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The relationship between school districts and parental commuting behavior: Analysis of gender differences in the Chinese context

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The distribution of school districts would largely influence people's commuting distance, but this association is hardly examined. This study applies the 2015 Xiamen household travel survey to investigate the associations between the school district and parental commuting behavior. The results showed that school districts mainly affect the parents' commuting distance when the interaction effects between gender and commuting distance are considered. Specifically, the school district is positively associated with commuting distances for males, whereas the opposite trend is observed for females. Then, variations exist in the effects of the school district on parental commuting distance between respondents with different levels of education. The school district quality is positively associated with the commuting distance for respondents without college degrees, especially male respondents, whereas no significant association was found for more respondents with college degrees. Male respondents, especially those without college degrees, suffer higher costs and longer commuting distances than their female counterparts. This study highlights that urban planners and policy makers should consider the impact of school districts and rethink the most effective distribution of high-quality primary schools to reduce socio-spatial inequality (e.g., disadvantage of males in commuting).

Introduction

As an important component of daily life against urbanization, commuting behavior exerts an effect on life satisfaction (Dickerson et al., 2014). In the past few decades, changes in urban, physical, and social spaces have profoundly affected the commuting behavior by changing the commuting time or distance (Li and Zhao, 2022). Due to

differences in the time and resources allocated to activities, it is widely recognized that the commuting behavior varies between individuals, cities, and countries. For instance, the average commuting time in the United States is 25 min, as opposed to 38 min in Europe (Rodrigue, 2020). Due to high population density and traffic congestion, Asian cities have an average daily commuting time of 50 min or more (Rodrigue, 2020). According to Li (2021), long-time and/or long-distance commuting can aggravate socio-spatial inequality and produce a range of socio-economic issues. For instance, a lack of resources—which usually indicates lack of money and/or time—will increase the physical stress, affect mental adaption, and generate negative emotions (Liu et al., 2022). Additionally, increased commuting time inevitably reduces the community engagement activities, thereby reducing the social capital (Putnam, 2000). Therefore, how to decrease commuting distance and time has received wide attention from both academic studies and planning/policy practices.

Among the studies, gender differences in the commuting behavior have received a wide attention. It is widely acknowledged that given the household responsibility and social norms, the women's commuting distance is shorter than that of men. Many studies have identified a range of factors affecting the commuting time/distance for males and females. These factors consist of individual and household characteristics. For instance, Crane (2007) revealed that women with a higher level of education have a longer commuting time. Schwanen (2007) found that with the increase in the share of household income, women's housework will decrease to a certain extent, thereby increasing their commuting distance. Nevertheless, other studies showed no significantly positive effect of education or income on female commute. For instance, Fan (2017) confirmed that due to the impact of gender roles, women still need to undertake more housework, even if they earn more money (have a higher level of education) than their husbands.

Although researchers have paid much attention to factors that explain differences in the gender commuting gap, there is a lack of literature that focuses on the association between school districts and parental commuting behavior, especially in the Asian context where school districts prevail. According to Fast (2020), the school district, consisting of a community-based learning area with one or more high-quality primary schools, guarantees access to compulsory education in close proximity. Only when parents buy a house in a particular school district can their children be enrolled in that community school. Therefore, high-quality school districts have become a scarce resource. In the Chinese context, competing for favorable school districts not only increases the household burden through purchasing premium school district housing, but also has a profound influence on parental commuting distance/time (Li and Zhao, 2022). When the school district housing is far from residential neighborhoods, the increase of commuting time will occupy an

individuals' leisure time and boost pressure, thus resulting in a series of socio-mental issues.

Despite the argued potential, our understanding of the association between neighborhood-based school districts and commuting behavior remains inadequate. First, some studies have argued that whether neighborhoods have high-quality primary schools may influence people's travel behaviors (He and Giuliano, 2018). This is because households with a high capability to pay price premiums prefer to live near high-quality schools whereas the lower-income families usually choose the opposite option. Parents would have to face differed commute behavior when this option is carried out. Second, previous studies chiefly focused on the effects of school districts on students' school travel behavior, whereas its relation to parents' commuting behavior has been largely neglected (Lin and Chang, 2010; Marzi et al., 2018; Fast, 2020). However, identifying and, more accurately, distinguishing the school district's influence on parental commuting behavior is significant to increasing the status quo through interventions, such as transportation and school district planning.

To fill the gaps, this study uses the 2015 Xiamen household travel survey to investigate the associations between school districts and parental commuting behavior at the individual level. This study makes two-fold contributions. Theoretically, this study is one of the first that empirically explores the effect of school districts—whether to live in high-quality school districts or not—on parental commuting behavior, which can enrich and broaden the current discussions on school districts and parental commuting behavior. Practically, this study can provide references for policymakers and urban planners who are interested in improving the neighborhood-based educational resource layout for facilitating and encouraging sustainable travel behaviors and practices.

