HHS Public Access

Author manuscript

Accid Anal Prev. Author manuscript; available in PMC 2020 November 09.

Published in final edited form as:

Accid Anal Prev. 2019 October ; 131: 350–356. doi:10.1016/j.aap.2019.07.017.

Parent-adolescent bicycling safety communication and bicycling behavior

Cara J. Hamann[a,*], **Steven Spears**[b]

[a]University of Iowa Injury Prevention Research Center, University of Iowa College of Public Health, Department of Epidemiology, 145 N. Riverside Dr., Iowa City, IA, 52242, United States

[b]University of Iowa, School of Urban and Regional Planning, 349 Jessup Hall, Iowa City, IA, 52242, United States

Abstract

Introduction: Efforts to encourage bicycling to school have increased in the United States. However, little is known about how parent-child communication affects bicycle safety. The purpose of this study was to examine parent-child agreement on biking instructions and their correlation with the early adolescents' real-world riding behavior.

Methods: Parent-child dyads were asked open-ended questions about instructions they had given/ received about bicycling. Answers were then coded into nine categories (e.g., crossing the road, bicycle control/handling). Distributions of parent-child agreement on parent-given bicycle safety instructions were examined in relation to the adolescent's real-world riding behaviors.

Results: 36 parent-child dyads were included. Average age was 11.9 (Range: 10–15) for adolescents and 43.3 (Range: 30–59) for parents. Common parental instructions included: wear helmet, ride on sidewalk, and trip routing specifications. High 'ride on sidewalk' instruction (38.9% both parent and adolescent, 22.2% parent only, 16.7% adolescent only) was concerning due to potential driveway conflicts. Agreement between parents and adolescents on reported instructions was low, overall. Mean safety-relevant event rates in real-world cycling did not differ significantly between bicycle safety instruction agreement groups (both parent & adolescent reported, parent only, adolescent only, neither). The proportion of time an adolescent rode on different infrastructure types (sidewalk, street, etc.) did not vary between dyads reporting parents had given instructions to ride on the sidewalk and those who had not.

Conclusions: Results highlight lack of agreement between parents and adolescents on cycling instructions the adolescent receives from the parent. Parent instructions to adolescents regarding bicycling safety were not associated with actual riding behaviors. Results suggest parent messaging to adolescents may be ineffective. Given parents are in a position of influence, results indicate a need for parental training on effective safety-related communication strategies to assist them in capitalizing on their parental role to increase their child's safety.

*Corresponding author. cara-hamann@uiowa.edu (C.J. Hamann).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Keywords

Rules; Adolescents; Risk; Parenting; Education; Vulnerable road users

1. Introduction

Overweight and obesity among adolescents has become a critical public health issue in the United States and is increasingly problematic worldwide. Physical inactivity is one of the main factors associated with weight increases among adolescents, and initiatives to increase activity have included active transportation to and from school, such as walking and bicycling. Efforts to encourage bicycling to school have been led by programs like Safe Routes to School (SRTS) (National Center for Safe Routes to School, 2017).

SRTS improvements, such as better bicycle facilities and improved crossings, have been implemented nationwide. However, bicycling crashes remain one of the leading causes and burdens of injury among adolescents aged 10–15 (Sleet et al., 2010; Agency for Healthcare Research and Quality, 2012; Hamann et al., 2013; Centers for Disease Control and Prevention, 2017; NHTSA, 2018). In the United States, Children ages 10–15 have over 57,000 bicycling-related emergency department visits and 50 deaths annually (National Center for Injury Prevention and Control, 2017) and bicycling injuries involving motor vehicles tend to be the most severe (Hamann et al., 2013). The continued problem of adolescent injuries and deaths in cycling crashes supports the need for a multi-pronged approach to increasing safety that includes not only changes to the built environment, but also education of drivers, adolescents, and their parents.

Parents are typically one of the main sources of safety information and teachers of safety-related behaviors throughout childhood (Wurtele et al., 1991; Morrongiello et al., 2014). However, during early adolescence the parent-child relationship may rapidly change, with adolescents becoming more independent and resistant to parental guidance, including safety messaging (Laursen, 2004; Morrissey and Gondoli, 2012). Overall, the parent-child relationship during adolescence often becomes more egalitarian, which can result in weakened parental control and increased frequency and intensity of parent-child conflict (Branje, 2018).

Despite adolescent resistance to guidance and instruction, parents are poised as key influencers in their child's bicycling safety. Parents are experienced road users who, through cycling and/or driving, have gained safety insights that are important to pass on to their adolescent cyclists. However, they often lack adequate training in what to teach their children, how to effectively communicate with their children, or do not take full advantage of their influential role (Muir et al., 2010). Little is known about parent-child communication concerning bicycle safety and how this translates to actual bicycling safety-related behavior. It is also unknown whether parental bicycling safety messaging is misunderstood, ignored, inadequate, or not present and how these issues relate to real-world adolescent bicycling behavior.

