A study on mode choice for young adolescents' non-school travel in Japanese rural areas and suburbia: Reevaluating independent mobility by adopting a socio-ecological approach

(日本の地方部と郊外部における思春期の通学以外のトリップ手段選択に関する研究：自立した移動の社会生態学的アプローチによる再評価)

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Dedication

To the best mom (Jaleh), best sister (Afshan), and best brother (Armin)

Life has no meaning without the three of you in it.

& To my dad (Samad)

You will always be in my heart.

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Abstract

Societies are becoming more car-oriented, and this pattern has affected the mobility of children and adolescents worldwide. In this regard, the importance of independent mobility has been highlighted as a critical factor in bringing benefits to children/caregivers and the environment. In many western countries, there have been tremendous efforts from researchers and practitioners of a wide range of disciplines to promote active school travel by enforcing policies and taking initiatives to change the prevailing pattern of escorted car trips. Although the cultural context plays a pivotal role in the success rate of such policies, Japan is among a handful of countries that have triumphantly passed this phase, evidenced by the high rate of active school travel (over 80%) among elementary and secondary school students nationwide.

Aiming to resolve the issue of school trips and physical health may have deviated the researchers' minds from taking a comprehensive look at the mobility of children and adolescents. Non-school trips are an understudied area of research in children's and adolescents' travel behavior, which have been brought to the attention of a few experts under the term of active leisure trips. Although children at the elementary school level are usually not public transport users, and their mobility is limited to active and escorted trips, the existing literature mainly fails to recognize the importance of public transport for adolescents' mobility. Early adolescence, in particular, is when children start using public transport. This service is more critical for young adolescents living in suburbs and rural areas since, due to the burdens of the environment, active modes cannot solely accommodate young adolescents' mobility/accessibility needs. Also, there is limited evidence of the effect of different factors on mode choice for non-school trips among the mentioned group.

Based on the points mentioned above, this study intends to address the gaps in the literature by delving deep into the nature of non-school trips among young adolescents (12-15) in the context of three case studies in Japan (one suburb and two rural areas). The socio-ecological approach was applied as the theoretical basis of this study to explore the multi-level factors involved in choosing different means of transport. This approach represents a robust background in investigating the impacts of the different levels (individual, family, the natural/physical built environment, policy) on young adolescents' travel behavior. The critical value of taking children as agents in their mobility, especially in the transition phase of early adolescence, burdens of the natural/physical environment in rural areas, and the lack of a holistic view about the nature of young adolescents' non-school trips and the influential underlying predictors of mode choice, have inspired the researcher to undertake this study.

Qualitative and quantitative research approaches were applied to fulfill the purpose of this study. Firstly, exploratory interviews were conducted in two towns to gain a preliminary perspective on young adolescents' mobility in the case studies. The results of this phase were later reflected in designing the questionnaires and travel diaries. Four hundred and eighty-seven adolescents and their caregivers in three small towns (suburban, coastal, and mountainous contexts) participated in the quantitative survey by filling out questionnaires. Young adolescents also reported 2131 non-school trips in the travel diaries in all the case studies. Apart from the descriptive statistics, the data were analyzed using McFadden's discrete choice modeling (conditional logit) for each case study. A general model was also developed by including the data of all three towns. In addition to the exponentiated coefficients, margins were calculated for the choice models to understand and interpret the results more intuitively applicable to policymaking.

The researcher found that young adolescents' independent mobility (a solo trip or in the company of friends/siblings) translates to walking/cycling and public transport trips in the case studies. However, private cars are the most common means of transport for young adolescents'

non-school travel, with around 50% and 70% share in the suburb and rural settings. The results of the logit models and the predictive margins revealed relatively different patterns in the three case studies, highlighting the role of the natural/physical environment in young adolescents' non-school mobility. In the individual models, socio-demographic characteristics (such as adolescents' age, caregiver's age/occupation and number of children per household, etc.) were more influential in selecting walking/cycling or public transport over the car, followed by the moderate effect of the perceived consent about independent mobility range and psychological variables such as self-efficacy and social support (received from caregivers and friends). Higher neighborhood safety was only found effective in elevating the odds of active non-school travel against escorted car trips in one of the rural areas. The findings of the general model were pretty much the combination of the separate models' results. Apart from the independent mobility variables (insignificant in the general model), the same influence degree pattern seen in the separate models was observed in the general model. Also, mode-specific perceived benefits and friends' social modeling were exclusively found effective in the estimation of mode choice in the general model.

In one of the rural areas, there was a mismatch between students' perceptions and their caregivers' image of the independent mobility distance range. Surprisingly, the effect of caregivers' opinions on their children's mode choice was counterintuitive, which reflects a lack of consciousness toward the independent mobility of young adolescents among families. Also, young adolescents used the consent for cycling on main roads differently in the suburb compared to rural areas, which was interpretable based on the different attributes of non-school travel, such as trip distance observed in these contexts. For instance, the complementary link of cycling trips and public transport was observed in the suburb (more similar to urban areas). In contrast, trips had a distinctive nature in the rural areas, and cycling could be used as the main/only mode of transport.

In conclusion, the results lead to a better understanding of young adolescents' non-school travels and the determinants of independent mobility among them in each context. The findings also emphasize the significant influence of caregivers/households and friends on the use of different modes for realizing non-school travel in the mentioned age range. Town-specific and general proposed policies can be reflected in each setting, benefiting individuals (the young adolescents and their caregivers) and towns by promoting more environmentally-friendly modes of transport and altering the households' mobility behavior in the long run.

Raising awareness regarding the significance of independent mobility among young adolescents and elevating the perceived capability for traveling independently by incentivizing fun joint trips with parents/grandparents, particularly for girls who seem to have more car-prone tendencies, is one of the suggestions. Additionally, developing trip planning apps for young adolescents could make non-school trip making easier (specifically independent travel). Besides building a network with friends who have similar hobbies, such apps can also be used to share virtual travel diaries among the same group to promote independent mobility. These virtual platforms can also become a source of collecting detailed longitudinal data on children's travel for experts. Building a continuous partnership with young adolescents could also be very helpful in appraising their mobility needs and views. Other initiatives such as providing public transport tickets for specific household types (e.g., younger families or those with multiple children) could also be considered. Overall, policy implications should be implemented at the level of young adolescents/families considering the characteristics of the physical/natural environments.

Keywords: Young Adolescents, Independent Mobility, Walking/Cycling & Public Transport, Non-School Trips, Rural Areas and Suburbia, Japan, Socio-Ecological Approach, McFadden's Discrete Choice Model, Conditional Logit

Abstract (in Japanese)

今日におけるモータリゼーションの進展は、世界中で子どもの移動に影響を及ぼしている。この点で、自立した移動の重要性は、子ども・保護者や環境に利益をもたらす重要な要因として注目されている。欧米の多くの国々では、自動車に依存するという一般的な流れを変えるため、様々な分野の研究者や実務者が、徒歩や自転車での通学を促進するための施策に取り組んでいる。このような施策の成功には、文化的背景が極めて重要な役割を果たすが、日本はこの段階をクリアした数少ない国の一つであり、徒歩や自転車で通学している小中学生の割合が 80%以上であることがそれを証明している。

通学と身体の健康の問題解決を目指したことで、子どもの移動全体を捉えることから研究者の意識がずれてしまったと考えられる。子どもの移動行動に関する研究の中でも、通学以外の移動では、徒歩や自転車による娯楽のための移動が一部の専門家に注目されている。小学生は通常、公共交通機関の利用者ではなく、その移動は徒歩や自転車での移動や送迎に制限されるが、既存の文献は思春期の移動における公共交通機関の重要性を認識していない。特に思春期初期は、子どもが公共交通機関を利用し始める時期である。公共交通機関は、郊外や地方に住む思春期にとってより重要である。なぜなら、徒歩や自転車だけでは思春期の移動のニーズに対応できないからである。また、思春期の通学以外の移動におけるモード選択に影響する、様々な要因に関するデータは限られている。

本研究では、上記の点を踏まえ、3 つの事例（郊外部 1 件、地方部 2 件）をもとに、12 歳から 15 歳の思春期の通学以外の移動を明らかにすることで、既往研究の不足を補うことを目的としている。社会生態学的アプローチを理論的基盤として、様々な交通手段の選択に関わる様々なレベル（個人、家族、自然的・物理的環境、政策）の要因について検討した。このアプローチは、様々なレベルの要因が思春期の移動行動に及ぼす影響を調査する上で、強固な背景となるものである。特に思春期初期の移行期において、思春期を移動の主体として捉えることの重要性、農村部における自然的・物理的環境の障害、思春期の通学以外の移動の性質や交通手段選択の影響力のある基礎的予測因子に関する全体的視点の欠如が、本研究に着手するきっかけとなった。

本研究では定性的および定量的な研究アプローチを適用した。まず、事例研究の対象となる思春期の移動についての予備的な視点を得るため、2 つの町でヒアリングを実施した。この結果は、後にアンケート調査票と移動日誌の設計に反映された。量的調査では、3 町（郊外部、沿岸部、山間部）の思春期とその保護者 487 人がアンケート調査に回答した。また、 3 町の思春期は計 2131 件の通学以外の移動を移動日誌で報告した。記述統計とは別に、各事例について McFadden の離散選択モデル（条件付きロジット）を適用してデータを分析した。また、3 町すべてのデータを含む一般的なモデルも作成した。指数化された係数に加えて、選択モデルに対してマージンを計算し、結果をより直感的に理解・解釈し、政策立案に適用できるようにした。

事例研究によって、思春期の自立した移動（1 人または友人・兄弟との移動）が、徒歩・自転車や公共交通機関を使った移動につながることを発見した。しかし、思春期の通学以外の移動では、自家用車が最も一般的な交通手段であり、郊外と農村の環境では約 50%と 70%の移動が自家用車であった。ロジットモデルと予測したマージンの結果から、3 つの事例で比較的異なるパターンが示され、思春期の通学以外の移動における自然的・物理的環境の役割が浮き彫りになった。個別モデルでは、社会人口統計学的特性（思春期の年齢、保護者の年齢・職業、世帯あたりの子どもの数など）が、自家用車よりも徒歩・自転車や公共交通機関を選択することに大きな影響を与えていた。次いで、思春期のみの移動を許容している範囲と、自己効力感や保護者・友人からの支援などの心理的変数が中程度の影響を与えることが示された。ある農村部において、近隣の安全性が高いことは、通学以外での徒歩・自転車移動の確率を高める効果があることがわかった。一般モデルの結果は、個別モデルの結果を統合したものとほぼ同じであった。独立した移動の変数（一般モデルでは有意ではない）を除けば、個別モデルで見られたものと同じ影響度パターンが一般モデルでも見られた。また、一般モデルでは、モード固有の便益と友人のソーシャルモデルがモード選択の推定に有効であることが確認された。

ある地方では、思春期の移動距離の範囲について、生徒と保護者の認識が異なっていた。これは、思春期の移動手段に対する家庭の意識の低さを反映していると考えられる。また、郊外と農村では、幹線道路での自転車利用の許可の有無に違いがあり、このことは、これらの文脈で観察される通学以外の移動パターンの違いから解釈可能である。例えば、都市部に近い郊外では、自転車移動と公共交通機関の補完的なつながりが見られたが、農村部では自転車が唯一の交通手段として利用されていた。

結論として、今回の結果は思春期の通学以外の移動と、それぞれの状況下における思春期の自立した移動の決定要因について理解を深めることにつながった。また本結果は、この年齢層における通学以外の移動を実現するためのさまざまな交通手段の利用について、保護者や家庭、友人が大きな影響を及ぼしていることを強調するものであった。より環境にやさしい交通手段を促進し、長期的には家庭の移動行動を変えることによって、個人（思春期とその保護者）および自治体に利益をもたらし、自治体の政策提案に反映させることができる。

思春期の自立した移動の重要性に関する意識を高め、特に車に乗る傾向がある女性には、両親や祖父母が同行した楽しい移動を奨励することによって、自立した移動ができるという認識を高めることが、提案の 1 つである。さらに、思春期向けの旅行計画アプリを開発すれば、通学以外の移動（具体的には個人での移動）をより簡単にできると考えられる。このようなアプリは、同じ趣味を持つ友人とのネットワークを構築するだけでなく、同じグループ内で仮想旅程表を共有し、自立した移動を促進する媒体にもなり得る。このような仮想プラットフォームは、専門家が思春期の移動に関する詳細な縦断的データを収集するデータソースにもなり得る。思春期と継続的なパートナーシップを

築くことも、思春期の移動に関するニーズや意見を把握する上で非常に有効である。その他、若年層や特定の世帯（子どもが複数いるなど）に対する公共交通機関の乗車券や、地域外への娯楽のための移動に使う公共交通機関パス（無料または割引あり）の提供などの取り組みの検討も考えられる。全体として、物理的環境の特徴を考慮し、思春期・家族レベルでの施策を実施する必要がある。

キーワード: 思春期、自立した移動、徒歩・自転車・公共交通機関、通学外移動、農村・郊外、日本、社会生態学的アプローチ、マクファーデンの離散選択モデル、条件付きロジット

Chapter 1: Introduction

1.1 Introduction

This chapter's beginning is dedicated to a summary of the literature and the gaps that led the researcher to undertake the current research, followed by the study's problem statement and scope. Then, research objectives and questions will be presented for addressing the mentioned issues and gaps. Last but not least, the significance and novelty of this study will be highlighted. At the end of the chapter, the dissertation structure is briefly explained and presented in the shape of a flow chart for further reference.

1.2 Background

It is broadly recognized that "transport" needs to become more sustainable around the world. Although "transport" includes both movements of people and goods, this study focuses only on people's travel. Even though there is a growing body of literature on "sustainable transport," the focus of the topic has mainly been on adults. However, children and youth also utilize transport to accommodate their "mobility" and "accessibility" needs for education, leisure, and employment. Nevertheless, transport planners mostly overlook children because of their age, physical size, dependence on others for moving around, etc. One evidence of such negligence is that the children's travel behavior data is hard to locate for developed or developing countries (McMillan, 2013). Encouraging sustainable modes of transport among children requires understanding children's needs and the constraints they face in their everyday mobility (Khaleghi et al., 2021). In the "convention on the rights of the child" (United Nations, 1989), recognition of children's needs has clearly been stated, which could be one of the reinforcements of developing more inclusive transport by considering vulnerable groups such as children. Such notions can also help achieve SDG targets such as item 11.2, "affordable and sustainable transport systems" of SDG 11, "sustainable cities and communities."

Studying children's travel behavior is associated with complexities. On the one hand, there are many varieties associated with different stages of childhood and adolescence (Stark, 2019). On the other hand, children's travel is usually faced with more burdens from the ecological contexts surrounding the transport system due to the specific characteristics of children. Over the past years, economic growth has led to a high rate of private motorized vehicle ownership in many parts of the world (Pucher et al., 2007) and consequently affected children's mobility. In many developed countries, attention was drawn to school trips since a considerable mode shift was witnessed over time, from active trips on foot or with the bicycle to escorted trips in private cars. This over-reliance on cars for children's mobility has negatively affected children's physical (more car trips lead to less physical activity) and mental health (more escorted trips translates to fewer opportunities for social engagement while on the move). Independent mobility, which is positively associated with enhancing children's spatial knowledge and self-esteem (Brown et al., 2008; Villanueva et al., 2014; Waygood et al., 2019) and makes children more skillful in decision-making related to their daily travels (McMillan, 2013) has also been hindered by the car-dependent pattern.

The repetitive and consistent nature of the school trips makes them a more predictable target for intervention. Many studies have investigated school trips to promote the active means of transport among children (Carlson et al., 2014; Fyhri et al., 2011), while others focused both on the positive outcomes for children and the environment (Simons et al., 2013; Zwerts et al., 2010). Although successful policies have been implemented based on such research, the multi-

faceted problem is not yet fully addressed. Spatial and social burdens arising from the prevailing mobility behavior inhibit children's active travel and independent mobility. Traffic safety, long commuting distance, lack of sufficient social surveillance, and above all, the convenience of the private car are among the reasons that are usually preventing parents from allowing children to actively commute to school (Aranda-Balboa et al., 2020; Mcdonald, 2007).

Since children's travel behavior is shaping/taking place in a complex system of distinctive surrounding environments, some researchers such as Ikeda et al. (2019) or Mitra (2013) highlighted the importance of system thinking by employing the socio-ecological model (Bronfenbrenner, 1977). A socio-ecological model portrays the interplay of different influencing factors on behavior, from the child's level, family, and school to social, cultural, and environmental contexts and eventually policy setting. Mitra (2013) has developed a framework for children's school travel mode choice based on the above-mentioned model. "Distance" and parental perception regarding "neighborhood safety" are among the repeatedly mentioned environmental determinants of children's independent school travel under the age of 15 (Broberg & Sarjala, 2015; Buliung et al., 2017; Fyhri & Hjorthol, 2009; Lam & Loo, 2014, 2014; Villanueva et al., 2014). In another study, "parental support frequency" was significantly related to children's active school trips (Mah et al., 2017). Children's attitudes toward different means of transport also affected the mode choice in school trips (Stark et al., 2019). In summary, distinctive factors from multiple levels seem to influence children's travel behavior in school travel. Although the existing literature mainly focuses on school trips, it provides a rich foundation for researching other types of daily travel.

Promotion of active modes of transport represents one view regarding children's travel behavior, particularly on school trips when the commuting distance in urban areas is relatively short (for elementary and junior high schoolers). Non-school trips, less investigated though, are also an essential part of children's mobility, representing a more diverse context against the school trips. For instance, in contrast to the constant distance of a school journey, non-school trips can represent a variety of trip distances (relatively longer). In a study on Austrian and German children (average age of 13), Stark et al. (2018) found that as the distance increases, children are more likely to use public transport for their school trips and the car for their non-school trips. Fyhri et al. (2011) revealed a similar pattern in children's increasing use of private cars for leisure activities, translating to less independent trips. Also, Japanese children and adolescents' use of the private motorized modes increases tremendously during weekends (Ministry of Land, Infrastructure, Transport, and Tourism (MLIT), 2015), which is a sign of more escorted travel for the non-school trips of children and adolescents. Unfortunately, even the general information on children's non-school trips is scarce.

Children's "age" as a sign of cognitive and physical development is significantly associated with certain types of mobility patterns (Stark, 2019). Since using public transport is more complicated than walking/cycling, children's use of public transport usually starts in later stages (from secondary school onwards). However, children's needs vary in different stages of their development, and public transport use is critical for older children in accommodating their needs. A comparative study on the elementary school students (10-11) in Canada, Sweden, and Japan showed that active traveling brings more social inclusion for this age group (Waygood et al., 2017). In contrast, a study in London revealed that the concept of active traveling should be redefined since a bus trip contributes both to physical activity and social experience for

adolescents of 12 to 18 years old (Jones et al., 2012). However, the data on children's use of public transport is also hard to find even in urban areas (McMillan, 2013), where public transport is more frequent and easier to access.

1.3 Problem Statement

Most Japanese elementary and junior high school students actively travel to and from school (Drianda & Kinoshita, 2011). Although the share of active school travel decreases in rural areas of Japan (replaced by school buses), the significant issues associated with school trips in other parts of the developed world seem to be already resolved in Japan. Children's non-school travel has received less attention in the existing literature, especially in rural areas. Rural environments restrict children's mobility differently than urban areas. Several burdens of the built environment, such as limited access to educational/recreational/employment facilities, and the relatively unfriendly environment for walking/cycling, along with inconveniences of public transport service, have led to the predominant pattern of car-dependent households.

Considering the burdens of the physical environments of rural areas on the mobility of children, the influence of different levels (from children's perceptions about the environment and transport modes to the influence of social/environmental settings on children's daily travel (excluding school trips) and mode choice is unclear. To the best of our knowledge, the extent of public transport use among children for their non-school travels in the rural areas is also scarcely studied.

Whether for improving independent mobility or bringing positive outcomes for the environment, there is a lack of research in appraising children's travel behavior and its influential underlying determinants for their non-school trips, particularly in small towns and rural areas where the built environment poses more burdens on children's sustainable and independent mobility. Collecting the data on the use of public transport by children in such contexts is also critical since active modes of transport cannot thoroughly accommodate children's mobility needs, especially independent mobility. Such data can also help policymakers improve and maintain the public transport service for non-drivers such as children. Moreover, the promotion of public transport can contribute to children's well-being by providing mobility and accessibility (Khaleghi & Kato, 2020).

1.4 Scope of the Study

Since younger children usually do not use public transport independently, this research focuses on adolescents to get a more comprehensive outlook on utilizing different mode options, including active modes, public transport, and the private car for non-school travels. According to Stark et al. (2018), the study of early stages of adolescence is more vital since in this phase, children transition to become more independently mobile. Hence, young adolescents enrolling in junior high schools (12-15 years old) of small towns and rural areas in Japan were selected as the target audience of this study. Moreover, this study treats children and adolescents as social agents of their age and gender and not future adults, an important point already mentioned by Barker et al. (2009). Both caregivers' and young adolescents' points of view are also considered to gain a better perspective on the child-adult relation and its effects on young adolescents' travel behavior for non-school trips.

1.5 Purpose of the Study

According to the problem statement, this research aims to address the knowledge gap by investigating the prevailing patterns in children's non-school travel in small towns and rural areas to identify the influential criteria in promoting independent and sustainable mobility from a socio-ecological point of view. The results can provide solid evidence for policymakers seeking the promotion of sustainable transport, especially for children and adolescents in rural areas and suburbia.

1.6 Research Questions

This study concentrates on the following questions for understanding the nature of non-school trips in small towns and rural areas leading to selecting a specific mode of transport to appraise the influential criteria for increasing the use of active modes and public transport in non-school travels. The primary research questions and their sub-questions are as follows:

Question 1: **What are the prevailing patterns in junior high school students' non-school travel in small towns and rural areas?**

- Where do junior high school students go on weekdays and weekends, and what are their trip purposes?
- What modes of transport do they use for their non-school trips?
- What are the patterns of companionship in young adolescents' non-school trips?
- Do the characteristics of the living environments (such as geographical contexts, size) make a difference in junior high school students' non-school travel?

Question 2: **How do the characteristics of young adolescents, their households, and the factors linked with the social/physical living environments influence young adolescents' mode choice for non-school trips in the rural and suburban areas?**

- What are the most influential factors on the independent trips of young adolescents?
- How is the independent mobility perception related to the realization of independent mobility? Any differences between young adolescents' perception and their caregivers'?
- Is young adolescents' mode choice for their non-school travel associated with psychological variables such as mode-specific attitudes, self-efficacy, or social modeling/norm/support of their significant others (caregivers and friends)?
- Are there any discrepancies between young adolescents' and their caregivers' perceptions about each other's mode use (independent mobility, modeling, etc.)?
- How and to what extent do socio-demographic characteristics affect young adolescents' mode choice for non-school trips?
- Do the built environment criteria, such as safety or walking/cycling-friendliness, affect young adolescents' mode choice?
- Do distinctive geographical settings differ in terms of factors influencing young adolescents' non-school trips?

Question 3: **How can understanding young adolescents' non-school travels provide insights for the policymakers to promote independent/more sustainable traveling?**

- What is the magnitude of the impacts on young adolescents' mode choice?

- How can the results be reflected in policy and planning to promote walking/cycling and public transport among young adolescents?

1.7 Significance and Novelty

Transport systems are the main arteries of the living environments in today's world, which connect us and enhance our opportunities for thriving. Although the movement has become relatively more straightforward by using private vehicles, car ownership has imposed burdens on the social/physical and natural environments. Children's travel is mainly under the impact of their surrounding systems. The current patterns in adults' travel behavior proved to affect children's active and independent travel negatively. It is critical to recognize the importance of studying children's travel behavior and paying attention to children's mobility needs to counter the current situation. It is noteworthy that researching children as sensitive subjects with relatively more limited abilities (compared to adults) is often more complex and challenging. However, this cannot justify negligence in children's travel behavior studies.

The existing literature covers the topic of active trips for school travel reasonably well. However, to the best of our knowledge, few studies have explored the scope of other types of trips such as leisure with a limited number of participants and sometimes only from caregivers' perspective. There is even less research on children's use of public transport, especially for their non-school trips. Also, the independent mobility definition has been limited to the use of active modes of transport among children and the youth (Marzi et al., 2018). Although the importance of public transport trips in independent travel has been recognized (Jones et al., 2012), such trips have rarely been included in the study of children's independent mobility. Also, comprehensive research on the multiple influencing factors on mode choice for non-school trips on an audience of 12-15 from a socio-ecological perspective has never been undertaken before. Additionally, one of the unique characters of this study is including different geographical contexts in the category of rural and suburban areas for comparison. Last but not least, the scale of the quantitative survey is impressive because all the junior high schools in the three towns agreed to cooperate in this study, and the response rates were remarkable.

The study results are interpreted to find the relationship between the influential factors and mode choice and the magnitude of the causal effects. This research outcome has already been presented in two case studies for its possible use in town's mobility management plans, proving the significance of such studies for transport providers, governors, and planners.

1.8 Structure of the Dissertation

Fig. 1.1 displays the structure of this dissertation. In chapter 2, the researcher will delve into the existing literature by elaborating the methodological background for studying the mobility of children and adolescents and the influential factors on their mode choice for school and non-school travel. Chapter 3 is dedicated to covering all the topics associated with the methodology of this research. In chapter 4, firstly, the author will present the descriptive statistics of the samples in each town. Secondly, the results of the choice models for each of the case studies will be explained. Chapter 5 is the interpretation of the results, followed by suggestions for inclusion in the policy settings. Finally, in Chapter 6, the conclusion is presented with some remarks for future studies. The final chapter is followed by the acknowledgments, a list of references, and the other supporting documents in the appendices.

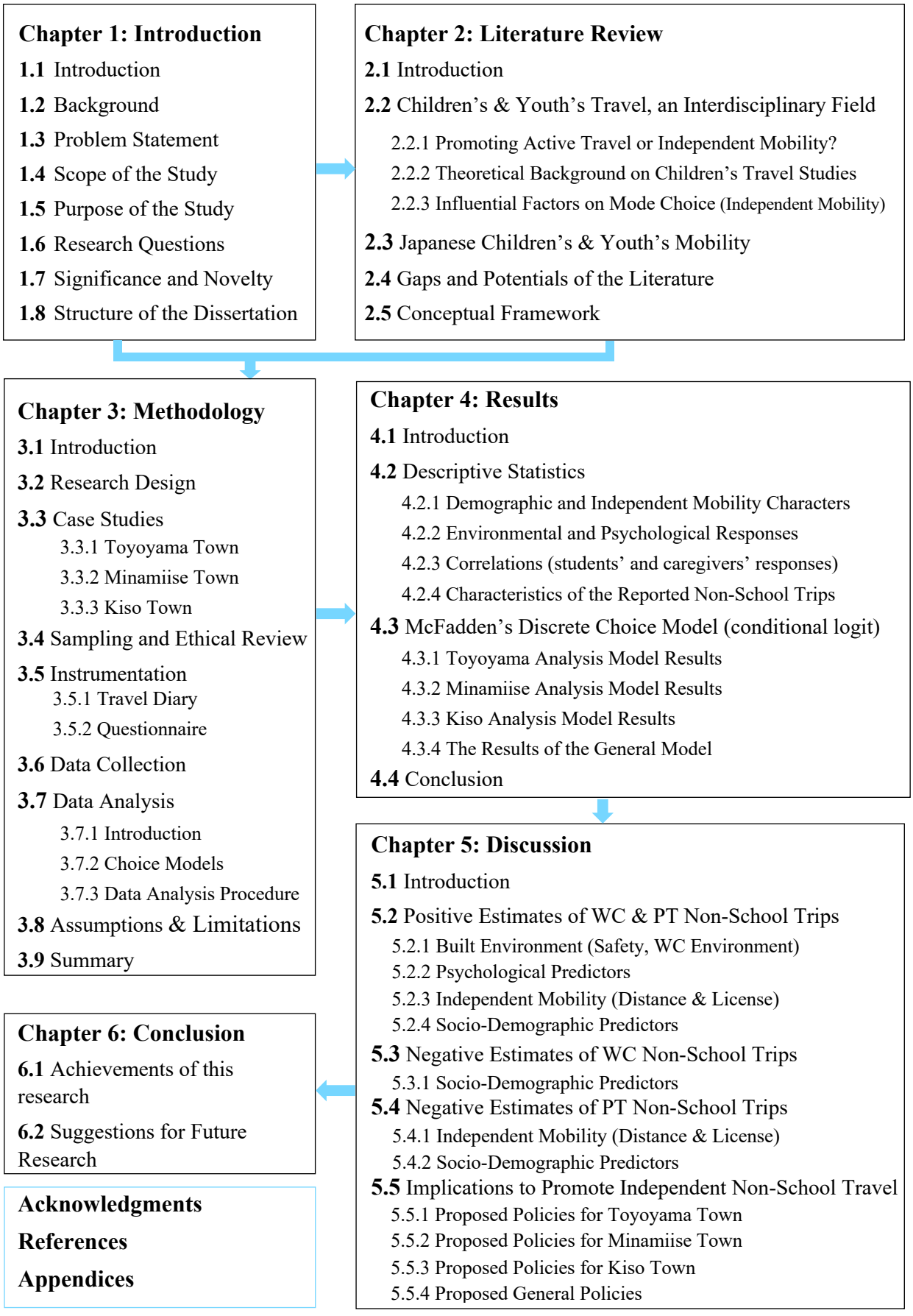


Figure 1.1 Structure of the dissertation

Chapter 2: Literature Review

2.1 Introduction

Since the study of children's travel behavior has started as an extension of adults' travel behavior research, it is critical to look into both groups' theoretical approaches to understand the topic thoroughly and distinguish the gaps and potentials. Hence, a summary of the applied theories in studying the travel behavior of children and adults is explained firstly, considering their strengths and shortcomings. Given that this research targets "early adolescence", a period between childhood and youth, understanding young adolescents' travel behavior depends on investigating the mobility patterns of children and youth. Considering the scarcity of research on non-school travels, the researcher will discuss the determinants of the mode choice for school trips and non-school trips for children and young people afterward. Next, some remarks will be provided on the mobility of children and youth in Japan. In the conclusion of this chapter, the gaps in the existing literature will be pointed out, and the important studies and theories will be distinguished. Finally, a conceptual framework for studying mode choice for young adolescents' non-school trips will be presented.

2.2 Children's & Youth's Travel, an Interdisciplinary Field

2.2.1 Promoting Active Travel or Independent Mobility?

In many countries, children's mobility has been brought into the spotlight due to the prevalence of escorted trips which has limited children's physical activity and independent mobility and led to more traffic congestion and environmental issues (Mitra, 2013). Although children and adults are different in many aspects of daily travel, many of the concerning issues remain the same for both groups. Hence, adults' travel behavior theories and concepts have been adopted and used for children. In studying children's travel behavior, it is vital to understand the child-adult power relations since the decision processes behind a child's travel are usually affected by caregivers (Barker et al., 2009). For instance, children's active travel to/from school depends on the level of children's independent mobility and their caregivers' availability for providing escorted trips (Copperman & Bhat, 2010; McDonald, 2008).

Children's travel can be classified into two main categories of 1) school trips and 2) non-school trips. There is an emerging body of literature regarding school travel, especially in western countries focused on promoting active and independent school travel. Although non-school trips include a broader range of purposes, the emphasis has mainly been on leisure trips. In the few studies on children's and adolescents' leisure activities, enhancement of physical activity and reduction of escorted car trips have remained the research objectives, and usually, public transport trips have not been incorporated in the scope of such studies. However, previous research pointed out that public transport should not be regarded as passive transport since such trips are usually complemented with active travel and promote independent mobility and social inclusion (Jones et al., 2012; Verhoeven et al., 2016).

Since school travel research is much further developed than other types of children's travel, they provide an excellent opportunity for extending the theoretical and empirical findings to the scope of non-school trips. Travel, particularly children's travel, is an interdisciplinary field of study. Many researchers in the fields of 1) transport and urban planning, 2) physical activity and public health, and 3) environmental psychology tried to unfold the matter and contribute to effective policymaking and interventions. These disciplines

have distinctive approaches to "mobility" and "children" derived from different underlying theories and objectives. A brief review of these approaches follows, drawing on previous travel studies of adults and children.

2.2.2 Theoretical Background in Children's Travel Studies

2.2.2.1 Economic Approach

"Transport and urban planning" disciplines have usually relied on the "consumer choice theory" and its economic foundation for quantitatively modeling travel behavior. In such models, it is assumed that selecting a specific travel mode is a rational choice based on the maximization of utility (benefit) (McFadden, 1974). "Trip chaining" is another related concept highlighting the desire of individuals to maximize the utility by minimizing the number of travels and incorporating many activities in one trip. Hensher & Reyes (2000) found that trip chaining could result in more car trips and fewer public transport trips among adults. Also, in a study on American families, McGuckin & Nakamoto (2005) found that in a household with two adults and children aged 6-15, women trip chain considerably more than men (over 35% of women and over 20% of men). Apart from including the trip features, the effects of the built-environment attributes such as density, land use mix, and design (Cervero & Kockelman, 1997) have been examined on adults' active travel (Cervero, 2002; Krizek, 2003).

2.2.2.2 Psychological Approach

"Theory of planned behavior" (TPB) is the primary psychological approach in the study of travel behavior, which many researchers have applied to overcome the shortcomings of "consumer choice theory" in reflecting the effects of the psychological dimensions on mode choice (Walker, 2001). TPB conceptualizes the impact of psychological variables, namely attitude, subjective norm, and perceived behavioral control, on intention and behavior (Ajzen, 1991). Various studies have been drawn on TPB for predicting the mode choice among adults (Cao et al., 2009; Heinen & Bohte, 2014). Previous research has also recognized the effect of psychological processes such as attitudes on adults' mode choice (Kuppam et al., 1999) and children's mode choice (McMillan, 2007). Panter et al. (2008) also highlight the impact of caregivers' attitudes toward transport modes on children's mode choice.

2.2.2.3 Activity-Travel Approach

"Activity-travel approach" is another popular theory in the field of transport/urban planning. This approach has been applied to studying individuals' travel behavior in a household based on the activities in which they engage in time and space (Chapin, 1974; Jones, 1979). This theory is very helpful in understanding children's travel behavior since it recognizes the mechanisms of child-caregiver relations in trip making, and it also includes psychological variables such as attitude (Mitra, 2013). This approach has mainly been applied in studying children's school travel under the age of 12 (elementary school level) (Carver et al., 2019; Leung et al., 2019).

2.2.2.4 Behavioral Approach

This approach is founded on behavioral theories such as social cognitive theory (SCT) (Miller & Dollard, 1941; Rotter, 1954), socio-ecological models (Bronfenbrenner, 1977; Stokols, 1977), and the human-environment interaction (HEI) model (Kuller, 1991). All the theories mentioned above recognize the behavior as a product of the relationship between an

individual and their surrounding environments (Mitra, 2013). Socio-ecological models conceptualize behavior as an interaction between the ecological systems by which an individual is surrounded, namely the intra-personal, interpersonal, organizational, social/built environment, and policy. These models have broad application in the study of human behavior and have been used by researchers to study children's and adolescents' mobility (Marzi et al., 2018; Woods et al., 2021) and adults' physical activity (Sallis et al., 2006). It is assumed that a behavior change is most probable when a motivated individual lives in a supportive environment (Mitra, 2013).

Moreover, Kuller (1991) introduces human-environment interaction (HEI) model based on a neuropsychological point of view in which the different phases of human activity are divided into four categories, namely 1) "activation" or arousal, 2) "orientation," 3) "evaluation'," and 4) "control." Applying HEI, Johansson (2006) studied the mechanism of selecting a transport mode (escorted vs. active) for leisure trips among Swedish children aged 8-11 years old based on caregivers' perception about the characteristics of physical/social environment and child/household. It is noteworthy that the influence of "habit" on behavior is also recognized in the HEI model.

2.2.2.5 Hybrid Approaches

Each of the mentioned approaches is associated with benefits and shortcomings and may not portray the reality of travel behavior in an interdisciplinary environment. Therefore, integrated theories and models have been introduced in the field of travel behavior studies. Although more complex in nature, these approaches have been used by some researchers. "Integrated choice and latent variables" (ICLV) or hybrid choice models were proposed by Ben-Akiva et al. (2002) to bring together the economic and psychological foundations of the previous theories (consumer choice theory and TPB). Some researchers, such as Tran et al. (2020) and Vredin Johansson et al. (2006), utilized ICLV models and found attitudes influential on the mode choice. To the best of our knowledge, ICLV has never been used for modeling children's travel behavior.

Epstein (1998) also draws on the importance of integrating the behavioral and economic approaches in the study of active travel. 'Behavioral economics' tries to shed light on the decision-making process behind behavior which may not be as rational as the utility theory suggests. Although the application of this theory in travel studies has been limited so far, it has the potential for understanding the travel behavior more effectively, and hence coming up with efficient policy applications (Epstein, 1998; Mitra, 2013).

Since "travel," especially children's travel, is a complicated behavior, and under the impact of multi-layers of influence, the socio-ecological model was adopted as the underlying theoretical background of this study. Therefore, the following section will discuss the effects of different contexts, including the individual and family to social/environmental settings and policy, on children's and youth's mobility (both school and non-school travel).

2.2.3 Influential Factors on Mode Choice (Independent Mobility)

Considering the existing literature on the mobility of children and youth, and the behavioral model of school travel by Mitra (2013), the influential factors on mode choice for children and youth will be discussed in four categories of 1) child/adolescent (intra-personal), 2) family and friends (interpersonal), 3) physical/social aspects of the built environment, and

4) natural environment and policy. In the following, the term "children" is used for the elementary school age range (less than 12 years old). "Youth" will be categorized into two classifications of 1) "young adolescents" enrolled in junior high school (around 12-15 years old), and 2) "older adolescents" enrolled in high school (approximately 15-18 years old).

2.2.3.1 Child/Adolescent (Intra-Personal)

According to Bronfenbrenner (1977), child development happens through the interaction of ecological contexts with which they are in contact. Children and youth learn from their surrounding social/physical environments and develop attitudes and beliefs; besides, "repeated exposure" to danger and unexpected situations makes them more experienced and capable and hence, more independently mobile (Bandura, 1989; Mitra, 2013). As far as school travel is concerned, a positive association was found between self-efficacy and the likelihood of active travel among American young adolescents (Lu et al., 2015) and Canadian older adolescents (Robertson-Wilson et al., 2008). In the context of non-school travel, the age of Swedish and Flemish children (Ghekiere et al., 2017; Johansson, 2006) and Norwegian young adolescents (Fyhri & Hjorthol, 2009) was found effective in the level of their independent mobility. Higher self-efficacy for cycling among Flemish older adolescents was positively associated with cycling to non-school destinations (Verhoeven et al., 2016).

In another study on German/Austrian young adolescents, girls were more likely to use the private car for school trips (Stark et al., 2018). Female older adolescents were also found to less actively commute to school (Robertson-Wilson et al., 2008). A study on Flemish children found that boys enjoy higher levels of independent cycling non-school trips (Ghekiere et al., 2017). Although the results show a pattern toward less active travels among girls, the effect of gender on school trips and non-school trips among children and youth is inconclusive.

2.2.3.2 Family (Household) and Friends (Inter-Personal)

Socio-demographic characters and the travel behavior of a household can influence children's mobility (either escorted or independent). Moreover, children and adolescents learn from their significant others' travel behavior and copy them (social modeling of caregivers and peers), promoting children's self-efficacy (McAlister et al., 2008). Social norms, the household's attitude, and the social/built environment affect the mobility of children and youth. The location of the household is also affecting a household's travel behavior and is essentially determining children's independent mobility (Mitra, 2013). Caregivers' perception of their children/young adolescents' self-efficacy also affects active traveling by altering the degree of independent mobility granted to the target age groups (Johansson, 2006; Lu et al., 2015).

McDonald (2008) shed light on the link between a caregiver's morning commute to work and the likelihood of escorted school trips for American children and young adolescents. Moreover, bigger households (more children) are associated with a higher likelihood of active school travel (Mitra & Buliung, 2012) and independent leisure trips (Johansson, 2006) among children. On another note, social modeling was appraised as a contributing factor of active mobility, whereas social modeling, norm, and support proved to positively influence public transport trips in older adolescents either for commuting to school or other destinations (Verhoeven et al., 2016).

Furthermore, one's household attitude toward mobility is critical in children's and young adolescents' travel behavior. In studies on Portuguese and American children, the researchers

observed a strong association between caregivers' perception of traffic safety, and places for walking/cycling and children's independent mobility (Janssen et al., 2016; Santos et al., 2013). In a longitudinal study in Belgium (Vanwolleghem et al., 2016), positive social norms and attitudes toward physical activity effectively maintained the same level of active travel for leisure destinations among young adolescents. Caregivers' perception about children's capabilities in dealing with the surrounding environment and possible unexpected situations is also influential in the independent trips to school (Faulkner et al., 2010; Lu et al., 2015) among children and young adolescents.

The literature on the association of school commute or leisure trips and household characteristics mainly highlights the dichotomous nature of a trip in which either a) the caregiver is driving the child or b) the child commutes independently on foot or by bicycle. The focus is on promoting physical activity and less car use, and public transport trips are rarely included. Nevertheless, the empirical evidence can be extended for the broader nature of independent travel for non-school trips.

2.2.3.3 Physical/Social Aspects of the Built Environment

The spatial structure of the built environment from regional to urban and rural, and other features such as land use, transport network, and design attributes can affect individuals' travel patterns, especially their physical activity (Transportation Research Board, 2005). According to Sharmin & Kamruzzaman (2017), some built environment characteristics, such as land use mix that encourages adults to make active trips, are negatively associated with children's independent mobility. Also, street connectivity which usually encourages adults to walk (Ewing & Cervero, 2010), appears to deter children's independent mobility (Larsen et al., 2012). Unique characters of the built environment (e.g., safety, the possibility of meeting/playing while walking) should be recognized for meeting children's needs (Mitra, 2013). Therefore, there have been several attempts to adapt the existing literature on the links of the built environment and adults' active mobility for children and youth. For instance, Sallis (2009) developed an adolescent version for the "neighborhood walkability scale."

Notably, most of the studies on children's mobility are undertaken in urban environments trying to identify the unique criteria of the built environment affecting active school travels. In a study on Danish children and young adolescents living in urban areas, it was found that better traffic safety and walking/cycling environment are needed to promote active mobility (Kaplan et al., 2016). In a study in New Zealand, Lin et al. (2017) argued that perceived dangers of the built environment linked to traffic and strangers could negatively affect the independent mobility of children and young adolescents in urban areas. In addition to the discussed items, the sudden appearance of wild animals can also impose burdens on non-motorized trips of children and adolescents in rural areas (Drianda & Kinoshita, 2011; McMillan, 2013).

As Ewing & Cervero (2010) suggest, accessibility to public transport service is linked to the use of buses and trains among adults. Such a factor was influential in adolescents' school travel in Hong Kong (Barnett et al., 2019). Access to public transport can also satisfy the needs of daily physical activity among adolescents for school travel (Jones et al., 2012; Zulkefli et al., 2020) since public transport trips are usually linked with active travel to the bus stops or train stations. It should be noted that although "distance" plays a vital role in children's and young adolescents' mode choice for school and non-school travel (Stark et al., 2018), and the use of motorized modes for long-distance trips is sometimes inevitable, access to public

transport can shift an escorted trip to an independent trip (either alone or in a group of friends/siblings). Finally, the opportunity for meeting and communicating with others (social interaction and inclusion) is another criteria that can positively contribute to children's independent mobility and active travel (Fyhri et al., 2011; Waygood et al., 2020) and the use of public transport among adolescents (Goodman et al., 2014; Jones et al., 2012).

2.2.3.4 Natural Environment and Policy

The natural environment with its unique form and features can affect children's mobility. Extreme weather (Zwerts et al., 2010) and topography (e.g., hilly terrains, geographical features, etc.) (McMillan, 2013) could contribute to less active travel and more car trips among children and adolescents. Additionally, regional, local, and school policies can promote specific transport modes for school trips (e.g., walking/cycling or school buses). Policies such as free bus pass for adolescents can provide accessibility and mobility options that are impossible otherwise. As Goodman et al. (2014) state, free access to public transport can reduce adolescents' mobility reliance on their parents and promote the sense of freedom for realizing optional leisure and recreational trips, specifically with friends and peers, since buses are suitable for traveling in groups.

2.3 Japanese Children's & Youth's Mobility

As mentioned in section 1.3 problem statement of chapter 1, the policies on school location and active school travel are very successful in Japan. According to Tanaka et al. (2019), Japan's rank of active school travel is located in the second place right after the Netherlands among the developed countries, making it a unique case. In rural Japan, due to the physical barriers of the environment and the longer distances between students' living areas and schools, school buses are also widespread among children and adolescents.

Also, in a study on the independent mobility of children and young adolescents in 16 countries by Shaw et al. (2015), Japan stood in fifth place after Finland, Germany, Norway, and Sweden. Shaw et al. (2015) also state that Japan is a special setting where most children and young adolescents are granted the consent to go out alone after dark (in Finland, Sweden, and Denmark, the same situation exists). Although the living environment of the mentioned comparative study is not mentioned/differentiated, it seems that the high score of Japanese children's and young adolescents' mobility must be due to the high level of perceived traffic safety and security by caregivers. Most Japanese children and youth are engaged in extracurricular activities on weekdays, which may also be extended to weekends. According to Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) (2015), there is higher share of car trips among children and youth on weekends, and the pattern is more substantial among those living in regional areas (compared to large cities). To the best of our knowledge, non-school travel is also understudied in Japan, especially in rural areas where there are more burdens associated with the physical environment.

2.4 Gaps and Potentials of the Literature

Looking at the findings of the existing literature, it is evident that most of the studies have explored the scope of school trips in urban environments mainly to promote physical activity. However, adolescents' non-school travel aims to satisfy various needs other than physical activity, and its influential underlying factors are rarely studied. Although a few

research mentioned the significance of public transport use in adolescents' mobility, contributing to both physical and social benefits, the consideration of public transport as a promoter of independent mobility is understudied. Additionally, the existing literature fails to cover a variety of distinctive environments in the investigation of children's and adolescents' mobility. Rural areas have received far less attention than urban environments in travel behavior studies of children and adolescents. Furthermore, studying the travel behavior of young adolescents needs further attention since they are transitioning from childhood (relatively dependent on parents) to adolescence and youth (relatively less reliant on parents). Finally, the case of Japan and its relatively safe/secure environment for the independent travels of children and adolescents even with public transport provides a potential for such studies.

2.5 Conceptual Framework

Based on the gaps in the existing literature and the opportunities associated with the theoretical/empirical findings and the context of this study, we adopted a socio-ecological approach as the theoretical background of this research. This approach helps us consider different layers of influence in investigating young adolescents' independent mobility for their non-school trips in the rural and suburban areas of Japan. The categories discussed in sub-section 2.2.3 are used in the main structure of the conceptual framework (Fig. 2.1).

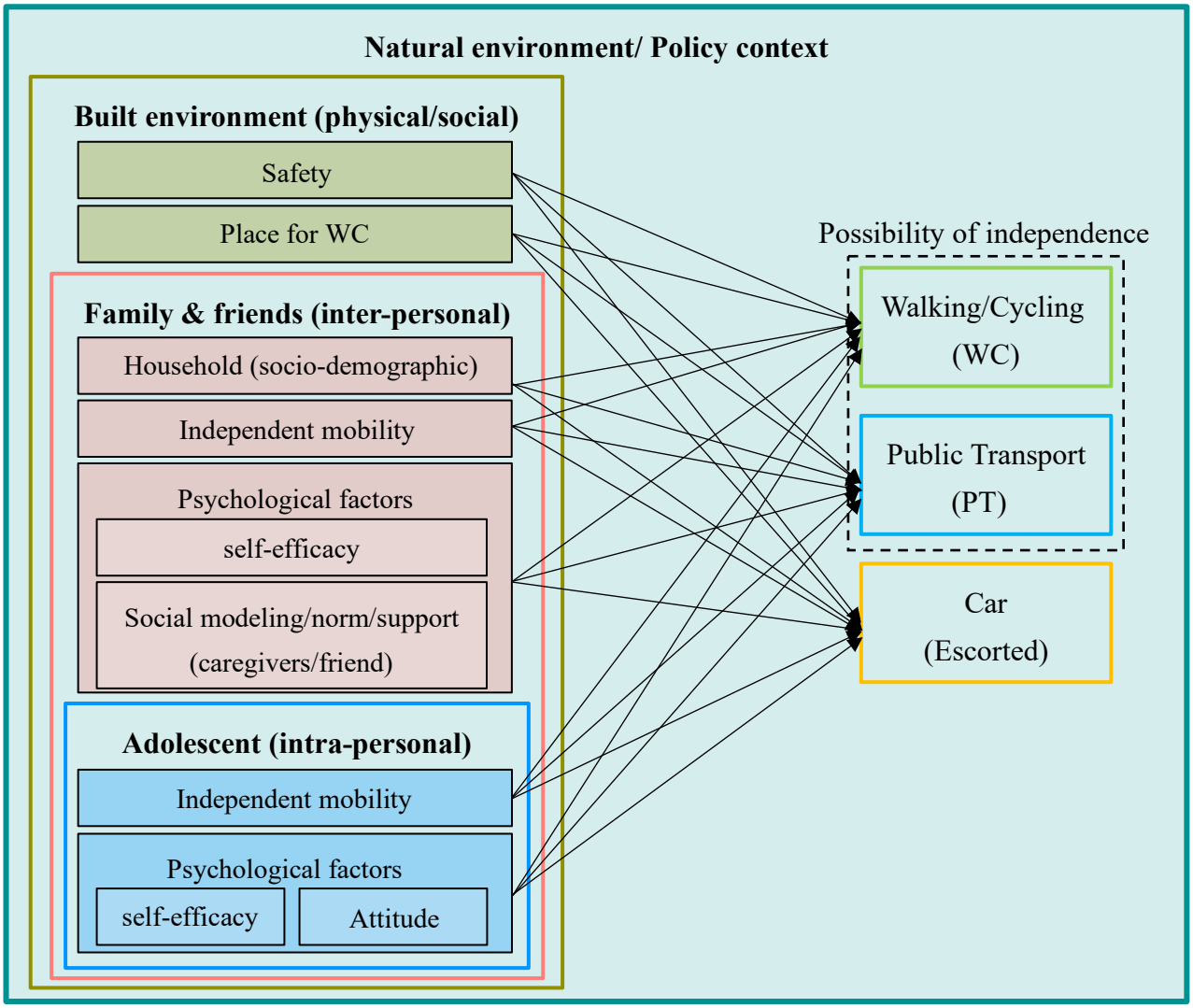


Figure 2.1 Conceptual framework for studying young adolescents' non-school trips adopting a socio-ecological model

Chapter 3: Methodology

3.1 Introduction

As mentioned in chapters 1 and 2, the primary purpose of this research is to study the effects of different factors influencing young adolescents' non-school travel within a socio-ecological framework in rural and suburban areas. Although such areas are highly dependent on private cars for daily mobility, it is not apparent how such a pattern affects young adolescents' daily travels for other purposes rather than going to school. The unique characteristics of the built and social environment of small towns and rural areas require specific attention toward maintaining and improving junior high school students' independent mobility. In this chapter, the research design, case studies, and sampling will be introduced first. Next, the instrumentation used in the survey is explained in detail. Last but not least, the data collection and analysis of this study will be described. An illustration of the conceptual model used as the basis of the analysis will close chapter 3.

3.2 Research Design

This study targets young adolescents enrolled in junior high schools (12-15 years old) of small towns and rural areas of Japan since this age group is transitioning between childhood and adolescence/youth, which could also be reflected in their travel behavior. In Japan, children's school travel is pre-determined by school policies and is mainly realized by utilizing active modes of transport or school buses. However, non-school travel (mode choice, conduct, etc.) is not following any rule and could be forged into different patterns. Hence, the main focus of this research is investigating the scope of non-school trips to identify the impacts of socio-demographic characteristics (e.g., age, gender, household construct, number of children/household, etc.), the level of independent mobility (i.e., license and distance), psychological variables (i.e., social modeling, norm, and support and perceived benefits and barriers of transport modes), and environmental factors (i.e., neighborhood safety, and walking/cycling environment) on young adolescents' mode choice.

As mentioned in previous chapters, children are the social agents of their age groups and should be the target respondents of the surveys designed to investigate their situation. Nevertheless, families and caregivers greatly influence children's daily mobility. Therefore, we designed quantitative research including junior high school students and their caregivers as the respondents to compare the viewpoints of these two groups in young adolescents' mode choice for non-school traveling. Since non-school trips have not been sufficiently investigated in the existing literature, especially in small towns and rural areas, we conducted a few exploratory interviews at the beginning of the survey to get a general outlook regarding the prevailing travel behavior. The results of these qualitative investigations (Khaleghi et al., 2021) were later reflected in the questionnaire design for the quantitative part of the study. It is noteworthy that the interviews only took place in two case studies.

3.3 Case Studies

Children are a sensitive group, and researching them is a complicated task in Japan, requiring consent from schools and other organizations such as educating councils, town offices, etc. Therefore, case studies were selected based on the collaboration chances we had at the time. To fulfill the goals of the research and answer its questions, we selected one town

in each of the following settings: a) suburban, b) coastal, and c) mountainous, which together could cover the whole range of small towns and rural areas in Japan (see Fig. 3.1).

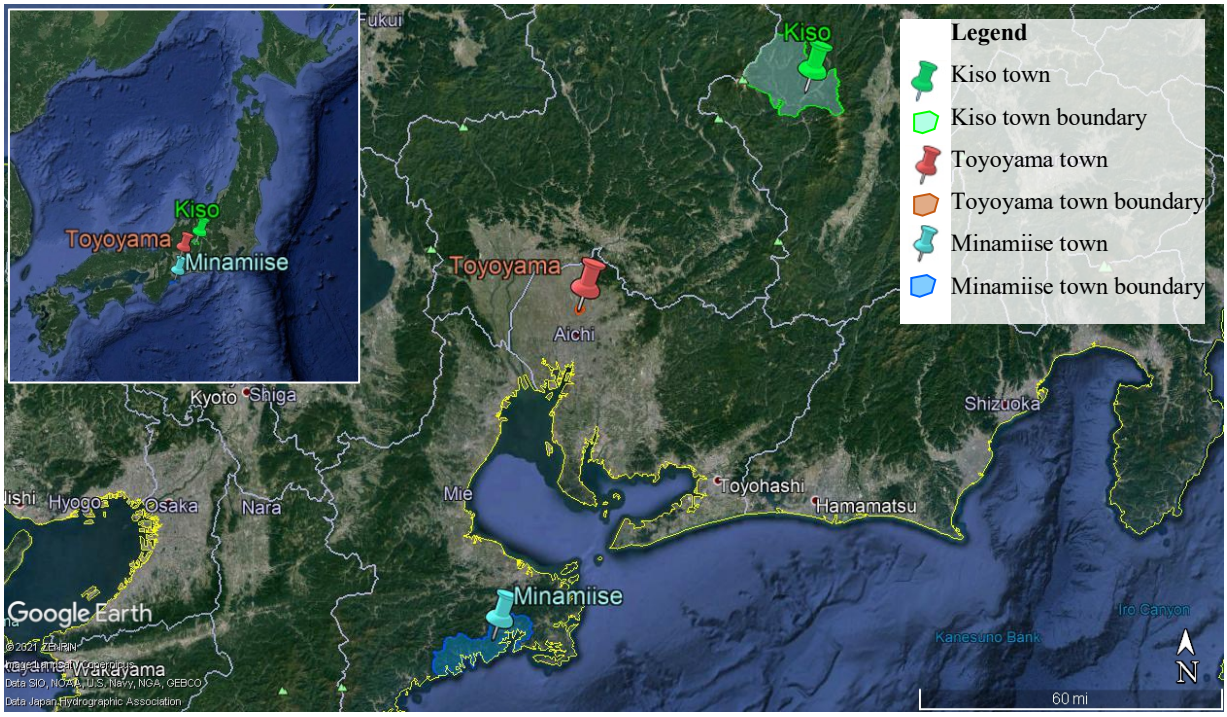


Figure 3.1 The location of the three case studies relative to one another

3.3.1 Toyoyama Town

Toyoyama town in the northeastern part of Nagoya was selected to represent the suburban small-sized setting. Toyoyama is the smallest town in Aichi with an area of 6.18 km^2, 15,844 inhabitants (as of March 2021), and a density of 2563 inhabitants/km^2 (Toyoyama Town Official Homepage, 2021). It is surrounded closely by Nagoya, Kita-Nagoya, Komaki, and Kasugai cities. The town is relatively flat (7-9 m above sea level) and represents no specific geographical features (Fig. 3.2). Despite the town's small size, it is relatively wealthy since it hosts industries such as Mitsubishi. The domestic Komaki airport is also located in Toyoyama.

Figure 3.2 Toyoyama, the town hall

Weather-wise, the summers are hot and humid, and winters are mild in Toyoyama town. This town has no railway tracks, but various companies provide different bus routes. The Toyoyama town bus can be utilized to get around in town; the Aoi bus and Meitetsu bus are available for traveling to locations out of the town. The most significant population inflow to Toyoyama is from Nagoya/Kita ward, whereas the largest outflow of Toyoyama's population is to Komaki city; and, Kasugai has the largest population inflow of Toyoyama's students (Toyoyama Town, 2020) (around 9 km, less than 20 minutes by car).

