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Understanding school trip mode choice – The case of Kanpur (India)

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ABSTRACT

School trips have distinct characteristics compared with trips for other purposes (e.g., work and recreation). School trips have been extensively studied in North American and western European countries. However, these have not been studied in developing countries, except for a few studies in China and Iran. Therefore, the basic understanding of the school travel in South Asian cities remains unclear. Thus, this study explored the travel decisions of schoolchildren in the Indian context by using primary data collected from Kanpur, a city in India. A multinomial logit framework was used to model the choice decisions of making trips to schools. The results indicated that the absence of a public transit system and the lack of good-quality school bus services resulted in the dependence of schoolchildren on other motorized modes, such as family vehicles and paratransit. Furthermore, lack of infrastructure support negatively influenced the use of active modes of transport.

1. Introduction

The travel behavior of children differs from that of adults (e.g., McMillan, 2005); however, the travel mode choices for school trips in developing countries remain unclear thus far. Most school-going teenagers participate in taking decisions regarding their school travel mode, whereas the school trips of younger children are decided solely by their parents. Thus, school-going teenagers should be considered as the major stakeholders in transportation policies and studying the travel patterns of this group of schoolchildren is crucial for understanding the travel mode choice decisions (Ross, 2007).

In India, children (defined as individuals aged younger than 14 years) comprise 39% of the population (Census of India, 2012). India also has the largest student population in the world, with nearly 260 million students enrolled at various levels of school education- primary, secondary, and higher secondary (MHRD-GoI, 2016). Hence, school trips can be considered a major factor affecting road traffic. Because most school and office timings are similar, school trips become part of peak hour traffic. Because of various factors, including lack of proper road traffic infrastructure and poor enforcement and lack of lane discipline, Indian roads pose serious traffic risk. In addition, people belonging to middle- and low-income groups are highly dependent on motorized two-wheelers, which add to the overall traffic risks of road-users. These poor conditions contribute to high road traffic injuries among adolescents (Debata et al., 2014; Hyder et al., 2006; Bhalla et al., 2017).

In Western countries, several studies have been conducted to understand school travel mode choices; recent studies in these countries have mainly focused on the decline in the tendency of walking and bicycling among schoolchildren and the resulting obesity (Ewing et al., 2004; McDonald, 2012). However, in low-income countries, such as India, understanding on even the basic issues related to travel mode choice for school trips remains insufficient.

2. Objective of the study

The objective of this study was to develop a reasonable understanding of travel mode choice behavior for school trips in India on the basis of primary data collected from a representative sample of schools in the city of Kanpur, India. This study provides basic insights into travel mode types used for school trips and the factors affecting these choices. To the best of the authors' knowledge, this study is the first to analyze school trips in relation with potential factors determining the travel mode choice decisions in the South Asian context.

3. Literature review

An extensive literature review regarding school trips was performed. Herein, the current understanding of significance and nature of the effects of several factors regularly included in travel mode choice studies are discussed.

Numerous studies have quantitatively identified various factors influencing travel mode choice decisions for school trips. Ewing et al. (2004) were one of the first authors to include various potential factors

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to model the travel mode choice decisions of school children; distance and sidewalk coverage were identified as significant factors affecting travel mode choice. McMillan (2005) proposed a systematic framework for understanding the mechanisms influencing school travel; it suggested that although distance predominantly influenced the mode of travel, decisions were also moderated by attitudinal, cultural, and sociodemographic factors.

Age and gender of the children are the two sociodemographic attributes typically included in travel mode choice studies. Although most studies have shown increase in the tendencies of walking and biking among students with increase in age (McDonald, 2008a, 2008b; Noland et al., 2014; Sidharthan et al., 2011), some have found an inverse (McMillan et al., 2006) or no association between age and travel mode choice (Wilson et al., 2010); However, these results may have depended on the selection of age groups for the survey. Regarding gender, boys are generally more likely to ride a bicycle than are girls in the same age group (Elias and Katoshevski-Cavari, 2014; Emond and Handy, 2012; McDonald, 2007; McMillan et al., 2006; Samimi and Ermagun, 2013a; Sidharthan et al., 2011). A study by Scheiner (2016) found that escorting behavior of parents to their kids in the age group of 6 to 13 years were dependent on the gender of children and positively influenced their income. Girls had higher probability of being accompanied by parents than boys. By contrast, some studies have reported no association between gender and travel mode (Wilson et al., 2010). Household-level factors have also been included in some school travel studies. Low household income can increase the likelihood of children commuting actively to school (Ewing et al., 2004; McMillan, 2007; Samimi and Ermagun, 2013b; Sidharthan et al., 2011; Wilson et al., 2010). Flexible work pattern of parents, particularly that of fathers, can increase the chances of children being accompanied by their parents in the active transport modes (McDonald, 2008b; Seraj et al., 2012; Yarlagadda and Srinivasan, 2008). A larger size of household can likely increase the chances of children being accompanied to school (including being dropped off in personal vehicles) (Li and Zhao, 2015). Furthermore, the presence of siblings attending the same school can also have a positive association with walking and biking; however, the results related to this sibling effect remain mixed (McMillan, 2005).

