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Do people act differently while using ridesharing services with children?

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ABSTRACT

Children are one of the most vulnerable population groups in traffic crashes. Child safety seats (CSSs) can reduce the severity of crash outcomes for children. The use of CSSs has significantly increased in the U.S. over the last 40 years, but the use of CSSs in popular ridesharing services (RSSs), such as Uber and Lyft, is not widespread. This paper used a publicly available nationwide online survey designed to understand the knowledge and attitudes of drivers and riders toward child passenger safety in RSSs. This study performed a rigorous exploratory data analysis to identify key insights about the survey participants. A recently developed dimension-reduction method was applied to understand the co-occurrence patterns of the responses to gain intuitive insights. Finally, open ended responses of survey participants have been analyzed for further insights. The findings of this study can be used to promote new safety legislation and the use of CSSs in RSSs.

1. Introduction

In-vehicle safety for children is a complex and important issue in the traffic safety field. Motor vehicle crashes are one of the leading causes of deaths among children (14 years of age or younger). In the United States, 736 children died in motor vehicle crashes in 2018, and 35% of them were not using any safety restraint (NHTSA, 2019). In 2018, an estimated 190,000 children were injured in crashes, which is 1% less than in 2017. Research has demonstrated that the proper use of child safety seats (CSSs) substantially reduces children's injuries and deaths in crashes. Car seat use has the potential to reduce the risk of children injuries in crashes up to 82% compared to seat-belt use (CDC, n.d.). Prince et al. (2019) found that <6% of taxis in crashes involving injured children used CSSs, according to crash data from New York City. Ehsani et al. (2021) reported that nearly 60% of parents/caregivers admitted to transporting young children (below 5 years of age) differently in rideshares. Of the 60%, 25% did not use proper child safety seat while 37%

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held the child on their lap.

Transportation Network Company (TNC) or ridehailing/ridesourcing is a service that provides the traveler with pre-arranged and/or on-demand access to a vehicle ride for fee using a digitally enabled application or platform (for example, smartphone apps) to connect travelers with drivers using their personal, rented, or leased motor vehicles. The “ridesharing” is generally not used to describe for-hire transportation services (TNCs/ridehailing/ridesourcing and taxis), even when pooled (SAE, 2021). Despite the safety benefits, the use of CSSs in taxicabs and other ridesharing services (RSSs), such as Uber and Lyft, is significantly lower than in personal vehicles. RSSs raise the question of child safety on the road and how rideshare companies, rideshare drivers, and parents/guardians manage the proper use of CSSs. State and federal regulations widely vary in terms of who is responsible for providing CSSs in RSSs. Two most renowned ridesharing services Uber and Lyft also have declared themselves not responsible or liable for providing car seats (Owens et al., 2019). An online survey by the Pew Research Center conducted in 2016 found that only 30% of users who were parents and only 34% of RSS users overall believed that RSSs were a safe transportation mode for children (Smith, 2016). The popularity of RSSs is also motivated by the cost savings provided by such mode of transportation (Hsieh, 2021). A poor distribution of cost reductions will make drivers and passengers unhappy and prevent acceptance of the shared mobility mode. As RSSs are popular in many urban cities, one potential solution is to mandate CSS in RSS trips. However, a regulation like this requires additional investigation. This paper used a nationwide, publicly available online survey, developed by Owens et al. (2019), designed to understand RSS riders’ and drivers’ knowledge and attitudes toward child passenger safety and the use of CSSs. The findings showed a general deficiency of understanding and consciousness about CSS use in RSS platforms. This study applied an innovative dimension reduction method known as Taxicab Correspondence Analysis (TCA) using survey data collected by Owens et al. (2019). The response patterns are expected to vary among parents/guardians based on their previous experience and their willingness to use RSSs while they are with young children. The current study aims to answer the following two research questions (RQ):

- **RQ1:** Do people act differently while using ridesharing services with children?
- **RQ2:** If so, what are the key contributing factors?

As the survey data collected by Owens et al. (2019) is categorical, it is important to identify a suitable approach to investigate the research questions. TCA has been used extensively as a survey analysis tool that can provide multiple contexts from a low dimensional space by identifying the closeness of the question responses and placing them in clusters. In addition, this study conducted qualitative analysis on the responses to an open-ended question for comprehensive understanding on the perceptions of these two groups of respondents. The findings of this research will help policy makers in understanding the problems associated with CSS use in RSSs and reducing children injuries and deaths during crashes, due to lack of or improper use of CSS.

The rest of the paper is as follows. After the introduction section, the next section briefly describes the objective of this study. The following section is a literature review. Section 4 describes the methodology of this study. The following provides exploratory data analysis. Section 6 includes the results and discussions of the TCA analysis and qualitative analysis on the textual responses of. The final section is conclusion, which contains key findings, uniqueness of this study, limitations, and future research needs. Additionally, the survey questionnaire is added in the Appendix.

2. Study objective and contribution

The general hypothesis of this study is that people act differently while using ridesharing services with children. The current study intended to explore this topic by performing TCA and qualitative data analysis to validate the hypothesis and identify the key factors associated with the patterns of usage of ridesharing with children. The findings of this study can help in refining policy level changes for ridesharing usage with children.

3. Literature review

Developed countries like the U.S. have established regulations on the widespread implementation of CSSs in privately owned cars. However, these regulations are not common in other countries. There are a handful of studies that focus on the safe use of CSSs. The brief literature review presented in this paper is based on such studies conducted both in the U.S. and outside. A summary of the CSS use related laws in the different states of the U.S. is provided.

3.1. Studies in the U.S.

Most of the previous U.S. based studies focused on the proper use of CSSs. Farmer et al. (2009) examined the association between booster seat legislatures and fatalities among children in vehicle frontal crashes. The results showed that children were less likely to die in states with a booster seat law than in states without such a law. Booster seat law enabled the use of proper restraints. Brown et al. (2009) trained and monitored twenty-seven adult participants in three stages of CSS installation (i.e., installing seat; securing tether; and placing and securing child in the seat). Proper instructions and training enabled improvement in CSS installation amongst the participants. However, physically demanding tasks in the installation process (e.g., awkward postures during routing and fastening of seatbelts) might lead to error in CSS installation, putting the child at higher risk in the car. Thoreson et al. (2009) compared booster seat education and distribution in childcare centers with no intervention. The intervention boosted parents’ access to information from childcare center employees and their understanding of booster seats, but it did not increase their use of booster seats. Impact of

