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A Cohort Study of Active Travel to School Levels and Correlates in Eight European Cities Before and After COVID-19 Pandemic

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Abstract

There is not enough empirical research on the effects of the COVID-19 pandemic on the levels of Active Transport to School (ATS) of children. Thus, this study attempts to address this shortcoming by answering three questions: (1) have the ATS levels of European children changed after the COVID-19 pandemic compared to before it? (2) has the pandemic influenced ATS in the city-level? and (3) have the household and land use correlates of ATS changed in European cities after the COVID-19 pandemic compared to before it? The objective of this paper is not only to measure the change in the ATS levels but also to investigate the changes in the correlates of ATS during and after the pandemic. The results of a binomial test show that the ATS level of eight European cities has significantly decreased from 67% to 63.7%. The ATS levels have significantly decreased in north-European cities but in the southeastern cities the ATS has increased after/during the pandemic. Moreover, the correlates of ATS during/after pandemic have changed. The results of Binary Logistic Regression models for the 2016 and 2022 samples show that three new correlates are now significant but were insignificant back in 2016.

Keywords: Active Travel to school (ATS), Travel Behavior, urban form characteristics, European cities, COVID-19

1. Introduction

Global travel restrictions, lockdowns, and behavioral changes have influenced travel behavior since mid-2020 due to the emergence and spread of COVID-19. Rapid and drastic changes have appeared in residents' mobility behavior such as active mode choice, frequency of public transportation use, frequency of commuting, and non-commuting trips, and using private motorized vehicles as a dominant mode choice. Among different aspects of travel habits, the impacts of COVID-19 restrictions on activity-travel habits are ambiguous. The travel behavior changes are not affected only by COVID-19 restrictions, but also by perceptual behaviors, socioeconomic, and cultural features of different contexts.

In addition to socioeconomics and perceptual behavior, street network configuration is related to sustainable mobility behavior (Leck 2011; ÖZBİL 2013; Kang 2017; Mehriar et al. 2021b; Mehriar et al. 2021a; Mehriar et al. 2020; E. Masoumi 2017; Masoumi et al. 2022). Although socioeconomics, urban form, and perceptual correlates of travel habits were discussed well in western transportation literature (Handy et al. 2005; Kattiyapornpong 2006; Guo and Chen 2007; Abreu e Silva 2014), the physiological, and behavioral impacts of COVID-19 are still limited in the literature.

The correlates of independent mobility to school in seven European countries were studied in 2020 (pre-pandemic period) by Masoumi et al. (2020). Independent travel to school is related to the physical

activity level of children. According to that study parent's mode choices, commute distance to school, bike ownership, environment quality, and parent's perception are determinants of independent mobility to school (Masoumi et al. 2020).

The ability of different socioeconomic groups and individuals to adjust their mobility behavior to new policies and changes in the pandemic is an important issue that can help transportation policymakers to have a clearer understanding of travel habits in the post-pandemic era. Different socioeconomic groups including different aging and income level groups behave differently regarding travel habits. While socioeconomic correlates of travel behavior in COVID-19 are less or non-studied topics. Our knowledge about associations between different socio-demographic groups of different countries and changed travel behavior during COVID-19 is not enough and deep.

Brough et al. (2021) studied the relationship of socioeconomic features with travel behavior during COVID-19 in Washington, America. According to that study, there was a larger reduction in the frequency of commuting trips among less-educated and lower-income Americans in comparison with other socioeconomic groups (Brough et al. 2021). Another study on travel behavior changes during COVID-19 investigated the impacts of the pandemic on public transportation users in America. The findings of that study showed that higher-income people have changed travel mode choices from public transportation to walking in America (Parker et al. 2021). The association between active mobility and well-being is studied for Iranian cities during COVID-19 by Ranjbarnia et al. (2022).

Masoumi et al. (2022) Studied socioeconomic and land use correlates of walking commuting in the Middle East and North Africa (MENA) by using binary logistic regression model. According to this study commuting distance, car ownership, street connectivity, mixed land use structure, and age are correlates of walking in the MENA region.

Abdullah et al. (2020) studied the impacts of COVID-19 on the mode preferences of people during the pandemic by collecting data from online questionnaires from various countries around the world. That study showed people changed their travel mode choice from public transportation mode to using private cars during the pandemic (Abdullah et al. 2020). This study is in line with another study in Istanbul that confirmed a sharp decline in the use of public transportation in addition to travel demand in Istanbul, Turkey (Shakibaei et al. 2021).

Bhaduri et al. (2020) modelled travel mode choice in Indian cities as an example of south Asian to study changed mode choice behavior of COVID-19 by doing an online survey. The one of important changes are switching from physical commuting to telecommuting. Virtual working and shopping are one of important behavioral changes that it has own impact in urban life and transportation. The another considerable change in travel behavior of Indian was shifting from public transportation to use private vehicles (motorbikes) during COVID-19 (Bhaduri et al. 2020).

In another study in context of South Asia, Abdullah et al. (2021) assessed travel behavior changes during COVID-19 in Pakistani cities. That study confirmed people used more non-motorized modes for short trips (less than 5 km) during COVID-19 in comparison with before pandemic. Also, Pakistani people have changed travel mode from public transit to private for long distance (longer than 5 km) during COVID-19. The other considerable travel behavior change is reduction of number of outdoor trips in Pakistan (Abdullah et al. 2021).

Anwari et al. (2021) analyzed travel behavior changes in developing countries by using ordinal logistic regression and Sankey diagrams. According to the results of that study, the impact of COVID-19 om reducing non-work trip is more than work trip in developing countries. There is a shortcoming on psychological impacts of COVID on behavioral changes of people. Although, some studies investigated psychological aspects of COVID-19 on transportation, this issue is less-studied topic among pandemic

studies in the field of transportation. It is essential to predict the short-term and long-term impacts of COVID-19 on the transportation system according to the rapid and effective operation of the urban transportation system during the COVID-19. Recent research study analyzed the influences of pandemic on the urban transportation system in China (Zhou et al. 2021). This study investigated short-term and long-term impact of the COVID-19 on the mobility system to provide important decision support during the recovery phase. Torrisi et al. (2021) investigated transportation mode choice before and after the COVID-19 in Italy due to find sustainable solution for transportation.