In the following sections, Section 2 reviews the gender differences in commuting behavior and the literature on association between neighborhood-based factors (including school districts) and the commuting behavior. Section 3 specifically introduces the data obtained and the methods used by this study. Section 4 presents the research results, followed by discussions on the results in Section 5. Section 6 concludes this study.

Literature review

Gender differences in commuting behavior

Studies have intensively examined commuting behavior and a significant difference in commuting behavior between females and males has been specifically highlighted (Schwanen, 2007; Elias et al., 2015; Ta et al., 2022). Researchers found that males are more mobile and can sustain longer commutes while working

women commute much shorter distances (Johnston-Anumonwo, 1992; Clark et al., 2003; Fan, 2017). Studies also indicated that gender differences in the commuting behaviors among two-worker households are more apparent than among one-worker households (Johnston-Anumonwo, 1992).

In the literature, a range of factors have been argued to influence the gender differences in commuting behavior, including social customs, policy conditions, demographic, and socio-economic characteristics such as household size, income, education, car ownership, workplace, and accessibility, and eventhe environment (Rosenbloom and Burns, 1993; Wang and Chai, 2009; Hu et al., 2018; Korzhenevych and Jain, 2018). For instance, with regard to the characteristics of wage, Madden and Chiu (1990) found that the change of job cannot significantly increase women's commuting distance. This is explained by the fact that the spatial difference of wage is small in these jobs. Additionally, the personal or household characteristics may affect the commuting behavior. Mauch and Taylor (1997) discovered that the gender differences in the commuting time are highest among whites and lowest among Hispanics. In this process, the commuting mode played an important role in the commuting time of both men and women. Due to a lack of transit provision and high car ownership among males, males tended to disproportionately make more tours and spend more time traveling by private cars whereas women disproportionately walked. Then, Rosenbloom and Burns (1993) found that due to females' household and childcare roles and responsibilities, their travel patterns differed from those of men. The birth of children may profoundly change the responsibility of women. For example, women may have part-time jobs or a shorter commuting distance. Some scholars argued that there is a need to improve the survey and conduct a holistic understanding of the commuting behavior that take the interplay of activities within the household into account. To do so, Elias et al. (2015) adopted a tour-based approach to examine the commuting behavior in Arab–Israeli communities and found gender to be a significant predictor of commuting.

Furthermore, the role of culture was also stressed on influencing females' commuting behavior (Peters, 2001). For instance, in a society featured with a gender segregation culture, females are often arranged or required to take segregated public transportation or to use segregated doors and seats (Polk, 2004). As a result, their travel behavior would differ considerably from that of males. Some studies revealed that security and safety issues facing female commuters contributed to the gender differences in commuting behavior (Whitzman, 2007). For instance, in a safe environment, females would prefer to choose more public transportation trips (Kabeer, 2004). Note that when culture is deemed as an influencing factor on commuting or travel behavior, we should be cautious of the operationalization problem (Hammel, 1990).

Furthermore, education and income are associated with the employed women's commuting behavior (Lee et al., 2022). With improved equality between men and women, women's education level has been gradually promoted during the past decades and thus has been increasing their income (Tyer-Viola and Cesario, 2010). However, note that the wives' share of the household income is relatively lower than their husbands; therefore, married men can have greater power on the allocation of household resources such as the car (Ta et al., 2022). Consequently, employed women may be more likely to choose non-automobile modes of travel such as bus, subway, or even walk, especially in families with the traditional contracts (Solá, 2016).

The explanation and interpretation regarding the gender differences in commuting behavior can provide important references for the optimization of public service and policies. For instance, the double pressure of both income-earning and household work forces married women to reduce the commuting time and constrict the commuting distance (Turner and Niemeier, 1997). This is named as the household responsibility hypothesis (HRH), which indicates that, affected by the social norms and gender identities, the married women have to undertake the housework such as cooking and cleaning (Gimenez-Nadal and Molina, 2016). Especially, the presence of children may further shorten the commuting distance; women with the children may select part-time jobs near their home (Lee and McDonald, 2003).

