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Factors Affecting Active Commuting to School in Sprawled Cities: The Case of Najran City, Saudi Arabia

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Abstract: An increased dependency on motorized modes of transportation has been noticed recently for school children commuting to school, while a major decline in walking to school has occurred. Dependency on motorized modes for commuting to school has many adverse consequences. This paper examines determinants that can influence how children commute to schools for both boys and girls in all school stages in Najran City. Data of morning school commutes were analyzed using a multinomial logit model (MLM). Analytical results indicate that about 37% of students live at a distance of more than 2 km from school, and only 16% live within 500 m of their schools. Almost half of the respondents own more than one car. Regarding walking to school, only 19% of students walk to school, while the rest use motorized modes when commuting to school. The results of MLM show that boys are more likely to walk to school than girls. In addition, age and unemployed family members have a positive relationship with students' odds of walking while owning cars, income, employed parents, parent education, and distance to school have a negative association with the likelihood of walking to schools. A shortage and uneven distribution of schools, lack of pedestrian infrastructure, and the higher dependency on private drivers can be considered the most important barriers to walking to schools. Thus, responsible agencies must add more schools to reduce the distance between homes and schools, implement safe, paved, and shaded pedestrian sidewalks, and educate students about walking benefits and safety principles.

Keywords: active commuting to school; motorized modes; distance to school; pedestrian infrastructure

Citation: AlQuhtani, S. Factors Affecting Active Commuting to School in Sprawled Cities: The Case of Najran City, Saudi Arabia. *Sustainability* **2023**, *15*, 9562. https://doi.org/10.3390/su15129562

Academic Editors: Katrin Lättman and Noriko Otsuka

Received: 12 May 2023
Revised: 10 June 2023
Accepted: 13 June 2023
Published: 14 June 2023

1. Introduction

In recent years, a rise in school-aged children commuting to school by motorized modes (i.e., cars, vans, buses) can be noticed; those motorized modes have become the primary mode of commuting to/from schools, while there is a sharp decline in the rates of children who walk to schools [1–3]. Automobile dependency may increase dramatically in sprawled cities that have been oriented toward automobiles, and almost all Saudi cities are considered autodependent cities. Major dependency on motorized modes for commuting to schools results in higher rates of childhood obesity and being overweight among students [4]. The obesity epidemic could have detrimental impacts on physical, mental, and social health. In Saudi Arabia, Al Shaikh et al. [5] found that around 15% of school children aged between 6 and 19 years were overweight in 2020 compared to 6% in 1988 [6].

Active commuting is considered the most sustainable transportation system that can also be an attractive solution to reduce dependency on automobiles. Promoting active commuting to school is believed to help combat childhood obesity and being overweight, and it can provide other health benefits, such as enhancing children's mental, physical, and psychosocial health [7–9]. Active school travel is also an affordable, convenient, and environmentally friendly mode of choice [10]. Another important potential benefit of daily active commuting to school is the reduction in motor vehicle dependency and, thus, less traffic congestion and environmental degeneration (e.g., air and noise pollution) either

within the districts or around school settings [11–13], especially given that transportation sector is one of the biggest contributors to greenhouse gas emissions in cities. A recent study investigated the sustainable benefits of active travel and found that switching one trip daily from a car to a bicycle can reduce a person's carbon footprint by around 0.5 tons over a year. Furthermore, when 10% of the population uses an active travel mode in their daily routine, 4% of the lifecycle of CO_2 emissions from all automobile travel would be saved [14].

Children's school travel mode in general and active commuting to school, in particular, has been widely discussed in Europe and North America. In addition, those previous studies have discussed the factors that can affect children's school travel mode such as demographics, socioeconomic, built environment, threat traffic, weather characteristics, and parental attitude. Yet, the distance between home and school can be considered the most influential factor, affecting walking to school either positively or negatively. As known, a significant amount of Saudi Arabia's students travel daily to school, yet little is known about factors affecting their commuting patterns to schools, especially for active commuting, since no study has been found investigating commuting patterns to schools. In Saudi Arabia, urban sprawl is a feature of most cities that may result in longer travel distances among children. In addition, cars are the main mode of commuting. This, in turn, may lead to more dependency on cars. Therefore, those special contextual factors may lead to even more variation in school travel modes among students. Thus, this paper outlines a conceptual framework for exploring children's school travel modes and shows the multiple levels of determinants that can influence children's mobility to school, particularly the factors that can affect active commuting for both boys and girls in all school stages in Najran City. Ultimately, understanding the thoughts of contemporary school travel behaviors of children, specifically for active commuting to school, can serve as valuable input for designing effective interventions and community planning policies. This can produce a positive change and shift commuters from motorized to active transportation modes, which will eventually support sustainable development in the Saudi context, particularly in Najran City.

