



## Article

# The Contribution of Socio-Demographic Factors to Walking Behavior Considering Destination Types; Case Study: Temuco, Chile

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**Abstract:** The improvement of walking contributes to maintain the minimum rate of physical activity and therefore the residents' public health. This is while the amount of walking in daily transport of inhabitants has significantly decreased during the last decades in Temuco, Chile. In addition, the impact of socio-demographic as well as social factors on the improvement of walking behavior has been paid less attention in previous studies. This study aims to examine the contribution of socio-demographic factors and the active family environment to walking behavior as well as walking level based on three types of destinations in Temuco. The results of "Encuesta Origin Destino" (EOD) in Temuco were used to examine the objectives. It was found that a high percentage of people who walk in Temuco belong to low-income families. Moreover, most of the people who walk, do not have a driver's license nor private cars in their household. Certain socio-demographic factors such as age, gender, driver's license, private cars, and access to TV were found to have associations with overall walking behavior as well as walking level depending on three different destination types. Furthermore, the correlation was found between walking behavior and active family environment. These findings were discussed and their implications were addressed as well.

**Keywords:** walking behavior; socio-demographic factors; active family environment; destination type



**Citation:** Paydar, Mohammad, and Asal Kamani Fard. 2021. The Contribution of Socio-Demographic Factors to Walking Behavior Considering Destination Types; Case Study: Temuco, Chile. *Social Sciences* 10: 479. <https://doi.org/10.3390/socsci10120479>

Academic Editor: Carlos Teixeira

Received: 14 September 2021

Accepted: 9 December 2021

Published: 15 December 2021

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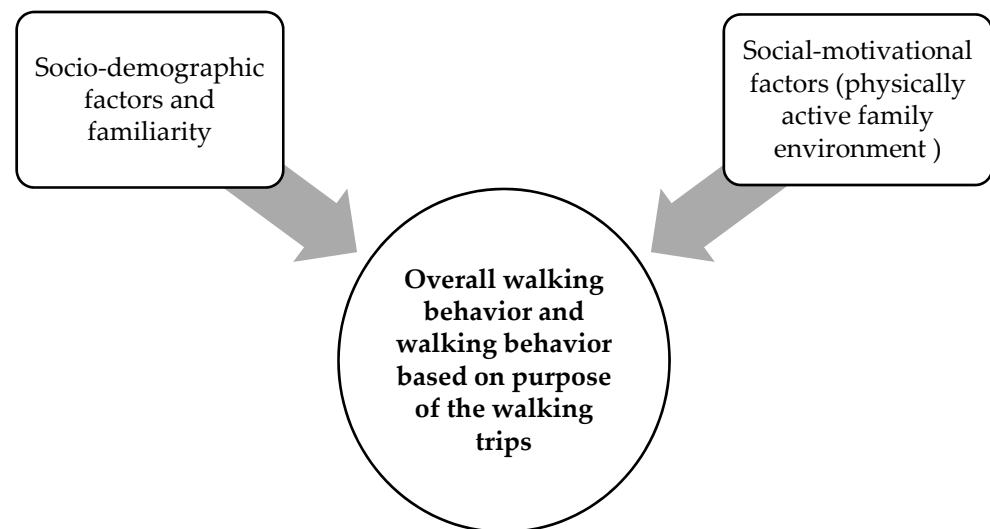
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## 1. Introduction

Non-motorized means of travel including walking and cycling are the most sustainable modes of transport due to their accessibility, lower pollution, and lower costs (Xiao et al. 2020; Harms et al. 2014). Furthermore, improvement of walking contributes to maintain the minimum rate of physical activity and therefore improves the residents' public health (Paydar et al. 2020a). The need to improve active travel and especially walking—as a daily travel mode—was also emphasized in the recent COVID-19 pandemic while using of public transport has caused several challenges for the residents' health. Walking has still remained the main mode of transport to date among low-income groups in Chile (Herrmann-Lunecke et al. 2020). However, the percentage of walking in daily transport of the residents in Temuco, Chile, has strongly decreased during last decades (Actualización Plan De Transporte Temuco Y Desarrollo De Anteproyecto, ETAPA II 2017). For instance, the number of trips by private cars has increased 7% from 2003 to 2013 versus a 5% decrease in walking trips during this time in this city (Actualización Plan De Transporte Temuco Y Desarrollo De Anteproyecto, ETAPA II 2017). Therefore, walking behavior needs to be significantly improved in this southern medium-sized city of Chile.