The aging rate in Toyoyama is currently around 22%, and it is expected to increase slightly. The town welcomes the elderly to voluntarily return their driving license for preventing traffic accident caused by this group. According to Toyoyama Town (2020), although the population is predicted to stay almost the same in the next 20 years, the children and young adolescents' population will slightly decrease in the same period. The person-trip survey conducted in 2011 shows that the rate of car share is very high in Toyoyama during weekdays and, particularly on weekends (67% and 86% respectively); roughly 25% more than Nagoya city (Toyoyama Town, 2020). Although walking/cycling are pretty popular on Toyoyama, bus share is tiny (1% of all trips) (Fig. 3.3 and 3.4). Additionally, in the latest public transport plan report, which targets 2020 to 2029, there is no specific mention regarding the promotion of public transport for this study's target group. For more information about the public transport plan and its proposed strategies, see appendix A1.

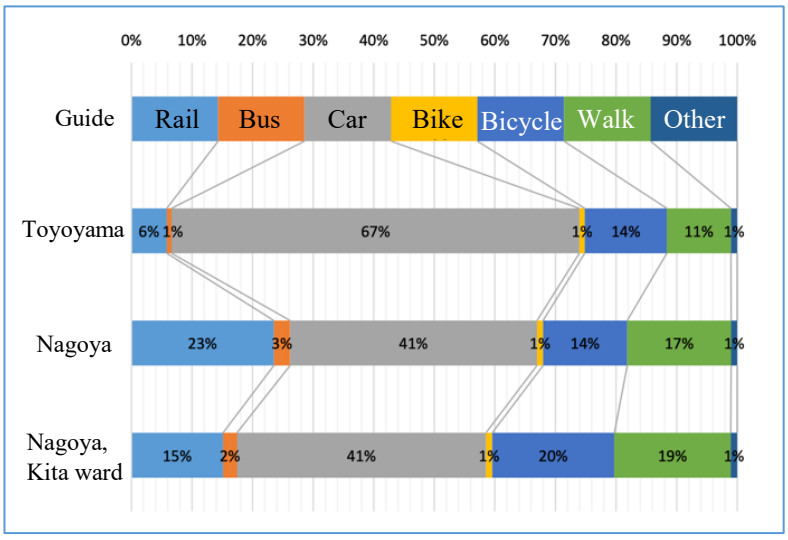


Figure 3.3 Modal split on weekdays, 2011 (Toyoyama Town, 2020, pp. 6)

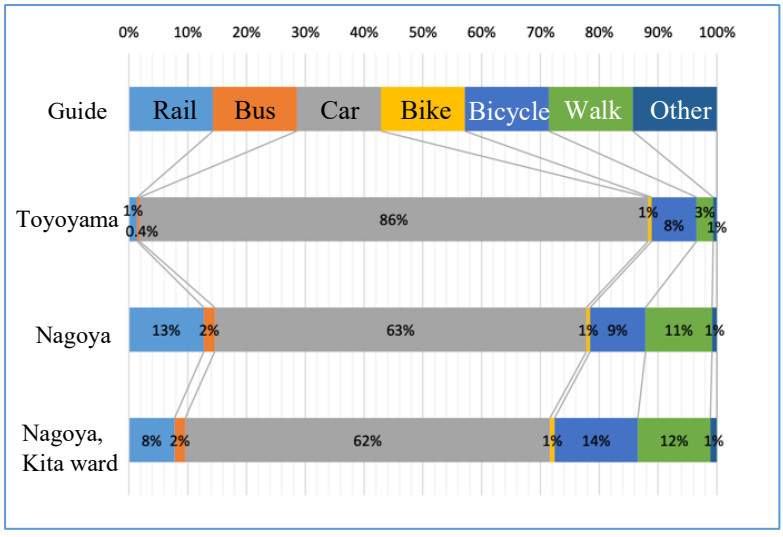


Figure 3.4 Modal split on weekends, 2011 (Toyoyama Town, 2020, pp. 6)

There are three elementary schools, one junior high school, and no high schools in this town. Toyoyama junior high school has 472 students (as of September 2020). Students usually walk or cycle to school. It is noteworthy that students in Toyoyama are not granted a free town bus pass.

3.3.2 Minamiise Town

Minamiise town in Mie prefecture was chosen for the mid-sized coastal context. Minamiise is a fishing town in a coastal region with an area of 242.98 km^2, 11,953 inhabitants (as of January 2021), a density of 49 inhabitants/km^2, and an aging rate of 50% (Minamiise Town Official Homepage, 2021). It is located in the central and southern part of the prefecture, bordering Ise city and Watarai town in the north, Shima city in the east, and Taiki town in the west. Minamiise is a rural area resulting from the merger of Nansei and Nantou towns in 2005. Minamiise, with its 245.6 km of coastline, small islands alongside the coast consisting of 38 villages, not very high lush mountains (less than 700 m), and relatively few flat areas, represents a very different context than the first case study (Fig. 3.5).

Figure 3.5 Minamiise, Nansei district
Photo by James Fichera - Own work, CC0,
https://commons.wikimedia.org/w/index.php?curid=47122552

The population is decreasing in Minamiise, which simultaneously has affected the use of means of public transport (town bus and on-demand bus). According to Minamiise town (2021), from 2015 through 2020, the town bus users have dropped more than 10000 rides (around 25% decrease) which is a lot sharper than the decrease in the population (approximately a 14% decrease) (Fig. 3.6). During the same period drastic decrease was observed in the share of on-demand buses (Fig. 3.7).

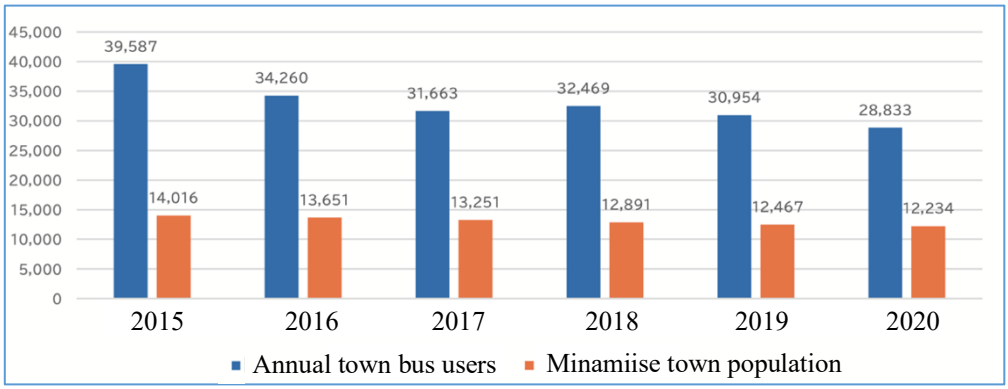


Figure 3.6 Trends in the population and the annual town bus ride (Minamiise town, 2021, pp. 7)

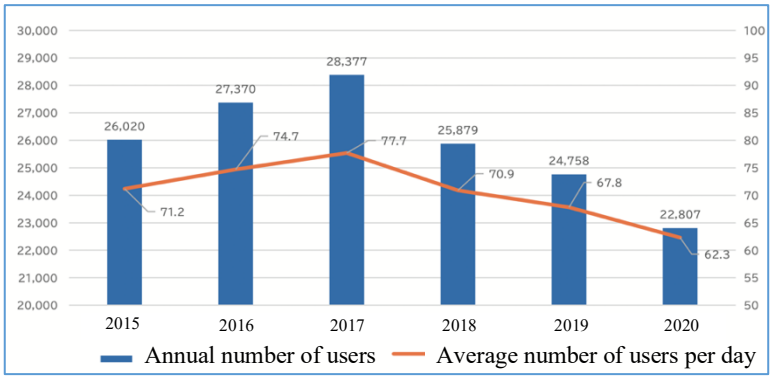


Figure 3.7 Annual number of on-demand bus users and average daily users (Minamiise town, 2021, pp. 7)

As far as the road distance to neighboring cities is concerned, from Gokasho in Nansei area, there is around 25 km to Ise city (approximately 30 minutes by car, and 1 hour by bus), 17 km to Shima city, 18 km to Watarai town, and 48 km to Taiki town. It is noteworthy that accessibility in Nantou areas is more complicated. Minamiise has hot and humid summers and mild winters. Due to its geographic location, Minamiise receives high levels of precipitation (mainly rain). There is no railroad in Minamiise town. For traveling in town, the infrequent service of the town bus and on-demand bus with limited working hours (8 am-5 pm requiring reservation in advance) are available. For getting out of the town, the Mie Kotsu bus is an option, providing an infrequent service (most of the time requires lots of transfers.)

The current public transport plan specifically aims to promote public transport for children by providing free town bus pass for elementary and junior high school students and regional bus discount for high schoolers to decrease children's mobility burdens on caregivers (Minamiise town, 2021). The town is very active in holding meetings among residents to exchange ideas for improving public transport service. Children and their mobility needs are considered explicitly in planning different means of public transport in this town (town bus, Mie Kotsu bus, and on-demand services). By investing in children and making the movement inside the town and to out-of-hometown locations, the town plans to slow down the depopulation since many families may leave when their children go to a high school out of town. For more information, see appendix A2. There are three elementary schools, two junior high schools, and one high school in this town. Nansei and Nantou junior high schools have 103 and 68 students, respectively (as of September 2020). Students usually use the school bus for their school trips.

3.3.3 Kiso Town

For the mountainous context, we selected Kiso town in the southwestern parts of Nagano prefecture bordering Gifu (Fig. 3.8). Kiso, is the largest town/village in Nagano listed as the 100 most beautiful villages in Japan. Kiso is mainly known for its historical background related to Nakasendo (one of the main passage trails connecting Tokyo and Kyoto in the Edo period), its abundant forests, Kiso River, and Mount Ontake (a sacred volcano). Most of the land is occupied by steep mountainous areas, except for some flat land along the Kiso River on the east side and the foot of Mt. Ontake on the west side.

Figure 3.8 Kiso, Kiso Fukushima district

Kiso town has an area of 476.03 km^2, 11,127 inhabitants (as of March 2019), and a density of 23 inhabitants/km^2 (Kiso Town Official Homepage, 2021). Kiso town results from the 2005 merger of Kiso-Fukushima town and the villages of Hiyoshi, Mitake, and Kaida. The altitude is approximately 700 to 850 m along the Kiso River, and about 1100 m in the Kaida area, making it one of the highest altitudes in Japan as a residential area (Kiso town, 2017). The tertiary industry is the largest share in Kiso town, mainly retail, wholesale, accommodation, and food, highlighting occupations linked to "tourism." Weather-wise, there

is a considerable difference in temperature between summers and winters and day and night in Kiso. Also, Kiso town receives heavy snowfall in winter, and frozen roads make transportation difficult in the cold season.

As far as the road distance to neighboring cities is concerned, there is 35 km to Ina city, from the center of Kiso town, 44 km to Shiojiri city, and 57 km to Nakatsugawa city in Gifu prefecture. Nagano city, where the prefectural office is located, is 130 km away from Kiso. In addition, Takayama city in Gifu is located 57 km away from the Kaida area. Also, one of the unique characteristics of transport in Kiso is easy railway access in parts of it (one major JR station in Fukushima and two local stations in the Hiyoshi district.)

Since most of the facilities are located in Kiso-Fukushima, the town's bus service is vital for the people living in other districts. However, the total number of bus users and revenue have been gradually decreasing between 2010 and 2014, putting a heavy burden on the town for maintaining the service (an annual value of 10000 yen per resident of the town) (Kiso town, 2017) (for more info, see Appendix A3). Also, the inconvenient service (infrequent, too many bus types) has caused an outflow of population to nearby cities such as Ina for shopping purposes. In 2015, a survey was conducted in Kiso, collecting the travel behavior data of 421 households (791 persons) (Kiso town, 2017). As the trip mode distribution for different purposes in Fig. 3.9 suggests, although the car ride is dominant in the categories of "commuting to work" and "going shopping," around 40% of trips with other purposes had at least a part made with public transport or active modes.

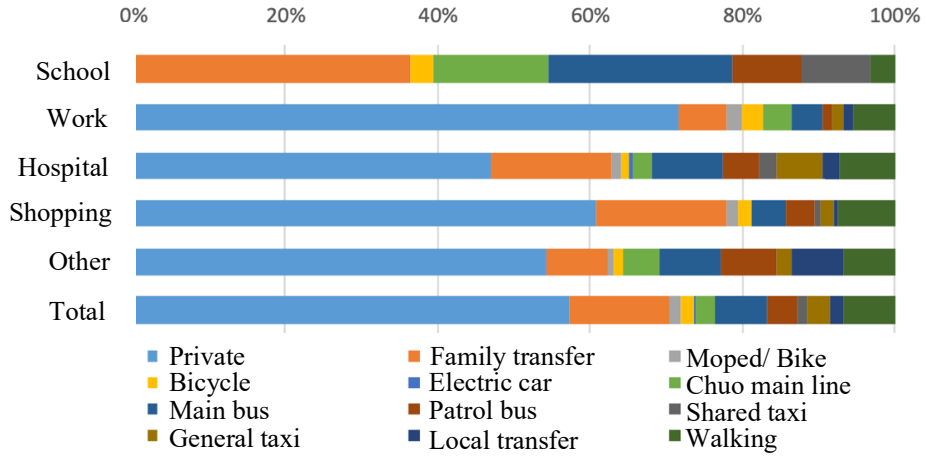


Figure 3.9 Distribution of transport modes based on the travel purpose (Kiso town, 2017, pp. 49)

Kiso town is facing severe depopulation and again issues (39% again rate in 2015). According to Kiso town (2017), around 70% of the population in Kiso town held a driving license in 2015 (more than a 20% increase in the past 30 years). In the same year, the average car ownership was two vehicles per household. Due to aging, many are not capable of driving and there are schemes for returning the driving license. However, not being able to drive causes many disadvantages, which are mostly felt by children and older women. Out of 4942 household of Kiso town in 2015, 765 (15.4%) belonged to single elderlies over 75 years old.

Kiso has three elementary schools, one elementary/junior high school, two junior high schools, and one high school. Kiso town, Hiyoshi, and Kaida junior high school have 161, 48, and 23 students, respectively (as of January 2021). Students usually use the school bus for their school trips. In Kiso town, junior high school students can use the town bus free of charge. Table 3.1 demonstrates a summary of the case studies' main features.

Table 3.1 Summary of the main characteristics of the case studies and their junior high schools

Small towns/rural areas category	small-sized suburban	mid-sized coastal	large-sized mountainous
	Toyoyama (Aichi)	Minamiise (Mie)	Kiso (Nagano)
Area (km^2)	6.18	242.98	476.03
Density (inhabitants/km^2)	2563	49	23
Available public transport	Different bus routes (In town/out of town: almost one service/hour)	Limited bus routes (In town: three-five services/day, out of town: almost one service/hour)	Train stations in Fukushima and Hiyoshi (limited bus routes, in town/out of town: almost one service/hour)
Number of junior high schools	1	2	3
Number of junior high school students	472	171	232
School trips main mode	Walking/Cycling	School bus	School bus

3.4 Sampling and Ethical Review

Due to the small population of the selected towns, we contacted every junior high school in the case studies (6 in total), and all schools agreed to participate in the survey. After the survey materials' translation procedure was completed from English (the original version) to Japanese (several translation/back translations were realized), each school checked the questions regarding the clarity of the language used for the target age group. We revised the questionnaires based on the comments and recommendations, keeping the survey's uniformity in all towns.

Moreover, the ethical issues of the research were discussed with the head principals, teachers of each school (in all three case studies), and the town officers collaborating with us (only in Minamiise and Kiso town). Based on such ethical reviews, we emphasized the voluntary basis of the survey, especially for questions regarding the respondents' personal information (such as gender, age, household construct, etc.). It is noteworthy that we were prohibited from asking caregivers about their income or education in all three towns. We added an introductory part at the beginning of each survey material to mainly emphasize the anonymous nature of the survey. The introduction also explained briefly the survey, the conductor and their contact information, and the utilization of collected data (in Kiso town, another complementary introduction from the town office was also added).

3.5 Instrumentation

In this paper-pencil survey, a questionnaire and a travel diary were uniquely designed for the young adolescents in which they answered questions about environmental variables, independent mobility extent, their positive and negative perception toward different transport modes, perception toward their significant others' travel behavior (social modeling/norm/support) and some personal socio-demographic characteristics (e.g., age, bicycle ownership, etc.). Junior high school students were also asked to fill out a travel diary about their non-school trips. In the caregivers' questionnaire, questions were asked regarding the consent around adolescents' independent mobility, socio-demographic features of the household, social modeling/norm/support (only the caregivers' opinion who filled out the survey was collected).

The questionnaire design was mainly based on validated questionnaires (De Bourdeaudhuij & Sallis, 2002; Hillman et al., 1990; Rosenberg et al., 2009; F. J. Sallis, 2009; J. F. Sallis et al., 1986; J. F. Sallis et al., 1989; Shaw et al., 2013). However, the results of the interviews in Minamiise (conducted in February 2020) and Toyoyama (conducted in September 2020) were utilized in adjusting the contents of the questionnaires to make it a better fit for junior high school students living in small towns and rural areas of Japan. The Japanese version of the survey contents used in Kiso town can be found in Appendix B.

3.5.1 Travel Diary

A travel diary was designed for the students to collect data about non-school trips. Due to the imposed limitations of the Covid19 pandemic on children's mobility, we had to take extraordinary measures in the data collection (will be discussed in the next section), which ultimately affected the travel diary template. Since we were unable to collect recent information about the non-school trips, the travel diary template should be simplified, asking only about the general details of a trip.

The introductory section of travel diaries provided information on the definition of a "trip," different types of "non-school trips," followed by filled-out samples. Students were asked to report their movement from A to B (when B is not located in the exact location of A) and give more details about their trip, including origin and destination, the realization time, the purpose, used transport modes, the people who accompanied them, and their mood during the trip. Due to the mentioned limitations, we decided not to include the possible different nature of the return trips in this study. Although there was space for reporting eight different trips in the travel diaries, students were asked to fill out the travel diary with at least four non-school trips traveling short and long-distances, keeping in mind to report both independent and supervised trips. An example of the travel diary sheet is available in Fig. 3.10.

Trip time (week)	NO.	Origin	Location	Destination	Location	Trip time (day)	Purpose	Mode/s of transport (Mark all the used modes for each trip)					Accompanying persons (Mark all the companions for each trip)				Feeling during each trip				
								Walk	Cycle	Bus	Train	Car	Parents / friends' parents	Friends	No one	Others	Very good	Good	Neither good or bad	Bad	Very bad
Weekday / Weekend	1		( )		( )												5	4	3	2	1
Weekday / Weekend	2		( )		( )												5	4	3	2	1
Weekday / Weekend	3		( )		( )												5	4	3	2	1
Weekday / Weekend	4		( )		( )												5	4	3	2	1

Figure 3.10 An example of the English version of the travel diary sheet

3.5.2 Questionnaire

3.5.2.1 Socio-Demographic

Young adolescents and their caregivers reported socio-demographic characteristics. Students reported their age, living district (there are three, two, and four main districts in Toyoyama, Minamiise, and Kiso town, respectively), ownership of bicycles and cellphone/smartphone, and information about elder siblings (if they had any elder siblings and also if any of those elder siblings were pursuing their career/educational goals out of the town).

Caregivers reported their age (was categorized into three categories of 1) less than 40, 2) 40-50, and 3) over 50), household construct (was categorized into four classifications of 1) parents and children, 2) parents, children, and grandparent/s, 3) single parent and children, and 4) single parent, children, and grandparent/s), caregivers' job (was classified into four categories of 1) full-time employees, 2) part-time employees, 3) full-time self-employed, and 4) full-time homemaker or unemployed), the number of cars per household (three categories of 1) one, 2) two, 3) three or more), and the number of children per household (four categories of 1) one, 2) two, 3) three, and 4) four or more). Caregivers also reported students' gender (except for Minamiise town, where the permission for collecting such information was not granted).

3.5.2.2 Independent Mobility License and Distance (subjective)

The independent mobility license index (Hillman et al., 1990; Shaw et al., 2013) was used to get a general perspective on the level of students' independent mobility. It is noteworthy that two items were deleted from the 6-item scale since Japanese junior high school students already cross main roads and travel home from school alone or with friends. The final 4-item scale included: 1) go to places other than the school within walking distance, 2) go out after dark, 3) cycle on main roads, 4) use the town bus. Young adolescents provided yes/no answers to the above items notifying the researchers of having/not having their caregivers' consent to realize each of the activities alone/with friends. The independent mobility distance was evaluated by the farthest destination to which students could travel independently. The options included a) home area, b) school area, c) inside the town, d) out of the town. Same questions were also asked from caregivers to understand the differences between young adolescents' and caregivers' perceptions about independent mobility.

3.5.2.3 Psychological variables (subjective)

According to the social learning theory, which concentrates on the cognitive processes of interactions between individuals and the environment in shaping the behavior, psychological variables were selected based on the previous questionnaires (De Bourdeaudhuij & Sallis, 2002; Sallis et al., 1986, 1989; Verhoeven et al., 2016). Some of the questions were not easily translated to Japanese, especially for the target group of 12–15-year-old. Therefore, wherever needed, more explanations were provided to make the questions clear and understandable for students. In general, perceived benefits and barriers of transport modes, self-efficacy for using walking/cycling and public transport over the car, social modeling/norm/support (related to different modes of transport) were considered. Transport modes were classified into three groups of 1) walking/cycling (active modes were grouped for the sake of simplicity), 2) public transport, and 3) private car.

Perceived positive and negative criteria associated with three categories of transport modes were assessed by asking students to rate their agreement with several different statements aiming to reflect the benefits and barriers of means of transport. For preparing the scales of these variables, in addition to the results of the preliminary qualitative research in the case studies (Khaleghi et al., 2021), the findings of the previous studies (Stark et al., 2019; Zwerts et al., 2010) were used. The data on positive and negative attitudes toward different transport modes were only collected from the students. Detailed information on the items used in appraising the mode-specific perceived benefits and barriers can be found in Table 3.2.

Table 3.2 Detailed information on the items used for measuring mode-specific benefits and barriers

No.	Perceived Benefits	Perceived Barriers
Walking/Cycling (WC)		
1	I am on the way without adult supervision	Walking can be tiring for long distances
2	I can choose my way without adult supervision	Walking is inconvenient in bad weather
3	I can talk/play games with my friends on the way	Cycling is not preferable in bad weather
4	Walking/cycling is an exercise (good for health)	I cannot walk far
5	I feel less stressed while walking/cycling	Walking is slow and takes much time
6	Walking/cycling do not produce any pollution	It is dangerous to walk on a road at night
7	Walking and cycling are free of charge (if I own a bicycle or benefit from bicycle-sharing)	Cycling is exhausting when there are steep slopes
8	I can do other things while walking/cycling	It is dangerous to ride a bicycle on a steep slope
9		It is dangerous to ride a bicycle at night
Public Transport (PT)		
1	I can move around safely even in bad weather	I find using public transport difficult (reading timetables, finding the location of bus stops, etc.)
2	The ride on the bus/train is quiet and relaxing	Getting to bus stops/stations is difficult
3	I can do other things while on the bus/train	Sometimes, I have to ask my caregivers or others to pick me up at the bus stops or stations
4	I feel confident and independent when I can go out by public transport without adult supervision	I am worried about making mistakes or getting lost without adult supervision
5	I can talk to my friends on the way	Public transport fare is high
6	I can go far away, access to different facilities and opportunities	Long waiting time at the bus stops or stations is very annoying
7	Public transport carries more people than a car, and that is why it can be less polluting than a car	It stops multiple times, so using public transport usually takes time
8	I exercise when I walk/cycle to the bus stops/train stations	If I get into trouble while riding, I have to ask a stranger for help (driver, station staff, etc.)
9	Public transport is necessary for the elderly who can no longer drive a car	I usually rely on adults' advice before using public transport (family members or school teachers)
10	Public transport is necessary for all the people who do not hold a driver's license	I do not know all about public transport (e.g., I have no idea what demand-buses are)
Private Car		
1	My caregivers can take me wherever I want to go at any time	I have to ask someone to give me a ride (it is not up to me)
2	I feel very comfortable	I cannot talk to friends while in the car
3	I can move around at a fast speed	I cannot go out alone in a car
4	The driver/other adults are responsible for everything, so I am less worried	Compared to other means of transport, it is more polluting (less environmentally friendly)
5	I can listen to music & enjoy the scenery while riding	It costs a lot to maintain a private vehicle (repair, insurance, etc.)
6	I can share a ride with my friends/others	The car ride is sedentary (no physical activity

To measure young adolescents' capability in using walking/cycling and public transport when a private car was also an option, we asked if they were willing/able to select 1) walking/cycling and 2) public transport over the private vehicle under challenging circumstances. Seven difficult situations were proposed: traveling in bad weather, at night when there is not much ambient light, being late for an activity, feeling tired, going to

unfamiliar places, carrying heavy things, and being on their own. Both students and their caregivers reported young adolescents' self-efficacy.

Social modeling, norm, and support in this study are basically about how the travel behavior of significant others affects young adolescents' mode choice for their non-school trips. The data on these variables were collected by firstly asking the students about their perceptions toward their caregivers and friends separately, and secondly, by asking caregivers to provide first-hand answers (only about themselves or their children). Both students and their caregivers reported their answers about the three classifications of transport modes mentioned above. Social modeling was evaluated by assessing students' caregivers' and friends' mode use frequency fulfilling different purposes. Social norm variable appraised students' and caregivers' beliefs toward using different modes for non-school trips. Finally, social support was evaluated based on the two criteria of 1) the frequency of encouragement received from students' caregivers and friends for utilizing different modes of transport, and 2) the frequency with which students made trips together with their caregivers and friends by walking/cycling, public transport, and the private car.

3.5.2.4 Environmental variables (subjective)

Current literature has highlighted "neighborhood walkability" as the primary concern in the category of environmental variables influencing children's mode choice. We used the adolescent version of the Neighborhood Environment Walkability Scale (NEWS-Y) (Rosenberg et al., 2009; Sallis, 2009) for our purpose. However, NEWS-Y is designed and validated for urban environments. Therefore, not all the subscales or items were relevant to the contexts of the case studies in this research. Eventually, subscales F/H/I (places for walking/cycling, neighborhood pedestrian and traffic safety, and crime safety, respectively) of the NEWS-Y were selected to be used in this research. We adjusted the contents according to the data we collected from the interviews with students in Toyoyama and Minamiise.

A 4-item scale for "places for walking and cycling" was made by keeping item 1 of the subscale "F" of the NEWS-Y and adjusting/adding three more items which are as follows: a) sidewalks feel like being narrow and dangerous, b) the sidewalks in my neighborhood are not well maintained, making it difficult to walk or ride a bicycle, and c) there are steep slopes on the roads in my neighborhood which makes it difficult to walk and ride a bicycle. Item 1 (there are sidewalks everywhere) in this subscale was later deleted since it decreased the scale's internal consistency in all three towns.

The subscales "H" and "I" were combined as a 9-item scale for "neighborhood safety," in which items 2/3/4/6 from the "H" subscale and item 1 from the "I" subscale were taken. Three following items were added for "traffic safety": a) some cars ignore the traffic lights, b) there are steep slopes on the roads in the neighborhood, especially around the curves, which are dangerous due to poor visibility, and c) sometimes I see dangerous wild animals, such as stray dogs, wild boars, etc. in my neighborhood. One item was added to the "crime safety" measures: fear of being hurt by suspicious strangers makes me worried about going out on foot or by bicycle with my friends or on my own. In Minamiise, two items, and in Kiso, three items were later discarded to improve the scale's internal consistency. In our study, higher scores denote better environmental qualities for walking and cycling. Therefore, the items which were asking about the negative features were reversed for calculating the scale scores. For all the scales, the averages of item scores were used in the data analysis. Fig. 3.11 illustrates a more detailed version of the conceptual framework based on the discussed instrumentation.

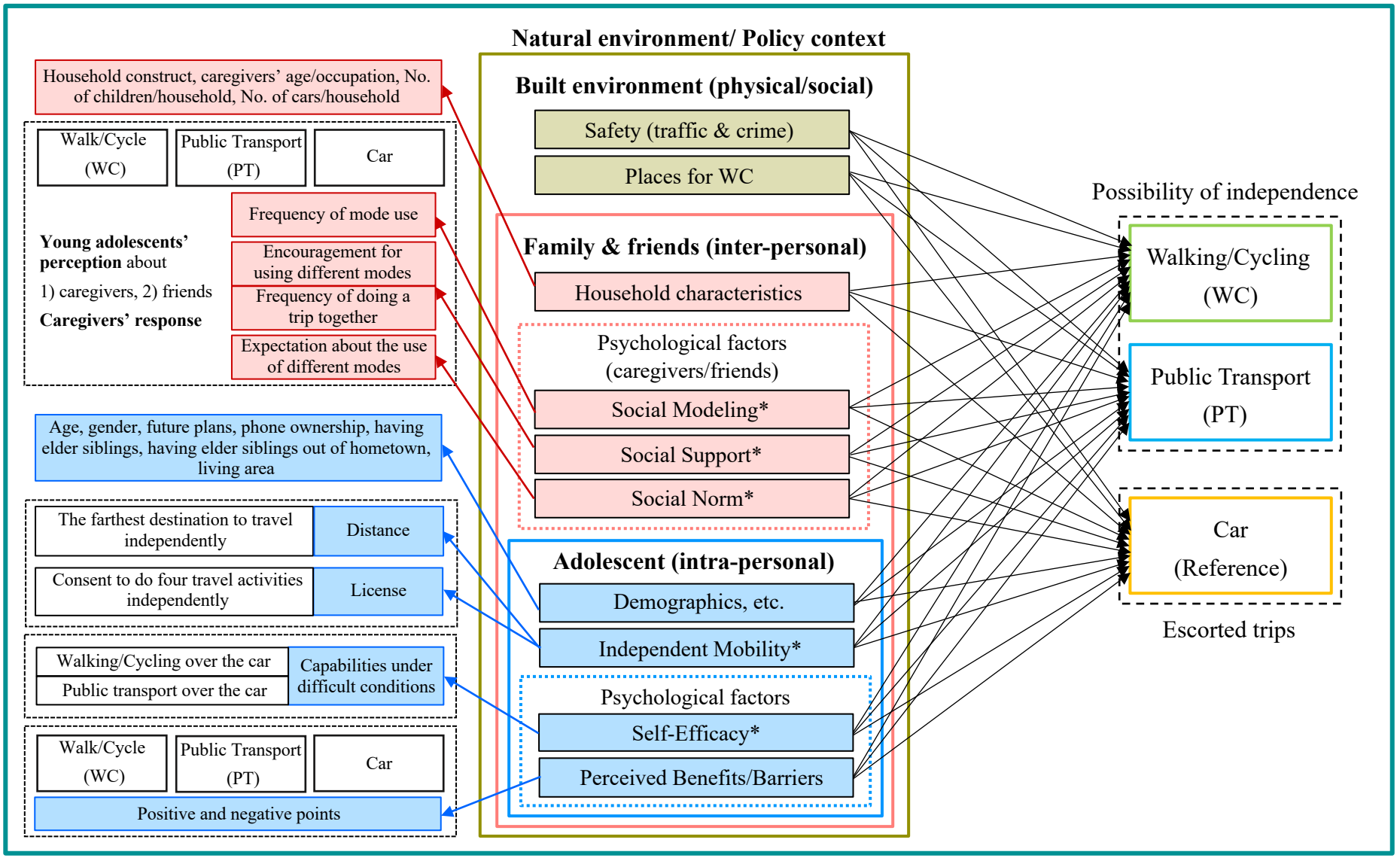


Figure 3.11 The conceptual framework used as the basis of the data analysis (young adolescents and their caregivers provides answers for the items with an *)

3.6 Data collection

We surveyed Toyoyama and Minamiise town in September 2020. Due to the difficulties caused by the pandemic, we surveyed Kiso town later in January 2021. The surveys were distributed at schools, and all students of the junior high schools received an envelope from their teachers containing two versions of questionnaires (one for the students, one for their caregivers) and a travel diary for students to report their non-school trips. The participants were given one week to fill out the survey and return the envelope to their teachers. In Toyoyama, we delivered and collected the survey materials. However, in Minamiise and Kiso, the procedure was done by post.

This research intended to target the non-school trips, especially the extent of independent mobility in small towns and rural areas, to understand the multi-level factors affecting the use of different transport modes. However, the outbreak of the Coronavirus coincided with the survey implementation and changed everything. At the beginning of 2020, children, among others (maybe even more strictly), were obligated to limit their activities out of the house or were only chauffeured around by their caregivers to cater to their necessary activities. Therefore, we had to take extraordinary measures and adapt to the new situation. Since collecting the data on non-school trips was vital to this study, and in the first half of the year 2020, even necessary daily trips such as school travels were limited, we decided to survey a period before the start of the pandemic. Consequently, every question in the questionnaire had to target the same timeframe. Therefore, the phrase "before the spread of the Coronavirus" was added at the beginning of all the questions.

Although the solution mentioned above seemed suitable on paper, 2020 was full of surprises and uncertainties. Hence, the plans were not progressing as smoothly as expected, especially for collecting the non-school trips. By the time we got the consent of schools and town offices, around nine months had passed from the start of the pandemic. After carefully considering the situation with schools in Toyoyama and Minamiise, we asked students to report the non-school trips they made between September and November 2019. This timeframe was representative of a typical situation before the pandemic, which did not coincide with the summer holidays, and weather-wise, represented the same characteristics in all the case studies. However, the survey was not implemented until the middle of January 2021 in Kiso town. Since the proposed timeframe for the data collection in Toyoyama and Minamiise was more than a year away for the case of Kiso, we changed the period to "between September and October 2020." Although this new period was in the middle of the pandemic, Kiso town officials and school principals assured us that Nagano prefecture was not affected by the Coronavirus until November 2020 (the beginning of the cold season). Such unfavorable decisions were necessary due to the exceptional circumstances of the pandemic and are part of this study's limitations.

In Toyoyama, Minamiise, and Kiso town, 220, 170, and 204 survey sets (including two questionnaires and a travel diary) were retrieved, respectively (a response rate of 46%, 99%, and 88% with the same order). However, not all the survey sets were wholly filled out, so we selected 173, 143, and 171 valid questionnaires in Toyoyama, Minamiise, and Kiso town for the data analysis.

3.7 Data Analysis

3.7.1 Introduction

Daily travel is a tangible experience for everyone and forges into new shapes based on our needs in every stage of life. Travel is a decision we make to meet those needs, which requires us to move around in specific ways, doing things in different places at different times (Goulias et al., 2020). Travel behavior is also entangled with psychological aspects of human behavior, such as attitudes, norms, intentions, feelings, etc. Establishing utilities or considering the intuitional behavior as the foundation of decision-making about the realization of different activities gives way to recognizing the underpinning of a complex behavior like travel (Goulias et al., 2020). Such understanding is essential since the economy relies on transport to a considerable part, and transport policies can critically change the systems and the living environment (McFadden, 1974), and as a result, alter the travel behavior. Therefore, the relationship between travel behavior and built environment/transport systems is interactive.

3.7.2 Choice Models

Choice models have been used to explore the nature of such decision-making for selecting one mode of transport among a set of mutually exclusive alternatives. These models hypothesize that a decision-maker (in our case, a young adolescent) can differentiate and prioritize among the alternatives (different modes of transport) based on a utility function, and the chosen alternative is the one with the highest level of utility (Croissant, 2020). Mainly in the field of adults' travel behavior, choice models have been applied to provide an efficient tool for travel demand forecasting and establishing proper transportation policies. Children face more limitations and less control over their travel behavior compared to adults. Notwithstanding, the same travel behavior definition can be applied to children. In a sense, children are more affected by than affecting the system. It is critical to distinguish these effects if we aim to promote specific modes of transport among children. In addition, the evolving nature of travel behavior in special stages of life in which behavior is shaping makes studying children's travel behavior even more prominent.

McFadden's discrete choice model (McFadden, 1974) is fit using conditional logistic regression (conditional logit model) and requires the IIA assumption to hold. The IIA assumption checks for the independence of irrelevant alternatives, which means that in case one of the alternatives is discarded from the model, the probability of other alternatives being chosen should remain the same compared to a model including all the alternatives. Choice models require data in a particular form called a "long format" in which every single observation in a "wide format" (the standard form) is multiplied by the number of available alternatives and altogether form a "case." In the long format, a new variable (called indicator variable) is generated representing the final choice which signifies the chosen alternative with the value of 1 and the rest with a value of 0. Both "case-specific" and "alternative-specific" independent variables can be used in McFadden's choice models. "Case-specific" variables, such a gender, remain the same among the observations of a case in the long format, whereas "alternative-specific" variables have different values for each of the observations in a case. An example of "alternative-specific" variables in our study is the "perceived benefits/barriers" of different modes.

Assuming J as the number of possible alternatives, p as the number of alternative-specific variables, and q representing the number of case-specific variables, the data matrix Xi for case i would be $J \times p$, whereas the data vector for case i would be $1 \times q$ (StataCorp, 2021a). The random utility model can be demonstrated in the following function:

$$u_i = X_i\beta + (z_i A)' + \varepsilon_i \quad \text{Equation 1}$$

In the above model, ui calculates the utility of J alternatives for case i in which the selected choice has the highest utility, and β is the alternative-specific regression coefficients (a vector of $p \times 1$), whereas $A = (\alpha_1, \ldots, \alpha_J)$ demonstrates the case-specific regression coefficients (a vector of $q \times J$) and elements of εi are extreme-value random variables ($J \times 1$ vector) (StataCorp, 2021a). One of the αj should be fixed to zero, usually called the base alternative to normalize the location. It is best to compare the logit model with a linear model to gain a better perspective. Equation 2 shows a linear model, whereas equation 3 represents a logit model.

$$Y = a + bX_1 + cX_2 \quad \text{Equation 2}$$

$$\text{logit}(p) = a + bX_1 + cX_2 \quad \text{Equation 3}$$

The two models are different in the sense that in Equation 2, a 1-unit increase in X_1 (assuming that other variables are not changing) can cause the Y to increase/decrease by b (depending on the sign of coefficient b). However, the same change in X_1 in function 3 is changing the logit value, not p, or Y. logit(p) is representing log(p/1-p) or log-odds in which p is demonstrating the probability of selecting a specific alternative, and (1-p) shows the probability of that specific alternative not being selected (i.e., another alternative is selected, e.g., the base alternative). Equations 4 and 5 show how we can alter Equation 3 to calculate odds ratio and probability.

$$\text{Odds ratio } (p/1-p) = \exp(a + bX_1 + cX_2) \quad \text{Equation 4}$$

$$\text{Probability } (p) = \frac{\exp(a+bX1+cX2)}{1+\exp(a+bX1+cX2)} = \frac{1}{1+\exp(-(a+bX1+cX2)} \quad \text{Equation 5}$$

Owing to the non-linear relationship between the independent variables and the outcome, the interpretation of choice models is relatively tricky. Apart from the sign of the coefficients (logit value) showing the direction of an effect, the coefficients are almost uninterpretable. Odds ratios and relative-risk ratios can also be computed, and the likelihood of an event over another event can be compared (in this research choosing a specific transport mode over the reference mode), which is still a lot more meaningful than the logit values. However, such an estimate is a ratio in which even the magnitude of odds is not showing. Besides, odds ratios do not provide any information on the probabilities. Hence a better intuitive interpretation is needed to overcome these shortcomings. Postestimation methods, such as "margins," are used to calculate the probabilities of choosing different modes under defined circumstances. Calculating average marginal effects (AME) is a practical way of providing more meaningful interpretations. With AME, the interpretation shifts to a change in the probabilities of different alternatives (here modes of transport) due to an infinitely small change in a continuous independent variable or a discrete change from a base level to a group level for a categorical variable. "Margins" can also be predicted with customized settings and make it possible to test different hypotheses and come up with better ways of explaining the causal effects for the sake of drafting efficient policies.

3.7.3 Data Analysis Procedure

IBM SPSS Statistics (version 27) was used for data preparation and explaining the sample characteristics. Moreover, since the outcome of our collected data are choices among modes of transport, and considering the diverse nature of independent variables, we used McFadden's discrete choice model for the data analysis by utilizing Stata/BE 17.0 (StataCorp, 2021b) and the "mlogit" package in statistical programming language R (version 3.6.3). As stated before, choice models are usually based on the utility theory and have broad application in studying adults' travel behavior. However, this study's target is young adolescents, and we adopted a socio-ecological model as the conceptual framework of this study which emphasizes behavioral reasoning rather than the economic rationale of the utility theory. Therefore, the utility might be redefined in the context of this research. The maximum value (utility) goes to the alternative, which is more supported by the behavioral settings including the intra-personal level (e.g., child's gender, age, attitude), inter-personal context (e.g., household and significant others' impacts), the built environment, and policy (provision of free bus passes, etc.).

We started the data analysis by data preparation. Firstly, we arranged the data in a "wide format" based on the unit of a single "trip." Except for some categorical variables such as students' gender, enrolling grade at school, living district, and caregivers' relation to the students, the rest of the missing values were replaced with the most frequently reported value in each question. It is noteworthy that the share of missing values was very small.

Next, we tried to simplify the collected data in the travel diaries. Trip destinations were categorized into: a) inside the town and b) out of the town. We classified the reported trip purposes according to the definition of Csikszentmihalyi & Schneider (2000) for teenagers' activities. Three main categories were distinguished for trip purposes, namely a) leisure (e.g., doing hobbies, socializing, etc.), b) productive (attending cram school, etc.), and c) maintenance (shopping, eating, etc.). The reported accompanying people for each trip were also classified into two groups: a) supervised (an adult is accompanying the young adolescents) and b) unsupervised (students are on their own or in the company of friends).

Also, since students reported more than one mode used for some of their trips, we analyzed the reported patterns and came up with six preliminary classifications, namely 1) walking/cycling, 2) public transport (public transport alone or with active modes), 3) car or taxi, 4) walking/cycling and the private vehicle, 5) public transport and the private vehicle, 6) trips with mixed modes including walking/cycling, public transport, and the private car. Notably, a tiny share of trips belonged to categories 4, 5, and 6 in all the case studies. We decided to add the trips in category 4 to category 3 since we assumed that the car is highly likely to be the main mode in a trip made by active modes and the car. Category 5 and 2 were also mixed based on another assumption that car pick-ups usually take place in trips realized with public transport. Category 6 was excluded from the analysis. Establishing the three main categories of transport modes (3 alternatives to be selected), we then generated the "long format'" of the data for each town in R, ready to be used for analysis (choice models and postestimation) in Stata.

On account of the high number of independent variables in this study and to discard the insignificant variables, the final models were made based on the results of preliminary models. It is noteworthy that we took the "car" as the reference outcome in all the models. Considering the mentioned method and since the natural environments of the case studies are relatively different in terms of size and geographical context, we analyzed each town's data separately

and compared the results in the end. It is noteworthy that a general model was also developed for the three case studies with a categorical variable represented each town's data, which gave a general outlook about the targets in small towns and rural areas. To prepare the final models, firstly, conditional logit models were built by including the socio-demographic variables (12 in Toyoyama and Kiso, 11 in Minamiise, and 11 in the general model). Furthermore, we repeated the same procedure for the psychological (with 15 continuous variables), environmental (with 2 continuous variables), and independent mobility variables (with 10 categorical variables) separately. Only those variables with a trend toward a significant relationship ($p<0.10$) were selected and used in the final model of each town. Fig. 3.12 and 3.13 demonstrate the model making process and the analysis model, respectively. The the selected variables in the preliminary phases of each model are depicted in Fig. 3.14 and 3.15.

Consequently, the four final models are not identical in terms of the predictors of mode choice. There is also another distinction among the final models related to some of the psychological variables. Except for the social support variable in Minamiise and Kiso, the rest of the data on social modeling/norm/support could not be used as a scale in the analysis due to low internal consistency (Cronbach's $\alpha < 0.5$). Therefore, they were utilized separately in terms of 1) students' perception about caregivers, 2) students' perception about friends, and 3) caregivers' responses in data analysis. In the general model, all the social modeling/norm/support variables were used separately.

We calculated both AME and customized margins for the significant variables of the final models in each town and used them in explaining and discussing the results. Finally, the suitability of models was tested using a Hausman-type test of IIA (independence of irrelevant alternatives). Since "public transport" and "private car" as motorized modes of transport are closer to each other than "walking/cycling," the chance of selecting them might be interrelated to one another. Hence, we discarded "public transport" cases and checked the chi-square value for the difference of the two models' estimates (one with all the alternatives, the other without the public transport cases). The two models' results were combined by a postestimation command in Stata called "suest" (seemingly unrelated estimation). Finally, by testing the difference of estimation between the two models and checking the chi-square and p-value (the insignificant value proves that IIA holds), we checked for the IIA assumption in our choice models. The same procedure was repeated by discarding the "private car" cases instead of the "public transport" cases. The results of the tests for all the three final models indicated that the IIA assumption was not violated.

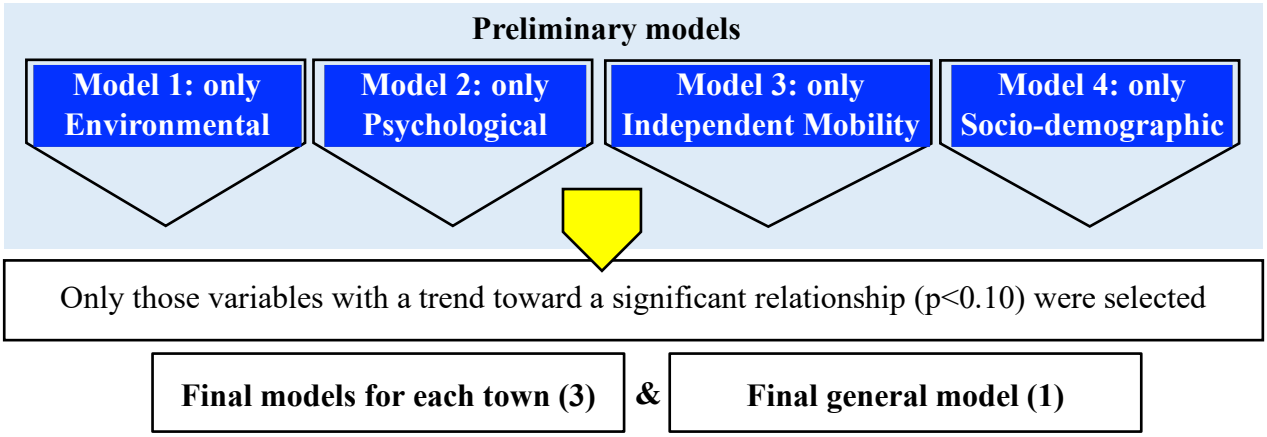


Figure 3.12 A simple illustration of the model making process

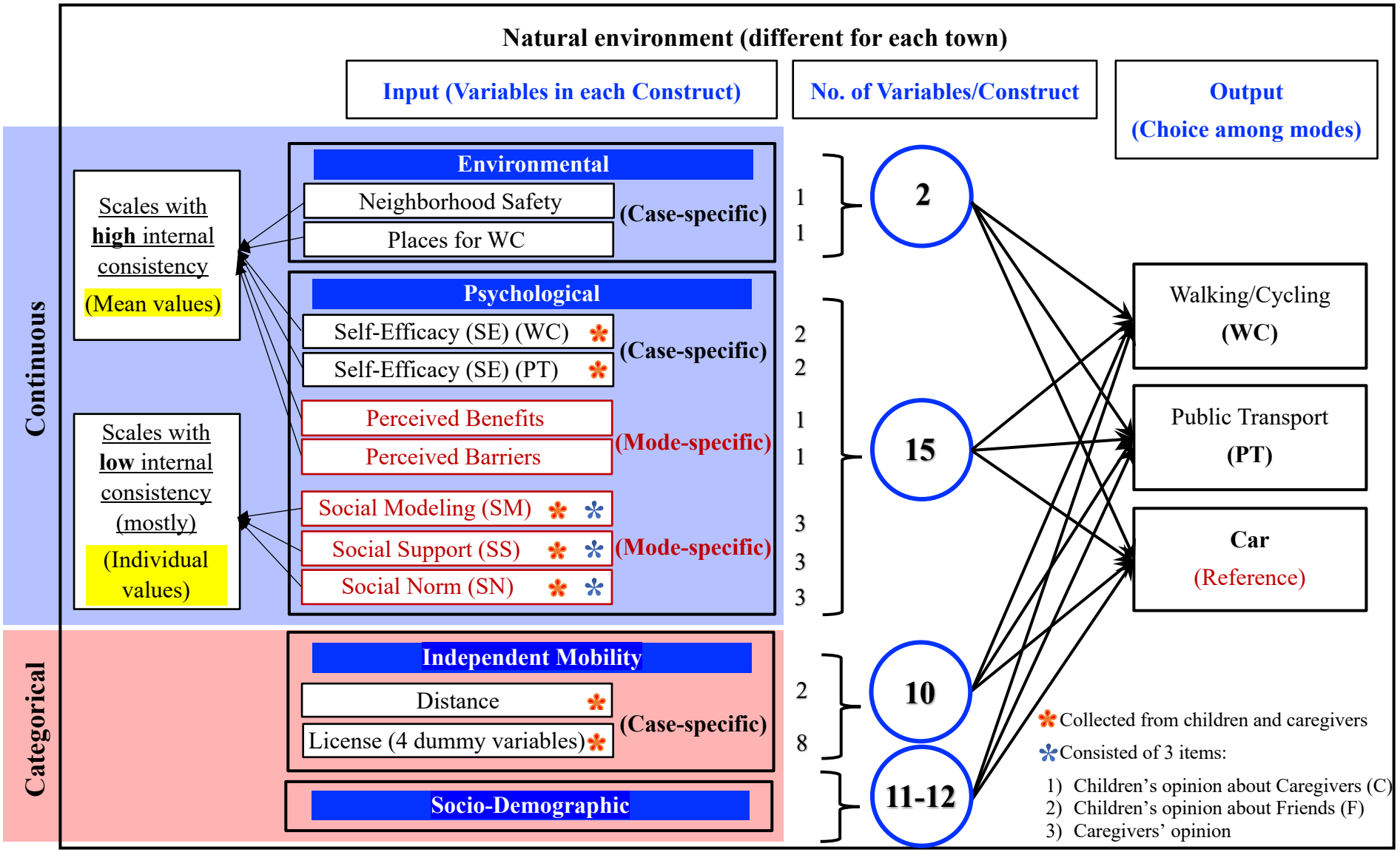


Figure 3.13 Analysis model used for developing the conditional logit models of each town and the general model

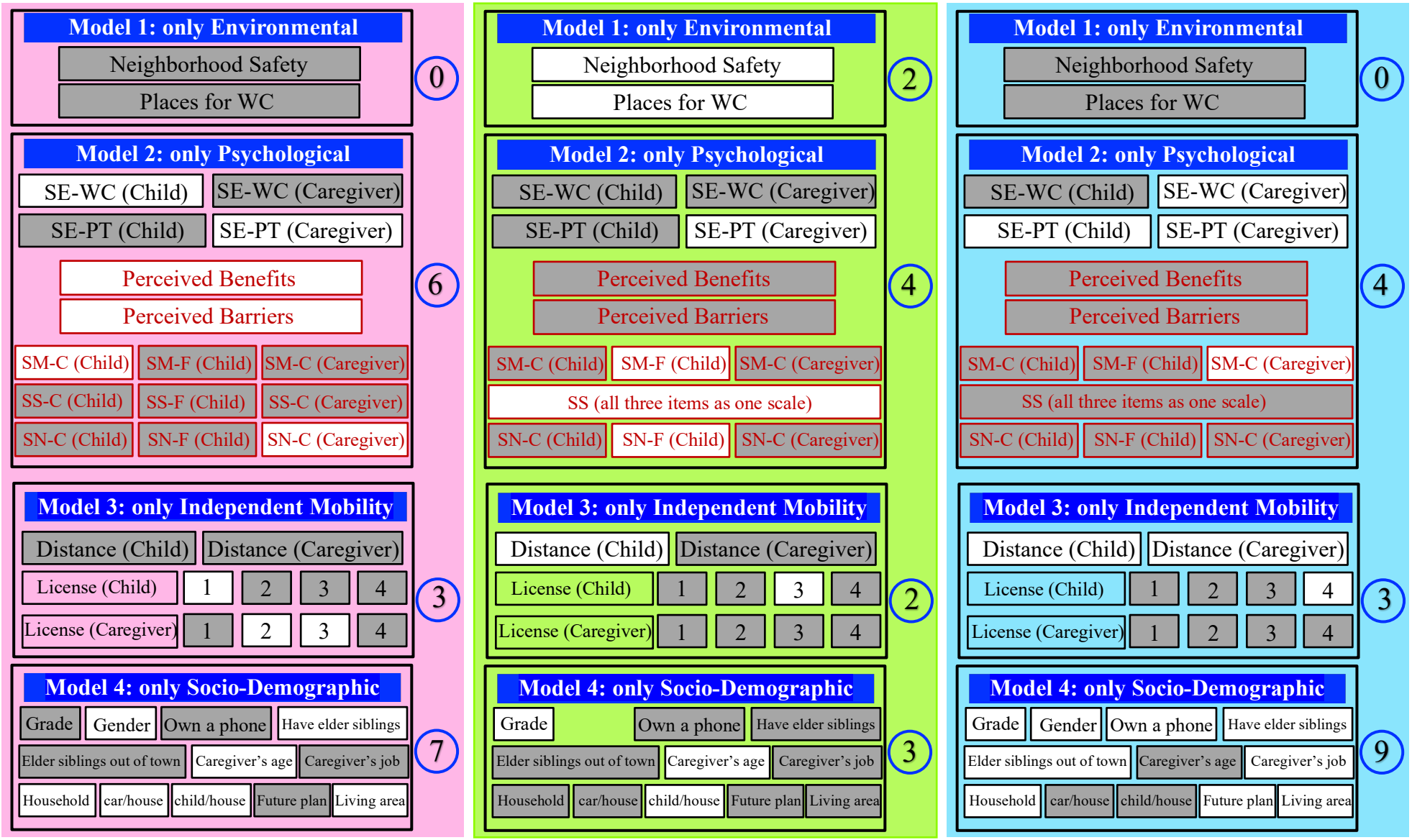
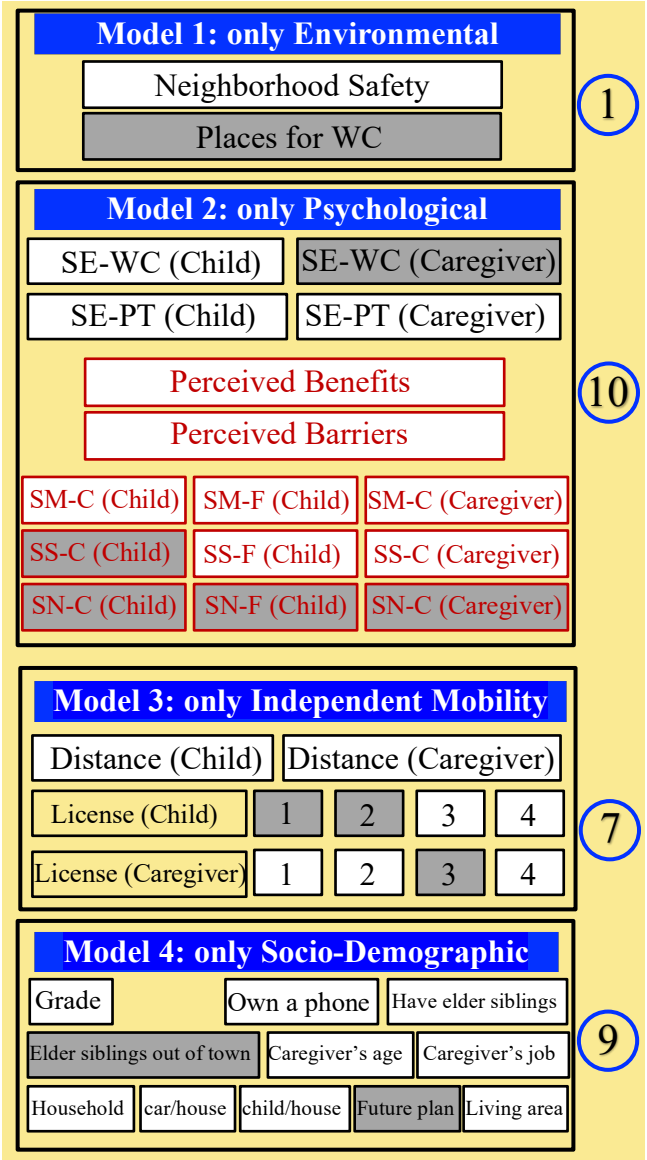


Figure 3.14 Preliminary models' results of each town, left to right: pink for Toyoyama, green for Minamiise, and blue for Kiso; insignificant variables are highlighted in grey



List of abbreviations in the psychological construct:

SE-WC: Self-Efficacy (WC over the car)

SE-PT: Self-Efficacy (PT over the car)

SM-C: Social Modeling of Caregivers

SM-F: Social Modeling of Friends

SS-C: Social Support from Caregivers

SS-F: Social Support from Friends

SN-C: Social Norm from Caregivers

SN-F: Social Norm from Friends

Figure 3.15 Preliminary models' results for developing the general model; insignificant variables are highlighted in grey

3.8 Assumptions & Limitations

The subject of this research and its target audience introduced opportunities and challenges in different parts of the research, from design to data collection and analysis. Furthermore, the Covid19 outbreak, with its burdens on children's mobility, negatively affected the data collection. In data collection/analysis, we mentioned some of the assumptions of the study, which are as follows:

- Active modes of transport (walking and cycling) are not differentiated in this study and taken into account as one group both in the data collection and analysis
- We did not differentiate the mode choice between going to a place and returning from it
- For classifying the transport mode groups in students' reported trips, we assumed that the main mode of the trips made with walking/cycling and the car is the private vehicle; and the main mode of the trips realized by public transport and the car was assumed to be public transport
- The definition of the underlying theory in the data analysis method (utility theory in McFadden's choice model) was adapted to this study's unique characteristics

The pandemic-imposed limitations on this research, especially in the data collection phase, might have adversely affected the results. These limitations have been discussed in detail in the data collection section. To summarize, the followings are the main limitations:

- Because of the pandemic, collecting the current data was not an option, and we had to rely on young adolescents' memory of the past (sometime before the start of the pandemic) in this study. Some details had to be excluded from the travel diaries (e.g., weather)
- Due to the difficulties in data collection, the survey was not conducted in all three case studies simultaneously. Therefore, not the same timeframe was used for reporting the non-school trips, and in one town, children were asked to report their trips during the pandemic (close to a normal situation in that town).
- The hybrid modeling methods (structural equation modeling) probably were more suitable for developing one single model, comparing the case studies. However, such methods could not be used due to the researcher's reliance on the available software for the data analysis and her limited experience/expertise in generating the mathematical equations from scratch. Therefore, separate conditional logit models were generated for each town, and one general model was developed to gain a more comprehensive perspective.
- Trip distance, and public transport service quality were not included in this study.
- Objective built-environment features such as density and traffic safety were not used.

