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ABSTRACT

Objective: While there are clear racial/ethnic disparities in child restraint system (CRS) use, to date no studies have identified mediators that quantitatively explain the relationship between race and CRS use. Therefore, the objective of this study was to provide an example of how a proportion-eliminated approach to mediation may be particularly useful in understanding the complex relationship between race and CRS use.

Methods: Sixty-two mothers with a child between 4-8 years old completed a survey and had their CRS use assessed by a Child Passenger Safety Technician using a structured assessment based on the 2018 American Academy of Pediatrics' Best Practice guidelines. Recruitment and data collection occurred in Birmingham, Alabama between June 2018 and January 2019. We used chi-squared tests, logistic regressions, and a proportion-eliminated approach to mediation to compare our variables of interest and to estimate the amount of the association between racial group membership and errors in restraint use that may be explained by sociodemographic, psychosocial, and parenting variables.

Results: Before mediation, Non-White mothers in this sample had a 7.38 greater odds of having an error in CRS use than White mothers. Mediation analyses indicated that being married and self-reported seatbelt use explained 47% and 35% of the effect of race on CRS use errors, respectively.

Conclusion: A proportion-eliminated approach to mediation may be particularly useful in child passenger safety research aiming to inform the development of interventions tailored for racial minority populations.

Introduction

Motor vehicle crashes are a leading cause of unintentional injury and death for children 1-15 years-old (CDC, 2019). Despite substantial reductions over recent decades in the overall age-adjusted mortality rate, racial and ethnic minority, or Non-White (e.g., Black, Hispanic/Latino), children remain more likely than White children to be killed or injured in a crash (CDC, 2019). This may be in part the result of differences in child restraint system (CRS) use. There are two CRS errors: (1) nonuse, or not using a CRS; and (2) misuse, or inappropriately using a CRS (e.g., incorrect installation, using an incorrect seat based on child's weight/height). Consistently, Non-White populations are more likely to not use or misuse CRS for their children (Li and Pickrell 2018), yet there remains a lack of effective intervention efforts to improve these outcomes for racial/ethnic minority groups. For example, universal prevention efforts, primarily legislation, may be ineffective and inadvertently increase rates of CRS misuse in minority groups (). Further, a recent systematic review and meta-analysis found few CRS interventions are tailored for minority groups; of those that are, few are rigorously conducted, evaluated, or report strong effects (Sartin et al. 2019). Therefore, it is paramount that we identify contributors to racial/ethnic disparities in CRS use, as knowing what contributes to disparities in use/misuse is the only way to inform the development of effective policies and interventions.

Caregiver income, education, and sources of information (i.e., where caregivers learned about CRS) have been hypothesized as potential contributors to disparities in CRS use/misuse (Macy et al. 2014); however, to date no studies have quantitatively identified factors that explain the relationship between race/ethnicity and CRS use. Importantly, there are many statistical approaches to assess mediation. One approach, known as the "proportion-eliminated approach", is frequently used in epidemiology and the biomedical sciences as it is particularly useful in intervention and policy work (VanderWeele 2013; Suzuki et al. 2014). This method consists of fitting two regression models, in which the first model regresses the outcome on the exposure to obtain the total effect of the exposure *A* on the outcome *Y*. Then, the second regression adds the mediator to the first model. The indirect effect is calculated as the change in the coefficient of the exposure variable, based on the presence of the mediating variable. When compared with the "product method"—which is more commonly used in the social sciences and has been the approach most often used in previous child passenger safety work—the proportion-eliminated method most often produces similar estimates of mediation (Baron and Kenny 1986; VanderWeele

2016). However, an advantage of the proportion-eliminated approach—and why it is more useful for applied purposes—is that it captures how much of the effect of the exposure on the outcome could be eliminated by intervening on the intermediate, not just insight into the role of different pathways (VanderWeele 2013). To date, no studies examining factors that contribute to racial/ethnic disparities in CRS use have used a proportion-eliminated approach to mediation.