According to ecological models, a person's walking behavior is influenced by a complex relationship between environmental (physical/social) and individual characteristics (Krogstad et al. 2015; Rind et al. 2015; Van Cauwenberg et al. 2014). In this regard, previous studies have demonstrated the impact of several personal as well as socio-demographic,

social, and built environment factors in improvement of walking behavior (Copperman and Bhat 2007; Inoue et al. 2010; Mesters et al. 2014; Paydar and Kamani Fard 2016; Paydar et al. 2017; Paydar and Kamani Fard 2021b; Van Cauwenberg et al. 2012; Yun 2019). However, the previous studies on walking behavior mostly focused on the contribution of built environment to walking behavior, whereas the role of socio-demographic as well as social factors in improvement of walking behavior has been less studied. In this regard, this study aims to investigate on the most relevant socio-demographic factors to walking behavior in Temuco in order to improve the walking behavior in this city. Understanding the relationships between socio-demographic factors and the level of walking behavior would help city/transport policy makers to find appropriate policies in congruent with such relationships in order to enhance the walking. Thus, the sustainable urban transport in each context would improve. This study also examines the relationship between walking behavior and physically active family environment as a recognized relevant social factor to walking by the previous studies (Booth et al. 2005; Troped et al. 2017). The conceptual framework of this study is shown in the Figure 1.



**Figure 1.** The Research Framework.

Furthermore, some of the previous studies on walking behavior have examined the relationship between walking behavior and its contributing factors based on specific goals of walking trips whether walking to/from work, walking to reach educational destinations, and other destinations as well (Craig et al. 2002; Plaut 2005; Sun et al. 2014, 2015). These studies suggest that the influence of different contributing factors to walking behavior may vary based on the purpose of the walking trips. Although these studies have shown the importance of the purpose of walking trips in regard to the contribution of different factors to walking behavior, this consideration has been done separately due to each type of destination. The current study also investigates the contribution of the selected factors to walking behavior based on different purposes of the walking trips simultaneously (Figure 1). This can be taken into account as one of the novelties of this study. The research questions of this study are as following:

- (1) What socio-demographic factors contribute to walking behavior in this city?
- (2) Does a physically active family environment contribute to walking behavior in Temuco?
- (3) How does the purpose of the walking trips influence the association between walking behavior and socio-demographic factors as well as physically active family environment?

## 2. Literature Review

In regard to socio-demographic factors, gender and age are found to be related to walking behavior (Mendes de Leon et al. 2009; Mesters et al. 2014). For instance, the level

of walking is usually decreased for older people (Mesters et al. 2014). Education level is also correlated with the walking behavior (Menai et al. 2015; Mesters et al. 2014; Mendes de Leon et al. 2009). For instance, men with higher education level walk more (Mesters et al. 2014). Having a driver's license is also associated with walking behavior (Copperman and Bhat 2007). Other studies found the relationships between walking and job, income, marital status, number of vehicles, number of adults, and body mass index (BMI) as well (Bicalho et al. 2018; Menai et al. 2015; Ory et al. 2016; Paydar et al. 2020b). Previous studies on walking behavior also demonstrated the relationships between the familiarity with walking environment and walking behavior (Van Cauwenberg et al. 2012).

Social environment refers to the influence that friends and family could have on an individual's walking (Clark and Scott 2013). Most of the social factors related to walking first emerged in the physical activity literature and then were adapted to walking (Mesters et al. 2014). Previous research has consistently found that a supportive social environment increases physical activity and walking (Cleland et al. 2010; Stathi et al. 2012; Paydar and Kamani Fard 2021a, 2021c). Van Cauwenberg et al. (2014) found that walking for transportation positively correlates with interpersonal relationships, place attachments, frequency of contacts with neighbors, and social support. Among the social factors related to walking, a role model has been identified as a motivational factor for walking and physical activity (Harley et al. 2009; Mesters et al. 2014). Role models, in regard to walking, are people who walk and whose participation encourages others to become involved. The support of family and friends and having a partner or friends who are physically active is significantly associated with physical activity and walking (Darlow and Xu 2011; Harley et al. 2009). Among the indicators of role model, physically active family environment has a remarkable role in the encouragement of people to do more physical activity and walking (Booth et al. 2005). However, some studies did not find the positive influence of this factor on walking and overall physical activity (Mesters et al. 2014).