School district/school district-housing and parental commuting behaviors

Although some specific factors affecting parental commuting behavior have been explored, little attention has been paid to school districts in relation to commuting behavior. In the Chinese context, a so-called school district means the designated region in which high-quality primary schools are located, making it possible for students to have free admissions to the nearest school (Wen et al., 2017; Peng et al., 2021). Furthermore, the school district (policy) is specifically applied to the 9-year compulsory education which includes primary school (6 years) and middle school (3 years). The rise of school districts results from the Chinese neo-liberalistic education reform since the mid-1980s. Local governments were empowered to administrate compulsory education while private sectors and other market forces were allowed to offer formal basic education (Wen et al., 2017; Xu et al., 2018). It is often argued that the neo-liberalistic education reform has brought a range of benefits to the society such as decreasing the local government's financial load in offering basic education, providing more possibilities for school-aged children, and improving the hard and soft powers of the school (Wen et al., 2017).

However, in reality, school-aged children are often not given an equal quality of education. This is because their enrollment in nearby public school is based on their local *hukou* and the housing property (Xu et al., 2018). As Wen et al. (2017) argued, housing ownership is deterministic to the access to a high-quality primary school. If students own a local *hukou* and their parents own housing property in one school district, they are given the priority to enroll in that high-quality school. Therefore, parents often attempt to buy houses in high-quality school districts. This, however, has created the possibility for parents' rent-seeking behaviors. For instance, the value of basic educational resources is often reflected in the surrounding housing prices and the districts with high-quality schools often have high housing prices. The result is that high-income households can easily afford the housing price whereas low-income families and their children are largely ruled out from the school district-housing market (Li, 2021). Negatively, this aggravates the residential segregation by income and intensifies socio-economic inequalities such as school travel distance/time (Yang et al., 2012; Xu et al., 2018; Fast, 2020).

In terms of the impacts of school districts on travel behavior, studies mainly investigated how school districts influence a student's school travel behavior. For instance, as parents worried much about convenience, security, and the comfort of children's school travel, they would prefer to buy school district housing for shortening the student's school travel (Li, 2021). In another study, Ewing and Cervero (2010) found that the quality of schools such as sizes would affect student travel mode choices.

However, how a school district affects the parental commuting behavior is understudied. As aforementioned, individual-level socio-economic indicators such as differences in gender, education, occupation and income influence parents' capabilities of competing for school district housing, consequently influencing their commuting behavior. With regard to gender, Ta et al. (2019) investigated the travel behavior of females in Beijing and found that, given that women have more household responsibility, they often experience shorter commuting distance. In addition, with the improvement of schooling, commuters can bear longer commuting distance and time. This is because a higher education leads to high-paying jobs, which can compensate the commuting costs (Giménez-Nadal et al., 2022). This influence was observed among commuters with different occupations. For instance, Sermons and Koppelman (2001) found that white-collar commuters in the San Francisco Bay Metropolitan Area had longer commuting time compared with blue-collar commuters, which results from the fact that white-collar commuters would like to escape from the noise downtown, and thus select the farther place of residence. Starting from this, a *hypothesis* is made that school districts influence parental commuting behavior since levels of school districts would have different capitalized residential land values, which influences households' capability to pay the price premiums and their willingness and ability to live near high-quality school district housing. In other words, parents (male and female) with differed educations, occupations, and incomes show different bid capabilities for high-quality school districts and sustain different opportunity costs, thereby having differed commuting behaviors. To test our hypothesis, this article takes Xiamen as the study area, and explores this association.

Methodology

### Study area and data source

Xiamen is a city located in the Fujian Province, Southeast China, covering an area of $1,700 \text{ km}^2$ with a population of 5.2 million in 2021. It is one of the most densely populated cities in China. The city has six districts, including Siming, Huli, Haicang, Xiang'an, Jimei, and Tong'an. The municipality was specifically listed in the state economic plan and is directly supervised by the State Council, People's Republic of China. In the past four decades, Xiamen has experienced an intensive urbanization process, leading to a huge change in urban forms and built environments. In terms of the travel behavior, the average commuting distance and time in 2020[1] have reached 22.8 km and 56.75 min, correspondingly.

To examine the relationship between school districts and parental commuting behavior, the socio-economic and travel data were collected from the 2015 Xiamen household travel survey. The dataset consists of socioeconomic data (i.e., age, gender, occupation, car ownership, education level, housing attribute, etc.) and travel behavior data (i.e., origin, destination, trip mode, trip purpose, travel time, etc.). Accounting for 3 % of Xiamen's population, the total number of trips was 219,552 and the commuting data were 49,531. According to the purpose of this research, we further screened the original data. Specifically, for each household, we only retained the household with at least one primary school student and conducted a regression analysis on the commuting distance of these respondents. After filtering the data, a total of 5,419 commuting data were reserved.