3.9 Summary

Chapter 3 has covered the methodology of the current research, including a wide range of topics. In the beginning and after the research design, case studies were introduced, and the sampling and ethical review process were described. Next, the measures used in the questionnaires were explained (based on the theoretical framework presented at the end of chapter 2), and more elaboration was provided regarding the design and template of the travel diary. Following the mentioned items and the data collection, the data analysis method was explained, and the steps taken in the data analysis procedure of the current study were identified and described. Finally, the limitations and assumptions of the research were mentioned.

Chapter 4: Results

4.1 Introduction

This chapter consists of two main sections, namely descriptive and choice models, in which the outcome of the quantitative survey will be reported. In the part of the descriptive statistics, sample characteristics will be displayed for each case study. Following the description of the questionnaires' data (categorical and continuous), the correlations between the variables will be reported, making it possible to see the relationship between students' answers and their caregivers' responses. Then, travel diaries' data will be presented and discussed in terms of the specific criteria of non-school trips made with the three categories of transport options in each case study. In the second section, the results of the choice models will be reported and described with the help of the exponentiated estimates and predictive margins regarding the effects of variables on mode choice in the four categories of a) environmental, b) psychological, c) independent-mobility, and d) socio-demographic.

4.2 Descriptive Statistics

4.2.1 Participants' Demographic and Independent Mobility Characters

Upon considering the quality of the collected data, all the questionnaire sets were appraised, and finally, 173, 143, and 171 valid sets from the junior high schools in Toyoyama, Minamiise, and Kiso town were selected for the data analysis. Summary of the general characteristics of the sample (mainly categorical variables) collected from students and their caregivers in the questionnaires are presented in Table 4.1 for each of the case studies. The data in table 4.1 suggests that a relatively similar number of male and female respondents were taken into account for the data analysis (apart from Minamiise, in which the data on young adolescents' gender could not be collected). However, the share of the participants' enrolling grades is not as homogenous as the gender. The highest share of responses was received from 1st graders in Toyoyama (41.6 %) and 3rd graders in Kiso (41.5%), whereas in Minamiise, the three grades accounted for a relatively similar share. Table 4.1 also illustrates that almost all the respondents (96%) in Toyoyama owned a bicycle. The share of bicycle ownership declines as the town's size increases, with Kiso town representing the lowest share (78%). The sample of this research in Toyoyama and Minamiise reported around 80% of smartphone/cellphone ownership. Surprisingly, only 40% of the students in Kiso town had a smartphone/cellphone. Similar differences were observed in students' plans for their future. Most junior high school students in Toyoyama and Minamiise reported having plans to pursue their educational/career goals out of their hometown after graduating from junior high school. However, around 70% of the students in Kiso town envisioned their future to happen inside their hometown.

The data on household characters reported by caregivers (primarily mothers) show that most of the students (60% and above) belonged to households comprised of two parents and children where at least one of the parents were in their 40s. In Toyoyama and Kiso, more than half of the young adolescents were from households owning two private vehicles. In Minamiise, however, a little over 50% of the households owned three or more cars. In Toyoyama, students were mainly from a two-child family, whereas in Minamiise and Kiso, families with two and three children were most common. Caregivers' occupations were almost similar in Minamiise and Kiso (the most reported occupations were full-time and part-time employment). In Toyoyama, though, around half of the caregivers reported working part-time.

Table 4.1 Summary of categorical independent variables (sample size in Toyoyama, Minamiise, and Kiso town are N=173, N=143, and N=171, respectively) (sample characteristics in grey highlight are not used in the data analysis)

Socio-demographic characteristics (Young Adolescents/Caregivers)		**Toyoyama**	**Minamiise**	**Kiso**
Gender	(% female)	49.1	-	45.6
Grade	(% 1st grade)	41.6	35	34.5
	(% 2nd grade)	26	35.7	22.8
	(% 3rd grade)	31.2	28.7	41.5
Living district	(% Toyoyama/Shinei/Shimizu)	37.6/27.7/33.5		
	(% Nansei/Nantou)		60.1/39.9	
	(% Fukushima/Hiyoshi/Mitake/Kaida)			55/24/7.5/10.5
Having elder siblings (%)		43.9	56.6	55.6
Having elder siblings who study or work out of town (%)		32.9	45.5	24.6
Bicycle ownership (%)		96	82.5	78.9
Cellphone/Smartphone ownership (%)		83.8	80.4	40.4
Access to the Internet on the phone (%)		80.3	80.4	39.8
Future plan	(% work/study out of town)	80.3	80.4	28.7
	(% work/study inside the town or others)	19.7	19.6	71.3
Respondent's relation to the child (% mother)		89	86	81.3
Caregivers' age	(% less than 40)	20.2	23.1	13.5
	(% between 40 and 50)	72.8	62.2	67.8
	(% over 50)	6.9	14.7	18.7
Household	(% parents, children)	75.7	60.8	63.7
	(% parents, grandparent/s, children)	9.8	24.5	21.6
	(% single parent, children)	10.4	4.9	8.8
	(% single parent, grandparent/s, children)	4	9.8	5.8
Caregivers' occupation	(% full-time, employee)	26.6	49	45.6
	(% part-time, employee)	49.7	36.4	40.4
	(% full-time, self-employed)	15	7	9.4
	(% full-time homemaker or unemployed)	8.7	7.7	4.7
No. of cars/ household	(% one)	31.1	6.3	9.9
	(% two)	56.6	42.7	57.9
	(% three or more)	11.6	51	32.2
No. of children/ household	(% one)	12.7	12.6	9.4
	(% two)	59	46.2	43.3
	(% three or more)	28.3	41.3	47.4
Independent Mobility (IM)				
IM distance (Students' response)	(% home neighborhood)	0	16.8	0
	(% school neighborhood)	16.8	32.2	19.3
	(% inside the town)	26.6	27.3	41.5
	(% out of town)	56.6	23.8	39.2
IM distance (Caregivers' response)	(% home neighborhood)	0	11.9	9.9
	(% school neighborhood)	20.8	38.5	19.3
	(% inside the town)	26.6	19.6	31
	(% out of town)	52.6	30.1	39.8
IM license (Students' response)	(% Allowance for Item 1)	90.2	88.1	90.6
	(% Allowance for Item 2)	20.2	24.5	9.4
	(% Allowance for Item 3)	72.8	65.7	26.3
	(% Allowance for Item 4)	55.5	86.7	82.5
IM license (Caregivers' response)	(% Allowance for Item 1)	86.1	78.3	75.4
	(% Allowance for Item 2)	17.9	11.2	11.1
	(% Allowance for Item 3)	69.9	49.7	22.2
	(% Allowance for Item 4)	57.2	79.7	78.9

Table 4.1 also reveals important information about students' independent mobility licenses. To better visualize the trend, we added the dimension of age (enrolling grade) to the criteria of independent mobility in the three case studies and illustrated the results in the following Fig. 4.1 and Fig. 4.2. The illustrations demonstrate students' responses to the items of independent mobility (license and distance) differentiated by their enrolling grade at the junior high schools. In Fig. 4.1, each item of the independent mobility license is represented by one particular color (blue for item 1, red for item 2, green for item 3, and brown for item 4). Case studies are demonstrated by distinctive line types (square dot for Toyoyama, solid for Minamiise, and long dash-dot for Kiso).

Although inconsistent, the plots show that the older young adolescents get, they perceive more consent over their independent mobility. More than 80% of the students believed they could go to different places on foot alone (item 1). Fig. 4.1 also shows that relatively fewer students could go out alone at night (item 2), and students in Kiso have the lowest consent rate for this item among the three case studies. Additionally, Kiso town stands in the last place with a vast difference from the other two case studies regarding young adolescents having the consent for cycling on main roads (item 3). Such patterns observed in Kiso can be justified considering its size and geographical features. Regrading using the town bus independently, participants in Minamiise stand first, followed by students in Kiso and Toyoyama.

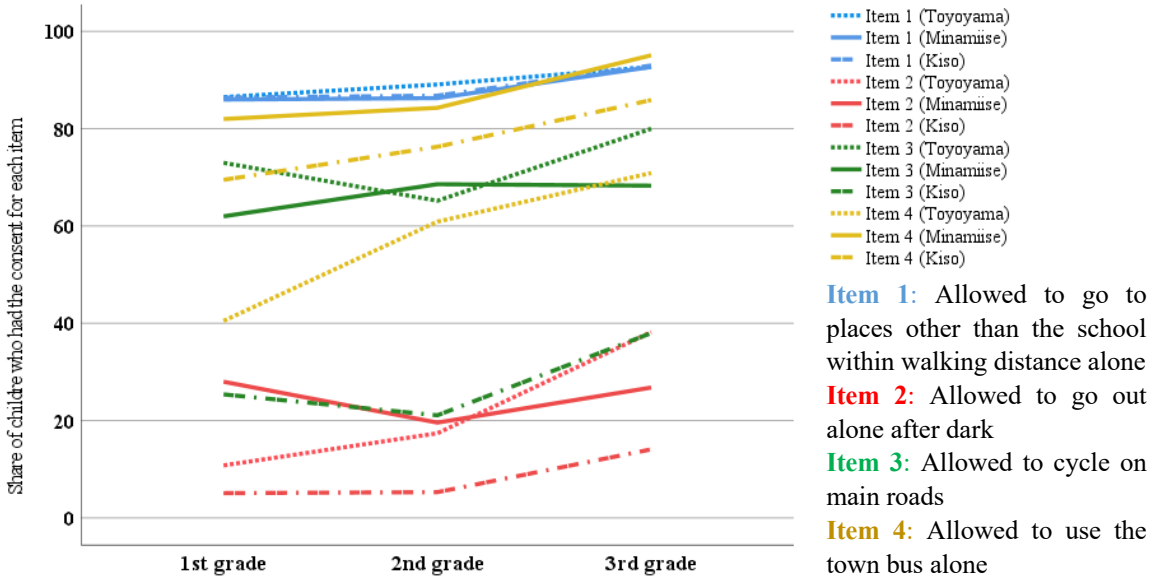


Figure 4.1 Independent mobility license range in the case studies (reported by students)

Fig. 4.2 shows the prevailing pattern of the license for independent mobility distance perceived by students in the three grades. Each color represents one enrolling grade at the junior high schools (blue for 1st graders, pink for 2nd graders, and purple for 3rd graders). Filling patterns have been utilized to show the differences among the case studies (solid for Toyoyama, dotted for Minamiise, and diagonal stripes for Kiso). A quick look at the bar graph shows that most 1st graders thought they were allowed to travel independently as far as destinations inside their hometown, with 1st graders in Kiso town having the highest share. Compared to 1st graders, 2nd graders seem to think that they could travel to farther destinations independently. Most of the 2nd graders in Toyoyama (over 60%) thought they had the consent to travel to destinations out of their hometown. However, in Minamiise, the highest share for 2nd graders

belongs to in-town trips (around 50%). Among the three grades, 3rd graders reported the highest share of "out of the hometown" perceived independent mobility distance, with the students in Toyoyama and Kiso towns accounting for the highest percentages (over 70% and 60%, respectively).

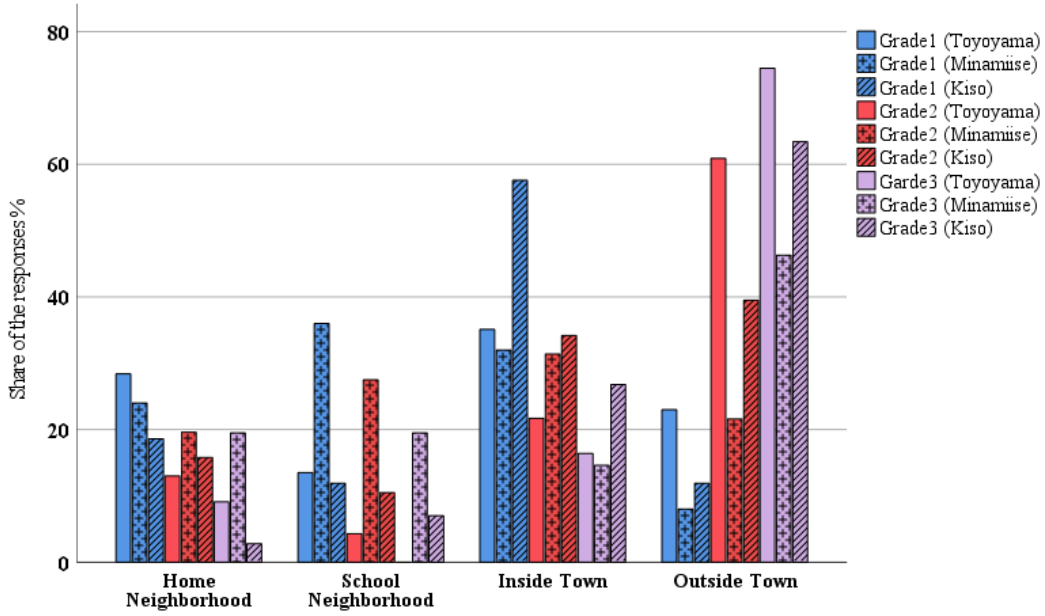


Figure 4.2 Independent mobility distance in the case studies (reported by students)

4.2.2 Participants' Responses to Environmental and Psychological Factors

A summary of all the environmental and psychological measures are demonstrated in Tables 4.2, 4.3, and 4.4 for Toyoyama, Minamiise, and Kiso, respectively. The variables are divided into two main classifications: case-specific (constant among each case) and alternative-specific variables (different values for each alternative, namely WC, PT, and Car). Since both students and their caregivers provided answers for the psychological variables, the target respondents are differentiated in the tables. Given that scales were used for measuring the environmental/psychological variables, the internal consistency of the scales was assessed by the value of Cronbach's α with 0.5 taken as the cut-off. Variables with an internal consistency over 0.5 were kept as a scale. Otherwise, the mean value was calculated for each scale item, and they were used individually (not as a scale) in the data analysis. Social modeling, norm, and support in Toyoyama and social modeling, and norm in Minamiise and Kiso are among the scales with low internal consistency. In the lower half of the tables, mean values of the individual components of social modeling, norm, and support are shown.

Comparing the tables, it is evident that students in Toyoyama perceived their environment to be safer and more suitable for walking/cycling, which affected their belief toward their capability in choosing walking/cycling over the car. Young adolescents' perception of the self-efficacy for using public transport over the car shows similar situation in the three towns. Surprisingly, the scores reported by students for the self-efficacy of using public transport is a little higher than what their caregivers believed about the same topic. Furthermore, students in the three case studies associated similar share of benefits to all transport modes. In contrast, "private car" had the lowest scores of perceived barriers in all three towns. "Walking/cycling" had the highest values of perceived barriers in the case studies.

Table 4.2 Summary of psychological and environmental measures in Toyoyama (sample size N=173)

Variables	Components	Target	Response category	Cronbach's α	Mean (SD)
Scales					
Case-specific variables					
Environmental					
Neighborhood safety	9 items	Students	five-point scale [a]	.595	3.58 (.60)
Places for WC	3 items	Students	five-point scale [a]	.626	3.42 (.92)
Psychological					
Self-efficacy					
WC over CAR	7 items	Students	five-point scale [b]	.870	3.49 (1.02)
		Caregivers		.911	3.30 (1.22)
PT over CAR	7 items	Students	five-point scale [b]	.968	2.63 (1.44)
		Caregivers		.974	2.02 (1.39)
Alternative-specific variables					
Psychological					
Perceived benefits					
WC	8 items	Students	five-point scale [a]	.775	4.10 (.63)
PT	10 items			.847	3.92 (.74)
Car	6 items			.699	4.35 (.63)
Perceived barriers					
WC	9 items	Students	five-point scale [a]	.809	4.01 (.73)
PT	10 items			.846	3.33 (.83)
Car	6 items			.693	3.07 (.69)
Social Modeling					
WC	3 items	Students/ Caregiver	five-point scale [c]	.436	
PT	3 items			.490	
Car	3 items			.200	
Social Norm					
WC	3 items	Students/ Caregiver	five-point scale [d]	.561	
PT	3 items			.447	
Car	3 items			.391	
Social support					
WC	3 items	Students/ Caregiver	five-point scale [e/c]	.511	
PT	3 items			.728	
Car	3 items			.402	

Variables	Components	Target	Response category	Mean (SD)		
				WC	PT	Car
Components of Social Modeling/Norm/Support						
Alternative specific variables						
Social Modeling	caregivers	Students	five-point scale [c]	3.38 (1.42)	1.90 (1.11)	4.68 (.56)
	friends			4.49 (.65)	2.06 (1.20)	3.66 (1.02)
	caregivers	Caregivers		2.29 (.77)	1.26 (.42)	4.27 (.97)
Social Norm	caregivers	Students	five-point scale [d]	4.08 (.98)	3.18 (.79)	3.29 (.87)
	friends			3.98 (.97)	3.32 (.82)	3.43 (.87)
	children	Caregivers		4.31 (.90)	3.17 (.92)	3.06 (.65)
Social support	caregivers	Students	five-point scale [e/c]	2.36 (.85)	2.17 (.94)	3.37 (.83)
	friends			3.90 (.89)	2.10 (1.06)	2.43 (1.03)
	children	Caregivers		3.46 (.83)	2.08 (.92)	3.51 (.84)

WC: Walking/Cycling, PT: Public Transport

[a] five-point scale from 5 (I think so) to 1 (I do not think at all)

[b] five-point scale from 5 (I/my child was able to do it without problems) to 1 (I/my child could not do it at all)

[c] five-point scale from 5 (Almost every day) to 4 (at least once a week), 3 (at least once a month), 2 (at least once a year), and 1 (I did not use it at all)

[d] five-point scale from 5 (I felt like they wanted me to use it) to 1 (I felt like they did not want me to use it at all)

[e] five-point scale from 5 (always recommended) to 1 (not recommended at all)

Table 4.3 Summary of psychological and environmental measures in Minamiise (sample size N=143)

Variables	Components	Target	Response category	Cronbach's α	Mean (SD)
Scales					
Case-specific variables					
Environmental					
Neighborhood safety	7 items	Students	five-point scale [a]	.528	2.60 (.62)
Places for WC	3 items	Students	five-point scale [a]	.618	2.74 (.92)
Psychological					
Self-efficacy					
WC over CAR	7 items	Students	five-point scale [b]	.910	2.98 (1.22)
		Caregivers		.935	2.43 (1.21)
PT over CAR	7 items	Students	five-point scale [b]	.951	2.56 (1.45)
		Caregivers		.964	1.97 (1.27)
Alternative-specific variables					
Psychological					
Perceived benefits					
WC	8 items	Students	five-point scale [a]	.857	4.24 (.65)
PT	10 items			.837	4.12 (.62)
Car	6 items			.845	4.60 (.47)
Perceived barriers					
WC	9 items	Students	five-point scale [a]	.877	3.92 (.82)
PT	10 items			.877	3.04 (.91)
Car	6 items			.790	2.94 (.83)
Social Modeling					
WC	3 items	Students/ Caregiver	five-point scale [c]	.294	
PT	3 items			.256	
Car	3 items			.195	
Social Norm					
WC	3 items	Students/ Caregiver	five-point scale [d]	.510	
PT	3 items			.593	
Car	3 items			.466	
Social support					
WC	3 items	Students/ Caregiver	five-point scale [e/c]	.652	3.08 (.77)
PT	3 items			.703	2.31 (.78)
Car	3 items			.519	3.41 (.59)

Variables	Components	Target	Response category	Mean (SD)		
				WC	PT	Car
Components of Social Modeling/Norm/Support						
Alternative specific variables						
Social Modeling	caregivers	Students	five-point scale [c]	2.12 (1.50)	1.36 (.68)	4.82 (.38)
	friends			4.36 (.74)	2.57 (1.45)	4.04 (.69)
	caregivers	Caregivers		1.41 (.69)	1.03 (.23)	4.71 (.39)
Social Norm	caregivers	Students	five-point scale [d]	3.94 (.99)	3.51 (.91)	3.25 (.93)
	friends			3.57 (.87)	3.31 (.82)	3.45 (.86)
	children	Caregivers		4.03 (1.22)	3.59 (1.16)	3.17 (.89)
Social support	caregivers	Students	five-point scale [e/c]	2.96 (1.02)	2.24 (.91)	3.58 (.77)
	friends			3.39 (.95)	2.47 (1.13)	3.00 (.95)
	children	Caregivers		2.88 (1.04)	2.22 (.89)	3.65 (.76)

WC: Walking/Cycling, PT: Public Transport

[a] five-point scale from 5 (I think so) to 1 (I do not think at all)

[b] five-point scale from 5 (I/my child was able to do it without problems) to 1 (I/my child could not do it at all)

[c] five-point scale from 5 (Almost every day) to 4 (at least once a week), 3 (at least once a month), 2 (at least once a year), and 1 (I did not use it at all)

[d] five-point scale from 5 (I felt like they wanted me to use it) to 1 (I felt like they did not want me to use it at all)

[e] five-point scale from 5 (always recommended) to 1 (not recommended at all)

Table 4.4 Summary of psychological and environmental measures in Kiso (sample size N=171)

Variables	Components	Target	Response category	Cronbach's α	Mean (SD)
Scales					
Case-specific variables					
Environmental					
Neighborhood safety	6 items	Students	five-point scale [a]	.510	2.22 (.59)
Places for WC	3 items	Students	five-point scale [a]	.665	2.70 (1.00)
Psychological					
Self-efficacy					
WC over CAR	7 items	Students	five-point scale [b]	.909	2.68 (1.11)
		Caregivers		.914	2.17 (1.07)
PT over CAR	7 items	Students	five-point scale [b]	.953	2.69 (1.45)
		Caregivers		.967	1.83 (1.07)
Alternative-specific variables					
Psychological					
Perceived benefits					
WC	8 items	Students	five-point scale [a]	.851	4.17 (.67)
PT	10 items			.836	4.10 (.64)
Car	6 items			.838	4.18 (.67)
Perceived barriers					
WC	9 items	Students	five-point scale [a]	.878	3.95 (.73)
PT	10 items			.864	2.67 (.80)
Car	6 items			.768	2.94 (.67)
Social Modeling					
WC	3 items	Students/ Caregiver	five-point scale [c]	.294	
PT	3 items			.256	
Car	3 items			.195	
Social Norm					
WC	3 items	Students/ Caregiver	five-point scale [d]	.638	
PT	3 items			.602	
Car	3 items			.435	
Social support					
WC	3 items	Students/ Caregiver	five-point scale [e/c]	.690	2.89 (.84)
PT	3 items			.679	2.29 (.79)
Car	3 items			.577	3.25 (.62)

Variables	Components	Target	Response category	Mean (SD)		
				WC	PT	Car
Components of Social Modeling/Norm/Support						
Alternative specific variables						
Social Modeling	caregivers	Students	five-point scale [c]	1.83 (1.25)	1.38 (.66)	4.85 (.35)
	friends			4.41 (.79)	3.36 (1.62)	4.29 (.75)
	caregivers	Caregivers		1.37 (.54)	1.15 (.30)	4.79 (.35)
Social Norm	caregivers	Students	five-point scale [d]	4.05 (1.03)	3.44 (.97)	3.12 (.91)
	friends			3.53 (.96)	3.25 (.77)	3.36 (.68)
	children	Caregivers		3.94 (1.09)	3.73 (.87)	3.00 (.66)
Social support	caregivers	Students	five-point scale [e/c]	2.82 (1.06)	2.27 (.95)	3.43 (.84)
	friends			3.06 (1.12)	2.38 (1.18)	2.55 (1.04)
	children	Caregivers		2.79 (1.02)	2.23 (.86)	3.77 (.60)

WC: Walking/Cycling, PT: Public Transport

[a] five-point scale from 5 (I think so) to 1 (I do not think at all)

[b] five-point scale from 5 (I/my child was able to do it without problems) to 1 (I/my child could not do it at all)

[c] five-point scale from 5 (Almost every day) to 4 (at least once a week), 3 (at least once a month), 2 (at least once a year), and 1 (I did not use it at all)

[d] five-point scale from 5 (I felt like they wanted me to use it) to 1 (I felt like they did not want me to use it at all)

[e] five-point scale from 5 (always recommended) to 1 (not recommended at all)

Looking at the mean values for individual items of social modeling/norm/support, sometimes a significant difference can be observed between students' perception of their caregivers' travel-related behavior/attitudes and the response of their caregivers toward the same thing. Furthermore, students' perception toward the travel behavior of their friends and caregivers seems to be very different, which must have been another reason for the observed low internal consistency among the mentioned scales. The mean values for social modeling suggest a high tendency toward using the car among students' caregivers and friends in nearly all the case studies. Although the frequency of using public transport among caregivers is minimal, caregivers' expectations of their children for using it are higher. Also, the data suggest that young adolescents think their caregivers expect them to use public transport more than the actual expectation of their caregivers. Surprisingly, the social support for using public transport does not match the social norm (expectation is higher than the received support).

4.2.3 Correlations Between Students' and Caregivers' Responses

As mentioned before, this research studies the factors affecting young adolescents' travel behavior, particularly mode choice, by considering students' and their caregivers' points of view about independent mobility extent, psychological/environmental variables, and household characteristics. Both of the target respondents (students and their caregivers) reported the psychological and independent mobility variables. Correlation analysis makes it possible to see the associations between students' and their caregivers' responses about the same item and compare them. Tables 4.6, 4.7., and 4.8 demonstrate the significant Pearson (for continuous variables) and Spearman's rho (for ordinal variables) correlation coefficients among the pair-wise (students vs. caregivers) psychological and independent mobility variables in Toyoyama, Minamiise, and Kiso, respectively. It is noteworthy that due to the high number of variables, it was impossible to report all the significant correlations. Also, no collinearity was seen among the continuous variable (all coefficients were less than 0.7).

Table 4.5 Significant correlations among the pair-wise (students vs. caregivers) psychological and independent mobility variables in Toyoyama

Pearson (correlation coefficients)

		Caregiver				
		SE-WC	SE-PT	SM-WC	SN-PT	SS-PT
Students	SE-WC	.341**				
	SE-PT		.327**			
	SM-WC			-.182*		
	SN-PT				.199**	
	SS-PT					.315**

Spearman's rho (correlation coefficients)

		Caregiver			
		IM-Distance	IM-License2	IM-License3	IM-License4
Students	IM-Distance	.413**			
	IM-License2		.365**		
	IM-License3			.166**	
	IM-License4				.378**

WC = Walking/Cycling, PT = Public Transport, IM = Independent Mobility
SM = Social Modeling, SN = Social Norm, SS = Social Support, SE = Self-Efficacy
**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

Table 4.6 Significant correlations among the pair-wise (students vs. caregivers) psychological and independent mobility variables in Minamiise

Pearson (correlation coefficients)

		Caregivers							
		SE-WC	SE-PT	SM-WC	SM-Car	SN-WC	SN-PT	SS-WC	SS-PT
Students	SE-WC	.266**							
	SE-PT		.309**						
	SM-WC			.177*					
	SM-Car				.173*				
	SN-WC					.259**			
	SN-PT						.263**		
	SS-WC							.289**	
	SS-PT								.243**

Spearman's rho (correlation coefficients)

		Caregivers		
		IM-License2	IM-License3	IM-License4
Students	IM-License2	.211*		
	IM-License3		.275**	
	IM-License4			.315**

WC = Walking/Cycling, PT = Public Transport, IM = Independent Mobility
SM = Social Modeling, SN = Social Norm, SS = Social Support, SE = Self-Efficacy
**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

Table 4.7 Significant correlations among the pair-wise (students vs. caregivers) psychological and independent mobility variables in Kiso

Pearson (correlation coefficients)

		Caregiver								
		SE-WC	SE-PT	SM-WC	SM-Car	SN-WC	SN-PT	SS-WC	SS-PT	SS-Car
Students	SE-WC	.242**								
	SE-PT		.355**							
	SM-WC			.280**						
	SM-Car				.230*					
	SN-WC					.311**				
	SN-PT						.331**			
	SS-WC							.355**		
	SS-PT								.286**	
	SS-Car									.198**

Spearman's rho (correlation coefficients)

		Caregiver				
		IM-Distance	IM-License1	IM-License2	IM-License3	IM-License4
Students	IM-Distance	.590**				
	IM-License1		.190*			
	IM-License2			.206**		
	IM-License3				.287**	
	IM-License4					.177*

WC = Walking/Cycling, PT = Public Transport
SM = Social Modeling, SN = Social Norm, SS = Social Support, SE = Self-Efficacy
IM = Independent Mobility
**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

Except for Toyoyama, most of the reported data by young adolescents and their caregivers (about the same subject) were positively correlated in Minamiise and Kiso. Regarding psychological variables, a correlation was seen between all the responses of students and their caregivers for the measures of self-efficacy (WC or PT over the car). The lack of association for some of the other psychological variables reveals a mismatch between students' perceptions and caregivers' thoughts. The only negative correlation was seen between students' perception about their caregivers' frequency of walking/cycling use and their caregivers' actual use of these modes in Toyoyama. Such a pattern demonstrates a mismatch between students' perception and the reality for the social modeling variable.

4.2.4 Characteristics of the Reported Non-School Trips

Young adolescents reported 798, 613, and 720 non-school trips (in total 2131) in Toyoyama, Minamiise, and Kiso town, respectively (none of the few reported school trips were included in the analysis). 28.2% of the reported trips were made either with walking or cycling. 83.4% of these trips were realized independently (alone or having friends as companions). Public transport trips comprised 10.9% of all the reported trips, out of which 76.4% were done independently. Such data suggest that public transport and active modes are the main options for making unsupervised non-school trips.

The modal split is illustrated in Fig. 4.3, revealing the current situation in utilizing transport options. Toyoyama proves itself as the most walking/cycling-friendly among the case studies, with around 45% of all the trips made with active modes of transport (color green). Still, around 48% of young adolescents' non-school trips are realized with the private car (color yellow) in Toyoyama. However, active modes and public transport (color blue) account for a little over half of the modes used for students' non-school trips. Minamiise and Kiso towns' patterns are almost similar, with around one-third of the trips realized with active modes and public transport. The highest share of mode use goes to the private car category in both towns.

Compared to Toyoyama, a small town with a semi-urban fabric, Minamiise and Kiso are larger and more rural. There is a direct relationship between the size of the built environment and the trip distance, which might explain the high shares of car use in Minamiise and Kiso. Also, hilly terrains in Minamiise and Kiso could be a constraint for realizing walking/cycling trips compared to Toyoyama, which represents a relatively flat environment. The share of public transport non-school trips in Minamiise and Kiso are almost twice the share of such trips in Toyoyama, which could be rationalized by considering the specific characteristics of rural areas. Besides, junior high school students in Minamiise and Kiso do access a free town bus pass.

The data already showed a high share of car ownership by the households in the three case studies, which is reflected in the caregivers' frequent use of cars in their daily trips. These car-dependent households (a notable character of such areas) also affect young adolescents' modal splits. Needless to say, the infrequent public transport service in the case studies also makes the private vehicle a more convenient mode of transport. Fig. 4.3 shows that most students' non-school trips in Minamiise and Kiso are made with the private car. According to the 2015 person-trip survey in Japan (Ministry of Land Infrastructure Transport and Tourism (MLIT), 2015), 10-19-year-olds living in regional areas of Japan use private vehicles more than those living in urban areas.

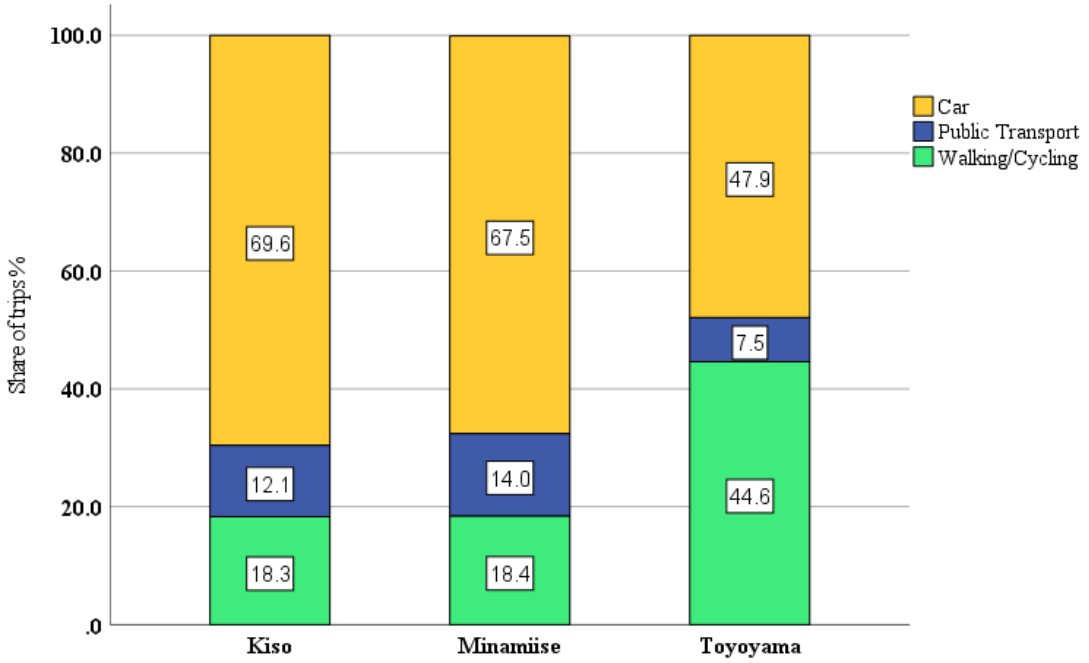


Figure 4.3 Modal split of reported non-school trips among young adolescents in the case studies

As previously mentioned in the methods, students reported different features of their non-school trips in the travel diaries. Apart from the used mode/s, data on other characteristics such as trip origin and destination, time, purpose, and accompanying persons for each trip were collected. According to Table 4.5, a little over half of the trips were bound for destinations inside Toyoyama and Minamiise. This share is relatively higher in Kiso (over 60%), indicating that around two-thirds of the destinations of students' trips were located inside Kiso town. Taking a closer look at the realization time of the trips in the three case studies, we can see that more than two-thirds of the trips were made on weekends. Lack of enough free time during weekdays for daily trips and the possibility of more family trips on weekends (usually with the private car) may have led to this pattern. Also, it seems that as the size of the town increases, young adolescents' non-school trips on weekdays decreases.

Table 4.8 Summary of trip features in Toyoyama, Minamiise, and Kiso town are 789, 613, and 720, respectively)

Trip features		**Toyoyama 798 trips**	**Minamiise 613 trips**	**Kiso 720 trips**
Destination	Out of town (%)	46.2	47.8	37.4
	In town (%)	53	52.2	62.5
	Missing values (%)	.8	-	.1
Time	Weekdays (%)	33.3	27.1	21.9
	Weekends (%)	61.8	70.8	76.9
	Missing values	4.9	2.1	1.1
Purpose	Productive (%)	19.4	15.3	13.5
	Leisure (%)	54	53.7	44.4
	Maintenance (%)	26.1	29.9	41.1
	Missing values (%)	.5	1.1	1
Trip companion	Supervised (%)	52.1	64.6	68.6
	Unsupervised (%)	45.7	35.4	31.4
	Missing values (%)	2.1	-	-

Fig. 4.4 illustrates the differences in trip time based on the use of different modes in Toyoyama, Minamiise, and Kiso. Although relatively distinctive patterns are seen among the modes, the overall situation for each mode in the towns are pretty similar. The yellow color representing weekend trips is the most dominant in all the categories, especially public transport, compared to the blue color representing weekday trips. Even though the share of weekend trips is still greater than weekday trips for walking/cycling and car trips, it seems that active modes of transport are popular among young adolescents for traveling on weekdays. Given the fact that car trips account for most of the used modes of students' non-school trips, the percentage of weekday trips (although smaller than weekend trips) is still substantial.

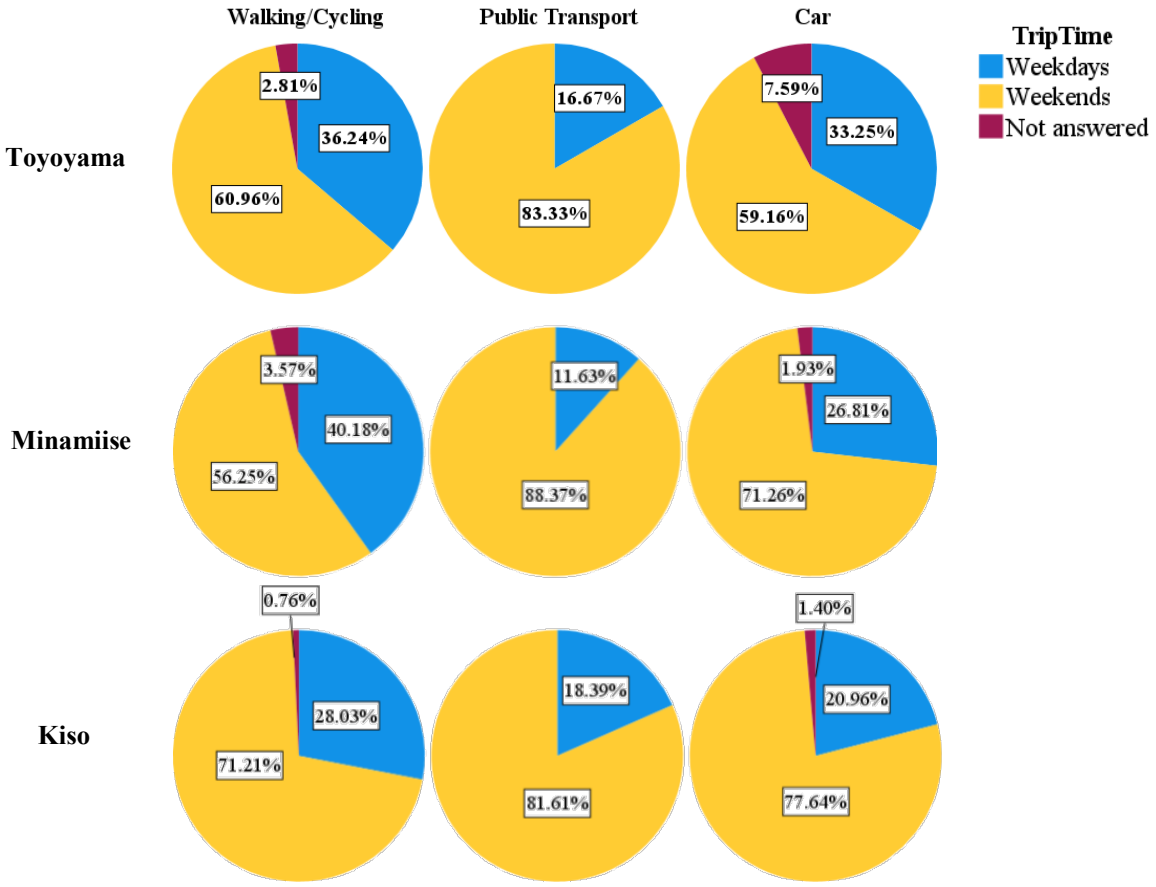


Figure 4.4 Trip time for walking/cycling, public transport and the car in the study areas

Fig. 4.5 illustrates the patterns in students' non-school trips based on the trip destinations in the three case studies of this research. Interestingly, the patterns represented among the towns are quite different. Toyoyama is the only town where 15% of the walking/cycling (probably cycling) trips were bound for a destination outside of students' hometown. This share is tiny in Minamiise and negligible in Kiso town.

The destination pattern of public transport trips in the three case studies shows distinctive differences. In Toyoyama, almost no trip was made with public transport for reaching a destination inside the town. On the contrary, in Minamiise around 80% of the public transport trips were bound for the destinations inside the town. Surprisingly, the destination types (inside and out of the town) for public transport trips comprised almost similar shares in Kiso town. Students' non-school trips made with private cars represent identical patterns in Toyoyama and

Minamiise. Around 65% of the car trips were made for getting to destinations located out of the town. However, in Kiso, the percentages of inside and outside destination categories are approximately the same.

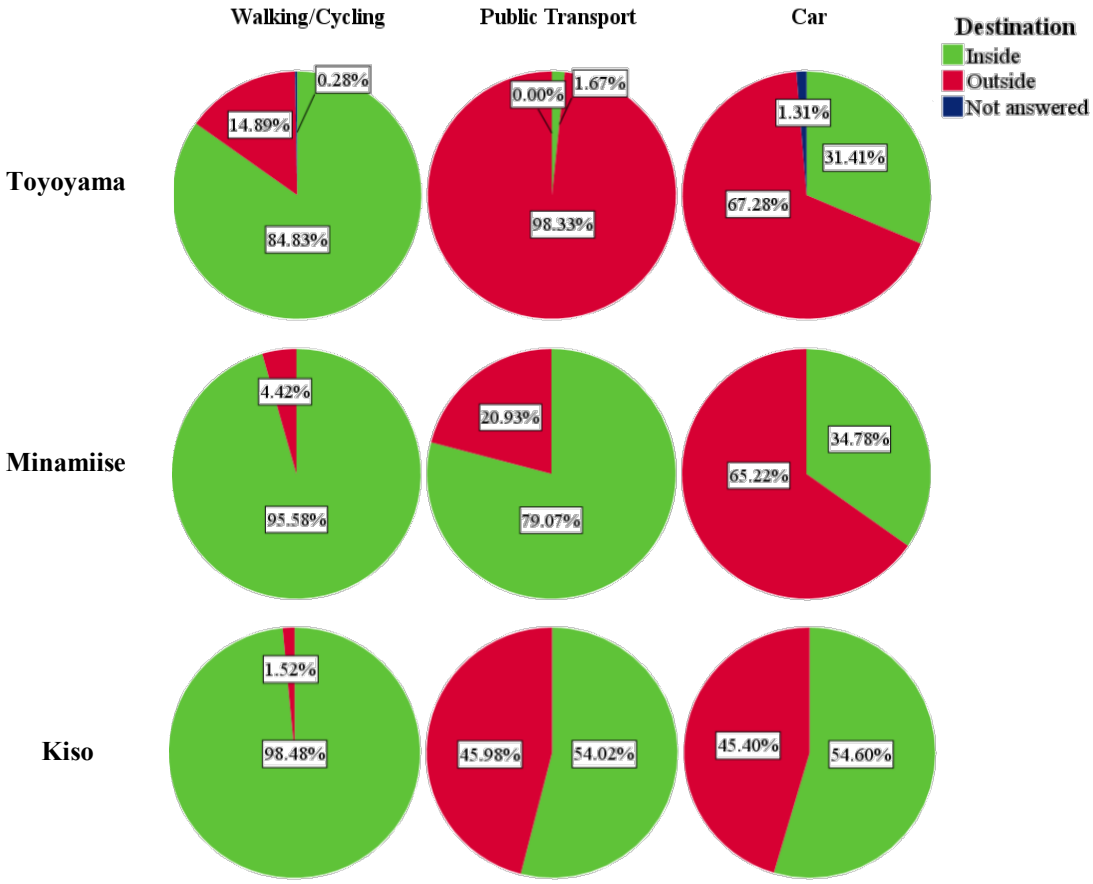


Figure 4.5 Share of different trip destination for walking/cycling, public transport and the car in the study areas

Fig. 4.6 portrays the differences between the three main categories of transport modes in accommodating different activities of young adolescents. Walking/cycling trips demonstrate a similar trip purpose pattern in the three case studies. Fig. 4.6 shows that around two-thirds of the walking/cycling trips are for leisure activities; the remaining one-third is divided almost equally between the other two categories of trip purposes, namely productive and maintenance. Among the three study areas, car trips are primarily used for fulfilling leisure and maintenance activities. Still, around 20% of the trips are dedicated to productive purposes (such as attending the cram school, etc.) in Toyoyama and Minamiise. Maintenance trips drop to approximately 10% in Kiso in favor of maintenance activities (such as shopping).

The share of trip purposes for public transport trips is quite different in Toyoyama, Minamiise, and Kiso. Although in all the three case studies, the highest percentage of trip purposes for public transport trips belong to leisure activities, only in Minamiise 90% of children's non-school trips with public transport were for leisure purposes. In Toyoyama, approximately 30% of the public transport trips were made for fulfilling maintenance purposes, standing in the second place after leisure activities. A different situation is seen in Kiso, where productive activities come after leisure activities with a slight difference. In Kiso, the shares of recreational and productive activities made with public transport are almost similar with 41.3% and 35.6%, respectively.

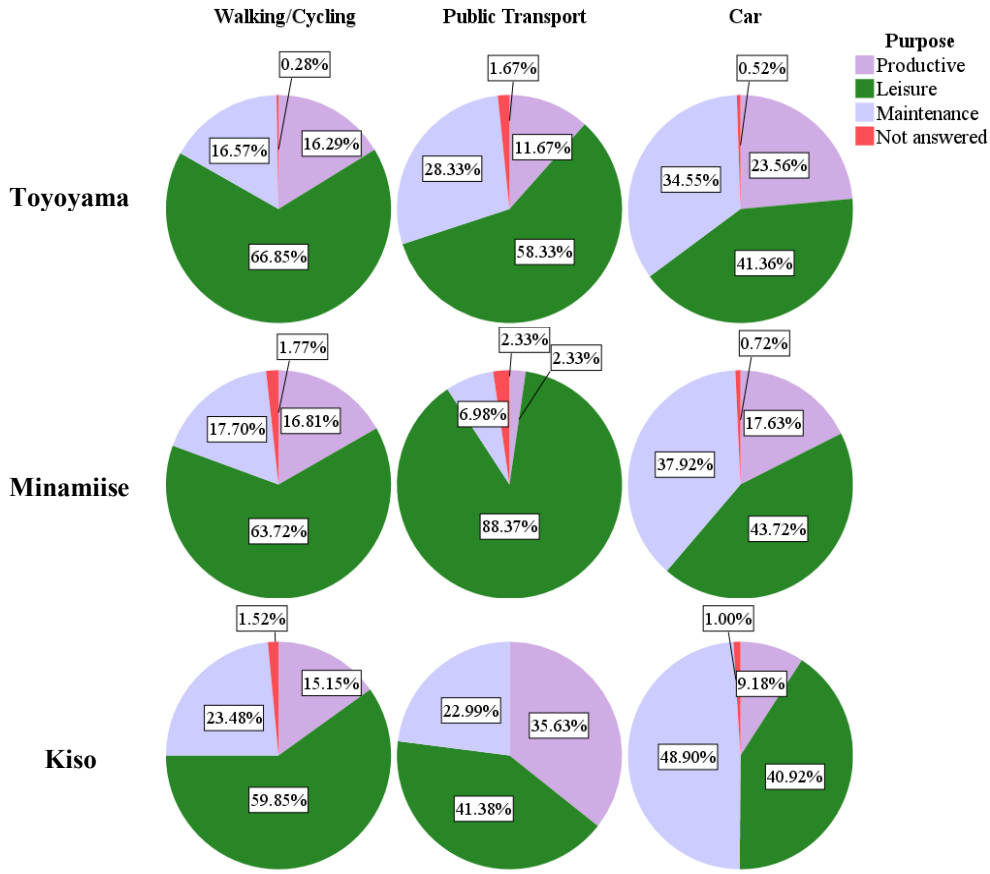


Figure 4.6 Share of different trip purposes for walking/cycling, public transport and the car in the study areas

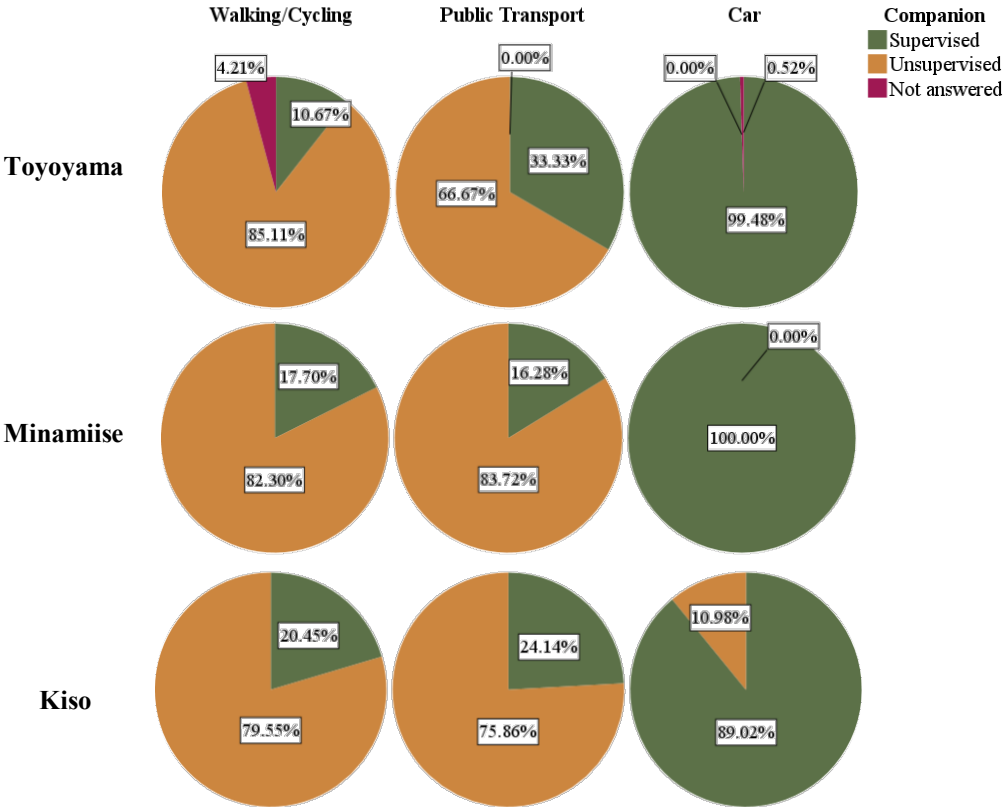


Figure 4.7 Share of different trip companions for walking/cycling, public transport and the car in the study areas

Finally, Fig. 4.7 provides mode-specific information on the companions of students' non-school trips. The demonstrated patterns among the modes are almost similar in all the case studies. Fig. 4.7 highlights that walking/cycling and public transport provide an opportunity for primarily unsupervised trips, which was already mentioned at the beginning of this sub-section. Interestingly, Toyoyama, as the most walking/cycling-friendly environment, has the highest share of unsupervised active trips. However, this town also has the highest share of supervised public transport trips among the case studies, which means that young adolescents in the other two towns make more independent public transport trips. The Car trips are completely supervised in both Toyoyama and Minamiise. Only in Kiso, 11% of students' non-school trips with the private vehicle were reported unsupervised, which could be due to two reasons. Firstly, students did not report the companions accurately; secondly, they may have considered their trips by taxi as unsupervised car trips.

4.3 McFadden's Discrete Choice Model (conditional logit)

4.3.1 Toyoyama Analysis Model Results (category: small-sized, suburban)

Model fitting information included the value (-628.34) for log-likelihood, a significant chi-square value of (116.84) for the likelihood ratio test, and a value of (0.10) for McFadden R square, which is a reasonably good fit. Table 4.9 summarizes this model's exponentiated coefficients (odds ratios and relative risk ratios) in which only the significant variables are shown. For a full report on the model's estimates (logit values and odds ratios/relative risk ratios), see Appendix C.

Table 4.9 The estimated results (exponentiated coefficients) of the choice model in Toyoyama town (only the significant estimates are shown)

Conditional logit choice model (Toyoyama)				No. of observations		2316	
Wald chi^2 (40)	116.84			No. of cases		772	
Log-likelihood -628.34	Prob>chi^2 0.00			Alternatives per case		3	
Variables	**Odds ratio**	**std. err.**	**z**	**P>|z|**	**[95% conf. interval]**		
Alternative-specific variables							
Psychological							
Social Modeling of caregivers (students)	1.14	.06	2.52	0.012	1.03	1.26	
Social Norm from caregivers (caregivers)	1.20	.09	2.44	0.015	1.03	1.38	
Variables	**Relative risk ratio**	**Std. err.**	**z**	**P>|z|**	**[95% conf. interval]**		
Case-specific variables							
Public Transport (PT) estimates (base alternative: CAR)							
Psychological							
Self-Efficacy "PT over CAR" (caregivers)	1.41	.17	2.88	0.004	1.11	1.77	
Independent Mobility (IM)							
IM license (base: not allowed to do) (caregivers)							
2: Allowed to go out after dark	.29	.16	-2.27	0.023	.10	.85	
3: Allowed to cycle on main roads	2.56	1.15	2.10	0.036	1.06	6.16	
Socio-demographic							
Living district (base: Shimizu elementary school district)							
Toyoyama elementary school	3.07	1.27	2.71	0.007	1.36	6.89	
Shinei elementary school							
Caregivers' age (base: over 50)							
Less than 40							
40-50	.22	.11	-3.00	0.003	.08	.59	
Number of cars/household (base: one)							
Two							
Three or more	4.17	2.86	2.08	0.037	1.09	15.98	
Number of children/household (base: one)							
Two	4.17	2.41	2.47	0.013	1.34	12.96	
Three or more							
cons	.04	.05	-2.34	0.019	.00	.59	

Variables	Relative risk ratio	Std. err.	z	P>|z|	[95% conf. interval]	
Walking/Cycling (WC) estimates (base alternative: CAR)						
Psychological						
Self-Efficacy "WC over CAR" (students)	1.20	.11	2.10	0.036	1.01	1.43
Self-Efficacy "PT over CAR" (caregivers)	1.26	.08	3.50	0.000	1.10	1.43
Socio-demographic						
Female (base: male)	.55	.10	-3.35	0.001	.39	.78
Living district (base: Shimizu elementary school district)						
Toyoyama elementary school	1.58	.33	2.20	0.028	1.05	2.38
Shinei elementary school						
Household construct (base: single parent and children)						
Parents and children						
Parents, grandparent/s, children						
Single parent, grandparent/s, children	.35	.19	-1.96	0.050	.12	1.00
Number of cars/household (base: one)						
Two						
Three or more	2.57	1.04	2.34	0.019	1.16	5.69
Number of children/household (base: one)						
Two	2.02	.56	2.54	0.011	1.17	3.47
Three or more						
_cons	.27	.18	-1.92	0.055	.07	1.03

Only the variables with a significant relationship trend ($p<0.10$) in the preliminary steps were used in making this final model.
For those variables reported by both students and their caregivers, the respondent is mentioned in parenthesis.
In the case of insignificant estimates for some of the levels of categorical variables, only the labels of the insignificant levels are kept in the table for the sake of clarity.
Note: '_cons' estimates baseline relative risk for each outcome.

As mentioned in subsection 3.7.2, since a conditional logit model is not linear, it is difficult to interpret. Apart from the sign of the coefficients, nothing intuitive can be understood from the value of the coefficients (logit values). The quantity of a coefficient is the amount that the log of the odds ratio changes when the continuous predictor is increased by one unit, or there is a discrete change from the base level of a categorical variable to other categories. Log odds do not give us a tangible measure or the magnitude of the relation between the predictors and outcome. Therefore, we used odds and relative-risk ratios (for categorical variables) to understand better the relationship between the predictors and the choice of transport modes.

Although the exponentiated coefficients are easier to interpret, they do not provide us with the magnitude of probabilities since they are a ratio. Hence, for understanding the causal effect between the predictors and choices, it is necessary to calculate the probabilities based on the changes in the predictors. To do this, we calculated "margins" for the significant variables in the model. The average marginal effects are also calculated for this town (see Appendix C). What follows is a report of the model results based on the interpretation of the exponentiated coefficients and the calculated margins (not necessarily average marginal effects) for each significant variable. It is noteworthy that apart from the main model results in the three case studies, the insignificant estimates are highlighted in grey in the rest of the tables of the predictive margins.