Not only the impacts of COVID-19 in travel behavior during the pandemic are important but also, post-COVID impacts on mobility is crucial issue for transportation scholars and policy makers. Miao et al. (2021) discussed psychological roots of travel behavior change by using the terror management theory to understand correlates of travel behavior in post-COVID.

Active transportation through biking and walking is related to physical and mental health by increasing physical activity and well-being. Also, active mobility is one of sustainable transportation modes that can positively affect environment and quality of urban areas. Despite increasing recognition that sustainable transportation including active mobility can positively influence physical and mental health, there is a limited literature that studies features that impact people's decisions to choose active mode choice. The theory of planned behavior and the social ecological model explained the impact of influential factors on decision making, but there is no agreement on measures. Particularly, the impact of COVID-19 on transportation decision making is less or non-study issue. The theory of planned behavior emphasized on social influence and issues of control (Ajzen 1991; Cusack 2021). In another study on transportation decision based on the theory of planned behavior, three crucial determinants including intention, social influence and self-efficacy were recognized on transportation decisions of college students (Chaney et al. 2013).

The social-ecological theory explains that one's environment is determined by things and experiences that happen with social and cultural practices and institutions, with actions associated with hierarchical levels that moving from individual-level to society-level (Cusack 2021). So, the social-ecological theory illustrates the limitations of individual knowledge and attitudes on behavior. Willis et al. (2015) identified perceptions, social environment, community options and workplace environment as contributions of active transportation based on incorporation of the theory of planned behavior and social-ecological model.

The objective of this study is to investigate the impacts of COVID-19 on the active mobility of schoolchildren aged 9-12 years old in eight European cities. Also, this paper aims to determine the correlates of active transport of schoolchildren before and during/after COVID-19 in eight European cities to clarify features that play important roles in the active transportation of schoolchildren during/after COVID-19. In the other words, determining influential features in decision making of schoolchildren regarding active transportation before and during/after the COVID- is an important aim of this paper to cover the knowledge gap in this area and provide a better and deep understanding of behavioral changes during pandemics.

The daily urban travel consists two main parts; work trips, and non-work trips. An investigation on a Japanese city, Tokyo metropolitan area indicated non-essential trips including recreational and leisure trips were decreased drastically during COVID-19 (Parady et al. 2020). It means social influence and perception of residents are related to travel behavior in Japan as high-income country and high urban population density city (Tokyo).

The other considerable issue related COVID-19 is long-term effects of it in travel behavior. Although the epidemy was controlled by governments after vaccination, the post-COVID period does not mean living without diseases. So, COVID-19 is one of challengeable issue in front of policy-makers and

strategists particularly in transportation to adjust new behavioral changes for new circumstances. A study investigated COVID-19 effects on active travel by using a theoretical approach (van Wee and Witlox 2021).

This paper consists of five main parts. The first part is a short introduction to the paper and reviewing travel behavior literature before and during/after COVID-19 to determine knowledge gaps and contributions of the current study. The second part explains the study area, data collection method, sample size, and the methodology of research analysis due to answer research questions. The third part describes the key findings of this paper and the fourth part discusses the findings of this paper and the other studies to gain a better understanding of active transport correlates and travel behavior changes regarding COVID-19 in European cities and suggests the relevant implications for decision-makers. Then, the final part presents the conclusion of this study.

2. Methodology

2.1. Research questions and hypotheses

The current paper seeks to answer the following questions: (1) have the ATS levels of European children changed after the COVID-19 pandemic compared to before it? (2) has the pandemic influenced ATS in the city-level? and finally (3) have the household and land use correlates of ATS changed in European cities after the COVID-19 pandemic compared to before it? The hypotheses of this study are as follows (1) the ATS levels Europe-wide as well as in the city level have significantly changed after the COVID-19 pandemic, and moreover, (2) the correlates of ATS have changed after the pandemic: the role of spatial/land use factors is now more important compared to before the pandemic, so urban planning policies can be an important preventive measure against Corona.

2.2. Data and Variables

This paper uses two sources for data originating from two European Commission-funded projects related to before the outbreak of Corona (2016) and during or in some countries after the Corona crisis (2022).
The first project was titled “Multisport against Physical Sedentary”, and the second one was “Promotion of Physical Activity of the Youth through Active Mobility to School”, which was based on a data collection about the ATS of schoolchildren and adolescents in 2022.
The baseline data collection was conducted in nine European cities, incluing Foggia, Italy; Berlin, Germany; Thessaloniki, Greece; Rijeka, Croatia; Utrecht, Netherlands; Łódź, Poland, Konstantynow Lodzki, Poland; Malatya, Turkey, and Doğanşehir, Turkey. During the data collection, 1304 self-reported questionnaires were filled out by parents of children of between 9 and 12 years in 21 schools of seven cities about children’s ATS, daily family mobility, the body weight and height of children, as well as the perceptions about safety and security. The questionnaire included 26 questions about household socioeconomics, mobility habits of the child and the parents, perceptions about safety and security. The overall response rate including all of the cities was 52 percent. More technical details of the survey including as well as descriptive statistics have already been published as a research paper by Masoumi et al. (2017). As a follow-up survey, in 2022 a second data collection with similar questions like in 2016 was undertaken in the same schools resulting in generation of a dataset including all the case cities except in Utrecht, Netherlands, in which logistic problems caused by the pandemic such as difficulties of reaching out to the Dutch schools and pupils made data collection impossible. As a result, the overall sample size of 2022 was reduced to 1012 pupils. The descriptive statistics of both surveys can be seen in Table 1, in which the variables used in this paper have been represented. The land use variables were calculated as an aggregate variable in a 3*3 km rectangular catchment area centered by the schools, in which the pupils lived. The values of street connectivity were estimated by dividing the number of intersection per area unit. Accessibility to public transport means the average distance to all sorts of public transportation stations/stops within the catchment area. Population density of the areas around schools were estimated by the dividing the population (all ages) by the area unit.