Variables and methods

The dependent variable of this study is the logarithm of the commuting distance. Note that the household travel survey did not include the travel distance data but provided departure traffic analysis zones (TAZs) and arrival TAZs. Thereby, we calculated approximate values of parental commuting distance. First, the

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FIGURE 1
The distribution of hot and provincial demonstration schools in Xiamen.
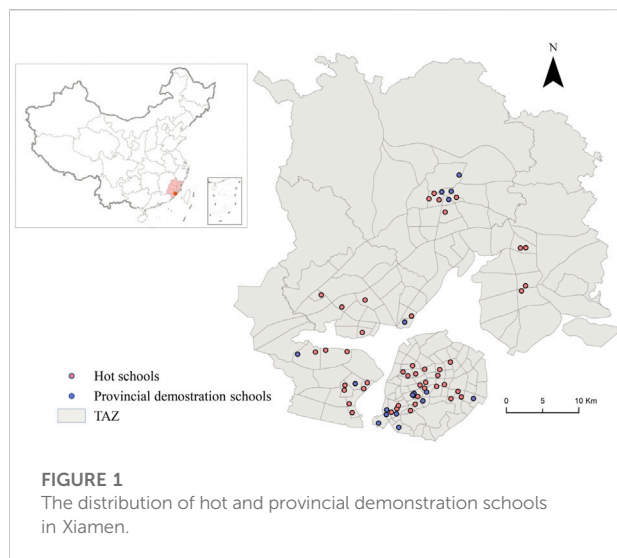
centroid of each TAZ was calculated via using ArcGIS. Then, ArcGIS's Origin–Destination (OD) cost matrix analysis was applied to acquire the commuting distance, spanning from 0.855 to 49.953 km. When the departure TAZ are the same with the arrival TAZ, the OD distance is 0. However, this would be impossible for the OD distance to be assigned a zero value. Thereby, we calculated the average speed of each commuting mode, multiplied by the travel time (provided by the household survey data), to assign a new value to the OD distance (see Supplementary Appendix SA for calculation details).

Furthermore, the school district data were collected from the Website of Bendibao[2]. Two types of high-quality primary schools are included in this study, including hot schools and provincial demonstration schools. Here, a hot school indicates the school that has a high reputation in the quality of education among the local citizens, but the number of admissions of these schools is limited. In other words, there exists a supply–demand mismatch, an imbalance between supply and demand for the number of schools in the market. They often receive high attention and were once treated as model primary schools but now they are called "hot schools". Differed from provincial demonstration schools that are officially confirmed as superior-quality schools, hot schools are often officially announced to the public but are not finally classified as any level of schools. Note that the year of the socio-economic and commuting behavior data was 2015, whereas the school district data consist of all high-quality schools in 2021. Thus, we excluded those schools that were not model schools (schools whose teaching quality was leading) before 2016 and finally obtained 45 hot schools (schools widely sought after by parents and students) and 18 provincial

2   http://xm.bendibao.com/edu/202132/65119.shtm

demonstration schools (schools recognized and supported by the provincial government). The distribution of these schools is illustrated in Figure 1. If the district in which one respondent resides has a provincial demonstration school, we assigned this relevant category to him/her. We did the same for the hot schools. Other districts without high-quality schools were assigned the category "ordinary schools".

Furthermore, we divided the education level into two major groups: higher-education groups and lower-education groups, which werebased on whether they received college degrees. The reason for this classification is that we would like to examine how people with different levels of education select their school districts and how the selection would influence their commuting behavior. Then, the workers were classified as blue-collar workers, pink-collar workers, and white-collar workers, comprised 16 %, 31 %, and 53 % of the total sample population, respectively. Gender differences in the parental commuting behavior between these categories were paid special attention.

Descriptive statistics

Table 1 shows the descriptive statistics of the variables. Female and male respondents are at rates of 45.57 % and 54.43 %, respectively. The average travel distance of the respondents is about 6,763 m, and more than half of the respondents (53.51 %) live outside Xiamen Island. Then, white-collar workers, pink-collar workers, and blue-collar workers have rates of 55.72 %, 29.23 %, and 15.05 % and most of the respondents (76.88 %) had local *hukou*. Around 76.47 % of the respondents lived in their own houses, 22.66 % in rent houses, and only few lived in Danwei houses (0.86 %). Concerning school districts, more than half of the respondents chose to live in districts of ordinary schools (57.59 %), and the proportions of living in districts of hot schools and provincial schools were 26.79 % and 15.60 %, respectively.

