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Project Title:
Reassessing Child Pedestrian Mode Choice & Safety via Perceived Parental Risk

University:
University of Colorado Denver

Principal Investigators:
Wesley Marshall
Associate Professor
University of Colorado Denver
Phone: (303) 352-3741
Email: wesley.marshall@ucdenver.edu
ORCID: 0000-0002-3106-7342

Bruce Janson
Professor
University of Colorado Denver
Phone: (303) 556-2831
Email: bruce.janson@ucdenver.edu
ORCID: 0000-0003-2901-8506

Research Needs:
The common narrative is that transportation safety outcomes for child pedestrians and bicyclists have been steadily improving for decades. Over a recent 10-year period, for instance, population-based fatality rates for child pedestrians decreased by over 40% and injury rates decreased by over 30% (Dukehart, Donahue, Deeks, and Prifti 2007, UNC Highway Safety Research Center 2010). Despite huge increases in population, even the raw number of child pedestrian deaths dropped from over 1,000 per year in the 1980s to now fewer than 400 annually (Percer 2009). However, these numbers can be misleading because they do not account for levels of child pedestrian and bicycling activity – also known as exposure – which is thought to be progressively decreasing over the years (PBIC 2012). Why does this matter? If children are now being driven to most of their destinations, we should expect fewer active transportation deaths and injuries. In other words, a low number of childhood pedestrian fatalities and injuries does not necessarily mean that roads are safer for child pedestrians; it could just mean that more children are in cars. Furthermore, these shifts away from active travel may not even mean that children are any safer in the overall transportation system since traffic-related deaths remain the number one cause of death for Americans aged 4 through 34 (CDC 2014).

These interrelated issues lead to the research questions that this project will strive to answer:

> To what extent have our cities actually been getting safer for child pedestrians and bicyclists, and to what extent has the transportation system been suppressing childhood active transportation?

To answer these research questions, this project will first evaluate existing rates of walking and bicycling to school for selected elementary and middle schools in Denver, Colorado. We will then measure the impact of parental safety perceptions – measured through a survey – and develop a mode choice model to estimate the number of active transport trips suppressed by road safety fears (Nevelsteen, Steenberghen, Rompaey, and Uyttersprot 2012). Lastly, we will reassess safety outcomes and attempt to identify unsafe areas that may have been neglected by traditional safety analyses. If child pedestrians and bicyclists are indeed safer now than in the past, this gives credence to the effectiveness of our current efforts. If our better safety record for child pedestrians and bicyclists has more to do with a system that has intimidated parents into chauffeuring their kids whenever possible, then it means that we have more work to do.

While these questions may be asked about pedestrians and bicyclists of all ages, children will be the focus of this work because of the critical role perceived safety plays in childhood mode choice and the important mental, physical, and developmental benefits that active travel provides for children. In addition, children's trips are typically regulated by parents and are often concentrated around select locations such as schools and parks, making them more feasible to systematically study at a large scale.

Research Objectives:

1. Collect child pedestrian and bicyclist exposure data
2. Gather built environment data
3. Measure perceived safety by parents
4. Build a mode choice model
5. Explore the implications of perceived safety on exposure
6. Reassess road safety outcomes
7. Advance policy and practice with respect to building safer cities
8. Advance education through the training of students
9. Build an evidence base by disseminating findings through publications and presentations

Child pedestrians and bicyclists are an important but understudied consideration when it comes to examining transportation system safety. Because of their unfinished physical and mental development, as well as their lack of protection from a vehicle, child pedestrians and bicyclists rank among our most vulnerable road users. Ensuring that a transportation system is safe for child pedestrians and bicyclists will go a long way towards making the system safe for most other road users. Towards these ends, this study will seek to:

1. Collect child pedestrian and bicyclist exposure data – We will estimate existing mode choice to school via a combination of manual observations and parental survey results. This will establish a baseline and allow for a calibration of the later mode choice model.
2. Gather built environment data – Built environment data will be obtained from publicly-accessible databases maintained by the City and County of Denver. This data, obtained in GIS format, will be operationalized to fit into the mode choice model. Data will include street and intersection design characteristics (including posted speeds limits, number of lanes, volumes, and roadway widths), non-motorized facilities networks, land use, and other pertinent variables.