Finally, green and open space indicator is the number of the such spaces with any size within the catchment area of 3*3 km.
In this paper, the target variable is the ATS of the children, which has been represented as a binary (dummy) variable, whereas walking and biking to school is considered as active transport and using public transport, household car, and other modes are categorized as passive mobility.

2.3. Analysis Methods

For answering the first research question of this study related to the differences between the levels of ATS before and after/during the pandemic in the overall sample of eight European cities, a binomial test was conducted. The test compared the mean of the pre-Corona ATS (2016) as test proportion with the outcome variable of post-Corona ATS including school mobility of all participants of the 2022-survey. The P-value of less than 0.05 indicated a significant difference between the two variables, both of which were binary.

The same test was conducted in the city level to find the significant differences between the pre- and post-Corona ATS in each city, whereas the significance level was again 0.05. The results answered the second research question of this paper.

Finally, two Binary Logistic (BL) regression models were generated using the two datasets of 2016 and 2022 to compare the correlates of ATS before and after the pandemic. The procedure included development of a baseline model using the 2016 dataset after elimination of four insignificant variables including monthly household gross income, age, number of children in household, and household size. After rerunning the model for five times and eliminating four insignificant variables from the model, the best model fit was resulted. The same model structure was applied to the 2022 model to find the differences in the explanatory variables. The significance levels were 0.05 in both BL models. For checking the validity of the models, Omnibus test and Hosmer and Lemeshow test were applied to both models, whereas P-values of less than 0.05 indicated validity for Omnibus test and values of more than 0.05 presented a validity for Hosmer and Lemeshow test. Both tests are often used for measuring the validity of logistic models, while the latter has proved to be a more accurate one.

3. Findings

3.1. Descriptive Statistics

Table 1 depicts the frequencies of active and passive transport to school for all the case cities of 2016 and 2022 (excluding Utrecht). According to the table, the ATS of the overall sample was reduced from 66.98% in 2016 to 63.74%, but this do not necessarily mean that the ATS levels dropped in all cities after the pandemic. In Berlin, Foggia, Konstantynów Łódzki, Łódz, and Rijeka, ATS was weakened, while in other cities, it was strengthened.

Table 2 summarizes the continuous variables derived from the questionnaire, all of which have been used in this paper. The mean age of the respondents was 10.6 and 11 years, living in household sizes of 4.17 and 4.02 members in 2016 and 2022 samples. The mean number of children was also very near: 2.12 versus 2. Moreover, the mean number of working household members were 1.45 and 1.56 respectively in the two datasets. However, the mean car ownership was increased from 1.07 to 1.24. The mean BMI decreased from 19.36 to 19.21.

The school commuting distance in the two samples was also comparable: 541.22m in 2016 versus 602.83 in 2022. The average number of intersections on the way to school decreased from 4.53 to 3.16, while street connectivity was almost the same in the two samples: 0.533 versus 0.566. The same is true about availability of public transportation infrastructures (0.0363 versus 0.0361), population

density (39584 versus 39192) and availability to green/open spaces (0.0164 versus 0.0169). The slight changes in the spatial variables is due to the fact that the number of respondents in each school changed in the follow-up data collection.

Table 1: The frequencies of school commuting types including active and passive in the eight case cities and the overall sample.

School Commuting		Measure	Berlin	Dogansehir	Foggia	Konstantynów Łódzki	Łódź	Malatya	Rijeka	Thessaloniki	Total
Commuting Type - Before Corona	Passive	No. of respondents	5	33	22	5	3	65	70	117	387
		Percent in the city sample	10,20%	44,59%	12,22%	14,71%	7,89%	70,65%	29,05%	45,88%	33,02%
	Active	No. of respondents	44	41	158	29	35	27	171	138	785
		Percent in the city sample	89,80%	55,41%	87,78%	85,29%	92,11%	29,35%	70,95%	54,12%	66,98%
	Total	No. of respondents	49	74	180	34	38	92	241	255	1172
Commuting Type - After/During Corona	Passive	No. of respondents	14	18	90	14	13	39	82	97	367
		Percent in the city sample	28,57%	23,68%	50,00%	41,18%	34,21%	36,45%	33,06%	34,64%	36,26%
	Active	No. of respondents	35	58	90	20	25	68	166	183	645
		Percent in the city sample	71,43%	76,32%	50,00%	58,82%	65,79%	63,55%	66,94%	65,36%	63,74%
	Total	No. of respondents	49	76	180	34	38	107	248	280	1012

Table 2: Descriptive statistics of the independent variables used in the study.

Variable	Before Pandemic (2016)					After/During Pandemic (2022)				
	N	Minimum	Maximum	Mean	Std. Deviation	N	Minimum	Maximum	Mean	Std. Deviation
Age	1154	9	12	10,60	0,90	1005	9	12	11,00	1,00
Household Size	1214	0	12	4,17	1,19	1011	1	10	4,02	1,00
No. of Children in the Household	1215	0	10	2,12	0,99	1011	1	8	2,00	0,88
No. of People Working Outside the House	1189	0	5	1,45	0,65	996	0	4	1,56	0,60
Average Monthly Household Income (€)	954	0	80000	2203	3212	847	0	615385	38782	59740
Household Car Ownership	1184	0	5	1,07	0,71	991	0	4	1,24	0,631
Body Mass Index	1103	12,17	28,75	19,355	6,8626	967	10,57	35,84	19,2067	3,1419
School Commuting Distance	941	0	6000	541,22	553,69	300	2	15000	602,83	1410,31
No. of Street Crossings on the Way to School	1159	0	35	4,53	4,677	906	0	30,00	3,16	3,123
Street Connectivity	1222	0,0400	1,3130	0,5327	0,394	1012	0,04	1,31	0,5662	0,406
Availability of Public Transport	1222	0,0083	0,0971	0,0363	0,0261	1012	0,01	0,10	0,0361	0,0267
Population Density	1222	3,0100	263,09	39,584	65,7446	1012	3,01	263,09	39,192	71,9069