Furthermore, some of the previous studies on walking behavior focused on walking behavior based on a special purpose of walking trips especially walking to work and university. For instance, Craig et al. (2002) examined the relationship between walking to work and neighborhood design characteristics. Plaut (2005) examined the association between non-motorized commuting, including walking and cycling to work, and socio-demographic factors. Other studies have examined the relationships between walking behavior of university students and its contributing personal and built environmental factors (Lemieux and Godin 2009; Sun et al. 2014, 2015).

Finally, with respect to socio-demographic patterns of physical activity and sedentary behavior in Chile, 19.8% of the Chilean population do not meet the minimum level of physical activity recommendations (150 min of physical activity per week) (Ministerio de Salud de Chile 2018; Celis-Morales et al. 2015). In addition, the prevalence of physical inactivity was higher in participants aged more than 65 years compared with the youngest age groups, and it was higher in women than in men (Celis-Morales et al. 2015). However, it was lower for participants with high—compared with low—education or income levels.

### 3. Materials and Methods

The information of Travel diary data taken from the Encuesta Origen Destino (EOD) Hogar y Viajes studies by the ministry of transport of Chile in 2013 was used to measure walking behavior and the relevant socio-demographic factors in the city of Temuco. Travel diary survey was applied by the previous studies to measure walking behavior and its relevant socio-demographic factors as well (Bagley and Mokhtarian 2002; Olsen et al. 2017). EOD is a general-purpose survey that covers a wide range of issues including transport and travel. The primary sampling unit was the household, which were selected randomly from all of the transport zones of Temuco; while the secondary sampling unit was a randomly selected individual member of the household, who acted as the respondent and completed two questionnaires regarding the information of the households (EOD Hogar) and their recent daily trips (EOD Viajes). Participants have completed a travel diary detailing all

journeys undertaken in the day of travel registration. Each diary was divided into individual journey stages which describe each phase of a journey (e.g., one journey may include three stages: walk to bus stop, travel on bus, and walk to destination). For each journey stage, data collection included the origin, destination, purpose (assigned to all stages that comprised a given journey), distance, and the mode of the travel. Walking behavior could be measured for each participant if walking is included in his/her travel diary since walking was an attribute assigned to each journey stage. "EOD Hogar y Viajes" also provided the required information for socio-demographic variables such as household size, workers per household, adults per household (household or individual), number of vehicles, having a driver's license, gender, employment status, and age. Continuous variables such as income have been transformed into the categorical variables as well. For instance, declared monthly income has been transformed into categorical variable based on the socioeconomic categorization in Chile. In addition, duration of living in the current residence has been used as the indicator of familiarity as people with more duration of living normally have more familiarity with the surrounding environments of their living places.

Using the EOD 2013, a sample of 1721 people who walk in their daily travel were selected in Temuco. Previous studies have demonstrated that the contribution of different factors to walking behavior differs based on the two types of walking that includes walking to reach a destination and walking for recreation (Kang et al. 2017; Perchoux et al. 2019). Accordingly, due to the challenge of aggregating the data of these two types of walking and few number of walking trips for recreation (85 people with recreational walking trips), the recreational walking trips were eliminated from further consideration. Therefore, 1636 people were finally selected as those who walk to reach different types of destinations in this city.

Role model and its selected indicator as physically active family environment was measured objectively through the "proportion of walking trips to total trips in each household". This measurement shows the level of being active in each household since walking is a type of physical activity that could encourage in the members of each household to walk more. SPSS software version 23.0 was used to analyze the data (Carrapatoso et al. 2017; Zandieh et al. 2017). Finally, to predict a dependent variable from the independent variables, multiple regression analysis was applied. Several models have been made to reach the best-fitting models in terms of explanatory power of the models and the multi-collinearity of the variables ( $VIF < 5$ ).