2. Literature Review

This study tries to fill gaps in the literature by identifying the correlates between the mode of travel among children to/from school and factors affecting their travel mode choices, especially in sprawled cities. Several previous studies show a decline in active school transportation over time. For example, rates of U.S. elementary and middle school students walking and bicycling to school declined from 48% in 1969 to 13% in 2009 [15,16]. In the U.K., the number of students walking to schools declined by 17% between 1985 and 2008 [17]. Walking to schools in Canada declined by 11% between 1986 and 2006 [18]. A similar trend also happened in Australia, where active commuting to school decreased from 61% to 32% between 1991 and 2012 [19]. Such behavioral shifts have adverse consequences such as reduced physical activity among students, increased traffic congestion and accidents, higher obesity rates among students, and adverse environmental impacts. Hence, detecting factors influencing this change is crucial for controlling this trend and promoting active student transportation.

From the previous studies, several critical factors have been found affecting school commute mode decisions: demographic characteristics of the students, socioeconomic characteristics for either the students or the parents, built environment attributes, and weather characteristics. Besides that, distance from home to school exhibits consistently influential patterns across almost all studies. However, some factors were inconsistent across studies; these differences between studies' results can be indicative of each study's different location and cultures, nonuniformity of sample and sizes, variable categorizations, and discrepancies in the overall settings of variables and models [20,21]. In the sections below, a review of some previous studies on students commuting to schools revealed that several studies had reported the importance of some factors in influencing children's travel

behavior to/from schools. In addition, Table 1 shows some relevant studies published between 2010 and 2019.

2.1. Demographic Characteristics

Age is considered one of the important demographic characteristics prioritized in many studies related to the patterns of students commuting to schools. Some prior research found a negative relationship between age and active student transportation; as age increases, the propensity to select active student transportation decreases [22–24]. For instance, McDonald [25] found that high school students are less likely to walk to school than younger students. In addition, Johansson et al. [26] found in Swedish schools that active transportation decreased with increased age—76% at the age of 11 years and 50% at the age of 15 years. However, other authors claimed that students' propensity for walking or biking to school increases with age. For example, in Toronto, Canada, younger students walked to schools less than other older students [27]; the same was found in Tirana, Albania [28], in Kanpur, India [21], and in Kandy, Sri Lanka [29]. Besides that, some studies did not find a significant correlation between age and active student transportation [20,24,30].

Another important demographic variable is the gender of the student, where it is widely investigated in previous literature. Many studies showed that male students are more likely to walk or bike to school than female students. For example, the studies of Singh and Vasudevan [21] in Kanpur, India; Guliani et al. [31] in Toronto, Canada; Larsen et al. [32] in London, Ontario; Yelavich et al. [33] in New Zealand; McMillan et al. [34] in California; and [35] in Ireland explored that boys were more likely to walk to school than girls. The increased dependency of girls on motorized modes could be related to parental risk perceptions associated with females [18,36–38]. However, contradictory conclusions were found in other studies. For example, in Australia [39] and in Norway [40], girls were found walking to schools more than boys. On the other hand, some studies did not find any association between gender and active transportation in school trips, such as in the Netherlands [41], in the United States [25], and in Canada [27].

2.2. Socioeconomic Characteristics of Household

Socioeconomic factors of households have shown an influence on the commuting patterns of students to schools. Previous studies, for example, found that students from a household with higher car ownership are more likely to be chauffeured to school [42–45]. Few concluded that there is no or weak association between car ownership and active commuting for school trips [46–48]. However, in Istanbul, Turkey, a study found a contrary result that increased car ownership was associated positively with walking to school, and this can be attributed to the fact that increased household car ownership and, hence, income, may indicate that a person lives in districts with appropriate pedestrian infrastructure [49].

Findings related to some other socioeconomic factor correlates remain mixed. Some studies have observed a negative relationship between active commuting to school and household income [10,21,29,42,44,50]. Nonetheless, other studies did not confirm this finding; they reported no or weak significant correlation between active transportation and household income [51,52]. Regarding the association between parents' education and active transportation in school trips, most studies found a negative association between the level of parents' education and active commuting to school [42,53,54] and a nonsignificant correlation in another [55]. This can be interpreted as with higher education levels, the probability of having higher income increases and, thereby, the higher the probability of being disposed toward active commuting to school. Sidharthan et al. [56] argued that the presence of a nonworker adult in the household was associated positively with walking to school since the adult accompanies the child to school. In addition, the utility of students walking to schools increases with unemployed parents and the presence of school-age children [27,44,57].

2.3. Built Environment Characteristics

In previous studies, a wide range of built environment characteristics were examined to explain the commuting patterns of students to schools, and many of them were found to influence those patterns. Results related to the impact of land use remain mixed. Some researchers found that urban form and land use are positively associated with walking to school [58,59]. For example, some studies concluded that neighborhoods with more mixed land use positively influence the likelihood of walking and biking to school [32,45,52,60]. Furthermore, some studies found a positive relationship between population density and active commuting to school [25,52,61–63], while others reported a negative or no association between population density or mixed land use with walking to school [49,64–66].