The Current Study

The overall objective of this study was to provide an example of how a proportion-eliminated approach to mediation may elucidate potential social and behavioral factors that underpin the association between race/ethnicity and CRS use. We identified several potential mediators of interest to explore in these analyses. First, Non-White or minority group membership is commonly associated with socioeconomic indicators, like educational attainment (Brown and Moran 1997; Cairney et al. 2003; Weitoft et al. 2003). Additionally, injury prevention researchers have posited that children's injury risk results from interactions among child, caregiver, and contextual/environmental factors. In other contexts, caregivers contribute to child injury risk through an interaction of caregiver supervision and individual differences in caregiver attributes (e.g., risk tolerance) (Morrongiello and House 2004; Saluja et al. 2004; Morrongiello et al. 2006; Schwebel et al. 2011; Goodman et al. 2018). For families living in stressed contexts (e.g., poverty), caregiver attitudes and sociodemographic factors may be especially associated with a child's risk of injury (Middlemiss 2003), but there is little research on this topic outside of the child abuse and neglect literature, and none related to CRS use. Additionally, previous risk behavior is an important antecedent to future behaviors (Gibbons et al. 1998; Gerrard et al. 2008), which may explain why a lack of caregiver seat belt use is often associated with CRS non/misuse (Benedetti et al. 2017; Lee et al. 2019).

Thus, we conducted a mixed-methods study of 62 mother-child dyads. Mothers completed a survey and had their CRS use assessed by a Child Passenger Safety Technician (CPST) using a structured observational protocol. We hypothesized that (1) Non-White mothers would have higher rates of CRS non/misuse than White mothers; (2) caregiver factors, including attitudes and sociodemographic variables, would be associated with CRS non/misuse; and (3) adopting a proportion-eliminated approach to mediation would identify potential mediators of race and CRS use.

Methods

Participants

The study protocol and recruitment materials were approved by the IRB of the University of Alabama at Birmingham (UAB). Eligible dyads were mothers and their children (4-8 years old) who were fluent in English and could travel to UAB. Participants were recruited from June 2018 to January 2019 using community advertisements (e.g., radio advertisements, flyers).

Eighty-nine people contacted the study team. Of these, 2 (2.2%) were ineligible because they were not the mothers of the child, 3 (3.4%) were ineligible because of their children's ages, and 2 (2.2%) were eligible but did not enroll. After enrollment, 10 (12.2%) dyads were unable to be contacted again to complete the survey or to schedule the observation, and 10 (12.2%) completed the survey but did not have CRS behaviors evaluated. Participants who enrolled but did not finish study procedures were more likely than those who completed study procedures to be single mothers (p=0.03), but did not differ on race (p=0.26) or education (p=0.24). The final sample included 62 mother-child dyads. Mothers received $40 and a CRS with personalized instruction provided by a certified child passenger safety technician (CPST), while children received a prize worth approximately $5.

Surveys

Mothers completed a phone survey. Responses were categorized for this study to create the following variables: race (White or Non-White), education (< 4 year degree or $\geq$ 4-year degree), marital status (single or married), seatbelt use (always or less than always when riding as a driver *and* a passenger), and categorical crash risk perceptions, measured by mothers' responses to the prompt: "*Overall, for you, do you believe you are at a low, medium, or high risk of getting into a crash when you are driving with your child or children?*" We originally asked participants to also report their ethnicity, however all participants identified as Non-Hispanic/Latino. Therefore, we only use race, not ethnicity, in our analyses.

Mothers then completed The Parent Supervision Attributes Profile Questionnaire (PSAPQ), a validated questionnaire measuring supervision related to children's risk of unintentional injury (Morrongiello and House 2004; Morrongiello and Corbett 2006). Mothers indicated the extent to which they agreed with statements using a 5 point likert scale of *Strongly Disagree to Strongly Agree.* An example items is, *"I have my child within arm's reach at all times."* The 29 items combine to create four factors: Protectiveness, Supervision Beliefs, Risk Tolerance, and Fate influences. Higher scores of Protectiveness and Supervision Beliefs and lower

scores of Risk Tolerance and Fate influences indicate stronger, more proximate, styles of supervision. While originally validated for caregivers with children 2-5 years old, the original measure has been successfully used in children up to 6.5 years old (Morrongiello et al. 2009), so for consistency this measure was used to assess caregivers' supervision practices of all children in the current sample, regardless of age.