The distance between the school and house (and therefore, the travel time) has consistently been shown to be associated with travel mode choice (Mitra, 2012). Studies have also shown that perceived and actual distances have different magnitudes of effects on travel mode choice (Emond and Handy, 2012). Some important built environment attributes include presence and quality of transportation infrastructure, such as sidewalk and pedestrian crossing. The effects of variables related to land use and urban form have been investigated in detail by Noland et al. (2014). By using a mixed logit approach, the authors found that a residential density exceeding a certain threshold motivated active commute; in particular, smaller block sizes encouraged walking. The household density of neighborhood around schoolchildren's homes has a strong positive association with active travel (Kerr et al., 2006). In addition, a higher traffic density is negatively correlated with the odds of walking (Kaplan et al., 2016; Su et al., 2013). However, because of the differential effects of built environment factors, cycling and walking as travel modes maybe differentiated for school travel (Kaplan et al., 2016).

Many studies have assumed that parents essentially make decisions on behalf of their children regarding travel mode choice and accompany them to school (Lang et al., 2011; McMillan, 2007; Yarlagadda and Srinivasan, 2008). Furthermore, a few studies have shown that children above a certain age take independent decisions on their school trips (Zwerts et al., 2010). School trip behavior is moderated by parental perceptions about safety. Built environment factors, including intersection type and presence and quality of sidewalk, influence travel mode choice for school trips (Curtis et al., 2015; Macgregor, 2013). Some studies have concluded that fear of crime, heavy traffic, and car ownership are significant determinants of parental perception of active travel modes for school trips (Schlossberg et al., 2006).Concerns regarding safety are negatively associated with active commute in many studies (Elias and Katoshevski-Cavari, 2014; McMillan, 2007; Panter et al., 2008). In addition to such moderation, literature associating travel behavior of adults with that of children suggests that the school travel decisions are household-level decisions (Ewing et al., 2004; McDonald, 2008a) and therefore must be conceptualized in that manner.

The aforementioned studies have reported several contradicting findings, probably because of the differences in culture and methods adopted for data collection (Pont et al., 2009). A study indicated notable variations in the correlation of active commute among children across the eight countries of different contexts, cultures, and geographies (Larouche et al., 2015). The context was distinctive feature in a study on German students, where weather and school profile were found to significantly affect the choices (Müller et al., 2008). In New Zealand study, road safety concerns and social norms were the dominant factors found by an analysis of school travel (Lang et al., 2011).

Some works have explored these associations in non-Western societies. A study conducted in Tehran, Iran, showed that shorter distance to school did not necessarily lead to walking and bicycling and that the decisions were significantly moderated by traffic safety concerns and perceptions (Shokoohi et al., 2012). Another study in Iran found that perceived walking time to school was the most significant barrier for active travel to school while the other variables considered were related to household characteristics, attitude and safety (Mehdizadeh et al., 2017). A study on active commuting to school in Bogota, Colombia, concluded that higher levels of educational achievement by parents were associated with higher odds of bicycling (Leblanc et al., 2015). A study in Ecuador identified traffic volume, traffic speed, crime and distance as parental perception barriers to active commuting (Huertas-Delgado et al., 2017). The institutional and cultural context unique to Beijing was found to be a significant determinant of modal split (Li and Zhao, 2015). A study on the built environment in Taipei found that unlike the trends in Western societies, travel mode choices for school trips in Taipei were not significantly related to the employment status of the mother and household income (Lin and Chang, 2010). In a recent study, one-sixth students reported experiencing a road traffic injury during school journeys in Hyderabad, and school bus and bicycle were respectively the safest and the least safe modes (Tetali et al., 2016).

In summary, literature on school trips in developing countries is limited. However, a wide range of factors, including distance to school, children's age and gender, parents' employment status and income, and personal automobile ownership, are some of the important decision variables for school trips. In addition, studies linking children's own perceptions and attitudes with the travel mode choices remain scant. Thus, the operant study attempted to fill in the identified research gaps.

4. Study area

Kanpur is an industrial city, with a population of > 2.7 million and is the twelfth largest city among all 497 cities in India (Census of India, 2012). The city has a geographical area of 266.7 km^2, with a population density of > 10,000 people per km^2. Of the total population, nearly 0.7 million children are aged 5–15 years, which can be considered the school-going age. The considerably high proportion (24.4%) of children and adolescents in Kanpur is consistent with the national average. Transport infrastructure in Kanpur has chronic problems, including a lack of maintenance of local and arterial roads and absence of good-quality public transport and even the basic traffic management systems (e.g., traffic signals).