Availability of Green & Open Spaces	1222	0,0023	0,05	0,0164	0,0132	1012	0,00	0,05	0,0169	0,014

3.2. Change in ATS Levels During/After the Pandemic in the Overall Sample

A binomial test was conducted to show the significance of the difference between the ATS of the 2016 and 2022 samples (66.98% versus 63.74%). The test proportion was set at 66.98% and the status of the 2022 sample including 1012 respondents were tested to test the significant change. The P-value of 0.016 indicates a significant decrease in the ATS of the overall sample in 2022. The results have been shown in Table 3.

Table 3: The results of binomial test comparing the ATS levels of before/during Corona with pre-Corona ATS for the overall sample of eight European cities.

	Category	N	Observed Proportion	Test Proportion (ATS Before Corona in the City)	P	Result
Overall Sample (Eight European Cities)	Passive	645	0,6374	0,6698	0.016	Pre-Corona ATS > ATS after/during Corona
	Active	367	0,3626			
	Total	1012	1,0000			

3.3. Change in ATS Levels During/After the Pandemic in City-Level Sub-samples

Like for the overall sample, binomial test was applied to show the significance of the differences between the 2016 and 2022 in the city level (Table 4). The results show that the ATS frequencies after/during COVID-19 are lower in Berlin, Germany and Konstantynów Łódzki and Łódz, Poland as well as in Foggia, Italy. The ATS rate in Berlin significantly decreased from 90% to 71%. The ATS rates of Foggia, Italy, decreased from 88% to 50%, as well as both Polish cities. In the small city of Konstantynów Łódzki, the rates dropped from 85% to 59% and in Łódz from in incredible 92% to 66%. The result of the binomial test indicates a marginally significant decrease from 71% to 67%.

In contrast, the ATS levels significantly increased in three southern cities of Dogansehir, Malatya, and Thessaloniki (P<0.001 for all). In the two Turkish cities of Dohansehir and Malatya, ATS significantly jumped from 55% to 76% and 29% to 36% respectively. Finally, the post/during-Corona ATS in Thessaloniki significantly increased from 54% to 65%.

Table 4: The results of binomial test comparing the ATS levels of before/during Corona with pre-Corona ATS broken down for each city.

City	Category	N	Observed Proportion (ATS After/During Corona)	Test Proportion (ATS Before Corona in the City)	P	Result
Berlin, Germany	Passive	14	0,2857	0,8980	<0.001	Pre-Corona ATS > ATS after/during Corona
	Active	35	0,7143			
	Total	49	1,0			
Dogansehir, Turkey	Active	58	0,7632	0,5541	<0.001	Pre-Corona ATS < ATS
	Passive	18	0,2368			
	Total	76	1,0			

						after/during Corona
Foggia, Italy	Passive	90	0,50	0,8778	<0.001	Pre-Corona ATS > ATS after/during Corona
	Active	90	0,50			
	Total	180	1,0			
Konstantynów Łódzki, Poland	Passive	14	0,4118	0,8529	<0.001	Pre-Corona ATS > ATS after/during Corona
	Active	20	0,5882			
	Total	34	1,0000			
Łódź, Poland	Active	25	0,6579	0,9211	<0.001	Pre-Corona ATS > ATS after/during Corona
	Passive	13	0,3421			
	Total	38	1,0			
Malatya, Turkey	Passive	68	0,6355	0,2935	<0.001	Pre-Corona ATS < ATS after/during Corona
	Active	39	0,3645			
	Total	107	1,0			
Rijeka, Croatia	Active	166	0,6694	0,7095	0.094	Pre-Corona ATS = ATS after/during Corona
	Passive	82	0,3306			
	Total	248	1,0			
Thessaloniki, Greece	Active	183	0,6536	0,5412	<0.001	Pre-Corona ATS < ATS after/during Corona
	Passive	97	0,3464			
	Total	280	1,0			

3.4. Change in the Correlates of ATS Before and During/After COVID-19 in European Cities

The BL models were generated with identical structure for before and after/during COVID-19 pandemic as explained in the methodology section. The results of both models have been summarized in Table 5. The 2016 model shows that five variables of school commuting distance, household car ownership, the number of street crossings on the way to school, availability of public transport, and availability of green and open spaces were significantly correlated with ATS. Out of the mentioned explanatory variables, availability of open and green spaces was significant (P=0.002) and all the rest were highly significant (P<0.001). Three insignificant variables of No. of Household Members Working Outside the House, Street Connectivity, and Population Density were non-significant, but they were kept in the model to produce the best possible validity. According to the model, before the pandemic, school commuting distance was negatively correlated with ATS. Having one more car decreases the probability of ATS by 44%. Every street crossing between the home and school decreases the likelihood of ATS by 78%. This variable seems to have a very strong negative association with active mobility to school among the respondents of the 2016 sample. Availability of public transport infrastructures like stations and stops strongly increased the likelihood of ATS. Finally, availability of open and green spaces was increased the probability of active school mobility but its effects on the model were not so strong. The Nagelkerke R^2 of the model is as high as 49%, which indicates that almost half of the variability of ATS in the year 2016 is explained by the model. According to the results of the Omnibus test, the model is valid (P<0.001). Hosmer and Lemeshow test also confirms the validity of the model (P=0.242).