Observation Protocol

Observations were conducted within 4 weeks of enrollment. Once the dyad arrived for their appointment, a CPST documented if the child arrived in a CRS, and if so, the type of seating, how and where the CRS was installed, if the seat moved less than 1 inch movement in any direction, and if the child was appropriately seated according to CRS manual stipulations (e.g., not sitting on knees, harness in appropriate position). Evaluated errors included: child not seated in a CRS, child too large or too small for CRS, a CRS installed incorrectly (e.g., LATCH and seat belt both used against seat manual instructions), a CRS not installed securely (only relevant for harnessed seats; more than 1 inch movement at the base), and a child not correctly restrained in CRS (e.g., harness error, belt not routed across chest as is appropriate for booster seats). This structured assessment was developed based on the most recent recommendations of the American Academy of Pediatrics (2018), which state caregivers should consult with CRS manuals to guide their CRS use and child passenger safety behaviors(American Academy of Pediatrics 2018).

Statistical Analyses

We conducted chi-squared tests to compare our variables of interest by mothers' racial group (White, Non-White). Logistic regression was used to estimate associations between racial group membership and errors (present, absent) and mediation analyses estimated the amount of the association between racial group membership and CRS non/misuse behaviors that may be explained by psychosocial and behavioral parenting variables. The outcome variable was the presence of any CRS error recorded by the CPST including not using a CRS. Each hypothesized mediating variable was examined separately to determine its individual effect on the relationship between race and CRS non/misuse. Mediation analysis was implemented using the proportion-eliminated approach, in which the change in the odds ratio (OR) associated with race was assessed with subsequent adjustment for potential mediating factors. Specifically, we utilized the formula

$$Proportion\ Eliminated = \frac{OR^{TE} - OR^{CDE}}{OR^{TE} - 1}$$

where OR^{CDE} denotes the estimated controlled direct effect of race (the OR for race after adjustment for the potential mediator), and OR^{TE} is the estimated total effect of race (VanderWeele 2015). Proportion eliminated was calculated for each potential mediating factor, where 0% indicates no indirect effect of race through the mediator. Adjusting for a potential mediator can increase or decrease the exposure OR, leading to negative and positive estimates of proportion eliminated, respectively. Given the preliminary nature of this paper and because this mediation approach is prone to wide confidence intervals that are not helpful in interpretation (MacKinnon and Luecken 2008; VanderWeele 2015), the proportion mediated results are not intended to be directly assessed for statistical significance. Therefore, we present the estimates and corresponding 95% confidence intervals for the ORs of race, but we do not present confidence intervals for the proportion eliminated estimates. All analyses were completed in R (version 3.4.0) (R Core Team, 2014).

Results

Participants and general descriptive information

Table A1 presents participant characteristics and PSAPQ factor scores by racial groups. The majority of Non-White mothers identified as Black (n=35); one identified as Asian and two as Mixed-race (Black and White). Compared to White mothers, Non-White mothers were less likely to use a CRS for their child upon arrival to the study ($p < 0.001$). Additionally, Non-White mothers were more likely to be single ($p < 0.001$), not have a four-year degree (p=0.007), reported more often they did not always wear a seat belt (p=0.003), and reported lower perceived risks of crashing while driving with their children (p=0.02). On the factor scores of the PSAPQ, Non-White mothers had higher scores than White mothers on Protectiveness (p=0.07) and Supervision ($p < 0.001$), and lower scores of Risk Tolerance (p=0.005). There were no differences between racial groups in CRS misuse (when a seat was present at the observation), the PSAPQ subscale of Fate beliefs, child's age, child's sex, or the mother's age.

Mediation analyses

Table 1 presents the results of the mediation analyses. Before mediators were included in the analyses, Non-White mothers had a 7.38 greater odds of having an error in CRS use (including not using a CRS) than White mothers. The mediation analyses indicated two variables were particularly influential on the OR of race: marital status and seat belt use. Marital status explained

47% of the effect of race on CRS errors, while the mother's reported frequency of using a seat belt explained 35%.