## 4. Results

### 4.1. Descriptive Statistics

The descriptive statistics of the socio-demographic variables and familiarity are shown in Table 1. Female residents (56.3%) walk more than male residents (43.6%) in this city. In addition, most of the respondents do not work or they are retired (63.7%). This could be explained by the sampling of EOD survey that had collected data from all of the household members, and normally one person is financially responsible for the family. The highest percentage in regard to the age belongs to the respondents between 19 and 29 years old (17.8%). From those respondents who have income, most of them belong to a low-income group, since 57.5% of the respondents who have income do receive less than three hundred thousand Chilean pesos monthly. Majority of the respondents live in houses (89.7%) as compared to those who live in apartments (8.8%), and most of them are owners of their houses and apartments (70.7%). In addition, majority of the respondents have neither a driver's license (83.5%) nor private cars (66.9%). Furthermore, majority of the respondents are those who have their primary and high school degrees (91.7%). Finally, the average number of family members is 4.12 persons in each household, and majority of the respondents have high familiarity with walking environment as most of them have the duration of living more than 20 years in their homes (35.4%). Regarding the purpose of the walking trips, the highest percentages of walking trips belong to walking to reach the educational destinations, walking to/from work, and walking for shopping, respectively

(Table 1). Accordingly, these three types of walking are selected to examine the contribution of socio-demographic and social factors to walking behavior based on the purpose of the walking trips.

**Table 1.** Descriptive statistics of socio-demographic variables and familiarity (N = 1636).

Variables	Description of Variable	Frequency	Percentage	Mean
Age (years old)				41.02
Gender	Male	714	43.6	
	Female	922	56.3	
Monthly income (Chilean Peso)	(Low) Less than 300 mil	483	57.5	
	(Medium) 300–1200 mil	318	37.9	
	(Upper-Medium and Higher) 1200–1700 and More	39	4.6	
Home Property	Owner	1234	75.4	
	Rent	386	23.6	
Education	Low (Primary school and Lower)	663	40.5	
	Intermediate (High School and similar degrees)	837	51.2	
	High (University degrees, bachelor and higher)	136	8.3	
Job Situación	With job (Full or part time)	562	34.3	
	Occasionally working	23	1.4	
	Retired and no job (The family members who do not work)	1042	63.7	
Access to Internet	No Internet	756	46.2	
	Having Internet	875	53.5	
Access to TV	No TV	684	41.8	
	Having TV	949	58	
Current Housing Type	Department	160	9.7	
	Villa Houses	1473	90	
Driver's license	Have	265	16.2	
	Do not have	1367	83.5	
Time Living Years (Familiarity)	Up to one year	101	6.2	
	1–5	383	23.4	
	6–10	224	13.7	
	11–20	345	21.1	
	More tan 20 years	580	35.4	
Number of Vehicles at Home	Have	541	33.1	
	Do not Have	1095	66.9	
Number of Bicycles at Home				1.07
Number of People in Household				4.12
Number of Trips for each household				11.95
<i>Walking trips based on purpose of walking</i>				
To study		509	29.6	
To Job		317	18.4	
For shopping		293	17	
See someone		190	12.7	
To health center		89	6.4	
For recreation		78	4.9	
Otra cosa		160	11	

#### 4.2. The Factors Influencing Walking Behavior (Overall Walking)

Table 2 shows the results of the multiple regression analysis considering the walking behavior and the selected independent variables of this study (Figure 1). R2 (0.087) shows that the independent variables of this study show an explicative power of almost 0.087 to predict the dependent variable (walking behavior). This rate of R2 generally shows a rather low overall contribution of the independent variables to walking behavior. However, the correlations identified among some of the independent variables with walking behavior are considerable.

**Table 2.** The results of adjusted multiple regression analysis in regard to walking behavior (N = 1636).

Variables	Standard Coefficient	t	p-Value
<i>Socio-demographic variables and Familiarity</i>			
Gender Dummy	0.103	4.102	0.000 **
Age (Continuous)	0.135	4.015	0.000 **
Monthly income ("Upper medium and higher income" is reference category)			
Dummy low income	0.024	0.675	0.500
Dummy medium income	−0.030	−0.854	0.394
Home property Dummy	−0.011	−0.382	0.702
Education (High education is reference category)			
Dummy low education	−0.084	−1.523	0.128
Dummy intermediate education	−0.056	−1.106	0.269
Job Situación ("Retired and no job" is reference category)			
Dummy with job	0.092	2.811	0.005 **
Dummy occasionally working	0.039	1.564	0.118
Access to internet (Dummy)	−0.016	−0.585	0.559
Access to TV (Dummy)	−0.042	−1.581	0.104
Dummy Housing Type	−0.046	−1.781	0.075 *
Driver's license (Dummy)	−0.057	−1.965	0.050 *
Time Living Years (Familiarity) (More than 20 years is reference category)			
Less than one year Dummy	0.015	0.504	0.614
1–5 years Dummy	0.014	0.467	0.641
6–10 years Dummy	0.015	0.531	0.596
11–20 years Dummy	0.046	1.638	0.102
Having private car at home (Dummy)	−0.043	−1.609	0.098 *
Number of Bicycles at Home (Continuous)	0.004	−0.159	0.874
Number of People in Household (Continuous)	0.122	3.623	0.000 **
Number of Trips in household (Continuous)	0.003	0.094	0.925
<i>Social variables</i>			
Proportion of walking trips to total trips in each household	0.176	6.313	0.000 **