4.3.1.1 The effects of psychological variables on mode choice

Starting from the alternative-specific variables, the logit model demonstrates that a one-unit increase in the value of social modeling of caregivers (students' perception about their caregivers' frequency of different mode use) increases the odds of mode choice by 1.14. A new scenario was introduced to interpret the model results for this specific variable, and the probability of mode choice was compared between the current and the new situation (for the three main categories of transport modes). In this new scenario, we proposed a one-unit increase for the usage frequency of walking/cycling and public transport by caregivers (perceived by young adolescents) and a one-unit decrease for the frequency of car use. Social modeling was reported on a 5-point Likert scale and assumed to be a continuous variable to simplify the modeling. Therefore, one unit is quite symbolic, which interprets as more or less frequent use than the current travel behavior.

Running the "margins" command in Stata results in the contents of Table 4.10 showing the probability of each mode used by young adolescents in their non-school trips for the current and new scenarios. Table 4.11 tells us about the significance of the differences between the current and the new scenarios. These numerical results are depicted in Fig. 4.8. Looking at Fig. 4.8 and Table 4.11, we can trace the results of the new scenario (green color) in which the probability (shown on the vertical axis) of car trips would decrease by 6%, and the likelihood of public transport and walking/cycling trips would increase by 1% and 5% respectively. Although all the differences are significant, the changes in the probabilities are small.

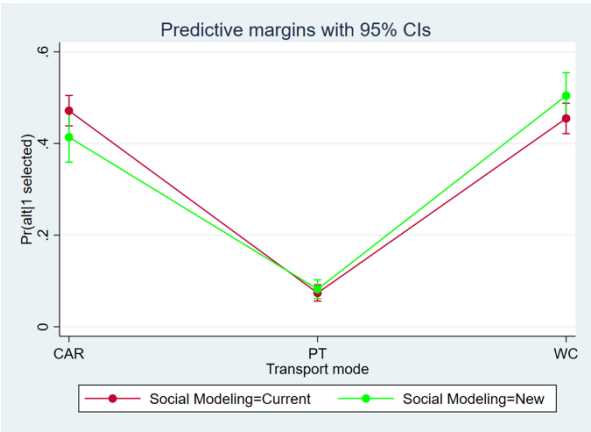


Figure 4.8 An illustration of the predictive margins for social modeling (Toyoyama)

Table 4.10 Predictive margins for the current and new scenarios of social modeling (Toyoyama)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
_outcome#_at						
CAR# current	.47	.02	27.86	0.000	.44	.50
CAR# new	.41	.03	14.88	0.000	.36	.47
PT# current	.07	.01	8.19	0.000	.06	.10
PT# new	.08	.01	7.89	0.000	.06	.10
WC# current	.45	.017	26.85	0.000	.42	.49
WC# new	.50	.02	19.62	0.000	.45	.55

Table 4.11 Contrast of the predictive margins for the current and new scenarios of social modeling (Toyoyama)

	Contrast	std. err.	z	P>|z|
_at@_outcome				
(New vs. current) CAR	-.06	.02	-2.58	0.010
(New vs. current) PT	.01	.00	2.43	0.015
(New vs. current) WC	.05	.02	2.58	0.010

Next, the logit model results for Toyoyama show that one unit increase in caregivers' expectation of their children's use of transport modes in their non-school trips raises the likelihood of mode use by 1.2 times, which is a little more than social modeling. A similar scenario was proposed for this variable to examine the magnitude of probabilities and compare social norm and social modeling. In this new scenario, we proposed a one-unit increase in caregivers' expectations of their children to use walking/cycling (caregivers' response) and a one-unit decrease in the car use. Table 4.12 shows the probability of each mode being chosen by young adolescents in their non-school trips for the current and new scenarios. Table 4.13 tells us about the significance of the differences between the current and the new scenarios. The numerical results are depicted in Fig. 4.9.

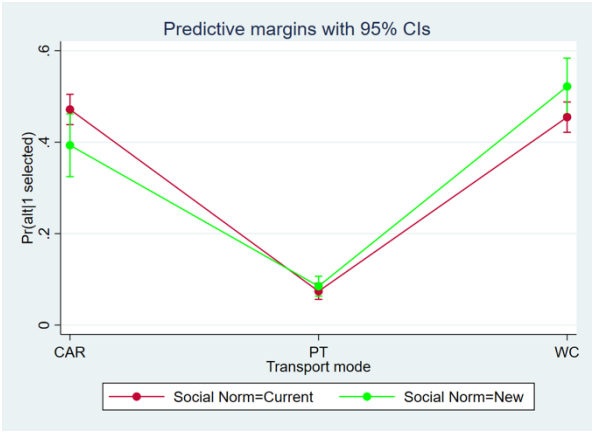


Figure 4.9 An illustration of the predictive margins for social norm (Toyoyama)

Table 4.12 Predictive margins for the current and new scenarios of social norm (Toyoyama)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
_outcome#_at						
CAR# current	.47	.02	27.86	0.000	.44	.50
CAR# new	.39	.03	11.24	0.000	.32	.46
PT# current	.07	.01	8.19	0.000	.06	.09
PT# new	.08	.01	7.64	0.000	.06	.11
WC# current	.45	.02	26.85	0.000	.42	.49
WC# new	.52	.03	16.51	0.000	.46	.58

Table 4.13 Contrast of the predictive margins for the current and new scenarios of social norm (Toyoyama)

	Contrast	std. err.	z	P>|z|
_at@_outcome				
(New vs. current) CAR	-.08	.03	-2.53	0.012
(New vs. current) PT	.01	.00	2.40	0.017
(New vs. current) WC	.07	.03	2.52	0.012

Although Fig. 4.8 and Fig. 4.9 show similar trends, proposing the new scenario for social norm seems to be slightly more influential in changing the probabilities of mode use. The results reveal that in the new proposed scenario, young adolescents would use walking/cycling and public transport more (7% and 1% increase respectively), and private car less than the existing situation (8% decrease). Comparing the social modeling and social norm results, it seems that caregivers' expectations of their children could play an essential role in changing young adolescents' mode use in favor of active modes and public transport.

Furthermore, young adolescents with higher perceived self-efficacy to choose walking/cycling under challenging situations (when the car option is also available) are 1.2 times more likely to walk/cycle rather than using the car. "Margins" were calculated for each category of transport modes to examine the effects of self-efficacy on mode use probability by changing the degree of self-efficacy (WC over the car) between its minimum and maximum values with increments of one. Fig 4.10 shows that the probability of walking/cycling gradually increases when the level of self-efficacy rises. Based on Table 4.14, at the highest level of self-efficacy, the likelihood of using walking/cycling is approximately 51% (a 15% increase compared to the lowest level of self-efficacy). However, Table 4.15 indicates that only the differences between the values of 2 vs. 1 and 3 vs. 2 are statistically significant, which means that reaching higher self-efficacy levels does not increase the chance of WC significantly compared to their immediate prior levels.

Although the likelihood of utilizing public transport would go up slightly (from 6% to 8%) as young adolescents became more capable in the use of walking/cycling over the car (Fig. 4.11 and Table 4.16), the differences between adjacent levels are insignificant (Table 4.17). Evidently, raising young adolescents' capability in using walking/cycling against the private vehicle could gradually decrease the chance of using the car (Table 4.18, and Fig. 4.12). Increasing young adolescents' self-efficacy could reduce the likelihood of car use by around 4% for each reverse adjacent level (Table 4.19). Additionally, students with higher perceived self-efficacy by their caregivers for utilizing public transport over the car are 1.26 and 1.41 times more likely to walk/cycle and use public transport instead of being driven in a private vehicle, respectively. Based on the results of the predictive margins (Fig. 4.13), the more the young adolescents find themselves capable of using public transport under difficult circumstances, the chances of walking/cycling trips increase.

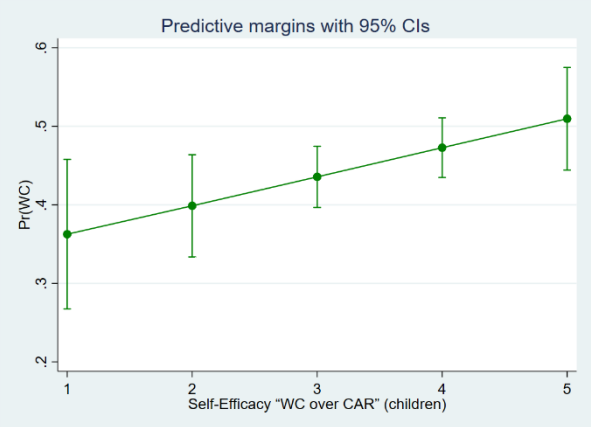


Figure 4.10 An illustration of the predictive margins of WC usage when increasing the self-efficacy (WC over the car) (Toyoyama)

Table 4.14 Margins of WC use at 1-5 levels of self-efficacy (WC over the car) (Toyoyama)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
_at						
1	.36	.05	7.46	0.000	.27	.46
2	.33	.03	12.01	0.000	.40	.46
3	.43	.02	21.91	0.000	.40	.47
4	.47	.02	24.36	0.000	.43	.51
5	.51	.03	15.29	0.000	.44	.57

Table 4.15 Contrast of WC use margins between adjacent levels of self-efficacy (WC over the car) (Toyoyama)

	Contrast	std. err.	z	P>|z|
_at				
(2 vs 1)	.04	.02	2.11	0.035
(3 vs 2)	.04	.02	1.99	0.046
(4 vs 3)	.04	.02	1.92	0.055
(5 vs 4)	.04	.02	1.88	0.060

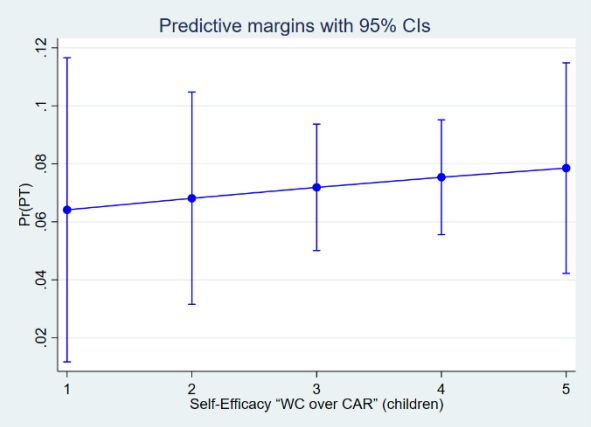


Figure 4.11 An illustration of the predictive margins of PT usage when increasing the self-efficacy (WC over the car) (Toyoyama)

Table 4.16 Margins of PT use at 1-5 levels of self-efficacy (WC over the car) (Toyoyama)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
_at						
1	.06	.03	2.40	0.016	.01	.12
2	.07	.02	3.65	0.000	.03	.10
3	.07	.01	6.47	0.000	.05	.09
4	.07	.01	7.47	0.000	.05	.09
5	.08	.02	4.24	0.000	.04	.11

Table 4.17 Contrast of PT use margins between adjacent levels of self-efficacy (WC over the car) (Toyoyama)

	Contrast	std. err.	z	P>|z|
at				
(2 vs 1)	.00	.01	0.45	0.653
(3 vs 2)	.00	.01	0.38	0.704
(4 vs 3)	.00	.01	0.32	0.749
(5 vs 4)	.00	.01	0.27	0.788

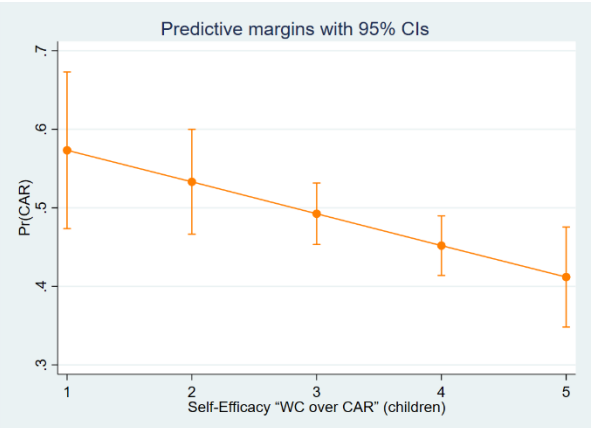


Figure 4.12 An illustration of the predictive margins of CAR usage when increasing the self-efficacy (WC over the car) (Toyoyama)

Table 4.18 Margins of CAR use at 1-5 levels of self-efficacy (WC over the car) (Toyoyama)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
_at						
1	.57	.05	11.26	0.000	.47	.67
2	.53	.03	15.65	0.000	.47	.60
3	.49	.02	24.69	0.000	.45	.53
4	.45	.02	23.31	0.000	.41	.49
5	.41	.03	12.66	0.000	.35	.47

Table 4.19 Contrast of CAR use margins between adjacent levels of self-efficacy (WC over the car) (Toyoyama)

	Contrast	std. err.	z	P>|z|
_at				
(2 vs 1)	-.04	.02	-2.16	0.031
(3 vs 2)	-.04	.02	-2.10	0.036
(4 vs 3)	-.04	.02	-2.10	0.036
(5 vs 4)	-.04	.02	-2.14	0.032

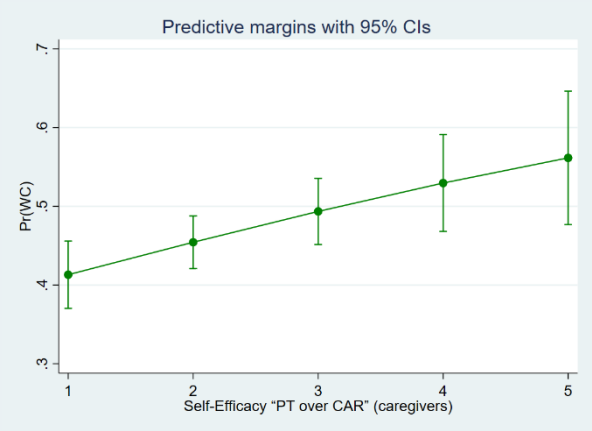


Figure 4.13 An illustration of the predictive margins of WC usage when increasing the self-efficacy (PT over the car) (Toyoyama)

Table 4.20 Margins of WC use at 1-5 levels of self-efficacy (PT over the car) (Toyoyama)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
_at						
1	.41	.02	18.96	0.000	.37	.45
2	.45	.02	26.61	0.000	.42	.49
3	.49	.02	23.01	0.000	.45	.53
4	.53	.03	16.86	0.000	.47	.59
5	.56	.04	12.97	0.000	.48	.65

Table 4.21 Contrast of WC use margins between adjacent levels of self-efficacy (PT over the car) (Toyoyama)

	Contrast	std. err.	z	P>|z|
_at				
(2 vs 1)	.04	.01	3.08	0.002
(3 vs 2)	.04	.01	2.88	0.004
(4 vs 3)	.04	.01	2.63	0.009
(5 vs 4)	.03	.01	2.28	0.023

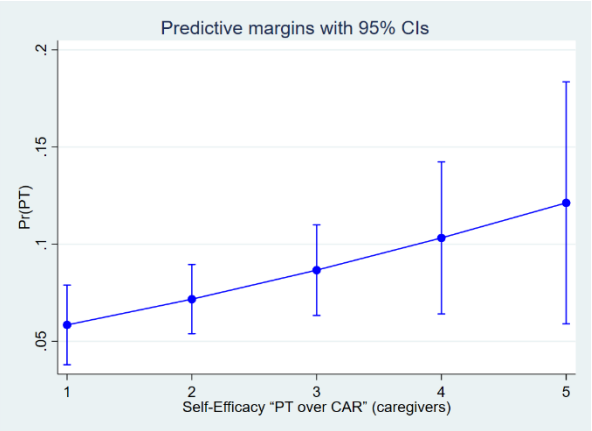


Figure 4.14 An illustration of the predictive margins of PT usage when increasing the self-efficacy (PT over the car) (Toyoyama)

Table 4.22 Margins of PT use at 1-5 levels of self-efficacy (PT over the car) (Toyoyama)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
_at						
1	.06	.01	5.59	0.000	.04	.08
2	.07	.01	7.88	0.000	.05	.09
3	.09	.01	7.27	0.000	.06	.11
4	.109	.02	5.17	0.000	.06	.14
5	.12	.03	3.81	0.000	.06	.18

Table 4.23 Contrast of PT use margins between adjacent levels of self-efficacy (PT over the car) (Toyoyama)

	Contrast	std. err.	z	P>|z|
at				
(2 vs 1)	.01	.00	2.36	0.018
(3 vs 2)	.01	.01	1.91	0.057
(4 vs 3)	.02	.01	1.61	0.108
(5 vs 4)	.02	.01	1.40	0.161

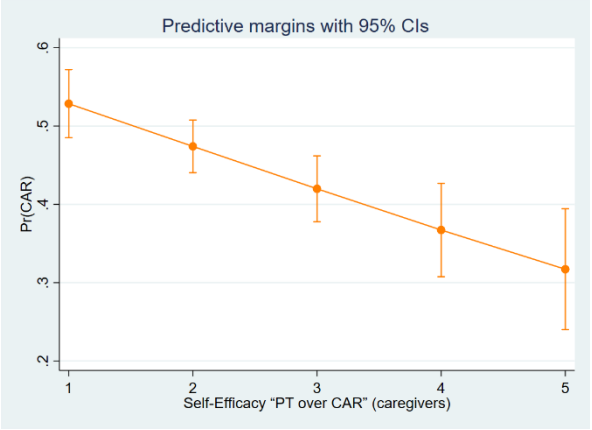


Figure 4.15 An illustration of the predictive margins of CAR usage when increasing the self-efficacy (PT over the car) (Toyoyama)

Table 4.25 Margins of CAR use at 1-5 levels of self-efficacy (PT over the car) (Toyoyama)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
_at						
1	.53	.02	23.80	0.000	.48	.57
2	.47	.02	27.70	0.000	.44	.51
3	.42	.02	19.58	0.000	.38	.46
4	.37	.03	12.08	0.000	.31	.43
5	.32	.04	8.06	0.000	.24	.39

Table 4.24 Contrast of CAR use margins between adjacent levels of self-efficacy (PT over the car) (Toyoyama)

	Contrast	std. err.	z	P>|z|
_at				
(2 vs 1)	-.05	.01	-3.90	0.000
(3 vs 2)	-.05	.01	-3.97	0.000
(4 vs 3)	-.05	.01	-4.22	0.000
(5 vs 4)	-.05	.01	-4.71	0.000

According to Table 4.20 and 4.21, there is approximately a 15% increase in the likelihood of walking/cycling from the lowest to the highest levels of public transport self-efficacy. A similar positive slope (with a smaller gradient) can be seen in Fig. 4.14, which predicts the probability of public transport use for one unit of increase (between 1 and 5) in the public transport self-efficacy. Young adolescents are expected to use public transport around 6% more when increasing the public transport self-efficacy from its lowest to highest levels (Table 4.22). The only significant changes in the likelihood of public transport use are seen between the lowest and highest levels of public transport self-efficacy, and the rest of the small gains in the probability of public transport use are not statistically significant (Table 4.23).

Consequently, we expect to see a 21% loss in the likelihood of car use by improving the public transport self-efficacy from its lowest to highest levels (Table 4.24, and Fig. 4.15). According to Table 4.25, the decrease in the likelihood of car use is statistically significant between all the adjacent levels. Although the public transport use gain is small, the car use decline is substantial, which could mean that improving young adolescents' self-efficacy for utilizing public transport is essential but may not be the most influential factor in raising the likelihood of public transport use for non-school trips among young adolescents.

4.3.1.2 The effects of (independent mobility)-related variables on mode choice

According to the model results, young adolescents allowed to go out after dark are 71% less likely to use public transport than cars. The results of the predictive margins (Table 4.26) indicate that the probability of using PT decreases by 6% for students who have the consent of going out after dark compared to those who do not. This 6% is the only statistically significant difference in the mode choice between having and non-having the consent to go out after dark (Table 4.27). However, the likelihood of using public transport is very slim. Even for the young adolescents who do not have the license, there is a 9% chance of using public transport for non-school trips.

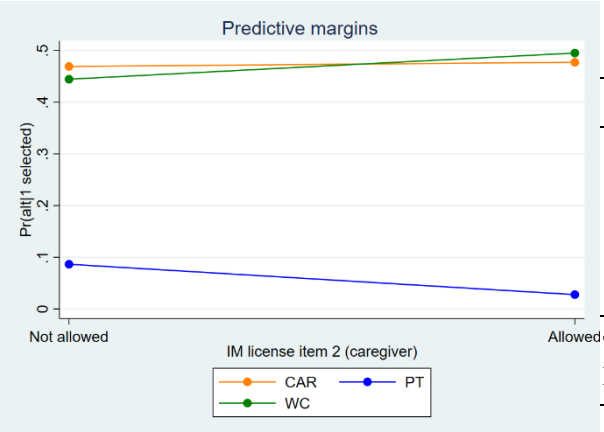


Figure 4.16 An illustration of the predictive margins of mode use at the two levels of IM license (No. 2: going out after dark alone) (Toyoyama)

Table 4.26 Margins of mode use at the two levels of IM license (No.2: going out after dark alone) (Toyoyama)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
outcome# IM license No.2						
CAR# not allowed	.47	.02	25.19	0.000	.43	.50
CAR# allowed	.48	.04	10.51	0.000	.39	.57
PT# not allowed	.09	.01	7.80	0.000	.06	.11
PT# allowed	.03	.01	2.19	0.028	.00	.05
WC# not allowed	.44	.02	23.68	0.000	.41	.48
WC# allowed	.50	.04	10.93	0.000	.41	.58

Table 4.27 Contrast of mode use margins at the levels of IM license (No.2: going out after dark alone) (Toyoyama)

	Contrast	std. err.	z	P>|z|
IM license No.2 @_outcome				
(Allowed vs. not) CAR	.01	.05	0.16	0.872
(Allowed vs. not) PT	-.06	.02	-3.39	0.001
(Allowed vs. not) WC	.05	.05	1.01	0.310

Surprisingly, young adolescents who were allowed to cycle on main roads (compared to those who were not) are 2.56 times more likely to use public transport over the car. Table 4.28 demonstrates that granting such allowance can increase the probability of PT trips by 5%,

which is statistically significant based on Table 4.29. Although the margin contrast for WC trips is not significant, Fig. 4.17 shows that young adolescents who had such allowance are less likely to walk/cycle in Toyoyama.

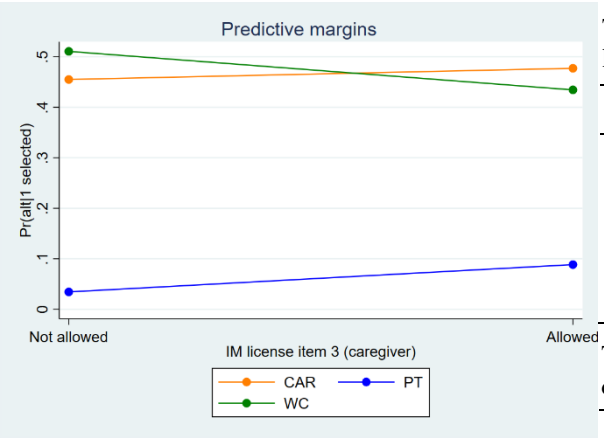


Figure 4.17 An illustration of the predictive margins of mode use at the two levels of IM license (No.3: cycling on main roads) (Toyoyama)

Table 4.28 Margins of mode use at the two levels of IM license (No.3: cycling on main roads) (Toyoyama)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
outcome# IM license No.3						
CAR# not allowed	.45	.03	13.06	0.000	.39	.52
CAR# allowed	.48	.02	23.62	0.000	.44	.52
PT# not allowed	.03	.01	2.69	0.007	.01	.06
PT# allowed	.09	.01	7.51	0.000	.06	.11
WC# not allowed	.51	.03	14.60	0.000	.44	.58
WC# allowed	.43	.02	21.60	0.000	.40	.47

Table 4.29 Contrast of mode use margins at the two levels of IM license (No.3: cycling on main roads) (Toyoyama)

	Contrast	std. err.	z	P>|z|
IM license No.3 @_outcome				
(Allowed vs. not) CAR	.02	.04	0.54	0.592
(Allowed vs. not) PT	.05	.02	3.05	0.002
(Allowed vs. not) WC	-.08	.04	-1.84	0.065

4.3.1.3 The effects of socio-demographic variables on mode choice

The choice model shows that females are 45% less likely to realize WC trips than car trips compared to their male counterparts. Fig. 4.18 depicts the differences in mode use between male and female students. According to the data presented in Table 4.30, girls aged 12-15 are 51%, 39%, and around 10% likely to use the car, walking/cycling, and public transport for their non-school trips, respectively. On the report of Table 4.31, boys, compared to girls, are 10% and 5% less likely to use the car and public transport for their non-school trips, whereas girls are 15% less likely to walk/cycle in comparison to boys, and all these differences are statistically significant. Such a pattern means that girls have a propensity to use the motorized modes of transport more than boys, and proportionally are using active modes of transport less than male students. Such differences in travel behavior related to gender need to be carefully taken into consideration.

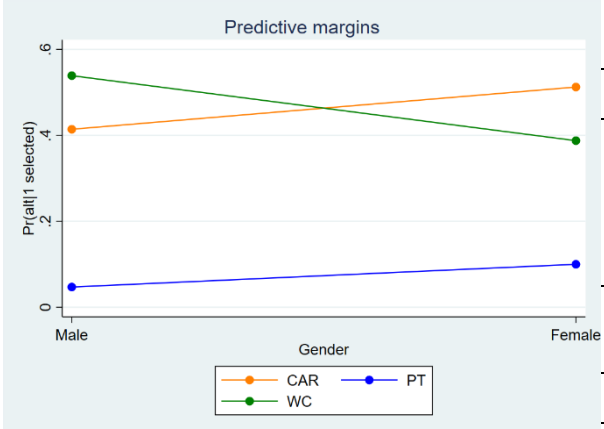


Figure 4.18 An illustration of the predictive margins of mode use for gender (Toyoyama)

Table 4.30 Margins of mode use for gender (Toyoyama)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
outcome# Gender						
CAR# male	.41	.03	15.28	0.000	.36	.47
CAR# female	.51	.02	21.73	0.000	.47	.56
PT# male	.05	.01	4.29	0.000	.02	.07
PT# female	.10	.01	6.61	0.000	.07	.13
WC# male	.54	.03	19.51	0.000	.48	.59
WC# female	.39	.02	16.51	0.000	.34	.43

Table 4.31 Contrast of mode use margins for gender (Toyoyama)

	Contrast	std. err.	z	P>|z|
Gender @_outcome				
(Female vs. male) CAR	.10	.04	2.63	0.009
(Female vs. male) PT	.05	.02	2.73	0.006
(Female vs. male) WC	-.15	.04	-3.99	0.000

Additionally, young adolescents living in bigger households with two children (compared to families with only one child) are two times more likely to realize WC trips and 4.17 times more likely to use PT than using the car, as shown in Fig. 4.19. According to Table 4.32 and 4.33, predictive margins show that for young adolescents' non-school trips in a two-child household compared to a single-child household, there is an 18% decrease in the probability of car use, while a 12% and 6% increase in the likelihood of walking/cycling and public transport use, respectively. Based on the results of Table 4.33, in households with three or more children, the chance of public transport use is approximately 5% less than a two-child household. It seems that single-child households need further attention if we plan to promote active modes or public transport. Bigger households (with three or more children) should also be taken into account to promote public transport.

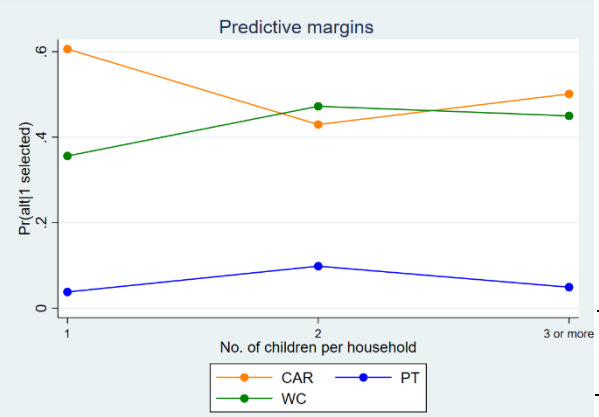


Figure 4.19 An illustration of the predictive margins of mode use for the number of children per household (Toyoyama)

Table 4.32 Margins of mode use for the number of children per household (Toyoyama)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
outcome# Children/house						
CAR#1	.61	.05	11.61	0.000	.50	.71
CAR#2	.43	.02	19.34	0.000	.39	.47
CAR#3 or more	.50	.03	14.11	0.000	.43	.57
PT#1	.04	.02	2.12	0.034	.00	.07
PT#2	.10	.01	6.78	0.000	.07	.13
PT#3 or more	.05	.01	3.34	0.001	.02	.08
WC#1	.36	.05	6.90	0.000	.25	.46
WC#2	.47	.02	20.92	0.000	.43	.52
WC#3 or more	.45	.03	12.80	0.000	.38	.52

Table 4.33 Contrast of mode use margins for the number of children per household (Toyoyama)

	Contrast	std. err.	z	P>|z|
Children/house @ outcome				
(2 vs. 1) CAR	-.18	.06	-3.09	0.002
(2 vs. 1) PT	.06	.02	2.57	0.010
(2 vs. 1) WC	.12	.06	2.05	0.041
(3 or more vs. 2) CAR	.07	.04	1.66	0.096
(3 or more vs. 2) PT	-.05	.02	-2.30	0.021
(3 or more vs. 2) WC	-.02	.04	-0.52	0.600

As for the household construct, the logit model shows that young adolescents in households consisting of a single parent, children, and grandparent/s are 65% less likely to walk/cycle than given a ride in a car compared to single-parent households without the presence of grandparent/s. This relationship is reported significant at the exact level of 0.05. Taking a look at the predictive margins in Fig. 4.20, we can detect distinctive trends for young adolescents' mode use among the households comprising parents (the first two items on the horizontal axis from the left) and the single-parent households (the last two items on the horizontal axis on the right). Sharp changes can be observed for the car and walking/cycling use among the single-parent households (with or without grandparent/s).

According to Table 4.34, the probability of public transport use for households other than the first type (parents and children) is not statistically significant, which can be due to the small number of reported trips with public transport in Toyoyama. Based on the results of Table 4.35, which documents the adjacent differences between different levels of household type, young adolescents belonging to single-parent households with grandparent/s are 23% more likely to use the car compared to the sing-parent households with no grandparent/s. Also, the

5% drop in the use of public transport by young adolescents in households with parents and grandparent/s in comparison to households with parents (only) is statistically significant.

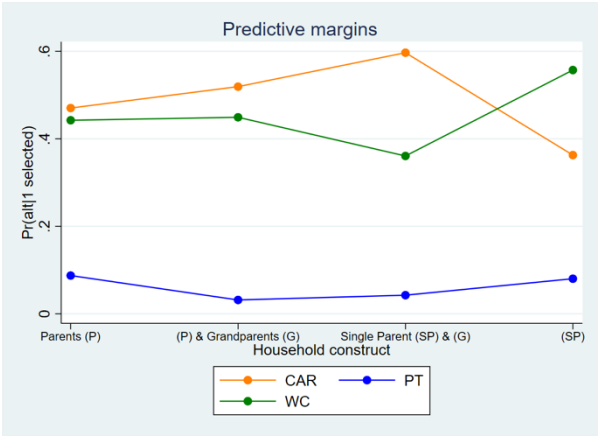


Figure 4.20 An illustration of the predictive margins of mode use at different levels of household construct (Toyoyama)

Table 4.35 Margins of mode use at different levels of household construct (Toyoyama)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
outcome# Household						
CAR#P	.47	.02	22.64	0.000	.43	.51
CAR#P & G	.52	.08	6.49	0.000	.36	.68
CAR#SP & G	.60	.08	6.94	0.000	.43	.76
CAR#SP	.36	.06	5.71	0.000	.24	.49
PT#P	.09	.01	6.33	0.000	.06	.11
PT#P & G	.03	.02	1.69	0.091	.00	.07
PT#SP & G	.04	.03	1.60	0.109	-.01	.09
PT#SP	.08	.04	1.87	0.062	.00	.16
WC#P	.44	.02	20.75	0.000	.40	.48
WC#P & G	.45	.08	5.66	0.000	.29	.60
WC#SP & G	.36	.08	4.30	0.000	.20	.52
WC#SP	.56	.07	8.08	0.000	.42	.69

Table 4.34 Contrast of mode use margins at different levels of household construct (Toyoyama)

	Contrast	std. err.	z	P>|z|
Household @ outcome				
(P & G vs. P) CAR	.05	.09	0.57	0.572
(P & G vs. P) PT	-.05	.03	-2.09	0.036
(P & G vs. P) WC	.01	.09	0.08	0.937
(SP & G vs. P & G) CAR	.08	.11	0.72	0.473
(SP & G vs. P & G) PT	.01	.03	0.36	0.721
(SP & G vs. P & G) WC	-.09	.11	-0.83	0.405
(SP vs. SP & G) CAR	-.23	.11	-2.16	0.031
(SP vs. SP & G) PT	.04	.05	0.73	0.465
(SP vs. SP & G) WC	.20	.11	1.78	0.075

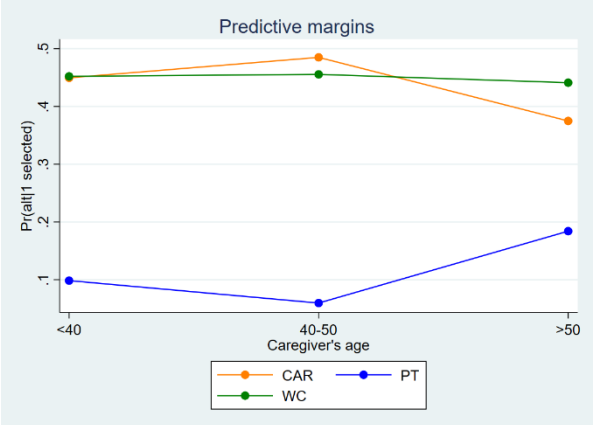


Figure 4.21 An illustration of the predictive margins of mode use for different levels of caregivers' age (Toyoyama)

Table 4.36 Margins of mode use for different levels of caregivers' age (Toyoyama)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
outcome# Caregivers' age						
CAR# <40	.45	.04	10.10	0.000	.36	.54
CAR# 40-50	.48	.02	23.41	0.000	.44	.52
CAR# >50	.37	.07	5.36	0.000	.24	.51
PT# <40	.10	.03	3.24	0.001	.04	.16
PT# 40-50	.06	.01	6.17	0.000	.04	.08
PT# >50	.18	.05	3.32	0.001	.07	.29
WC# <40	.45	.04	10.18	0.000	.36	.54
WC# 40-50	.45	.02	22.10	0.000	.41	.50
WC# >50	.44	.07	6.25	0.000	.30	.58

Table 4.37 Contrast of mode use margins for different levels of caregivers' age (Toyoyama)

	Contrast	std. err.	z	P>|z|
Caregivers' age @ outcome				
(40-50 vs. <40) CAR	.03	.05	0.68	0.493
(40-50 vs. <40) PT	-.04	.03	-1.18	0.240
(40-50 vs. <40) WC	.00	.05	0.07	0.947
(>50 vs. 40-50) CAR	-.11	.07	-1.49	0.135
(>50 vs. 40-50) PT	.12	.06	2.21	0.027
(>50 vs. 40-50) WC	-.01	.07	-0.19	0.846

Furthermore, based on Table 4.6, young adolescents whose mothers (dominant respondents) are in their 40s (compared to over 50) were 78% less likely to use PT rather than the car. The likelihood of different mode use for young adolescents' non-school trips based on

the age of their caregivers (mostly their mothers) is reported in Table 4.36 and illustrated in Fig. 4.21. According to Table 4.37, a discrete change from mothers aged 40-50 to those over 50 can raise the probability of using public transport for non-school trips by 12%.

While the share of students' walking/cycling trips remains the same among the different caregivers' age groups, car and PT trips show more fluctuations. Around 45-48% of students' non-school trips are made with the vehicle where at least one of the caregivers is less than 50 years old, which seems to affect students' use of public transport negatively. The smallest share of young adolescents' PT trips belongs to those having at least one caregiver in their 40s. While the reasons behind this pattern are not completely clear, it could be due to the caregivers' lifestyle at this specific age range. Understanding the underlying factors for such a pattern can help address the over-reliance on the private car for students' non-school trips.

Surprisingly, the logit model results show that households with three or more cars (compared to households with only one car) are more likely to realize WC/PT trips than car trips. Given the margins results, it seems that as the number of cars per household increases, the share of young adolescents' car trips decreases, while the share of walking/cycling and public transport trips increases (Fig. 4.22). According to Table 4.38, car trips decrease around 22% from a single-car household to a multiple-car household. More particularly, the probability of car use among young adolescents in households with multiple cars is 18% less than households owning two private vehicles, which is the only significant change between the adjacent levels (Table 4.39). Such a result is unexpected and warrants further investigation.

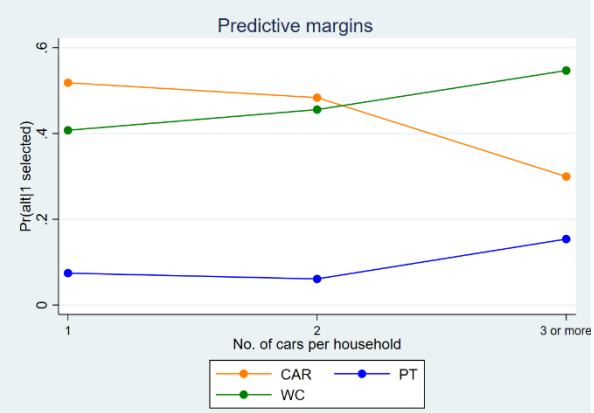


Figure 4.22 An illustration of the predictive margins of mode use for the number of cars per household (Toyoyama)

Table 4.38 Margins of mode use for the number of cars per household (Toyoyama)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
outcome# Cars/house						
CAR#1	.52	.03	14.41	0.000	.45	.59
CAR#2	.48	.02	18.92	0.000	.43	.53
CAR#3 or more	.30	.06	4.72	0.000	.17	.42
PT#1	.07	.02	4.32	0.000	.04	.11
PT#2	.06	.01	5.15	0.000	.04	.08
PT#3 or more	.15	.06	2.36	0.018	.02	.28
WC#1	.41	.03	11.44	0.000	.34	.48
WC#2	.45	.02	17.89	0.000	.40	.50
WC#3 or more	.55	.07	7.29	0.000	.40	.69

Table 4.39 Contrast of mode use margins for the number of cars per household (Toyoyama)

	Contrast	std. err.	z	P>|z|
Cars/house @ outcome				
(2 vs. 1) CAR	-.03	.05	-0.74	0.460
(2 vs. 1) PT	-.01	.02	-0.61	0.539
(2 vs. 1) WC	.05	.05	1.03	0.302
(3 or more vs. 2) CAR	-.18	.07	-2.48	0.013
(3 or more vs. 2) PT	.09	.07	1.36	0.174
(3 or more vs. 2) WC	.09	.08	1.08	0.280

Finally, junior high school students living in Toyoyama district (compared to Shimizu district) were 1.58 times and 3.07 times more likely to realize WC and PT trips rather than car trips, respectively. Looking at Fig. 4.23, we can see that those young adolescents living in the Toyoyama district use PT more than the other two districts. According to Table 4.41, this difference is around 6% and is statistically significant. Although Toyoyama district has a

relatively smaller share of car use compared to the other two districts (Table 4.40), no statistically significant trend was observed for this transport mode.

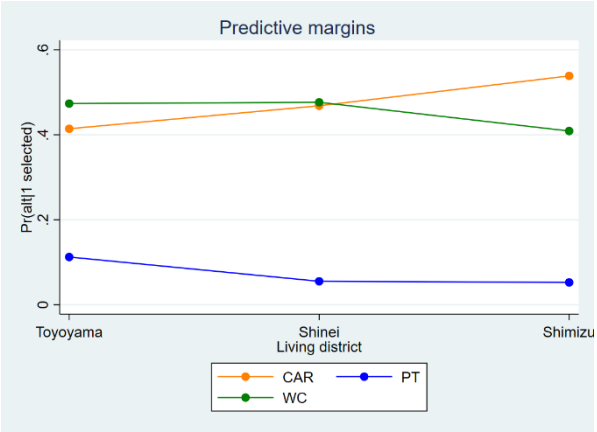


Figure 4.23 An illustration of the predictive margins of mode use for the different living districts in Toyoyama

Table 4.40 Margins of mode use for the different living districts in Toyoyama

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
outcome# Living district						
CAR# Toyoyama	.41	.03	14.46	0.000	.36	.47
CAR# Shinei	.47	.04	12.62	0.000	.39	.54
CAR# Shimizu	.54	.03	17.48	0.000	.48	.60
PT# Toyoyama	.11	.02	5.35	0.000	.07	.15
PT# Shinei	.05	.02	3.39	0.001	.02	.09
PT# Shimizu	.05	.01	3.88	0.000	.03	.08
WC# Toyoyama	.47	.03	16.07	0.000	.41	.53
WC# Shinei	.48	.04	12.76	0.000	.40	.55
WC# Shimizu	.41	.03	13.53	0.000	.35	.47

Table 4.41 Contrast of mode use margins for the different living districts in Toyoyama

	Contrast	std. err.	z	P>|z|
Living district @ outcome				
(Shinei vs. Toyoyama) CAR	.05	.05	1.10	0.271
(Shinei vs. Toyoyama) PT	-.06	.03	-2.09	0.037
(Shinei vs. Toyoyama) WC	.00	.05	0.06	0.951
(Shimizu vs. Shinei) CAR	.07	.05	1.45	0.146
(Shimizu vs. Shinei) PT	.00	.02	-0.12	0.904
(Shimizu vs. Shinei) WC	-.07	.05	-1.40	0.160

4.3.2 Minamiise Analysis Model Results (category: mid-sized, coastal)

Model fitting information included the value (-467.19) for log-likelihood, a significant chi-square value of (84.17) for the likelihood ratio test, and a value of (0.097) for McFadden R square, which is a reasonably good fit. Table 4.42 is a summary of this model's exponentiated coefficients (odds ratios and relative risk ratios) in which only the significant variables are shown. For a full report on the model's estimates (logit values and odds ratios/relative risk ratios), see Appendix D. To interpret the results, we rely on the estimates reported in Table 4.42 and the calculated margins for each significant variable in the logit model for Minamiise. Also, the average marginal effects can be used for further reference (see Appendix D).

Table 4.42 The estimated results (exponentiated coefficients) of the choice model in Minamiise town (only the significant estimates are shown)

Conditional logit choice model (Minamiise)				No. of observations		1827	
Wald chi^2 (40)		84.17		No. of cases		609	
Log-likelihood	-467.18	$Prob>chi^2$	0.00	Alternatives per case		3	
Variables		**Odds ratio**	**std. err.**	**z**	**P>|z|**	**[95% conf. interval]**	
Alternative-specific variables							
Psychological							
Social Support		1.82	.23	4.64	0.000	1.41	2.34
Variables		**Relative risk ratio**	**Std. err.**	**z**	**P>|z|**	**[95% conf. interval]**	
Case-specific variables							
Public Transport (PT) estimates (base alternative: CAR)							
Independent Mobility (IM)							
IM license (base: not allowed to do) (students)							
3: Allowed to cycle on main roads		.52	.15	-2.22	0.027	.29	.93
Socio-demographic							
Grade (base: third grade)							
First grade		.45	.16	-2.25	0.025	.22	.90
Second grade							
_cons		.51	.45	-0.75	0.451	.09	2.92
Walking/Cycling (WC) estimates (base alternative: CAR)							
Environmental							
Neighborhood Safety		1.62	.31	2.55	0.011	1.12	2.35
Socio-demographic							
Grade (base: third grade)							
First grade							
Second grade		2.05	.68	2.14	0.032	1.06	3.94
cons		.06	.05	-3.68	0.000	.014	.27

Only the variables with a significant relationship trend ($p<0.10$) in the preliminary steps were used in making this final model.
For those variables reported by both students and their caregivers, the respondent is mentioned in parenthesis.
In the case of insignificant estimates for some of the levels of categorical variables, only the labels of the insignificant levels are kept in the table for the sake of clarity.
Note: '_cons' estimates baseline relative risk for each outcome.

4.3.2.1 The effects of psychological variables on mode choice

The logit model results for Minamiise show that junior high school students receiving more social support from their caregivers/friends for utilizing each specific mode of transport had higher odds of realizing trips with those respective means of transport. A new scenario was

introduced to interpret the model results for this variable, and the probability of mode choice was compared between the current and the new situation (for the three main categories of transport modes). In this new scenario, we proposed increasing the social support for using walking/cycling and public transport by one unit and decreasing the social support for using the car by one unit. It is noteworthy that social support is received from young adolescents' caregivers and friends, which includes the encouragement for using each mode and the frequency of trips made together with young adolescents' significant others by each transport mode.

The results of the margins can be seen in Table 4.43, which is also illustrated in Fig. 4.24. The color red shows the probability of using different modes for the current social support situation, whereas green represents the likelihood of mode choice for the new scenario. Based on the contrast results in Table 4.44, introducing the new scenario can significantly change the probability of different modes' use. Given the circumstances of the new scenario, young adolescents' use of walking/cycling and public transport for their non-school trips would increase by 15% and 11%, respectively, which could decrease the use of the car by 26% consequently (Table 4.44). Other scenarios could have been tested in this regard. However, since the focus of this research is the promotion of active modes and public transport among young adolescents, we proposed the above changes. The induced substantial changes in the probabilities of mode use emphasize the prominent role of social support on young adolescents' mode choice. The support is received from students' caregivers and friends in terms of encouragement and making trips with each mode together (either with caregivers or friends), which could translate to more use of walking/cycling and public transport and less use of the car.

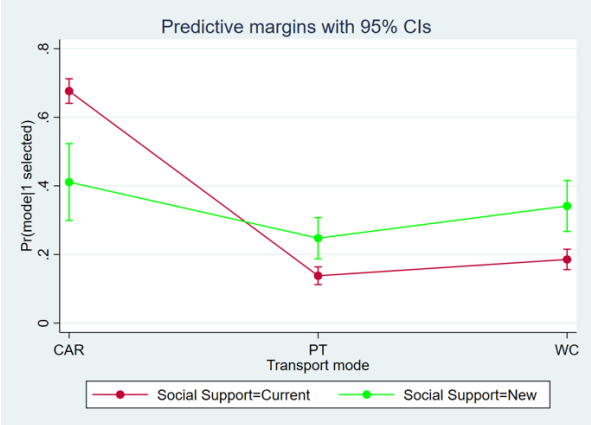


Figure 4.24 An illustration of the predictive margins for social support (Minamiise)

Table 4.43 Predictive margins for the current and new scenarios of social support (Minamiise)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
_outcome#_at						
CAR# current	.68	.02	37.10	0.000	.64	.71
CAR# new	.42	.06	7.19	0.000	.30	.52
PT# current	.14	.01	10.48	0.000	.11	.16
PT# new	.25	.03	8.08	0.000	.19	.31
WC# current	.18	.01	12.24	0.000	.15	.21
WC# new	.34	.04	9.00	0.000	.27	.41

Table 4.44 Contrast of the predictive margins for the current and new scenarios of social support (Minamiise)

	Contrast	std. err.	z	P>|z|
_at@_outcome				
(New vs. current) CAR	-.26	.05	-4.95	0.000
(New vs. current) PT	.11	.02	4.51	0.000
(New vs. current) WC	.15	.03	4.87	0.000

4.3.2.2 The effects of environmental variables on mode choice

Neighborhood safety also significantly affects the odds of walking/cycling compared to the likelihood of car use. According to the results of Table 4.42, if young adolescents perceive their neighborhood safety one unit higher, it is 1.62 times more likely they use walking/cycling rather than the car. To examine the effects of neighborhood safety on mode use probability, margins were calculated for each category of transport modes when changing the neighborhood

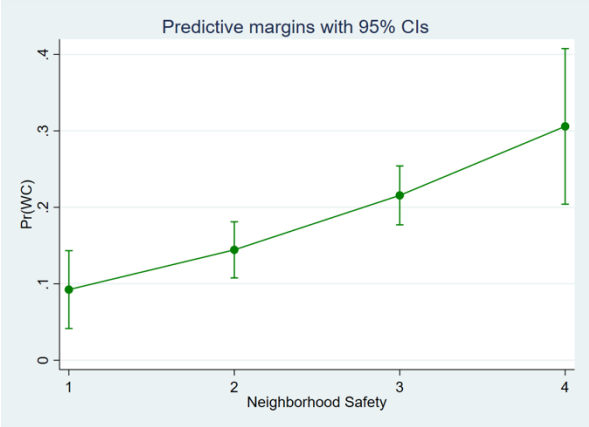


Figure 4.25 An illustration of the predictive margins of WC usage when increasing the neighborhood safety (Minamiise)

Table 4.45 Margins of WC use at 1-4 levels of neighborhood safety (Minamiise)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
_at						
1	.09	.02	3.56	0.000	.04	.14
2	.14	.02	7.71	0.000	.11	.18
3	.21	.02	10.97	0.000	.18	.25
4	.30	.05	5.89	0.000	.20	.41

Table 4.46 Contrast of WC use margins between adjacent levels of neighborhood safety (Minamiise)

	Contrast	std. err.	z	P>|z|
_at				
(2 vs 1)	.05	.01	4.59	0.000
(3 vs 2)	.07	.02	2.93	0.003
(4 vs 3)	.09	.04	2.39	0.017

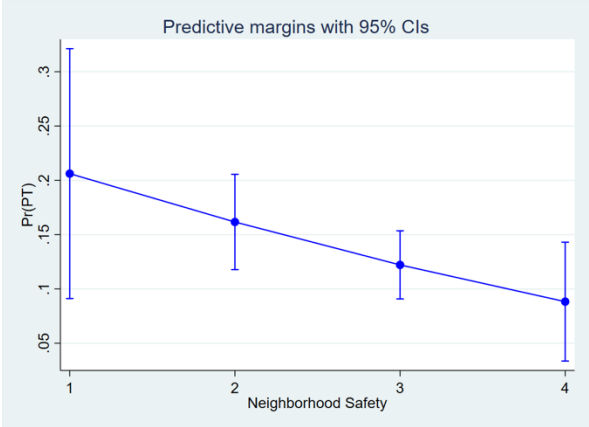


Figure 4.26 An illustration of the predictive margins of PT usage when increasing the neighborhood safety (Minamiise)

Table 4.47 Margins of PT use at 1-4 levels of neighborhood safety (Minamiise)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
_at						
1	.21	.06	3.51	0.000	.09	.32
2	.16	.02	7.22	0.000	.12	.20
3	.12	.01	7.64	0.000	.09	.15
4	.09	.03	3.16	0.002	.03	.14

Table 4.48 Contrast of PT use margins between adjacent levels of neighborhood safety (Minamiise)

	Contrast	std. err.	z	P>|z|
_at				
(2 vs 1)	-.04	.04	-1.13	0.258
(3 vs 2)	-.04	.03	-1.44	0.151
(4 vs 3)	-.03	.02	-2.11	0.035

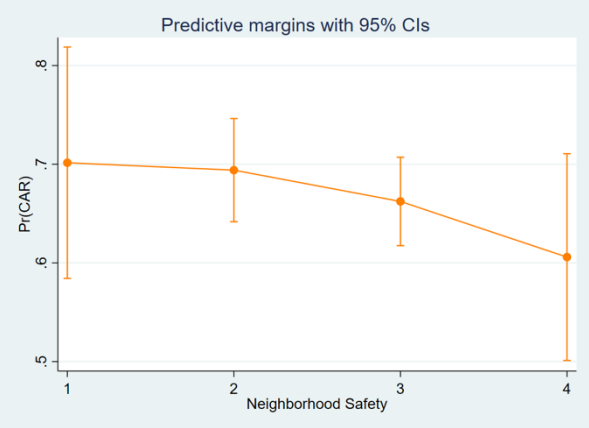


Figure 4.27 An illustration of the predictive margins of CAR usage when increasing the neighborhood safety (Minamiise)

Table 4.49 Margins of CAR use at 1-4 levels of neighborhood safety (Minamiise)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
_at						
1	.70	.06	11.73	0.000	.70	.06
2	.69	.03	26.01	0.000	.69	.03
3	.66	.02	28.97	0.000	.66	.02
4	.60	.05	11.33	0.000	.60	.05

Table 4.50 Contrast of CAR use margins between adjacent levels of neighborhood safety (Minamiise)

	Contrast	std. err.	z	P>|z|
at				
(2 vs 1)	-.01	.04	-0.19	0.846
(3 vs 2)	-.03	.03	-0.95	0.340
(4 vs 3)	-.06	.04	-1.51	0.131

safety between the minimum and maximum reported values with one-unit increments. Fig 4.25 shows that WC probability gradually increases when the neighborhood is perceived to be safer. According to Table 4.45, at the highest level of neighborhood safety, the likelihood of using walking/cycling is approximately 30% (a 21% increase compared to the lowest level of neighborhood safety). Table 4.46 indicates that the rise in the likelihood of WC use at each level of neighborhood safety compared to its previous level is statistically significant.

On the contrary, as young adolescents find their living environment safer, the chances of using public transport or the car decreases (Fig. 4.26 and 4.27). Based on the results of predictive margins in Table 4.47 and 4.49, at the highest level of neighborhood safety, students would make around 9% and 60% of their non-school trips by public transport and private car, respectively (around 10% decrease compared to the lowest level of neighborhood safety for both transport modes). However, the only statistically significant marginal contrasts for public transport use are found between the highest level of neighborhood safety and all its previous levels (Table 4.48). The marginal differences for car use are not statistically significant (Table 4.50). Perceived safety only seems to affect the probability of WC use substantially, which needs to be considered to promote active modes among the target age group.

4.3.2.3 The effects of (independent mobility)-related variables on mode choice

On the contrary to what was discussed for Toyoyama, the model for Minamiise shows that those young adolescents who had the consent to cycle on main roads (compared to those who did not) were 48% less likely to make public transport trips than car trips. The results of the predictive margins (Table 4.51) are demonstrated in Fig. 4.28, which shows that students who are allowed to cycle on main roads in Minamiise are approximately 6% more likely to walk or cycle and around 8% (the only statistically significant difference based on Table 4.52) less likely to use public transport for their non-school trips. Considering the characteristics of the built environment in Minamiise, it seems that this item of the independent mobility license gives young adolescents some freedom in their mobility that can be solely enjoyed and replaced the need to use public transport for longer-distance journeys. It is noteworthy that around 80% of the public transport trips in Minamiise were realized inside the town, whereas in Toyoyama, 100% of them were bound for out of town (Fig. 4.6). In Toyoyama, cycling on main roads may be translated to freedom in making long-distance trips with active modes and public transport.

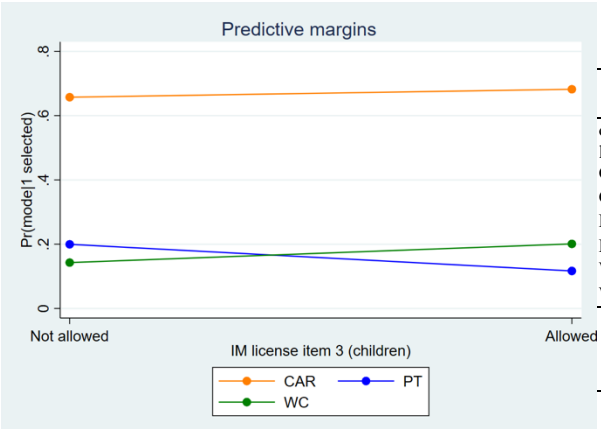


Figure 4.28 An illustration of the predictive margins of mode use at the two levels of IM license (No.3: cycling on main roads) (Minamiise)

Table 4.51 Margins of mode use at the two levels of IM license (No.3: cycling on main roads) (Minamiise)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
outcome# IM license No.3						
CAR# not allowed	.66	.04	17.61	0.000	.58	.73
CAR# allowed	.68	.02	31.51	0.000	.64	.72
PT# not allowed	.20	.03	6.26	0.000	.14	.26
PT# allowed	.12	.01	8.02	0.000	.09	.145
WC# not allowed	.14	.03	5.25	0.000	.09	.20
WC# allowed	.20	.02	10.76	0.000	.16	.24

Table 4.52 Contrast of mode use margins at the two levels of IM license (No.3: cycling on main roads) (Minamiise)

	Contrast	std. err.	z	P>|z|
IM license No.3 @_outcome				
(Allowed vs. not) CAR	.02	.04	0.56	0.575
(Allowed vs. not) PT	-.08	.03	-2.31	0.021
(Allowed vs. not) WC	.06	.03	1.72	0.085

4.3.2.4 The effects of socio-demographic variables on mode choice

Finally, the model results for Minamiise shows that students in their second grade (compared to those enrolling in the third grade) are two times more likely to walk/cycle rather than get around in a private car for their non-school trips. Additionally, students in the first grade of junior high school (compared to those in the third grade) seem 55% less likely to use public transport over the car. We can observe the magnitude of age effect (enrolling grade) on the probability of mode choice in the predictive margins reported in Table 4.53. Looking at Fig. 4.29, the chance of car use seems to stay unchanged among the students of different grades. There is a slight insignificant increase in the likelihood of walking/cycling and public transport for second graders (compared to first graders). However, in the event of a discrete change from second-grade students to third-graders, a sharp increase can be detected in the probability of public transport (8%) and a decrease in the likelihood of walking/cycling (10%), both of which are statistically significant according to Table 4.54. Although there are no considerable nuances in the age of adolescents in this study (12-15-year-olds), the differences of mode choice between different enrolling grades are detectable.