Many studies reported a negative association between concern about personal and traffic/pedestrian safety and the probability of active traveling to school [36,67–69]. In addition, traffic congestion in the neighborhood streets [52,70,71] and major road intersections or crossings [64,65,71,72] on the way to school were found to be barriers to active traveling to school. For example, in Toronto, Canada, the absence of major street crossings in the routes to schools encouraged students to walk more to school [27]. On the other hand, the presence of active transportation infrastructure (e.g., sidewalk and pedestrian crossings, controlled traffic crossings) was found to be supportive of students walking to schools [21,61,64,73]. In addition, the presence of street trees increased the likelihood of walking or biking to schools in London, Ontario [32]. However, McMillan [60] and Yarlagadda and Srinivasan [74] reported that built environment attributes did not have any impact on school mode choice, while socioeconomic attributes and distance had a major effect.

Distance between residence and school or travel time from/to school has been consistently reported as the most important factor affecting the probability of choosing active commuting to school. Many studies showed a negative correlation between school travel distance or walking travel time and active student transportation [2,21,29,45,50,75]. For example, McDonald [76] found that a 1 min increase in walking time leads to a 0.2% decline in the probability of a student walking to school. Another study found that a 1% increase in distance between home and school, the probability of walking to school decreased by 0.85% [77]. Furthermore, Davison et al. [78] gathered many studies about commuting to school and found that students living within 1 mile of schools are three to five times more likely to walk to school than those who live further away. However, Ermagun et al. [79] showed that 85% of students can walk until 1.9 km, and Nelson et al. [35] found that 82% of older Irish students can walk to school if they live within 2.4 km of the school. Many students living within reasonable walking distance from school have a great opportunity to accumulate physical activity on a regular basis. However, as stated earlier, some factors can negatively affect active commuting to school.

Understanding the relationship between active student transportation for school and demographic factors, socioeconomic attributes, and built environment characteristic is a necessary prerequisite for evaluating the effectiveness of policy measures. Thus, some of those policy measures have been investigated in previous studies. Mammen et al. [10] reported that improving infrastructure (e.g., pedestrian sidewalks, pedestrian crossings, controlled traffic crossings) and safety education were the most effective strategies in encouraging students to walk to school. Additionally, Jassas [80] concluded that adding a physical activity class can increase students' knowledge about walking benefits and thereby increase active school transportation. Spinney et al. [81] added that setting smaller elementary schools in the center of compact and high-density neighborhoods reduces school distance and increases active student transportation.

Table 1. Some of the relevant studies published between 2010 and 2022.

Reference	Study Area	Age (Years)	Analysis Method
Dias et al. [29]	Kandy, Sri Lanka	11–18	Multinomial logistic; mixed logit frameworks
Ozbil et al. [49]	Istanbul, Turkey	12–14	Multinomial logistic
Spinney et al. [81]	Halifax, Canada	5–11	Multinomial logistic
Assi et al. [50]	Khobar, K.S.A.	16–18	Logistic regression; neural networks
Singh and Vasudevan [21]	Kanpur, India	5–15	Multinomial logistic
Zhang et al. [44]	Beijing, China	7–18	Multinomial logistic
Mitra and Buliung [27]	Toronto, Canada	11, 14–15	Multinomial logistic
Broberg and Sarjala [64]	Helsinki, Finland	11–14	Multinomial logistic
Guliani et al. [31]	Toronto, Canada	10–12	Structural equation model
Hsu and Saphores [38]	California, USA	5–15	Binary logit model
Mammen et al. [10]	Canada	6–14	Binary logit model
Pojani and Boussauw [28]	Tirana, Albania	11–13	Multinomial logistic
McDonald [36]	USA	8–13	Multinomial logistic
Seraj et al. [82]	USA	5–15	Multivariate ordered response model
Johansson [26]	Sweden	11–15	Multinomial logistic
Mitra and Buliung [83]	Toronto, Canada	11–12	Binary logit model
McDonald et al. [15]	USA	5–14	Binary logit model
Mitra et al. [84]	Toronto, Canada.	11–13	Binary logit model
Panter et al. [85]	Norfolk, UK	9–10	Cross-sectional study
Leslie et al. [39]	Australia	10–14	Binary logit model
Lin and Chang [52]	Taiwan	3–18	Nested logit models
Wilson et al. [24]	USA	7–12	Multinomial logistic

3. Methodology

3.1. Study Area

Najran City is located in the southwestern part of Saudi Arabia. Its area is about 885 km^2, and it has 78 residential districts, as shown in Figure 1; the city's population in 2019 was 454,035 [86]. The average population density in the city varied by the district; it was higher around the city center and some old districts, at roughly 174 person/hectare, and subsequently fell to around 48 person/hectare in the other districts. In half of the city's districts, particularly in the eastern districts, it drops to less than five person/hectare. In 2017, there were 332 schools distributed in most of the city's districts containing 77,891 students (Saudi General Authority for Statistics [GASTAT], 2017 [87]). Schools in Saudi Arabia are gender separated physically for boys and girls at the three educational stages. The number of boys' schools is 169 in different stages, while there are 163 girls' schools in

Najran city. The students' ages in Saudi schools range between 6 and 18 years for the three stages.