As mentioned earlier, the same model was applied to the 2022 sample. Two of the significant variables of 2016 were not anymore significant in the 2022 model: household car ownership and availability of public transportation. This indicates that motorized transportation including personal or public lost importance in the ATS models after the pandemic. Instead, three variables of number of household members who work outside the house, street connectivity, and population density became significant in the 2022 model. In the new model, school commuting distance still explains the likelihood of ATS significantly. A one-person increase in the number of working household members decreases the

probability of ATS by 40%. This addresses the likelihood of pupils being taken to school by household members on their way to workplace. However, in the 2022 model, car ownership is not a significant predictor anymore. The number of street-crossings is still a predictor of ATS, but its power is now less than in 2016; one more street-crossing on the way to school decreases the likelihood of ATS by 39% (compared to 78% in 2016). In contrast with 2016, in 2022 two land use variables, namely street connectivity and population density, are strongly associated with ATS. The value of Nagelkerke R^2 is 46%, which is good for such a BL model. The results of Omnibus test (P<0.001) and Hosmer and Lemeshow test (P=0.093) also reflect the validity of the 2022 model (Table 5).

Table 5: Two binary logistic models for ATS using the overall sample of eight European cities (Dependent variable: school commuting type. Coding: Passive transport to school: 0; Active transport to school: 1).

Pre-Pandemic Model of ATS						**Post-Pandemic Model of ATS**				
Variable	**B**	**S.E.**	**Wald**	**P**	**β**	**B**	**S.E.**	**Wald**	**P**	**β**
School Commuting Distance	-0,002	≈0	93,904	<0.001	0,998	-0,001	0,001	5,372	0,020	0,999
No. of Household Members Working Outside the House	-0,056	0,176	0,103	0,748	0,945	-0,919	0,357	6,630	0,01	0,399
Household Car Ownership	-0,816	0,159	26,380	<0.001	0,442	-0,425	0,318	1,792	0,181	0,654
No. of Street Crossings on the Way to School	-0,250	0,033	57,876	<0.001	0,779	-0,945	0,152	38,438	<0.001	0,389
Street Connectivity	-0,171	0,355	0,231	0,631	0,843	24,069	6,436	13,984	<0.001	2,84E+10
Availability of Public Transport	15,228	4,414	11,899	0,001	4,10E+06	-13,776	7,413	3,453	0,063	1,04E-06
Population Density	0,001	0,002	0,114	0,736	1,001	0,106	0,052	4,189	0,041	1,112
Availability of Green & Open Spaces	-25,593	8,124	9,925	0,002	≈0	83,564	29,997	7,760	0,005	1,96E+36
Constant	4,608	0,473	95,049	<0.001	100,293	0,304	1,565	0,038	0,846	1,355

Omnibus Tests of Model Coefficients		
Chi-square	df	P
351,646	8	<0.001

Hosmer and Lemeshow Test		
Chi-square	df	P
10,335	8	0,242

Model Summary	
-2 Log likelihood	Nagelkerke R^2
633,66	0,488

Omnibus Tests of Model Coefficients		
Chi-square	df	P
122,611	8	<0.001

Hosmer and Lemeshow Test		
Chi-square	df	P
13,597	8	0,093

Model Summary	
-2 Log likelihood	Nagelkerke R^2
270,576	0,459

4. Discussion

This paper was targeted towards travel behavior changes, and correlates of active mobility among schoolchildren before and after the COVID-19 in eight different European cities. The results of the current study show a reduction of ATS of eight European city during/after COVID-19 in comparison with before the pandemic (Doubleday et al. 2021). A study on three American cities including Houston, New York, and Seattle confirms our results regarding changes in active transportation. However, active

mobility behavior has different patterns in different American cities. For example, the active transportation in New York has decreased during the COVID-19. While that study indicated the biking and walking have increased during the pandemic in Houston (Doubleday et al. 2021).

Also, the current paper shows the pattern of active transportation is not same in all eight European cities. According to the results of this study, Berlin, Germany and Konstantynów Łódzki and Łódz, Poland as well as in Foggia, Italy have a lower amount of ATS during/after COVID-19 compared to the period before. In contrast, the ATS levels increased in three cities of Mediterranean region including Dogansehir, Malatya, and Thessaloniki. The differing findings shown across the different European cities, probably reflect the reality of different the pandemic situation and restrictions in each country. The existence of some strict restrictions on physical presentence of schoolchildren in Germany could influence the reducing active commuting during/after COVID-19. This study does not discuss about the other transportation mode choice. So, the investigation of mode choice shift during/after the COVID-19 is not the objective of this study. But understanding of mode choice shift during/after the pandemic can help transportation decision makers and strategists to provide effective policies in pandemics. The findings of this paper is in line with another study on the impacts of COVID-19 on the people's mobility in American city (Li et al. 2022). However, the results of that study illustrated different pattern in travel behavior changes. For example, bike-sharing significantly decreased while active mobility for recreational purposes increased in the U.S (Li et al. 2022). In addition, the results of this study accept findings of another study on reduction of active transportation in commuting trips (Anwari et al. 2021).

Determining correlates of ATS in pre-pandemic and post-pandemic is one of main objectives of this paper. According to the results, commuting distance, number of streets crossing on the way to school, availability of public transportation, and availability of green/open space are correlates of ATS in both before and during/after the COVID-19. However, the directions of the association between availability of open space and ATS are different between the pre-pandemic and the after-pandemic. This can be interpreted parents and children need to more open space to have active mobility and physical activity according to keep social distancing during the COVID-19. Number of household members that working outside the house, street connectivity, and population density are correlated to active transportation in the post-pandemic. Car ownership is related to ATS only in pre-pandemic. The significant correlation of car ownership only in pre-pandemic and the negative significant association of availability to public transportation in post-COVID can be interpreted as that there is no relationship between lower level of ATS and choosing other mode choices of transportation in the post-pandemic.