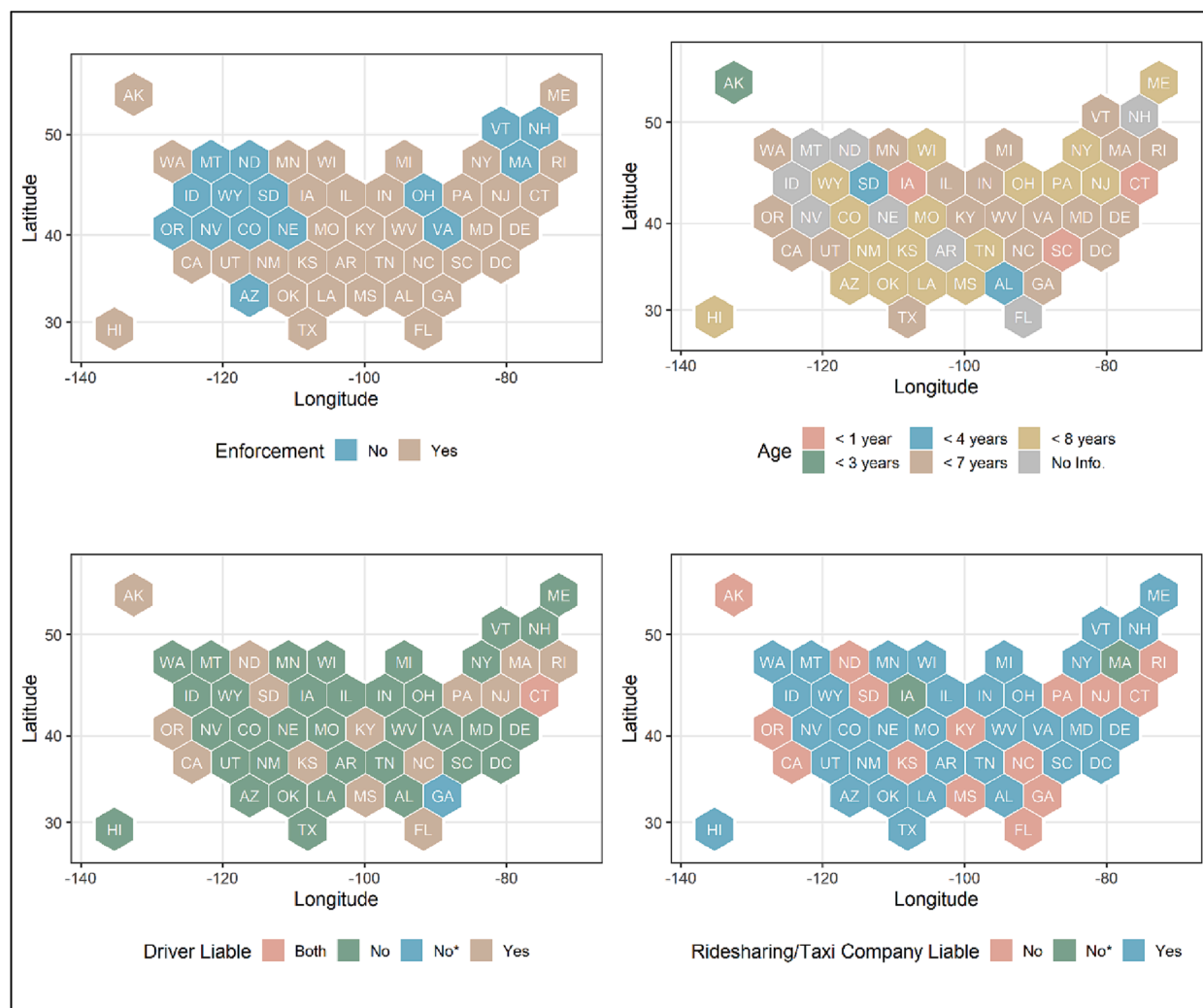


Fig. 1. Regulation on CSSs by the U.S. states.

education on road safety improvement using different traffic safety campaigns has been studied in several studies (Zatoński and Herbec, 2016; Faus, et al., 2021). Kroecker et al. (2015) analyzed the CSS inspection forms for two SafeKids Worldwide Coalitions in Michigan. The retrospective, cross-section analysis showed that 1 in 10 car seat inspections are for booster seats and half are for rear-facing car seats. Billie et al. (2016) conducted a study to increase the use of safety seats among tribal communities to improve the safety of children. All five tribal communities, which implemented evidence-based strategies, increased their CSS use (ranging from 6% to 40%). Four out of the five initiatives achieved their intended levels of usage growth. A total of 91 CSS events took place throughout the five communities, resulting in 1417 CSS checks or contributions. Asbridge et al. (2018) performed a thorough systematic review and meta-analysis of observational studies that focused on CSSs to reduce injury and mortality from traffic crashes among child passengers from four to eight years old. However, the systematic review and meta-analysis revealed no evidence that using booster seats instead of seatbelts would result in a lower risk of injury. Ojo (2018), performing an unobstructed observational survey guided by the Theory of Planned Behaviour, examined seat belt use by drivers and accompanied children being transported/dropped off in school by collecting data from Cape Coast Metropolis, Ghana. 53.1% of drivers did not wear their seat belts with 13.2% of kids buckled up. Both the type of vehicle and the gender of the driver had a big impact on whether child restraint was used. Olsen et al. (2010) examined the relationship between the restraint usage of the driver and child emergency department (ED) evaluation following a traffic collision. Child restraint use, decreased alcohol/drug use, and a lower relative risk of severe crash types were all linked to driver restraint use. In the event of a motor vehicle crash, wearing a seat belt as the driver is linked to a lower probability of ED examination for minor passengers. Sun et al. (2010) examined the influence of the New York State upgraded child restraint law (UCRL) implemented in 2005 and the subsequent crash-related injury rate among four to six years old. Following the adoption of UCRL, the injury rate for children ages 4 to 6 dropped by 18%, although it did not significantly alter for children ages 0 to 3 who were not directly impacted by the UCRL. Jeffrey et al. (2016) investigated an upside to including descriptive norms in health and safety appeals towards booster seat usage. As long as the

descriptive norms are constructive, they can promote constructive intentions and behaviors. Topic involvement is a significant mediator of the impact of descriptive norms, and the study showed that those people who were otherwise uninterested in the message were the ones that responded to descriptive norms most strongly. This is especially promising because the people with the lowest levels of involvement are typically the ones who are most at risk.

3.2. Studies outside the U.S.

Several non-U.S. studies examined the usage of CSSs and the related legislature. Desapriya et al. (2008) explored the legislative impact on fatalities in Japan during 1994–2005. In April 2000, a requirement that child restraint seat be used for children under the age of 5 years was mandated. Analyzing fatality data pre/post 6 years of enactment of the law showed that fatalities did not drastically decrease despite increase in child restraint seat use. Kakefuda et al. (2008) assessed associations between the use of CSSs and mindsets among Japanese mothers. For short trips, the key contributing factors for inconsistent use of CSSs include child resistance to use CSSs for short period, hassles associated with CSSs, and low level of eagerness of the mother to use one due to the presence of another adult in the car. Kulanthayan et al. (2010) determined the CSS usage rates in Malaysia to assess driver traits that were associated with CSS use. The nine variables examined in this study were urban versus rural study location, age, gender, marital status, educational status, monthly family income, number of children present in the vehicle, distance traveled to the study location, and attitude. The three driver characteristics that were found to be statistically significant were age, educational status, and attitude. Additionally, results showed that 27% of the drivers used a CSS at least once during the time of the survey. Using data from Russia, Ma et al. (2012) examined the use of CSSs and associated insights, attitudes, and perceptions of the safety of CSS use. Of the 39,833 drivers and passengers observed, only 11% of the cars were reported to have any type of child safety measure. Bromfield and Mahmoud (2017) conducted a United Arab Emirates (UAE) based preliminary investigation on the use of CSSs among UAE parents ($n = 366$ citizens with at least one child younger than age 13 years). <20% of Emirati parents use car seats for children under 24 months. Thus, the findings call for additional studies on CSS usage in the UAE. Moradi et al. (2017) determined the prevalence of CSS use and the elements influencing its use in the safe community of Tehran, Iran. The authors found that CSS was used by 4.3% of the 2,178 personal cars observed, with its use being significantly higher among women, and on highways. Nazif-Munoz and Nikolic (2018) examined the short- and long-term impacts of Serbia's 2009 legislation update about the use of CSSs. The case of Serbia suggests that the new law was effective in reducing injuries among children aged 0–3 in the short term and injuries among children aged 4–12 in both short and long terms. Using data from Iran, Moradi et al. (2019) determined the prevalence of child safety seat use in vehicles to determine the influential factors. The use of child safety seats was also influenced by a child's age, weight, and height. The most frequent justifications for using child safety seats among parents were knowledge of its advantages and concern for the child's safety, while the most frequent justifications for not using them were cost and the intolerance of the child for using the seat.

The research findings show that there are almost no studies, except Owens et al. (2019), which focused on the use of CSSs in RSSs. A key gap in the literature is the lack of understanding of the complex relationships between RSS user characteristics and travel habits with children. The current study, which is based on the survey conducted by Owens et al. (2019), performed a rigorous investigation to explore the insights from the response patterns.

3.3. Child safety seat use related laws in different states of the U.S.

Fig. 1 illustrates four maps of the U.S. to provide a visual representation of child safety seat laws in different states. The map in the upper left corner shows which states have primary enforcement of child safety laws. The states in brown have primary enforcement of CSSs, while the states in blue do not. Thirty-six of the fifty states have primary enforcement of child safety laws. The fourteen states that do not have primary enforcement of child safety laws are (in alphabetical order) Arizona, Colorado, Idaho, Massachusetts, Montana, Nebraska, Nevada, New Hampshire, North Dakota, Ohio, South Dakota, Vermont, Virginia, and Wyoming. The map in the upper right corner of Fig. 1 highlights the age at which child safety laws are in effect in each state. Most states have laws for children less than seven or eight years old. Twenty states have child safety laws in effect for children under the age of seven years old, and seventeen states have laws for children under the age of eight years old. The map in the bottom left corner of Fig. 1 illustrates the liability of the driver for children's safety in different states. The map shows that the driver is liable in only fourteen states. The map in the bottom right corner of Fig. 1, however, shows that the ridesharing or taxi company is liable for children's safety in thirty-three states. Other states do not mandate liability entirely (no) or partially (no*), as shown in the figure. Overall, child safety seat laws are not uniform in the different states of U.S. Some states exempt for-hire vehicles while implementing CSS laws. In addition, current state laws do not specifically include a CSS-related provision for ridesharing vehicles. Only the state of Georgia currently has legislation with distinct laws regarding CSS use in ridesharing vehicles compared to other hired vehicles (Owens et al., 2019).

Note that the regulations of CSSs by different states are needed to be examined more carefully. One of the key takeaways is that the regulations related to RSS and CSS are not well defined. There is a need for better policies regarding children safety in RSSs.

4. Methodology

4.1. Survey data

This study collected the open-source survey data conducted by the Texas A&M Transportation Institute (TTI) and Virginia Tech Transportation Institute (VTTI) with the help of Survey Sampling International, who identified and approached prospective survey

participants (Owens et al., 2019). The survey sample comprised of about 1,200 participants (parents with children up to the age of five - the age at which the transition from harness child seats to booster seats usually has been made for many children). The participants were randomly selected from targeted locations where the UberFAMILY car seat program was available, as well as from other areas in the U.S. The data collection for this survey and analysis followed the ethical approval by following Human Research Ethics regulation.