5. Data collection: sampling and survey design

Nine high schools were selected through random stratified sampling to obtain a sufficient representative sample of a school population. In

brief, the 112 municipal wards in Kanpur were demarcated into eight zones of a nearly equal geographical area by clubbing neighborhood wards together. These zones were further stratified according to population density and then according to school density (number of schools per unit area). Finally, the selected schools were distributed across the city spatially and were located in regions with representative population densities and economic activities.

To collect the data on travel behavior, this study opted for self-administered (drop-off type) questionnaire survey, a method which has been prominently used in travel mode choice studies worldwide. The survey form was aimed to collect information on attitudinal and personal factors pertaining to school trips. In addition, efforts were made to collect data related to other important factors, such as distance between their school and home and route characteristics. Basic data requirement and other relevant information were initially drawn from literature and later modified to adapt to the Indian scenario. Information on the travel modes of home-to-school and school-to-home trips was also included. Personal information (e.g., age, gender, and home locality), household information (e.g., number of family members, parents' employment status, monthly household income, and vehicle ownership), and attitudinal information (e.g., perception about motor vehicles and active commuting) were included in the questionnaire. Because schoolchildren could not estimate their travel times correctly (Murakami and Wagner, 1999; Tetali et al., 2015), these were estimated by using locations of major landmarks in the vicinity of their homes. The names of landmarks reported by parents were geo-coded to estimate distance and travel time from and to their schools. Prevailing protocols to collect data from human subjects were followed.

The questionnaire comprised two parts. The first part was to be filled by the students and the other by their parents. Considering that the study area contains predominantly Hindi-speaking population, the survey form was bilingual (English and Hindi). Parallel translation by multiple translators, a standard methodology to translate survey forms, was followed. A pilot study was conducted with a smaller focus group of schoolchildren, which facilitated several improvements in the survey instrument. Accordingly, the survey questionnaire was revised before conducting main data collection. The students were handed out the questionnaires in schools, and all the questions were explained to them in detail. An additional round of doubt-clearance discussion was organized at each school. The students responded to the questions about travel mode choice, travel time, route characteristics, and cognitive and attitudinal aspects, whereas the parents filled the information about student's age and gender as well as selected household-related characteristics, including income, size, and vehicle ownership. A set of questions related to the reasons for opting or not opting school buses and perception about the service provided were responded by the students in consultation with their parents. The survey forms were collected with the assistance of the school administration over a period of one week. The details of the schools were obtained through a school information form, filled by the interviewer in consultation with the school administration. Data on zone level variables for household and school zones were extracted from Census of India (2012).

6. Descriptive analysis

Nearly 2100 questionnaire survey forms were distributed in the selected schools; of these, 1238 were returned, yielding a net response rate of 35.9%. The response rates across the schools were in the range of 16% to 51%. After a quality check, 1096 responses were deemed suitable for analysis. The response rate was higher than the typical 20% to 25% reported for self-administered questionnaire surveys. Because the questionnaires were handed over to the students in their classrooms, the students and their parents might have perceived the survey as an important task, similar to homework assignments. This could be the reason for higher than usual response rate. Table 1 presents a descriptive summary of the sample characteristics.

No significant difference was noted between journey “to school” and return trip “to home.” Fig. 1 illustrates that although bicycle was the travel mode chosen by boys, most girls were dropped off in family vehicles. Fig. 2 provides a visual presentation of the modal share with respect to household income categories. Notably, walking and bicycling were the major modes for the low-income groups, whereas cycle rickshaws and tempos were almost never preferred by the high-income groups. Fig. 3 displays the distance traveled and travel time for school trips. On the basis of the collected data, the median distance was the highest for school bus and family vehicle (approximately 7 km). Among all modes, time to travel was the longest in school buses, with a median travel time of nearly 30 min. In addition, trips in school buses showed more variation in distance traveled compared with other available modes. Nonmotorized modes (walking, bicycling, and cycle-rickshaw) were largely used for short distances. In northern India, tempo, a motorized three-wheeler, is a popular mode of informal paratransit. Although tempos have a capacity of six passengers, typically they carry over 10 passengers and hence do not offer comfortable travel for its passengers. Yet, according to the survey, tempo has significant modal share in school trips. Approximately 37% of the students were unaccompanied in their school trips. The most common companion in school trips were siblings or peers, whereas approximately one-third of the accompanied students traveled with either of their parents.

To understand the cognitive aspect of school trips, the questionnaire included queries to grade respondents' opinions regarding four statements related to culture, safety, speed, and peer effect. The cultural effect was assumed to reflect their perception about motor vehicles being considered status symbols augmenting the prestige of their owners. Nearly one-third of the respondents agreed with the proposition “Owning a motor vehicle, rather than a bicycle, is a status symbol. It elevates social status and reputation.” Table 2 summarizes the responses on attitudinal questions. The ratings shown in Table 2 are on a scale of 5. Zero denotes complete disagreement, 2 denotes a neutral opinion, and 4 denotes complete agreement.