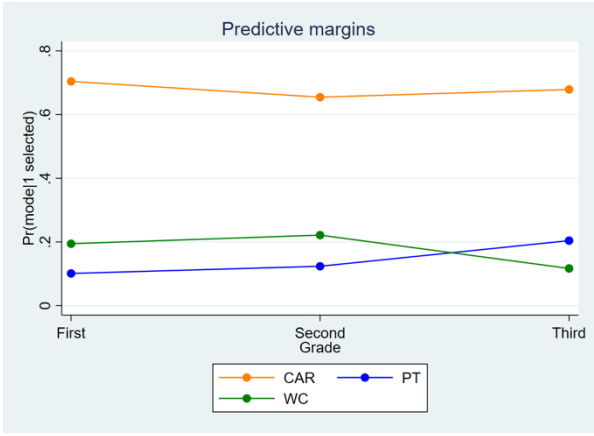


Figure 4.29 An illustration of the predictive margins of mode use for young adolescents' age (students' grade) (Minamiise)

Table 4.53 Margins of mode use for young adolescents' age (students' grade) (Minamiise)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
outcome# Grade						
CAR# first	.70	.03	22.66	0.000	.64	.76
CAR# second	.65	.03	20.76	0.000	.59	.72
CAR# third	.68	.04	17.44	0.000	.60	.75
PT# first	.10	.02	4.74	0.000	.06	.14
PT# second	.12	.02	5.52	0.000	.08	.17
PT# third	.20	.03	6.20	0.000	.14	.27
WC# first	.19	.03	7.27	0.000	.14	.25
WC# second	.22	.03	8.19	0.000	.17	.27
WC# third	.12	.03	4.24	0.000	.06	.17

Table 4.54 Contrast of mode use margins for young adolescents' age (students' grade) (Minamiise)

	Contrast	std. err.	z	P>|z|
Grade @ _outcome				
(Second vs. first) CAR	-.05	.04	-1.09	0.274
(Second vs. first) PT	.02	.03	0.71	0.476
(Second vs. first) WC	.03	.04	0.70	0.487
(Third vs. second) CAR	.02	.05	0.49	0.628
(Third vs. second) PT	.08	.04	2.01	0.044
(Third vs. second) WC	-.10	.04	-2.70	0.007

4.3.3 Kiso Analysis Model Results (category: large-sized, mountainous)

Model fitting information included the value (-472.72) for log-likelihood, a significant chi-square value of (131.03) for the likelihood ratio test, and a value of (0.15) for McFadden R square, which is a good fit. Table 4.55 is a summary of this model's exponentiated coefficients (odds ratios and relative risk ratios) in which only the significant variables are shown. For a full report on the model's estimates (logit values and odds ratios/relative risk ratios), see Appendix E. To interpret the results, we rely on the estimates reported in Table 4.55 and the calculated margins for each significant variable in the logit model for Kiso. Also, the average marginal effects can be used for further reference (see Appendix E).

Table 4.55 The estimated results (exponentiated coefficients) of the choice model in Kiso town

Conditional logit choice model (Kiso)				No. of observations		2004	
Wald chi^2 (40)		131.03		No. of cases		668	
Log-likelihood	-472.72	$Prob>chi^2$	0.00	Alternatives per case		3	
Variables		**Relative risk ratio**	**Std. err.**	**z**	**P>|z|**	**[95% conf. interval]**	
Case-specific variables							
Public Transport (PT) estimates (base alternative: CAR)							
Psychological							
Self-Efficacy "PT over CAR" (caregivers)		1.45	.22	2.37	0.018	1.07	1.96
Independent Mobility (IM)							
IM Farthest Distance (base: school neighborhood) (students)							
Inside the town							
Out of town		4.15	2.65	2.23	0.026	1.19	14.48
IM Farthest Distance (base: home neighborhood) (caregivers)							
School neighborhood							
Inside the town		.27	.15	-2.34	0.019	.09	.81
Out of town		.24	.14	-2.44	0.015	.07	.75
Socio-demographic							
Living district (base: Kaida district)							
Fukushima		.39	.16	-2.25	0.024	.17	.88
Hiyoshi							
Mitake							
Household construct (base: single parent and children)							
Parents and children							
Parents, grandparent/s, children							
Single parent, grandparent/s, children		12.39	14.55	2.14	0.032	1.24	123.67
_cons		.01	.02	-2.48	0.013	.00	.40
Walking/Cycling (WC) estimates (base alternative: CAR)							
Psychological							
Self-Efficacy "WC over CAR" (caregivers)		1.34	.17	2.28	0.023	1.04	1.73
Independent Mobility (IM)							
IM Farthest Distance (base: school neighborhood) (students)							
Inside the town							
Out of town		3.21	1.44	2.60	0.009	1.33	7.74

Variables	Relative risk ratio	Std. err.	z	P>|z|	[95% conf. interval]	
Socio-demographic						
Female (base: male)	.56	.14	-3.35	0.001	.33	.93
Grade (base: third grade)						
First grade						
Second grade	2.32	.76	2.57	0.010	1.22	4.42
Future plan (base: work/study inside the town or others)						
Work/study out of town	.44	.13	-2.79	0.005	.25	.78
Living district (base: Kaida district)						
Fukushima	3.97	2.38	2.30	0.021	1.23	12.84
Hiyoshi	7.34	4.63	3.16	0.002	2.13	25.29
Mitake						
Caregivers' job (base: full-time homemaker or unemployed)						
Full-time employee	.32	.16	-2.30	0.021	.12	.84
Part-time employee						
Full-time self-employed						
_cons	.10	.12	-1.81	0.070	.01	1.21

Only the variables with a significant relationship trend ($p<0.10$) in the preliminary steps were used in making this final model.
For those variables reported by both students and their caregivers, the respondent is mentioned in parenthesis.
In the case of insignificant estimates for some of the levels of categorical variables, only the labels of the insignificant levels are kept in the table for the sake of clarity.
Note: '_cons' estimates baseline relative risk for each outcome.

4.3.3.1 The effects of psychological variables on mode choice

The conditional logit model results in Table 4.55 show that those young adolescents perceived by their caregivers to be more capable of choosing walking/cycling over the private car under challenging circumstances are 1.34 times more likely to realize WC trips than car trips. Fig. 4.30, 4.31, and 4.32 visualize the predictive margins (shown in Tables 4.56, 4.58, and 4.60) of choosing different transport modes when increasing the self-efficacy for WC with increments of one unit. As young adolescents' capability in walking/cycling (instead of taking a car ride) increases, the expected probability of selecting walking/cycling is estimated to rise. At the highest level of self-efficacy (WC over the car), there is approximately a 15% increase in the probability of walking/cycling compared to the lowest level. According to Table 4.57, the first two reverse adjacent contrasts are significant at the 0.05 significance level. Although there is around a 5% increase in the expected probability of public transport from level 1 to 5 of self-efficacy (WC over the car), none of the adjacent contrasts are significant (Table 4.59). Consequently, we find a significant decrease (5 to 6%) in the expected probability of using the car for each unit of increase in the caregivers' perceived self-efficacy of their children for using walking/cycling (Table 4.61).

Additionally, young adolescents whose caregivers recognize them as more capable of traveling with public transport (when a private car is also an option) are 1.45 times more likely to select means of public transport over private vehicles to realize their non-school trips. Fig. 4.33, 4.34, and 4.35 demonstrate the trend in the expected probability of transport modes when young adolescents' self-efficacy increases from 1 (the lowest) to 5 (the highest) with one unit of increment.

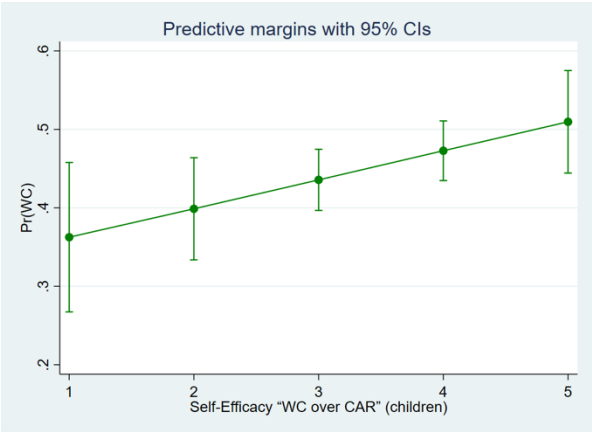


Figure 4.30 An illustration of the predictive margins of WC usage when increasing the self-efficacy (WC over the car) (Kiso)

Table 4.56 Margins of WC use at 1-5 levels of self-efficacy (WC over the car) (Kiso)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
_at						
1	.36	.05	7.46	0.000	.27	.46
2	.33	.03	12.01	0.000	.40	.46
3	.43	.02	21.91	0.000	.40	.47
4	.47	.02	24.36	0.000	.43	.51
5	.51	.03	15.29	0.000	.44	.57

Table 4.57 Contrast of WC use margins between adjacent levels of self-efficacy (WC over the car) (Kiso)

	Contrast	std. err.	z	P>|z|
_at				
(2 vs 1)	.04	.02	2.11	0.035
(3 vs 2)	.04	.02	1.99	0.046
(4 vs 3)	.04	.02	1.92	0.055
(5 vs 4)	.04	.02	1.88	0.060

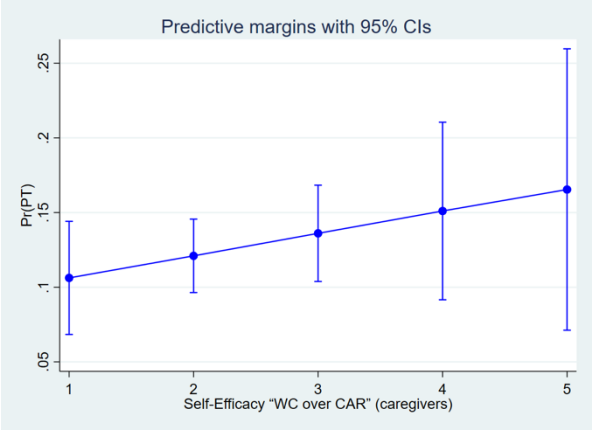


Figure 4.31 An illustration of the predictive margins of PT usage when increasing the self-efficacy (WC over the car) (Kiso)

Table 4.58 Margins of PT use at 1-5 levels of self-efficacy (WC over the car) (Kiso)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
_at						
1	.11	.02	5.50	0.000	.07	.14
2	.12	.01	9.65	0.000	.10	.14
3	.14	.02	8.27	0.000	.10	.17
4	.15	.03	4.98	0.000	.09	.21
5	.16	.05	3.44	0.001	.07	.26

Table 4.59 Contrast of PT use margins between adjacent levels of self-efficacy (WC over the car) (Kiso)

	Contrast	std. err.	z	P>|z|
at				
(2 vs 1)	.01	.01	1.23	0.218
(3 vs 2)	.01	.01	1.04	0.298
(4 vs 3)	.01	.01	0.89	0.374
(5 vs 4)	.01	.02	0.76	0.447

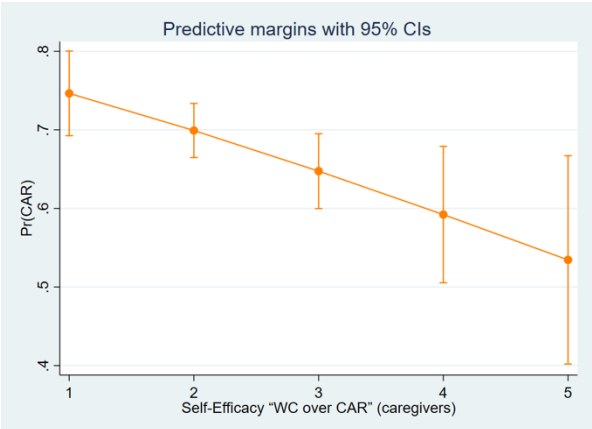


Figure 4.32 An illustration of the predictive margins of CAR usage when increasing the self-efficacy (WC over the car) (Kiso)

Table 4.60 Margins of CAR use at 1-5 levels of self-efficacy (WC over the car) (Kiso)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
_at						
1	.75	.03	27.16	0.000	.69	.80
2	.70	.02	39.78	0.000	.66	.73
3	.65	.02	26.62	0.000	.60	.69
4	.59	.04	13.37	0.000	.50	.68
5	.53	.07	7.90	0.000	.40	.67

Table 4.61 Contrast of CAR use margins between adjacent levels of self-efficacy (WC over the car) (Kiso)

	Contrast	std. err.	z	P>|z|
_at				
(2 vs 1)	-.05	.02	-2.65	0.008
(3 vs 2)	-.05	.02	-2.43	0.015
(4 vs 3)	-.05	.02	-2.32	0.020
(5 vs 4)	-.06	.02	-2.33	0.020

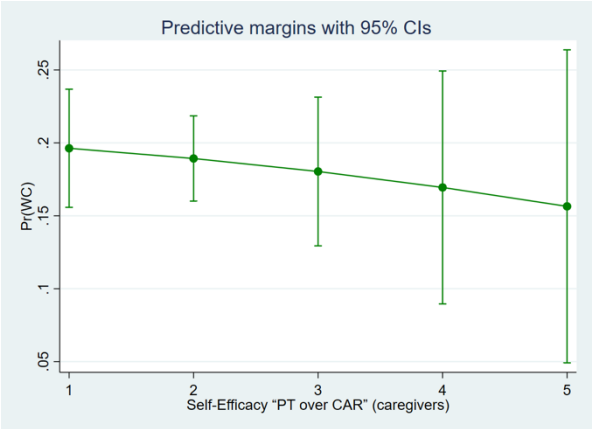


Figure 4.33 An illustration of the predictive margins of WC usage when increasing the self-efficacy (PT over the car) (Kiso)

Table 4.62 Margins of WC use at 1-5 levels of self-efficacy (PT over the car) (Kiso)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
_at						
1	.20	.02	9.50	0.000	.15	.24
2	.19	.01	12.70	0.000	.16	.22
3	.18	.03	6.93	0.000	.13	.23
4	.17	.04	4.16	0.000	.09	.25
5	.16	.05	2.86	0.004	.05	.26

Table 4.63 Contrast of WC use margins between adjacent levels of self-efficacy (PT over the car) (Kiso)

	Contrast	std. err.	z	P>|z|
at				
(2 vs 1)	-.01	.02	-0.37	0.710
(3 vs 2)	-.09	.02	-0.50	0.618
(4 vs 3)	-.01	.02	-0.66	0.511
(5 vs 4)	-.01	.01	-0.85	0.393

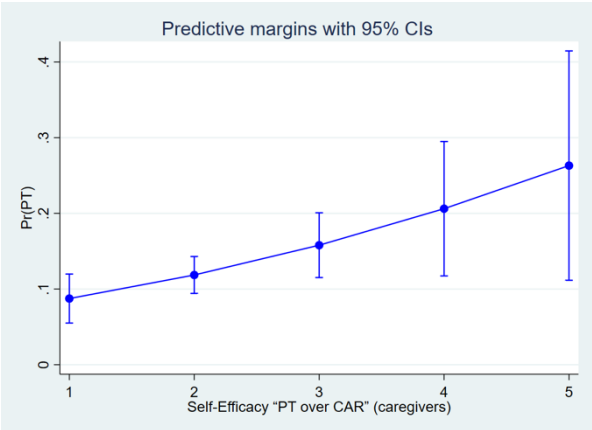


Figure 4.34 An illustration of the predictive margins of PT usage when increasing the self-efficacy (PT over the car) (Kiso)

Table 4.64 Margins of PT use at 1-5 levels of self-efficacy (PT over the car) (Kiso)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
_at						
1	.09	.02	5.29	0.000	.05	.12
2	.12	.01	9.54	0.000	.09	.14
3	.16	.02	7.24	0.000	.11	.20
4	.21	.04	4.55	0.000	.12	.29
5	.26	.08	3.40	0.001	.11	.41

Table 4.65 Contrast of PT use margins between adjacent levels of self-efficacy (PT over the car) (Kiso)

	Contrast	std. err.	z	P>|z|
_at				
(2 vs 1)	.03	.01	2.73	0.006
(3 vs 2)	.04	.02	2.15	0.032
(4 vs 3)	.05	.02	1.86	0.063
(5 vs 4)	.06	.03	1.72	0.085

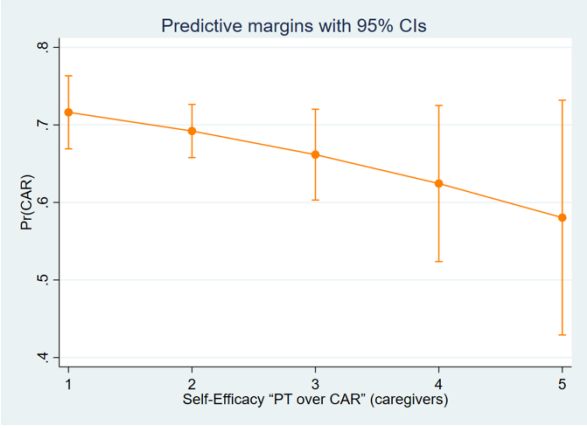


Figure 4.35 An illustration of the predictive margins of CAR usage when increasing the self-efficacy (PT over the car) (Kiso)

Table 4.66 Margins of CAR use at 1-5 levels of self-efficacy (PT over the car) (Kiso)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
_at						
1	.72	.02	29.80	0.000	.67	.76
2	.69	.02	39.60	0.000	.66	.73
3	.66	.03	22.13	0.000	.60	.72
4	.62	.05	12.16	0.000	.52	.72
5	.58	.08	7.52	0.000	.43	.73

Table 4.67 Contrast of CAR use margins between adjacent levels of self-efficacy (PT over the car) (Kiso)

	Contrast	std. err.	z	P>|z|
at				
(2 vs 1)	-.02	.02	-1.19	0.234
(3 vs 2)	-.03	.02	-1.39	0.166
(4 vs 3)	-.04	.02	-1.50	0.135
(5 vs 4)	-.04	.03	-1.55	0.120

As expected, raising young adolescents' self-efficacy for using public transport instead of the private car positively affects the likelihood of using PT. According to the reported margins in Table 4.64, there is approximately a 17% increase in the expected probability of selecting public transport for making non-school trips when changing the self-efficacy from 1 to 5. Although the last two rows in Table 4.65 labeled (4 vs. 3) and (5 vs. 4) are not statistically significant at the 5% significance level, the overall change is substantial.

The results show a slightly negative association between self-efficacy (PT over the car) and the expected probability of walking/cycling. The likelihood of WC trips decreases by roughly 4% when moving from the first level of self-efficacy to its last level (Table 4.62). However, based on the reported results in Table 4.63, which demonstrates the adjacent contrasts, none of these differences are significant. A similar pattern can be observed in Fig. 4.35. The expected probability of choosing the car for the non-school trips decreases by 14% when young adolescents' self-efficacy for using public transport over the car increases from 1 to 5 (Table 4.66). Still, when young adolescents' caregivers find them the most capable in selecting public transport instead of taking a ride in a car, the expected probability of using the car for non-school trips is around 58% which is relatively high. The differences of the estimates in the likelihood of utilizing the car for the adjacent levels of self-efficacy are not significant at 0.05 significance level.

4.3.3.2 The effects of (independent mobility)-related variables on mode choice

The choice model in Kiso town also shows the positive influence of young adolescents' perception of independent mobility distance on utilizing walking/cycling or public transport instead of the car. As the results suggest, those junior high school students who think they are allowed to travel out of town alone or with friends (compared to those who are allowed only to move around as far as the school neighborhood) are 3.21 times more likely to walk/cycle and 4.15 times more probable to select public transport travel over the car travel.

According to the results depicted in Fig. 4.36 and Table 4.68, getting consent to travel farther independently (from traveling as far as the school neighborhood to out of town) increases the expected probability of choosing walking/cycling and public transport by 13% and 10%, respectively, whereas decreases the car travel by 22%. Regarding the estimates of the reverse adjacent contrasts (Table 4.69), the only significant difference is an 11% decrease in the expected probability of car use between the "inside the town" and "school neighborhood" levels of independent mobility distance perceived by young adolescents.

The choice model also shows the negative impact of higher levels of young adolescents' independent mobility distance perceived by their caregivers on walking/cycling and public transport instead of using the car, which is counterintuitive since WC and PT are the primary means of traveling independently. We do not have enough evidence from the results of this research to rationalize such results. However, caregivers' beliefs about their children's independent mobility distance do not seem to reflect the reality of young adolescents' independent mobility situation. On the other hand, perception is subjective, and caregivers' thoughts might not be communicated well with their children. Hence, the caregivers' perception might not be overlapped with the truth. Looking at Fig. 4.37, we can observe the paradoxical pattern in the plot evidenced by the results reported in Table 4.70. According to the existing literature, young adolescents' responses described previously seem to be more accurate in this case.

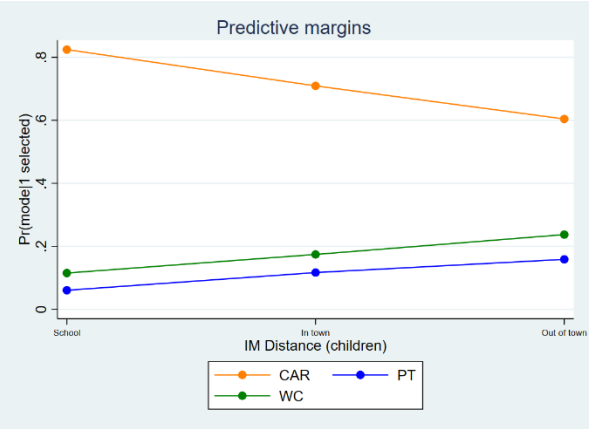


Figure 4.36 An illustration of the predictive margins of mode use for the independent mobility (IM) distance (students) (Kiso)

Table 4.69 Margins of mode use for the independent mobility (IM) distance (students) (Kiso)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
_outcome# IM distance						
CAR# school	.82	.04	20.55	0.000	.74	.90
CAR# in town	.71	.03	22.73	0.000	.65	.77
CAR# out of town	.60	.04	15.21	0.000	.53	.68
PT# school	.06	.02	2.35	0.019	.01	.11
PT# in town	.12	.02	4.86	0.000	.07	.16
PT# out of town	.16	.03	4.90	0.000	.09	.22
WC# school	.11	.03	3.57	0.000	.05	.18
WC# in town	.17	.02	6.97	0.000	.12	.22
WC# out of town	.24	.03	7.23	0.000	.17	.30

Table 4.68 Contrast of mode use margins for the independent mobility (IM) distance (students) (Kiso)

	Contrast	std. err.	z	P>|z|
IM distance @ outcome (In town vs school) CAR	-.11	.05	-2.31	0.021
(In town vs. school) PT	.06	.03	1.68	0.093
(In town vs. school) WC	.06	.04	1.43	0.151
(Out of town vs. in town) CAR	-.10	.06	-1.79	0.073
(Out of town vs. in town) PT	.04	.05	0.88	0.380
(Out of town vs. in town) WC	.06	.05	1.35	0.178

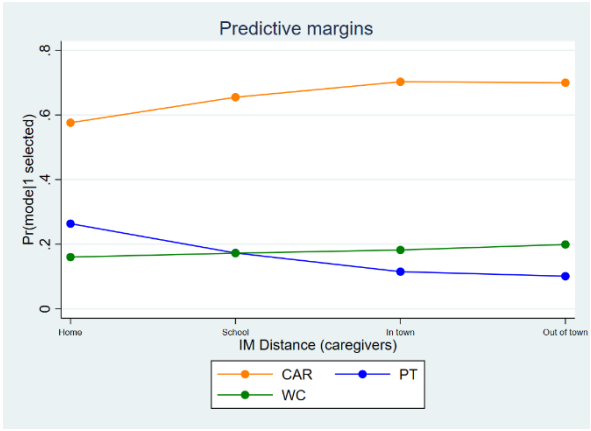


Figure 4.37 An illustration of the predictive margins of mode use for the independent mobility (IM) distance (caregivers) (Kiso)

Table 4.70 Margins of mode use for the independent mobility (IM) distance (caregivers) (Kiso)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
_outcome# IM distance						
CAR# home	.58	.06	8.84	0.000	.45	.70
CAR# school	.65	.05	13.29	0.000	.56	.75
CAR# in town	.70	.04	19.02	0.000	.63	.77
CAR# out of town	.70	.03	21.48	0.000	.63	.76
PT# home	.26	.06	4.00	0.000	.13	.39
PT# school	.17	.05	3.63	0.000	.08	.27
PT# in town	.11	.03	4.06	0.000	.06	.17
PT# out of town	.10	.02	5.30	0.000	.06	.14
WC# home	.16	.05	3.19	0.001	.06	.26
WC# school	.17	.03	4.92	0.000	.10	.24
WC# in town	.18	.03	5.88	0.000	.12	.24
WC# out of town	.20	.03	6.90	0.000	.14	.25

Table 4.71 Contrast of mode use margins for the independent mobility (IM) distance (caregivers) (Kiso)

	Contrast	std. err.	z	P>|z|
IM distance @ outcome				
(School vs. home) CAR	.08	.08	1.03	0.302
(School vs. home) PT	-.09	.07	-1.24	0.215
(School vs. home) WC	.01	.06	0.20	0.840
(In town vs. school) CAR	.05	.06	0.82	0.411
(In town vs. school) PT	-.06	.05	-1.13	0.257
(In town vs. school) WC	.01	.04	0.22	0.825
(Out of town vs. in town) CAR	.00	.06	-0.05	0.958
(Out of town vs. in town) PT	-.01	.04	-0.35	0.725
(Out of town vs. in town) WC	.02	.05	0.36	0.720

4.3.3.3 The effects of socio-demographic variables on mode choice

Firstly, the choice model indicates that females are 44% less likely to walk/cycle instead of taking a car ride. Fig. 4.38 depicts the differences in the expected mode use between males and females. According to the data presented in Table 4.72, the expected probability of car use is almost similar for both girls and boys. On the other hand, girls are 9% less likely to

walk/cycle and 5% more likely to use public transport for non-school trips than boys. However, the only statistically significant difference is seen for the expected probability of WC travel (Table 4.73). Nevertheless, the results state that gender makes a difference in young adolescents' travel behavior, and such distinctions should be considered in policy-making and practice.

Secondly, young adolescents currently enrolled in the second grade of junior high school are 2.32 times more likely to use walking/cycling instead of the private car for their non-school trips than those in the third grade. The results of the predictive margins illustrated in Fig. 4.39 indicate that second-grade students use private vehicles for their non-school trips the least. Second graders also walk/cycle more than the other two grades. Interestingly, the expected probability of choosing public transport stays almost the same (a total of 12-13% share of all trips) among junior high school students (Table 4.74). Among the mentioned patterns, only a decline of 11% in the expected probability of walking/cycling and an increase of 12% in the likelihood of car trips for the third graders (compared to second graders) are statistically significant (Table 4.75).

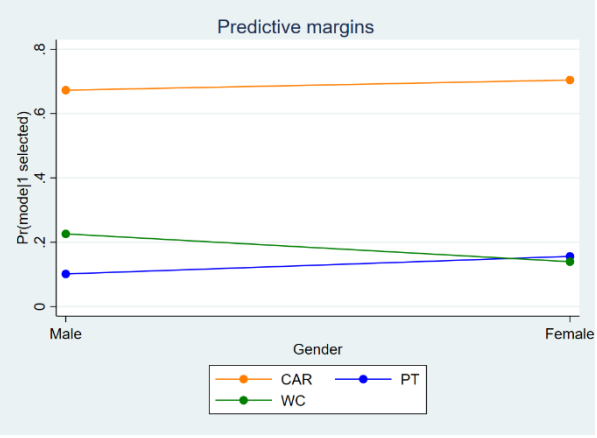


Figure 4.38 An illustration of the predictive margins of mode use for gender (Kiso)

Table 4.72 Margins of mode use for gender (Kiso)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
outcome# Gender						
CAR# male	.67	.02	27.33	0.000	.62	.72
CAR# female	.70	.03	25.72	0.000	.65	.76
PT# male	.10	.01	6.39	0.000	.07	.13
PT# female	.16	.02	6.82	0.000	.11	.20
WC# male	.22	.02	10.19	0.000	.18	.27
WC# female	.14	.02	6.58	0.000	.10	.18

Table 4.73 Contrast of mode use margins for gender (Kiso)

	Contrast	std. err.	z	P>|z|
Gender @_outcome				
(Female vs. male) CAR	.03	.04	0.80	0.422
(Female vs. male) PT	.05	.03	1.80	0.072
(Female vs. male) WC	-.09	.03	-2.62	0.009

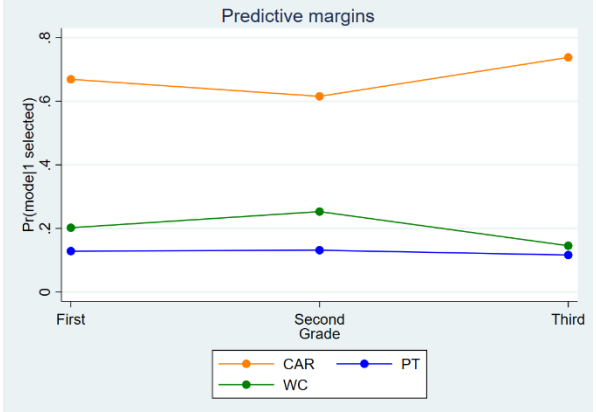


Figure 4.39 An illustration of the predictive margins of mode use for young adolescents' age (enrolling grade) (Kiso)

Table 4.74 Margins of mode use for young adolescents' age (enrolling grade) (Kiso)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
outcome# Grade						
CAR# first	.67	.03	19.13	0.000	.60	.74
CAR# second	.61	.04	15.49	0.000	.54	.70
CAR# third	.74	.03	27.85	0.000	.69	.79
PT# first	.13	.03	4.64	0.000	.07	.18
PT# second	.13	.03	4.67	0.000	.08	.19
PT# third	.12	.02	6.53	0.000	.08	.15
WC# first	.20	.03	6.99	0.000	.14	.26
WC# second	.25	.04	6.80	0.000	.18	.32
WC# third	.14	.02	6.60	0.000	.10	.19

Table 4.75 Contrast of mode use margins for young adolescents' age (enrolling grade) (Kiso)

	Contrast	std. err.	z	P>|z|
Grade @_outcome				
(Second vs. first) CAR	-.05	.05	-0.99	0.325
(Second vs. first) PT	.00	.04	0.07	0.943
(Second vs. first) WC	.05	.05	1.07	0.284
(Third vs. second) CAR	.12	.05	2.46	0.014
(Third vs. second) PT	-.01	.03	-0.43	0.666
(Third vs. second) WC	-.11	.04	-2.37	0.018

Thirdly, those students who imagined their work/education future taking place primarily out of their hometown are 56% less likely to walk/cycle than take a ride in the car. Based on the result of the predictive margins in Table 4.76, around 76% of the non-school trips of young adolescents who intend to pursue their future somewhere out of their hometown are realized with the private car. This share drops to 65% (a significant difference of 11%) for students planning to pursue their near-future goals inside their hometown. Along with the increase in car use, a considerable 9% decrease is seen in the expected probability of walking/cycling when young adolescents have plans to work/study out of their town instead of pursuing their goals where they live now (Table 4.77). Fig. 4.40 helps visualize the discussed situations in a simple plot.

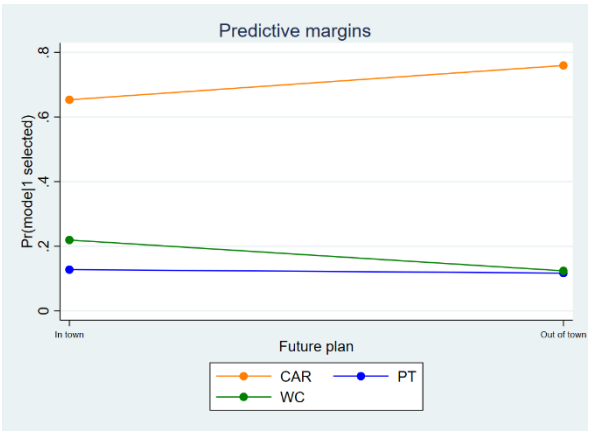


Figure 4.40 An illustration of the predictive margins of mode use for young adolescents' future plan (Kiso)

Table 4.77 Margins of mode use for young adolescents' future plan (Kiso)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
outcome# Future plan						
CAR# in town	.65	.02	29.83	0.000	.61	.70
CAR# out of town	.76	.03	25.38	0.000	.70	.82
PT# in town	.13	.01	8.01	0.000	.10	.16
PT# out of town	.12	.02	5.25	0.000	.07	.16
WC# in town	.22	.02	11.32	0.000	.18	.26
WC# out of town	.12	.02	5.30	0.000	.08	.17

Table 4.76 Contrast of mode use margins for young adolescents' future plan (Kiso)

	Contrast	std. err.	z	P>|z|
Future plan @ outcome				
(Out of town vs. in town) CAR	.11	.04	2.69	0.007
(Out of town vs. in town) PT	-.01	.03	-0.36	0.718
(Out of town vs. in town) WC	-.09	.03	-2.95	0.003

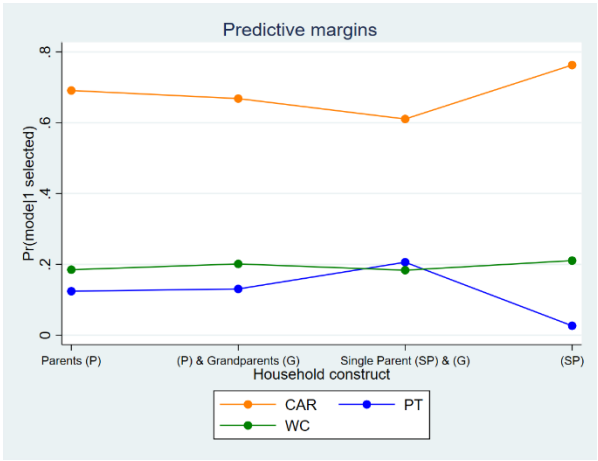


Figure 4.41 An illustration of the predictive margins of mode use at different levels of household construct (Kiso)

Table 4.78 Margins of mode use at different levels of household construct (Kiso)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
outcome# Household						
CAR#P	.69	.02	31.90	0.000	.65	.73
CAR#P & G	.67	.04	15.84	0.000	.58	.75
CAR#SP & G	.61	.08	7.37	0.000	.45	.77
CAR#SP	.76	.06	12.01	0.000	.64	.89
PT#P	.12	.01	7.78	0.000	.09	.15
PT#P & G	.13	.03	4.49	0.000	.07	.19
PT#SP & G	.20	.07	2.93	0.003	.07	.34
PT#SP	.03	.02	1.02	0.307	-.02	.08
WC#P	.18	.02	10.55	0.000	.15	.22
WC#P & G	.20	.04	5.29	0.000	.13	.27
WC#SP & G	.18	.06	2.83	0.005	.06	.31
WC#SP	.21	.06	3.43	0.001	.09	.33

Table 4.79 Contrast of mode use margins at different levels of household construct (Kiso)

	Contrast	std. err.	z	P>|z|
Household @ outcome				
(P & G vs. P) CAR	-.02	.05	-0.46	0.643
(P & G vs. P) PT	.01	.03	0.18	0.854
(P & G vs. P) WC	.02	.04	0.38	0.705
(SP vs. G & P) CAR	-.06	.09	-0.61	0.539
(SP vs. G & P) PT	.07	.08	0.98	0.329
(SP vs. G & P) WC	-.02	.07	-0.23	0.814
(SP & G vs. SP) CAR	.15	.10	1.45	0.146
(SP & G vs. SP) PT	-.18	.07	-2.38	0.017
(SP & G vs. SP) WC	.03	.09	0.30	0.762

Fourthly, the choice model states that young adolescents in single-parent households that live with grandparent/s are 12.39 times more likely to use public transport for their non-school trips than young adolescents in single-parent households without grandparent/s. Fig. 4.41 demonstrates no significant change at the left side of the figure where families with both parents with or without grandparent/s are located. The sharpest difference seems to exist among distinctive categories of single-parent households. Table 4.79 indicates a significant 18% decrease in the expected probability of public transport use when moving from a single-parent family living with grandparent/s to a single-parent household with no grandparents. However, such results should be considered with caution since the likelihood of PT use for young adolescents in single-parent families is not statistically significant (Table 4.78). Additionally, young adolescents in single-parent families living with grandparent/s use the private car the least, whereas those in single-parent households take a ride in the car the most. However, such a difference is not statistically significant.

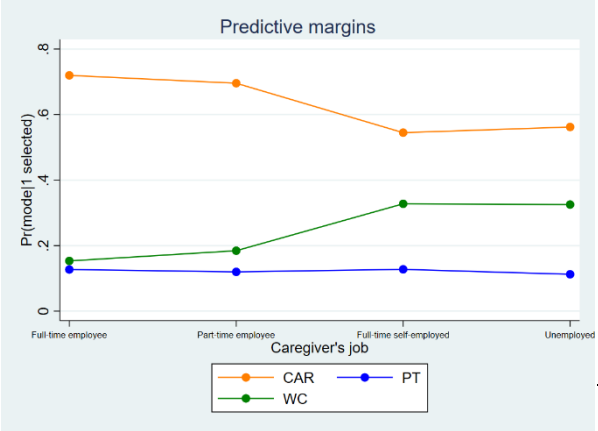


Figure 4.42 An illustration of the predictive margins of mode use at different levels of caregivers' job (Kiso)

List of abbreviations used in the tables:

FT E: Full-time employee

PT E: Part-time employee

FT SE: Full-time self-employed

UN E: Unemployed

Table 4.80 Margins of mode use at different levels of caregivers' job (Kiso)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
outcome# Caregivers' job						
CAR# FT E	.72	.03	27.35	0.000	.67	.77
CAR# PT E	.69	.03	24.99	0.000	.64	.75
CAR# FT SE	.54	.06	8.32	0.000	.42	.67
CAR# UN E	.56	.09	6.38	0.000	.39	.73
PT# FT E	.13	.02	6.43	0.000	.09	.16
PT# PT E	.12	.02	5.90	0.000	.08	.16
PT# FT SE	.13	.04	3.32	0.001	.05	.20
PT# UN E	.11	.05	2.16	0.031	.01	.21
WC# FT E	.15	.02	7.34	0.000	.11	.19
WC# PT E	.18	.02	7.74	0.000	.14	.23
WC# FT SE	.33	.06	5.06	0.000	.20	.45
WC# UN E	.32	.08	3.88	0.000	.16	.49

Table 4.81 Contrast of mode use margins at different levels of caregivers' job (Kiso)

	Contrast	std. err.	z	P>|z|
Caregivers' job @_outcome				
(PT E vs. FT E) CAR	-.02	.04	-0.59	0.552
(PT E vs. FT E) PT	-.01	.03	-0.24	0.813
(PT E vs. FT E) WC	.03	.03	0.93	0.351
(FT SE vs. PT E) CAR	-.15	.07	-2.12	0.034
(FT SE vs. PT E) PT	.01	.04	0.18	0.858
(FT SE vs. PT E) WC	.14	.07	2.07	0.038
(UN E vs. FT SE) CAR	.02	.11	0.16	0.875
(UN E vs. FT SE) PT	-.01	.06	-0.23	0.817
(UN E vs. FT SE) WC	.00	.11	-0.02	0.983

Last but not least, young adolescents with caregivers being employed full-time are 68% less likely to choose walking/cycling instead of the private car than those whose caregivers are unemployed. It is essential to remember that over 80% of the respondents of caregivers' questionnaires were mothers in Kiso town. On the one hand, Fig. 4.42 suggests that young adolescents' mode use is pretty similar when caregivers are employed full-time or part-time. Furthermore, almost identical patterns can be detected for young adolescents with self-employed and unemployed caregivers. On the other hand, a significant 15% decline in young adolescents' car use and a 14% increase in their walking/cycling can be observed when transitioning their caregivers' occupation from employee to self-employed (Table 4.81). According to Table 4.80, the expected probability of selecting public transport among the

household types stays nearly the same (around 11-13% of all the non-school trips). Although it is hard to interpret the rationale behind the observed pattern, it is safe to say that certain types of jobs are more time-sensitive, leading to more car use. Family travel patterns can affect young adolescents' travel behavior which is also observed in the case of Kiso town. Public transport use remains almost unchanged, which is a little concerning. However, many families living in small towns rely on private cars for daily trips and find the public transport service inconvenient and unreliable, which can also be reflected in young adolescents' mode choice.

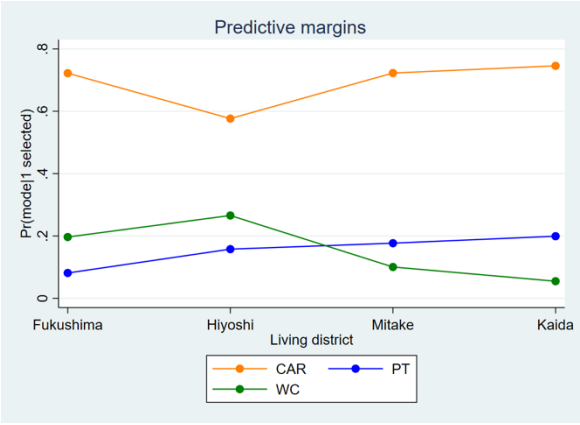


Figure 4.43 An illustration of the predictive margins of mode use at different levels of living district in Kiso

Table 4.82 Margins of mode use at different levels of living district in Kiso

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
_outcome # Living district						
CAR# Fukushima	.72	.02	30.27	0.000	.67	.77
CAR# Hiyoshi	.58	.05	12.07	0.000	.48	.67
CAR# Mitake	.72	.06	11.62	0.000	.60	.84
CAR# Kaida	.74	.05	14.44	0.000	.64	.85
PT# Fukushima	.08	.01	5.54	0.000	.05	.11
PT# Hiyoshi	.16	.04	3.90	0.000	.08	.24
PT# Mitake	.18	.05	3.47	0.001	.08	.28
PT# Kaida	.20	.05	4.20	0.000	.11	.29
WC# Fukushima	.20	.02	9.05	0.000	.15	.24
WC# Hiyoshi	.26	.04	6.19	0.000	.18	.35
WC# Mitake	.10	.04	2.32	0.020	.01	.18
WC# Kaida	.05	.03	2.01	0.044	.00	.11

Table 4.83 Contrast of mode use margins at different levels of living district in Kiso

	Contrast	std. err.	z	P>|z|
Living district @_outcome				
(Hiyoshi vs. Fukushima) CAR	-.14	.06	-2.57	0.010
(Hiyoshi vs. Fukushima) PT	.08	.04	1.72	0.085
(Hiyoshi vs. Fukushima) WC	.07	.05	1.34	0.180
(Mitake vs. Hiyoshi) CAR	.15	.08	1.76	0.078
(Mitake vs. Hiyoshi) PT	.02	.07	0.27	0.784
(Mitake vs. Hiyoshi) WC	-.16	.06	-2.56	0.011
(Kaida vs. Mitake) CAR	.02	.08	0.30	0.761
(Kaida vs. Mitake) PT	.02	.06	0.35	0.729
(Kaida vs. Mitake) WC	-.04	.05	-0.90	0.366

Finally, the choice model indicates that young adolescents in mainly two districts of Kiso town, namely Fukushima and Hiyoshi, are more likely to walk/cycle rather than take a car ride than those living in the somewhat remote Kaida district. Furthermore, the model suggests that the chance of young adolescents' public transport use in Fukushima is 61% less than in Kaida. Fig. 4.43 reveals interesting information on young adolescents' used modes in different districts of Kiso town. Hiyoshi seems to be the district where the private car use for non-school trips is the least among the four districts (58% of all the trips). The share of car trips in the other districts is almost the same at 72-74% of all the trips (Table 4.82). Young adolescents in Hiyoshi also walk/cycle more than the rest of the junior high school students living in the other areas of Kiso town. In general, the plot in Fig. 4.43 shows that Fukushima and Hiyoshi are more walking/cycling-friendly for students than Mitake and Kaida, where public transport overtakes walking/cycling travel. However, the private car stays the dominant mode in realizing young adolescents' non-school trips in all areas of Kiso town.

4.3.4 The Results of the General Model

Model fitting information included the value (-1683.29) for log-likelihood, a significant chi-square value of (371.38) for the likelihood ratio test, and a value of (0.11) for McFadden R square, which is a good fit. Table 4.84 is a summary of this model's exponentiated coefficients (odds ratios and relative risk ratios) in which only the significant variables are shown. For a full report on the model's estimates (logit values and odds ratios/relative risk ratios), see Appendix F. To interpret the results, we rely on the estimates reported in Table 4.84 and the calculated margins for each significant variable of the general model. Also, the average marginal effects can be used for further reference (see Appendix F).

Table 4.84 The estimated results (exponentiated coefficients) of the general choice model

Conditional logit choice model (Kiso)				No. of observations		6324	
Wald chi2 (40)	371.38			No. of cases		2108	
Log-likelihood -1683.29	Prob>chi2	0.00		Alternatives per case		3	
Variables	**Odds ratio**	**std. err.**	**z**	**P>|z|**	**[95% conf. interval]**		
Alternative-specific variables							
Psychological							
Perceived Benefits	1.19	.09	2.20	0.028	1.02	1.38	
Social Support of friends (students)	1.13	.05	2.73	0.006	1.03	1.23	
Social Support of caregivers (caregivers)	1.22	.05	4.64	0.000	1,12	1.33	
Social Modeling of friends (students)	1.10	.04	2.24	0.025	1.01	1.19	
Variables	**Relative risk ratio**	**Std. err.**	**z**	**P>|z|**	**[95% conf. interval]**		
Case-specific variables							
Public Transport (PT) estimates (base alternative: CAR)							
Psychological							
Self-Efficacy "PT over CAR" (students)	1.18	.08	2.50	0.012	1.04	1.36	
Socio-demographic							
Having elder siblings (base: not having)	.68	.12	-2.21	0.027	.49	.96	
Household construct (base: single parent and children)							
Parents and children							
Parents, grandparent/s, children							
Single parent, grandparent/s, children	2.57	1.11	2.18	0.029	1.10	6.00	
Caregivers' age (base: over 50)							
Less than 40							
40-50	.54	.12	-2.75	0.006	.35	.84	
Number of cars/household (base: three or more)							
One							
Two	.60	.12	-2.44	0.015	.40	.90	
cons	.21	.21	-1.57	0.117	.03	1.48	
Walking/Cycling (WC) estimates (base alternative: CAR)							
Environmental							
Neighborhood Safety	1.23	.11	2.33	0.020	1.03	1.46	
Psychological							
Self-Efficacy "WC over CAR" (students)	1.13	.07	2.13	0.033	1.01	1.27	

Variables	Relative risk ratio	Std. err.	z	P>|z|	[95% conf. interval]	
Socio-demographic						
Town (base: Toyoyama)						
Minamiise	.58	.12	-2.56	0.010	.38	.88
Kiso	.63	.14	-2.00	0.046	.40	.99
Grade (base: third grade)						
First grade						
Second grade	1.40	.22	2.21	0.027	1.04	1.90
Caregivers' job (base: full-time homemaker or unemployed)						
Full-time employee	.56	.13	-2.48	0.013	.35	.88
Part-time employee	.63	.14	-2.02	0.044	.40	.99
Full-time self-employed						
cons	.38	.27	-1.35	0.176	.10	1.53

Only the variables with a significant relationship trend ($p<0.10$) in the preliminary steps were used in making this final model.
For those variables reported by both students and their caregivers, the respondent is mentioned in parenthesis.
In the case of insignificant estimates for some of the levels of categorical variables, only the labels of the insignificant levels are kept in the table for the sake of clarity.
Note: '_cons' estimates baseline relative risk for each outcome.

4.3.4.1 The effects of psychological variables on mode choice

According to Table 4.84, all psychological variables are positively affecting the outcome (mode choice). Starting from the alternative-specific variables, the logit model demonstrates that a one-unit increase in the perceived benefits (students' perception toward each mode) increases the odds of mode choice by 1.19. A new scenario was introduced to evaluate the probability changes of mode choice when manipulating this variable. In the new scenario, we proposed a one-unit increase for the perceived benefits of walking/cycling and public transport and a one-unit decrease for the perceived benefits of private vehicles. The results of the predictive margins are presented in Table 4.85, showing the probability of each mode used by young adolescents in their non-school trips for the current and new scenarios. Table 4.86 highlights the significance of the differences between the current and the new scenarios. Looking at Fig. 4.44 and Table 4.86, we can trace the results of the new scenario (green color) in which the probability (vertical axis) of car trips would decrease by 7%, and the likelihood of public transport and walking/cycling trips would increase by 2% and 5% respectively. Although all the differences are significant, the changes in the probabilities are small.

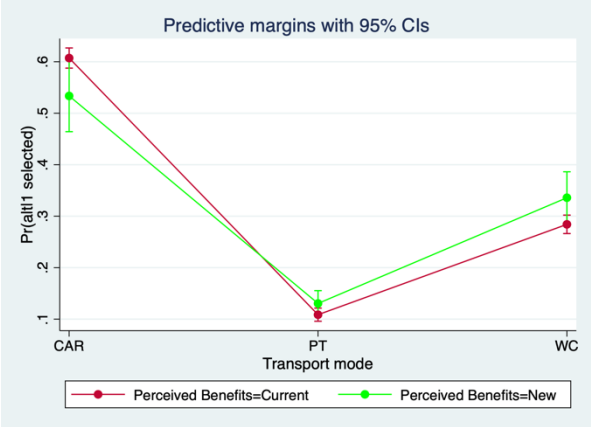


Figure 4.44 An illustration of the predictive margins for perceived benefits

Table 4.85 Predictive margins for the current and new scenarios of perceived benefits

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
_outcome#_at						
CAR# current	.61	.01	60.75	0.000	.59	.63
CAR# new	.53	.03	15.06	0.000	.46	.60
PT# current	.11	.01	16.73	0.000	.09	.12
PT# new	.13	.01	100.30	0.000	.10	.15
WC# current	.28	.01	31.13	0.000	.27	.30
WC# new	.33	.02	13.07	0.000	.28	.39

Table 4.86 Contrast of the predictive margins for the current and new scenarios of perceived benefits

	Contrast	std. err.	z	P>|z|
_at@_outcome				
(New vs. current) CAR	-.07	.03	-2.17	0.030
(New vs. current) PT	.02	.01	2.13	0.033
(New vs. current) WC	.05	.02	2.18	0.029

The results of the general model also show that junior high school students receiving more social support from their caregivers and friends for utilizing each specific mode of transport had higher odds of realizing trips with those respective means of transport. A new scenario was introduced to interpret the model results for this variable, and the probability of mode choice was compared between the current and the new situation. In this new scenario, we proposed increasing the social support for using walking/cycling and public transport by one unit and decreasing the social support for using the car by one unit. It is noteworthy that the social support variable was evaluated by the amount of perceived encouragement for using each mode and the frequency of trips made together with young adolescents and their significant others by each transport option.

Results of the margins for friends' and caregivers' support can be seen in Table 4.87 and 4.89, respectively, which is also illustrated in Fig. 4.45 and 4.46. Based on the contrast results in Table 4.88 and 4.90, introducing the new scenario can significantly change the probability of mode use. Given the circumstances of the new scenarios, young adolescents' use of WC and PT for their non-school trips would increase a little more by changing their caregivers' support than their friends (2% vs. 1% for PT, and 6% vs. 4% for WC). Caregivers' support (compared to friends') has a more substantial effect in decreasing the probability of car use (9% vs. 5%).

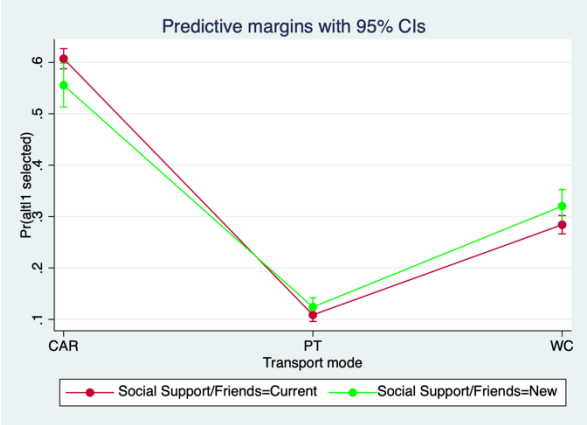


Figure 4.45 An illustration of the predictive margins for social support from friends (students)

Table 4.87 Predictive margins for the current and new scenarios of social support from friends (students)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
_outcome#_at						
CAR# current	.61	.01	60.75	0.000	.59	.63
CAR# new	.55	.02	25.67	0.000	.51	.60
PT# current	.11	.01	16.73	0.000	.09	.12
PT# new	.12	.01	13.48	0.000	.10	.14
WC# current	.28	.01	31.13	0.000	.27	.30
WC# new	.32	.02	19.41	0.000	.29	.35

Table 4.88 Predictive margins contrast of the current and new scenarios for social support from friends (students)

	Contrast	std. err.	z	P>|z|
_at@_outcome				
(New vs. current) CAR	-.05	.02	-2.71	0.007
(New vs. current) PT	.01	.00	2.66	0.008
(New vs. current) WC	.04	.01	2.71	0.007

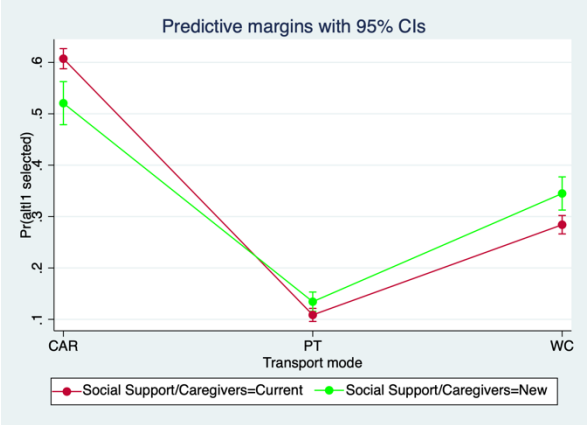


Figure 4.46 An illustration of the predictive margins for social support from caregivers (caregivers)

Table 4.89 Predictive margins for the current and new scenarios of social support from caregivers (caregivers)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
_outcome#_at						
CAR# current	.61	.01	60.75	0.000	.59	.63
CAR# new	.52	.02	24.36	0.000	.48	.56
PT# current	.11	.01	16.73	0.000	.09	.12
PT# new	.13	.01	14.04	0.000	.11	.15
WC# current	.28	.01	31.13	0.000	.27	.30
WC# new	.34	.02	20.97	0.000	.31	.38

Table 4.90 Predictive margins contrast of the current/new scenarios for social support from caregivers (caregivers)

	Contrast	std. err.	z	P>|z|
_at@_outcome				
(New vs. current) CAR	-.09	.02	-4.64	0.000
(New vs. current) PT	.02	.00	4.43	0.000
(New vs. current) WC	.06	.01	4.65	0.000

Table 4.84 also shows that a one-unit increase in the perceived frequency of mode use by young adolescents' friends can positively affect selecting the respective modes for their non-school trips. A new scenario featuring the same criteria was proposed for assessing friends' modeling influence on students' mode choice (a one-unit increase for the perceived usage frequency of WC and PT and a one-unit decrease for the perceived frequency of car use by friends). Social modeling was reported on a 5-point Likert scale and assumed to be a continuous variable to simplify the modeling. Therefore, one unit is quite symbolic, interpreted as more or less frequent use than the current travel behavior.

Running the "margins" command in Stata results in the contents of Table 4.91 showing the probability of each mode used by young adolescents in their non-school trips for the current and new scenarios. Table 4.92 represents the predictive margins contrasts between the current and the new scenarios. These numerical results are depicted in Fig. 4.47. Looking at Fig. 4.47 and Table 4.92, we can trace the significant effects of the new scenario (green color) in which the probability (vertical axis) of car trips would decrease by 4%, and the likelihood of public transport and walking/cycling trips would increase by 1% and 3%, respectively. Although all the differences are significant, the changes in the probabilities are pretty small.

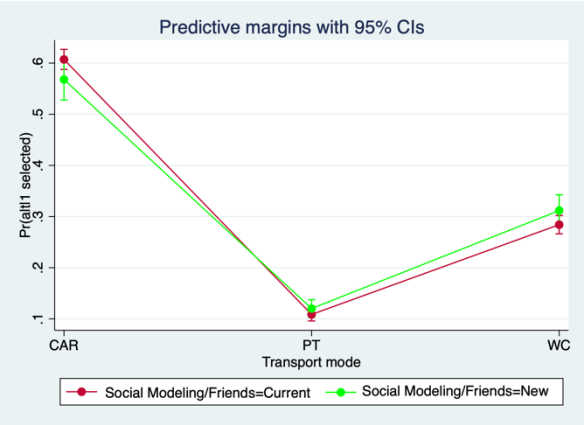


Figure 4.47 An illustration of the predictive margins for social modeling of friends (students)

Table 4.91 Predictive margins for the current and new scenarios of social modeling of friends (students)

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
_outcome#_at						
CAR# current	.61	.01	60.75	0.000	.59	.63
CAR# new	.57	.02	27.81	0.000	.53	.61
PT# current	.11	.01	16.73	0.000	.09	.12
PT# new	.12	.01	13.68	0.000	.10	.14
WC# current	.28	.01	31.13	0.000	.27	.30
WC# new	.31	.01	19.88	0.000	.28	.34

Table 4.92 Predictive margins contrast of the current/new scenarios for social modeling of friends (students)

	Contrast	std. err.	z	P>|z|
_at@_outcome				
(New vs. current) CAR	-.04	.02	-2.22	0.026
(New vs. current) PT	.01	.00	2.20	0.028
(New vs. current) WC	.03	.01	2.22	0.026

Regarding the case-specific variables, the conditional logit model results in Table 4.84 show that those young adolescents who perceive themselves more capable of selecting walking/cycling over the private car under challenging circumstances are 1.13 times more likely to realize WC trips than car trips. Fig. 4.48 visualizes the predictive margins (shown in Tables 4.93) of choosing different transport modes when increasing the self-efficacy for WC with increments of one unit. As young adolescents become more self-efficacious in walking/cycling, the expected probability of active non-school trips rises. At the highest level of self-efficacy (WC over the car), there is approximately a 10% increase in the probability of walking/cycling compared to the lowest level. According to Table 4.94, all the reverse adjacent contrasts are significant at the 0.05 significance level for WC trips. Although the expected probability of public transport and car trips is witnessing a gradual decrease, no significant difference is seen between the reverse adjacent levels of self-efficacy (Table 4.94).