Table A (refer Appendix) details the list of questions used in the survey questionnaire. There were five questions about the participants' socio-demographic information, which included gender, education level, age group, where they live, and how many children they care for. The rest of the questions asked information about their travel habits with children and, specifically, their use of RSSs with children. The participants answered questions that applied to their situation; for example, if they answered that they have never used RSSs with children, then they were asked why they had not used an RSS with children under the age of 5. If they used an RSS with children, then they were asked questions about what safety precautions were taken and what was their experience. There were also several questions regarding child safety laws and the legal responsibilities of the parents and the drivers. More details of the survey design can be found in Owens et al. (2019).

4.2. Analysis method

4.2.1. Taxicab correspondence analysis

Choulakian recently proposed an improved version of correspondence analysis (CA), known as TCA, in a series of papers (Choulakian, 2013, 2006a, 2006b). Different variants of CA have been used by transportation researchers in recent years (Das et al., 2019; Jalayer et al., 2018; Das et al., 2020; Das et al., 2018)

The Euclidean distance measure is used in CA, whereas TCA uses Manhattan city block or taxicab distance as the distance measure. Let $X = (x_1, x_2, \dots, x_n)$ and $Y = (y_1, y_2, \dots, y_n)$ and a vector $v = (v_1, v_2, \dots, v_n)$ to present these two distances, then these distances can be calculated using the following equations:

$$\text{Euclidean Distance} = ED(X, Y) = \sqrt{\sum_{i=1}^n (x_i - y_i)^2} \text{ [with } L_2 \text{ Norm} = \|v\|_2 = \sqrt{\sum_{i=1}^n (v_i)^2}] \quad (1)$$

$$\text{Taxicab Distance} = TD(X, Y) = \sum_{i=1}^n |x_i - y_i| \text{ [with } L_1 \text{ Norm} = \|v\|_1 = \sum_{i=1}^n |v_i|] \quad (2)$$

The concepts of TCA lay within singular value decomposition (SVD), more specifically taxicab singular value decomposition (TSVD). Let a real matrix A be decomposed as $M\Lambda^{1/2}N'$, where Λ is the diagonal matrix of the real non-negative eigenvalues of AA' , M is the orthogonal matrix of the corresponding eigenvectors, and N is the matrix of eigenvectors of $A'A$ (with constraints $M'M = I$ and $N'N = I$). Choulakian (2006) proposed developing the SVD solution through a recursive optimization process. The relations between rows and columns of N are summarized by the χ^2 statistics, which measure the relationship's departure from the independence. TCA is defined as the Taxicab SVD of the data table $D = T - RL'$; where it considers the table's profiles, $R = D_r^{-1}D$ for the rows and $L = D_c^{-1}D$ for the columns.

To perform the analysis, the research team used open-source R software package 'TaxicabCA' (Allard and Choulakian, 2019). TCA has been performed on the datasets developed for both groups (i.e., participants who used RSSs with children, and participants who never used RSSs with children). In addition, this study adopted an inductive qualitative data analysis approach to analyze open-ended responses. An inductive coding framework was developed from the data, which helped to generate new knowledge on the perceptions of the respondents (Gabriel, 2013). Inductive coding followed a close reading of the responses, identification of text segment(s) with inherent meaning(s) and assigning text segment(s) to categories, which were used to group patterns observed in the data/responses into meaningful units (Thomas, 2003). Responses were coded using a "line-by-line open coding" method to remain open to all possible theoretical directions (Saldana, 2015). Open coding helped to understand the contents and nuances of the data in-depth by breaking down the qualitative data into discrete parts, examining them closely, and comparing the data for similarities and differences. Overlaps and redundancies among the categories were reduced to develop a framework with 3–8 important categories (Creswell, 2002).

Respondents were not forced to provide responses to any questions, which resulted in some incomplete responses and were excluded from the analysis. NVIVO 12 software was used to perform coding tasks (NVIVO, n.d.). NVIVO is a qualitative data analysis application, which is used to organize, analyze, and visualize unstructured or semi-structured data. Research findings were interpreted based on the categories identified from the data/responses. Moreover, an estimation of the frequency of the related categories was presented. Quantification of qualitative data have been used to impose relative importance on the response categories and to visualize the qualitative data and research findings (Gerede, 2015). Studies of Gerede (2015), Ko et al. (2019), Ta et al. (2020), Rahman et al. (2021), and Kester et al. (2018) used statistical analysis to present qualitative data.

5. Exploratory data analysis

5.1. Survey participants' socio-demographic characteristics

Table A (refer appendix) lists the questions included in the survey. Fig. 2 illustrates the location, age, education level, and gender of the survey participants who used RSSs with children and who never used RSSs with children. For any socio-demographic characteristic of the survey participants, the green bars represent the percentage of participants who used RSSs with children present, while the red bars represent those that never used RSSs with children present. The highest percentage (40%) of survey participants who never used

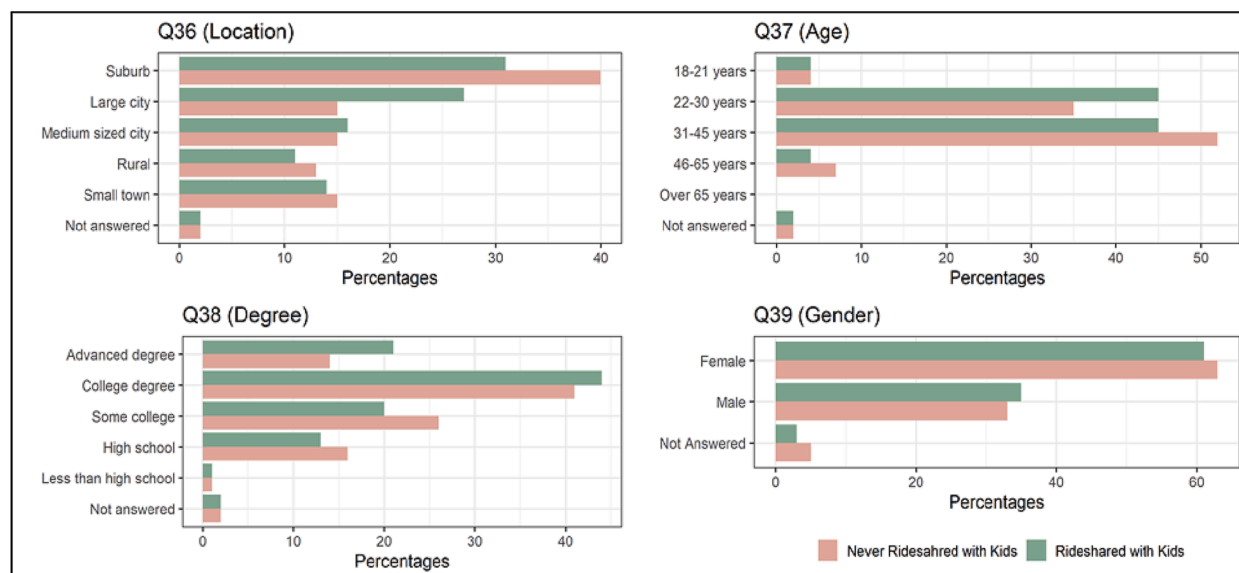


Fig. 2. Traits of the participants.

RSSs with children were from the suburbs. The highest percentage of those who used RSSs with children present (31%) were also located in the suburbs, although they were smaller in percentage than those who didn't use RSSs with children present. The opposite was true for participants in large cities where survey participants who used RSSs with children (27%) were higher than the survey participants who never used RSSs with children (15%). Majority of the participants who used RSSs with children present were in the age groups of 22–30 years or 31–45 years old (45% for both demographics). The majority of participants who never used RSSs with children present were also in the age groups of 22–30 years and 31–45 years old. In the age group of 22–30 years, the percentage of participants who never used RSSs with children were comparatively low 35%, where the percentage in 31–45 years age group were comparatively high (52%), respectively. Participants with higher education (advanced degree or college degree) were more likely to rideshare with children present. The opposite trend was observed in those who have some college or high school level education. There was no significant difference was observed among the respondents based on gender. The percentage of females who used RSSs with children was 61%, where the percentage of females who never used RSSs with children was 62%. The same is true for males who used RSSs with children (27%) and the males who never used RSSs with children (26%).