3. Measure perceived safety by parents – Utilizing a survey administered to parents and guardians of school children, we will determine how roadway characteristics and non-motorized facilities impact perceptions of safety. Age, gender, and other demographic data will be collected while respecting the privacy of respondents. It is anticipated that parents will be reached by email, and the survey will be administered online. The survey will be approved by the Institutional Research Board at the University of Colorado Denver.
4. Build a mode choice model – Once an understanding of how different facilities impact parental perceptions of safety is obtained, the impact on child mode choice to school will be derived through a multinomial logistic regression mode choice model. The mode choice model will control for demographic, socio-economic, and built environment factors as well as other reasons – beyond perceived road safety fears – such as scheduling conflicts that explain why parents may opt to drive their children to school.
5. Explore the implications of perceived safety on exposure – By finding the difference between existing levels of pedestrian and bicycle activity and the possible levels that account for perceived – and real – safety fears, we will estimate the number of trips that are being suppressed by perceptions of unsafe conditions.
6. Reassess road safety outcomes – A more thorough understanding of the demand suppressed by perceived and real road safety issues will help us identify unsafe areas that may have been neglected by traditional safety analyses.
7. Advance policy and practice with respect to building safer cities – Findings will be utilized to implement policies aimed at building safer cities. Methodologies will be shared so that transportation analysts in other cities may identify previously neglected links in their non-motorized networks. Improvements that may maximize child pedestrian and bicycling activity will be identified.
8. Advance education through the training of students – Interested students may participate in research activities as well as be provided access to data and methodologies for further analysis.
9. Build an evidence base by disseminating findings through publications and presentations – Methodologies and findings will be presented at conferences as well as published in peer-reviewed journals.

Research Methods:

The research project will consist of three key stages: 1) obtaining data and administering a survey; 2) developing a mode choice model; and 3) performing a safety analysis.

Data will first be gathered for child pedestrian and bicyclist exposure, built environment factors, safety, demographics, and socio-economics. Current exposure levels will be measured as the number of child pedestrians and bicyclists arriving and departing from the study schools. Both elementary and middle schools will be observed so that we can assess child age as a variable in itself. Because many high school students may have their own driver's license and may not be dependent on parental supervision, they will not be included in the analysis. Built environment factors will include roadway networks and characteristics such as roadway width, volume, posted speed limit, and the presence of non-motorized facilities. This data will be obtained from the City and County of Denver in GIS format and operationalized for the model. Safety data will

take the form of points in GIS for injuries and fatalities. Neighborhood-level demographics and socio-economics will be collected from the Census.

While following the Institutional Research Board process, the survey will account for the age and gender of each student and whether a trip is supervised or autonomous. Working with the school board, the survey will be emailed directly to parents. Portions of the survey will be adapted from a 2012 Belgian study by Nevelsteen et al. Parents will be shown pictures of a number of roadway scenarios with different pedestrian and bicycle facilities, posted speed limits, and roadway widths. The parents will be asked if they would let their child: 1) walk alone; 2) walk supervised; 3) bicycle alone, and/or; 4) bicycle supervised. Based on responses from the parents, we will understand which factors most influence perceptions of safety, and in turn, influence child mode choice to school.

The second step of the research project consists of creating a mode choice model. Ewing et al. (2004) found that a multinomial logit model is well suited for school mode choice. Characteristics of both the alternatives and the subjects can be accounted for with a multinomial logit mode choice model. This allows us to control for factors such as school accessibility, school size, trip distance, sidewalk presence, and grade level.

Utilizing known exposure levels and the mode choice model, the objective is to optimize the perceived safety variables in order to understand how many trips may be expected if safety was rendered a non-issue. Then, after deriving actual and suppressed levels of child pedestrian and bicycling exposure, crashes will be integrated with model outputs. Once safety has been integrated with the models, negative binomial regression analysis will be used to explore the significance of the key corridors identified. Negative binomial regressions are commonly used when analyzing relatively rare and discrete events and are common when measuring transportation casualties (Harwood, Bauer, Potts, Torbic, Richard, Kohlman Rabbani, Hauer, and Elefteriadou 2002).

Findings from this work will be two-fold: i) which roadway characteristics are most responsible for suppressing child pedestrian and bicycle trips; and ii) locations which have suppressed trips because of poor safety perceptions and therefore have few casualties (and have consequently been neglected by traditional safety analyses). Findings will be compared to DRCOG's Pedestrian and Bicycle Safety in the Denver Region (2012), and policy implications will be explored.

Expected Outcomes:

In order to prioritize transportation improvements, traditional safety analyses typically identify corridors and intersections with either high numbers of absolute casualties or high rates of casualties. Either way, a corridor needs to have casualties to be identified. But what if a corridor or intersection is so unsafe that it completely suppresses pedestrian and/or bicycling activity, and therefore, does not have any casualties? Is it possible that there are parts of our transportation system that have been neglected by traditional safety analyses because they are so unsafe? Such zero-inflation frequently occurs with transportation safety data (Lee, Stevenson, Wang, and Yau 2002). While existing levels of pedestrian and bicycling activity may be low, these corridors could be important missing links or vital connections in a non-motorized network. In order to

identify these missing links, we will focus on the areas that child pedestrians and bicyclists want or need to use but that parental perceptions deem unsafe. Related to these issues, the expected outcomes of this work include:

1. Findings with respect to the testable hypotheses and research questions;
2. A set of explanatory and dependent variables and constructs where we can disaggregate the factors influencing better road safety for child pedestrians and bicyclists;
3. Manuscripts for presentation/publication at TRB and other peer-reviewed journals;
4. Presentations to academic and policy audiences; and
5. A module about road safety, active transportation, and vulnerable road users for transportation graduate courses at the University of Colorado Denver.