This purpose of this study was to 1) identify the types of bicycle safety-related messaging that take place between parents and their children in the form of instructions, 2) examine parent-child agreement on bicycling safety instructions, and 3) determine how parental bicycling safety instructions were reflected in their child's real-world riding behavior.

2. Methods

2.1. Recruitment

Participants were recruited primarily via a university mass-email listserv. Emails sent through the listserv asked for interested participants to call or email the research team. The study was also advertised in a university hospital 'Noon News' newsletter and Twitter account, the local community school district's virtual backpack, and as a flyer to contacts at the county neighborhood centers.

2.2. Eligibility and enrollment

Eligible participants were early adolescents aged 10–15 who attended school within the metropolitan region (Johnson or Linn counties in Iowa) and rode their bicycle to school regularly. Participants were enrolled in-person either at their residence or another agreed upon location. At the enrollment visit, research staff consented/assented each adolescent participant and one parent/guardian, attached a GPS-enabled helmet camera to the adolescent's helmet and gave instructions on how to operate it. The camera angle and operation were also tested during this visit by connecting the camera via Bluetooth to either a tablet computer or cell phone to transmit and view the image being recorded. Participants were compensated with $25 at the time of enrollment and $50 at the end of the one-week study period, for a total of $75 each.

2.3. Data collection

At enrollment, each adolescent and parent filled out baseline surveys on demographic and bicycling-related questions. In the survey, adolescents were asked "Have your parents/ guardians given you any specific instructions on how you should bike when riding by yourself? And "If yes, what are the instructions they have given you?" Parents were asked how frequently they ride a bicycle, whether they have taken a bicycle education class, and whether they had given their child any specific instructions about how to bicycle when riding independently.

The parent and adolescent questions regarding bicycling instructions were intentionally chosen to be open-ended because little is known about conversations between parents and their children about bicycling safety or about safety conversations in general, so a list of options would likely have been incomplete and biased. Additionally, studies of parent-child communication related to injuries and injury prevention have used open-ended question format as part of in-home interviews(Peterson et al., 1993; O'Neal et al., 2016).

Research on open-ended questions related to recall of a crime film found that the quantity of responses was smaller with open-ended questions versus a close-ended checklist, but the accuracy of responses was higher(Lipton, 1977; Shapiro, 2006). This would suggest that the responses elicited from our open-ended question may have elicited fewer responses than a close-ended question, but the accuracy of the recall may be higher. Open-ended questions have also been found to lead to a more diverse set of responses. For example, a study comparing open- and close-ended questions with a write-in option found that respondents most frequently restricted their answers to the alternatives offered, whereas the open-ended question elicited a more diverse answer set (8 additional to the 10 that were in the close-ended list)(Reja et al., 2003). This is particularly relevant to our project, for which the knowledge needed to create a robust close-ended checklist question was lacking.

Adolescent participants were asked to video record all of their bicycling trips for seven consecutive days using Contour action cameras (170° horizontal field of view, 30 frames per second, GPS-enabled). All trips were captured between September and November 2015, while school was in session. Participants were also asked to keep a written trip diary in addition to recording their trips with the GPS camera. In the diary they recorded the trip date, time of day, trip purpose, and descriptions of any crash, near crash, or things that made them feel unsafe. A trip was defined as a ride from one origin to one destination, therefore riding from home to school and then school to home was recorded as two trips.

Data from the cameras were uploaded via USB connection after the cameras were collected from participants at the end of their respective data collection periods. All trip videos and GPS were manually viewed by trained raters and ride characteristics and safety-relevant events were coded using a graphical user interface designed specifically for this purpose by the research team. The raters were trained using practice data which gave examples of each behavior type, until they could consistently identify and code to 100% agreement. Ten percent of all coded videos were randomly selected to be double-coded to confirm agreement of at least 95%. Any discrepancies were reviewed by both raters and the larger research team and were resolved via consensus.

2.4. Variables

2.4.1. Bicycling instruction topics—The instructions reported by the parents and children from the open-ended questions were categorized into nine topic areas: 1) general (unspecified) safety (e.g., ‘Be safe’), 2) bicycle control and handling, 3) ride on sidewalk or off-street, 4) things to wear (e.g., helmet, bright clothing), 5) crossing the road (e.g., only cross at designated crosswalks), 6) personal security (e.g., call when you arrive), 7) be predictable, 8) which route to take/avoid, 9) position (e.g., ride on right side of street; Table 1). All responses were reviewed and subjectively grouped into categories by the study research assistants, based on common themes. These groupings were then reviewed and revised by the research team until a consensus was met. Four reporting groups were created based on comparison between parents and their children for each instruction topic: both parent and adolescent reported, parent only reported, adolescent only reported, neither.