5.2. Comparison between two groups

To investigate the research question 1 (*Do people act differently while using ridesharing services with children?*), a list of 24 survey questions was selected for comparing the two major groups: 1) group of respondents who used RSSs with children, and 2) group of respondents who never used RSSs with children. Table 1 lists the comparison test measures for the selected questions. Statistical analyses were performed using R (version 3.6.0) and using the package 'compareGroups' (Salvador, 2020). This study defined statistical significance at 95% confidence interval (i.e., p -value < 0.05). Responses to six questions were not statistically significant. There was no statistically significant difference between two groups when they were asked about their knowledge of state laws regarding CSS guidelines in RSSs. Some of the queries regarding the importance of driver and vehicle characteristics to make decision on using RSS with children (i.e., importance of vehicle type, rear seat space, and vehicle cleanliness asked in question 28) were not statistically significant among the two groups. The broader perspective of Question 28 helped to understand the importance of the key factors mostly related to RSS driver and vehicle characteristics that the respondents considered to be important when deciding whether to use an RSS with a child under the age of 5. The identified factors in the question were 1) pre-installed child seat available, 2) rear seat space, 3) driver's driving record, 4) type of vehicle, 5) convenience of child seat installation in a vehicle, 6) vehicle cleanliness, and 7) availability of information about child seat laws and regulations. The perceived difference in importance of the factors such as pre-installed child seat availability in the RSS vehicle, convenience of child seat installation, drivers' driving record, and availability of information about child seat laws and regulations were found to be statistically significant between the two groups of respondents. Respondents who never used ridesharing with children provided comparatively higher importance on the factors in their RSS choice decision making with their children. For example, approximately 53% the respondents who never used RSS with children perceived the pre-installed child seat availability in RSS vehicle as very important, whereas 44% of their counterpart put the same level of importance on this factor in their RSS choice with children. In terms of the other two-vehicle-related factors that were found significant in the analysis—convenience of installing child seat in RSS vehicle and vehicle cleanliness—the same patterns were revealed. In addition, variables related to driver's characteristics (e.g., driver safety record) were deemed very important among the respondents who never used RSS with children (76%) compared to who did use RSS with children (66%). The perceived importance on the factor availability

Table 1

Comparison of the responses provided by two main groups.

Question	Never Rideshared with Children (N = 409)	Rideshared with Children (N = 768)	p-overall
17: In what situations and how often have you used a ride share service such as Uber or Lyft without a child or children?			
17a: For local travel while on an out-of-town trip			
Have used only once	54 (13.2%)	120 (15.6%)	<0.001
Used a few times (2–5 times)	122 (29.8%)	202 (26.3%)	
Used often (6–10 times)	55 (13.4%)	196 (25.5%)	
Used regularly (>10 times)	38 (9.29%)	150 (19.5%)	
Never	140 (34.2%)	100 (13.0%)	
17b: For routine local travel where I live			
Have used only once	46 (11.2%)	125 (16.4%)	<0.001
Used a few times (2–5 times)	67 (16.4%)	209 (27.4%)	
Used often (6–10 times)	54 (13.2%)	164 (21.5%)	
Used regularly (>10 times)	19 (4.65%)	101 (13.2%)	
Never	223 (54.5%)	165 (21.6%)	
17c: For non-routine local travel where I live			
Have used only once	58 (14.3%)	132 (17.3%)	<0.001
Used a few times (2–5 times)	63 (15.5%)	201 (26.3%)	
Used often (6–10 times)	40 (9.83%)	166 (21.8%)	
Used regularly (>10 times)	18 (4.42%)	105 (13.8%)	
Never	228 (56.0%)	159 (20.8%)	
17d: To make an out-of-town trip			
Have used only once	32 (7.84%)	105 (13.9%)	<0.001
Used a few times (2–5 times)	43 (10.5%)	139 (18.3%)	
Used often (6–10 times)	27 (6.62%)	146 (19.3%)	
Used regularly (>10 times)	21 (5.15%)	94 (12.4%)	
Never	285 (69.9%)	274 (36.1%)	
18: In what situations and how often have you used a taxi when transporting a child or children under your care?			
18a: For local travel while on an out-of-town trip			
Have used only once	43 (10.6%)	132 (17.2%)	<0.001
Used a few times (2–5)	66 (16.2%)	174 (22.7%)	
Used often (6–10 times)	23 (5.65%)	110 (14.4%)	
Used regularly (>10 times)	17 (4.18%)	104 (13.6%)	
Never	258 (63.4%)	246 (32.1%)	
18b: For routine local travel where I live			
Have used only once	41 (10.1%)	107 (14.0%)	<0.001
Used a few times (2–5)	33 (8.11%)	163 (21.3%)	
Used often (6–10 times)	23 (5.65%)	129 (16.9%)	
Used regularly (>10 times)	9 (2.21%)	68 (8.89%)	
Never	301 (74.0%)	298 (39.0%)	
18c: For non-routine local travel where I live			
Have used only once	33 (8.09%)	125 (16.3%)	<0.001
Used a few times (2–5)	42 (10.3%)	143 (18.7%)	
Used often (6–10 times)	18 (4.41%)	117 (15.3%)	
Used regularly (>10 times)	11 (2.70%)	76 (9.93%)	
Never	304 (74.5%)	304 (39.7%)	
18d: To make an out-of-town trip			
Have used only once	26 (6.42%)	93 (12.3%)	<0.001
Used a few times (2–5)	23 (5.68%)	113 (14.9%)	
Used often (6–10 times)	21 (5.19%)	115 (15.2%)	
Used regularly (>10 times)	17 (4.20%)	76 (10.0%)	
Never	318 (78.5%)	362 (47.7%)	
Q21: How familiar are you with the recommended child seat guidelines for the age or ages of your children?			
Very	264 (64.9%)	495 (64.7%)	0.591
Somewhat	124 (30.5%)	242 (31.6%)	
A little	14 (3.44%)	24 (3.14%)	
Not at all	5 (1.23%)	4 (0.52%)	
Q22: How familiar are you with your state's laws for child safety seat use for the age or ages of your children?			
Very	235 (58.8%)	456 (60.7%)	0.886
Somewhat	130 (32.5%)	234 (31.2%)	
A little	28 (7.00%)	51 (6.79%)	
Not at all	7 (1.75%)	10 (1.33%)	
Q24: How confident are you that you have followed state laws when using taxi services with children under 5 years old?			
Very confident	86 (46.7%)	270 (48.0%)	0.001
Somewhat confident	56 (30.4%)	187 (33.2%)	
Not very confident	16 (8.70%)	69 (12.3%)	
Not at all confident	16 (8.70%)	34 (6.04%)	
Have not used taxis with children under 5 years old	10 (5.43%)	3 (0.53%)	
Q25: Who is legally responsible for correct child safety seat use for children under 5 years old as passengers in ride-share services such as Uber or Lyft?			
			<0.001

(continued on next page)

Table 1 (continued)

Question	Never Rideshared with Children (N = 409)	Rideshared with Children (N = 768)	p-overall
The parent, guardian, or caregiver	221 (54.4%)	397 (52.1%)	<0.001
The driver	88 (21.7%)	179 (23.5%)	
The ride share company	15 (3.69%)	63 (8.27%)	
Depends on the circumstances	7 (1.72%)	46 (6.04%)	
Depends on the State	17 (4.19%)	18 (2.36%)	
Not sure	58 (14.3%)	59 (7.74%)	
Q26: Who is legally responsible for correct child safety seat use for children under 5 years old as passengers in taxis?			
The parent, guardian, or caregiver	222 (54.7%)	391 (51.7%)	
The driver	93 (22.9%)	175 (23.1%)	
Depends on the circumstances	13 (3.20%)	85 (11.2%)	0.033
Depends on the State	20 (4.93%)	35 (4.62%)	
Not sure	58 (14.3%)	71 (9.38%)	
28: How important are each of the factors below in your decisions about using a ride-share service with a child or children under the age of 5?			
28a: Pre-installed child seat available			
Very important	197 (52.5%)	327 (43.8%)	
Somewhat important	94 (25.1%)	210 (28.1%)	
Somewhat unimportant	47 (12.5%)	106 (14.2%)	
Not at all important	37 (9.87%)	104 (13.9%)	
28b: Rear seat space			0.429
Very important	226 (59.8%)	423 (56.0%)	
Somewhat important	99 (26.2%)	220 (29.1%)	
Somewhat unimportant	36 (9.52%)	86 (11.4%)	
Not at all important	17 (4.50%)	27 (3.57%)	0.002
28c: Driver safety record			
Very important	292 (76.0%)	490 (65.5%)	
Somewhat important	57 (14.8%)	158 (21.1%)	
Somewhat unimportant	22 (5.73%)	75 (10.0%)	0.477
Not at all important	13 (3.39%)	25 (3.34%)	
28d: Type of vehicle			
Very important	162 (42.7%)	291 (38.9%)	
Somewhat important	135 (35.6%)	273 (36.4%)	0.043
Somewhat unimportant	54 (14.2%)	130 (17.4%)	
Not at all important	28 (7.39%)	55 (7.34%)	
28e: Convenience of child seat installation in vehicle			0.043
Very important	209 (55.7%)	349 (47.2%)	
Somewhat important	102 (27.2%)	240 (32.4%)	
Somewhat unimportant	49 (13.1%)	106 (14.3%)	
Not at all important	15 (4.00%)	45 (6.08%)	0.63
28f: Vehicle cleanliness			
Very important	210 (55.1%)	389 (51.7%)	
Somewhat important	121 (31.8%)	246 (32.7%)	
Somewhat unimportant	36 (9.45%)	87 (11.6%)	0.029
Not at all important	14 (3.67%)	30 (3.99%)	
28 g: Availability of information about child seat laws and regulations			
Very important	159 (43.2%)	282 (38.5%)	0.001
Somewhat important	116 (31.5%)	215 (29.4%)	
Somewhat unimportant	57 (15.5%)	170 (23.2%)	
Not at all important	36 (9.78%)	65 (8.88%)	
Q36: Which best describes the area where you live?			0.001
Suburb	165 (40.8%)	239 (31.3%)	
Large city	62 (15.3%)	209 (27.4%)	
Medium sized city	60 (14.9%)	123 (16.1%)	
Rural	54 (13.4%)	85 (11.1%)	
Small town	63 (15.6%)	108 (14.1%)	0.004
Q37: Which age group are you in?			
18–21 years	18 (4.46%)	33 (4.32%)	
22–30 years	143 (35.4%)	351 (45.9%)	
31–45 years	216 (53.5%)	347 (45.4%)	
46–65 years	27 (6.68%)	32 (4.19%)	0.001
Over 65 years	0 (0.00%)	1 (0.13%)	
Q38: What is your education level?			
Advanced degree	59 (14.6%)	161 (21.1%)	
College degree	170 (42.0%)	340 (44.6%)	
Some college	106 (26.2%)	153 (20.1%)	0.655
High school	67 (16.5%)	103 (13.5%)	
Less than high school	3 (0.74%)	6 (0.79%)	
Q39: What is your gender?			
Female	258 (65.6%)	476 (63.3%)	
Male	135 (34.4%)	275 (36.6%)	