Among those who did not use school buses, 25.7% stated “Bus-stop is not near to (their) home” as the reason for not using school buses. Some parents specified reasons not present among the options provided in the survey form. Most frequent among these was the inherent dislike for buses. The poor scores for school bus services in terms of user perception could be due to a lack of adequate infrastructure, safety, and comfort, both inside the buses and in areas surrounding bus stops. A sufficient portion of respondents (14%) had their homes in the vicinity of their schools, and hence, these responses were omitted from the set of potential school bus users. After these rearrangements were made, finally, 31.3% respondents found greater distance to bus stop (option 2) as the prime hindrance to traveling by school bus.

Of $< 20\%$ respondents who chose school bus as their regular mode of travel, a considerable majority (83%) stated the main reason as “(the) bus was safer for a child.” This is sufficient to suggest that the school buses have a positive image, and parents perceive them to be a safe mode of transport.

Table 2 shows high of response rates for all questions, except for the statement on peer effect. Cross-tabulation of responses did not reveal any consistency across the responses for these four statements indicating that the chances of misunderstanding the statements or filling blind responses are low.

Similar to most cities across South Asia, data on built environment were not available for Kanpur. To include basic built environment factors in the model, the survey recorded the availability of sidewalk and presence of major roads in the school neighborhood as proxies of built environment. Census data on ward-level population were also extracted.

7. Multinomial logit model of travel mode choice

The descriptive analysis presented in the previous section indicated a relationship between travel mode choice for school trips and various

Table 1
Brief summary of sample characteristics.

Characteristic	% respondents	Mode of commute (percentage of sub-population)						Accompanying behaviour	Distance to school (km)	
		NMT			Motorized travel					
		Walk	Bicycle	Cycle rickshaw	School bus	Para-transit	Family vehicle	Accompanied[a]	Average	Med.
Age										
10 years or less	3.5	29.8	2.7	8.1	16.2	16.2	27.0	63.9	5.4	3.3
11 years	15.6	30.7	14.4	9.6	6.6	5.5	9.9	68.6	6.0	5.0
12 years	26.5	18.4	11.3	6.4	19.8	15.5	28.6	63.1	5.3	3.9
13 years	27.0	13.7	19.6	3.8	16.8	18.2	27.7	59.6	5.4	5.0
14 years	18.0	11.8	28.3	5.9	11.8	11.2	31.0	68.0	4.7	3.5
15 years or more	9.4	28.0	35.0	6.0	13.0	7.0	11.0	57.0	4.1	3.6
Gender										
Male	58.1	15.4	24.5	3.9	13.6	16.2	26.3	58.9	5.1	4.2
Female	41.9	17.6	10.2	8.4	19.7	13.3	30.8	69.4	5.3	4.2
Monthly income (₹)[b]										
< 5000	10.4	47.0	23.5	0	7.8	12.7	8.8	48.6	3.0	1.7
5000–10,000	22.8	21.6	26.0	6.0	12.5	11.3	22.6	59.5	3.9	2.5
10,000–15,000	15.1	16.3	22.9	8.5	17.0	12.4	22.9	58.8	5.2	3.8
15,000–35,000	24.2	12.7	18.1	7.4	11.1	16.9	33.8	65.8	5.2	3.8
35,000–75,000	16.9	7.0	11.1	5.3	25.9	20.0	30.6	67.8	6.6	6.0
> 75,000	10.6	6.5	4.7	0	23.4	12.1	52.3	74.1	7.2	7.5
Vehicle ownership										
Car owned	42.9	7.4	9.2	4.5	21.1	15.5	42.4	73.9	5.2	4.2
Motorcycle owned	76.1	12.9	18.0	6.2	15.5	17.1	30.3	65.0	5.2	4.2
Bicycle owned	73.2	15.6	22.7	4.8	15.9	15.4	25.5	61.4	5.2	4.2
No vehicle owned	3.5	64.7	–	5.9	8.8	20.6	–	50.0	2.4	1.2
Employment of parents										
Mother employed (self-employed/unemployed)	12.6 (87.4)	12.2 (17.2)	16.8 (18.6)	7.0 (5.2)	17.5 (15.8)	17.5 (14.6)	29.0 (25.5)	69.2 (62.8)	5.2 (4.1)	5.7 (5.2)
Father employed (self-employed/unemployed)	48.6 (51.4)	20.4 (12.7)	20.5 (16.1)	6.9 (3.8)	16.5 (15.8)	14.3 (15.4)	20.8 (36.1)	59.9 (67.2)	4.8 (5.5)	3.3 (5.0)
Built environment										
Sidewalk present around the school	31.8	16.2	25.6	6.0	18.7	14.9	18.7	53.8	5.0	3.3
A major road in vicinity of school	79.1	10.2	16.2	5.6	19.4	17.2	31.1	64.8	5.7	5.0
Total	100.0	18.3	18.4	6.1	15.7	16.2	25.3	63.2	5.2	4.2

[a] The responses in which students were not accompanied by siblings or peers are included.
[b] ₹ is Indian Rupee; US $1 ~ ₹65 as on December 2017.