Additionally, young adolescents recognizing themselves as more capable of traveling with public transport (when a private car also exists) are 1.18 times more likely to choose

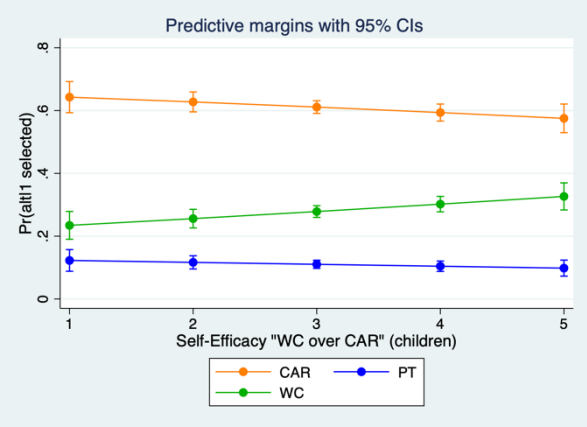


Figure 4.48 An illustration of the predictive margins when increasing the self-efficacy (WC over the car) (students)

Table 4.93 Predictive margins at 1-5 levels of self-efficacy (WC over the car) (students)

_at	Margin	std. err.	z	P>|z|	[95% conf.	interval]
CAR#1	.64	.02	25.43	0.000	.59	.69
CAR#2	.63	.02	38.76	0.000	.59	.66
CAR#3	.61	.01	59.39	0.000	.59	.63
CAR#4	.59	.01	42.90	0.000	.57	.62
CAR#5	.57	.02	24.71	0.000	.53	.62
PT#1	.12	.02	6.98	0.000	.09	.16
PT#2	.12	.01	10.88	0.000	.09	.14
PT#3	.11	.01	16.56	0.000	.10	.12
PT#4	.10	.01	12.37	0.000	.09	.12
PT#5	.10	.01	7.53	0.000	.07	.12
WC#1	.23	.02	10.37	0.000	.19	.28
WC#2	.25	.01	16.91	0.000	.23	.28
WC#3	.28	.01	29.15	0.000	.26	.30
WC#4	.30	.01	24.10	0.000	.28	.33
WC#5	.33	.02	14.84	0.000	.28	.37

Table 4.94 Contrast of margins between adjacent levels of self-efficacy (WC over the car) (students)

	Contrast	std. err.	z	P>|z|
at@_outcome				
(2 vs 1) CAR	-.01	.01	-1.44	0.150
(2 vs 1) PT	-.01	.01	-0.79	0.431
(2 vs 1) WC	.02	.01	2.47	0.014
(3 vs 2) CAR	-.02	.01	-1.50	0.132
(3 vs 2) PT	-.01	.01	-0.85	0.395
(3 vs 2) WC	.02	.01	2.32	0.020
(4 vs 3) CAR	-.02	.01	-1.56	0.120
(4 vs 3) PT	-.01	.01	-0.92	0.355
(4 vs 3) WC	.02	.01	2.21	0.027
(5 vs 4) CAR	-.02	.01	-1.60	0.110
(5 vs 4) PT	-.01	.00	-1.01	0.312
(5 vs 4) WC	.02	.01	2.13	0.033

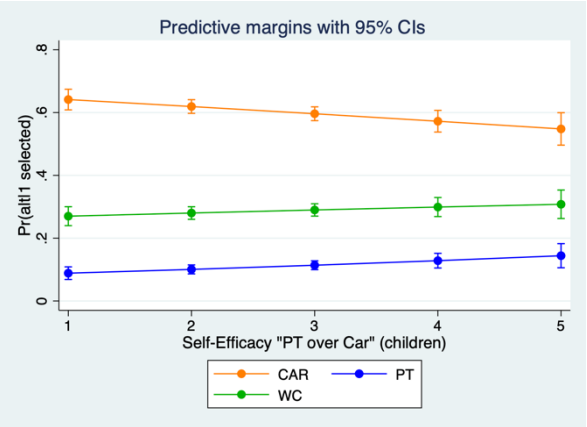


Figure 4.49 An illustration of the predictive margins when increasing the self-efficacy (PT over the car) (students)

Table 4.95 Predictive margins at 1-5 levels of self-efficacy (PT over the car) (students)

at	Margin	std. err.	z	P>|z|	[95% conf.	interval]
CAR#1	.64	.02	38.23	0.000	.60	.67
CAR#2	.62	.01	55.74	0.000	.60	.64
CAR#3	.60	.01	53.25	0.000	.57	.62
CAR#4	.57	.02	32.53	0.000	.54	.60
CAR#5	.55	.03	20.80	0.000	.50	.60
PT#1	.09	.01	8.65	0.000	.07	.11
PT#2	.10	.01	13.79	0.000	.09	.11
PT#3	.11	.01	15.90	0.000	.10	.13
PT#4	.13	.01	10.76	0.000	.10	.15
PT#5	.14	.02	7.37	0.000	.10	.18
WC#1	.27	.01	17.57	0.000	.24	.30
WC#2	.28	.01	27.50	0.000	.26	.30
WC#3	.29	.01	28.96	0.000	.27	.31
WC#4	.30	.01	19.33	0.000	.27	.33
WC#5	.31	.02	13.31	0.000	.26	.35

Table 4.96 Contrast of margins between adjacent levels of self-efficacy (PT over the car) (students)

	Contrast	std. err.	z	P>|z|
at@_outcome				
(2 vs 1) CAR	-.02	.01	-2.50	0.013
(2 vs 1) PT	.01	.00	2.51	0.012
(2 vs 1) WC	.01	.01	1.27	0.205
(3 vs 2) CAR	-.02	.01	-2.47	0.013
(3 vs 2) PT	.01	.00	2.23	0.026
(3 vs 2) WC	.01	.01	1.18	0.239
(4 vs 3) CAR	-.02	.01	-2.46	0.014
(4 vs 3) PT	.01	.01	2.01	0.044
(4 vs 3) WC	.01	.01	1.09	0.278
(5 vs 4) CAR	-.02	.01	-2.46	0.014
(5 vs 4) PT	.01	.01	1.85	0.064
(5 vs 4) WC	.01	.01	0.99	0.323

means of public transport over private vehicles to realize their non-school trips. Fig. 4.49 demonstrates the increasing trends in the expected probability of WC and PT and a decreasing trend in the predicted probability of car trips when young adolescents' self-efficacy for using PT increases from 1 (the lowest) to 5 (the highest) with one unit of increment. According to Table 4.95, young adolescents being the most self-efficacious in using PT under difficult circumstances are nearly 9% less likely to take a ride in a car and 5% more likely to use PT for their non-school trips than those with the lowest level of such capability. According to Table 4.96, most of the reverse adjacent contrasts for the expected probability of car and PT trips are significant at the 0.05 significance level. Although the anticipated probability of walking/cycling increases slowly, no significant difference is seen between the reverse adjacent levels of self-efficacy (Table 4.96).

4.3.4.2 The effects of environmental variables on mode choice

As for the environmental variables, neighborhood safety seems to affect the probability of walking/cycling positively. According to the results of Table 4.84, one unit increase in the neighborhood safety perception increases the odds of WC by 1.23 compared to a car ride. To examine the effects of neighborhood safety on mode use probability, margins were calculated for each category of transport modes when changing the neighborhood safety between the minimum and maximum reported values with one-unit increments (Table 4.97). Fig 4.50 shows the trends of all modes in one graph. Despite the insignificant change in the probability of public transport, a gradual increase can be detected for WC trips (16% increase from the lowest to the highest level of neighborhood safety).

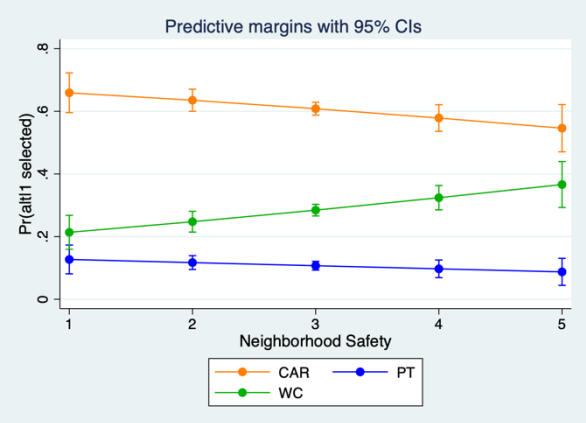


Figure 4.50 An illustration of the predictive margins when increasing the neighborhood safety

Table 4.97 Predictive margins at 1-5 levels of neighborhood safety

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
_at						
CAR#1	.66	.03	20.42	0.000	.59	.72
CAR#2	.63	.02	35.39	0.000	.60	.67
CAR#3	.61	.01	57.81	0.000	.59	.63
CAR#4	.58	.02	26.64	0.000	.53	.62
CAR#5	.55	.04	14.21	0.000	.47	.62
PT#1	.13	.02	5.43	0.000	.08	.17
PT#2	.12	.01	10.43	0.000	.09	.14
PT#3	.11	.01	15.03	0.000	.09	.12
PT#4	.10	.01	6.78	0.000	.07	.12
PT#5	.09	.02	3.97	0.000	.04	.13
WC#1	.21	.03	7.73	0.000	.16	.27
WC#2	.25	.02	14.64	0.000	.21	.28
WC#3	.28	.01	30.21	0.000	.27	.30
WC#4	.32	.02	16.34	0.000	.28	.36
WC#5	.37	.04	9.79	0.000	.72	.44

Table 4.98 Contrast of margins between adjacent levels of neighborhood safety

	Contrast	std. err.	z	P>|z|
at@_outcome				
(2 vs 1) CAR	-.02	.02	-1.47	0.141
(2 vs 1) PT	-.01	.01	-0.75	0.455
(2 vs 1) WC	.03	.01	2.82	0.005
(3 vs 2) CAR	-.03	.02	-1.61	0.106
(3 vs 2) PT	-.02	.01	-0.85	0.396
(3 vs 2) WC	.04	.01	2.52	0.012
(4 vs 3) CAR	-.03	.02	-1.71	0.087
(4 vs 3) PT	-.01	.01	-0.98	0.326
(4 vs 3) WC	.04	.02	2.34	0.019
(5 vs 4) CAR	-.03	.02	-1.78	0.075
(5 vs 4) PT	-.01	.01	-1.16	0.247
(5 vs 4) WC	.04	.02	2.24	0.025

According to Table 4.98, the contrasts of the predicted margins between the adjacent neighborhood safety levels are only statistically significant for WC trips. Nevertheless, along with this increasing trend in the probability of WC trips between the minimum and maximum levels of neighborhood safety, an 11% decrease is seen for the likelihood of car trips.

4.3.4.3 The effects of socio-demographic variables on mode choice

The general model shows that young adolescents enrolled in the second grade of junior high school are 1.40 times more likely to use walking/cycling instead of the private car for their non-school trips than those in the third grade. The results of the predictive margins illustrated in Fig. 4.51 and Table 4.99 indicate that second-grade students use private vehicles the least, and third graders use them the most. According to the reported margin contrasts in Table 4.100, the probability of WC trips drops by 6% when moving from the second to the third grade. Although the expected probability of choosing public transport increases around 3% from the first to the third grade (Table 4.99), the change is pretty small and not statistically significant.

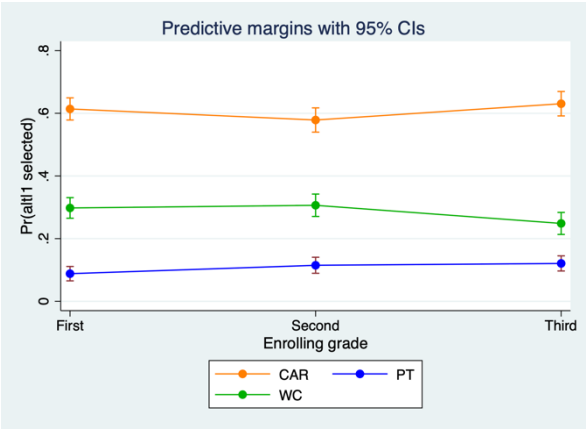


Figure 4.51 An illustration of the predictive margins of mode use for young adolescents' age (students' grade)

Table 4.99 Margins of mode use for young adolescents' age (students' grade)

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
outcome# Grade						
CAR# first	.61	.02	34.07	0.000	.58	.65
CAR# second	.58	.02	29.33	0.000	.54	.62
CAR# third	.63	.02	31.70	0.000	.59	.67
PT# first	.09	.01	7.54	0.000	.06	.11
PT# second	.11	.01	8.82	0.000	.09	.14
PT# third	.12	.01	9.80	0.000	.10	.14
WC# first	.30	.02	17.76	0.000	.26	.33
WC# second	.30	.02	16.80	0.000	.27	.34
WC# third	.25	.02	13.85	0.000	.21	.28

Table 4.100 Contrast of mode use margins for young adolescents' age (students' grade)

	Contrast	std. err.	z	P>|z|
Grade @_outcome				
(Second vs. first) CAR	-.03	.03	-1.29	0.197
(Second vs. first) PT	.02	.02	1.51	0.132
(Second vs. first) WC	.01	.02	0.33	0.738
(Third vs. second) CAR	.05	.03	1.84	0.066
(Third vs. second) PT	.00	.02	0.32	0.747
(Third vs. second) WC	-.06	.02	-2.23	0.025

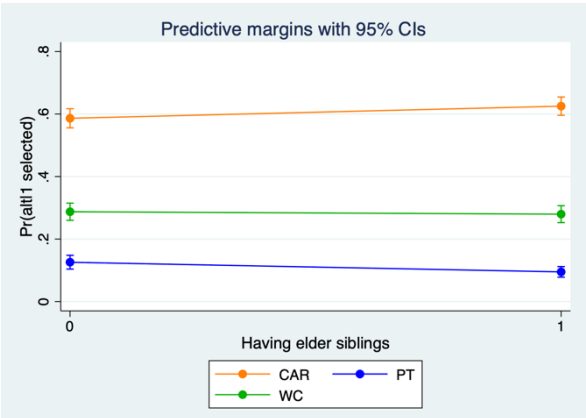


Figure 4.52 An illustration of the predictive margins of mode use for having elder siblings (1=have, 0=not)

Table 4.101 Margins of mode use for having elder siblings

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
outcome# Having elder siblings						
CAR# 0	.59	.01	37.52	0.000	.55	.62
CAR# 1	.62	.01	42.00	0.000	.60	.65
PT# 0	.13	.01	11.18	0.000	.10	.15
PT# 1	.09	.01	11.02	0.000	.07	.11
WC# 0	.29	.01	20.53	0.000	.26	.31
WC# 1	.28	.01	20.21	0.000	.25	.31

Table 4.102 Contrast of mode use margins for having elder siblings

	Contrast	std. err.	z	P>|z|
Having elder siblings@ _outcome				
(1 vs. 0) CAR	.04	.02	1.69	0.092
(1 vs. 0) PT	-.03	.01	-2.07	0.039
(1 vs. 0) WC	-.01	.02	-0.37	0.713

Moreover, the model results in Table 4.84 show that those young adolescents with elder siblings are 32% less likely to take public transport than a ride in the car. The predictive margins for this variable are presented in Tables 4.101 and illustrated in Fig. 4.52. According to Table 4.102, the only statistically significant difference in mode use between adolescents with/without elder siblings is observed for public transport trips. Having an elder brother/sister could translate to less probability of using public transport (3% as reported in Table 4.102). Although insignificant, the likelihood of non-school car trips increases for those with elder siblings.

As for the household construct, the model results indicate that adolescents in single-parent households living with grandparents are 2.57 times more likely to take public transport than the private vehicle for their non-school trips. The results of the calculated margins depicted in Fig. 4.53 also show different patterns of used modes between the two types of single-parent households (numbers 3 and 4 on the horizontal axis). According to Table 4.104, the probability of using public transport drops significantly by 7% for adolescents living in single-parent households compared to those who live with a single parent and grandparent/s. The patterns of used modes in families with two parents (number 1 and 2 on the horizontal axis) are pretty similar, except that adding grandparent/s to a two-parent family can increase the likelihood of active non-school trips among young adolescents.

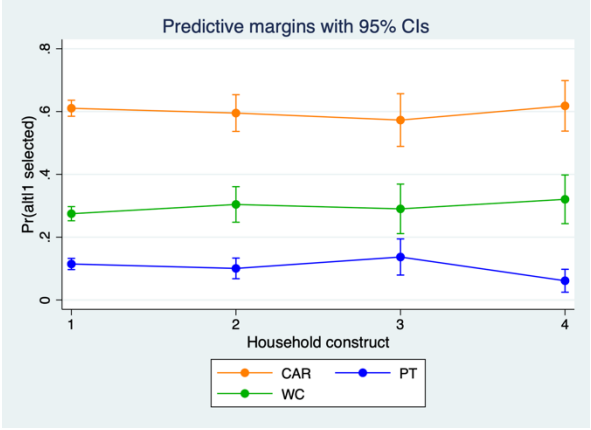


Figure 4.53 An illustration of the predictive margins of mode use at different levels of household construct

The numbers on the horizontal axis represent:

1: Parents and children

2: Parents, children, and grandparent/s

3: Single parent, children, and grandparent/s

4: Single parent and children

Table 4.103 Margins of mode use at different levels of household construct

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
outcome# Household						
CAR#1	.61	.01	46.82	0.000	.58	.64
CAR#2	.59	.03	19.96	0.000	.54	.65
CAR#3	.57	.04	13.38	0.000	.49	.66
CAR#4	.62	.04	15.06	0.000	.54	.70
PT#1	.11	.01	12.57	0.000	.10	.13
PT#2	.10	.02	5.99	0.000	.07	.13
PT#3	.14	.03	4.66	0.000	.08	.19
PT#4	.06	.02	3.29	0.001	.02	.10
WC#1	.27	.01	23.87	0.000	.25	.30
WC#2	.30	.03	10.54	0.000	.25	.36
WC#3	.29	.04	7.21	0.000	.21	.37
WC#4	.32	.04	8.11	0.000	.24	.40

Table 4.104 Contrast of mode use margins at different levels of household construct

	Contrast	std. err.	z	P>|z|
Household @ outcome				
(2 vs 1) CAR	-.01	.03	-0.45	0.654
(2 vs 1) PT	.01	.02	-0.70	0.486
(2 vs 1) WC	.03	.03	0.90	0.368
(3 vs 2) CAR	-.02	.05	-0.43	0.665
(3 vs 2) PT	.04	.03	1.07	0.283
(3 vs 2) WC	-.01	.05	-0.29	0.772
(4 vs 3) CAR	.04	.06	0.78	0.436
(4 vs 3) PT	-.07	.03	-2.24	0.025
(4 vs 3) WC	.03	.05	0.55	0.583

The model results in Table 4.84 show that young adolescents living in families owning two private vehicles (compared to families with multiple cars) are 40% less likely to use public transport instead of the car in their non-school trips. The calculated margins of Table 4.105 illustrated in Fig. 4.54 surprisingly indicate that the probability of non-school car trips is the least for adolescents in households with three or more cars among the three categories of

household car ownership. Young adolescents in two-car households have the lowest probability of using PT. Surprisingly, students living in a home with multiple car ownership are 4% more likely to use means of public transport for their non-school trips than families owning two private vehicles (Table 4.106). The mentioned difference is the only statistically significant contrast among the reverse adjacent levels.

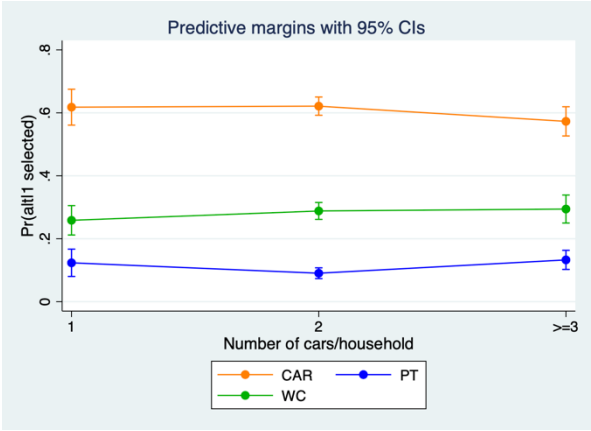


Figure 4.54 An illustration of the predictive margins of mode use for the number of cars per household

Table 4.105 Margins of mode use for the number of cars per household

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
outcome# Cars/house						
CAR#1	.62	.03	21.22	0.000	.56	.67
CAR#2	.62	.01	42.00	0.000	.59	.65
CAR# >=3	.57	.02	24.17	0.000	.53	.62
PT#1	.12	.02	5.58	0.000	.08	.17
PT#2	.09	.01	10.35	0.000	.07	.11
PT#>=3	.13	.01	8.57	0.018	.10	.16
WC#1	.26	.02	10.85	0.000	.21	.30
WC#2	.29	.01	21.08	0.000	.26	.31
WC#>=3	.29	.02	12.97	0.000	.25	.34

Table 4.106 Contrast of mode use margins for the number of cars per household

	Contrast	std. err.	z	P>|z|
Cars/house @ outcome				
(2 vs. 1) CAR	.00	.03	0.10	0.921
(2 vs. 1) PT	-.03	.02	-1.39	0.165
(2 vs. 1) WC	.03	.03	1.06	0.291
(>=3 vs. 2) CAR	-.04	.03	-1.61	0.108
(>=3 vs. 2) PT	.04	.02	2.22	0.026
(>=3 vs. 2) WC	.00	.03	0.21	0.833

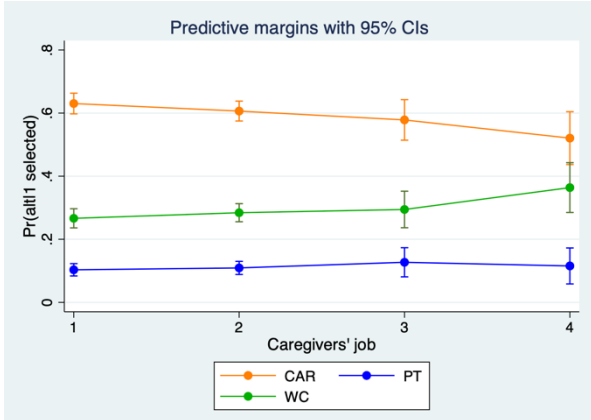


Figure 4.55 An illustration of the predictive margins of mode use at different levels of caregivers' job

Table 4.107 Margins of mode use at different levels of caregivers' job

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
outcome# Caregivers' job						
CAR#1	.63	.02	37.69	0.000	.60	.66
CAR#2	.61	.02	37.68	0.000	.57	.64
CAR#3	.58	.03	17.66	0.000	.51	.64
CAR#4	.52	.04	12.18	0.000	.44	.60
PT#1	.10	.01	10.36	0.000	.08	.12
PT#2	.11	.01	10.32	0.000	.09	.13
PT#3	.13	.02	5.39	0.000	.08	.17
PT#4	.11	.03	3.97	0.000	.06	.17
WC#1	.27	.01	17.17	0.000	.24	.30
WC#2	.28	.01	19.43	0.000	.25	.31
WC#3	.29	.03	9.96	0.000	.24	.35
WC#4	.36	.04	9.04	0.000	.28	.44

Table 4.108 Contrast of mode use margins at different levels of caregivers' job

	Contrast	std. err.	z	P>|z|
Caregivers' job @_outcome				
(2 vs 1) CAR	-.02	.02	-1.00	0.319
(2 vs 1) PT	.00	.01	0.40	0.686
(2 vs 1) WC	.02	.02	0.81	0.419
(3 vs 2) CAR	-.03	.04	-0.77	0.441
(3 vs 2) PT	.02	.02	0.69	0.493
(3 vs 2) WC	.01	.03	0.31	0.754
(4 vs 3) CAR	-.06	.05	-1.09	0.276
(4 vs 3) PT	-.01	.04	-0.31	0.756
(4 vs 3) WC	.07	.05	1.41	0.158

List of abbreviations used in the tables:

1: Full-time employee

2: Part-time employee

3: Full-time self-employed

4: Unemployed

Additionally, the model results indicate that young adolescents with full-time and part-time employed caregivers are respectively 44% and 37% less likely to choose walking/cycling instead of the private car than those with unemployed caregivers. Table 4.107 shows the result of the calculation of the predictive margins. Although none of the margins' contrasts reported in Table 4.108 are statistically significant, the pattern of students' mode use among different classifications of caregivers' occupation can be compared. Fig. 4.55 suggests that young adolescents' mode use changes consistently toward more use of active modes and public transport and less use of private cars when moving from the left of the graph to the right (from number 1: full-time employed to number 3: self-employed caregivers). The same trend continues for mode choice of adolescents with unemployed caregivers (number 4 on the horizontal axis), except that the gradual increase and decrease in the respective probability of WC and cars become sharper for this group. The probability of PT use for adolescents with unemployed caregivers is nearly as small as the PT probability value for students with full-time/part-time employed caregivers (around 10-11%).

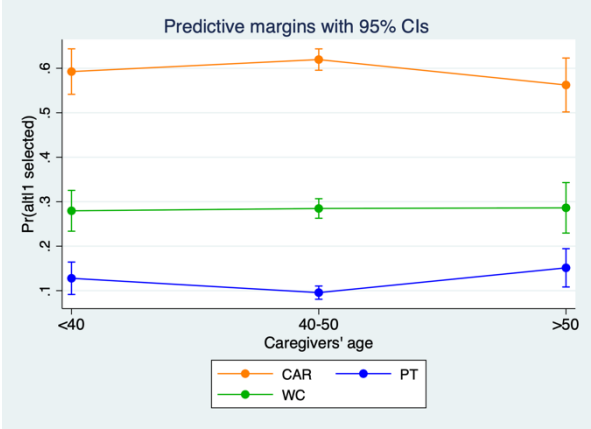


Figure 4.56 An illustration of the predictive margins of mode use for different levels of caregivers' age

Table 4.109 Margins of mode use for different levels of caregivers' age

	Margin	std. err.	z	P>|z|	[95% conf.	interval]
outcome# Caregivers' age						
CAR# <40	.59	.03	22.72	0.000	.54	.64
CAR# 40-50	.62	.01	50.63	0.000	.59	.64
CAR# >50	.56	.03	18.19	0.000	.50	.62
PT# <40	.13	.02	6.88	0.001	.09	.16
PT# 40-50	.09	.01	12.63	0.000	.08	.11
PT# >50	.15	.02	6.89	0.001	.11	.19
WC# <40	.28	.02	11.94	0.000	.23	.32
WC# 40-50	.28	.01	25.41	0.000	.26	.31
WC# >50	.29	.03	9.88	0.000	.23	.34

Table 4.110 Contrast of mode use margins for different levels of caregivers' age

	Contrast	std. err.	z	P>|z|
Caregivers' age @_outcome				
(40-50 vs. <40) CAR	.03	.03	0.91	0.363
(40-50 vs. <40) PT	-.03	.02	-1.57	0.117
(40-50 vs. <40) WC	.00	.03	0.19	0.846
(>50 vs. 40-50) CAR	-.06	.03	-1.70	0.088
(>50 vs. 40-50) PT	.05	.02	2.38	0.017
(>50 vs. 40-50) WC	.00	.03	0.05	0.963

Furthermore, based on Table 4.84, young adolescents whose caregivers are in their 40s (compared to over 50) are 46% less likely to use PT rather than the car. Table 4.109 represents the predictive margins for this variable. According to Fig. 4.56, the probability of active modes is stable among different categories of caregivers' age. However, students with caregivers in their 40s are most likely to use the private car and least likely to use the means of public transport for their non-school trips. According to Table 4.110, a discrete change from caregivers aged 40-50 to those over 50 can increase the probability of public transport for non-school trips by a statistically significant value of 5% and decrease the likelihood of car trips by 6% simultaneously.

Last but not least, the estimations of Table 4.84 indicate that young adolescents living in Minamiise and Kiso are 42% and 37% less likely to use active modes of transport than the car for their non-school trips compared to those living in Toyoyama. Fig. 4.57 shows that young adolescents living in rural areas have more tendency to use motorized modes of transport than

active modes compared to those living in a walking/cycling-friendly suburb. However, according to Table 4.112, the drop in the share of active trips (9-11%) is the only statistically significant change.

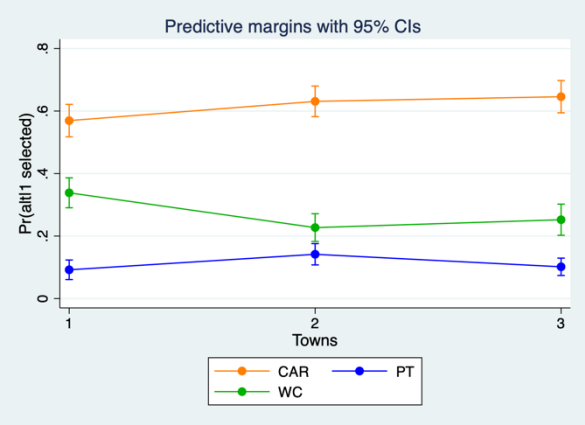


Figure 4.57 An illustration of the predictive margins of mode use for different case studies

The numbers on the horizontal axis represent:

1: Toyoyama

2: Minamiise

3: Kiso

Table 4.111 Margins of mode use for different case studies

	Margin	std. err.	z	P>|z|	[95% conf. interval]	
outcome# Grade						
CAR# 1	.57	.03	21.54	0.000	.52	.62
CAR# 2	.63	.02	25.24	0.000	.58	.68
CAR# 3	.64	.03	24.52	0.000	.59	.70
PT# 1	.09	.01	5.78	0.000	.06	.12
PT# 2	.14	.02	8.15	0.000	.10	.17
PT# 3	.10	.01	7.19	0.000	.07	.13
WC# 1	.34	.02	13.87	0.000	.29	.39
WC# 2	.23	.02	10.03	0.000	.18	.27
WC# 3	.25	.02	9.93	0.000	.20	.30

Table 4.112 Contrast of mode use margins for different case studies

	Contrast	std. err.	z	P>|z|
Grade @_outcome				
(2 vs 1) CAR	.06	.04	1.48	0.138
(2 vs 1) PT	.05	.02	1.93	0.053
(2 vs 1) WC	-.11	.04	-2.87	0.004
(3 vs 2) CAR	.01	.03	0.42	0.676
(3 vs 2) PT	-.04	.02	-1.72	0.085
(3 vs 2) WC	.02	.03	0.78	0.436

4.4 Conclusion

Chapter 4 is a detailed explanation of the descriptive and inferential statistics of the research. Firstly, the sample statistics of each town were provided. Secondly, the responses of young adolescents and their caregivers were compared through the correlation analysis. Next, detailed information was provided regarding the nature of non-school trips based on three distinguished categories of transport modes, namely 1) walking/cycling, 2) public transport, and 3) private cars. Following the descriptive statistics, the results of the choice models (one separate model for each town, and a general model) were presented by explaining the exponentiated coefficients and the calculated margins for the variables toward which a significant association was observed. The margins provided an intuitive way of interpreting the results by considering the effects of a slight change in the predictors on the probabilities of selecting different modes. The choice models' results were explained under four subheadings of a) built environment, b) psychological, c) (independent mobility)-related variables, and d) socio-demographic characteristics. As previously mentioned in subsection 3.7.3, the final models were made by incorporating the significant variables extracted from the preliminary models made for each town. Therefore, the final models do not include the same variables, and the results of each town are distinctive. The same procedure was applied for developing the general model, which provides evidence for policymakers at levels higher than the local level, such as regional or national, by generalizing the findings.

Chapter 5: Discussion

5.1 Introduction

The current study attempts to rethink the independent mobility of young adolescents for non-school purposes in rural and suburban areas in Japan from a socio-ecological perspective. To the best of our knowledge, non-school travel is an understudied field in the mobility of children and youth, and the inclusion of public transport as a means of realizing independent mobility for young adolescents is scarce (if non-existent). Besides, by considering the beliefs and perceptions of both caregivers and the young adolescents, this research seeks to picture the determinants of the mode choice among the mentioned age group more holistically. A simplified summary is provided in Table 5.1 for comparison, portraying an overarching view on the significant enablers and disablers of walking/cycling (WC) and public transport (PT) in the three case studies found in the choice models (separate and general) in chapter 4.

The following discussion elaborates the results concerning the distinctive predictors of independent non-school travel among the case studies (considering the unique impact of each town's characteristics on mobility patterns). The titles (suburban, coastal, mountainous) are only used to emphasize the geographical contexts, and by no means, try to generalize the results. The findings of the separate models and the general model are interpreted and discussed using the available statistics/features of each town and evidence in the existing literature. Since there are many similarities between the positive contributors of walking/cycling and public transport, the findings will be jointly discussed. The negative estimates are only found for the categories of "independent mobility" and "socio-demographic" and are unrelated among the modes. Therefore, they will be discussed separately for active and public transport trips. After discussing the results, context-tailored and general policies will be proposed.

5.2 Positive Estimates of WC & PT Non-School Trips

As Table 5.1 suggests, there are similarities and discrepancies among the enablers of walking/cycling and public transport in the three case studies, which should be discussed in respect of the distinctive natural/geographical, demographic, and spatial environments of the towns. Building on this premise, the choice model for the small-sized suburban environment with the highest share of reported active travel for non-school trips (around 45%) reveals the highest number of positive estimates of walking/cycling followed by the large-sized mountainous context in which only 18% of the non-school travel was conducted on foot or by bicycle. Apart from the fact that the distance between origin and destination of trips is usually longer in rural areas, Sjolie (2002) also found that rural adolescents are less likely to travel long distances on foot or by bicycle than their urban counterparts. Regardless, the positive predictors of walking/cycling will be discussed in the order of presentation in Table 5.1.

5.2.1 Built Environment Predictors (Safety, WC Environment)

The only significant association between the subjective measure of "neighborhood safety" from the "built environment" construct was found for the mid-sized town (Minamiise). Neighborhood safety (especially traffic) is very much affected by density, number of cars/intersections, drivers' behavior, and other built environment characters. Although Minamiise may not have the criteria of a walking/cycling-friendly urban environment, its geography and the layout of its numerous settlements along the coastline, not too steep hilly terrains, and beautiful sceneries give it a relatively acceptable appeal for walking/cycling.

However, fairly longer trip distances compared to a place like Toyoyama, more difficulty associated with cycling due to the topographical features, less enforcement for traffic-calming measures because of the low density, and the coexistence of humans and wild animals in the untamed natural environment make active trips challenging. As a result, students who perceived the environment to be safer from the danger of traffic, crime, and wild animals were more likely to travel on foot or by bicycles to non-school destinations. However, neglecting to acknowledge the importance of "neighborhood safety," particularly the criteria associated with traffic and wild animals in rural areas of Japan, can adversely affect children's opinion about active trips (Drianda & Kinoshita, 2011).

On the other hand, "neighborhood safety" was not even in the list of the selected variables from the preliminary models developed for Toyoyama town (see Fig. 3.14), which might not be easily justifiable. As mentioned in subsections 3.3.1, the size of Toyoyama and its flat environment make it a walking/cycling-friendly environment, which is appealing not only to children but adults. This town was the only place where children reported out-of-hometown destinations for cycling trips (subsection 4.2.1). Nevertheless, private vehicles are the primary mode of almost half of children's travel and around two-thirds of adults' trips, imposing possible traffic safety issues. Compared to urban and rural environments, and considering the characteristics of this town, such as size and population, Toyoyama appears to be relatively saturated in terms of the activation of walking/cycling. More objective data on traffic safety measures are required to justify Toyoyama town's choice model results.

As for the largest case study with the most challenging natural environment regarding mobility (longer trip distances and many sharp altitude fluctuations), "neighborhood safety" was an insignificant estimate even in the preliminary models (see Fig. 3.14). Based on the discussed characters of Kiso in subsection 3.3.3, although active modes do not seem to be an ideal transport option in this town, they may be used for a small part of a trip (see Fig. 3.9). However, it can be said that the natural/built environment features are far more influential in children's preference for using active modes than safety measures. Young adolescents' perception about "neighborhood safety" was also found significant in the estimation of WC trips in the general model, indicating the importance of this environmental criterion in encouraging young adolescents to travel more on foot or by bicycle. It is noteworthy that traffic safety situations could differ in the three case studies. Hence, it is necessary to include objectively-measured traffic safety items in the modeling to evaluate better the influence of this variable on children's mode choice.

In contrast to WC trips, no association was found between the items of the built environment (safety and walking/cycling facilities) and public transport trips. The existing literature suggests that most PT trips comprise a short active journey to the stations or bus stops; hence, promoting neighborhood safety can indirectly affect public transport use (Jones et al., 2012). Later, the findings of this study regarding the connection of active modes and public transport will be discussed, which are a little inconsistent and need further exploration.

5.2.2 Psychological Predictors

5.2.2.1 Individual-level (adolescent)

According to the results, in the small-sized suburb, adolescents' higher perception of their capabilities (in making WC against car trips) significantly contributes to more use of

active modes and simultaneously less being driven in a private car, which translates to more independent mobility for non-school travels. Considering that active trips are pretty common among the target age group in Toyoyama for school and non-school trips, the observed association between self-efficacy and the actual active travels emphasizes the role of learning through exposure and repetition, which contributes to children's capability building (Bandura, 1989). Such a relationship was already found in the context of school travel among young adolescents (Lu et al., 2015).

Young adolescents' perception about self-efficacy (WC over the car) has not been found significant in any of the other case studies, which may emphasize the unfriendliness of the natural/built environment for realizing active trips in Minamiise and Kiso. Regarding children's perception of their PT self-efficacy, same pattern was seen, which is a little surprising since young adolescents access a free town bus pass and have some opportunities for building self-esteem through practice and repetition in Minamiise and Kiso. The author suspects that the size of the town and its travel environment play an essential role in intimidating our target age group for making public transport trips. As subsection 3.3.2 explains, in Minamiise, the bus service is infrequent, and usually, there is no direct route, especially for getting out of town. Transfers are complicated and worrisome for children preventing them from taking trips on their own. Caregivers' perception seems to be more critical in bigger and more challenging built environments (will be discussed in the following subsection.)

Apart from the variable mentioned above, the general model also highlights the role of young adolescents' positive perception regarding their capabilities in using public transport against the private vehicle on the increased number of public transport trips and fewer car rides. The predictive margins in subsection 4.3.4.1 revealed that becoming more efficacious in using active modes over the private vehicle will not necessarily have a positive effect on choosing the means of public transport if it does not decrease PT probability at the very best. However, helping children to build self-esteem and capability in using means of public transport contributes to the promotion of both WC and PT.

The general model also finds a positive association between young adolescents' specific perceived benefits and the mode choice, which elaborates the importance of perception in selecting modes and can be reflected in policymaking. It is noteworthy that such a link was not found in the separate final models (this variable was only significant in the preliminary modeling process of Toyoyama town). The modal split of the reported non-school trips revealed similar patterns in Minamiise and Kiso, with car trips the dominant share. Only in Toyoyama, active modes were almost as popular as private vehicles. However, looking at the mean values of this variable in Tables 4.2-4.4, one can see that the only town where young adolescents' perception of each mode's benefits has some nuances relatively according to the actual travel behavior is Toyoyama. In Minamiise and Kiso, mean values for the perceived benefits of all mode categories are almost similar, which does not correlate with the mode choice patterns in these two towns. It seems that young adolescents could not objectively differentiate the benefits of transport modes. Since both Minamiise and Toyoyama are challenging environments for children's mobility, such a pattern could be due to adolescents' lack of experience. Or, maybe the small number of PT trips in the separate models caused such results. Clarifying this issue warrants further investigation.

5.2.2.2 Social level (caregivers & friends)

At the inter-personal level, the results of the separate models and the general model are quite different. Separate models show that those adolescents whose caregivers had more trust in their walking/cycling capabilities had higher chances of making active non-school trips in Kiso. Also, in the small-sized town, those students perceived by their caregivers as more self-efficacious to use public transport (when the option of private car was also available) reported more active non-school trips than car trips (same one-way direction of WC and PT discussed in the previous subsection.) The author is not sure why the caregivers' viewpoint on their children's self-efficacy was insignificant in Minamiise or the general model. Apart from Minamiise, either young adolescents' perception or their caregivers' opinion, and sometimes both (the two are usually slightly correlated) were significant predictors of WC. Hence, it is safe to say that higher perceived self-efficacy for active travel and public transport (either perceived by the target group or their caregivers) raises the probability of active trips.

Additionally, caregivers' higher perception of their children being capable of using public transport over the private car independently can increase the probability of public transport non-school travel among young adolescents in the small-sized and large-sized contexts. As mentioned in subsection 3.3.1, Toyoyama's neighbor cities/towns are within easy distance by public transport. The straightforward trip route may lead to less concern and more trust from the caregivers' side. In Kiso town, access to the railway could also reassure caregivers that their children can successfully make a trip independently since trains are more punctual and easier to travel with than buses (issues associated with complicated bus maps and fare system, waiting time, etc.). Minamiise, on the other hand, does not benefit from either of the positive points the author mentioned for the other two case studies. It should be noted that adolescents' and their caregivers' responses about self-efficacy (either for WC or PT over the car) are also positively correlated (correlation coefficient = 0.2-0.4). The results of this part are insightful, mainly because young adolescents' self-efficacy toward using public transport has never been explored in the previous literature (to the best of our knowledge).

Regarding the social modeling, norm, and support, significant associations were found in the suburban small-sized, coastal mid-sized contexts, and the general model. These are all mode-specific variables suggesting that the effects are not limited to WC and PT. The results are different and inconsistent among the case studies. In the small-sized town, caregivers' travel behavior modeling (perceived by young adolescents) and caregivers' norm set for their children positively estimate the mode choice. Such findings can be verified by the person-trip survey results conducted in 2011 in Toyoyama. According to the modal split data in Fig. 3.3, children's non-school travel modal share almost follows the travel behavior pattern of the town (high percentage of car and active modes and tiny bus share), which makes the probability of car trips and active trips for adolescents' non-school travel more sensitive to change compared to public transport trips). The author does not have enough evidence to explain why there are no significant social norm/modeling estimates in Minamiise or Kiso.

On the other hand, a positive link was found between friends' social modeling and young adolescents' mode choice in the general model. Such a finding emphasizes the effect of peers' travel behavior on adolescents' mode choice. Social norm was insignificant in the general model, which could be due to the discrepancies of existing norms in the case studies.

Table 5.1 The summary of the choice models results (separate & general) in the case studies classified in the two main categories of a) positive effects, and b) negative effects

Positive effects	**Toyoyama** (Small-sized, suburb)	**Minamiise** (Mid-sized, coastal)	**Kiso** (Large-sized, mountainous)	**General model**
Built environment		➢ Neighborhood Safety (1.62)		➢ Neighborhood Safety (1.23)
Psychological	➢ Social Modeling of caregivers (child) (1.14) ➢ Social Norm of caregivers (caregiver) (1.20) ➢ Self-Efficacy for PT (caregiver) (1.14) (1.26) ➢ Self-Efficacy for WC (child) (1.20)	➢ Social Support (1.82)	➢ Self-Efficacy for PT (caregiver) (1.45) ➢ Self-Efficacy for WC (caregiver) (1.34)	➢ Perceived Benefits (1.19) ➢ Social Support of friends (child) (1.13) ➢ Social Support of caregivers (caregiver) (1.22) ➢ Social Modeling of friends (child) (1.10) ➢ Self-Efficacy for PT (child) (1.18) ➢ Self-Efficacy for WC (child) (1.13)
Independent Mobility (IM)	➢ Cycling on main roads (caregiver) (2.56)		➢ IM farthest distance: out of town (ref: school area) (child) (4.15) (3.21)	
Socio-demographic	➢ Toyoyama district (ref: Shimizu district) (3.07) (1.58) ➢ ≧3 car/house (ref: 1) (4.17) (2.57) ➢ 2 child/house (ref:1) (4.17) (2.02)	➢ 2nd grade (ref: 3rd grade) (2.05)	➢ Fukushima & Hiyoshi districts (ref: Kaida district) (3.97, 7.34) ➢ 2nd grade (ref: 3rd grade) (2.32) ➢ Single-parent family & grandparent/s (ref: single-parent family) (12.39)	➢ 2nd grade (ref: 3rd grade) (1.40) ➢ Single-parent family & grandparent/s (ref: single-parent family) (2.57)
Negative effects	**Toyoyama** (Small-sized, suburb)	**Minamiise** (Mid-sized, coastal)	**Kiso** (Large-sized, mountainous)	**General model**
Independent Mobility (IM)	➢ Going out after dark (caregiver) (.29)	➢ Cycling on main roads (child) (.52)	➢ IM farthest distance: inside/out of town (ref: home area) (caregiver) (.27/.24)	
Socio-demographic	➢ Caregiver in 40s (ref: >50) (.22) ➢ Females (ref: males) (.55) ➢ Single-parent family & grandparent/s (ref: single-parent family) (.35)	➢ 1st grade (ref: 3rd grade) (.45)	➢ Fukushima district (ref: Kaida district) (.39) ➢ Females (ref: males) (.56) ➢ Future out of hometown (ref: inside) (.44) ➢ Full-time caregiver (ref: unemployed) (.32)	➢ Having elder siblings (ref: not) (.68) ➢ Caregiver in their 40s (ref: >50) (.54) ➢ 2 car/house (ref: ≧3) (.60) ➢ Full/part-time caregiver (ref: unemployed) (.56/.63) ➢ Minamiise/Kiso towns (ref: Toyoyama) (.58/.63)

Note: the numbers in parenthesis are odds ratios for alternative specific variables and relative risk ratios for case-specific variables (car is taken as the reference).
Alternative-specific variables affecting the choice of all modes
Variables affecting the relative use of Walking/Cycling (WC)
Variables affecting the relative use of Public Transport (PT)
Variables affecting the relative use of both WC and PT over the car (estimates for WC and PT are differentiated with changing the colors for this group)

In Minamiise, social support from caregivers and friends could positively estimate the mode choice. Among the three variables of social modeling, norm, and support, the latter seems to be the most explicit one, which can be associated with supporter's consciousness (at least to some level). Although the predominant mobility pattern in all the case studies is a heavy reliance on private vehicles, Minamiise may be the only case in which many efforts have been made to raise awareness about the public transport service and promote its use among children. In other words, the support is getting enabled through multiple layers of influence from policy to organizations, families, and individuals. The author believes that this integrated effort in Minamiise has already manifested itself in the high value of the internal consistency of this scale. Compared to Minamiise, there is not enough support or incentives to promote the service among families or children in Toyoyama (Toyoyama town, 2020), or maybe the issue is not regarded as urgent of a problem as it is in Minamiise. If Toyoyama sits at one end of a spectrum, Kiso town would be on the other end. Although the maintenance and promotion of the service are very urgent in Kiso, due to its natural/spatial characteristics and its vast scale (size-wise), the management of the service and coordination among residents has gone out of control.

Social support of the significant others also proved influential on young adolescents' mode choice in the general model. In the previous chapter, subsection 4.3.2.1 and 4.3.4.1, the effects of this estimate on the mode choice were better elaborated in a scenario in which a one-unit increase for social support toward the use of active modes and public transport and a one-unit decrease for car use was proposed. The observed influence of social support was the highest among the social modeling, norm, and support. Such results emphasize the importance and potential of the social environments with which adolescents have contact in foregrounding specific types of mobility behavior such as active travel (McAlister et al., 2008), independent mobility, or the use of more sustainable modes of transport that can also contribute to adolescents' well-being (Goodman et al., 2014). However, it is still not completely clear why social support was not significant in the final models of Minamiise and Kiso. The author believes that this matter needs further investigation.

5.2.3 Independent Mobility Predictors (Distance & License)

5.2.3.1 Individual-level (adolescent)

The results of this category are also inconclusive among the case studies. It is noteworthy that these variables proved insignificant in the general model, which makes sense since the perception around the concept of independent mobility is highly dependent on the living environment features. Only in the large-sized context, more perceived license for traveling independently to farther destinations (e.g., as far as out of the hometown compared to school neighborhood) raised the probability of selecting active modes of transport and public transport while decreasing the chance of car use for non-school trips. Finding such association for the large-sized mountainous rural area emphasizes the significance of a positive perception toward independent mobility on adolescents' actual realization of WC and PT trips, specifically in areas where accessibility is more restricted. This license may also be linked to the level of self-efficacy for independent travel using active modes or public transport. The existing literature supports such findings on school travel (Faulkner et al., 2010; Lu et al., 2015).

The author thinks that the difficulties associated with independent public transport or walking/cycling trips in Minamiise might have prevented this variable from being significant in the final model. In Toyoyama, although active modes are pretty common for realizing

independent mobility, most long-distance trips in Toyoyama are made with the private car. However, the distance between origins and destinations is not too far in Toyoyama compared to Minamiise and Kiso. Hence, children's mobility may not appear as an extensive burden on caregivers in a small-size suburb such as Toyoyama leading to a different understanding of the independent mobility concept. Another possibility is that there is potential for independent mobility realization in Toyoyama and it just needs a catalyzer to be activated.

5.2.3.2 Social level (family: caregivers)

Additionally, the results suggest a positive link between having the license of "cycling on main roads" (caregivers' response) and using public transport in Toyoyama. Due to its small size and proximity to other potential destinations, the configuration of the built environment in Toyoyama, and the absence of significant geographical features, cycling is prevalent among the target age group (96% of bicycle ownership among adolescents). It seems that riding the bicycle makes it possible for our target group to get to the bus stops and travel to the destinations they desire by bus (this town's primary means of public transport are different types of bus service). Although the share of reported public transport trips is small in this town, the results remark a potential in bringing together the active modes and public transport to fulfill young adolescents' (independent) mobility needs.

5.2.4 Socio-Demographic Predictors

5.2.4.1 Individual-level (adolescent)

One of the only consistent results found in Minamiise, Kiso, and the general model is the effect of age (2nd graders compared to 3rd graders) on the use of active modes for non-school trips. The results of the predicted margins for the mid-sized coastal case study in subsection 4.3.2.4 shows that 3rd graders are significantly less likely to walk/cycle and more likely to use public transport than 2nd graders. However, in Kiso, the decreased share of active travel shifts to car trips for 3rd graders. Given that there is not a substantial variation in the age range of the target participants, this result should be taken into account with caution. However, Stark et al. (2019) observed different age-related travel patterns and preferences, especially more affinity for motorized modes for older children (i.e., young adolescents compared to children).

5.2.4.2 Social level (family: caregivers)

In Toyoyama, participants belonging to families of two children were more likely to make active or public transport trips in comparison to an only-child family. The results of the marginal effects in subsection 4.3.1.3 also displayed a significant drop in the car trips for adolescents in a two-child household. More active school trips and independent leisure trips among children in bigger households living in urban areas were already observed (Johansson, 2006; Mitra & Buliung, 2012). In the same case study, having more private vehicles (three or more compared to only one vehicle) could significantly reduce the likelihood of car trips and raise the chance of active or public transport trips. Notably, this town has the least share of households with multiple cars (11.6%) among the case studies (in Minamiise and Kiso, this share is 51% and 32.2%, respectively). In the general model, a similar association of such nature is also found (to be discussed later). However, the author has no clue why this variable "No. of cars per household" was not even selected in the preliminary model-making phases for Minamiise and Kiso, which warrants further investigation.

Finally, the impacts of the household construct in Kiso and the general model revealed that belonging to a single-parent household in which grandparent/s also live/s can raise the odds of making public transport trips and reduce the probability of car trips (compared to single-parent families without grandparent/s). There is not enough evidence supporting such behavior, but it might postulate the possibility of adolescents' joint trips with their grandparent/s with the means of public transport. Except for Toyoyama, the aging rate is high in Minamiise and Kiso, and many of the elderly people are encouraged to return their driving license and benefit from public transport schemes (Toyoyama town, 2020; Kiso town, 2017). Joint public transport trips between grandparents and their grandchildren could also be heightened because young adolescents in Minamiise and Kiso can use the town bus free of charge. There is not much evidence in the existing literature regarding the effect of household type on children's/adolescents' mode choice. In one study, single-parent households were associated with fewer escorted trips in the private vehicle for adolescents' leisure trips (Bjerkan & Nordtømme, 2014). Nevertheless, this topic needs further investigation since the results were only observed in one case study in which the mentioned two types of single-parent households comprised a small share of the sample.

5.3 Negative Estimates of WC Non-School Trips

Based on the summary of results displayed in Table 5.1, the only negative impact on the likelihood of walking/cycling was observed in the category of socio-demographic characters. Apart from the "gender," which showed consistent results in the two case studies in which the data was collected, almost all the other estimates were unique to each case study. However, some of the findings of the separate models are also found significant in the general model. It is noteworthy that since the data on gender was not available for one of the case studies, it could not be included in the general model. In sum, most of the following discussions should be considered regarding the natural/physical contexts of each of the towns.

5.3.1 Socio-Demographic Predictors

5.3.1.1 Individual-level (adolescent)

Firstly, "gender" played an important role in the mode choice (in Toyoyama and Kiso), with female students (compared to male students) reporting fewer active non-school trips versus escorted car trips. Although gender data could not be incorporated in the model of Minamiise, it would lead to a similar result since such a pattern is quite common among females evidenced by the studies of Robertson-Wilson et al. (2008) and Stark et al. (2018) in the scope of school trips. Since active trips are the most accessible and straightforward transport options for children, such a link indicates fewer chances of independent mobility for girls. Considering that Japan is relatively a safe country, the reasons for such a pattern (less affinity for active trips among females) should be investigated.

Furthermore, according to Table 5.1, the chance of making active non-school trips is less for those young adolescents visioning their future goals to take place somewhere out of their hometown in Kiso. Logically, pursuing such aspirations requires greater levels of independent mobility. However, based on Kiso town (2017), the prevalent share of private car transfers for high school students reaffirms this study's finding, which is concerning. Moreover, no association was seen between life plans and public transport use in any models, which is also critical and requires awareness-raising among families and their children.

5.3.1.2 Social level (family: caregivers)

In the same setting of the large-sized rural town (Kiso), and the general model, having at least a parent with full-time occupation (80% of the respondents were young adolescents' mothers) resulted in less active traveling and more use of the car for non-school trips versus a family in which at least a parent is unemployed. According to the modal share graph made for different purposes in subsection 3.3.3 (Kiso town, 2017), more than 70% of "commuting to work" trips are with a private car in Kiso town, which could result in more trip chaining, especially with full-time employed mothers (McGuckin & Nakamoto, 2005). Bjerkan & Nordtømme (2014) also witnessed fewer car trips for leisure purposes in families where caregivers do not have a job. The author cannot fully understand why this variable was not significant in Toyoyama and, more importantly, Minamiise. It might also be interesting to understand better the effects of caregivers' occupations on the probability of public transport trips among young adolescents. In any case, this finding emphasizes the impact of households' activities on their children's mobility.

Finally, in Toyoyama, adolescents in the single-parent households living with grandparent/s (versus a single-parent household) were less likely to walk/cycle and more likely to be driven in a private car. Regarding this socio-demographic variable, a different pattern was discussed in subsection 5.2.5 for positive estimates toward the use of public transport in Kiso. Since the two case studies are very different in their character and demographics, such finding is not surprising. According to Toyoyama town (2020) and Kiso town (2017), Toyoyama's aging rate is almost half of Kiso's, which means that the chances of having a grandparent still being able to drive a car in Toyoyama are higher than Kiso. Building on this premise, in Toyoyama, having grandparent/s living with the household may translate to chauffeuring around the grandchildren for their non-school trips. Studying the trip-making process in different settings can illuminate this topic more.

5.4 Negative Estimates of PT Non-School Trips

Table 5.1 demonstrates the negative estimates of selecting public transport (over the car) in the groups of "independent mobility" and "socio-demographic" variables. Considering the differences of the towns, it is no wonder that the results are inconsistent among the case studies. As mentioned before, the distinctive characters of the case studies should be kept in mind while making interpretations of the choice model results. The negative estimates of public transport trips are only found in the "socio-demographic" category for the general model.