Approximately 47.19 % of respondents received higher education and of them, 44.73 % were females while 55.27 % were males. It shows that people who received higher education are more likely to have local *hukou* and tend to live in neighborhoods with better access to transportation (higher bus stop and road density), higher population, and job density. Furthermore, respondents with college degrees have longer commuting distance (7,136 m) compared to those respondents without college degrees (6,628 m). Note that 64.33 % of respondents with college degrees live outside the island of Xiamen, which is higher than those without college degrees (44 %). Half of the respondents' own cars and people with college degrees have higher rates of car ownership. In terms of school districts, about half of the respondents with college degrees lived in districts with hot schools and provincial demonstration schools (48.62 %), which is higher than that of

TABLE 1 Descriptive statistics.

Variable	All sample		Without college degrees		With college degrees	
	Mean/percentage	Std. Dev	Mean/percentage	Std. Dev	Mean/percentage	Std. Dev
Travel Distance	6762.91	6915.67	6030.75	6628.70	7584.83	7136.60
Bus stop density (unit: per sq. km)	6.02	4.61	5.09	4.01	7.06	4.99
Road density (unit: per sq. km)	12.87	6.89	11.55	6.52	14.35	7.01
Population density (unit: 10,000 per sq. km)	1.13	0.79	1.05	0.80	1.22	0.77
Job density (unit: 10,000 per sq. km)	0.57	0.41	0.51	0.39	0.64	0.41
Xiamen Island						
yes	46.49%	0.50	56.15%	0.50	35.67%	0.48
no	53.51%	0.50	43.85%	0.50	64.33%	0.48
Age	37.28	5.54	37.28	6.23	37.28	4.65
Education level						
without college degrees	52.82%	0.50				
with college degrees	45.35%	0.50				
Mater or more	1.84%	0.13				
Profession						
White	55.72%	0.50	35.37%	0.48	78.49%	0.41
Pink	29.23%	0.45	39.47%	0.49	17.78%	0.38
Blue	15.05%	0.36	25.16%	0.43	3.73%	0.19
Hukou						
Locals	76.88%	0.42	65.67%	0.47	89.42%	0.31
Migrants	23.12%	0.42	34.33%	0.47	10.58%	0.31
Home ownership						
Danwei housing	0.86%	0.09	0.73%	0.09	1.01%	0.10
Owner-occupied housing	76.47%	0.42	66.68%	0.47	87.44%	0.33
Rental housing	22.66%	0.42	32.59%	0.47	11.55%	0.32
Car ownership	0.50	0.50	0.45	0.50	0.56	0.50
Household size	3.67	1.07	3.72	1.12	3.62	1.00
School district						
Ordinary	57.59%	0.49	63.13%	0.48	51.38%	0.50
Hot	26.79%	0.44	23.87%	0.43	30.07%	0.46
Provincial	15.60%	0.36	12.96%	0.34	18.55%	0.39
Gender						
Female	45.57%	0.50	46.32%	0.50	44.73%	0.50
Male	54.43%	0.50	53.68%	0.50	55.27%	0.50

the full sample. Among those without college degrees, this proportion was only 36.83 %. This reveals that respondents with college degrees tend to occupy more high-quality schools.

Results

To explore the relationship between a school district and commuting time, we performed an ordinary least squares (OLS) regression analysis (Table 2). The dependent variable is the logarithm of the commuting distance. Model 1 presents a simple model without any interaction effect, whereas Model

2 considers the interaction effects between gender and school districts. Here, the interaction effect indicates the mutual effects of two or more variables on the process outcome. It occurs when the effect of one independent variable relies on another independent variable.

In terms of the built environment, population density has a positive association with the commuting distance. According to Litman (2017), higher urban densities are often related to longer commuting time and greater traffic congestion, which was reconfirmed in this article. Then, the job density is negatively associated with the commuting distance, indicating that the more jobs around the residence, the shorter the commuting distance. This

TABLE 2 Regression of the natural logarithm of commuting distance.

|	Model 1		Model 2	
Variables	Coef	Std. Dev	coef	Std. Dev
Bus stop density	−0.002	0.004	−0.002	0.004
Road density	−0.001	0.003	−00.000	0.003
Population density	0.059*	0.034	0.059*	0.034
Job density	−0.237***	0.075	−0.239***	0.075
Xiamen Island	0.100***	0.038	0.101***	0.038
Age	−0.006**	0.003	−0.006**	0.003
Education level (ref: without college)				
college	0.231***	0.032	0.231***	0.032
Master or more	0.256**	0.104	0.252**	0.105
Profession (ref: White)				
Pink	−0.080**	0.033	−0.078**	0.033
Blue	0.076*	0.042	0.079*	0.042
Hukou (ref: migrants)	0.045	0.047	0.046	0.047
Locals				
Home ownership	—	—	—	—
Danwei housing	0.206	0.170	0.206	0.169
Owner-occupied housing	0.165***	0.048	0.166***	0.048
Car ownership	0.273***	0.031	0.273***	0.031
Household size	0.014	0.013	0.014	0.013
School district (ref: Ordinary)				
Hot	−0.013	0.032	−0.025	0.047
Provincial	0.005	0.040	−0.073	0.056
Gender	0.296***	0.030	0.267***	0.037
Male				
School district*Gender	—	—	—	—
Hot*Male	—	—	0.022	0.063
Provincial*Male	—	—	0.148**	0.075
Constant	7.994***	0.117	8.008***	0.117
Observations	5,419	—	5,419	—
R-squared	0.089	—	0.090	—