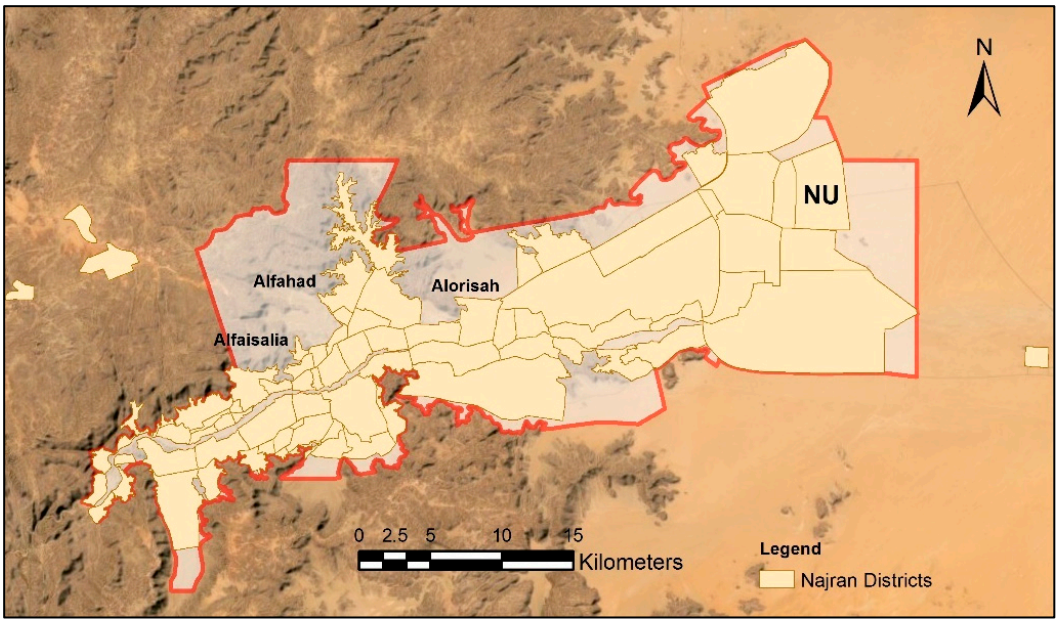

Figure 1. Najran city districts. Satellite image source: Esri and the GIS User Community.

3.2. Data and Survey Design

The study area is a good mix of old development in old districts and new suburban development in the city's east part. In addition, it has a good mix of dense developments; for instance, the neighborhoods near the city center are very dense, while the ones in the east part of the city have a very low population density.

No government agency nor academic institution has collected data regarding students' commuting patterns to schools in Najran City. There is, therefore, a need to collect and analyze such data. One major approach prominently used to collect and understand the commuting patterns of students to schools is administering a questionnaire survey. A questionnaire is a very useful research tool that can help assess a large population with relative ease; it helps reach a population's feedback within a reasonable timeframe and is more accurate and fixable. Therefore, the author built the questionnaire based on previous studies on children's school commuting patterns. The survey was focused on children aged between 6 and 18 years, representing elementary school entry until high school exit ages, belonging to 332 schools in Najran City. What makes this study different from other studies is that the study researcher has built a questionnaire survey. In contrast, most previous studies depended mainly on available data such as national surveys, census, school commute surveys, or national travel surveys that other agencies previously collected.

In this study, the researcher wanted to develop the quality of the research instrument, a questionnaire survey. Thus, validity and stability were used to develop and test through some practices. After that, the final instrument further included questions about students' descriptive information (age, gender, nationality, grade), information about the parents (e.g., car ownership, number of siblings, employment status, education, income), and students' commuting patterns to school (e.g., walk, private car, bus).

The questionnaire survey was made online through "Google Forms" and sent to all of the parents of students (6–18 years) for two weeks (from the middle to the end of January 2022); a reminder was also sent to all of them to remind them to fill in the questionnaire (from the beginning to the middle of February 2022). Parents were asked to complete only one survey if they had more than one student at home. The main reason behind choosing the parents was they have more precise information about household socioeconomic and

demographic attributes and influence on the commuting patterns of students to schools. The target population consisted of all students' parents from the 332 schools in Najran City. The number of families having students in schools is 29,636 persons, representing the study's population size.