5.4.1 Independent Mobility Predictors (Distance & License)

5.4.1.1 Individual-level (adolescent)

The results in this subsection for the mid-sized case study (Minamiise) revealed a negative association between adolescents' perception of being granted the consent to "cycle on main roads" and the likelihood of using public transport for their non-school travel. This result is the opposite of what was observed in the small-size suburb (Toyoyama) in which the same consent could elevate the share of public transport trips. Based on the distinctive characteristics of the natural/physical environments and adolescents' travel patterns in the two areas, it is logical to assume that such differences caused this contrasting result. According to Fig. 4.5, around 80% of the public transport trips in Minamiise were made inside the town, whereas in

Toyoyama, almost all the public transport trips were bound for destinations outside the town. Elaborating on the observed pattern, it seems that adolescents living in the suburb ride their bicycles to access public transport services and reach farther destinations. However, if a young adolescent can make long-distance bicycle trips on main roads in the mid-sized rural area, this capability makes them less needy to the public transport service (since most PT trips were bound for destinations located inside the town).

Besides, traveling by the town bus in Minamiise requires trip planning in advance and may not be suitable due to its limited frequency. By comparison, cycling is way more flexible, providing more opportunities for our target age group in their daily mobility. The mentioned points are reasons for promoting active modes among female students to expand their independent mobility scope and benefit from its advantages.

5.4.1.2 Social level (family: caregivers)

According to Table 5.1, young adolescents living in the small suburb who had the allowance of "going out after dark" were less likely to use public transport for their non-school trips. Toyoyama has a walking/cycling-friendly environment; hence most of the trips made with public transport are for the sake of fulfilling accessibility to farther destinations (see Table 4.5). Given that public transport service is not functioning late in the small towns and that traveling far independently (especially with the means of public transport) is way more comfortable during daylight for children and young adolescents (less risky), the observed result seems to be justified.

Regarding the independent mobility distance, a counterintuitive result was observed in Kiso town. A negative association was found between caregivers' responses on granting consent to their children for traveling longer distances independently and the likelihood of using public transport for non-school travel. We observed an opposite pattern between adolescents' responses on the same matter and the possibility of walking/cycling and public transport trips in the same case study. Such finding shows the mismatch between caregivers' perception about the scope of independent mobility and the actual reality. Interestingly, another mismatch of the exact nature was found by Shaw et al. (2015), indicating that Japanese caregivers' perception of their children's independent mobility level is usually higher than their children's report.

5.4.2 Socio-Demographic Predictors

5.4.2.1 Individual-level (adolescent)

In the mid-sized coastal setting, the odds of making non-school trips with the means of public transport against escorted car trips were smaller for 1st graders (compared to 3rd graders), suggesting that the probability of using public transport increases as young adolescents mature, and become more experienced. Although the existing literature might usually regard the effect of age on mode choice as a generic influence, such context-specific variations are interesting.

5.4.2.2 Social level (family: caregivers, siblings)

In the small-sized suburb and the general model, having caregivers (mothers were the most common respondents) between the age of 40-50 was associated with less probability of public transport trips and more car trips for young adolescents' non-school travels (compared

to older caregivers). Such a finding highlights the specific travel preferences of caregivers in this age range. Since households' travel behavior has a pivotal influence on children's and young adolescents' travel patterns, it is essential to trace the reasons for such results. Looking into the trip-making process for non-school purposes can elucidate this matter. In the general model, having elder siblings found to be significant in making fewer public transport trips and more car trips for the non-school purposes.

The general model also revealed a negative association between the odds of public transport trips against car trips for the households with two private vehicles compared to families owning multiple cars, which seems counterintuitive. The same pattern was also seen in Toyoyama, discussed before in subsection 5.2.4. However, the author cannot provide any clarification due to a lack of evidence supporting such a pattern.

5.5 Implications to Promote Independent Non-School Travel

Reflecting the findings of the current study on the household level and the policy settings is a fundamental step in promoting independent mobility among young adolescents (either by walking/cycling or means of public transport) and enhancing the use of environmentally-friendly modes among households. Comparing the findings of the general model and separate models and discussing the results of each town's model based on its characteristics have helped the researcher to understand the similarities and discrepancies in the travel behavior patterns. In the following sections, town-specific and general policies will be proposed based on the results of the models (the underlined policy items can be generalized.)

5.5.1 Proposed Policies for Toyoyama Town

The model's results for Toyoyama revealed that the chances of independent mobility could be elevated if young adolescents or their caregivers had more trust in adolescents being capable of making trips with WC and PT against the car. Such a matter needs to be informed and regularly communicated among children and their families. Also, as almost all the public transport trips were bound for out of Toyoyama town, distinguishing the most popular destinations for our target group and providing the appropriate incentives would be critical to promote public transport among them and their families. Notably, the public transport plan report of Toyoyama town (2020) suggests Kasugai city as the main host of the most significant outflow of students.

Furthermore, caregivers' travel behavior in Toyoyama (modeling and norm) was influential in the young adolescents' mode choice. In Toyoyama, caregivers' mobility mainly depends on private cars followed by a smaller share of active modes and a negligible bus use (modeling), affecting the travel norm. As children's travel behavior is enormously influenced by households' travel behavior, having a comprehensive outlook on the dynamics of mobility decisions in a family should be highlighted in the policy setting. Furthermore, cycling proved to be an enabler of PT trips in this town, and adolescents in bigger households showed a tendency for more WC and PT trips, both of which could be nurtured to ameliorate the situation in favor of active modes and public transport.

On the other hand, adolescents with younger caregivers were less likely to use PT trips, and those living with a single-parent and grandparents were more likely to be chauffeured around. Considering that Toyoyama stands in the last place in terms of the aging rate, it seems that many elderlies still hold a driving license and depend on private cars for daily mobility.

Finally, the odds of female students using active modes for their non-school trips (against a ride in the private car) was less than male students. Boys usually cycle more, and hence, enjoy more independent mobility. Although such a situation could be due to the caregivers' or societies' concerns for girls' safety, the mentality should be altered, especially in a safe country like Japan. It should not be forgotten that children's first experiences of independent mobility are through active modes, which complement public transport. Considering the detailed discussion in the previous sections, the following items are the proposed policies for the promotion of independent mobility in Toyoyama:

- Providing incentives to promote joint caregiver/child public transport trips to bring a balance to the modal share by decreasing the car trips, especially better motivation during weekends, such as public transport family tickets for bigger and younger households
- Promoting joint grandparent/child public transport trips by unique campaigns such as visiting popular destinations on special weekdays or weekends under the title of "fun trip with grandpa-grandma," to decrease the number of chauffeured car trips by grandparents
- Holding informal meetings with children to exchange ideas about public transport in the town to improve the service and its environment for them
- Providing a free town bus pass for elementary and junior high school students, it could be pilot seasonal or weekend-only passes, etc. to promote the share of public transport
- Promoting the use of public transport for popular destinations among young adolescents, especially those in the nearby cities/towns, for example, enhancing better and more convenient public transport service from Toyoyama to Kasugai
- Providing public transport discounts for traveling to popular destination out of town for adolescents
- Using the potentials of the environment to promote cycling in favor of the public transport trips, for example by establishing better equipped or more bicycle parking where needed based on the outflow data of the population in Toyoyama
- Raising awareness about the benefits of independent mobility for young adolescents, particularly girls who seem to have more propensity for car trips
- Holding cycling events for children, children with their caregivers, and children with their grandparents to further nurture the walking/cycling potentials of the town

5.5.2 Proposed Policies for Minamiise Town

The model's results for Minamiise highlighted the influence of neighborhood safety on the probability of active trips against car trips. It also emphasized the positive effect of caregivers'/friends' support toward WC and PT (in the form of encouragement and making trips together) on the actualization of walking/cycling and public transport trips. Also, it was found that at the final year of the junior high school, children become less likely to walk/cycle and more likely to take a ride in the private car (compared to the second graders), and more likely to use public transport rather than a car ride (compared to the first graders). Finally, cycling proved to have a potential in the promotion of independent mobility (not specifically public transport trips).

According to the results of the exploratory interviews in Minamiise (Khaleghi et al., 2021), the target age group (12-15) revealed fear of encountering wild animals as a disabler for

walking trips. Hilly terrains of the town and the limited cycling infrastructure also made cycling difficult and a little dangerous for junior high schoolers. Additionally, children reported traffic safety as a concerning issue for the realization of active trips. In the same interviews, children informed the researcher of the challenges they deal with for trip making with public transport, such as difficulties associated with reading the timetables, paying the fare, missing the stop, not getting help when required. Those who could seek help for trip planning/realization from friends, teachers, or friends' parents were more likely to use public transport. Additionally, the current research revealed that most public transport trips are made during weekends, and according to the interview results (Khaleghi et al., 2021), the town bus timetable cannot meet the needs of children on weekends.

Also, according to Minamiise town (2021), public transport users (either the town bus or the on-demand bus) are dropping sharply over the past five years, and maintaining a frequent town bus service is becoming more difficult due to the town population and low demands. Many children expressed the infrequent town bus service as a crucial negative factor in choosing the private car over public transport (Khaleghi et al., 2021). Considering the detailed discussion in the previous sections, the following items are the proposed policies for the promotion of independent mobility in Minamiise:

- Improving the walking/cycling environment by enforcing better traffic safety and better infrastructure for active modes, especially cycling such as cycling paths for enjoying the beautiful sceneries of Minamiise
- Devising a supportive network of friends and caregivers by developing smartphone apps to ease young adolescents' trip planning with public transport and promote independent mobility

  (Since some of the young adolescents' public transport trips are made in groups of friends, this platform can support such trips. In these apps, caregivers or children themselves could play the role of consultants providing support/remarks on independent trips easing the process of trip planning/trip making by various means of public transport.

  Such apps can provide the same kind of support younger children receive from adults to facilitate walking school trips in elementary school periods in Japan, but for older children with different mobility needs.)
- Promoting the use of the on-demand bus among young adolescents, especially on weekends, to compensate for the infrequent town bus service
- Teaching children how to make a reservation for the on-demand bus, or making new reservation systems that are easier for children to handle (compared to phone reservation), for example, placing touch screens in the bus stops with visual instructions
- Keeping an eye on the integration of active modes and public transport, especially for older adolescents, to meet their greater mobility needs and decrease their tendency for car rides

5.5.3 Proposed Policies for Kiso Town

The model's results for Kiso revealed that being perceived as more self-efficacious in using active modes and public transport by one's caregivers can positively affect the likelihood of walking/cycling and public transport among young adolescents. Moreover, caregivers

provided support by allowing their children to travel farther distances independently, promoting self-efficacy through practice. However, caregivers' perception of independent mobility distance did not estimate the realized independent trips intuitively. Furthermore, adolescents in a single-parent family with grandparents were more likely to make public transport than car trips. Regarding the high aging rate in Kiso town (around 40% in 2017), there is a high chance that grandparents are no longer capable of driving a car, which could be the reason behind such a result.

On the other hand, girls were less likely to walk/cycle than boys in Kiso town, similar to Toyoyama town. Children wishing to go out of town for pursing their future had higher odds of car trips against active trips. Additionally, like Minamiise, third graders (compared to second graders) were more likely to take a ride in the car than make an active trip. Finally, having a full-time caregiver could decrease the chance of active trips and increase the car ride compared to having a full-time homemaker or unemployed caregiver.

Households and students being heavily reliant on private vehicles for daily mobility adversely affects children's independent mobility in Kiso town, which is a concerning issue. The importance of this argument should be predicated on the assumption that independent mobility exposes young adolescents to their physical/social surroundings with which they interact and from which they learn about many things. Independent mobility helps young adolescents build self-esteem, reducing their dependence on their caregivers in their current and future travels. Evidently, young adolescents' mobility is a shared issue among them and their caregivers (families). Therefore, awareness-raising is a top priority matter, targeting the family/household level. This current car-dominant mobility pattern also negatively affects public transport use, wasting the town's financial resources to maintain the PT service (Kiso town, 2017). Considering the characteristics of Kiso and the detailed discussion in the previous sections, the following items are the proposed policies for the promotion of independent mobility in Kiso:

- Raising awareness about the benefits of independent mobility, especially active modes for young adolescents, particularly girls at the household level
- Holding informal meetings for children, their caregivers, and transport planners for exchanging ideas about public transport in the town to improve the service and its environment (more friendly and appealing for children and families by taking into account their opinions/needs)
- Disseminating the information on the adverse effects of the current household's travel behavior (high reliance on private cars) on young adolescents' mobility, and the town's financial resources
- Cooperating with nearby towns in exchanging resources and negotiating for public transport incentives for students
- Reducing the number of different buses and planning an integrated and straightforward service that is more efficient
- Making the public transport service a more competitive option to private cars in terms of comfort and convenience
- Surveying the town bus use meticulously and providing on-demand service for less-frequently used town bus routes to meet the needs of users, especially children, better
- Teaching children how to use the on-demand service

- Providing a platform/campaign for children and their grandparents to communicate and make trips together with the buses
- Using technology to promote the use of public transport among adolescents for traveling inside or out of the town, for example, by mobile apps

5.5.4 Proposed General Policies

The general model showed that perceived neighborhood safety plays an important role in the realization of active trips. Also, young adolescents' perception of their self-efficacy for using WC and PT against the car positively affects the likelihood of independent mobility with active modes and public transport. The more support children receive from their friends and caregivers for using a transport mode; the greater is the probability of using that mode. Additionally, friends' mode use can significantly affect young adolescents' mode choice. Also, higher perceived benefits for a transport mode results in a greater likelihood of using that mode to make non-school trips. Furthermore, belonging to a single-parent household living with grandparent/s increases the chance of public transport trips against a car ride.

On the other hand, young adolescents having elder siblings are less likely to use public transport instead of a car ride. Similar to the models' results in Minamiise and Kiso, older adolescents (third graders compared to second graders) tended to use more car trips than active trips. Finally, having a full-time or part-time caregiver could decrease the chance of active trips and increase the likelihood of car rides compared to having a full-time homemaker or unemployed caregiver.

As mentioned before, the general model results are almost a combination of the separate models. Hence some of the proposed policies for each town can also be generalized and used for the general model. Apart from the underlined items in the previously proposed policies for each town, a few more items are specifically drafted for the generalized situation:

- Educating children about mobility, accessibility, and different modes of transport by playing games (after a while, children can coordinate the sessions on their own)
- Devising a system in which children can keep track of their mobility behavior in simple virtual diaries and rate them based on the level of independence and sustainability. These diaries could be shared among a small group of friends to enhance the friends' modeling effect

Overall, the mentioned insights have the potential to be implemented in the mentioned case studies or similar settings and open up new opportunities for the enhancement of independent mobility in rural areas and suburbs among young adolescents.

Chapter 6: Conclusion

6.1 Achievements of This Research

The current research aimed at shedding light on the nature of young adolescents' non-school travels in the rural and suburban environments by investigating the factors affecting mode choice from various social/physical surrounding environments with which they interact. As previously mentioned, the existing literature is lacking regarding the study of non-school travel. Additionally, the need for such research is critical in rural and suburban areas where mobility/accessibility is more limited than urban areas. Besides, the consideration of early adolescence in the scope of this research highlights the significance of this phase in shaping travel behavior as children move to adolescence/youth. To fulfill the goal of the research, we attempted to find answers for these three main questions:

Question 1: **What are the prevailing patterns in junior high school students' non-school travel in small towns and rural areas?**

Question 2: **How do the characteristics of young adolescents, their households, and the factors linked with the social/physical living environments influence young adolescents' mode choice for non-school trips in the rural and suburban areas?**

Question 3: **How can understanding young adolescents' non-school travels provide insights for the policy-makers to promote independent/more sustainable traveling?**

Considering the methodology of this research, and based on the presented results in chapter 4 and the discussions in chapter 5, the questions are relatively thoroughly answered, and the target goal of the research is accomplished. However, considering the limitation of the current study, the results also provided insights/possibilities for more research to illuminate the topic from another perspective. In the following, a summary of the results based on the research questions is provided, followed by some suggestions/remarks for future studies in the next section.

Regarding the **first question**, the detailed reports of non-school travel revealed invaluable information regarding different aspects of young adolescents' trips for every destination other than the school in two rural settings and one suburban context. The general travel patterns with high rates of private car trips and a relatively smaller share of active and public transport trips, particularly in the rural areas, were expected. However, the distinctive spatial/temporal characters of the trips realized with each of the modes fulfilling a variety of purposes were pretty novel and informative in the three case studies. Additionally, the information on the trips' companions represented in Fig. 4.6 emphasized the importance of active modes and public transport in young adolescents' implementation of independent trips. Overall, the results showed a high chance of private car use for young adolescents' non-school travels in the rural areas, which means more escorted trips and less independent mobility for the target participants. Multiple-car ownership, infrequent/inconvenient public transport service, and the dominance of private vehicles in such environments contribute to such a pattern.

Concerning the **second question**, the current study results mainly emphasized the unique impacts of distinctive natural/physical settings of rural areas and suburbia in Japan on young adolescents' travel behavior for their non-school trips. The unique characters of the place may usually be overlooked in large-scale surveys by categorizing all these settings under one homogeneous classification. The research findings of the separate models revealed that the

predictors of the actual independent mobility (trips made with walking/cycling or public transport) could differ in each context:

In **Toyoyama** (a small suburban town), social modeling/norm of caregivers and self-efficacy (for WC and PT) were influential in estimating mode choice under the psychological construct. As far as socio-demographic variables are concerned, living district, the number of children and cars per household, family's construct, caregivers' age, and young adolescents' gender were significant in the choice model. Two independent mobility license items, namely 1) cycling on main roads and 2) going out after dark, also affected the mode choice for non-school traveling.

In **Minamiise** (a mid-sized coastal town), neighborhood safety (under the built environment construct), social support (under the category of psychological variables), cycling on main roads (one item of the independent mobility license), and young adolescents' age influenced the preference toward the selection of transport modes for trips other than school travel.

In **Kiso** (a large mountainous town), self-efficacy variables for WC and PT (in the psychological category), the perception around independent mobility distance, and socio-demographic variables, namely living district, family's construct, caregivers' occupation, young adolescents' age/gender and young adolescents' vision of their future (either pursuing their goals in their hometown or out of it) affected the mode choice for non-school trips.

However, a general model is always insightful, and hence one was developed for comparison and its application for higher-level policymaking. In the **general model**, "neighborhood safety" influenced mode choice under the built environment construct. Perceived mode-specific benefits, social support, social modeling of friends, and self-efficacy measures for WC and PT affected the selection of transport modes in the psychological classification. Finally, family's construct, caregivers' occupation/age, the number of cars per household, living environments (the context of each town), having elder siblings, and young adolescents' age estimated the selection of transport modes for traveling to destinations other than school.

Despite the uniqueness of results, a similar pattern was seen among the separate models and the general model regarding the impact level of each construct (environmental, psychological, independent mobility, and socio-demographic) on young adolescents' mode choice. According to the calculated margins presented in chapter 4 and the appendices, socio-demographic variables, namely young adolescents' age/gender, household characteristics (e.g., number of children/family, caregivers' age/occupation, and household construct) proved to substantially affect young adolescents' mode choice. Unfortunately, in this research, no data were collected regarding the influence mechanism of each of the mentioned items on young adolescents' mode choice, especially in different stages of children's growth. Altering these characteristics may not be possible directly, but context-specific and general policies can gradually affect the current situation.

Regarding the degree of influence, socio-demographic characters are followed by moderate effects of psychological variables (e.g., social support, self-efficacy, and social modeling/norm) in all the models and perceived consent for independent mobility distance and license in the separate models. As for the built environment, only in one case study and the general model, a moderate association was found between the neighborhood safety and the

probability of walking/cycling. As mentioned before, the significant variables in each main construct are inconsistent among the separate models, which emphasize the fundamental influence of the natural/physical/spatial built environment on the mode choice for young adolescents' non-school trips. Such a pattern was also seen in different districts of the small-sized and large-sized settings (same influence on a smaller scale). Christian et al. (2015) have previously highlighted the impacts of the physical environment on children's travel behavior. It is noteworthy that characteristics of public transport service as a criterion of the built environment were not included in this study, limiting the interpretation. Also, the lack of the researcher's experience/expertise in hybrid modeling resulted in multiple models, which made the results complicated and lengthy.

As for the **third question**, at the end of chapter 5, insights were provided for promoting independent mobility among young adolescents in each case study, depending on its unique characteristics. While some of the policies can be generalized, others may only be effective for the specific town. Few unique general policies were also suggested at the end of chapter 5 (for detailed information on the policies, see subsection 5.5). Since most of the positive estimates of walking/cycling and public transport trips were linked to the household (attitude toward each mode, independent mobility/self-efficacy, support, etc.), and friends (modeling and support) awareness-raising toward the importance of independent mobility, and the adverse impact of households' travel behavior on children's independent mobility is very critical. This awareness could also take a pedagogical trajectory translating to mobility education, etc. Such efforts could go even further and manifest themselves in the form of a partnership with children to improve public transport and active traveling.

Making joint trips of children and their parents/grandparents using public transport or active modes a fun norm could also open doors to a paradigm shift in the current travel behavior and attitudes. Furthermore, easing the process of trip planning in groups of friends (with mobile apps) or devising a fun mobility monitoring system (shared virtual travel diaries among friends) were proposed to act as a catalyst for promoting independent and sustainable mobility. Other initiatives such as the provision of public transport tickets for younger families or specific households (e.g., with one child or multiple children) or public transport pass for leisure trips (free or with a significant discount) for traveling out of town were also suggested. Notably, it is critical to consider each environment's distinctive natural/physical characters in devising and implementing these initiatives.

6.2 Suggestions for Future Research

Since "travel" is a complex system interacting with various disciplines, researchers usually come up against many challenges and difficulties for conducting a comprehensive study. Although this cross-sectional study provided many insightful results, the rationale behind some patterns (e.g., the link of active modes and public transport) and the influence mechanism of significant variables on mode choice are not clear. Studying the process of trip-making (or decision-making about trips) for non-school travels among young adolescents in rural and suburban areas can elucidate such patterns and provide more solid evidence for policy-makers to alter the paradigms of independent mobility. Such information can also help understand the relationship between active modes and public transport in rural and suburban areas among young adolescents and strengthen such a connection. Moreover, researching

children's mobility under the continued situation of pandemic is necessary and could be enlightening for transport planners and policymakers.

Although age plays a vital role in children's travel behavior, detailed longitudinal data on the mobility of children and adolescents is scarce, which seems to be critical in understanding and meeting the unique needs of these target groups. Investigating the influence of "independent non-school traveling" in early adolescents on the travel behavior of the same sample as older adolescents in the form of longitudinal research could be very illuminating. Furthermore, the inclusion of urban environments along with rural and suburban areas for studying the young adolescents' non-school trips could lead to a more comprehensive comparison of distinctive types of built environments, which could be analyzed by more suitable methods such as hybrid modeling. Moreover, the situation of Japan could be compared to other countries, especially those with similar levels of independent mobility for children/young adolescents.

Furthermore, it is critical to include "trip distance" and "weather" condition as influential factors in predicting children's mode choice. Apart from using other modeling methods, such as Structural Equation Modeling (SEM), incorporating objective measures of the built environment, such as density, traffic safety, and public transport service quality obtained from external sources of data, could also be beneficial in developing more suitable generalized models for comparing the differences of the case studies in future studies. It will also be helpful to devise methods for evaluating the service quality of public transport from the viewpoint of children/adolescents and incorporate such index/score in the travel behavior studies. After all, children and adolescents are current and potential future users of public transport with unique needs and capabilities different than adults, and an inclusive transport system (one of the items of goal 11 of SDGs) should meet the primary needs of all its users.

Finally, it is also recommended to examine the feasibility of the proposed policies with each of the case studies. It would be exciting to evaluate the practicality of the suggested solutions (e.g., the campaigns, mobile apps, virtual travel diaries, or the PT family tickets, etc.) in pilot studies.

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Appendices

Appendix A: An Overview of Case Studies' Public Transport Plans

A1: Toyoyama Town (Plan Period: 2020-2029)

According to the latest report, the new plan supports a scheme envisioning a "small and glowing" town in which people do not excessively depend on their private vehicles for mobility (Toyoyama Town, 2020). In the same report, the information about several public transport surveys is shared (usage of different bus services in Toyoyama), among which a few of the respondents were reported their status as "students." However, there is no specific mention of this group in the current plan, except for the purpose of providing a nurturing environment for child-rearing. The plan intends to promote the use of public transport by:

- developing a comprehensive regional network based on the inflow and outflow of customers
- enhancing the bus usage environment, such as new boarding systems (IC cards, commuter passes, etc.), easy-to-use fare systems
- improving the bus convenience by taking into account the users' needs
- introducing demand responsive service
- creating bus maps based on the opinion of users and residents
- teaching prospective users how to ride a bus
- improving the waiting area (providing benches, lighting, public transport info, real-time bus location QR codes estimating the waiting time, etc.)
- providing support for search services such as google maps
- setting up meetings for the promotion of environmentally-friendly transport

There is also an emphasis on better routing the bus lines (based on the customer needs) and integrating cycling and public transport by providing safe and attractive bicycle lanes and bicycle parking. Taking into account the increasing rate of aging in Toyoyama, some parts of the plan are concentrated on the promotion of public transport for senior citizens.

A2: Minamiise Town (Plan Period: 2020-2024)

The plan has been established on 3Ks (Koukousei, Koureisha, and Kankoukyaku) (Minamiise town, 2021). These three pillars focus on 1) providing comfortable and safe transport for high school students, 2) enhancing the environment for the elderly to go out peacefully, and 3) promoting the exchange of resources with other areas. The population is constantly decreasing. Therefore, this town has taken special measures to promote public transport from an early age to slow down the migration of residents when children go to high school. Free town bus passes are provided for elementary and junior high school students and a 20% discount for the Mie Kotsu bus (for traveling out of town) for high school students. Minamiise is very attentive to the needs of the bus users.

This town has organized several meetings with the residents to find out the issues of decreasing passengers and improving the service. Reducing the burden of picking up/dropping off children for parents is one of the objectives of this plan. Making public transport more efficient (fewer transfer points, better routing, etc.) and customer-friendly (more straightforward fare system, etc.) are the other objectives. The plan (Minamiise town, 2021) intends to promote the use of public transport, particularly among children, by:

- providing early morning/late evening service for children
- making the interior of buses more convenient for studying with wi-fi, power supply, resting areas, and more comfortable seats
- promoting the use of the on-demand bus for children
- using ICT (Maas) to enhance public transport service
- promoting cycling infrastructure
- including amphibious buses (like ferries) to make the transport in town more attractive

A3: Kiso Town (Plan Period: 2017-2021)

The public transport plan in Kiso focuses on different districts of Kiso town and Otaki village. According to the report, the issues of depopulation and aging are very concerning in Kiso town (Kiso town, 2017). Around 70% of the population in Kiso town held a driving license in 2015 (more than a 20% increase in the past 30 years). Moreover, the average car ownership was two vehicles per household in 2015. It is noteworthy that most of the facilities are located in one of the districts of Kiso town called Kiso-Fukushima, making the public transport service vital for the other districts. However, the total number of users and revenue have been gradually decreasing between 2010 and 2014 (Fig. A 1), putting a heavy burden on the town for maintaining the service (an annual value of 10000 yen per resident of the town). As Fig. A 2 suggests, despite the increase in ridership in 2015, the sharp revenue decrease continued from 2013 through 2015.

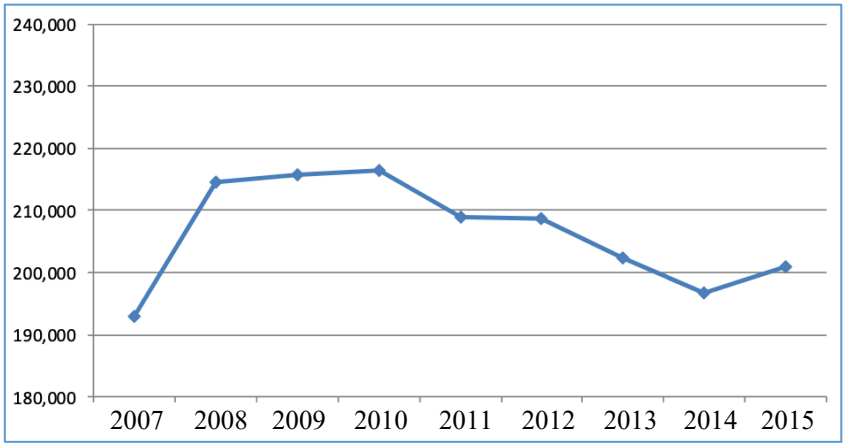

Figure A 1 Annual number of public transport users (Kiso town, 2017, pp. 38)

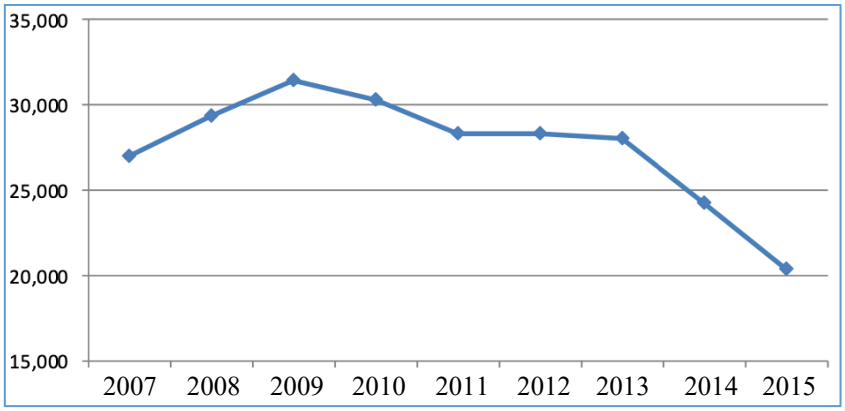

Figure A 2 Annual revenue of public transport in thousand yen (Kiso town, 2017, pp. 38)

The plan also highlights the importance of public transport for mobility-disadvantaged groups such as children and senior citizens who do not hold a driving license or are no longer capable of driving. The plan (Kiso town, 2017) intends to promote the use of public transport and make it profitable by:

- making a wide-area regional public transport system
- involving the residents in improving an efficient service and promoting the sense of autonomy
- raising awareness toward the benefits of public transport as a basic infrastructure supporting locals' daily lives that can also promote the tourism industry
- holding meetings among citizens to exchange opinions
- promoting campaigns, such as "no private car day" or "eco-community."
- cooperating with families and schools to decrease the number of school transfers in a private car
- providing more service on weekends
- reviewing the fare system

The report mentions one of the drawbacks of the current system: the lack of an evaluation verification mechanism that prevents the town office from accurate planning that can adapt itself to the changes.

Appendix B: Survey Materials (in Japanese)

B1: Children's Questionnaire (version used in Kiso[1])

（生徒のみなさん用）

おでかけに関する

アンケート

【実施主体】

名古屋大学大学院環境学研究科地域戦略研究室

[1] The only differences between case studies' questionnaire versions are in questions 2, 14, and 24

＜アンケートへのご協力のお願い＞

私は名古屋大学大学院環境学研究科後期博士課程に通うイラン人大学院生のカレギィ・マルジャンです。私は大学で、子どもの交通行動（「おでかけ」のこと）について研究をしています。

このアンケートは、「あなたがおでかけするとき、移動手段をどのような理由（*例えば、あなたの好み、学校やお家のルール、あなたの生活環境、地域の特徴など*）で選んでいるのか」を明らかにするために調査するものです。

もし、答えづらい質問があるときは、空欄でも構いません。

お答えいただいた内容は、あなたが答えたことがわからないように集計します。

集計と分析をした最終的な結果は、私の研究に使用するとともに、学校の先生と木曽町役場の人に結果のみ報告しますが、それ以外の目的では使用しません。

このアンケートにお答えいただいた内容は、名古屋大学の集計・分析担当者だけが見ます。あなたの家族や学校の先生など、他人に見せることはありません。

あなたの成績には全く関係しませんし、回答に正解もありません。

安心して、あなたの率直な意見をお聞かせください。

（カレギィ・マルジャン）

＜お問い合わせ＞

名古屋大学大学院環境学研究科地域戦略研究室

後期博士課程３年

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【1】あなたの家の「近所」についてお答えください。

ここでの「近所」とは「自宅から 10～15 分で徒歩または自転車で行ける範囲」のことです。

1. 近所の様子について、最もあてはまるものに**1つだけ**○をしてください。

近所の安全性	そう思う	少し思う	どちらでもない	あまり思わない	全く思わない
例. 近所の人たちは親切だ	○				
1. 近所の道路を走る車のスピードは遅い（時速 40 キロ以下）					
2. 近所の道路を走る車は、制限速度をオーバーしていると感じる					
3. 近所の道路には街灯があり、夜でも明るい					
4. 近所の道路には横断歩道と信号機がある					
5. 信号を無視する車がいる					
6. 近所の道路には急な坂道があり、特にカーブの周辺は見通しが悪くて危険だ					
7. 近所で野生動物（野良犬など）を見かける時がある					
8. 近所は犯罪発生件数が多い					
9. 不審者に出会うのが怖いので、子どもだけで徒歩や自転車でおでかけするのは不安だ					
徒歩・自転車の環境	そう思う	少し思う	どちらでもない	あまり思わない	全く思わない
例. 近所に自転車専用レーンがあります				○	
1. 近所のほとんどの道路には歩道がある					
2. 歩道は狭く危険だと感じる					
3. 近所の歩道が整備されておらず、歩きにくい・自転車で走りづらい					
4. 近所の道路には急な坂道がある、歩きにくい・自転車で走りづらい					

【2】新型コロナウイルス感染症が広がる前のことについてお答えください。

あてはまるものに１つだけ〇をつけてください。

2. コロナが広がる前、あなたは子どもだけで、**どこまで行くこと**が出来ましたか？

1. 家の近所（地区内）　2. 中学校区　3. 木曽町内全域　4. 木曽町外（伊那市など）

3. コロナが広がる前、子どもだけで、**公共交通機関**（バス・電車など）でおでかけしても良いと、**保護者の人は言ってくれましたか？**

1. はい、**昼も夜も**、どこへ行くときも、公共交通機関でおでかけして良いと言ってくれた
2. はい、**昼も夜も**、行っても良いと言われたところは、公共交通機関でおでかけして良いと言ってくれた
3. はい、**昼だけ**、どこへ行くときも、公共交通機関でおでかけして良いと言ってくれた
4. はい、**昼だけ**、行っても良いと言われたところは、公共交通機関でおでかけして良いと言ってくれた
5. いいえ、付き添いの大人がいないときは公共交通機関でおでかけできなかった

4. コロナが広がる前、子どもだけでの以下の**おでかけ**を、あなたの**保護者は許してくれましたか？**

項目	はい	いいえ
例. 幅の広い大きな道路を横断する	〇	
1. 徒歩圏内の、学校以外の場所に行く		
2. 暗くなってから外出する		
3. 車の通行量が多い、大きい道路を自転車で走る		
4. 町営バスの利用		

5. コロナが広がる前、それぞれの移動手段の良かったところ・悪かったところについて教えてください。
あなたの考えに一番近いものに、１つだけ○をしてください。

徒歩・自転車

コロナがなかったときの 徒歩・自転車の良かったところ	そう 思った	少し 思った	どちら でも なかった	あまり 思わ なかった	全く 思わ なかった
例. 自転車は遠くへ行くことができる	○				
1. 大人がいなくても、自由におでかけできる					
2. 自分で通りたい道順を決めることができる					
3. 友達と遊んだり話したりできる					
4. 運動になり、健康的になる					
5. ストレスを感じない					
6. 排気ガスを出さないから、地球環境にやさしい					
7. お金がかからない					
8. 徒歩のときは音楽を聴いたり、立ち止まって道端の草花や景色を楽しんだりすることができる					

コロナがなかったときの 徒歩・自転車の良かったところ	そう 思った	少し 思った	どちら でも なかった	あまり 思わ なかった	全く 思わ なかった
例. 道路がきちんと整備されていないと、自転車で走るのは危険だ		○			
1. 長距離だと疲れる					
2. 天気が悪い時、暑い時・寒い時は歩きたくない					
3. 天気が悪い時、暑い時、寒い時は自転車に乗りたくない					
4. 歩いて遠くへは行けない					
5. 歩きは時間がかかる					
6. 暗い夜道を、歩くのは危険だ					
7. 急な坂道があると、自転車で走るのは疲れる					
8. 急な坂道があると、自転車で走るのは危険だ					
9. 暗い夜道を、自転車で走るのは危険だ					

公共交通機関					
コロナがなかったときの 公共交通機関の良かったところ	そう 思った	少し 思った	どちら でも なかった	あまり 思わ なかった	全く 思わ なかった
例. みんなで乗るから、便利です	○				
1. 遠くへおでかけして、いろいろな施設に行ったりさまざまな経験をしたりすることができる					
2. 付き添いの大人なしで、公共交通機関を利用しておでかけすると、自分は自立したと感じられる					
3. 乗っている間、音楽を聴いたり、景色を楽しんだりすることができる					
4. 乗っている間、リラックスできる					
5. 友達とおしゃべりができる					
6. 天気が悪いときでも、安全に移動できる					
7. 自家用車に比べて１人あたりで排気ガスを出す量が少ないから、地球環境にやさしい					
8. バス停や駅まで、歩くとき・自転車に乗るとき、運動になり、健康的になる					
9. 車を運転できない高齢者のために必要だ					
10. 運転免許証を持っていない人のために必要だ					
コロナがなかったときの 公共交通機関の悪かったところ	そう 思った	少し 思った	どちら でも なかった	あまり 思わ なかった	全く 思わ なかった
例. 公共交通機関の使い方がわからない				○	
1. 時刻表の読み方、バス停や駅の場所を探すことが難しい					
2. バス停や駅まで行きづらい					
3. 保護者にバス停や駅までの送り迎え（送迎）を頼まなければいけない					
4. 運賃が高い					
5. 長い待ち時間が面倒だ					
6. 複数回停車し、遠回りだ。					
7. 付き添いの大人がいないと、間違えたり迷ったりしそうで不安だ					
8. 乗っている間に困ったとき、知らない人（運転手さんや駅員さん）に質問しなければならない					

コロナがなかったときの 公共交通機関の悪かったところ	そう 思った	少し 思った	どちら でも なかった	あまり 思わ なかった	全く 思わ なかった
9. 乗る前に、わからないことがあったら、大人（家族や学校の先生）に聞かないといけない					
10. 公共交通機関のすべてはわからない （例：バスのことはわかるが、電車や地下鉄のことはわからない・利用できない）					
自家用車					
コロナがなかったときの 自家用車の良かったところ	そう 思った	少し 思った	どちら でも なかった	あまり 思わ なかった	全く 思わ なかった
例. 車に乗るのはかっこいい		○			
1. おでかけしたいときは、ほぼ毎回、保護者や周りの大人が送迎してくれる					
2. 快適に移動できる					
3. 速く移動できる					
4. 友達を自分の家の車に乗せたり、友達の家の車に乗せてもらったりすることができる					
5. 乗っている間、音楽を聴いたり、景色を楽しんだりすることができる					
6. 自家用車を運転する保護者や周りの大人に任せればよいので、楽だ					
コロナがなかったときの 自家用車の悪かったところ	そう 思った	少し 思った	どちら でも なかった	あまり 思わ なかった	全く 思わ なかった
例. 自家用車で移動するときは、保護者や周りの大人の決定に従わなければならない		○			
1. 保護者や周りの大人がいなければ運転してもらえない					
2. 乗っている間、友達と話すことができない					
3. 自家用車で送迎してもらうことは、自分１人でおでかけすることの妨げになる					
4. 他の移動手段に比べて１人あたりで排気ガスを出す量が多いから、地球環境にやさしくない					
5. 自家用車の維持にはお金がかかる （定期点検・修理・保険など）					
6. 運動にはならないので、不健康だ					

6. **コロナが広がる前**、あなたの**保護者**は、仕事や買い物等のために、**どのくらいの回数で**以下の移動手段を使っていましたか？
それぞれの移動手段について、あてはまるもの（回数）に**１つだけ**○をしてください。

保護者が使っていた移動手段	ほぼ毎日	週に１回以上	月に１回以上	年に１回以上	全く使っていなかった
例. 徒歩・自転車				○	
1. 徒歩・自転車					
2. 公共交通機関					
3. 自家用車					

7. **コロナが広がる前**、あなたの**友達**は、**どのくらいの頻度で**以下の移動手段を使用していましたか？
それぞれの移動手段について、あてはまるもの（回数）に**１つだけ**○をしてください。

友達が使っていた移動手段	ほぼ毎日	週に１回以上	月に１回以上	年に１回以上	全く使っていなかった
例. 徒歩・自転車		○			
1. 徒歩・自転車					
2. 公共交通機関					
3. 自家用車					

【３】新型コロナウイルス感染症が広がる前、あなたの学校に行く以外のおでかけについてお答えください。あてはまるものに**１つだけ**○をつけてください。

8. **コロナが広がる前**、以下の**場合**、保護者に送迎を頼まずに、**徒歩**や**自転車**で**自分で移動できましたか？**

場合	問題なくできた	だいたいできた	できた時とできない時があった	あまりできなかった	全くできなかった
例. 天気が良いとき	○				
1. 天気が悪いとき					
2. 夕方、夜の暗い時間					
3. 疲れているとき					
4. 一緒に行く友達がいないとき					
5. 不慣れな町や場所に行くとき					
6. 遅刻しているとき					
7. 重いものを運ぶとき					

9. コロナが広がる前、以下の場合、保護者に送迎を頼まずに、公共交通機関で自分で移動できましたか？

場合	問題なくできた	だいたいできた	できた時とできない時があった	あまりできなかった	全くできなかった
例. 天気が良いとき		○			
1. 天気が悪いとき					
2. 夕方、夜の暗い時間					
3. 疲れているとき					
4. 一緒に行く友達がいないとき					
5. 不慣れな町や場所に行くとき					
6. 遅刻しているとき					
7. 重いものを運ぶとき					

10. コロナが広がる前、あなたが以下の移動手段を使うことを、保護者と友達はどのように思っていると、あなたは感じましたか？

保護者の場合、以下の移動手段を…	とても使ってほしいと思っているように感じた	時々使ってほしいと思っているように感じた	どちらでもないように感じた	あまり使ってほしくないように感じた	全く使ってほしくないように感じた
例. 徒歩・自転車				○	
1. 徒歩・自転車					
2. 公共交通機関					
3. 自家用車で送迎					
友達の場合、以下の移動手段を…	とても使ってほしいと思っているように感じた	時々使ってほしいと思っているように感じた	どちらでもないように感じた	あまり使ってほしくないように感じた	全く使ってほしくないように感じた
例. 徒歩・自転車		○			
1. 徒歩・自転車					
2. 公共交通機関					
3. 自家用車で送迎					

11. コロナが広がる前、あなたが以下の移動手段を使うことを、保護者と友達から、どれくらい勧められましたか？

保護者の場合、以下の移動手段を…	必ず勧められた	よく勧められた	時々勧められた	あまり勧められなかった	全く勧められなかった
例. 徒歩・自転車			○		
1. 徒歩・自転車					
2. 公共交通機関					
3. 自家用車で送迎					
友達の場合、以下の移動手段を…	必ず勧められた	よく勧められた	時々勧められた	あまり勧められなかった	全く勧められなかった
例. 徒歩・自転車		○			
1. 徒歩・自転車					
2. 公共交通機関					
3. 自家用車で送迎					

12. コロナが広がる前、あなたは保護者や友達と一緒に、以下の移動手段をどれくらい使いましたか？

保護者と一緒に	いつも使った	よく使った	たまに使った	あまり使わなかった	全く使わなかった
例. 徒歩・自転車			○		
1. 徒歩・自転車					
2. 公共交通機関					
3. 自家用車で送迎					
友達と一緒に	いつも使った	よく使った	たまに使った	あまり使わなかった	全く使わなかった
例. 徒歩・自転車	○				
1. 徒歩・自転車					
2. 公共交通機関					
3. 自家用車で送迎					

【4】新型コロナウイルス感染症が広がる前、あなたの気分や感情についてお答えください。

あてはまるものに1つだけ○をつけてください。

13. あなたは・・・	そう思った	少し思った	どちらでもなかった	あまり思わなかった	全く思わなかった
例. ○○○○に満足していた				○	
1. 自分自身に満足していた					
2. 学校生活に満足していた					
3. 友人関係に満足していた					
4. 家族関係に満足していた					
5. 住んでいる場所に満足していた					

【5】あなたご自身のことについて、お答えください。

あてはまるものに1つだけ○をつけてください。

答えづらい質問は、空欄でも構いません。

14. あなたが**住んでいる地区**はどこですか？

木曾福島　　日義　　三岳　　開田

15. 何歳ですか？

a. 12 歳　　b. 13 歳　　c. 14 歳　　d. 15 歳

16. 何年生ですか？

a. 1 年生　　b. 2 年生　　c. 3 年生

17. 卒業後の進路について、今のあなたの予定・考えにあてはまるものはどれですか？

1. 木曾**町外の高校**へ進学する予定だ・進学したいと思っている
2. 木曾**町内の高校**へ進学する予定だ・進学したいと思っている
3. 木曾**町外で就職**する予定だ・就職したいと思っている
4. 木曾**町内で就職**する予定だ・就職したいと思っている
5. わからない

18. あなたに、**お兄さん・お姉さん**はいますか？

1. はい　　2. いいえ

19. あなたの**お兄さん・お姉さん**は、**コロナが広がる前**、木曾**町外の学校・職場**に通っていましたか？

1. はい　　2. いいえ　　3．兄・姉はいない

20. あなたは自分の**自転車**を持っていますか？

1. はい　　2. いいえ

21. あなたは自分の**携帯電話・スマートフォン**を持っていますか？

1. はい　　2. いいえ

22. あなたは自分の携帯電話・スマートフォンで**インターネット**を利用しますか？

1. はい　　2. いいえ

23. あなたは自分の携帯電話・スマートフォンで**ナビ（乗換）アプリ**を使っていますか？

1. はい　　2. いいえ　　3.「ナビ（乗換）アプリ」がわからない

「はい」の場合 は、アプリの名前を記入してください。【回答欄】

24. バスや電車を使って、木曾町外におでかけしたことはありますか？

1. はい　　2. いいえ　　3. したいとは思っているが、まだしていない

25. バスや電車でおでかけするとき、**運賃**（バス代・電車代など）は**誰のお金で支払いますか**？

1. 保護者のお金で支払う（お小遣いとは別に渡してくれる）
2. 自分のお金（お小遣いなど）で支払う
3. バスや電車を使って、おでかけしたことはない

【6】意見や感想を自由に書いてください。

おでかけのこと、あなたが使う移動手段のことで気になること・気づいたことなど、自由に書いてください。

ご協力ありがとうございました。

B2: Caregivers' Questionnaire (version used in Kiso[2])

（保護者の皆様へ）

お子様のおでかけに関するアンケート

【実施主体】

名古屋大学大学院環境学研究科地域戦略研究室

[2] The only difference between case studies' questionnaire versions is in questions 1

＜アンケートへのご協力のお願い＞

私は名古屋大学大学院環境学研究科後期博士課程に通うイラン人大学院生のカレギィ・マルジャンと申します。私は大学で、子どもの交通行動（「おでかけ」のこと）について研究をしています。

この度、木曾中学校の先生方にご協力いただき、お子様の「おでかけ」に関するアンケート調査を行わせていただきます。

このアンケートは、「お子様がおでかけするときの移動手段をどのような理由で選んでいるのか」「お子様にとっておでかけは楽しいものか」「お子様の生活の満足度におでかけはどう影響を与えるのか」を、調査するものです。

もし、答えづらい質問があるときは、空欄でも構いません。

お答えいただいた内容は、個人が特定されないよう統計的に処理・集計し、その結果は「①私の研究」「②学校の先生方と木曾町役場の方への結果報告」のみに使用します。それ以外の目的では一切使用いたしません。

このアンケートにお答えいただいた内容は、名古屋大学の集計・分析担当者だけが拝見いたします。ご家族や学校の先生など、他人に見せることはありません。

ご多忙中のところ恐れ入りますが、主旨をご理解のうえ、本アンケート調査にご協力くださるようお願い申し上げます。

（カレギィ・マルジャン）

＜お問い合わせ＞

名古屋大学大学院環境学研究科地域戦略研究室

後期博士課程 3 年

カレギィ・マルジャン

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【1】新型コロナウイルス感染症が広がる前のことについてお答えください。

あてはまるものに１つだけ○をつけてください。

1. コロナが広がる前、お子様が保護者の付き添いなしで（子どもだけで）**おでかけすることを、どの範囲まで認めていましたか？**

1. 家の近所　　2. 中学区内　　3. 木曽町内全域
4. 木曽町外（伊那市など）

2. コロナが広がる前、お子様が保護者の付き添いなしで（子どもだけで）**公共交通機関を利用することを認めていましたか？**

1. **日中・夜間ともに**、行き先を問わず、公共交通機関の利用を認めていた。
2. **日中・夜間ともに**、行き先を制限して、公共交通機関の利用を認めていた。
3. **日中のみ**、行き先を問わず、公共交通機関の利用を認めていた。
4. **日中のみ**、行き先を制限して、公共交通機関の利用を認めていた。
5. 子どもだけで公共交通機関を利用することは、認めていなかった。

3. コロナが広がる前、お子様が保護者の付き添いなしで（子どもだけで）**おでかけすることを認めていましたか？**

各項目、あてはまるものに**１つだけ**○をしてください。

項目	認めていた	認めていなかった
例. 主要道路（大きい道路）を横断	○	
1. 通学以外の目的で、徒歩圏外へのおでかけ		
2. 日没後のおでかけ		
3. 車の通行量が多い道路を、自転車で走るおでかけ		
4. 町営バスを使ったおでかけ		

4. コロナが広がる前、あなたが普段の通勤で次の移動手段をどれくらいの頻度で利用していましたか？

※通勤していない方は、次の質問へお進みください。

あなたの通勤手段	ほぼ毎日	週に１回以上	月に１回以上	年に１回以上	全く使っていなかった
例. 徒歩					○
1. 徒歩					
2. 自転車					
3. 公共交通(バス・電車など)					
4. 自家用車					
5. その他(　　)					

5. コロナが広がる前、あなたが通勤以外の目的で次の移動手段をどれくらいの頻度で利用していましたか？

あなたのお仕事以外の移動手段	ほぼ毎日	週に１回以上	月に１回以上	年に１回以上	全く使っていなかった
例. 徒歩			○		
1. 徒歩					
2. 自転車					
3. 公共交通(バス・電車など)					
4. 自家用車					
5. その他 (　　)					

【2】新型コロナウイルス感染症が広がる前、お子様の通学以外のおでかけについ ていてお答えください。
あてはまるものに１つだけ○をつけてください。

6. コロナが広がる前、以下の状況で、お子様はあなたや周囲の大人に自家用車の送迎をお願いせず、徒歩や自転車によって自力で移動することができましたか？

状況	問題なくできた	だいたいできた	できた時とできない時があった	あまりできなかった	全くできなかった
例：天気が良いとき	○				
1. 天気が悪いとき					
2. 夕方、夜の暗い時間					
3. 疲れているとき					
4. 一緒に行く友人がいないとき					
5. 不慣れな町に行くとき					
6. 遅刻しているとき					
7. 重いものを運ぶとき					

7. コロナが広がる前、以下の状況で、お子様はあなたや周囲の大人に自家用車の送迎をお願いせず、公共交通機関によって自力で移動することができましたか？

状況	問題なくできた	だいたいできた	できた時とできない時があった	あまりできなかった	全くできなかった
例：天気が良いとき		○			
1. 天気が悪いとき					
2. 夕方、夜の暗い時間					
3. 疲れているとき					
4. 一緒に行く友人がいないとき					
5. 不慣れな町に行くとき					
6. 遅刻しているとき					
7. 重いものを運ぶとき					

8. コロナが広がる前、通学以外のおでかけで、**お子様が**以下の移動手段を使うことを、あなたはどれくらい**望んでいましたか**？

移動手段	とても使ってほしかった	時々使ってほしかった	どちらでもなかった	あまり使ってほしくなかった	全く使ってほしくなかった
例. 徒歩・自転車				○	
1. 徒歩・自転車					
2. 公共交通機関					
3. 自家用車で送迎					

9. コロナが広がる前、通学以外のおでかけで、**お子様が**以下の移動手段を使うことを、あなたはどれくらい**勧めましたか**？

移動手段	必ず勧めた	よく勧めた	時々勧めた	あまり勧めなかった	全く勧めなかった
例. 徒歩・自転車		○			
1. 徒歩・自転車					
2. 公共交通機関					
3. 自家用車で送迎					

10. コロナが広がる前、お子様は、**あなたや周囲の大人と一緒に**、以下の**移動手段**を**どれくらいの頻度で使いましたか**？

移動手段	いつも使った	よく使った	たまに使った	あまり使わなかった	全く使わなかった
例. 徒歩・自転車			○		
1. 徒歩・自転車					
2. 公共交通機関					
3. 自家用車で送迎					

【4】あなた自身とお子様のことについて、お伺いします。
あてはまるものに、1つだけ○をつけてください。
答えづらい質問は、空欄でも構いません。

11. あなたから見た、**お子様の性別**を教えてください。

1．男の子　　2．女の子　　3. 性別に拘らず、教育している

12. **お子様から**見た**あなたの続柄について**、あてはまるものをお答えください。

1．父　　2．母　　3．祖父母　　4．兄・姉　　5．親戚
6．その他（＿＿＿＿＿＿＿＿＿＿＿＿）

13. あなたの**年齢**をお聞かせください。

1. 30 歳未満　　2. 30-39 歳　　3. 40-49 歳　　4. 50-59 歳
5. 60 歳以上

14. **家族構成（同居している方）**をお聞かせください。

※答えづらい場合は、空欄でも構いません。

1．配偶者・子どもと同居　　2．子どもと同居
3．親・配偶者・子どもと同居　　4．親・子どもと同居
5．その他（＿＿＿＿＿＿＿＿＿＿＿＿）

15. あなた自身の**職業**について、お聞かせください。

※答えづらい場合は、空欄でも構いません。

1．フルタイム（会社員、公務員など）　　2．短時間労働（パートなど）
3．自営業　　4．家族従事者（家族が営む事業に従事）
5．学生　　6．専業主婦・主夫
7．無職　　8．その他（＿＿＿＿＿＿＿＿）

16. 「**主たる生計維持者の方の**」**職業**について、お聞かせください。

あなたが「**主たる生計維持者**」の場合は、次の質問へお進みください。

※「**主たる生計維持者**」とは、その世帯の生計を主に維持している方のことです。

※ 答えづらい場合は、空欄でも構いません。

1．フルタイム（会社員、公務員など）　　2．短時間労働（パートなど）
3．自営業　　4．家族従事者（家族が営む事業に従事）
5．学生　　6．専業主婦・主夫
7．無職　　8．その他（＿＿＿＿＿＿＿＿）

17. あなたは**運転免許**をお持ちですか?

1. 持っている　　2. 持っていない

18. ご家庭に**車**は**何台**ありますか?

1. 1 台　　2. 2 台　　3. 3 台以上　　4. 持っていない

19. お子様は何人**兄弟・姉妹**ですか？

1. 1 人　　2. 2 人　　3. 3 人　　4. 4 人以上

20. お子様が 1 人で公共交通機関を利用することを、**何歳頃から**認めていますか?