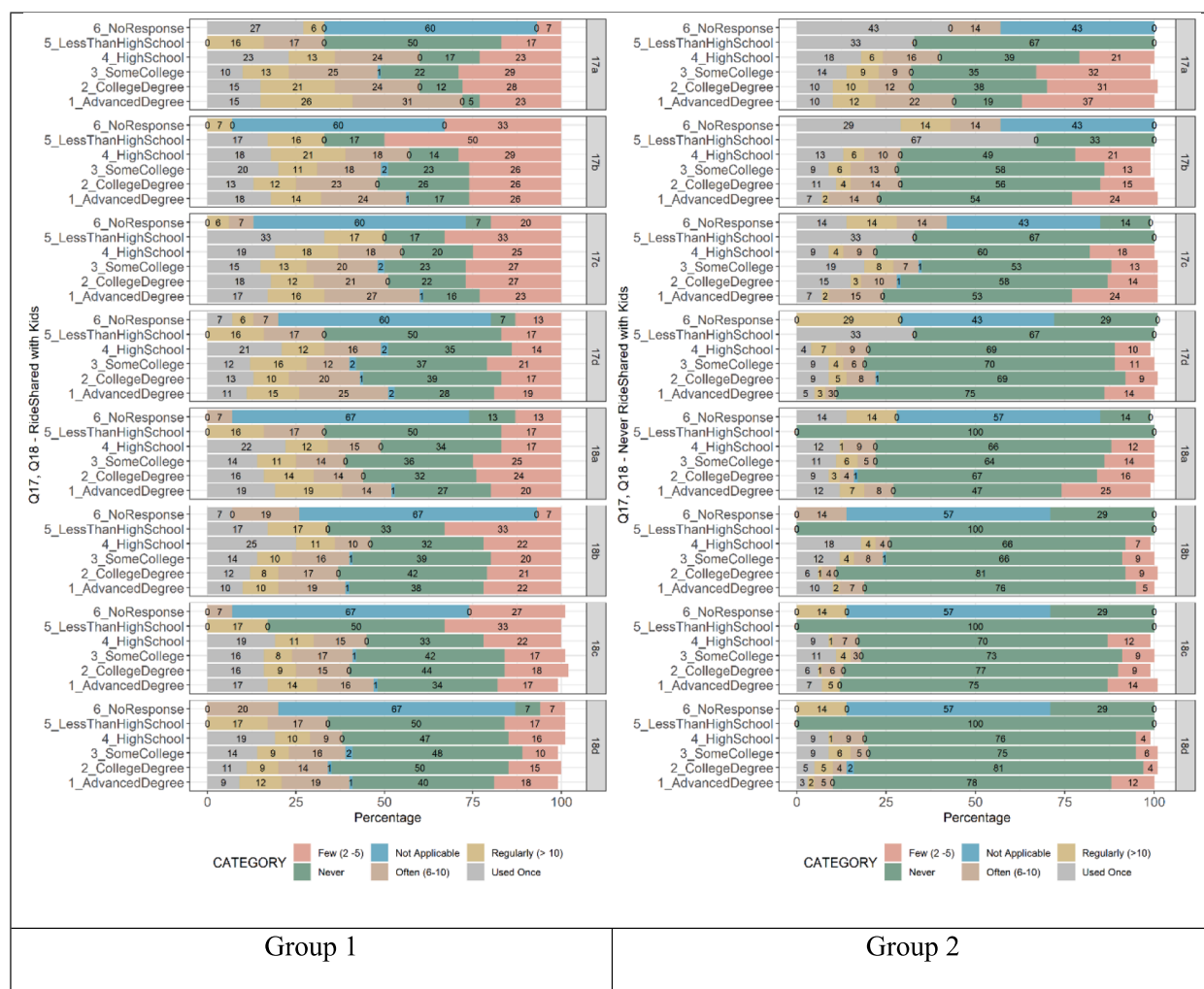


Fig. 3. Response patterns on the use of RSSs without children (Question 17) and the use of taxis with children (Question 18).

of information about child seat laws and regulations also followed the same pattern. Overall, experience of the respondents in using RSS with children influenced their perceived importance on the assessed factors.

5.3. Example showing traits of the selected two groups

Two sets of survey questions were designed to collect the perspectives of the respondents on the use of RSSs without children and the use of taxis with children (Questions 17 and 18). Each set of question has four trip scenarios:

- For local travel while on an out-of-town trip (a).
- For routine local travel where I live (b).
- For non-routine local travel where I live (c).
- To make an out-of-town trip (d).

The participants need to choose one of the five multiple choices options (i.e., never, have used once, used 2–3 times, used 6–10 times, and used >10 times) for each of the scenarios from these two questions (Questions 17 and 18). To understand the patterns of the responses based on personal traits, it is important to examine the descriptive nature of the data. The following section considers education level of the respondent as an example of person specific traits and explored two key questions related to CSS usage in the form of exploratory data analysis.

Fig. 3 shows the response patterns of these two questions for both groups: participants who used RSSs with children and participants who never used RSSs with children based on their level of education. One observed clear pattern was that respondents who did use RSSs without children or taxis with children for various trip purposes also showed the tendency to use rideshare with children

Table 2

Column scores from separate TCA on both groups.