The results of this study on the positive correlations of built environment characteristics including density, availability to green/open space, street connectivity and the negative associations of commuting distance and availability to public transportation with ATS emphasizes on the impacts of built environment features on active transportation during/after COVID-19. The findings of paper on impacts of dense and diverse (green/open space) is in line with results of study in Shiraz, Iran in post-COVID (Shaer et al. 2021). Pabayo et al. (2011) studied socioeconomic and urban setting determinants of ATS in in Canada and determined urban form chrematistics has positive impacts on the ATS. So that study on Canadian young students confirmed the findings of this study in pre-pandemic. The association of shorter distance, higher street connectivity and access to green/open spaces with ATS in this study confirm the results of another study regarding the positive correlations of ATS with walkability environment in European and American cities (D'Haese et al. 2015). Also, the negative association between school distance and ATS was confirmed by other scholars (Deweese et al. 2013; van Goeverden and Boer 2013) .

Pont et al. (2009) studied physical, economic, socio-cultural and political correlates of ATS among people aged 5-48 years old by using systematic review. The results of that study in agreement with the finding of the current paper on the negative correlation between distance to school and ATS in pre and

post-pandemic. In addition, the negative significant relationship between car ownership and ATS in post-pandemic confirms the results of the study by Pont et al. (2009).

The association between residential area and ATS was studied in German cities by Reimers et al. (2013) and the results of the current paper is in accordance with that study on German cities. However, different built environment features were studied in both papers.

The positively correlated of street connectivity and ATS in post-pandemic is contrast with the result of the study on determinants of ATS among schoolchildren in California, U.S. (Su et al. 2013). However, the positive association between street connectivity and active mobility not only for schoolchildren but also for different socioeconomic groups was confirmed by urban transportation scholars (Mehriar et al. 2021b; Dogan et al. 2020; Hess et al. 2017; Koszowski et al. 2018).

Although the body of research is strong in the pre-pandemic, there is a need to more studies that investigate the relationship between urban form setting, socioeconomic and physiological background, cultural features of people in different age groups during/after the COVID-19 to gain deep and clear understanding of travel behavior in pandemics. Particularly, the travel behavior changes, mode choices, and physical activity level of schoolchildren during/after COVID-19 is less-studied topics among COVID-19 literature.

The impact of urban built environment on the ATS in the post-pandemic period is very important. All significant correlates of ATS are related to urban form setting. The findings of this paper show characteristics of environment such as land use structure (short commuting distance to school, and availability of green/open space), street network configuration (number of streets crossing on the way to school, and street connectivity), and population density are correlated to ATS in the post-pandemic period.

The results of this paper on the association of urban built environment characteristics and street network configuration can help urban transportation planners and decision makers to use mixed land use structures and consider green/open spaces and sidewalks in the neighborhood to promote suitable and active transportation modes. Also, greater street connectivity with more street nodes and shorter length of street is correlated with active mobility. So, urban planners can design more intersections in new plans of street and modify street network configuration in renovation and rehabilitation plans.

5. Conclusion

The current paper studies the changes of active travel to school before and after COVID-19 in eight European cities to understand the impact of COVID-19 on travel behavior of schoolchildren. Also, determining the correlates of active travel to school (ATS) in pre and post-pandemic is another aim of this study. The ATS level of schoolchildren decreased during/after COVID-19 in compared of before period. However, in three south European cities; Dohansehir and Malatya in Turkey and Greek city of Thessaloniki the ATS rate increased in the post-pandemic in compassion with the pre-pandemic. Different restrictions and situation in different countries could influenced the active mobility level in different cities and countries. ATS is correlated with school commuting distance, number of street cross on the way to school, availability of public transport, and availability of green/open space in both pre and post-pandemic eras. There is a negative association between increasing of car ownership in household and the level of active transportation to school in the pre-pandemic period in eight European cities. Population density and street connectivity are correlated to active travel school positively in the post-pandemic. While the relationship between number of household members that working outside house and ATS is negative in the post-pandemic.

Collecting data from several cities in different countries during the COVID-19 restriction is one of the difficult aspects of this research study. Also, there is no strong body of research on transportation during/after the COVID-19 to compare findings of this research with other studies in transportation during/after COVID-19.

So, there is a need for new studies to not only investigate the impact of transportation and urban forms in spreading of the virus, but also to shed light on the travel behavior of citizens in pandemics. The future studies can investigate on the perceptual behavior, socioeconomic features and urban form characteristics factors that have correlation with active transportation.

References

Abdullah, Muhammad; Ali, Nazam; Hussain, Syed Arif; Aslam, Atif Bilal; Javid, Muhammad Ashraf (2021): Measuring changes in travel behavior pattern due to COVID-19 in a developing country: A case study of Pakistan. In *Transport Policy* 108, pp. 21–33. DOI: 10.1016/j.tranpol.2021.04.023.

Abdullah, Muhammad; Dias, Charitha; Muley, Deepti; Shahin, Md (2020): Exploring the impacts of COVID-19 on travel behavior and mode preferences. In *Transportation research interdisciplinary perspectives* 8, p. 100255. DOI: 10.1016/j.trip.2020.100255.

Abreu e Silva, João de (2014): Spatial self-selection in land-use–travel behavior interactions: accounting simultaneously for attitudes and socioeconomic characteristics. In *JTLU* 7 (2), p. 63. DOI: 10.5198/jtlu.v7i2.696.

Ajzen, Icek (1991): The theory of planned behavior. In *Organizational Behavior and Human Decision Processes* 50 (2), pp. 179–211. DOI: 10.1016/0749-5978(91)90020-T.

Anwari, Nafis; Tawkir Ahmed, Md.; Rakibul Islam, Md.; Hadiuzzaman, Md.; Amin, Shohel (2021): Exploring the travel behavior changes caused by the COVID-19 crisis: A case study for a developing country. In *Transportation research interdisciplinary perspectives* 9, p. 100334. DOI: 10.1016/j.trip.2021.100334.