\*  $p < 0.05$ ; \*\*  $p < 0.01$ . Dependent variable: Walking Behavior; R Square: 0.087.

Age has shown the highest significant positive correlation with walking behavior among the socio-demographic variables ( $\beta = 0.135$ ,  $p = 0.000$ ), which shows that older people significantly walk more than younger ones in this city. The results also show that men significantly walk more than women ( $\beta = 0.103$ ,  $p = 0.000$ ). The respondents who work and have a monthly income walk significantly more than those who do not work ( $\beta = 0.092$ ,  $p = 0.005$ ). People who live in apartments walk significantly more than those who live in houses ( $\beta = -0.046$ ,  $p = 0.075$ ). In addition, a higher number of people in each household contributes to improve the level of walking and vice versa ( $\beta = 0.122$ ,  $p = 0.000$ ). Furthermore, those who do not have a driver's license walk significantly more than those who have it and vice versa ( $\beta = -0.057$ ,  $p = 0.005$ ). Similarly, people with a higher number of vehicles in their household walk significantly less than others and vice versa ( $\beta = -0.043$ ,  $p = 0.098$ ). Among the social factors, "proportion of walking trips to total trips in household" showed a significant positive correlation with walking behavior ( $\beta = 0.176$ ,  $p = 0.000$ ). This association shows that higher percentage of walking trips to total trips in household contribute to increase the walking behavior.

#### 4.3. The Factors That Impact on Walking Behavior Considering Three Types of Destination

It was previously explained that three types of walking (based on the types of destinations) form the largest number of walking trips. It includes walking to reach educational destinations, walking to/from work, and walking for shopping. Table 3 shows the results of three models on the multiple regression analyses between walking behavior—separated based on these types of walking—and the selected independent variables of this study.

**Table 3.** The results of adjusted multiple regression analysis in regard to walking behavior based on the purpose of the walking trips.

	Standard Coefficient <sup>1</sup>	p-Value	Standard Coefficient <sup>2</sup>	p-Value	Standard Coefficient <sup>3</sup>	p-Value
<i>Socio-demographic variables</i>						
Gender (Dummy)	0.057	0.372	0.093	0.035 **	0.141	0.023 **
Age (Continuous)	0.119	0.116	0.143	0.057 *	0.144	0.027 **
Monthly income (“Upper medium and higher income” is reference category)						
Dummy low income	−0.073	0.326	0.092	0.054	0.067	0.528
Dummy medium income	−0.186	0.113	0.214	0.754	0.109	0.335
Home property Dummy	−0.020	0.771	−0.021	0.671	0.104	0.126
Education (High education is reference category)						
Dummy low education	−0.151	0.169	−0.199	0.472	−0.008	0.931
Dummy intermediate education	−0.159	0.129	−0.038	0.887	−0.018	0.824
Job Situación (“Retired and no job” is reference category)						
Dummy with job	0.173	0.011 **	0.032	0.478	−0.066	0.326
Dummy occasionally working	−0.044	0.463	0.036	0.434	0.033	0.599
Access to internet (Dummy)	−0.113	0.122	−0.058	0.263	0.046	0.490
Access to TV (Dummy)	−0.051	0.446	−0.011	0.819	−0.110	0.071 *
Dummy Housing Type	0.037	0.567	−0.114	0.017 **	−0.159	0.012 **
Driver’s license (Dummy)	−0.002	0.976	−0.177	0.000 **	−0.137	0.052 *
Time Living Years (Familiarity) (More than 20 years is reference category)						
Less than one year Dummy	−0.124	0.103	0.126	0.025	0.112	0.134
1–5 years Dummy	0.029	0.653	−0.021	0.722	0.083	0.236
6–10 years Dummy	−0.083	0.211	0.025	0.637	0.062	0.344
11–20 years Dummy	−0.068	0.278	0.073	0.184	0.124	0.050 **
Having private car at home (Dummy)	0.010	0.883	−0.077	0.110	0.008	0.899
Number of Bicycles at Home (Continuous)	−0.037	0.573	0.043	0.357	−0.064	0.312
Number of People in Household (Continuous)	0.112	0.179	0.078	0.146	0.141	0.124
Number of Trips in household (Continuous)	0.167	0.054 *	−0.003	0.959	0.028	0.746
<i>Social Variables</i>						
Proportion of walking trips to total trips in each household	0.295	0.000 **	0.065	0.193	0.172	0.009