3.3. Descriptive Analysis

A total of 1218 responses were recorded and used in the analysis, so the section below discusses respondents' general results regarding the socioeconomic attributes of students, distance to school, and mode of commuting to schools. Following the building and distribution of the questionnaire, the results showed responses from different students' ages. As shown in Table 2, the higher responses were from students' ages between 11 and 14 years, with response rates of about 38%, followed by 34% for students' ages between 15 and 18 years. However, the lowest groups were those whose ages were between 6 and 10 years. As seen in Table 2, the number of males who responded to the questionnaire was nearly double that of females.

Table 2. Socioeconomic attributes of the respondents.

Factors	N	%
Age (years)		
6–10	341	28
11–14	465	38
15–18	412	34
Gender		
Male	801	66
Female	417	34
Nationality		
Saudi	1027	84
Non-Saudi	191	16
Grade		
Elementary school	553	45.4
Intermediate school	394	32.3
High school	271	22.2
Distance to school		
<500 m	197	16.2
500 to 1000 m	277	22.7
1000 to 1500 m	141	11.6
1500 to 2000 m	159	13.1
>2000 m	444	36.5
Number of owned vehicles		
0	36	3
1	609	50
2	355	29.1
3	114	9.4
4 and more	104	8.5

The respondents were divided into three categories based on grade: the first is the elementary school, which represents 45% of the respondents; the intermediate school represents 32.3%; and the high school, which represents 22.2% of the respondents. We think the high percentage of elementary schools can be due to the fact that the period of elementary schools in Saudi Arabia is six years, so they represent nearly half of the respondents.

Regarding the distance between home and school, around 36.5% of the respondents stated that they live more than 2 km away from students' schools, followed by a distance of 500 m to 1 km (23%), and only around 16% of the respondents live less than 500 m from schools. As stated in many previous studies, students are more likely to walk as the distance decreases between home and school. The percentage of families owning one

vehicle is 50%, and around 30% of the respondents own two cars, while only 3% of the households do not own cars. The average car ownership among the respondents is around two cars for each household, which can be considered a relatively high number. However, increased car ownership may increase automobile dependency [88].

3.4. Mode of Commuting to Schools

As shown in Table 3, more than half of the students were driven to school by a family member; they represent around 55.4%. In addition, 15% of the students were driven to school by either family or nonfamily drivers (In Saudi Arabia, many families have family drivers to chauffeur family members, particularly those who cannot drive, to destinations. Additionally, in Saudi Arabia, many Saudi and non-Saudi people who own cars or vans chauffeur students to schools without permission from responsible agencies). However, only 19% of students walked to school, which can be considered a good number, especially since Saudi cities depend mainly on automobiles. Around 10.5% of the students commute by school bus to school. Some of the previous studies have shown that the different patterns of students' movement to school are due to several factors, such as the parents' decisions, higher car ownership, concerns about traffic and neighborhood safety, lack of pedestrian sidewalks, and longer distances between homes and schools.

Table 3. Mode of commuting to school.

Mode of Commuting to School	N	%
Walking	233	19.1
Car driven by a nonfamily driver	129	10.6
Car driven by family driver	53	4.4
Car driven by a family member	675	55.4
School bus	128	10.5

4. Multinomial Logit Model

4.1. Model Description

The descriptive analysis results showed general results that disclose some demographic and socioeconomic attributes, distance to schools, and mode of commuting of students to schools; however, those results did not show when a particular factor changes, how the choice of mode of commuting to school follows, and whether some variables can be more influential on one commuting pattern than others. This, in turn, can tell entities responsible for commuting to schools how to prioritize different efforts to promote alternative modes other than commuting by automobile to schools. Thus, one of the best models to find this fact is utilizing the Multinomial Logit Model (MLM), especially since this study has a categorical dependent variable with unordered levels (i.e., commuting patterns to schools).

MLM is used since it can estimate [$k - 1$] models, where [k] is the number of commuting modes to schools used by students in Najran. In addition, MLM can predict the probabilities that the commuter [ith] would choose the commuting pattern [jth] among the set of available patterns [k] as given by Equation (1). MLM also allows one to assess the effect of different factors (e.g., age, gender, nationality, and distance to school) on a specific commuting pattern to school, meaning MLM quantifies how various variables are associated with the probability of a commuting pattern being chosen, which is always of interest to decision makers.

$$P_{ij} = \Pr(U_{ij} > U_{ik}), \forall k \neq j \quad (1)$$

where [k] represents various commuting patterns to schools and [Uij] is the maximum utility attainable for the traveler [i] if the traveler chooses the mode [jth] which is given by Equation (2):

$$U_{ij} = \beta_j X_{ij} + \varepsilon_{ij} \quad (2)$$

where $[\beta_j]$ is a vector of unknown coefficients for each of the explanatory variables, $[X_{ij}]$ is the vector of the known variable, and $[\varepsilon_{ij}]$ is the random component of the utility. If the stochastic terms $[\varepsilon_{ij}]$ have independent and Weibull distributions, the Multinomial Logit Model can be expressed as:

$$P_{ij} = \frac{e^{\beta_j X_{ij}}}{\sum e^{\beta_j X_{ij}}} \quad (3)$$

4.2. Empirical Results

MLM was developed, and it studied the impact of the explanatory variables on the marginal utility of individual commuting patterns to school, including walking, school bus, a car driven by a parent, and a car driven by a nonfamily driver relative to the reference alternative—car driven by a family driver has been chosen because it has the smallest number of estimated coefficients for corresponding utility function [89]. SPSS 23 was used to generate the MLM, and the results are presented in Table 4.