Participants Rideshared with Children					Participants Never Rideshared with Children				
Ques.	Response	Axis1	Axis2	Quad.	Ques.	Response	Axis1	Axis2	Quad.
17a	> 10 times	0.34	-0.64	4th	17a	1	0.42	0.28	1st
17a	0	-0.78	-0.27	3rd	17a	Not appli	1.12	1.11	1st
17a	1	0.26	0.57	1st	17b	> 10 times	0.91	0.57	1st
17a	2-5 times	-0.21	0.46	2nd	18b	> 10 times	0.90	0.20	1st
17a	6-10 times	0.25	-0.25	4th	18c	> 10 times	1.12	0.20	1st
17a	Not appli	-1.08	1.14	2nd	17b	Not appli	1.12	1.11	1st
17b	> 10 times	0.41	-0.60	4th	17c	> 10 times	1.01	0.54	1st
17b	0	-0.94	-0.22	3rd	Q25	Parent/Caregiver	0.23	0.36	1st
17b	1	0.15	0.52	1st	Q26	Parent/Caregiver	0.19	0.41	1st
17b	2-5 times	0.20	0.46	1st	Q36	Large city	0.25	0.24	1st
17b	6-10 times	0.42	-0.48	4th	17c	Not appli	0.72	0.68	1st
17b	Not appli	-1.08	1.14	2nd	17d	Not appli	1.12	1.11	1st
17c	> 10 times	0.50	-0.64	4th	18a	Not appli	0.72	1.08	1st
17c	0	-0.98	-0.30	3rd	18b	Not appli	1.12	1.11	1st
17c	1	0.01	0.59	1st	18c	Not appli	1.12	1.11	1st
17c	2-5 times	0.15	0.38	1st	18d	Not appli	0.55	0.78	1st
17c	6-10 times	0.53	-0.33	4th	28c	Not appli	0.19	0.19	1st
17c	Not appli	-1.08	1.14	2nd	Q25	Not appli	0.79	0.75	1st
17d	> 10 times	0.65	-0.68	4th	Q26	Not appli	0.79	0.75	1st
17d	0	-0.81	-0.07	3rd	Q36	Not appli	1.12	1.11	1st
17d	1	0.31	0.54	1st	Q37	Not appli	1.12	1.11	1st
17d	2-5 times	0.35	0.48	1st	Q38	Not appli	1.12	1.11	1st
17d	6-10 times	0.68	-0.36	4th	Q36	Rural	0.08	0.37	1st
17d	Not appli	-0.88	0.62	2nd	Q36	Small town	0.26	0.26	1st
18a	> 10 times	0.77	-0.78	4th	Q37	18-21	0.68	0.63	1st
18a	0	-0.96	-0.20	3rd	Q37	22-30	0.16	0.36	1st
18a	1	0.26	0.64	1st	17d	> 10 times	0.84	0.14	1st
18a	2-5 times	0.28	0.43	1st	Q38	High school	0.38	0.55	1st
18a	6-10 times	0.76	-0.39	4th	Q38	Some college	0.22	0.43	1st
18a	Not appli	-0.91	1.12	2nd	17a	0	-0.44	0.35	2nd
18b	> 10 times	0.75	-0.73	4th	17b	0	-0.44	0.21	2nd
18b	0	-0.93	-0.16	3rd	18a	0	-0.41	0.22	2nd
18b	1	0.40	0.69	1st	18b	0	-0.39	0.10	2nd
18b	2-5 times	0.60	0.36	1st	18c	0	-0.37	0.15	2nd
18b	6-10 times	0.77	-0.38	4th	18d	0	-0.29	0.13	2nd
18b	Not appli	-1.08	0.98	2nd	17c	0	-0.44	0.18	2nd
18c	> 10 times	0.84	-0.88	4th	28c	Very important	-0.17	0.08	2nd
18c	0	-0.99	-0.16	3rd	Q36	Medium sized city	-0.15	0.09	2nd
18c	1	0.51	0.58	1st	Q24	Not appli	-0.51	0.24	2nd
18c	2-5 times	0.66	0.41	1st	Q37	46-65	-0.21	0.28	2nd
18c	6-10 times	0.80	-0.26	4th	17d	0	-0.32	0.15	2nd
18c	Not appli	-1.08	1.14	2nd	17a	2-5 times	-0.08	-0.35	3rd
18d	> 10 times	0.90	-0.91	4th	Q25	Depends on the State	-0.17	-0.62	3rd
18d	0	-0.80	-0.10	3rd	Q25	Driver	-0.33	-0.53	3rd
18d	1	0.54	0.67	1st	Q25	Not sure	-0.50	-0.38	3rd
18d	2-5 times	0.80	0.58	1st	Q25	Ride share company	-0.21	-0.18	3rd
18d	6-10 times	0.84	-0.32	4th	Q26	Driver	-0.28	-0.53	3rd
18d	Not appli	-0.76	0.79	2nd	Q26	Not sure	-0.46	-0.51	3rd
28c	Not appli	-0.48	0.75	2nd	Q26	State	-0.38	-0.39	3rd
28c	Not at all important	0.52	0.11	1st	Q36	Suburb	-0.22	-0.40	3rd
28c	Some important	0.32	0.19	1st	Q37	31-45	-0.17	-0.37	3rd
28c	Some unimportant	0.66	0.53	1st	Q38	Advanced degree	-0.13	-0.74	3rd
28c	Very important	-0.20	-0.19	3rd	Q38	College degree	-0.27	-0.27	3rd
Q24	Never used taxis with children	0.92	0.96	1st	Q38	Less than high school	-0.88	-0.36	3rd
Q24	Not appli	-1.04	-0.25	3rd	17a	> 10 times	0.38	-0.36	4th
Q24	Not at all confident	0.04	0.45	1st	17a	6-10 times	0.54	-0.20	4th
Q24	Not very confident	0.31	0.58	1st	17d	1	0.50	-0.50	4th
Q24	Some confident	0.43	0.26	1st	17d	2-5 times	0.61	-0.55	4th
Q24	Very confident	0.43	-0.20	4th	17d	6-10 times	1.05	-0.38	4th
Q25	Circumstances	0.27	0.58	1st	17b	1	0.43	-0.24	4th
Q25	Not appli	-0.83	0.87	2nd	18a	> 10 times	1.00	-0.31	4th
Q25	Not sure	-0.94	0.72	2nd	18a	1	0.70	-0.32	4th
Q25	Parent/Caregiver	0.04	-0.12	4th	18a	2-5 times	0.52	-0.45	4th
Q25	Ride share company	0.51	0.46	1st	18a	6-10 times	0.95	-0.64	4th
Q25	State	-0.52	0.42	2nd	17b	2-5 times	0.40	-0.46	4th
Q25	Driver	0.10	-0.41	4th	18b	1	1.12	-0.31	4th
Q26	Circumstances	0.50	0.48	1st	18b	2-5 times	1.00	-0.54	4th

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rideshare car (Question 25) and in a taxi (Question 26). Cluster 3 included participants with an advanced degree who were from a large city. This cluster included the answer “very confident” indicating that participants in this cluster followed child safety laws when using taxicab services. Participants in this cluster shared ride (i.e., used RSSs without children or taxi services with children) 6–10 times or >10 times. Higher experience in shared rides might result in higher use of RSS services among the respondents who fall in this cluster. In addition, socio demographic characteristics such as higher level of education and living in large city could result in frequent use of RSS with children. The other two blue dotted boxes included ‘not application’ or ‘zero’ responses.

6.2. Clusters for riders never shared RSS with children

Fig. 6 shows a TCA plot from the selected responses of Group (2) (never used RSSs with children). There were three main clusters (cluster 4 to 6) for Group (2) as well. Cluster 4 contained participants with high school or some college education and participants who were located in a small town, large city, or rural area. This cluster also included the answer that the parent/caregiver was responsible for child safety in a rideshare car (Question 25) and in a taxi (Question 26). Perceived responsibility of parent/caregiver to ensure child safety in shared vehicle and less education level of the participants could be the reason that the respondent in this cluster never used RSS with children. Impact of education was found as a critical factor in Kulanthayan et al. (2010) study too. Cluster 5 included participants with a college degree, advanced degree, or less than high school education and participants who were located in a suburb. This cluster also included the answer that the driver was responsible, the rideshare company was responsible, or that they were not sure who was responsible for child safety in a rideshare car (Question 25) and in a taxi (Question 26). Uncertainty on child safety responsibility could be one of the reasons the participants in this cluster never used RSS with children. Cluster 6 included answers that they were very confident, not very confident, or somewhat confident that they followed state laws while using taxi services with children. This cluster consisted of respondents who had experience to use taxi with children or RSS without children. However, they never used RSS with children present. The dotted boxes shown in Fig. 6 indicated that the associations of some responses that were either ‘not applicable’ or ‘zero’.

The TCA clearly shows that there are disagreements in safety comfort levels among parents about child transportation safety in RSSs. It is partially based on their geographic location, education level, understanding of children safety in the RSSs, and the demand of the situations due to the urban busy lifestyle. Additionally, state regulations are not specific and consistent. To understand additional personal thoughts on these issues, this study performed an analysis of the open-ended responses, which is described in the next section.

6.3. Analysis of open-ended responses

In the open-ended questions, respondents were asked about their perceptions on using RSS services with children under 5 years old. In addition, respondents were asked about their suggestions on improvement scopes in RSS services so that users can have better experiences while ridesharing with children under 5 years old. In this section, perceptions of the respondents are analyzed considering their exposure regarding RSS use with children.

6.3.1. Perceptions of respondents who never used RSSs with children.

6.3.1.1. Positive and negative perceptions. Respondents who never rideshared with children expressed a few positive perceptions. A total of only 17 text segments consisting of positive perceptions were identified. In twelve text segments, respondents liked the idea of using RSS services with children. In four text segments, respondents perceived that RSS services with children can be a good option for emergency use or for the people who do not have personal vehicle in their household. One respondent reported RSS use with children as a safe option for travelling.

The negative perceptions of the respondents who never used RSSs with children were divided into three major categories- (i) perceived safety, trust, and comfort issues, (ii) hassle of travelling with own car seat, and (iii) insufficient information. Negative perceptions included a total of 63 text segments. Perceived safety, trust, and comfort issues were the predominant category among the negative perceptions of the respondent who never used RSS with children (67% of the text segments). Respondents expressed less trust in RSS drivers, as most of them were unfamiliar with these services. In addition, they feared that children might be scared or upset while travelling in strangers’ vehicles. As stated by two respondents:

“I would NEVER take my child in a ride share situation. It is not safe, and I do not know the driver. I do not even want to use it myself. I will only use my personal vehicle.”

“It would be very inconvenient because of the car seats and because I’d be nervous about my child getting upset or scared because they are in a stranger’s car.”

Respondents expressed their perceived discomfort in car seat supplied by RSS services. They had concern about improper car seat installation and aesthetic issues. Respondents, however, perceived difficulties in carrying their own car seats for using RSS services with children (11% of text segments). As stated by one respondent:

“Have never used a ride share since it is not convenient for me to use the car seat around.”