Bhaduri, Eeshan; Manoj, B. S.; Wadud, Zia; Goswami, Arkopal K.; Choudhury, Charisma F. (2020): Modelling the effects of COVID-19 on travel mode choice behaviour in India. In *Transportation research interdisciplinary perspectives* 8, p. 100273. DOI: 10.1016/j.trip.2020.100273.

Brough, Rebecca; Freedman, Matthew; Phillips, David C. (2021): Understanding socioeconomic disparities in travel behavior during the COVID-19 pandemic. In *Journal of regional science* 61 (4), pp. 753–774. DOI: 10.1111/jors.12527.

Chaney, Robert A.; Bernard, Amy L.; Wilson, Bradley R. A. (2013): Characterizing active transportation behavior among college students using the theory of planned behavior. In *International quarterly of community health education* 34 (3), pp. 283–294. DOI: 10.2190/IQ.34.3.f.

Cusack, Meagan (2021): Individual, social, and environmental factors associated with active transportation commuting during the COVID-19 pandemic. In *Journal of transport & health* 22, p. 101089. DOI: 10.1016/j.jth.2021.101089.

Deweese, Robin S.; Yedidia, Michael J.; Tulloch, David L.; Ohri-Vachaspati, Punam (2013): Neighborhood perceptions and active school commuting in low-income cities. In *American journal of preventive medicine* 45 (4), pp. 393–400. DOI: 10.1016/j.amepre.2013.04.023.

D'Haese, Sara; Vanwolleghem, Griet; Hinckson, Erica; Bourdeaudhuij, Ilse de; Deforche, Benedicte; van Dyck, Delfien; Cardon, Greet (2015): Cross-continental comparison of the association between the physical environment and active transportation in children: a systematic review. In *The*

international journal of behavioral nutrition and physical activity 12, p. 145. DOI: 10.1186/s12966-015-0308-z.

Dogan, Timur; Yang, Yang; Samaranayake, Samitha; Saraf, Nikhil (2020): Urbano: A Tool to Promote Active Mobility Modeling and Amenity Analysis in Urban Design. In *Technology|Architecture + Design* 4 (1), pp. 92–105. DOI: 10.1080/24751448.2020.1705716.

Doubleday, Annie; Choe, Youngjun; Busch Isaksen, Tania; Miles, Scott; Errett, Nicole A. (2021): How did outdoor biking and walking change during COVID-19?: A case study of three U.S. cities. In *PloS one* 16 (1), e0245514. DOI: 10.1371/journal.pone.0245514.

E. Masoumi, Houshmand (2017): Active Transport to School and Children's Body Weight: A Systematic Review. 95-110 Paginazione / Tema. Journal of Land Use, Mobility and Environment, Vol 10, N° 1 (2017): Methods, tools and best practices to increase the capacity of urban systems to adapt to natural and man-made changes. DOI: 10.6092/1970-9870/4088.

Guo, Jessica Y.; Chen, Cynthia (2007): The built environment and travel behavior: making the connection. In *Transportation* 34 (5), pp. 529–533. DOI: 10.1007/s11116-007-9131-y.

Handy, Susan; Xinyu Cao; Mokhtarian, Patricia (2005): Correlation or causality between the built environment and travel behavior? Evidence from Northern California. In *Transportation Research Part D: Transport and Environment* 10 (6), pp. 427–444. DOI: 10.1016/j.trd.2005.05.00.

Hess, Franck; Salze, Paul; Weber, Christiane; Feuillet, Thierry; Charreire, Hélène; Menai, Mehdi et al. (2017): Active Mobility and Environment: A Pilot Qualitative Study for the Design of a New Questionnaire. In *PloS one* 12 (1), e0168986. DOI: 10.1371/journal.pone.0168986.

Kang, Chang-Deok (2017): Measuring the effects of street network configurations on walking in Seoul, Korea. In *Cities* 71, pp. 30–40. DOI: 10.1016/j.cities.2017.07.005.

Kattiyapornpong, Uraiporn (2006): Understanding travel behavior using demographic and socioeconomic variables as travel constraints. In *ANZMAC*, pp. 1–9.

Koszowski, Caroline; Gerike, Regine; Hubrich, Stefan; Götschi, Thomas; Pohle, Maria; Wittwer, Rico (2018): Active Mobility: Bringing Together Transport Planning, Urban Planning, and Public Health: Springer.

Leck, Eran (2011): The Impact of Urban Form on Travel Behavior: A Meta-Analysis. In *Planning Journal* 19 (1). DOI: 10.5070/BP319111488.

Li, Xiao; Farrukh, Minaal; Lee, Chanam; Khreis, Haneen; Sarda, Soham; Sohrabi, Soheil et al. (2022): COVID-19 impacts on mobility, environment, and health of active transportation users. In *Cities* 131, p. 103886. DOI: 10.1016/j.cities.2022.103886.

Masoumi, Houshmand; Chakamera, Chengete; Mapamba, Liberty; Pisa, Noleen; Soltanzadeh, Hamid (2022): Relations of Public Transport Use and Car Ownership with Neighbourhood and City-Level Travel Purposes in Kerman, Iran. In *Urban Science* 6 (3), p. 48. DOI: 10.3390/urbansci6030048.

Masoumi, Houshmand; van Rooijen, Martin; Sierpiński, Grzegorz (2020): Children's Independent Mobility to School in Seven European Countries: A Multinomial Logit Model. In *International journal of environmental research and public health* 17 (23). DOI: 10.3390/ijerph17239149.

Masoumi, Houshmand E.; Zanoli, Gabriele; Papageorgiou, Athanasios; Smaga, Soultana; Miloš, Ana; van Rooijen, Martin et al. (2017): Patterns of children's travel to school, their body weight, spatial factors, and perceptions: A survey on nine European cities. In *GeoScape* 11 (2), pp. 52–75. DOI: 10.1515/geosc-2017-0005.