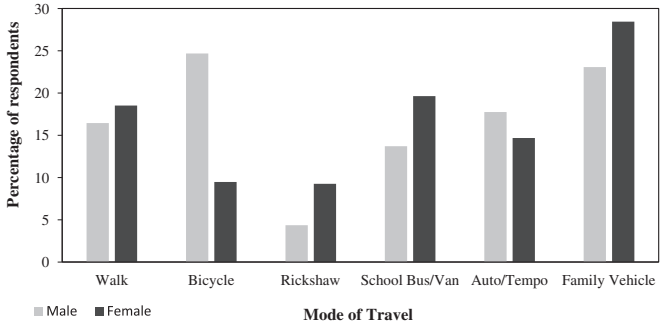

Fig. 1. Gender aspect of travel mode choices for school trips.

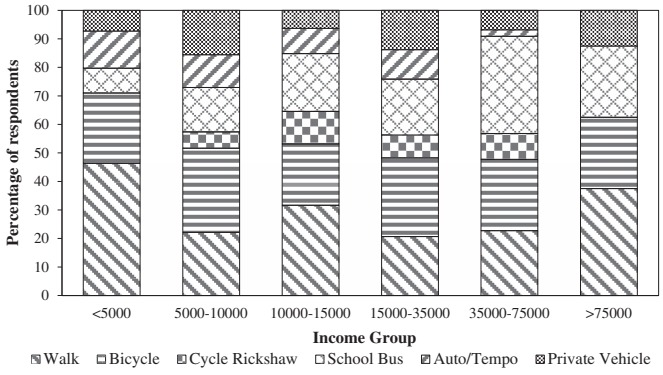

Fig. 2. Income group-wise travel mode choice characteristics of the respondents.

demographic variables. A quantitative explanatory model of choice probabilities may complement the exploratory analysis. Logit models are discrete choice models, most widely used in travel mode choice studies. These models are based on the random utility theory. According to this theory, each individual decision-maker has a unique utility function and the alternative with the maximum utility is preferred over all other alternatives available in the choice set. In a logit model, the random component of utility is assumed to be independent and identically distributed (IID) across the individual choice-makers and the alternatives (Ben-Akiva and Lerman, 1985). Although several standard approaches, such as nested logit, are available, the present work employed a multinomial logit (MNL) framework to model the travel mode choice probabilities because it provides reliable results, which are easier to interpret (Mitra and Buliung, 2014; Yarlagadda and Srinivasan, 2008).

8. Model specification and results of estimation

As previously discussed, the travel mode choice model of home-to-school trips is presented here. Pearson's correlation coefficient was

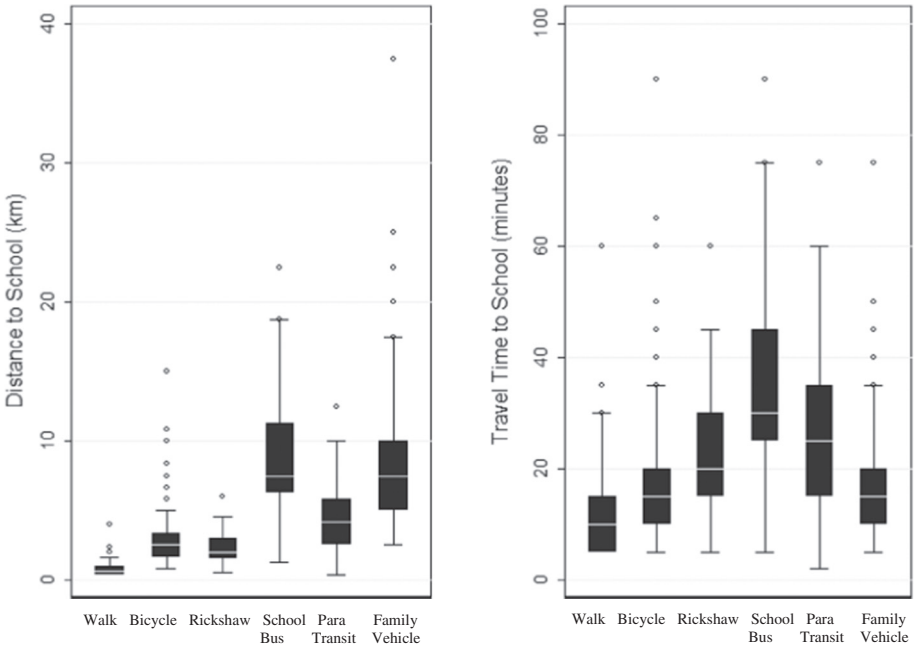

Fig. 3. Variation in distance to school and travel time.

not > 0.4 for any pair of the independent variables. In case of the indicator variables for perception and attitude, the correlation coefficients for various pairs of variables were as low as 0.01. The suitability of the MNL framework was tested for the independence of irrelevant alternatives IIA assumption by using the Hausman-McFadden method and the Small-Hsiao method (Cheng and Long, 2007). Both the tests confirmed that the IIA assumption was not violated, and hence, the MNL framework was adopted to model the travel mode choice.