Table 4. Summary of MLM estimation results.

	Explanatory Variables	**Walking (N = 233) 21.332**	**Car Driven by a Nonfamily Driver (N = 129) 21.666**	**Car Driven by a Parent (N = 675) 24.347**	**School Bus (N = 127) 22.140**
		Explanatory variables (categorical)			
Gender	Male = 0	1.729 ***	−0.206	0.251	−1.673 ***
	Female = 1	-	-	-	-
Nationality	Saudi = 0	−2.617 ***	−1.584 *	−1.912 **	−0.759
	Non-Saudi = 1	-	-	-	-
Grade	Elementary = 0	−1.949 **	−0.531	−1.026	−0.865
	Intermediate = 1	−1.069 *	−1.386 **	−1.442 ***	0.020
	High school = 2	-	-	-	-
Distance to home	<500 m = 0	2.127 ***	−0.509	−0.984 **	−0.519
	500 to 999 m = 1	2.085 ***	0.662	−0.113	0.099
	1000 to 1499 m = 2	0.937 *	−0.528	−0.372	−0.380
	1500 to 2000 m = 3	0.352	−0.807 *	−0.471	0.070
	>2000 m = 4	-	-	-	-
Father's education	No qualification = 0	0.218	−0.655	−0.677	−1.410
	Elementary = 1	1.049	1.000	1.210	−0.566
	Intermediate = 2	2.109 *	1.650	1.789 *	0.665
	High school = 3	0.427	0.598	0.395	−0.989 *
	Diploma = 4	0.351	0.281	0.363	−0.647
	University = 5	0.119	−0.055	0.514	−0.800
	Graduate school = 6	-	-	-	-
Mother's education	No qualification = 0	2.684 **	1.229	1.443	2.036 *
	Elementary = 1	2.523 **	0.674	0.824	0.937
	Intermediate = 2	2.630 **	1.092	1.837 *	1.906
	High school = 3	1.707 *	0.234	0.811	0.904
	Diploma = 4	1.368	0.540	0.005	1.079
	University = 5	0.741	0.199	−0.087	−0.146
	Graduate school = 6	-	-	-	-
Father's job	Private sector = 0	−18.816 ***	−17.785 ***	−18.091 ***	−18.104 ***

Table 4. *Cont.*

	Explanatory Variables	Walking (N = 233) 21.332	Car Driven by a Nonfamily Driver (N = 129) 21.666	Car Driven by a Parent (N = 675) 24.347	School Bus (N = 127) 22.140
	Government = 1	−17.966 ***	−16.764 ***	−17.296 ***	−18.577 ***
	Businessman = 2	−18.132 ***	−17.003 ***	−17.412 ***	−18.009 ***
	Retired = 3	−17.543 ***	−16.713 ***	−17.141 ***	−17.670
	Unemployed = 4	-	-	-	-
Mother's job	Private sector = 0	0.560	0.332	−0.360	−1.476
	Government = 1	−0.070	0.043	0.468	−1.167 *
	Businesswomen = 2	−1.398	−19.279 ***	−0.974	0.375
	Retired = 3	−0.716	0.847	0.959	−0.548
	Housewife = 4	-	-	-	-
Household income	<5000 SAR = 0	0.837	0.513	0.762	1.401 *
	5000–8000 SAR = 1	0.755	0.292	0.887	1.403 *
	8001–12,000 SAR = 2	0.150	0.608	0.142	1.122
	12,001–15,000 SAR = 3	0.241	−0.238	−0.016	0.390
	15,001–20,000 SAR = 4	0.139	0.811	0.641	0.830
	>20,000 = 5	-	-	-	-
	Explanatory variables (continuous or ordinal)				
	Age	−0.254 **	−0.111	−0.205 *	−0.146
	Population density (acre)	0.003	−0.001	0.001	−0.013 **
	Years in district	0.019	0.011	0.001	0.021
	Number of owned vehicles	−0.239 *	−0.208	0.005	−0.153
	Number of male/female adults in the household	−0.094	−0.185	−0.027	−0.052
	Number of working members from family	0.010	−0.103	−0.083	−0.022
	Number of unemployed family members including parents	−0.038	−0.190 **	−0.124 *	−0.150 *
	Number of male students who attend school from the same home	0.061	0.035	−0.007	0.105
	Number of female students who attend school from the same home	−0.026	−0.037	−0.049	0.080

Note: * Significant at the 0.10; ** Significant at the 0.05 level; and *** Significant at the 0.01 level. Car driven by a family driver is the reference mode, for all modes N = 1164. McFadden R2 = 0.224.