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

is understandable that residents would prefer to find jobs nearby (Li et al., 2021). Whether people live on Xiamen Island also affects the commuting distance. As the results show, respondents who live on Xiamen Island experienced a longer commuting distance. One explanation is that in the past decade, a range of manufacturing industries were relocated outside the Xiamen Island, and people who once lived on the Xiamen Island would face longer commuting distance after the relocation. Age is negatively associated with commuting distance. This is understandable that older people would occupy more resources, thus they are more likely to have a chance to live near school districts.

Socio-economic factors as covariates also influence parental commuting distance. The level of education is positively associated with commuting distance, indicating that

respondents with college degrees have longer commuting distances (Cassel et al., 2013). The reason may be that some highly skilled and specialized jobs are concentrated in some areas of the city like the central business district (CBD) (Li et al., 2019), while low-income workspaces are more widely distributed, such as convenience stores (Manaugh et al., 2010). Consequently, people tend to be closer to low-paying jobs but far from high-paying skilled jobs (Manaugh et al., 2010). The significant association between the commuting distance and profession also confirms this finding. Given that the wage of a blue-collar work is relatively lower than that of a white-collar work, they have to choose housing with longer commute distance. The pink-collar profession is negatively associated with commuting distance. Another interesting finding is that differing from previous findings (Li et al., 2021), when only families with school-aged children are considered, blue-collar workers travel longer than white-collar workers. One possible reason is that blue-collar workers live in dormitories of their workplaces before they get married. Once they get married and have children of their own, they may relocate to school districts areas for better access to schooling. *Hukou* had no significant effect on travel distance. Compared to those who rent, those who own homes have a longer commuting distance, so as those who have a car (Plaut, 2006; Islam and Saphores, 2022).

Model 2 presents the result with interaction effects between gender and school districts. The positive and negative effects of the control variables, such as built environment and socio-economic attributes on the commuting distance are similar to those in Model 1. In terms of the focus variables, when the gender difference was not considered, the quality of school districts had no effect on the residents' travel distance. After considering the interaction effects between gender and school districts in Model 2, school districts have a significant impact on the commuting distance. As can be seen from Figure 2A, a male's commuting distance is generally longer than that of a female, especially one who lived in districts of provincial demonstration schools. The possible reason for this result is that in order to facilitate women to take care of children, husbands tend to choose to live closer to their wives' work places, resulting in a longer commuting distance for men. Another explanation is that in China, women are often responsible for picking up their children (Zhang (2022); consequently, females would choose to find a job closer to the school district. Table 3 further shows the gender differences in picking up children at different quality schools. With the increase of the level of school quality, the proportion of women picking up is on the rise, while men show the opposite trend. This implies that the higher the quality of the school districts, the higher their wives drop off their children.

Models 3 and Model 4 show the regression results of respondents without college degrees, and Model 4 presents the interaction effects between gender and school districts. Model 5 and Model 6 show the regression results of the respondents with college degrees, and Model 6 considers the interaction
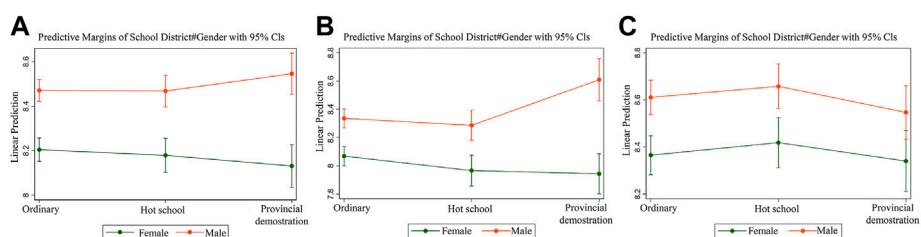
FIGURE 2
(A) Gender difference in the commuting distance of all respondents, **(B)** Gender difference in the commuting distance of respondents without college degrees; **(C)** Gender difference in the commuting distance of respondents with college degrees.

TABLE 3 Gender differences in the percentage of kid drop-offs.