In the stepwise addition, every explanatory variable was found to have significant explanatory power, except for density indicators (population density at home and school ward levels). The MNL model for travel mode choice was estimated by the likelihood maximization technique; the coefficients are shown in Table 3. The likelihood ratio and adjusted rho-squared were reported to be 869.13 ($p < 0.005$) and 0.3312, respectively.

Walking was the reference alternative. Coefficients for distance were positive and significant for bicycle, cycle-rickshaw, school bus, and paratransit modes at 99% significance level and for family vehicle at 95% significance level. The results, as expected, indicated that increase in distance between home and school, with every other factor constant, increased the odds of traveling by faster modes. Notably, the odds of choosing school bus and family vehicles were higher compared with other faster modes. This could also be interpreted as follows: students choose far away schools only if they have access to family vehicles or school buses. Because bicycling or riding in cycle rickshaws is difficult, this result also is logical.

Demographic variables were expected to be important attributes for travel mode choice. The results show that coefficient of age was positive for bicycle, which is a reasonable finding. The parents of younger children are likely to be more skeptical about safety of their children when they ride a bicycle for commuting to school, particularly when busy roads are part of their routes. Age did not show any significant association with other travel modes, potentially because all other modes were used by all age groups.

The effect of gender on choice of bicycle, cycle-rickshaw, or school bus was noted because the corresponding coefficients were significant. The results indicated that the girls were less likely to ride bicycles for school trips than were their male counterparts. Notably, even among adults, the proportion of women riding bicycles is lower in India. In addition, the girls were more likely to use cycle-rickshaw and school bus.

Notably, gender did not show a significant relation with the odds of using auto rickshaw or tempo. Coefficients of another demographic variable “household size” were not significant for the modes considered.

The most vital socioeconomic covariate was household income. Here, the reference category was the lowest income groups with monthly income below ₹5000. The overall trend showed that as the income level increases, the odds of using faster modes generally increase. However, the coefficients for bicycle mode were significant only for two lower income groups (II and III). Effects were more prominent for modes such as school bus and personal vehicles. For students belonging to higher income groups, the odds of using family vehicles compared with other modes increased. For students belonging to households in the high income groups, among all modes, the odds of choosing family vehicle as the mode of school trips were the highest, followed by school bus. If the mother was self-employed, as opposed to being employed, the odds of a child walking to school increased. Notably, if the father was self-employed, rather than employed, the chances of a student walking to school decreased. This indicated that a student was more likely to be accompanied by their father in a family vehicle if the father was self-employed and was more likely to be

Table 2
Children's attitude toward active modes (on a scale of 0 to 4).

Aspect	Statement	Response rate (%)	Average rating (Std. Dev.)
Culture	Owning a motor vehicle, rather than a bicycle, is a status symbol. It elevates social status and reputation of owner.	88.2	1.47 (0.21)
Safety	A car or motorbike feels safer than riding a bicycle or walking.	91.5	1.92 (0.30)
Requiem for speed	Walking and bicycling are slow and time-taking. This is why you don't choose them for going to school.	86.6	1.96 (0.40)
Peer effect	If your friend chooses to ride a bicycle to school, you would also like to go to school by bicycle.	69.1	1.85 (0.34)

Table 3
Estimated beta values and related statistics of the final MNL model.

Variable	Bicycle	Cycle-rickshaw	School bus	Tempo/auto	Family vehicle
Alternative specific constant	− 11.789 (1.667)	− 20.805 (136.704)	− 11.545* (2.069)	− 5.617** (1.673)	− 4.389*** (1.554)
Distance in km	0.312*** (0.058)	0.050*** (0.008)	1.524*** (0.175)	1.131*** (0.017)	1.226** (0.277)
Demographic					
Age in years	0.524*** (0.104)	− 0.089 (0.125)	0.095 (0.120)	− 0.076 (0.105)	− 0.145 (0.096)
Gender (female)	− 1.165*** (0.300)	0.552* (0.355)	0.578* (0.317)	− 0.106 (0.289)	0.146 (0.269)
Household size	− 0.029 (0.045)	0.046 (0.056)	− 0.015 (0.049)	− 0.054 (0.046)	0.024 (0.037)
Socioeconomic					
Household income group (in ₹ per month)					
I. < 5000	Base category				
II. 5000–10,000	0.884** (0.439)	Insufficient number of observations[a]	1.703** (0.712)	0.711 (0.541)	2.006*** (0.632)
III. 10,000–15,000	0.908* (0.500)		1.577** (0.745)	0.771 (0.583)	1.539** (0.678)
IV. 15,000–35,000	0.593 (0.490)		1.844*** (0.737)	1.208** (0.561)	2.189*** (0.649)
V. 35,000–75,000	0.923 (0.613)		3.043*** (0.804)	1.915*** (0.659)	2.629*** (0.731)
VI. > 75,000	0.293 (0.845)		2.784*** (0.885)	1.368** (0.771)	2.854*** (0.786)
Vehicle ownership					
Whether car is owned (yes)	− 0.277 (0.356)	0.423 (0.436)	0.581 (0.405)	0.119 (0.369)	1.002*** (0.344)
Whether motorbike is owned (yes)	0.733** (0.330)	1.058** (0.491)	0.311 (0.370)	1.303*** (0.367)	0.936*** (0.327)
Whether bicycle is owned (yes)	1.470** (0.398)	− 0.965** (0.381)	− 0.268 (0.357)	− 0.293 (0.325)	− 0.625** (0.302)
Employment					
Whether mother is employed (yes)	Base category				
Whether mother is self-employed (yes)	− 1.157* (0.701)	− 1.847 (1.223)	− 0.131 (0.740)	− 3.023** (1.211)	− 0.470 (0.623)
Whether mother is unemployed (yes)	− 0.179 (0.453)	− 0.362 (0.511)	− 0.108 (0.488)	− 0.136 (0.452)	− 0.365 (0.424)
Whether father is employed (yes)	Base category				
Whether father is self-employed (yes)	0.543* (0.295)	Insufficient number of observations	0.559* (0.343)	0.727*** (0.308)	0.929*** (0.290)
Whether father is unemployed (yes)	Insufficient number of observations				