Insufficient information availability on using RSS services with children was negatively perceived by the respondents (19% of text segments). They were doubtful of the availability of car seats in RSS. Some of the respondents assumed that RSS do not supply car seats

Table 3

Categories identified on RSS experience improvement recommendations.

	Never used Rideshare with Children		Used Rideshare with Children	
	(144 text segments)		(269 text segments)	
	Frequency	Percent	Frequency	Percent
		frequency		frequency
In terms of car seat		46.50%		48%
Car seat supply in RSS	48		107	
Following car seat regulation	9		8	
Available facility of connecting existing car seat easily	2		1	
Seat inspection	2		5	
Clean seat	5		6	
Seat in good condition	1		2	
Drivers related		11.80%		12.30%
Safe and experienced driver	8		1	
Patient driver			1	
Driver education	5		27	
Assigning kid friendly drivers	1		2	
Background check of drivers	1		1	
Driver incentive	2		1	
Vehicle related		16.70%		7.40%
Separate vehicle types for ridesharing	10		12	
Vehicle with safety features	7		1	
Good environment inside vehicles	7		7	
RSS Information		16.70%		21.90%
Adequate information ahead of travel	14		24	
Different RSS options for travelling with children	7		35	
Advertisement	3			
Others		8.30%		10.40%
Strict regulations			3	
Responsibility allocation	6		16	
Low price	6		9	

for travelling children. In addition, some respondents were unaware of the car seat regulations and whether RSSs follow the car seat regulations. As stated by two respondents:

“Don’t use it because I don’t know if the driver has a car seat available.”

“Car seat safety is very important. I could not be 100% sure about all the regulations being followed.”

Another negative perception identified by respondents was the high cost of using RSSs. One respondent expressed that family travel with children might require a large RSS vehicle, which might cost more.

6.3.1.2. RSS experience improvement recommendations. RSS experience improvement recommendations of respondents who never used RSS with children can be helpful to understand and identify the strategies that can be adopted to change their mind to become users of RSS. Four major categories of recommendations were identified from the analysis- (i) recommendations in terms of car seat, (ii) recommendations related to RSS drivers, (iii) recommendations related to RSS vehicles, and (iv) recommendation on the dissemination of RSS information (Table 3). Car seat related recommendations were predominant, which consists of 46.5% of total text segments obtained on RSS experience improvement recommendations. Mostly respondents prefer car seat availability in RSS vehicles, as carrying personal car seats for using RSS was perceived as difficult among the respondents. Respondents expected car seats to be clean and in good condition. Respondents recommended RSS to follow car seat regulations appropriately and inspect car seats at regular interval to check condition and proper installation in RSS vehicles.

In terms of RSS drivers, respondents expected RSS drivers to be safe, experienced, and kid friendly. Respondents expected that drivers would go through a training program on child safety laws and regulations as well as proper installation of child seats. One respondent mentioned the need for a background check of drivers. Also, respondents suggested to provide incentives to drivers as a form of increased profit, which could motivate them to transport RSS users with children and follow related laws and regulations appropriately.

Respondents desired wider vehicles to comfortably accommodate children with car seat. Few respondents recommended RSS vehicles with accommodation of two car seats. Respondents expected RSS vehicles to be equipped with safety features for safer transportation of children. As mentioned by one respondent:

“They would need to have bigger cars with side air bags minimally.”

Clean in-vehicle environment was expected by the respondents as well. Respondents suggested RSS vehicles should be clean and free of bad odor. Some respondents demanded the presence of child friendly amenities such as toys, and children’s books.

Adequate information for travelling RSS with children were expected by the respondents. They wanted to be well-informed about the experience and the experiences they might expect while using RSS with children. Also, before using, RSS should provide information regarding the availability of child seat in the RSS vehicle, seat size, appropriateness of the seat for child age groups, seat condition and cleanliness, availability of pre-installed, and drivers' experience in transporting children. These findings are in line with Moradi et al. (2019). As stated by two respondents:

"It's good to let parents know ahead of time what the situation will be like & what they can expect."

"I think it would be beneficial to know which drivers have experience transporting young children and have the capacity for whatever child seat is required."

Drivers should also be informed about the presence of child in the upcoming trip so that they could be well prepared. Respondents expected RSS apps should include various options for RSS users travelling with children. One respondent suggested a dedicated section in RSS apps for children. Respondents recommended advertising the availability and features of RSS related to children transportation (e.g., availability of car seat) for promotion of the service and increase RSS use with children. Besides the recommendations presented in four major categories, respondents expected proper guidelines on the roles of different stakeholders (e.g., parents, drivers, RSS company) to ensure safety of children while using RSS. In addition, some respondents expected low price (i.e., in terms of discount rate for using with children, little or no extra price for car seat) while using RSS with children.

6.3.2. Perceptions of respondents who used RSS with children.

6.3.2.1. Positive and negative perceptions. Respondents who rideshared with children provided their responses in the open-ended prompt, presumably based on their experiences of using RSS with children. Respondents who shared rides with children perceived RSSs very positively. A total of 191 text segments were extracted as positive perceptions from the responses of the respondents, who used RSS with children. In 126 text segments, respondents identified RSS satisfactory for travelling with children. Respondents also identified RSSs were easy to use (9 text segments), cheap (4 text segments), safe (9 text segments), convenient (11 text segments), and accessible (8 text segments). Good behavior of RSS drivers resulted positive perceptions among the respondents (observed in 18 text segments). Respondents found RSS drivers patient, safe, experienced, courteous, professional, and friendly. The findings are in line with the findings of Smith (2016) and Kulanthayan et al. (2010). Some respondents identified the usefulness of RSS for households with no private vehicles, in emergency situations, for out-of-town travel, and travelling during peak hours and while on vacation (7 text segments).

Relatively, fewer negative perceptions were found among the respondents who used RSS with children (51 text segments). Negative perceptions of the respondents were classified into three major categories- (i) hassle of using RSS with children, (ii) perceived safety, trust, and comfort issues, and (iii) RSS drivers' behaviors and actions. Majority of the negative perceptions on RSS were on the difficulties of travelling with personal car seats (39% of text segments identified as negative perceptions). The perceived concerns of the respondents who never used RSS with children were reiterated by the respondents who shared RSS with children. As stated by one respondent:

"It is a hassle to have to bring your own seat get it down and take it everywhere then put it back in. They should have their own car seat carrying in trunk or in vehicle probably and that would get more customers."

The perceived safety, trust and comfort issues were not high among the respondents who shared RSS with children. Only 15 text segments (29% of text segments identified as negative perceptions) were focused on lack of perceived safety, trust, and comfort in terms of travelling in RSSs with children. Some respondents experienced bad behaviors and observed inappropriate actions among the RSS drivers (identified in 12 text segments). Negative drivers' behaviors and actions included impatience, annoyed by the presence of child passenger, unsafe driving, and lack of knowledge on car seat regulations and child passenger handling. As stated by two respondents:

"The drivers often act annoyed if or when babies cry, they act annoyed when it takes a few minutes to correctly install the seats, they often comment on preferring not to transport children."

"Drivers do not have seats available, lack of knowledge, grumpy about having to wait for me to install seat."

In addition, some respondents expressed negative perceptions on expensive RSS, insufficient RSS information for travelling with children, and unavailability of RSSs at the time of their needs.

6.3.2.2. RSS experience improvement recommendations. From the qualitative data analysis, categories of RSS experience improvement recommendations were obtained for the groups of respondents who used RSS with children, which were the same categories discussed earlier for the respondents who never used RSS with children (Table 3). However, due to having experience of using RSS, respondents in this group provided more in-depth information on the identified categories. Car seat supply by the RSS companies were predominant the improvement recommendation by the respondents who used RSS with children, similar to respondents who never used RSS with children. One respondent suggested providing disposable covers on the seat to reduce disease transmission and for cleanliness. Respondents mentioned local police and fire department can perform the inspection of child seat to check proper installation and ensure good operating condition. A certificate of inspection can be uploaded to the RSS website, so that users can make an informed decision before requesting ride.

Respondents who used RSS with children also mentioned the need for drivers' education more than the respondents who never used RSS with children. In general, safety education is essential for all roadway users (Zatoński and Herbec, 2016; Faus et al., 2021). Conventional traffic safety campaigns can include the importance of CSS in RSS, which will be beneficial in improving the safe ridesharing behavior. In addition to proper training on child seat installation and related laws and regulation, respondents suggested drivers to be up to date and maintain high standard keeping in mind that proper transportation of child is their responsibility. One respondent suggested the drivers to sign acknowledgement of related laws and regulations to become eligible for transporting RSS users with children. One respondent suggested RSS drivers to be patient while serving riders with children. However, recommendation to be safe and experienced as RSS drivers were not observed as much in the responses of the respondents who shared RSS with children.