	Female (%)	Male (%)
Ordinary	59.5	40.5
Hot	63.7	36.3
Provincial demonstration	71.0	29.0

effects (Table 4). The results indicate that school districts have a significant impact on respondents without college degrees, especially for the male respondents in this group. For instance, Figure 2B compares the gender difference in the commuting distance. It reveals that in the districts of the provincial demonstration schools, male respondents without college degrees had a much longer commuting distance than those of female respondents. This means that males without college degrees are more likely to sacrifice their commuting time to shorten their wives' commuting distance. Table 5 further shows the gender differences in kid drop-offs by educational level and school quality. Among the groups with college degrees, male and female have a similar rate of kid drop-offs. However, among the groups without college degrees, the proportion of females in kid drop-offs is significantly higher than that of males. This can be explained that the improved education level increases the females' income, which consequently decreases the time they spent on family like kid drop-offs whereas it increases the proportion of males in kid drop-offs.

Except for the influence of school districts, the built environment and socio-economic factors also have a mediating impact on the commuting distance of the respondents. For instance, population and job location density, whether living on Xiamen Island, age, occupation type, housing ownership, and car ownership all affect the commuting distance of respondents without college degrees. This mediating influence is similar to the findings in Table 2. For the group of respondents with college degrees, only car ownership, family size and gender affect their commuting distance, whereas other factors show no significant

association. The findings indicate that respondents without college degrees face more restrictions on their commuting behavior besides the school district effect.

Discussions

This research contributes to the existing studies with a focus on the relationship between school districts and parental commuting behavior. Special attention is paid to the gender differences in the impact of the school district on parental commuting behavior. This study is one of the first to investigate the relationship between school districts and parental commuting behaviors in the Chinese context.

First, we provide evidence that school districts have an influence on commuting behavior, but the influence is significant only after considering the interaction effect between gender and commuting distance. We find that school districts are positively associated with commuting distances for men, while showing the opposite trend in the female group. Although the study shows no association between the school district and the commuting distance of the total sample, it verifies that school districts would be vital in influencing the travel behavior between males and females in high-density cities in developing countries. The result confirms the finding by some studies that the male is often subjected to longer commuting distance/time (Kersting et al., 2021), and this feature is more obvious in the Chinese context. As Wen et al. (2017) highlight, males in China would often choose to reside near schools to reduce the school travel of their children, whereas females are often responsible for picking up kids and tend to work more within their communities. The potential influence is that male commuting distance significantly increases but females' commuting distance would be much shorter compared to their male counterparts.

Based on this finding, we highlighted that there is a need to consider how the profits, expenses, and burdens related to commuting are distributed across the population (e.g., females and males) and to identify methods, plans, and policies that can

TABLE 4 Regression of the natural logarithm of the commuting distance for respondents without/with college degrees.

	Without college degrees				With college degrees			
	Model 3		Model 4		Model 5		Model 6	
Variables	coef	Se	coef	se	coef	se	coef	se
Bus stop density	−0.005	0.006	−0.006	0.006	0.001	0.004	0.001	0.004
Road density	0.003	0.004	0.003	0.004	−0.003	0.003	−0.003	0.003
Population density	0.097*	0.053	0.098*	0.053	0.015	0.044	0.015	0.044
Job density	−0.429***	0.113	−0.429***	0.112	−0.073	0.097	−0.073	0.098
Xiamen Island	0.228***	0.054	0.226***	0.054	−0.027	0.052	−0.027	0.052
Age	−0.009***	0.003	−0.009***	0.003	0.002	0.004	0.002	0.004
Profession (ref: White)								
Pink	−0.103**	0.044	−0.093**	0.044	−0.041	0.050	−0.041	0.050
Blue	0.087*	0.050	0.096*	0.050	0.013	0.091	0.012	0.092
Hukou ref: migrants								
Locals	0.097	0.065	0.100	0.064	−0.073	0.069	−0.073	0.069
Home ownership								
Danwei housing	0.389*	0.235	0.386*	0.228	0.002	0.238	0.003	0.238
Owner-occupied housing	0.169**	0.066	0.174***	0.065	0.108	0.071	0.108	0.071
Car ownership	0.290***	0.044	0.288***	0.044	0.262***	0.042	0.261***	0.043
Household size	−0.008	0.017	−0.010	0.017	0.049**	0.021	0.049**	0.021
School district (ref: Ordinary)								
Hot	−0.073	0.046	−0.103	0.065	0.050	0.046	0.053	0.068
Provincial	0.079	0.060	−0.125	0.080	−0.046	0.053	−0.025	0.078
Gender								
Male	0.329***	0.041	0.267***	0.050	0.236***	0.043	0.245***	0.057
School district*Gender								
Hot*Male	—	—	0.054	0.089	—	—	−0.006	0.089
Provincial*Male	—	—	0.399***	0.111	—	—	−0.039	0.101
Constant	8.130***	0.146	8.159***	0.146	8.033***	0.191	8.028***	0.192
Observations	2,866	—	2,866	—	2,553	—	2,553	—
R-squared	0.094	—	0.098	—	0.055	—	0.055	—

Note: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

TABLE 5 Gender differences in the percentage of picking up children.