2.4.2. Route characteristics—Route characteristics extracted from participant video and GPS data included the proportion of total riding type by surface infrastructure type: sidewalk, street, street with bike facility, bike path, gravel, and other. The proportion of total riding times on different infrastructure types were compared across the dyads who did or did not report an instruction indicating that the adolescent should ride on the sidewalk (off-street).

2.4.3. Safety-relevant event rates—

Safety-relevant events coded from the video and GPS data that could be mapped to the bicycling instruction topics included: reckless riding, yielded when should have stopped, failure to stop or yield, and on-street wrong way riding (riding opposite the flow of traffic). Event rates were calculated with riding time as the denominator and number of events observed as the numerator (events per hour). These event rates were compared to corresponding bicycle safety instruction topics based on whether both the parent and adolescent, parent only, adolescent only, or neither had reported that bicycle safety instruction was given (Table 4). For example, the reckless riding event rates were compared across dyads who had or had not reported an instruction related to bicycle handling or bicycle control.

2.5. Analysis

Survey data and recorded riding behavior were analyzed to evaluate three research questions: 1) What types of instructions do parents give to their children about bicycling safety? 2) To what degree do parent and adolescent responses agree in terms of cycling instructions given by the parent? 3) What impact does the number and type of instructions have on observed safety-relevant events during actual riding?

2.5.1. Parent-child cycling instruction agreement—

Distributions of parent and adolescent demographic and bicycling-related questions from the baseline surveys were examined. Agreement between parents and their children on the nine categories of bicycling instructions were assessed using the Kappa coefficient, which is appropriate for matched data with a categorical dependent variable that has more than two levels. Kappa is a measure of the agreement between two individuals, in this case parents and their children, and agreement ranges from 0 (poor/none) to 1 (perfect).

2.5.2. Parent bicycle safety instructions and adolescent riding behavior—

Four of the nine parent and adolescent instructions were compared to the real-world adolescent bicycling behavior: ride on sidewalk or off-street, bicycle handling/control, crossing the road, and positioning (e.g., ride on right side of street). The remaining five instruction topic areas could not be directly mapped to the real-world riding behaviors. For example, helmet-related instructions could not be compared because all the children in the study were required to wear a helmet and helmet-mounted camera on each ride.

Means and standard deviations were calculated and ANOVAs were performed to test the difference between the means of each route characteristic outcome (see Table 1) across the four reporting groups for each instruction topic (both parent and adolescent reported, parent only reported, adolescent only reported, neither). Each of the proportion outcomes were log-transformed, to better approximate a normal distribution.

Unadjusted models were built for each of the safety-relevant rate-based outcomes (reckless riding, yielded when should have stopped, failure to stop or failure to yield, and wrong way riding), based on the negative binomial distribution, and a log link function, which was appropriate given that the outcomes were counts of events. Total riding hours (log transformed) were included as an offset variable, which allowed for the modeling of rates based on ratios of event counts (numerator) to trip duration (hours, denominator). Model diagnostics, including examination of residuals were used to assess adequacy of model fit. The negative binomial distribution was a better fit than Poisson, given the overdispersed nature of the data.

Spearman's rank-order correlation coefficients were also calculated to examine the association between the number of child instructions reported with the rate of safety-relevant events per hour and the number of parent instructions reported with the safety-relevant event rate per hour. The Spearman's rank order correlation (r_s) test was chosen because it is non-parametric and is a measure of the monotonic relationship between two variables, which is appropriate for our non-normally distributed data. Values of r_s can range from −1 to +1, where −1 is a perfect negative association, 0 is no association, and +1 is a perfect positive association.

3. Results

Forty parent-child dyads were enrolled and 36 with complete data were included in this study. Average age of adolescents was 11.9 (SD = 1.5, range 10–15) and 43.3 (SD = 6.1, range 30–59) for parents (Table 2). Among adolescents, 58.3% were male and 88.9% were white. Among enrolled parents, 50% were mothers, 94.4% were white, and the majority were highly educated (90% had 4-year college degree or higher education).

The most common types of bicycling instructions reported by parents and their children were: wear helmet, ride on sidewalk, intersection crossing caution, and trip routing (Table 3). Most topics were caution/avoid in nature (e.g., busy streets, driveways, pedestrians). Agreement on parent-child reported instructions was minimal, overall, with the exception routes to take/avoid ($\kappa = 0.42$, $p < 0.01$). Bicycle control/handing ($\kappa = 0.48$, $p < 0.01$) also had slightly higher agreement, but very few dyads reported those instructions, so agreement was due to the high number of both the parent and their child not reporting the instruction (neither reported). Adolescents reported a mean of 2.9 (SD = 1.3) instructions and parents reported 3.8 (SD = 1.7).