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; <sup>1</sup>: Model 1: Walking for shopping; R Square: 0.154; N = 293; <sup>2</sup>: Model 2: Walking to reach educational destinations; R Square: 0.125; N = 509; <sup>3</sup>: Model 3: Walking to/from work; R Square: 0.143; N = 317.

Among these models, R2 (0.154)—referring to walking for shopping—shows an explicative power of almost 0.154 to predict the dependent variable (walking behavior), which is the highest rate among those three models. The respondents who work and have monthly income walk significantly more for shopping than those who do not work ( $\beta = 0.173$ ,  $p = 0.011$ ). In addition, “number of trips in the household” showed a significant positive correlation with walking for shopping among the socio-demographic variables.

This shows that a higher number of daily trips in the household contributes to an increase in the walking for shopping ( $\beta = 0.167, p = 0.054$ ). Finally, among the social factors, “proportion of walking trips to total trips in each household” showed a significant positive correlation with walking for shopping ( $\beta = 0.295, p = 0.000$ ). This confirms that higher percentages of walking trips from total trips in the household contribute to increase the walking for shopping.

In regard to walking to reach educational destinations ( $R^2: 0.125$ ), men significantly walk more than women ( $\beta = 0.093, p = 0.035$ ). Older people walk significantly more to reach educational destinations ( $\beta = 0.143, p = 0.057$ ). People who do not have a driver’s license walk significantly more to reach educational destinations compared to those who do have it and vice versa ( $\beta = -0.177, p = 0.000$ ). In addition, people who live in apartments walk significantly more to reach educational destinations than those who live in houses ( $\beta = -0.114, p = 0.017$ ). Finally, people with less than one year duration of living in their home walk significantly more to reach educational destinations than those with duration of more than 20 years living in their house. In other words, people with less familiarity walk more to reach the educational destination than people with more familiarity with the surrounding environment.

In regard to walking to/from work ( $R^2: 0.143$ ), men significantly walk more than women ( $\beta = 0.141, p = 0.023$ ). Older people walk significantly more to/from work ( $\beta = 0.144, p = 0.027$ ). Those who have TV in their home walk significantly less to/from work ( $\beta = -0.110, p = 0.071$ ). People who do not have a driver’s license walk significantly more to work than those who have it and vice versa ( $\beta = -0.137, p = 0.052$ ). In addition, the people who live in the apartments walk significantly more to/from work compared to those who live in houses ( $\beta = -0.159, p = 0.012$ ). Furthermore, people who have lived between 11 and 20 years in their houses, walk significantly more to work than those who have lived more than 20 years in their houses ( $\beta = 0.124, p = 0.005$ ). Finally, more “proportion of walking trips to total trips in household” contributes to walk more to/from work ( $\beta = 0.172, p = 0.009$ ).

## 5. Discussion

Descriptive analysis showed that most of the respondents who have an income belong to low-income families. This shows that a high percentage of people who walk in Temuco belong to low-income families. This is in line with the results of [Herrmann-Lunecke et al. \(2020\)](#), who found that walking is a prominent mode of transport especially for low-income groups in Chile. In addition, the overall walking increases among the people who have a job and receive monthly income as well. These results should be considered in the context of low-to-middle income families as the majority of those who walk in this city. Those who work and have monthly income are responsible for their family and they need to be more active to meet the needs of other family members; consequently, they walk more as compared to their other family members.