Mehriar, Melika; Masoumi, Houshmand; Aslam, Atif Bilal; Gillani, Syed Mubasher (2021a): The Neighborhood Effect on Keeping Non-Commuting Journeys within Compact and Sprawled Districts. In *Land* 10 (11), p. 1245. DOI: 10.3390/land10111245.

Mehriar, Melika; Masoumi, Houshmand; Aslam, Atif Bilal; Gillani, Syed Mubasher; Suhail, Tuba; Zulfiqar, Ayesha (2021b): The Relations between Street Network Configuration and Travel Behavior in Pakistan; the Optimal Level of Street Connectivity for a More Active Mobility. In *Applied Sciences* 11 (22), p. 11015. DOI: 10.3390/app112211015.

Mehriar, Melika; Masoumi, Houshmand; Mohino, Inmaculada (2020): Urban Sprawl, Socioeconomic Features, and Travel Patterns in Middle East Countries: A Case Study in Iran. In *Sustainability* 12 (22), p. 9620. DOI: 10.3390/su12229620.

Miao, Li; Im, Jinyoung; Fu, Xiaoxiao; Kim, Haemi; Zhang, Yi Estella (2021): Proximal and distal post-COVID travel behavior. In *Annals of Tourism Research* 88, p. 103159. DOI: 10.1016/j.annals.2021.103159.

ÖZBİL, Ayşe (2013): Modeling Walking Behavior in Cities Based on Street Network and Land-Use Characteristics: The Case of İstanbul. In *METUJFA* 30 (02). DOI: 10.4305/METU.JFA.2013.2.2.

Pabayo, Roman; Gauvin, Lise; Barnett, Tracie A. (2011): Longitudinal Changes in Active Transportation to School in Canadian Youth Aged 6 Through 16 Years. In *Pediatrics* 128 (2), e404-e413. DOI: 10.1542/peds.2010-1612.

Parady, Giancarlos; Taniguchi, Ayako; Takami, Kiyoshi (2020): Travel behavior changes during the COVID-19 pandemic in Japan: Analyzing the effects of risk perception and social influence on going-out self-restriction. In *Transportation research interdisciplinary perspectives* 7, p. 100181. DOI: 10.1016/j.trip.2020.100181.

Parker, Madeleine E.G.; Li, Meiqing; Bouzaghrane, Mohamed Amine; Obeid, Hassan; Hayes, Drake; Frick, Karen Trapenberg et al. (2021): Public transit use in the United States in the era of COVID-19: Transit riders' travel behavior in the COVID-19 impact and recovery period. In *Transport Policy* 111, pp. 53–62. DOI: 10.1016/j.tranpol.2021.07.005.

Pont, Karina; Ziviani, Jenny; Wadley, David; Bennett, Sally; Abbott, Rebecca (2009): Environmental correlates of children's active transportation: a systematic literature review. In *Health & place* 15 (3), pp. 827–840. DOI: 10.1016/j.healthplace.2009.02.002.

Ranjbarnia, Behzad; Kamelifar, Mohammad Javad; Masoumi, Houshmand (2022): The Association between Active Mobility and Subjective Wellbeing during COVID-19 in MENA Countries. In *Healthcare (Basel, Switzerland)* 10 (9). DOI: 10.3390/healthcare10091603.

Reimers, Anne K.; Jekauc, Darko; Peterhans, Eliane; Wagner, Matthias O.; Woll, Alexander (2013): Prevalence and socio-demographic correlates of active commuting to school in a nationwide representative sample of German adolescents. In *Preventive medicine* 56 (1), pp. 64–69. DOI: 10.1016/j.ypmed.2012.11.011.

Shaer, Amin; Rezaei, Meysam; Moghani Rahimi, Behnam; Shaer, Fatemeh (2021): Examining the associations between perceived built environment and active travel, before and after the COVID-19 outbreak in Shiraz city, Iran. In *Cities* 115, p. 103255. DOI: 10.1016/j.cities.2021.103255.

Shakibaei, Shahin; Jong, Gerard C. de; Alpkökin, Pelin; Rashidi, Taha H. (2021): Impact of the COVID-19 pandemic on travel behavior in Istanbul: A panel data analysis. In *Sustainable cities and society* 65, p. 102619. DOI: 10.1016/j.scs.2020.102619.

Su, Jason G.; Jerrett, Michael; McConnell, Rob; Berhane, Kiros; Dunton, Genevieve; Shankardass, Ketan et al. (2013): Factors influencing whether children walk to school. In *Health & place* 22, pp. 153–161. DOI: 10.1016/j.healthplace.2013.03.011.

Torrisi, Vincenza; Campisi, Tiziana; Inturri, Giuseppe; Ignaccolo, Matteo; Tesoriere, Giovanni (Eds.) (2021): Continue to share? An overview on italian travel behavior before and after the COVID-19 lockdown, 2021.

van Goeverden, C. D.; Boer, E. de (2013): School travel behaviour in the Netherlands and Flanders. In *Transport Policy* 26, pp. 73–84. DOI: 10.1016/j.tranpol.2013.01.004.

van Wee, Bert; Witlox, Frank (2021): COVID-19 and its long-term effects on activity participation and travel behaviour: A multiperspective view. In *Journal of transport geography* 95, p. 103144. DOI: 10.1016/j.jtrangeo.2021.103144.

Willis, Devon Paige; Manaugh, Kevin; El-Geneidy, Ahmed (2015): Cycling Under Influence: Summarizing the Influence of Perceptions, Attitudes, Habits, and Social Environments on Cycling for Transportation. In *International Journal of Sustainable Transportation* 9 (8), pp. 565–579. DOI: 10.1080/15568318.2013.827285.

Zhou, Huiyu; Wang, Yacan; Huscroft, Joseph R.; Bai, Kailing (2021): Impacts of COVID-19 and anti-pandemic policies on urban transport-an empirical study in China. In *Transport Policy* 110, pp. 135–149. DOI: 10.1016/j.tranpol.2021.05.030.