	Without college degree		With college degree	
	Female (%)	Male (%)	Female (%)	Male (%)
Ordinary	51.31	48.69	46.15	53.85
Hot	58.29	41.71	55.06	44.94
Provincial_demonstration	63.06	36.94	52.50	47.50

decrease gender commuting gap differences. For instance, constructing more cost-effective and economical transport facilities such as subways and para-transit services would help improve parents' accessibility to jobs and reduce their commuting distance or time. In fact, a recent survey showed that in 2021 there were about 99.4 billion urban public transport passengers in China, and of them, around half used buses or trolleybuses, and around 23.7 billion passengers used the metro (Statista Research Department, 2022). Our study finds that males, especially those blue-collar males, suffered more cost or sustained

longer commuting time. Thus, promoting the suggestions listed previously could not only enable them to approach more job opportunities, but could also allow them to have higher work duration, subsequently improving their socio-economic condition and position.

Second, the heterogeneous influence of school districts on parental commuting behavior is also evidenced in the groups of respondents with different levels of education. More specifically, we find that the school district is positively associated with the commuting distance of residents without college degrees, especially for the male group. No significant association was found among individuals with college degrees. The finding implies that male respondents, especially those without college degrees, would sustain longer commuting distances. This is according to the finding by Li (2021) that long commutes are the share of both those who are socially advantaged and disadvantaged. The heterogeneity in the influence of school districts on parental commuting behavior with different levels of education actually reflects the long-standing inequality issue concerning affordability of school district housing and accessibility of public services in developing countries like China. As aforementioned, affordable school district housing in China is important for accessing high-quality primary schools and is vital in influencing parental travel behavior and health. Thus, policy makers should rethink existing resource allocation strategies and focus on the most effective distribution of public service resources across city districts.

At present, efforts to tackle high-quality primary school housing are related to random allocation or reorganization of high-quality schools spatially. However, less attention has been paid to target on offering more high-quality primary schools. In particular, there is an extreme lack of government actions on supplying high-quality primary schools to those low- and medium-income households. Therefore, this study recommends refining the public service policy by promoting social fairness concerning the supply and demand for high-quality primary schools. This can be promoted through a balanced spatial allocation of high-quality primary schools. For instance, accessible high-quality primary schools to low- and medium-income households could be included mandatorily in the school district plan. Such measures would allow parents to pay less time on commute and would significantly free up time for other activities such as active travel.

We also acknowledge the limitations. First, the measurement of commuting distance was based on TAZ calculations, thus, values may truly reflect the real commuting behaviors of parents. Further studies could use accelerometers and global positioning system (GPS)-based tracking devices to collect more accurate travel behavior data. Second, we did not consider the commuters' subjective attitude toward the association between school districts and commuting behaviors, thus the relationship could be overestimated or underestimated. Third, this cross-sectional study indicated a correlation between variables, which precluded inferred causality.

Conclusion

The distribution of school districts would largely influence parental commuting distance, but this association is hardly examined. This negligence stimulates this study which examines the associations between a school district and parental commuting behavior. The results show that the school district mainly affects the residents' commuting distance when the interaction effects between gender and commuting distance are considered. Specifically, a school district is positively associated with the commuting distances for males, whereas females show the opposite trend. Then, variations exist in the effects of the school district on the parental commuting distance between respondents with different levels of education. A school district is positively associated with the commuting distance of respondents without college degrees, especially those male respondents, whereas no significant association was found among respondents with college degrees. Compared with females, male respondents, especially those without college degrees, suffer more cost and sustain longer commuting distance. From this, this study highlights that urban planners and policy makers should consider the school district influences and rethink the most effective distribution of high-quality primary schools to reduce socio-spatial inequalities (e.g., disadvantage of males in commute).

Data availability statement

The data analyzed in this study are subject to the following licenses/restrictions: the authors will use the data for another research which is being conducted at this moment. Requests to access these datasets should be directed to huaxiong_jiang@163.com.

Author contributions

HJ: Conceptualization, Supervision, Original draft, and editing; QL: Conceptualization and Writing—review and editing; YL: Conceptualization, Methodology, Supervision, and Writing—review and editing; KG: Results analysis and Writing—review and editing YG: Writing—review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fenvs.2022.1019753/full#supplementary-material

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