Next, we examined the rate at which adolescents were involved in safety-relevant events, such as not obeying traffic rules or riding in an unsafe manner. The mean safety-relevant event rate for all adolescents was 8.5 (SD = 5.8) per hour of riding. The overall correlations between the number of instructions reported by the adolescent and safety-relevant event rates and between the number of instructions reported by the parents and safety-relevant event rates were very weak ($r_s = 0.15$ and $r_s = 0.13$, respectively), suggesting that there is a weak relationship between parental bicycle safety related instructions on safety-relevant event rates during riding.

The proportion of time spent on the different surface types (sidewalk, street, bike facility, bike path, gravel, other) did not significantly differ based on the parent-child report groups (both, parent only, adolescent only, neither) of having a bicycle instruction to ride on the sidewalk (off-street) (Table 4). Safety-relevant event rates (reckless riding, yielded when should have stopped, failure to stop or yield, and wrong way riding) did not significantly differ between the related bicycle safety instruction topic agreement groups (both parent and child reported, parent only, child only, neither). Although there was variation between groups, the standard deviations and confidence intervals were large, indicating large variations between individual riders.

4. Discussion

Parents have an influential role in modeling and teaching their children about traffic safety (Muir et al., 2010; Hoskins, 2014; Muir et al., 2017). However, parents often do not use their position as an influencer to its maximum potential in reducing their child's injury risk (Muir et al., 2010). This study examined the type of bicycling safety instructions parents give to their children and the agreement between parents and children on the content of those instructions. The reported instructions were also compared to real-world child bicycling to examine if instructions were reflected in the child's riding behaviors.

The agreement between parents and children on what kind of bicycle safety instructions the parent had given was very low overall. Evidence from teen driving research has shown similar disagreement between parents and teens on driving expectations (Hamann et al., 2014) and parent-imposed driving restrictions (Beck et al., 2005). These teen driving findings may be comparable to early adolescent cyclists, as both represent a time of learning to be independent (non-adult supervised) road users- as drivers for the teens and as cyclists for the 10- to 15-year-olds. Previous research has also shown that parents tend to take more preventive actions if they believe that doing something can help their child avoid injury and if they feel they have the knowledge and competence level needed to teach their child the appropriate safety skills (Peterson et al., 1990).

We did not assess parental beliefs in this study, but we did see indications that parents may not be adequately informed about what type of guidance they should be giving their kids. Our sample of parents were largely infrequent or non-bicyclists themselves, so they may have a lack of personal knowledge on bicycling safety best practices. For example, a high number of participants reported 'ride on sidewalk' instruction (35.1% both parent and child, 16.2% parent only, 18.9% child only). This is of concern, given sidewalk riding is known to increase crash risk (Wachtel and Lewiston, 1994; Aultman-Hall and Hall, 1998; Cripton et al., 2015; Embree et al., 2016) and not generally recommended for cyclists age 10 or older, which encompasses our study population. Many of the dyads in the study reported that the parents gave general, non-specific safety messages, like "be careful", which is consistent with previous research on parental safety messaging (Eichelberger et al., 1990), but may also indicate parents lack the knowledge or skill to be most effective in increasing their child's bicycling safety.

In addition to there being little agreement between parents and their children on what instructions were given, the results of this study suggest that parent instructions have little influence on actual safe riding behavior. The rates of safety-relevant events during the adolescent's bicycling were not significantly associated with the instructions reported by the parent or child. These results suggest that parental safety messages are either not received (ignored) or not retained by the adolescent. For example, the parent may have provided safety information years ago and still remember, but their child may have forgotten or think it may not be applicable now that they are older. Results may also suggest that the parental messaging may be inappropriate (i.e., not aligned with best practices), ineffective, or misinterpreted. Though the reasons for the lack of retention, receptivity, and impact of parent instructions are not clear, making the most of all available means of relaying traffic safety information to children is important and more should be done to improve the potential influence that parents have in promoting bicycle safety.

Our findings contrast with evidence from the general parent-child communication literature, which has established a relationship between parent-teen discordance on parenting behaviors (e.g., parenting style, rules imposed, etc.) and negative adolescent outcomes and behaviors, e.g., (Howard et al., 1999; Beck et al., 2005; Mollborn and Everett, 2010; Maurizi et al., 2012). Although we did not find a similar negative relationship, it is possible that follow-up over a longer period of time and a larger sample size might reveal such a relationship. A larger sample size is particularly needed to study rare/infrequent outcomes, including crashes and near crashes (as opposed to errors and other safety-relevant events focused on in this study).