Discussion

The importance of asking and answering research questions in ways that produce actionable and interpretable results for policy-makers concerned with improving child health and development has long been noted (Huston 2005). In this vein, the purpose of this study was to demonstrate how a proportion-eliminated approach to mediation can be more useful for applied social and behavioral injury prevention research than other statistical mediation methods, particularly in work aiming to inform the development of interventions tailored for racial minority populations. The results of this paper indicated that this method is feasible to use and produces easy to understand quantitative results that can be readily translated to academic and other audiences. Specifically, we estimated how much of the effect of race on CRS use could be eliminated by intervening on constructs represented by the variables marital status and reported seat-belt use.

Strengths of this study include the novel application of a statistical method to child passenger safety. It is also the first study to successfully identify factors that may explain at least part of the relationship between race and CRS non/misuse, which researchers and practitioners can leverage to inform future work aiming to inform the development of intervention efforts and resources for Non-White populations. While our study had many strengths, the size and nature of the associations we observed may differ in other samples due to our reliance on a small convenience sample of participants. The proportion-eliminated approach we used has several limitations, including being extremely variable and prone to producing wide confidence intervals (MacKinnon and Luecken 2008; VanderWeele 2015). More work is needed to explain the complex relationships between race and CRS use, with acknowledgement that these relationships are dynamic and likely culturally and contextually. The methodology demonstrated in this report illustrates the application of a statistical method to support that effort.

Table 1. Odds of Non-White mothers having CRS non/misuse after mediation

Model	Race OR	% Change in OR
No Mediators (Non-White)	7.4 (2.4, 25.1)	-
Marital Status (Married)	4.4 (1.1, 19.8)	47
Seat Belt Use (Always)	5.1 (1.6, 18.2)	35
Crash Risk (Medium)	6.4 (2.0, 22.3)	15
Risk Tolerance	6.8 (2.1, 23.8)	10
Protectiveness	6.7 (2.1, 23.2)	10
Supervision	7.3 (1.9, 32.6)	<1
Fate	8.6 (2.6, 32.7)	-19
Education ($\geq$ 4 Year)	8.8 (2.6, 36.3)	-22

Table 1 notes. Each OR value indicates the OR for race (Non-White) after the mediation of each variable. For example, after the addition of marital status, the OR for Non-White mothers decreased from 7.4 to 4.4.

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children living with single parents in Sweden: a population-based study. Lancet. 361(9354):289–295.

Appendix

Table A1. *Participant characteristics and measures by race*

Variable	White (N= 24) N (%)	Non-White (N=38) N (%)	p
Marital Status			
Single	1 (4)	26 (68)	<0.001
Married	23 (96)	10 (32)	
Education			
< 4 year degree	5 (19)	21 (55)	<0.01
≥ 4 year degree	21 (81)	17 (45)	
Child's Age			
4	7 (29)	13 (34)	0.97
5	7 (29)	9 (26)	
6	3 (13)	5 (13)	
7	5 (21)	6 (16)	
8	2 (8)	4 (11)	
Child's Sex			
Boy	12 (50)	15 (39)	0.42
Girl	12 (50)	23 (61)	
Seat Belt Use			
Every Time	23 (96)	24 (63)	<0.00
Not every time	1 (4)	14 (37)	
Perceived Crash Risk			
Low	15 (63)	33 (87)	0.02
Medium	9 (38)	5 (13)	
High	-	-	
CRS Used			
Yes	23 (96)	18 (47)	<0.00
No	1 (4)	20 (53)	
Errors when seat used			
Yes	8 (33)	11 (29)	0.09
No	15 (63)	7 (18)	
	Mean (95% CI)	Mean (95% CI)	p
Mother's Age	33.7 (31.6, 35.8)	32.9 (31.1, 34.7)	0.56
PSAPQ			
Protectiveness	36.5 (34.6, 38.2)	38.4 (36.9, 39.9)	0.07
Supervision	30.0 (28.6, 31.4)	34.7 (33.4, 36.0)	<0.00
Risk Tolerance	32.3 (30.9, 33.8)	30.3 (29.1, 31.4)	<0.01
Fate	6.0 (5.2, 6.7)	6.8 (6.0, 7.5)	0.11

Table A1 note. Percentages rounded to the nearest whole number.