. 6-17), child sex (male vs. female), type of special healthcare needs (4 categories), chronic condition severity index (continuous), region of the U.S. (North, South, Midwest, West), and urban vs. rural residence

** Natural direct and indirect effects were calculated using equations 1 and 2 discussed in the methods section.