Variable	Bicycle	Cycle cycle-rickshaw	School bus	Tempo/auto	Family vehicle
Attitudinal (0 = completely disagree, 4 = completely agree)					
Motorbikes enhance social status	− 0.132 (0.099)	0.174 (0.122)	− 0.016 (0.111)	− 0.018 (0.101)	0.119 (0.093)
Motorized vehicles feel safer than walk/bicycle	0.095 (0.084)	− 0.001 (0.116)	0.051 (0.103)	0.148* (0.087)	0.002 (0.089)
Motorized vehicles preferable because of their greater speeds	0.031 (0.093)	0.266** (0.112)	0.477*** (0.103)	0.357*** (0.935)	0.461*** (0.089)
Peers may influence to ride bicycle to school	–	0.282*** (0.109)	0.139 (0.099)	0.107 (0.089)	0.219*** (0.085)
Built environment					
Sidewalk (0 = absent, 1 = present)	0.695** (0.288)	0.793** (0.374)	1.826*** (0.373)	0.659** (0.312)	0.391 (0.301)
Major road (0 = no, 1 = yes)	1.193*** (0.321)	1.139*** (0.437)	3.374*** (0.614)	2.330*** (0.443)	1.910*** (0.371)

Note: Walking is reference alternative; Standard error in parenthesis.
[a] Number of observations was too low and yielded extremely high values of standard error.
* $p < 0.01$.
** $p < 0.05$.
*** $p < 0.10$.

accompanied by a self-employed mother. This can be attributed to the fact that in India, men generally have more access to motorized transport modes than women do.

Of the proxy variables for assessing the effect of attitudes and perceptions of schoolchildren, not all were significant. Perceptions of social prestige and safety associated with motorcycles showed no apparent correlation with decrease or increase in the odds of a student's choice. However, response to the other two statements, about “requiem of speed” and “peer influence,” showed a strong correlation with preference to various modes over walking. The effect of positive attitude for higher speed of travel was noted. The results also show that peers' decision to bicycle was likely to influence those children currently escorted in family vehicles than those who walked. In other words, those who walked were not as much inclined toward using bicycle than those escorted in family vehicle.

Though the binary variable presence of “Sidewalk” appears significant, the relations are not justifiable. It is important to point out that sidewalks are absent in the majority of sections on the routes considered in this study, and on streets of Kanpur city in general. Therefore, the results do not qualify for serious discussion. The binary variable presence of “Major road” was used as a proxy variable for connectivity. Here, the ‘presence of a major road’ indicated the presence of state or national highway or a major arterial road within a kilometer of the school. Coefficients of this variable were significant for all the mode alternatives at 99% confidence level. A major road passing by the neighborhood of schools reduced the odds of walking against use of any other mode. Also, in such a case, odds of using bicycle or cycle-rickshaw was less likely than using school bus, auto rickshaw or tempo or family vehicle (in decreasing order of choice probability) for the school trips. This could be attributed to the safety perceptions of parents and children on major roads. Along with the result for the effect of presence of sidewalk (if the finding on sidewalks is not contested or discarded by further research), this indicates a notable proposition that for schools near an arterial or heavy-traffic road, even the presence of basic infrastructure for walking might not positively help the children in deciding to walk. Therefore, due attention must be given in providing safer options for school trips.

As part of the post-estimation analysis of the results, point elasticity (elasticity calculated for infinitesimal changes in the value of an attribute) estimates of travel mode choice, with respect to independent variables, were calculated at the mean values of the covariates (Table 4). Walking is sensitive to the presence of major road in the vicinity, but the probability of walking is likely to decrease in the presence of a major road. The marginal effects of auto rickshaw or tempo and school bus on the independent variable distance were positive and large, indicating that greater distance likely promotes the use

Table 4
Aggregate point elasticity estimates of key explanatory variables.