Overall, the results of this study indicate that more can be done to increase the relevance and effectiveness of the cycling safety messages parents give to their children to enhance adolescent receptivity, retention, and increased safety behaviors. Further assessment of parental involvement in their child’s bicycling safety is also warranted, to better understand the parental beliefs and practices and the parent-child relationship and how those could be improved to result in bicycling risk reductions. Increased parent restrictions and limit setting, for example, has been shown to be an effective method to reduce teen risky driving (Beck et al., 2001; Hartos et al., 2002; Simons-Morton, 2007) and this may also translate to adolescent bicycling behaviors. Parent-child communication and parental monitoring during early adolescence have been found to be important mediators for health-risk behaviors (e.g., substance use, unintentional injury, risky sexual behaviors) (Dishion et al., 1998; Riesch et al., 2006; Bravender, 2015).

Parents may also need more information about how their children bicycle when unsupervised in order to better understand the extent of their child’s risk exposure and engagement. Although this study collected real world bicycling behavior, we did not provide feedback on that riding to the parents. Possible avenues for parent education include integrating more parent components into existing bicycle safety programs (Hamann and Conrad, 2018) and community helmet promotion programs (Royal et al., 2007) or via primary care visits (Clements, 2005). Development of parent-focused interventions may also be useful.

4.1. Limitations

Our sample was comprised of adolescents and parents that were generally highly educated (90 percent of parents had a college degree), relatively affluent, and Caucasian, which may limit the generalizability of results. Though the home locations of the study participants included a mix of urban and suburban locations, most of the near-home environments of the participants consisted of moderate density residential development.

In addition, our sample of 36 adolescents (21 males, 15 females) was too small to allow the construction of more complex multivariable models or examination of subgroups (e.g., gender, parent cycling experience) that may be important to understanding the effect of parent instruction. The data indicate, for example, that the safety relevant event rate for female participants is lower than for males and that parents gave fewer instructions to females than males. Future studies with larger sample sizes that examine behaviors of more diverse populations and environments would help to develop more generalizable results and better understand behaviors of subgroups of adolescents.

Finally, the main independent variables were based on open-ended, self-reported questions given to the parent and their child. The open-ended nature of the questions, in particular, may have been problematic in terms of recall by participants and without a prompted list, a parent or adolescent may have omitted an instruction they consider self-evident or not specific enough. Despite these limitations, previous research on open-ended questions has shown that responses tend to be more diverse compared to checklist-type type close-ended questions for which respondents frequently restrict themselves to given options (Reja et al., 2003). This is particularly helpful because little is known about what parents tell their children about bicycle safety, so creation of a list would have been underinformed and likely biased. We also did not have the capacity to conduct structured interviews, given this was largely a pilot study, but future research would benefit from gaining an even deeper understanding of parent-child communication around bicycling safety (e.g., frequency of conversations, emphasis placed, and reasoning given for instructions) using a structured interview approach. The information gleaned from the current study may also be useful in the future to create informed close-ended questions.

5. Conclusions

Results highlight lack of agreement between parent-child biking instructions and lack of correlation between those instructions and real-world riding behaviors. Findings also suggest that parents may not be adequately equipped and may benefit from training in what to teach their children regarding risk factors and safety practices, as well as techniques for overcoming barriers to communicating with adolescents who may be resistant to parental messaging. Results from this study indicate need for developing parent-focused or parent-involved adolescent bicycle safety education programs. Parent-focused or parent-involved bicycle safety education programming is both sparse and meagre, often limited to take-home handouts passed from the children to their parents, void of any direct, hands-on parent training component (Hamann and Conrad, 2018). Future research is needed to develop parent-involved bicycle safety programs to improve parent-child communication and increase parental capacity for modeling and informing safe riding behaviors and increasing bicycling safety among adolescents.

Acknowledgments

The authors would like to thank Ryan Dusil and Matt Van Hoeck for their assistance with data collection and processing and Omotoyosi Soniyi, Niki Asa, Tara Cullison, Menno Schukking, and Alyssa Conrad for assistance with data coding.

Funding

This research was funded in part by grant #1R49CE002108-01 of the National Center for Injury Prevention and Control/CDC.

References

Agency for Healthcare Research and Quality, 2012 Statistical Brief #135. Healthcare Cost and Utilization Project (HCUP) (accessed 02.01.18). http://www.hcup-us.ahrq.gov/reports/statbriefs/sb135.jsp.

Aultman-Hall L, Hall FL, 1998 Ottawa-Carleton commuter cyclist on- and off-road incident rates. Accid. Anal. Prev 30 (1), 29–43. [PubMed: 9542542]

Beck KH, Hartos JL, Simons-Morton BG, 2005 Parent-teen disagreement of parent-imposed restrictions on teen driving after one month of licensure: Is discordance related to risky teen driving? Prev. Sci 6 (4), 259–267. [PubMed: 16416508]

Beck KH, Shattuck T, Raleigh R, 2001 Parental predictors of teen driving risk. Am. J. Health Behav 25 (1), 10–20. [PubMed: 11289724]

Branje S, 2018 Development of parent–adolescent relationships: conflict interactions as a mechanism of change. Child Dev. Perspect 12 (3), 171–176.