The average number of vehicles in the household of those who walk in Temuco is less than 1 (0.39) and the majority of people who walk do not have a driver’s license (83.5%). These results show that owning a private car has no fundamental role in the lives of people who walk in this city. In addition, the overall walking, walking to reach educational destinations and walking to/from work increases considering those who do not have a driver’s license. Similarly, the overall walking increases with a lower number of vehicles in each household. The previous studies support the finding of this study as they have found that active travel as well as walking decreases with a higher number of cars in the household and having a driver’s license ([Clark and Scott 2013](#); [Clark et al. 2014](#)). In addition, these results show an incompatibility between walking and using private cars in the daily transport of the people especially for commuting trips including walking to work as well as educational destinations. For instance, with respect to walking to reach the educational destinations, among younger ones and millennials in this city: Most of the people who walk to reach educational destinations are younger ones and millennials who



were born after 1980/1990. Both of these factors—having a driver’s license and more cars in the household—contribute to less walking of younger people and millennials in Temuco. Taking into account the correlations of both of these factors—number of private cars and having a driver’s license—with overall walking as well as commuting, the walking trips lets us infer that the people may have more tendency to use private cars than walking with respect to their commuting trips. However, the current research did not address other modes of transportation such as private cars, and this initial inference needs further investigation by the future studies.

In addition, it was found that the overall walking and two types of walking, including walking to/from work and walking to reach educational destinations, are enhanced with respect to the people who live in apartments as compared to houses. Temuco is traditionally a flat city with few apartments and the construction of these apartment buildings started in recent decades. In addition, most of the apartments in this city are located near the city center, where there is a concentration of shops, malls, and different activities. Construction of apartments at/near the city center is one of the components of a compact city, and the compact city is one of the well-known approaches of sustainable urban development (Kotulla et al. 2019). This approach also leads to an increase in the sustainable transport modes such as walking and cycling (Stevenson et al. 2016). These results show that the approach of creation of a compact city through building apartments in Temuco was successful in terms of enhancement of general walking trips as well as commuting walking trips as one of the components of sustainable urban transport. This is especially important considering that there has been much traffic in different streets of this city especially in the peak hours, and the commuting walking trips plays a key role in the pattern of urban daily movement especially during peak hours. Thus, the approach of a compact city around the center of Temuco is to be maintained and enhanced in order to improve walking and sustainable urban transport in this city.

Moreover, older people significantly walk more in Temuco. Considering the types of walking trips based on the destination types, older people also significantly walk more to/from work and educational destinations as well. Further analysis also showed that such a correlation between age and walking behavior is related to the age groups between adolescent to adults until 60 years old, and not more than this age group. This is in contrast with the results of previous studies which have found that physical activity as well as walking behavior decreases with age (Berger et al. 2005; Mesters et al. 2014; Sun et al. 2013). In addition, our analysis showed that the majority of people who walk to reach educational destinations are adolescents as well as young people (10 to 29 years old; 89%). One interpretation in regard to the influence of age on walking to educational destinations is that the adolescents especially in the earlier stage (early adolescence; 11 to 14 years old) are not able to ward off potential health risks during walking. Thus, they have less possibility of choosing walking independently from their family and consequently walk less than other adolescents as well as young people.

Furthermore, men significantly walk more as compared to women. Likewise, men significantly walk more than women to/from work and to reach the educational destinations. Previous studies support the impact of gender on walking behavior (Foster et al. 2004; Mendes de Leon et al. 2009). In addition, this result is in line with the finding of the National Health Survey (2009–2010), which found that women are more inactive as compared to men in Chile (Celis-Morales et al. 2015). In this regard, future studies may also investigate on the barriers to women’s walking in this city.

The people who have a TV in their home walk significantly less to/from work. This is an interesting result which shows the negative impact of technological equipment on physical activities and walking. Perhaps the first perceived reason is that entertaining the residents with television leads to sedentary behaviors. This is supported by previous studies which have found that watching more TV contributes to more sedentary behavior and decreases physical activities as well as walking, especially among elderly people and women (DiPietro et al. 2018; Hu et al. 2003). However, it is inferred that there may be other

reasons rather than simply the direct effect of TV on sedentary behavior. In this regard, another reason may be related to the types of presented programs and news by different TV channels in Chile which may have a negative effect on their level of walking. For instance, one of these negative effects on level of walking may be related to exaggerated presentation of insecurity by different TV channels' news. Future studies may focus more on the reason/s for such findings in this city.