Variable	Walk	Bicycle	Cycle-rickshaw	School Bus	Auto/ Tempo	Family Vehicle
Distance	-5.915	-0.939		2.452	1.253	-1.592
Gender (Female)	0.022	-0.128	0.036	0.066		
Father self-employed (yes)	-0.062					0.070
Sidewalk (yes)	-0.063			0.132		-0.063
Major road present	-0.206			0.124	0.076	0.066

Note: Blank cells indicate that the corresponding values were non-significant at 90% confidence level.

of motorized vehicles in school trips. Notably, the elasticity of choosing bicycle or family vehicle was negative for distance. A unit percent increase in distance decreased the probabilities of using bicycle or family vehicle by 93.9% and 159.2% points, respectively. This result indicated that parents would not drop-off their children in their personal vehicles if the distance to school is beyond a certain value. The positive elasticity of girls to walk means that probability of walking is likely to be higher for girl students compared with boys. Furthermore, the elasticity of girls for bicycle was negative, indicating that girls were 12.8% points less probable to cycle to school. This reaffirms gender role in active transport, as indicated by the significant beta coefficients mentioned here.

9. Conclusions

Only a few school travel mode choice studies have been conducted in developing countries. To the best of the authors' knowledge, this is the first research to understand the school travel modal split in a South Asian city. The findings suggested that the significant determinants of travel mode choice were distance (spatial variable); age and gender (demographic); income, vehicle ownership including bicycles, and employment status of parents (economic status); attitude toward non-motorized travel and peer influence (context-specific); and, availability of sidewalk and presence of a major road in vicinity of school (ease of active travel). The relationships of travel mode choice with these attributes were mostly consistent with previous research in the developed societies.

This study identified that children used nonmotorized modes for their school trips if the school was not far and tended to travel by school bus or family vehicle if school was at a greater distance. For students who had to travel longer distances to school, the objective must be to provide school bus service or reliable public transport, which can accommodate children. In addition, more fundamental causes of longer travel such as unbalanced distribution of schools (Cheng et al., 2017) should also be systemically addressed by providing better-quality neighborhood schools. This would facilitate a higher percentage of students to walk or to ride a bicycle. This observation is similar to the one made by Andersson et al. (2012) in Sweden where he observed a trend that disadvantaged ethnic and social groups have a lower mobility-positional capital than less disadvantaged groups, which has an influence on selecting closest schools for their kids, irrespective of their qualities. Hence, the hypothesis that the better spatial distribution of schools may not reduce the journey distances because of factors such as cultural segregation and capacity constraints (Boussauw et al., 2014) must be tested for the local context.

Another notable finding of this study is the “second gender effect” on the travel mode choice. Girls, in comparison to the boys, were less likely to travel independently and odds were high that they would be dropped-off by their parents in personal vehicles. Girls were less likely to use bicycle or auto rickshaw or tempo for traveling to school. Mothers accompany their children mostly on foot and, therefore, this will be viable for schools within walking distance. This reflects a confirmation to the intuitive understanding that in gender-skewed societies, commuting to school is also sensitive to the social bias. A systematic study addressing this phenomenon is expected to bring out some interesting results. The study also identified the dependency of children on their parents for school travel, particularly for older children. The results indicated that a high proportion of children, both younger and older, were accompanied to school. This result also is similar to the findings from Germany (Scheiner, 2016). Hence, a study on the parental accompanying behavior in an Indian context can provide some detailed insights.

The primary survey conducted as part of the study reveals that the larger section of school children in Kanpur travel shorter distances and opt for the most sustainable modes, namely walking, bicycle and cycle rickshaw. However, these modes are also most exposed to the road crash risks in India. Therefore, while the policy implications of school travel research in the economically advanced societies has been to promote active transportation, it would be strategically more sound if urban transportation planning and education policy in India, and more specifically in Kanpur, aim to facilitate and augment the state of active transport by building a safer built environment. Although there are huge differences in the socio-economic characteristics of Kanpur compared to those in most of the cities in Western Europe and North America, the results from this study indicate that the relationships of various factors influencing school trips do not have any remarkable deviation from those found in the literature on school travel in North America and Western Europe.

In this study, a few necessary practical compromises led to some limitations. Travel distances were estimated on the basis of the nearest landmarks reported by the respondents. The estimation of the error associated with reporting could not be performed. Information on built environment and neighborhood characteristics of household and school could not be gathered because of a lack of data availability. Only limited data on sidewalk were collected, which may not account for the quality of sidewalks and perception of pedestrians regarding the utility of infrastructure. Interaction between variables such as gender, employment status and income has not been presented in the simple exploratory model presented here, and that should be sincerely considered while explaining the significant relationships. Future studies should address these issues.

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