4.2.1. Demographic Characteristics

Regarding the demographic characteristics, the statistical significance of the coefficients for gender was highly significant and positive for walking while negative for school bus; the positive sign suggests that being male increases the utilities of walking to school and decreases the utilities of riding a school bus. This is consistent with the knowledge that in Saudi Arabia, females are less likely to walk to school than males due to social fear of allowing females to walk to schools, even among adult females. In addition, this has been proven by much of the previous research that found females usually commute to schools by motorized modes due to parental risk perceptions associated with females either in developed countries [10,36,38] or developing countries [21,29,49]. After controlling for other variables, the influence of nationality is significant. Saudi students are more inclined to be accompanied by their private family driver; they show negative utility for walking to

school, being driven by a family member, or by a nonfamily driver. It is common in Saudi Arabia for many families to have private drivers, especially when the father or mother is an employee, and the household has many students in school. In other words, if parents have jobs, they have more income, and thereby they have the ability to hire a family driver to chauffeur children to school.

4.2.2. Socioeconomic Characteristics of Household

The significant effects of grade confirm that elementary and intermediate school students are less likely to walk to school. In other words, high school students are more likely to walk than the other groups of students. This can be a reasonable finding since parents of younger children are likely to be worried about their children's safety when walking to schools, particularly when there are busy roads or intersections on their routes or the area lacks efficient pedestrian infrastructure. This is consistent with much of the previous literature that found older students walked to schools more than younger students in both developed and developing countries [21,29,63,90]. Besides the lower likelihood of walking to school, intermediate school students significantly reduce the utility of commuting by a car driven by a parent or a nonfamily driver, meaning they are more likely to be driven by a private family driver. This may be explained by the fact that many families have private drivers, so they chauffeur students to school. This can also be attributed to the lack of active transportation infrastructure and the long distance to schools; as shown in the descriptive analysis results, 50% of intermediate school students live more than 1.5 km from schools.

As expected, if the family owns more cars, students are less likely to walk to school. This outcome is supported by previous studies in developed and neighboring regions, which concluded that students from a household with higher car ownership are more likely to be chauffeured to schools [29,42–45,49]. Regarding income, the statistical significance of the coefficient for low and below-middle-income households suggests that low and middle-income households are more likely to use school buses rather than commuting by automobile. This is a surprising result since the coefficient of walking is not significant; in much of the previous research, walking to school has a negative relationship with household income in developed and developing countries [10,20,21,29,44,91]. The higher probability of using a school bus by low and middle-class households can be attributed to the fact that school buses in Saudi Arabia are very cheap and supported by the government.

In terms of the father's employment, the results show that the coefficient of the father's employment is negative and significant for almost all commuting patterns at a 99% significance level. This means if the father is employed, the chances of a student being accompanied by the family driver to school increases. However, if the mother is a businesswoman, the chances of a student being driven to school by a nonfamily driver increases, and the chances of commuting by school bus increase if the mother works in a government sector. This indicated that the children of employed parents commute to schools by motorized modes, particularly by drivers, and not by parents. Notably, if the father has an intermediate school qualification rather than having graduate school qualification, the chance of a student walking or being driven by a parent to school increases. In addition, students of mothers who do not have a certificate or have elementary to high school certificates are more likely to walk to school. Our study findings are consistent with much of the literature that found that active commuting to schools decreases as the parents' education increases. Higher education levels mean the probability of higher income and, therefore, a higher likelihood of car ownership and dependency. The coefficients on unemployed family members are significant for all alternative modes except walking. As the number of unemployed family members increases, students are less likely to commute to school by school bus or by car driven by a nonfamily driver or a parent. This can be attributed to the fact that as the number of nonworker adults increases in the household, car ownership decreases, thereby leading to more walking to school or there is a desire to walk to school with children since they are available or to do some exercise. What is a little surprising is that some of the socioeconomic variables, such as household size, the

number of adults in the household who can drive children to school, and the number of working members in the household, were not significant for all modes of transportation considered. Those variables are significant in many previous studies, so these variables need more investigation.

4.2.3. Built Environment Characteristics

In terms of built environment related variables, regarding distance, for students living within 1.5 km of school, the coefficients for distance are significant and positive for walking at 99% for a distance up to 1 km and 90% for a distance between 1 and 1.5 km. When the distance exceeds 1.5 km, there is a significant transfer to commuting by a car driven by a nonfamily driver. As expected, this result indicates that as the distance increases between home and school, where other factors are constant, the odds of commuting by faster modes increase. Understandably, longer distance between home and school increases the dependency on motorized modes. Many previous studies assert that the distance between home and school is a key determinant of active commuting to school in both developed and developing countries [21,29,44,57,64]. The coefficient for population density is significant only for school bus. However, in many previous studies, walking to school was significant and positively correlated with population density. In Saudi Arabia, the increase in car ownership and lack of pedestrian infrastructure can reduce walking to schools, even in districts with high population density. In addition, the increased level of automobile traffic due to increased population density can pose unsafe conditions for walking, similar to the conditions of Istanbul, Turkey [49].