Bravender T, 2015 Adolescents and the importance of parental supervision. Pediatrics 136 (4), 761–762. [PubMed: 26391939]

Centers for Disease Control and Prevention, 2017 Injury Prevention & Control: Data & Statistics (WISQARS). (accessed 15.02.2019). http://www.cdc.gov/injury/wisqars/index.html.

Clements JL, 2005 Promoting the use of bicycle helmets during primary care visits. J. Am. Acad. Nurse Pract 17 (9), 350–354. [PubMed: 16115113]

Cripton PA, Shen H, Brubacher JR, Chipman M, Friedman SM, Harris MA, Winters M, Reynolds CC, Cusimano MD, Babul S, Teschke K, 2015 Severity of urban cycling injuries and the relationship with personal, trip, route and crash characteristics: analyses using four severity metrics. BMJ Open 5 (1), e006654.

Dishion TJ, McMahon RJJCC, Review FP, 1998 Parental monitoring and the prevention of child and adolescent problem behavior: a conceptual and empirical formulation. Clin. Child Fam. Psychol. Rev 1 (1), 61–75. [PubMed: 11324078]

Eichelberger MR, Gotschall CS, Feely HB, Harstad P, Bowman LM, 1990 Parental attitudes and knowledge of child safety: a national survey. Am. J. Dis. Child 144 (6), 714–720. [PubMed: 2346154]

Embree TE, Romanow NT, Djerboua MS, Morgunov NJ, Bourdeaux JJ, Hagel BE, 2016 Risk factors for bicycling injuries in children and adolescents: a systematic review. Pediatrics. 138 (5).

Hamann C, Conrad A, 2018 Inventory of Youth Bicycle Education Programs. Iowa Department of Transportation Project Number 17-SPR0-016, https://www.public-health.uiowa.edu/iprc/research/research-projects/bicyclepedestrian-safety/ (accessed 17.07.19).

Hamann C, Peek-Asa C, Lynch CF, Ramirez M, Torner J, 2013 Burden of hospitalizations for bicycling injuries by motor vehicle involvement: united States, 2002 to 2009. J. Trauma Acute Care Surg 75 (5), 870–876. [PubMed: 24158209]

Hamann CJ, Ramirez M, Yang J, Chande V, Peek-Asa C, 2014 Parent and teen agreement on driving expectations prior to teen licensure. Am. J. Health Behav 38 (1), 13–21. [PubMed: 24034676]

Hartos J, Eitel P, Simons-Morton B, 2002 Parenting practices and adolescent risky driving: a three-month prospective study. Health Educ. Behav 29 (2), 194–206. [PubMed: 11942714]

Hoskins DH, 2014 Consequences of parenting on adolescent outcomes. Societies. 4 (3), 506–531.

Howard DE, Cross SI, Li X, Huang W, 1999 Parent-youth concordance regarding violence exposure: relationship to youth psychosocial functioning. J. Adolesc. Health 25 (6), 396–406. [PubMed: 10608579]

Laursen B, 2004 Parent-child Communication During Adolescence in: Vangelisti AL. Ed. Handbook of Family Communication. Lawrence Erlbaum Associates, Mahwah, New Jersey, pp. 333–348.

Lipton JP, 1977 On the psychology of eyewitness testimony. J. Appl. Psychol 62 (1), 90–95.

Maurizi LK, Gershoff ET, Aber JL, 2012 Item-level discordance in parent and adolescent reports of parenting behavior and its implications for adolescents' mental health and relationships with their parents. J. Youth Adolesc 41 (8), 1035–1052. [PubMed: 22258760]

Mollborn S, Everett B, 2010 Correlates and consequences of parent-teen incongruence in reports of teens' sexual experience. J. Sex Res 47 (4), 314–329. [PubMed: 19431037]

Morrissey RA, Gondoli DM, 2012 Change in parenting democracy during the transition to adolescence: the roles of young adolescents' noncompliance and mothers' perceived influence. Parenting. science and practice 12 (1), 57–73.

Morrongiello BA, Widdifield R, Munroe K, Zdzieborski D, 2014 Parents teaching young children home safety rules: implications for childhood injury risk. J. Appl. Dev. Psychol 35 (3), 254–261.

Muir C, Devlin A, Kopinathan C, Charlton J, Koppel S, 2010 Parents As Role Models in Road Safety. Monash University Accident Research Centre, Victoria, Australia.