Vehicle related improvement recommendations were also similar among the respondents who used RSS with children. However, this group of respondents provided suggestions in terms of dissemination and availability of RSS information more in comparison to the respondents who never used RSS with children. About 16% of text segments were identified on 'RSS information' category among the respondents who never used RSS with children, where this category was observed in 21% of the text segments among the respondents who used RSS with children. One respondent preferred to have pictorial illustration on rules and regulations and on car seat installation. One respondent wanted to have the option to use a personal car seat while using RSS service due to the lack of trust on the supplied car seat. Another respondent wanted to learn the drivers' driving history to identify safe drivers while travelling with children. Travel prescheduling thorough RSS app was another suggestion found in the responses. Overall, a need of comprehensive information dissemination and various options related to RSS use with children were evident from the responses. As stated by one respondent:

"The more information the better. Information on laws, information about the driver, information about the vehicle, and any information about the responsibility. It can be a little bit of uncomfortable, so it is good to have ease of mind."

Besides the major categories, some respondents who shared ride with children wanted to see strict regulations that the RSS company and drivers must abide while transporting children.

7. Conclusions

Serious and fatal injuries can be reduced significantly by seating young children in an appropriate position and securing them in car seats, booster seats, or seat belts that are age and size appropriate. CSSs are designed to promote child safety and protect children from being injured in car crashes. The improper use of CSSs is a pervasive and long-standing problem that negatively impacts the risk of injury and death in traffic crash occurrences. However, the usage of CSSs in RSSs is an area of research that is very limited, and there are very few studies focused on this important issue. The present study shows that there is significant disagreement among parents about child transportation safety in rideshare vehicles. These issues most likely prevail due to the inconsistent regulations in the U.S., where it is the responsibility of each state to develop and communicate its own child passenger safety regulations. These state regulations are often difficult for riders and drivers of rideshare vehicles to find and comprehend; they sometimes involve multiple statutes, have confusing wording, or are overall vague and unclear. The current study highlights this important issue and analyzes a comprehensive survey data.

By performing a comparison test, this study found that response patterns vary widely among the participants of the two groups. The TCA determined several patterns. For example, urban-dwelling parents with higher education degrees often used RSSs. They were well adapted to the use of RSSs with children when necessary. Analysis of open-ended responses revealed that negative perceptions regarding RSS use with children can be reduced if users have RSS experience with children. The overall findings are generally in line with the findings from other studies (Smith, 2016; Kulanthayan et al., 2010; Ma et al., 2012).

The current study is not without limitations. The current study comprises two main research questions. Additional issues and insights can be drawn using the survey conducted by Owens et al. (2019). For example, personal traits can also be linked to the association between these two groups and their response patterns. Additionally, cost allocation factor can influence how the roadway users use RSSs with or without children. This issue can be explored in-depth in future studies.

CRedit authorship contribution statement

Subasish Das: Conceptualization, Data curation, Formal analysis, Methodology, Software, Writing – original draft. **Md Tawhidur Rahman:** Formal analysis, Methodology, Software, Writing – original draft. **Nuzhat Kabir:** Writing – original draft. **Oscar Oviedo-Trespalacios:** Writing – original draft. **Kakan Dey:** Writing – original draft. **Md Mahmud Hossain:** Writing – original draft.

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.

Data availability

Data will be made available on request.

Table A1

List of questions in the survey questionnaire (Source: 2).

1. How many children in each age group do you care for on a regular basis? Please leave blank if zero. (choose from four options)
2. How often do you transport a child or children under your care? (choose from five options)
3. How do you typically use each of the transportation types below when transporting the child or children under the age of 5 under your care?
 - a. Your personal vehicle (choose from six options)
 - b. A borrowed vehicle (choose from six options)
 - c. Bus/train/subway (choose from six options)
 - d. Bicycle (choose from six options)
 - e. Ride share (e.g., Uber or Lyft) (choose from six options)
 - f. Other (please specify type) (choose from six options)
4. **[ASK ONLY IF 3e= 'NEVER']** What are the reasons you have not used a ride share service for children under the age of 5 in your care? (Please Click All Response Options That Apply)
5. **[ASK ONLY IF 4 'Traveling with children' SELECTED]** What are the reasons you felt you could not use a ride share service while traveling with children? (Please Click All Response Options That Apply) **SKIP to 17**
6. In what situations and how frequently have you used a ride share service such as Uber or Lyft when transporting a child or children under your care?
 - a. For local travel while on an out-of-town trip (Examples: airport to hotel, hotel to restaurant, etc.) (choose from five options)
 - b. For routine local travel where I live (Examples: daily activity, school, shopping, social activities, etc.) (choose from five options)
 - c. For non-routine local travel where I live (Examples: usual vehicle not available, emergencies, etc.) (choose from five options)
 - d. To make an out-of-town trip (choose from five options)
7. When you have used Uber/Lyft or a similar ride-share service while traveling with a child or children under 5 years old in your care, how often was a car seat used? (choose from three options)
8. What was/were the reasons a car seat was not used? (Please Click All Response Options That Apply) **Go to 16 if 7 = Not Used**
9. What type of child safety seat(s) was used? (choose from six options)
10. What was the position of the child safety seat(s) used? (choose from four options)
11. How was the child safety seat attached to the vehicle? (choose from five options)
12. Who provided the seat(s)? (choose from two options)
13. Who installed the child safety seat(s)? (choose from four options)
14. Who adjusted the straps in the child safety seat? (choose from four options)
15. How confident overall were you in the correctness of the installation of the child safety seat(s) used in the Uber/Lyft service(s)? (choose from four options)
16. Have you ever transported a child in a ride-share vehicle in a manner different from your personal vehicle? (Please Click All Response Options That Apply)
17. In what situations and how often have you used a ride share service such as Uber or Lyft without a child or children?
 - a. For local travel while on an out-of-town trip (Examples: airport to hotel, hotel to local destination, etc.) (choose from five options)
 - b. For routine local travel where I live (Examples: daily activity, work, shopping, etc.) (choose from five options)
 - c. For non-routine local travel where I live (Examples: usual vehicle not available, emergencies, etc.) (choose from five options)
 - d. To make an out-of-town trip (choose from five options)
18. In what situations and how often have you used a taxi when transporting a child or children under your care?
 - a. For local travel while on an out-of-town trip (Examples: airport to hotel, hotel to local destination, etc.) (choose from five options)
 - b. For routine local travel where I live (Examples: daily activity, work, shopping, etc.) (choose from five options)
 - c. For non-routine local travel where I live (Examples: usual vehicle not available, emergencies, etc.) (choose from five options)
 - d. To make an out-of-town trip (choose from five options)
19. When you have used a taxi while traveling with a child or children under 5 years old in your care, how often was a car seat used? (choose from three options)
20. What was/were the reasons a car seat was not used? (Please Click All Response Options That Apply)
21. How familiar are you with the recommended child seat guidelines for the age or ages of your children? (choose from four options)
22. How familiar are you with your state's laws for child safety seat use for the age or ages of your children? (choose from four options)
23. How confident are you that you have followed state laws when using ride-share services such as Uber and Lyft with children under 5 years old? (choose from five options)
24. How confident are you that you have followed state laws when using taxi services with children under 5 years old? (choose from five options)
25. Who is legally responsible for correct child safety seat use for children under 5 years old as passengers in ride-share services such as Uber or Lyft? (choose from six options)
26. Who is legally responsible for correct child safety seat use for children under 5 years old as passengers in taxis? (choose from five options)
27. When you travel, how do you get information about child seat regulations? (Please Click All Response Options That Apply)
28. How important are each of the factors below in your decisions about using a ride-share service with a child or children under the age of 5?
 - a. Pre-installed child seat available (choose from five options)
 - b. Rear seat space (choose from five options)
 - c. Driver safety record (choose from five options)
 - d. Type of vehicle (choose from five options)
 - e. Convenience of child seat installation in vehicle (choose from five options) Vehicle cleanliness (choose from five options)
 - f. Availability of information about child seat laws and regulations (choose from five options)

(continued on next page)

Table A1 (continued)

29. Are there any other factors that would influence your decision to use a ride-share service with a child or children under the age of 5? (choose from two options)
30. Are you a driver for a ride-share vehicle? (choose from two options)
31. Do you provide child seats as part of a formal family-focused ride-share service such as Uber Family? (choose from two options)
32. Do you provide child seats when you are driving for the ride share? (choose from two options)
33. Have you transported passengers with children under the age of 5? (choose from two options)
34. Have any of those riders installed their own child seats? (choose from two options)
35. Have you allowed children under 5 years old to ride in your vehicle without an appropriate child seat? (choose from two options)
36. Which best describes the area where you live? (choose from five options)
37. Which age group are you in? (choose from five options)
38. What is your education level? (choose from five options)
39. What is your gender? (choose from three options)
40. Please share your comments on using ride-share services such as Uber/Lyft and/or taxi services with children under 5 years old and how you think the ride-share experience could be improved for riders who want to use these services with children under the age of 5.

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Appendix

(See Table A1).

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