To conclude, many of the results are similar to existing studies in Europe and North America about active commuting to school, while other results are partially different. The similarities of results can be noticed in gender, where boys are more likely to walk to school than girls; high school students are more likely to walk than the other groups of students, whereas children from families who own more cars, children of employed parents, or children of parents with higher education certificates are more likely to be chauffeured to schools. In addition, as the number of nonworker adults increases in the household, walking to school increases. As proven in many studies, the odds of commuting by faster modes increase as the distance increases between home and school in Saudi Arabia.

However, the differences can be shown in some empirical results. Students from low- and middle-income families are more likely to commute by motorized modes. A higher percentage of private drivers (family or nonfamily drivers) and the lack of active transportation infrastructure in almost all districts discourage students from actively commuting to school. Finally, some important variables were statistically significant in most previous studies in Europe and North America and even in neighboring regions, but they were insignificant in this study, such as the number of adults or working members in the household, number of students in the same school, population density, and number of owned cars.

5. Discussion and Conclusions

Investigating factors affecting the commuting patterns of students to schools is an important step in predicting future travel demand. Those factors can help city and transportation planners to promote active transportation to school and reduce dependency on automobiles, but not many studies were found investigating commuting patterns of students to schools in Saudi Arabia, where there is a high dependency on automobiles and an absence of pedestrians and walking. Therefore, this study contributes comprehensively by examining factors that can affect the commuting patterns of students to schools. It also investigates the associations between students' mode of commuting to schools and the social and economic attributes of the students and their families, as well as spatial attributes such as distance between homes and schools and population density.

The main results of this study showed that a large number of students commute by automobile (70%) and there were low rates of walking (19%) to schools. Around half of

the students lived at a distance of more than 1.5 km from schools, and around 74% of the families had more than one vehicle. In addition, the results showed that younger or female students were less likely to walk to school due to parents' fears and the lack of walking infrastructure. The findings of this study also showed that the presence of family and nonfamily drivers reduces walking to schools.

Najran City is a very secure and safe city, but the lack of schools in all stages and the unbalanced distribution of schools in Najran leads to long distances between home and schools; in addition, the lack of pedestrian infrastructure and parental risk perceptions played major roles in discouraging students from walking to schools which can be in line with the findings of most studies conducted in developing countries. Besides all of that, the abundance of family and nonfamily drivers reduces walking to schools. Thus, at least four suggestions should be presented to improve children's school accessibility and increase active transportation modes.

The first can be increasing the number of schools in all stages since there is still some shortage and uneven distribution in the number of schools, while many vacant lands are allocated for schools [92]. Secondly, responsible agencies must implement safe, paved, and shaded pedestrian sidewalks, especially since most of Najran's districts lack basic needs for pedestrian infrastructure. Currently, there are no regulations that enforce implementing well-equipped pedestrian sidewalks in neighborhoods; very few pedestrian-friendly neighborhoods can be found in Saudi Arabia, and developers created those that exist just for marketing purposes. The third is that current schools should educate students about walking benefits and walking safety principles. Notably, it is very important to advocate walking as one of the effective modes to combat childhood obesity, as well as bringing other health benefits, reducing automobile dependency, and sustaining an environmentally-friendly mode of choice in Najran. Finally, the increased dependency on family and nonfamily drivers is an issue that must be organized through authority agencies by implementing regulations about chauffeuring children to schools.

Further research is needed to fill the following gaps. Firstly, future research should examine additional physical and social environmental characteristics, such as the availability of sidewalks in the neighborhoods, land use, traffic safety, and social norms, along with individual and family characteristics. Furthermore, measuring the exact distance between home and school may reveal more accurate results. Our findings showed that some variables were not significant, while they were significant in many of the previous studies, such as family income and size, and the number of adults or workers in the household; further research is needed to determine the precise relationship between those variables and commuting patterns to school. In addition, investigating reasons behind discouraging and encouraging students to walk is very important to make students walk to schools, especially in extended cities. Finally, some research should be conducted regarding the gender differences in social, personal, and environmental impacts on walking to schools.

Funding: This research was funded by [Deanship of Scientific Research at Najran University] grant number [NU/NRP/SERC/12/7] and The APC was funded by [the author].

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by Ethics Committee of Najran University (protocol code 443-43-52950-DS and date of approval is 4-1-2022).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy.

Acknowledgments: The author is thankful to the Deanship of Scientific Research at Najran University for funding this work under the Research Priorities and Najran Research funding program grant code (NU/NRP/SERC/12/7).

Conflicts of Interest: The authors declare no conflict of interest.

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