Muir C, O'Hern S, Oxley J, Devlin A, Koppel S, Charlton JL, 2017 Parental role in children's road safety experiences. Transp. Res. Part F Traffic Psychol. Behav 46, 195–204.

National Center for Injury Prevention and Control, 2017 Data and Statistics (WISQARS): Fatal Injury Data, 1999-2015 Unintentional Injury Data. (accessed 17.07.19). https://www.cdc.gov/injury/wisqars/index.html.

National Center for Safe Routes to School, 2017 About Us. (accessed 07.12.17). http://www.saferoutesinfo.org/.

NHTSA, 2018 Traffic Safety Facts 2016 Data: Bicyclists and Other Cyclists (Report No. DOT HS 812 507). US DOT, Washington, DC.

O'Neal EE, Plumert JM, Peterson C, 2016 Parent-child injury prevention conversations following a trip to the emergency department. J. Pediatr. Psychol 41 (2), 256–264. [PubMed: 26275976]

Peterson L, Farmer J, Kashani JH, 1990 Parental injury prevention endeavors: a function of health beliefs? Health Psychol. 9 (2), 177–191. [PubMed: 2331977]

Peterson L, Moreno A, Harbeck-Weber C, 1993 And then it started bleeding': children's and mothers' perceptions and recollections of daily injury events. J. Clin. Child Psychol 22 (3), 345–354.

Reja U, Manfreda K, Hlebec V, Vehovar V, 2003 Open-ended vs In: Ferligoj A, Mrvar A (Eds.), Close-Ended Questions in Web Questionnaires. Development in Applied Statistics, Metodoloski zvezki, Ljubljana, Slovenia.

Riesch SK, Anderson LS, Krueger HA, 2006 Parent-child communication processes: preventing children's health-risk behavior. J. Spec. Pediatr. Nurs 11 (1), 41–56. [PubMed: 16409505]

Royal S, Kendrick D, Coleman T, 2007 Promoting bicycle helmet wearing by children using non-legislative interventions: systematic review and meta-analysis. Inj. Prev 13 (3), 162–167. [PubMed: 17567970]

Shapiro L, 2006 The effects of question type and eyewitness temperament on accuracy and quantity of recall for a simulated misdemeanor crime. Emporia State Res. Stud 43 (1), 1–7.

Simons-Morton B, 2007 Parent involvement in novice teen driving: rationale, evidence of effects, and potential for enhancing graduated driver licensing effectiveness. J. Safety Res 38 (2), 193–202. [PubMed: 17478190]

Sleet DA, Ballesteros MF, Borse NN, 2010 A review of unintentional injuries in adolescents. Annu. Rev. Public Health 31 (1), 195–212. [PubMed: 20235851]

Wachtel A, Lewiston D, 1994 Risk factors for bicycle-motor vehicle collisions at intersections. ITE Journal(Institute of Transportation Engineers) 64 (9), 30–35.

Wurtele SK, Currier LL, Gillispie EI, Franklin CF, 1991 The efficacy of a parent-implemented program for teaching preschoolers personal safety skills. Behav. Ther 22 (1), 69–83.

Table 1

Major Independent and Dependent Variables.

Independent Variables	Description
Bicycle Safety Instruction Topics	Nine topic areas: general (unspecified) safety (e.g., 'Be safe'), bicycle control and handling, ride on sidewalk or off-street, things to wear (e.g., helmet, bright clothing), crossing the road (e.g., only cross at designated crosswalks), personal security (e.g., call when you arrive), be predictable, which route to take/avoid, position (e.g., ride on right side of street)
Dependent Variables	**Nature of response**
Bicycle route characteristics	
Sidewalk	% of total riding time
Street	% of total riding time
Bike facility	% of total riding time
Bike path	% of total riding time
Gravel	% of total riding time
Other paved/not paved	% of total riding time
Safety-relevant event rates	
Reckless riding	Rate per hour
Yielded when should have stopped	Rate per hour
Failure to stop or failure to yield	Rate per hour
Wrong way riding/ riding opposite traffic flow	Rate per hour

Table 2

Adolescent, parent, and household characteristics.