Improving safety outcomes for vulnerable child pedestrians can also result in substantial benefits beyond road safety. While low levels of physical activity have been shown to lead to increased rates of obesity and diabetes, walking and bicycling can be important sources of daily physical activity for children (Sallis and Glanz 2006, Marshall, Piatkowski, and Garrick 2015, Rahman, Cushing, and Jackson 2011, Fox 2004, Troiano, Berrigan, Dodd, Masse, Tilert, and McDowell 2008). The research also suggests that walking and biking to school can help improve academic and behavioral outcomes (Louv 2005, O'Brien and Tranter 2006, Taras 2005, UK Department of Transport 2006). Moreover, building the habit of walking early on is more likely to result in utilitarian walking as a lifelong activity (Tudor-Locke, Ainsworth, and Popkin 2001). For all of these reasons, it is important to ensure that children are provided with the opportunity to safely use their transportation system as pedestrians and bicyclists.

Relevance to Strategic Goals:

- Safety
- Livable Communities

The work primarily falls under the strategic goal of safety, but it also highly relates to livable communities. When considering road safety, child pedestrians and bicyclists are some of the most important users to account for, often being specifically called attention to in safety studies (Karsch, Hedlund, Tison, Leaf 2012, National Highway Traffic Safety Administration 2017). However, they are also some of the most overlooked users and typically lack any political voice to call attention to their needs. Therefore, if we are to pursue the strategic goals of safety and livable communities, this work will serve as an especially important bridge to those ends.

Educational Benefits:

This study will be integrated into Dr. Marshall's "Transportation System Safety" graduate course and Dr. Janson's "Traffic Safety Data and Analysis" graduate course. The data collected and models constructed for this project will also be made available to students for use in term projects and/or master's reports. As a result, this project will influence students from a variety of disciplines. Students who work on the project will have the opportunity to be co-authors on publications and presentations.

Tech Transfer:
Further utilization of the models by others for more holistic pedestrian and bicycle safety analyses is the overarching goal of this work, and transfer of the information is vital. The modeling results will be in a non-proprietary form so that others may use them. The structure of the developed models will be made available so that other researchers may apply the safety analyses techniques to their cities. We will also disseminate knowledge through personal correspondence, publications, and conference attendance.

Work Plan:

1. Conduct literature review
2. Collect pedestrian/bike exposure data
3. Collect built environment/SES data
4. Administer Parental/Guardian Survey
5. Collect and geocode safety data
6. Develop mode choice model
7. Integrate safety with mode choice
8. Analyze data
9. Incorporate lessons into transportation classes
10. Draft manuscripts and presentation materials

The proposed scope of work is scheduled for a one-year timeframe, beginning with notice to proceed from the Mountain Plains Consortium. Major project steps include the following:

Task Timeline
Months 1-2: Conduct literature review; Collect pedestrian/bike exposure data; and Collect built environment/SES data
Months 2-4: Administer Parental/Guardian Survey
Months 3-6: Collect and geocode safety data
Months 4-6: Develop mode choice model
Months 6-7: Integrate safety with mode choice
Months 7-10: Analyze data
Months 8-10: Incorporate lessons into transportation classes
Months 10-12: Draft manuscripts and presentation materials

The research project will begin with an exhaustive literature review focusing on mode choice, exposure, demand, and safety modeling, specifically related to children and active transportation modes. Both primary and secondary data will be collected pertaining to exposure, built environment, and safety. Along with secondary data collection, a survey will administered to understand the impacts of parental safety perceptions on child mode choice. Once all data is collected, a mode choice model for children's trips to school will be developed that accounts for parental safety perceptions. Actual safety outcomes will then be integrated with the mode choice model to identify areas where trips are being suppressed but poor safety outcomes are not seen (unsafe areas that would be neglected by traditional safety analyses). Denver Regional Council of Government's Pedestrian and Bicycle Safety in the Denver Region (2012) will then be examined in order to see if any vital corridors have been neglected.

Project Cost:

Total Project Costs:	$177,882
MPC Funds Requested:	$88,940
Matching Funds:	$88,941
Source of Matching Funds:	University of Colorado Denver

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