People with less duration of living and less familiarity with the surrounding environments walk more to reach educational destinations. This result is in contrast to the previous finding with respect to relationships between familiarity and the level of walking. To our knowledge, only the positive influence of more familiarity with walking environment on walking level has been found in previous studies (Harms et al. 2019; Van Cauwenberg et al. 2012). One interpretation is that most of the people who walk to educational destinations are adolescents, and people with this age have more curiosity to explore the environments; thus, they walk more to explore the environments and enhance their familiarity with the surrounding environments. This inference is partially supported by the affordance theory with respect to adolescents, in which the functional significance of environments is very different for adolescents than other age groups and they have more curiosity to explore the environments and have better adaptation of these environments with their needs (Clark and Uzzell 2002; Paydar and Kamani Fard 2021c).

Finally, the higher "proportion of walking trips to total trips in household" contributes to increase the overall walking, as well as two types of walking including walking for shopping and walking to/from work. Increasing the proportion of walking trips from the overall trips of the family members encourages them to walk more. This is in line with the findings of the previous studies which have showed the positive impact of role models and active family environment on encouragement and increasing the physical activity and walking (Booth et al. 2005; Darlow and Xu 2011; Harley et al. 2009). The policy makers of this city need to pay attention to this motivational factor to enhance walking behavior in Temuco. This relationship shows the possibility of the association of other social factors with walking behavior in this city as well. This could be investigated further by future studies.

## 6. Limitations of the Study

This research is a part of a research project that was started in 2020. Due to the limitation of COVID-19 in terms of access to people and implementing research in the field, it was decided to use the information of EOD survey of 2013 as a part of the data of this research project. EOD 2013 is the latest survey regarding daily transport, implemented by the Ministry of Transport and Telecommunications, in Temuco, Chile. In this regard, the limitations of the study are the cross-sectional design and the measurement of walking behavior through a self-reported questionnaire. Self-report measurement requires the good memory of the participants and high estimation skills. Consequently, measurement errors may exist due to lack of valid recall (Matthews 2002). Another limitation of the study is the use of a long questionnaire to measure travel mode choice and the other variables, which may result in nonresponse and invalid results (Mesters et al. 2014).

## 7. Conclusions

While the amount of using private cars has increased in daily transport of people in the recent decades in Temuco, the amount of walking has remarkably decreased at the same time. This is while walking as the most sustainable transport mode is appropriate for the post-pandemic era especially, in such medium-sized city. This research aimed to study the most relevant socio-demographic factors to walking behavior and examine the contribution of active family environment and density to overall walking behavior as well as the level of walking based on three types of destinations. It was found that high percentages of people who walk in Temuco belong to low-income families. In addition, most of the people who walk in this city do not have a driver's license nor private cars in

their household. The impacts of several socio-demographic factors on walking behavior, including age, gender, education, monthly income, having job, type of house whether house or department, having a TV at home, and having a driver's license, were analyzed in this study. One of the interesting results is that people who have a TV in their homes walk less to/from work. Another interesting result is that people with less duration of living and less familiarity with the surrounding environments walk significantly more to reach educational destinations.

In addition, the impacts of different socio-demographic and social factors on walking behavior were found based on three selected types of destinations. Furthermore, the association between walking behavior and active family environment was also found. These findings were discussed, and their implications were addressed as well. For instance, it was inferred that people may have the tendency to use the private cars rather than walk for their commuting trips in this city. This should be further investigated by future research.

One of the important implications of this study is in regard to the correlations between types of the residence, whether house or apartment, and overall walking as well as walking to/from work and to educational destinations. The people who live in apartments walk more compared to those who live in houses. These results show that the approach of a compact city that has been followed by policy makers—through the construction of high-rise buildings around the city center during the recent decades—has been successful in regard to enhancing the walking behavior in Temuco. Considering the traffic jam in many streets of Temuco, especially in peak traffic periods, this approach toward a compact city needs to be enhanced to improve the walking behavior and reinforce the sustainable transport in this city.

**Author Contributions:** Conceptualization, M.P.; methodology, M.P.; software, M.P.; validation, M.P.; formal analysis, M.P. and A.K.F.; investigation, M.P.; data curation, A.K.F.; writing—original draft preparation, M.P. and A.K.F.; writing—review and editing, M.P. and A.K.F.; supervision, M.P. and A.K.F. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Acknowledgments:** We are grateful for the support from the School of Architecture, Temuco, Universidad Mayor. We would also like to thank Javier Arangua Calzado, Director of the School of Architecture, Temuco, Universidad Mayor, for his support in finalizing this article.

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

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