Adolescent Characteristics	**Mean**	**SD**
Age	11.9	1.5
Sex	#	%
Male	21	58.3
Female	15	41.7
Grade in School		
3rd	1	2.8
5th	6	16.7
6th	10	27.8
7th	9	25.0
8th	4	11.1
9th	3	8.3
10th	3	8.3
Race/ethnicity		
White/Caucasian	32	88.9
Other	4	11.1
Typical frequency of riding by season, times per week	Mean	SD
Winter	0.3	0.7
Spring	4.3	1.7
Summer	4.4	1.8
Fall	4.1	1.6
Parent Characteristics	Mean	SD
Age	43.3	6.1
Relationship to child	#	%
Mother	18	50.0
Father	18	50.0
Race/ethnicity		
White/Caucasian	34	94.4
Other	2	5.6
Marital status		
Married or domestic partner	32	88.9
Single, never married	1	2.8
Single, but divorced/separated	3	8.3
Education		
Post high school	3	8.3
4-year college degree	19	52.8
Graduate or professional degree	14	38.9
Annual household income, gross (USD)		
<$20,000	2	5.6
$20,000-$39,999	0	0.0

Adolescent Characteristics	**Mean**	**SD**
$40,000-$59,999	4	11.1
$60,000-$79,999	6	16.7
$80,000+	22	61.1
Refused	2	5.6
Employment status		
Currently employed	34	94.4
Not currently employed	2	5.6
Bike to work/Bike commuter		
Yes	13	36.1
No	23	63.9
Typical frequency of riding by season, times/week	Mean	SD
Winter	0.6	1.5
Spring	1.6	1.9
Summer	1.9	2.0
Fall	1.6	1.9

Table 3

Parent-child bicycle safety instructions reported topics and agreement.

Topics	Both parent and Adolescent Reported N(%)	Parent only reported N(%)	Adolescent only reported N(%)	Neither parent or adolescent reported N(%)	Kappa	Kappa p-value
General Safety	4 (11.1)	10 (27.8)	7 (19.4)	15 (41.7)	−0.03	0.84
Bicycle control/handling	1 (2.8)	2 (5.6)	0 (0)	33 (91.7)	0.48	<0.01
Ride on sidewalk/Off-street	14 (38.9)	8 (22.2)	6 (16.7)	8 (22.2)	0.20	0.22
Wear (helmet, bright clothing, etc.)	25 (69.4)	4 (11.1)	4 (11.1)	3 (8.3)	0.29	0.08
Crossing the road	11 (30.6)	9 (25.0)	5 (13.9)	11 (30.6)	0.23	0.15
Personal security	1 (2.8)	4 (11.1)	2 (5.6)	29 (80.6)	0.16	0.31
Be predictable	0 (0)	4 (11.1)	2 (5.6)	30 (83.3)	−0.08	0.61
Which route to take/avoid	6 (16.7)	8 (22.2)	1 (2.8)	21 (58.3)	0.42	<0.01
Positioning/Ride on the right side of street	2 (5.6)	5 (13.9)	1 (2.8)	28 (77.8)	0.32	0.03

Note: N = 36, 4 were removed because the child said they were given instructions but did not give a description of those instructions.

Table 4

Adolescent bicycling events and route choice by parent-child bicycle safety reported topics and agreement groups.

		Adolescent Naturalistic Bicycling Trip Characteristics by Parent-child bicycle safety instruction agreement groups					
		Both parent and adolescent reported	Parent only reported	Adolescent only reported	Neither parent or adolescent reported	ANOVA	
Bicycle Safety Instruction Topics	**Related Adolescent Naturalistic Bicycling Route Characteristics and Safety-Relevant Events**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**F**	**p-value**
Ride on sidewalk (off-street)	Sidewalk % of total riding time	0.7 (0.3)	0.7 (0.2)	0.6 (0.2)	0.6 (0.3)	0.74	0.54
	Street % of total riding time	0.2 (0.2)	0.1 (0.1)	0.2 (0.1)	0.3 (0.3)	0.23	0.88
	Bike facility % of total riding time	0.01 (0.04)	0 (0)	0 (0.002)	0 (0)	1.03	0.39
	Bike path % of total riding time	0.1 (0.2)	0.1 (0.2)	0.1 (0.1)	0.06 (0.09)	0.37	0.78
	Gravel % of total riding time	0 (0)	0 (0)	0 (0)	0.01 (0.02)	0.48	0.70
	Other paved/not paved % of total riding time	0.04 (0.04)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.97	0.42
Bicycle handling/control-related instructions		Rate Ratio & (95% Cl)					
	Reckless riding event rate per hour	0.3 (0.02-4.2)	1.8 (0.3-9.4)	n/a	ref		
Crossing-related instructions	Yielded when should have stopped event rate per hour	1.8 (0.6-5.8)	0.7 (0.2-2.5)	0.7 (0.2-3.3)	ref		
	Failure to stop or failure to yield event rate per hour	1.8 (0.7-4.5)	0.7 (0.2-2.0)	1.1 (0.3-3.7)	ref		
Ride on the right side of street/Positioning instructions	Wrong way riding/riding opposite traffic flow event rate per hour	0.5 (0.1-3.1)	2.7 (0.8-8.4)	nc	ref		

N = 35, one participant's naturalistic data video/GPS was incomplete and could not be coded.

n/a = there were no dyads in this category of safety instructions, ref = referent group, nc = not computed because no participants in this category had any wrong way riding events.