1. 10 歳未満　　2. 10 歳　　3. 11 歳　　4. 12 歳　　5. 13 歳
6. 13 歳より上の年齢　　7. 1 人で公共交通機関を利用することを認めていない

【5】ご意見やご感想をお書きください。

お子様のおでかけのこと、お子様が使う移動手段のことで気になること・気づいたことなど、自由に書いてください。

ご協力ありがとうございました。

B3: Travel Diary (version used in Kiso[3])

おでかけ日記

2020 年 9 月から 2020 年 10 月までの期間で、あなたの**通学以外のおでかけ**について、記入例を参考に「おでかけの記録」をつけてください。

おでかけの内容は、**よく行くおでかけ**や**思い出に残っているおでかけ**など から、４種類以上の異なるおでかけについて記入してください。

そのうち、豊山町内でのおでかけで２種類以上、豊山町外へのおでかけで２種類以上、それぞれ記入してください。

また、子どもだけのおでかけ（１人または友だちと一緒）と、大人と一緒のおでかけの、両方のおでかけについて教えてください。

可能ならば、移動手段を使っている間のあなたの気分や感情も思い出して教えてください。忘れてしまっている場合は空欄で構いません。

「おでかけの目的」には、以下のようなものが例としてあげられます。
思い出すときの参考にしてください。

- 休日の学校の部活動
- 塾などの、学校外での勉強
- スポーツクラブやピアノ教室などの、習い事・クラブ活動
- 映画を見に行く、美術館に行くなどの文化・芸術活動
- 友達と遊ぶ、買い物をする、祖父母や親せきの家に行くなどの、レジャー・レクリエーション活動
- その他、何でも構いません

あなたが答えてくれた内容は、あなたが答えたことが特定されないように統計的に処理・集計し、私の研究のみに使用します。後で誰かに知られることはありません。

ご協力ありがとうございます。

[3] The only difference between case studies' travel diary versions is in the timeframe of data collection and the samples

記入例

		番号	出発地（名前）	出発地の地区名や都市名	目的地（名前）	目的地の地区名や都市名	何時頃に出発しましたか？（「午前」や「夕方」など、だいたいでも構いません）	おでかけの目的	使った移動手段は？ あてはまるものすべてに〇をしてください					一緒に行った人はいますか？ あてはまるものすべてに〇をしてください				移動手段を使っている間のあなたの気分や感情にあてはまるものはどれでしたか？ あてはまるものに〇をしてください。（使った移動手段が複数ある場合は、〇の下に移動手段の名前を書いてください）				
									歩き	自転車	バス	列車	車	家族/友達の両親	友達	いなかった	その他	とても良かった	良かった	ふつうだった	悪かった	とても悪かった
平日		1	自宅	（　町内　）	福島関所	（　町内　）	午前	遊びに行く	〇		〇				〇			⑤ 歩き	④ バス	3	2	1
休日	〇																					
平日	〇	2	木曽町中学校	（　町内　）	菓子田ぐち	（　町内　）	午後	遊びに行く		〇					〇			⑤	4	3	2	1
休日																						
平日	〇	3	木曽町中学校	（　町内　）	図書館	（　町内　）	午後 4 時	本を読む	〇							〇		5	④	3	2	1
休日																						
平日	〇	4	自宅	（　町内　）	ラーメン５５	（　町内　）	午後	食事する		〇					〇			⑤	4	3	2	1
休日																						
平日		5	友達の家	（　町内　）	イオン	（　町内　）	午前 10:30	買い物に行く					〇		〇			⑤	4	3	2	1
休日	〇																					
平日		6	自宅	（　町内　）	祖母の家	（上松町）	午前	遊びに行く	〇		〇	〇		〇	〇			列車.バス 5	④	歩き ③	2	1
休日	〇																					
平日		7	自宅	（　町内　）	木曽町中学校	（　町内　）	午前	クラブ活動			〇				〇			5	④	3	2	1
休日	〇																					
平日		8	自宅	（　町内　）	個別教室のトライ 伊那市駅前校	（　那市　）	午前	塾					〇				〇	5	4	③	2	1
休日	〇																					

		番号	出発地（名前）	出発地の地区名や都市名	目的地（名前）	目的地の地区名や都市名	何時頃に出発しましたか？（「午前」や「夕方」など、だいたいでも構いません）	おでかけの目的	使った移動手段は？ あてはまるもの すべてに〇をしてください					一緒に行った人はいますか？ あてはまるもの すべてに〇を してください				移動手段を使っている間のあなたの気分や感情にあてはまるものはどれでしたか？ あてはまるものに〇をしてください。(使った移動手段が複数ある場合は、〇の下に移動手段の名前を書いてください)				
									歩き	自転車	バス	列車	車	家族/友達の両親	友達	いなかった	その他	とても良かった	良かった	ふつうだった	悪かった	とても悪かった
平日				(　　)		(　　)												5	4	3	2	1
休日																						
平日				(　　)		(　　)												5	4	3	2	1
休日																						
平日				(　　)		(　　)												5	4	3	2	1
休日																						
平日				(　　)		(　　)												5	4	3	2	1
休日																						
平日				(　　)		(　　)												5	4	3	2	1
休日																						
平日				(　　)		(　　)												5	4	3	2	1
休日																						
平日				(　　)		(　　)												5	4	3	2	1
休日																						
平日				(　　)		(　　)												5	4	3	2	1
休日																						

B4: Sample of the Survey Manual for Children and Caregivers

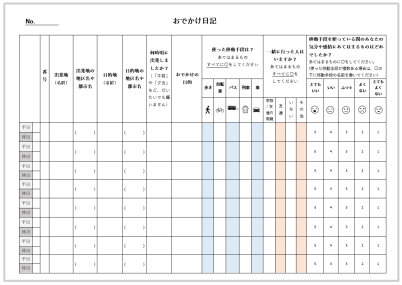
アンケート調査についてのご説明

はじめに・本アンケート調査の目的

このアンケート調査は、名古屋大学大学院環境学研究科後期博士課程３年カレギィ・マルジャンの博士論文研究「子どもの交通行動に関する研究」の一環として、木曽町中学校のご協力を得て行うものです。本調査では、**「子どもがおでかけするとき、移動手段をどのような理由で選んでいるのか**（例えば、子ども自身の好き嫌い、学校や家庭内のルール、生活環境、地域の特徴など）」を明らかにすることを目的としております。ご多忙中のところ恐れ入りますが、主旨をご理解のうえ、本アンケート調査にご協力くださるようお願い申し上げます。

配布物（封筒の中身について）

おでかけアンケート（生徒用）
A4 冊子×1（12 ページ）



おでかけ日記（生徒用）
A4 説明用紙×1、A3 記入例×1
A3 記入シート×1

お子様のおでかけに関する アンケート（保護者用）
A4 冊子×1（7 ページ）

※この他に、ご案内のかがみ文を同封しております

アンケート調査へのご回答について

① 「おでかけに関するアンケート（生徒用）」と「おでかけ日記」は**生徒の方が**お答えください。
② 「お子様のおでかけに関するアンケート」は**保護者の方が**お答えください。
③ **答えづらい質問があるときは、空欄にしていただいて構いません。**可能な範囲でお答えください。
④ お答えいただいた内容は、**誰が回答したかわからないよう**に集計します。
⑤ アンケートが入っている**封筒は提出時に使用します**。紛失にご注意ください。

アンケートのご提出について

◆ **お答えいただいたアンケート用紙を封筒に入れ、密封してからクラス担任の先生にご提出ください。**

先生に提出する日：２０２〇年〇〇月〇〇日（〇）まで

お問い合わせ先

名古屋大学大学院環境学研究科地域戦略研究室後期博士課程 3 年
カレギィ・マルジャン
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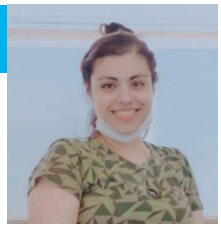


B5: Sample of the Survey Manual for Teachers

＜先生方へ＞ アンケート調査についてのご説明

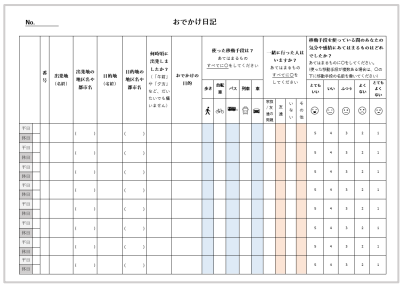
はじめに・本アンケート調査の目的

このアンケート調査は、名古屋大学大学院環境学研究科後期博士課程３年カレギィ・マルジャンの博士論文研究「子どもの交通行動に関する研究」の一環として行うものです。

本調査では、「子どもがおでかけするとき、移動手段をどのような理由で選んでいるのか（例えば、子ども自身の好き嫌い、学校や家庭内のルール、生活環境、地域の特徴など）」を明らかにすることを目的としております。

配布物（封筒の中身について）

おでかけアンケート（生徒用）
A4 冊子×1（12 ページ）



おでかけ日記（生徒用）
A4 説明用紙×1、A3 記入例×1
A3 記入シート×1

お子様のおでかけに関するアンケート（保護者用）
A4 冊子×1（7 ページ）

※この他に、ご案内のかがみ文を同封しております

配布時に、生徒さんへご説明いただきたいこと

① 本調査についての簡単な紹介（「はじめに・本アンケート調査の目的」をご参照ください）
② 封筒の中身の確認（不足時には予備をお渡しください）
③ 新型コロナウイルス感染拡大前（20〇〇年〇月～〇月）のことを思い出して、回答してください
④ 答えづらい質問があるときは、空欄でも構いません
⑤ 答えた内容は、誰が回答したかわからないように集計するので、素直な意見を書いてください
⑥ 3 種類のアンケートに答え終わったら、すべて封筒に入れて、テープで封して先生に提出します

回収方法と回収日

3 種類のアンケート調査用紙を返信用封筒に入れ、テープで封されたものを回収してください

先生に提出する日：２０２〇年〇〇月〇〇日（〇）まで

お問い合わせ先

名古屋大学大学院環境学研究科地域戦略研究室後期博士課程 3 年
カレギィ・マルジャン
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Appendix C: Complete Choice Model Results of Toyoyama

Table C 1 The estimated results (logit values) of the choice model in Toyoyama town (insignificant estimates are highlighted in grey)

Conditional logit choice model (Toyoyama)				No. of observations		2316	
Wald chi^2 (40)		116.84		No. of cases		772	
Log-likelihood	-628.34	Prob>chi^2	0.00	Alternatives per case		3	
Variables		**Coefficient**	**std. err.**	**z**	**P>|z|**	**[95% conf. interval]**	
Alternative-specific variables							
Psychological							
Perceived barriers		-.03	.08	-0.42	0.676	-.20	.13
Perceived Benefits		.21	.12	1.73	0.083	-.03	.44
Social Modeling of caregivers (students)		.13	.05	2.52	0.012	.03	.23
Social Norm from caregivers (caregivers)		.18	.07	2.44	0.015	.03	.32
Case-specific variables							
Public Transport (PT) estimates (base alternative: CAR)							
Psychological							
Self-Efficacy "WC over CAR" (students)		.15	.18	0.82	0.410	-.20	.50
Self-Efficacy "PT over CAR" (caregivers)		.34	.12	2.88	0.004	.11	.57
Independent Mobility (IM)							
IM license (base: not allowed to do) (caregivers)							
2: Allowed to go out after dark		-1.23	.54	-2.27	0.023	-2.29	-.16
3: Allowed to cycle on main roads		.94	.45	2.10	0.036	.06	1.81
IM license (base: not allowed to do) (students)							
1: Allowed to travel to places other than school within walking distance		-.63	.47	-1.35	0.177	-1.55	.28
Socio-demographic							
Female (base: male)		.56	.34	1.62	0.104	-.12	1.24
Having elder siblings (base: not having)		.00	.36	0.00	0.996	-.71	.71
Living district (base: Shimizu elementary school district)							
Toyoyama elementary school		1.12	.41	2.71	0.007	.31	1.93
Shinei elementary school		.21	.47	0.45	0.652	-.71	1.14
Caregivers' age (base: over 50)							
Less than 40		-.90	.62	-1.47	0.142	-2.11	.30
40-50		-1.53	.51	-3.00	0.003	-2.53	-.53
Household construct (base: single parent and children)							
Parents and children		-.21	.68	-0.30	0.761	-1.55	1.13
Parents, grandparent/s, children		-1.42	1.06	-1.34	0.180	-3.50	.66
Single parent, grandparent/s, children		-1.28	1.02	-1.25	0.213	-3.30	.73
Number of cars/household (base: one)							
Two		-.13	.38	-0.35	0.724	-.89	.62
Three or more		1.43	.68	2.08	0.037	.08	2.77
Number of children/household (base: one)							
Two		1.43	.58	2.47	0.013	.29	2.56
Three or more		.50	.66	0.76	0.449	-.79	1.78
cons		-3.20	1.37	-2.34	0.019	-5.89	-.52

Variables	Coefficient	std. err.	z	P>|z|	[95% conf. interval]	
Walking/Cycling (WC) estimates (base alternative: CAR)						
Psychological						
Self-Efficacy "WC over CAR" (students)	.19	.09	2.10	0.036	.012	.36
Self-Efficacy "PT over CAR" (caregivers)	.23	.06	3.50	0.000	.10	.36
Independent Mobility (IM)						
IM license (base: not allowed to do) (caregivers)						
2: Allowed to go out after dark	.10	.23	0.42	0.675	-.35	.55
3: Allowed to cycle on main roads	-.23	.19	-1.20	0.229	-.61	.14
IM license (base: not allowed to do) (students)						
1: Allowed to travel to places other than school within walking distance	.27	.28	0.98	0.327	-.27	.81
Socio-demographic						
Female (base: male)	-.59	.17	-3.35	0.001	-.93	-.24
Having elder siblings (base: not having)	.21	.19	1.12	0.261	-.16	.59
Living district (base: Shimizu elementary school district)						
Toyoyama elementary school	.46	.21	2.20	0.028	.05	.87
Shinei elementary school	.32	.22	1.46	0.144	-.11	.77
Caregivers' age (base: over 50)						
Less than 40	-.18	.41	-0.43	0.669	-.99	.64
40-50	-.26	.37	-0.69	0.492	-.98	.47
Household construct (base: single parent and children)						
Parents and children	-.55	.34	-1.60	0.109	-1.22	.12
Parents, grandparent/s, children	-.65	.51	-1.27	0.205	-1.66	.36
Single parent, grandparent/s, children	-1.05	.54	-1.96	0.050	-2.11	.00
Number of cars/household (base: one)						
Two	.20	.22	0.91	0.362	-.23	.64
Three or more	.94	.40	2.34	0.019	.15	1.73
Number of children/household (base: one)						
Two	.70	.28	2.54	0.011	.16	1.24
Three or more	.47	.31	1.52	0.128	-.13	1.08
cons	-1.30	.68	-1.92	0.055	-2.62	.03

Only the variables with a significant relationship trend ($p<0.10$) in the preliminary steps were used in making this final model.
For those variables reported by both students and their caregivers, the respondent is mentioned in parenthesis.

Table C 2 The estimated results (exponentiated coefficients) of the choice model in Toyoyama town (insignificant estimates are highlighted in grey)

Conditional logit choice model (Toyoyama)			No. of observations		2316	
Wald chi^2 (40)	116.84		No. of cases		772	
Log-likelihood -628.34	Prob>chi^2	0.00	Alternatives per case		3	
Variables	**Odds ratio**	**std. err.**	**z**	**P>|z|**	**[95% conf. interval]**	
Alternative-specific variables						
Psychological						
Perceived barriers	.96	.08	-0.42	0.676	.82	1.14
Perceived Benefits	1.23	.15	1.73	0.083	.97	1.56
Social Modeling of caregivers (students)	1.14	.06	2.52	0.012	1.03	1.26
Social Norm from caregivers (caregivers)	1.20	.09	2.44	0.015	1.03	1.38
Variables	**Relative risk ratio**	**Std. err.**	**z**	**P>|z|**	**[95% conf. interval]**	
Case-specific variables						
Public Transport (PT) estimates (base alternative: CAR)						
Psychological						
Self-Efficacy "WC over CAR" (students)	1.16	.21	0.82	0.410	.81	1.65
Self-Efficacy "PT over CAR" (caregivers)	1.41	.17	2.88	0.004	1.11	1.77
Independent Mobility (IM)						
IM license (base: not allowed to do) (caregivers)						
2: Allowed to go out after dark	.29	.16	-2.27	0.023	.10	.85
3: Allowed to cycle on main roads	2.56	1.15	2.10	0.036	1.06	6.16
IM license (base: not allowed to do) (students)						
1: Allowed to travel to places other than school within walking distance	.53	.25	-1.35	0.177	.21	1.33
Socio-demographic						
Female (base: male)	1.75	.60	1.62	0.104	.89	3.45
Having older siblings (base: not having)	1.00	.36	0.00	0.996	.49	2.04
Living district (base: Shimizu elementary school district)						
Toyoyama elementary school	3.07	1.27	2.71	0.007	1.36	6.89
Shinei elementary school	1.24	.58	0.45	0.652	.49	3.11
Caregivers' age (base: over 50)						
Less than 40	.40	.25	-1.47	0.142	.12	1.35
40-50	.22	.11	-3.00	0.003	.08	.59
Household construct (base: single parent and children)						
Parents and children	.81	.55	-0.30	0.761	.21	3.10
Parents, grandparent/s, children	.24	.25	-1.34	0.180	.03	1.93
Single parent, grandparent/s, children	.28	.28	-1.25	0.213	.04	2.08
Number of cars/household (base: one)						
Two	.87	.33	-0.35	0.724	.41	1.85
Three or more	4.17	2.86	2.08	0.037	1.09	15.98
Number of children/household (base: one)						
Two	4.17	2.41	2.47	0.013	1.34	12.96
Three or more	4.17	2.41	2.47	0.013	1.34	12.96
cons	.04	.05	-2.34	0.019	.00	.59

Variables	Relative risk ratio	Std. err.	z	P>|z|	[95% conf. interval]	
Walking/Cycling (WC) estimates (base alternative: CAR)						
Psychological						
Self-Efficacy "WC over CAR" (students)	1.20	.11	2.10	0.036	1.01	1.43
Self-Efficacy "PT over CAR" (caregivers)	1.26	.08	3.50	0.000	1.10	1.43
Independent Mobility (IM)						
IM license (base: not allowed to do) (caregivers)						
2: Allowed to go out after dark	1.10	.25	0.42	0.675	.70	1.73
3: Allowed to cycle on main roads	.79	.15	-1.20	0.229	.54	1.16
IM license (base: not allowed to do) (students)						
1: Allowed to travel to places other than school within walking distance	1.31	.36	0.98	0.327	.76	2.25
Socio-demographic						
Female (base: male)	.55	.10	-3.35	0.001	.39	.78
Having older siblings (base: not having)	1.24	.24	1.12	0.261	.85	1.80
Living district (base: Shimizu elementary school district)						
Toyoyama elementary school	1.58	.33	2.20	0.028	1.05	2.38
Shinei elementary school	1.39	.31	1.46	0.144	.89	2.15
Caregivers' age (base: over 50)						
Less than 40	.84	.35	-0.43	0.669	.37	1.89
40-50	.77	.29	-0.69	0.492	.37	1.60
Household construct (base: single parent and children)						
Parents and children	.58	.20	-1.60	0.109	.29	1.13
Parents, grandparent/s, children	.52	.27	-1.27	0.205	.19	1.43
Single parent, grandparent/s, children	.35	.19	-1.96	0.050	.12	1.00
Number of cars/household (base: one)						
Two	1.22	.27	0.91	0.362	.79	1.89
Three or more	2.57	1.04	2.34	0.019	1.16	5.69
Number of children/household (base: one)						
Two	2.02	.56	2.54	0.011	1.17	3.47
Three or more	1.61	.50	1.52	0.128	.87	2.96
cons	.27	.18	-1.92	0.055	.07	1.03

Note: '_cons' estimates baseline relative risk for each outcome.

Table C 3 The estimated Average Marginal Effects (AME) for the choice model in Toyoyama town (insignificant estimates are highlighted in grey)

Variables	dy/dx	std. err.	z	P>|z|	[95% conf.	interval]
Alternative-specific variables						
Psychological						
Perceived barriers *outcome#alt*						
CAR#CAR	-.01	.02	-0.42	0.676	-.04	.03
CAR#PT	.00	.00	0.42	0.677	-.00	.01
CAR#WC	.01	.01	0.42	0.676	-.02	.04
PT#CAR	.00	.00	0.42	0.677	-.00	.01
PT#PT	-.00	.00	-0.42	0.677	-.01	.01
PT#WC	.00	.00	0.42	0.677	-.00	.01
WC#CAR	.01	.01	0.42	0.676	-.02	.04
WC#PT	.00	.00	0.42	0.677	-.00	.01
WC#WC	-.01	.02	-0.42	0.676	-.045	.03
Perceived Benefits *outcome#alt*						
CAR#CAR	.04	.03	1.74	0.081	-.00	.10
CAR#PT	-.01	.00	-1.70	0.089	-.01	.00
CAR#WC	-.04	.02	-1.74	0.081	-.08	.00
PT#CAR	-.01	.00	-1.70	0.089	-.01	.00
PT#PT	.01	.01	1.71	0.088	-.00	.03
PT#WC	-.01	.00	-1.70	0.090	-.01	.00
WC#CAR	-.04	.02	-1.74	0.081	-.08	.00
WC#PT	-.01	.00	-1.70	0.090	-.01	.00
WC#WC	.05	.03	1.74	0.081	-.00	.01
Social Modeling of caregivers (students) *outcome#alt*						
CAR#CAR	.03	.01	2.54	0.011	.01	.05
CAR#PT	-.00	.00	-2.40	0.016	-.01	-.00
CAR#WC	-.02	.01	-2.54	0.011	-.04	-.00
PT#CAR	-.00	.00	-2.40	0.016	-.01	-.00
PT#PT	.01	.00	2.44	0.015	.00	.01
PT#WC	-.00	.00	-2.43	0.015	-.01	-.00
WC#CAR	-.02	.01	-2.54	0.011	-.04	-.00
WC#PT	-.00	.00	-2.43	0.015	-.01	-.00
WC#WC	.03	.01	2.55	0.011	.01	.05
Social Norm from caregivers (caregivers) *outcome#alt*						
CAR#CAR	.04	.02	2.47	0.014	.01	.07
CAR#PT	-.00	.00	-2.35	0.019	-.01	-.00
CAR#WC	-.03	.01	-2.47	0.014	-.06	-.01
PT#CAR	-.00	.00	-2.35	0.019	-.01	-.00
PT#PT	.01	.00	2.36	0.018	.00	.02
PT#WC	-.00	.00	-2.34	0.019	-.01	-.00
WC#CAR	-.03	.01	-2.47	0.014	-.06	-.01
WC#PT	-.00	.00	-2.34	0.019	-.01	-.00
WC#WC	.04	.01	2.46	0.014	.01	.07
Case-specific variables						
Psychological						
Self-Efficacy "WC over CAR" (students) _ outcome						
CAR	-.04	.02	-2.13	0.033	-.08	-.00
PT	.00	.01	0.32	0.753	-.02	.02
WC	.04	.02	1.94	0.052	-.00	.07
Self-Efficacy "PT over CAR" (caregivers) _ outcome						
CAR	-.05	.01	-3.99	0.000	-.08	-.03
PT	.01	.01	2.03	0.042	00	.03
WC	.04	.01	2.97	0.003	.01	.07

Variables	dy/dx	std. err.	z	P>|z|	[95% conf. interval]	
Independent Mobility (IM)						
IM license (base: not allowed to do) (caregivers)						
2: Allowed to go out after dark _outcome						
CAR	.01	.05	0.16	0.872	-.09	.10
PT	-.06	.02	-3.39	0.001	-.09	-.02
WC	.05	.05	1.01	0.310	-.05	.15
3: Allowed to cycle on main roads _outcome						
CAR	.02	.04	0.54	0.592	-.06	.10
PT	.05	.02	3.05	0.002	.02	.09
WC	-.08	.04	-1.84	0.065	-.16	.00
IM license (base: not allowed to do) (students)						
1: Allowed to travel to places other than school within walking distance _outcome						
CAR	-.02	.06	-0.39	0.693	-.14	.09
PT	-.06	.04	-1.41	0.157	-.14	.02
WC	.08	.06	1.47	0.142	-.03	.19
Socio-demographic						
Female (base: male) _outcome						
CAR	.10	.04	2.63	0.009	.02	.17
PT	.05	.02	2.73	0.006	.01	.09
WC	-.15	.04	-3.99	0.000	-.22	-.08
Having elder siblings (base: not having) _outcome						
CAR	-.04	.04	-1.00	0.317	-.12	.04
PT	-.01	.02	-0.31	0.759	-.05	.03
WC	.05	.04	1.17	0.243	-.03	.13
Living district (base: Shimizu elementary school district)						
Toyoyama elementary school _outcome						
CAR	-.12	.04	-2.82	0.005	-.21	-.04
PT	.06	.03	2.28	0.023	.01	.11
WC	.06	.04	1.46	0.144	-.02	.15
Shinei elementary school _outcome						
CAR	-.07	.05	-1.45	0.146	-.16	.02
PT	.00	.02	0.12	0.904	-.04	.04
WC	.07	.05	1.40	0.160	-.03	.16
Caregivers' age (base: over 50)						
Less than 40 _outcome						
CAR	.07	.08	0.89	0.371	-.09	.24
PT	-.08	.06	-1.33	0.184	-.21	.04
WC	.01	.08	0.13	0.897	-.15	.18
40-50 _outcome						
CAR	.11	.07	1.49	0.135	-.03	.25
PT	-.12	.06	-2.21	0.027	-.23	-.01
WC	.01	.07	0.19	0.846	-.13	.16
Household construct (base: single parent and children)						
Parents and children _outcome						
CAR	.11	.07	1.57	0.117	-.03	.24
PT	.01	.04	0.16	0.870	-.08	.09
WC	-.11	.07	-1.56	0.119	-.26	.03
Parents, grandparent/s, children _outcome						
CAR	.16	.10	1.47	0.141	-.05	.36
PT	-.05	.05	-0.96	0.336	-.15	.05
WC	-.11	.11	-0.98	0.328	-.32	.11
Single parent, grandparent/s, children _outcome						
CAR	.23	.11	2.16	0.031	.02	.45
PT	-.04	.05	-0.73	0.465	-.14	.06
WC	-.20	.11	-1.78	0.075	-.41	.02

Variables	dy/dx	std. err.	z	P>|z|	[95% conf. interval]	
Number of cars/household (base: one)						
Two _outcome						
CAR	-.03	.05	-0.74	0.460	-.13	.06
PT	-.01	.02	-0.61	0.539	-.06	.03
WC	.05	.05	1.03	0.302	-.04	.14
Three or more _outcome						
CAR	-.22	.07	-2.91	0.004	-.37	-.07
PT	.08	.07	1.17	0.243	-.05	.21
WC	.14	.08	1.63	0.102	-.03	.31
Number of children/household (base: one)						
Two _outcome						
CAR	-.18	.06	-3.09	0.002	-.29	-.06
PT	.06	.02	2.57	0.010	.01	.11
WC	.12	.06	2.05	0.041	.00	.23
Three or more _outcome						
CAR	-.10	.06	-1.61	0.108	-.23	.02
PT	.01	.02	0.47	0.639	-.03	.06
WC	.09	.06	1.45	0.147	-.03	.22

Note: dy/dx for factor levels is the discrete change from the base level.

Appendix D: Complete Choice Model Results of Minamiise

Table D 1 The estimated results (logit values) of the choice model in Minamiise town (insignificant estimates are highlighted in grey)

Conditional logit choice model (Minamiise)				No. of observations		1827	
Wald chi^2 (40)		84.17		No. of cases		609	
Log-likelihood	-467.18	Prob>chi^2	0.00	Alternatives per case		3	
Variables		**Coefficient**	**std. err.**	**z**	**P>|z|**	**[95% conf. interval]**	
Alternative-specific variables							
Psychological							
Social Support		.60	.13	4.64	0.000	.34	.85
Social Modeling of friends (students)		.15	.08	1.89	0.058	.00	.30
Social Norm from friends (students)		-.22	.12	-1.76	0.078	-.46	.02
Case-specific variables							
Public Transport (PT) estimates (base alternative: CAR)							
Environmental							
Neighborhood Safety		-.27	.26	-1.06	0.289	-.78	.23
Walking/Cycling Environment		.19	.16	1.22	0.223	-.12	.50
Psychological							
Self-Efficacy "PT over CAR" (caregivers)		.11	.10	1.10	0.270	-.09	.32
Independent Mobility (IM)							
IM license (base: not allowed to do) (students)							
3: Allowed to cycle on main roads		-.65	.29	-2.22	0.027	-1.23	-.07
IM Farthest Distance (base: home neighborhood) (students)							
School neighborhood		.02	.47	0.03	0.972	-.91	.94
Inside the town		.37	.49	0.77	0.442	-.58	1.33
Out of town		.94	.50	1.88	0.060	-.04	1.92
Socio-demographic							
Living district (base: Nansei)		.06	.28	0.21	0.830	-.49	.61
Grade (base: third grade)							
First grade		-.80	.36	-2.25	0.025	-1.50	-.10
Second grade		-.51	.32	-1.59	0.112	-1.14	.12
Number of children/household (base: one)							
Two		.21	.47	0.45	0.656	-.71	1.12
Three or more		.31	.44	0.70	0.486	-.56	1.18
cons		-.67	.89	-0.75	0.451	-2.41	1.07
Walking/Cycling (WC) estimates (base alternative: CAR)							
Environmental							
Neighborhood Safety		.48	.19	2.55	0.011	.11	.85
Walking/Cycling Environment		-.24	.16	-1.50	0.133	-.55	.07
Psychological							
Self-Efficacy "PT over CAR" (caregivers)		-.06	.09	-0.65	0.519	-.25	.12
Independent Mobility (IM)							
IM license (base: not allowed to do) (students)							
3: Allowed to cycle on main roads		.33	.28	1.18	0.238	-.22	.87
IM Farthest Distance (base: home neighborhood) (students)							
School neighborhood		.06	.37	0.16	0.871	-.66	.78

Variables	Coefficient	std. err.	z	P>|z|	[95% conf. interval]	
Inside the town	-.12	.38	-0.32	0.746	-.86	.62
Out of town	.15	.44	0.34	0.732	-.72	1.02
Socio-demographic						
Living district (base: Nansei)	-.10	.24	-0.40	0.691	-.58	.38
Grade (base: third grade)						
First grade	.50	.35	1.42	0.155	-.19	1.19
Second grade	.72	.33	2.14	0.032	.06	1.37
Number of children/household (base: one)						
Two	.42	.41	1.03	0.304	-.38	1.22
Three or more	.33	.41	0.82	0.414	-.46	1.13
_cons	-2.79	.76	-3.68	0.000	-4.28	-1.30

Only the variables with a significant relationship trend ($p<0.10$) in the preliminary steps were used in making this final model.
For those variables reported by both students and their caregivers, the respondent is mentioned in parenthesis.

Table D 2 The estimated results (exponentiated coefficients) of the choice model in Minamiise town (insignificant estimates are highlighted in grey)

Conditional logit choice model (Minamiise)			No. of observations		1827	
Wald chi^2 (40)	84.17		No. of cases		609	
Log-likelihood -467.18	Prob>chi^2	0.00	Alternatives per case		3	
Variables	**Odds ratio**	**std. err.**	**z**	**P>|z|**	**[95% conf. interval]**	
Alternative-specific variables						
Psychological						
Social Support	1.82	.23	4.64	0.000	1.41	2.34
Social Modeling of friends (students)	1.16	.09	1.89	0.058	.99	1.36
Social Norm from friends (students)	.80	.10	-1.76	0.078	.63	1.02
Variables	**Relative risk ratio**	**Std. err.**	**z**	**P>|z|**	**[95% conf. interval]**	
Case-specific variables						
Public Transport (PT) estimates (base alternative: CAR)						
Environmental						
Neighborhood Safety	.76	.19	-1.06	0.289	.46	1.26
Walking/Cycling Environment	1.21	.19	1.22	0.223	.89	1.65
Psychological						
Self-Efficacy "PT over CAR" (caregivers)	1.12	.12	1.10	0.270	.91	1.37
Independent Mobility (IM)						
IM license (base: not allowed to do) (students)						
3: Allowed to cycle on main roads	.52	.15	-2.22	0.027	.29	.93
IM Farthest Distance (base: home neighborhood) (students)						
School neighborhood	1.02	.48	0.03	0.972	.40	2.56
Inside the town	1.45	.71	0.77	0.442	.56	3.79
Out of town	2.57	1.29	1.88	0.060	.96	6.86
Socio-demographic						
Living district (base: Nansei district)	1.06	.30	0.21	0.830	.61	1.83
Grade (base: third grade)						
First grade	.45	.16	-2.25	0.025	.22	.90
Second grade	.60	.19	-1.59	0.112	.32	1.13
Number of children/household (base: one)						
Two	1.23	.57	0.45	0.656	.49	3.08
Three or more	1.36	.61	0.70	0.486	.57	3.27
cons	.51	.45	-0.75	0.451	.09	2.92
Walking/Cycling (WC) estimates (base alternative: CAR)						
Environmental						
Neighborhood Safety	1.62	.31	2.55	0.011	1.12	2.35
Walking/Cycling Environment	.79	.12	-1.50	0.133	.58	1.07
Psychological						
Self-Efficacy "PT over CAR" (caregivers)	.94	.09	-0.65	0.519	.78	1.13
Independent Mobility (IM)						
IM license (base: not allowed to do) (students)						
3: Allowed to cycle on main roads	1.39	.39	1.18	0.238	.80	2.39
IM Farthest Distance (base: home neighborhood) (students)						

Variables	Relative risk ratio	Std. err.	z	P>|z|	[95% conf. interval]	
School neighborhood	1.06	.39	0.16	0.871	.51	2.19
Inside the town	.88	.33	-0.32	0.746	.42	1.85
Out of town	1.16	.52	0.34	0.732	.49	2.77
Socio-demographic						
Living district (base: Nansei)	.91	.22	-0.40	0.691	.56	1.47
Grade (base: third grade)						
First grade	1.65	.58	1.42	0.155	.83	3.28
Second grade	2.05	.68	2.14	0.032	1.06	3.94
Number of children/household (base: one)						
Two	1.52	.62	1.03	0.304	.68	3.38
Three or more	1.39	.57	0.82	0.414	.63	3.10
_cons	.06	.05	-3.68	0.000	.01	.27

Note: '_cons' estimates baseline relative risk for each outcome.

Table D 3 The estimated Average Marginal Effects (AME) for the choice model in Minamiise town (insignificant estimates are highlighted in grey)

Variables	dy/dx	std. err.	z	P>|z|	[95% conf. interval]	
Alternative-specific variables						
Psychological						
Social Support *outcome#alt*						
CAR#CAR	.12	.02	4.86	0.000	.07	.17
CAR#PT	-.05	.01	-4.50	0.000	-.07	-.03
CAR#WC	-.07	.01	-4.74	0.000	-.10	-.04
PT#CAR	-.05	.01	-4.50	0.000	-.07	-.03
PT#PT	.06	.01	4.44	0.000	.03	.09
PT#WC	-.01	.00	-3.82	0.000	-.02	-.01
WC#CAR	-.07	.01	-4.74	0.000	-.10	-.04
WC#PT	-.01	.00	-3.82	0.000	-.02	-.01
WC#WC	.08	.02	4.68	0.000	.05	.12
Social Modeling of friends (students) *outcome#alt*						
CAR#CAR	.03	.01	1.90	0.058	.00	.06
CAR#PT	-.01	.01	-1.89	0.059	-.02	.00
CAR#WC	-.02	.01	-1.88	0.060	-.04	.00
PT#CAR	-.01	.01	-1.89	0.059	-.02	.00
PT#PT	.01	.01	1.89	0.058	.00	.03
PT#WC	.00	.00	-1.87	0.062	-.01	.00
WC#CAR	-.02	.01	-1.88	0.060	-.04	.00
WC#PT	.00	.00	-1.87	0.062	-.01	.00
WC#WC	.02	.01	1.89	0.059	.00	.04
Social Norm from friends (students) *outcome#alt*						
CAR#CAR	-.04	.02	-1.77	0.076	-.09	.00
CAR#PT	.02	.01	1.75	0.080	.00	.04
CAR#WC	.02	.01	1.77	0.077	.00	.05
PT#CAR	.02	.01	1.75	0.080	.00	.04
PT#PT	-.02	.01	-1.75	0.081	-.05	.00
PT#WC	.00	.00	1.70	0.089	.00	.01
WC#CAR	.02	.01	1.77	0.077	.00	.05
WC#PT	.00	.00	1.70	0.089	.00	.01
WC#WC	-.03	.02	-1.76	0.078	.06	.00
Case-specific variables						
Environmental						
Neighborhood Safety _outcome						
CAR	-.03	.03	-1.02	0.306	-.10	.03
PT	-.04	.03	-1.47	0.141	-.09	.01
WC	.07	.02	2.85	0.004	.03	.12
Walking/Cycling Environment _outcome						
CAR	.01	.02	0.48	0.630	-.04	.06
PT	.02	.02	1.56	0.118	.00	.06
WC	-.04	.02	-1.73	0.083	-.08	.00
Psychological						
Self-Efficacy "PT over CAR" (caregivers) _outcome						
CAR	.00	.01	-0.15	0.880	-.03	.03
PT	.01	.01	1.26	0.209	-.01	.03
WC	-.01	.01	-0.85	0.395	-.04	.01
Independent Mobility (IM)						
IM license (base: not allowed to do) (students)						
3: Allowed to cycle on main roads _outcome						
CAR	.02	.04	0.56	0.575	-.06	.11

Variables	dy/dx	Std. err.	z	P>|z|	[95% conf. interval]	
PT	-.08	.03	-2.31	0.021	-.15	-.01
WC	.06	.03	1.72	0.085	-.01	.12
IM Farthest Distance (base: home neighborhood) (students)						
School neighborhood _outcome						
CAR	-.01	.06	-0.14	0.885	-.13	.11
PT	.00	.04	0.01	0.992	-.08	.08
WC	.01	.05	0.16	0.873	-.09	.11
Inside the town _outcome						
CAR	-.01	.06	-0.24	0.809	-.14	.11
PT	.04	.04	0.86	0.390	-.05	.13
WC	-.02	.05	-0.45	0.649	-.12	.08
Out of town _outcome						
CAR	-.10	.07	-1.41	0.158	-.25	.04
PT	.10	.05	1.97	0.049	.00	.21
WC	.00	.06	-0.02	0.986	-.12	.12
Socio-demographic						
Living district (base: Nansei district)						
Nantou district _outcome						
CAR	.01	.04	0.16	0.875	-.07	.09
PT	.01	.03	0.29	0.771	-.05	.06
WC	-.01	.03	-0.45	0.655	-.08	.05
Grade (base: third grade)						
First grade _outcome						
CAR	.02	.05	0.48	0.628	-.08	.13
PT	-.10	.04	-2.49	0.013	-.18	-.02
WC	.08	.04	1.95	0.051	.00	.15
Second grade _outcome						
CAR	-.02	.05	-0.49	0.628	-.12	.07
PT	-.08	.04	-2.01	0.044	-.16	.00
WC	.10	.04	2.70	0.007	.03	.18
Number of children/household (base: one)						
Two _outcome						
CAR	-.06	.06	-1.04	0.297	-.18	.06
PT	.01	.04	0.29	0.772	-.07	.10
WC	.05	.05	1.03	0.301	-.05	.15
Three or more _outcome						
CAR	-.06	.06	-1.05	0.294	-.18	.05
PT	.02	.04	0.59	0.552	-.06	.11
WC	.04	.05	0.75	0.455	-.06	.13

Note: dy/dx for factor levels is the discrete change from the base level.

Appendix E: Complete Choice Model Results of Kiso

Table E 1 The estimated results (logit values) of the choice model in Kiso town (insignificant estimates are highlighted in grey)

Conditional logit choice model (Kiso)				No. of observations		2004	
Wald chi2 (40)	131.03			No. of cases		668	
Log-likelihood	-472.72	Prob>chi2	0.00	Alternatives per case		3	
Variables	**Coefficient**	**std. err.**		**z**	**P>|z|**	**[95% conf. interval]**	
Alternative-specific variables							
Psychological							
Social Modeling of caregivers (caregivers)	.22	.16		1.37	0.170	-.10	.54
Case-specific variables							
Public Transport (PT) estimates (base alternative: CAR)							
Psychological							
Self-Efficacy "WC over CAR" (caregivers)	.22	.15		1.50	0.133	-.07	.51
Self-Efficacy "PT over CAR" (students)	.20	.12		1.65	0.099	-.04	.43
Self-Efficacy "PT over CAR" (caregivers)	.37	.15		2.37	0.018	.06	.67
Independent Mobility (IM)							
IM license (base: not allowed to do) (students)							
4: Allowed to use the town bus	.48	.44		1.09	0.276	-.39	1.35
IM Farthest Distance (base: school neighborhood) (students)							
Inside the town	.89	.53		1.67	0.095	-.15	1.94
Out of town	1.42	.64		2.23	0.026	.17	2.67
IM Farthest Distance (base: home neighborhood) (caregivers)							
School neighborhood	-.70	.54		-1.29	0.197	-1.77	.36
Inside the town	-1.29	.55		-2.34	0.019	-2.37	-.21
Out of town	-1.44	.59		-2.44	0.015	-2.59	-.28
Socio-demographic							
Female (base: male)	.44	.31		1.39	0.163	-.18	1.05
Grade (base: third grade)							
First grade	.24	.39		0.62	0.537	-.52	1.00
Second grade	.37	.38		0.96	0.338	-.38	1.12
Future plan (base: work/study inside the town or others)							
Work/study out of town	-.29	.33		-0.86	0.387	-.94	.36
Having elder siblings (base: not having)	-.49	.38		-1.29	0.198	-1.23	.25
Having elder siblings studying/working out of town (base: not having)	.31	.45		0.69	0.488	-.57	1.20
Owning a phone (base: not owning)	-.22	.34		-0.66	0.511	-.89	.44
Living district (base: Kaida district)							
Fukushima	-.94	.42		-2.25	0.024	-1.76	-.12
Hiyoshi	.07	.54		0.12	0.903	-1.00	1.13
Mitake	-.09	.50		-0.19	0.853	-1.08	.89
Household construct (base: single parent and children)							
Parents and children	1.78	1.07		1.67	0.095	-.31	3.88
Parents, grandparent/s, children	1.88	1.07		1.75	0.080	-.22	3.98
Single parent, grandparent/s, children	2.52	1.17		2.14	0.032	.22	4.82

Variables	Coefficient	std. err.	z	P>|z|	[95% conf. interval]	
Caregivers' job (base: full-time homemaker or unemployed)						
Full-time employee	-.14	.67	-0.21	0.832	-1.45	1.16
Part-time employee	-.17	.68	-0.25	0.803	-1.50	1.16
Full-time self-employed	.18	.76	0.24	0.810	-1.31	1.67
cons	-4.34	1.75	-2.48	0.013	-7.77	-.90
Walking/Cycling (WC) estimates (base alternative: CAR)						
Psychological						
Self-Efficacy "WC over CAR" (caregivers)	.29	.13	2.28	0.023	.04	.55
Self-Efficacy "PT over CAR" (students)	.00	.09	-0.02	0.987	-.18	.18
Self-Efficacy "PT over CAR" (caregivers)	.00	.14	0.00	0.996	-.27	.27
Independent Mobility (IM)						
IM license (base: not allowed to do) (students)						
4: Allowed to use the town bus	.16	.30	0.53	0.597	-.43	.76
IM Farthest Distance (base: school neighborhood) (students)						
Inside the town	.63	.41	1.54	0.122	-.17	1.43
Out of town	1.17	.45	2.60	0.009	.29	2.05
IM Farthest Distance (base: home neighborhood) (caregivers)						
School neighborhood	-.08	.49	-0.16	0.869	-1.04	.88
Inside the town	-.11	.47	-0.23	0.821	-1.03	.82
Out of town	.00	.49	-0.00	0.998	-.97	.96
Socio-demographic						
Female (base: male)	-.59	.17	-3.35	0.001	-.93	-.24
Grade (base: third grade)						
First grade	.49	.32	1.52	0.129	-.14	1.11
Second grade	.84	.33	2.57	0.010	.20	1.49
Future plan (base: work/study inside the town or others)						
Work/study out of town	-.81	.29	-2.79	0.005	-1.38	-.24
Having elder siblings (base: not having)	-.51	.30	-1.72	0.086	-1.09	.07
Having elder siblings studying/working out of town (base: not having)	.61	.35	1.72	0.086	-.08	1.30
Owning a phone (base: not owning)	-.20	.27	-0.73	0.468	-.73	.34
Living district (base: Kaida district)						
Fukushima	1.38	.60	2.30	0.021	.20	2.55
Hiyoshi	1.99	.63	3.16	0.002	.75	3.23
Mitake	.67	.75	0.89	0.374	-.80	2.14
Household construct (base: single parent and children)						
Parents and children	-.04	.46	-0.08	0.938	-.94	.87
Parents, grandparent/s, children	.10	.50	0.20	0.841	-.88	1.08
Single parent, grandparent/s, children	.10	.67	0.15	0.880	-1.21	1.41
Caregivers' job (base: full-time homemaker or unemployed)						
Full-time employee	-1.14	.50	-2.30	0.021	-2.12	-.17
Part-time employee	-.90	.51	-1.76	0.078	-1.90	.10
Full-time self-employed	.04	.59	0.07	0.941	-1.11	1.19
_cons	-2.34	1.29	-1.81	0.070	-4.87	.19

Only the variables with a significant relationship trend ($p<0.10$) in the preliminary steps were used in making this final model.
For those variables reported by both students and their caregivers, the respondent is mentioned in parenthesis.

Table E 2 The estimated results (exponentiated coefficients) of the choice model in Kiso town (insignificant estimates are highlighted in grey)

Conditional logit choice model (Kiso)			No. of observations	2004
Wald chi^2 (40)	131.03		No. of cases	668
Log-likelihood -472.72	Prob>chi^2	0.00	Alternatives per case	3

Variables	**Odds ratio**	**std. err.**	**z**	**P>|z|**	**[95% conf. interval]**	
Alternative-specific variables						
Psychological						
Social Modeling of caregivers (caregivers)	1.25	.20	1.37	0.170	.91	1.72
Variables	**Relative risk ratio**	**Std. err.**	**z**	**P>|z|**	**[95% conf. interval]**	
Case-specific variables						
Public Transport (PT) estimates (base alternative: CAR)						
Psychological						
Self-Efficacy "WC over CAR" (caregivers)	1.25	.18	1.50	0.133	.93	1.66
Self-Efficacy "PT over CAR" (students)	1.22	.14	1.65	0.099	.96	1.53
Self-Efficacy "PT over CAR" (caregivers)	1.45	.22	2.37	0.018	1.07	1.96
Independent Mobility (IM)						
IM license (base: not allowed to do) (students)						
4: Allowed to use the town bus	1.62	.72	1.09	0.276	.68	3.87
IM Farthest Distance (base: school neighborhood) (students)						
Inside the town	2.44	1.30	1.67	0.095	.85	6.93
Out of town	4.15	2.65	2.23	0.026	1.19	14.48
IM Farthest Distance (base: home neighborhood) (caregivers)						
School neighborhood	.49	.27	-1.29	0.197	.17	1.44
Inside the town	.27	.15	-2.34	0.019	.09	.81
Out of town	.24	.14	-2.44	0.015	.07	.75
Socio-demographic						
Female (base: male)	1.55	.49	1.39	0.163	.84	2.87
Grade (base: third grade)						
First grade	1.27	.49	0.62	0.537	.59	2.72
Second grade	1.44	.55	0.96	0.338	.68	3.07
Future plan (base: work/study inside the town or others)						
Work/study out of town	.75	.25	-0.86	0.387	.39	1.44
Having elder siblings (base: not having)	.61	.23	-1.29	0.198	.29	1.29
Having elder siblings studying/working out of town (base: not having)	1.37	.62	0.69	0.488	.56	3.31
Owning a phone (base: not owning)	.80	.27	-0.66	0.511	.41	1.56
Living district (base: Kaida district)						
Fukushima	.39	.16	-2.25	0.024	.17	.88
Hiyoshi	1.07	.58	0.12	0.903	.37	3.11
Mitake	.91	.46	-0.19	0.853	.34	2.44
Household construct (base: single parent and children)						
Parents and children	5.95	6.36	1.67	0.095	.73	48.30
Parents, grandparent/s, children	6.55	7.04	1.75	0.080	.80	53.82
Single parent, grandparent/s, children	12.39	14.55	2.14	0.032	1.24	123.67

Variables	Relative risk ratio	Std. err.	z	P>|z|	[95% conf. interval]	
Caregivers' job (base: full-time homemaker or unemployed)						
Full-time employee	.87	.58	-0.21	0.832	.23	3.20
Part-time employee	.84	.57	-0.25	0.803	.22	3.19
Full-time self-employed	1.20	.91	0.24	0.810	.27	5.33
cons	.01	.02	-2.48	0.013	.00	.40
Walking/Cycling (WC) estimates (base alternative: CAR)						
Psychological						
Self-Efficacy "WC over CAR" (caregivers)	1.34	.17	2.28	0.023	1.04	1.73
Self-Efficacy "PT over CAR" (students)	1.00	.09	-0.02	0.987	.83	1.20
Self-Efficacy "PT over CAR" (caregivers)	1.00	.14	0.00	0.996	.76	1.31
Independent Mobility (IM)						
IM license (base: not allowed to do) (students)						
IM-L4 Allowed to use the town bus	1.17	.36	0.53	0.597	.65	2.13
IM Farthest Distance (base: school neighborhood) (students)						
Inside the town	1.88	.77	1.54	0.122	.84	4.19
Out of town	3.21	1.44	2.60	0.009	1.33	7.74
IM Farthest Distance (base: home neighborhood) (caregivers)						
School neighborhood	.92	.45	-0.16	0.869	.35	2.41
Inside the town	.90	.42	-0.23	0.821	.35	2.27
Out of town	1.00	.49	-0.00	0.998	.38	2.62
Socio-demographic						
Female (base: male)	.56	.14	-3.35	0.001	.33	.93
Grade (base: third grade)						
First grade	1.63	.52	1.52	0.129	.87	3.05
Second grade	2.32	.76	2.57	0.010	1.22	4.42
Future plan (base: work/study inside the town or others)						
Work/study out of town	.44	.13	-2.79	0.005	.25	.78
Having elder siblings (base: not having)	.60	.18	-1.72	0.086	.34	1.07
Having elder siblings studying/working out of town (base: not having)	1.84	.65	1.72	0.086	.92	3.69
Owning a phone (base: not owning)	.82	.22	-0.73	0.468	.48	1.40
Living district (base: Kaida district)						
Fukushima	3.97	2.38	2.30	0.021	1.23	12.84
Hiyoshi	7.34	4.63	3.16	0.002	2.13	25.29
Mitake	1.95	1.46	0.89	0.374	.45	8.49
Household construct (base: single parent and children)						
Parents and children	.96	.44	-0.08	0.938	.39	2.38
Parents, grandparent/s, children	1.10	.55	0.20	0.841	.41	2.95
Single parent, grandparent/s, children	1.10	.74	0.15	0.880	.30	4.09
Caregivers' job (base: full-time homemaker or unemployed)						
Full-time employee	.32	.16	-2.30	0.021	.12	.84
Part-time employee	.41	.21	-1.76	0.078	.15	1.11
Full-time self-employed	1.04	.61	0.07	0.941	.33	3.30
_cons	.10	.12	-1.81	0.070	.01	1.21

Note: '_cons' estimates baseline relative risk for each outcome.

Table E 3 The estimated Average Marginal Effects (AME) for the choice model in Kiso town (insignificant estimates are highlighted in grey)

Variables	dy/dx	std. err.	z	P>|z|	[95% conf.	interval]
Alternative-specific variables						
Psychological						
Social Modeling of caregivers (caregivers) *outcome#alt*						
CAR#CAR	.04	.03	1.37	0.169	-.02	.10
CAR#PT	-.02	.01	-1.36	0.173	-.04	.01
CAR#WC	-.02	.02	-1.37	0.170	-.06	.01
PT#CAR	-.02	.01	-1.36	0.173	-.04	.01
PT#PT	.02	.01	1.36	0.173	-.01	.05
PT#WC	.00	.00	-1.34	0.179	-.01	.00
WC#CAR	-.02	.02	-1.37	0.170	-.06	.01
WC#PT	.00	.00	-1.34	0.179	-.01	.00
WC#WC	.03	.02	1.37	0.170	-.01	.07
Case-specific variables						
Psychological						
Self-Efficacy "WC over CAR" (caregivers) _outcome						
CAR	-.05	.02	-2.55	0.011	-.09	-.01
PT	.01	.01	1.08	0.281	-.01	.04
WC	.03	.02	2.07	0.039	.00	.07
Self-Efficacy "PT over CAR" (students) _outcome						
CAR	-.01	.01	-0.94	0.346	-.04	.01
PT	.02	.01	1.68	0.092	.00	.04
WC	.00	.01	-0.35	0.725	-.03	.02
Self-Efficacy "PT over CAR" (caregivers) _outcome						
CAR	-.03	.02	-1.29	0.196	-.07	.01
PT	.03	.01	2.43	0.015	.01	.06
WC	-.01	.02	-0.43	0.671	-.04	.03
Independent Mobility (IM)						
IM license (base: not allowed to do) (students)						
4: Allowed to use the town bus _outcome						
CAR	-.05	.05	-1.06	0.288	-.14	.04
PT	.04	.03	1.13	0.260	-.03	.10
WC	.01	.04	0.31	0.756	-.06	.09
IM Farthest Distance (base: school neighborhood) (students)						
Inside the town _outcome						
CAR	-.11	.05	-2.31	0.021	-.21	-.02
PT	.06	.03	1.68	0.093	-.01	.12
WC	.06	.04	1.43	0.151	-.02	.14
Out of town _outcome						
CAR	-.22	.06	-3.51	0.000	-.34	-.10
PT	.10	.05	2.08	0.038	.00	.19
WC	.12	.05	2.45	0.014	.02	.22
IM Farthest Distance (base: home neighborhood) (caregivers)						
School neighborhood _outcome						
CAR	.08	.08	1.03	0.302	-.07	.23
PT	-.09	.07	-1.24	0.215	-.23	.05
WC	.01	.06	0.20	0.840	-.10	.13
Inside the town _outcome						
CAR	.13	.07	1.72	0.085	-.02	.27
PT	-.15	.07	-2.13	0.034	-.28	-.01
WC	.02	.06	0.38	0.705	-.09	.13
Out of town _outcome						
CAR	.12	.08	1.62	0.106	-.03	.27

Variables	dy/dx	std. err.	z	P>|z|	[95% conf. interval]	
PT	-.16	.07	-2.26	0.024	-.30	-.02
WC	.04	.06	0.64	0.520	-.08	.16
Socio-demographic						
Female (base: male) _outcome						
CAR	.03	.04	0.80	0.422	-.04	.11
PT	.05	.03	1.80	0.072	.00	.11
WC	-.09	.03	-2.62	0.009	-.15	-.02
Grade (base: third grade)						
First grade _outcome						
CAR	-.07	.05	-1.45	0.148	-.16	.02
PT	.01	.03	0.35	0.726	-.06	.08
WC	.06	.04	1.42	0.155	-.02	.13
Second grade _outcome						
CAR	-.12	.05	-2.46	0.014	-.22	-.02
PT	.01	.03	0.43	0.666	-.05	.08
WC	.11	.04	2.37	0.018	.02	.20
Future plan (base: work/study inside the town or others)						
Work/study out of town _outcome						
CAR	.11	.04	2.69	0.007	.03	.18
PT	-.01	.03	-0.36	0.718	-.07	.05
WC	-.09	.03	-2.95	0.003	-.16	-.03
Having elder siblings (base: not having) _outcome						
CAR	.09	.05	2.00	0.045	.00	.18
PT	-.03	.03	-1.00	0.320	-.10	.03
WC	-.06	.04	-1.47	0.141	-.13	.02
Having elder siblings studying/working out of town (base: not having) _outcome						
CAR	-.09	.06	-1.62	0.104	-.21	.02
PT	.01	.04	0.36	0.718	-.07	.10
WC	.08	.05	1.51	0.131	-.02	.18
Owning a phone (base: not owning) _outcome						
CAR	.04	.04	0.92	0.359	-.04	.12
PT	-.02	.03	-0.54	0.586	-.08	.04
WC	-.02	.03	-0.61	0.540	-.09	.05
Living district (base: Kaida district)						
Fukushima _outcome						
CAR	-.02	.06	-0.40	0.686	-.14	.09
PT	-.12	.05	-2.33	0.020	-.22	-.02
WC	.14	.04	3.87	0.000	.07	.21
Hiyoshi _outcome						
CAR	-.17	.07	-2.25	0.024	-.32	-.02
PT	-.04	.07	-0.61	0.544	-.17	.09
WC	.21	.05	4.04	0.000	.11	.31
Mitake _outcome						
CAR	-.02	.08	-0.30	0.761	-.17	.13
PT	-.02	.06	-0.35	0.729	-.15	.10
WC	.04	.05	0.90	0.366	-.05	.14
Household construct (base: single parent and children)						
Parents and children _outcome						
CAR	-.07	.07	-1.05	0.294	-.21	.06
PT	.10	.03	3.13	0.002	.04	.16
WC	-.02	.06	-0.40	0.693	-.15	.10
Parents, grandparent/s, children _outcome						
CAR	-.09	.07	-1.26	0.206	-.24	.05
PT	.10	.04	2.72	0.007	.03	.18
WC	-.01	.07	-0.13	0.895	-.15	.13
Single parent, grandparent/s, children _outcome						

Variables	dy/dx	std. err.	z	P>|z|	[95% conf. interval]	
CAR	-.15	.10	-1.45	0.146	-.36	.05
PT	.18	.07	2.38	0.017	.03	.33
WC	-.03	.09	-0.30	0.762	-.20	.15
Caregivers' job (base: full-time homemaker or unemployed)						
Full-time employee _outcome						
CAR	.16	.09	1.71	0.087	-.02	.34
PT	.01	.05	0.26	0.795	-.09	.12
WC	-.17	.09	-2.00	0.046	-.34	.00
Part-time employee _outcome						
CAR	.13	.09	1.42	0.156	-.05	.32
PT	.01	.06	0.13	0.897	-.10	.12
WC	-.14	.09	-1.58	0.113	-.31	.03
Full-time self-employed _outcome						
CAR	-.02	.11	-0.16	0.875	-.23	.20
PT	.01	.06	0.23	0.817	-.11	.14
WC	.00	.11	0.02	0.983	-.21	.21

Note: dy/dx for factor levels is the discrete change from the base level.

Appendix F: Complete Results of the General Choice Model

Table F 1 The estimated results (logit values) of the general choice model (insignificant estimates are highlighted in grey)

Conditional logit choice model (Kiso)				No. of observations		6324	
Wald chi2 (40)	371.38			No. of cases		2108	
Log-likelihood	-1683.29	Prob>chi2	0.00	Alternatives per case		3	
Variables	**Coefficient**	**std. err.**		**z**	**P>|z|**	**[95% conf. interval]**	
Alternative-specific variables							
Psychological							
Perceived Benefits	.17	.08		2.20	0.028	.02	.32
Perceived Barriers	-.09	.05		-1.93	0.053	-.19	.00
Social Support of friends (students)	.12	.04		2.73	0.006	.03	.21
Social Support of caregivers (caregivers)	.20	.04		4.64	0.000	.11	.28
Social Modeling of caregivers (students)	.03	.03		0.85	0.395	-.04	.10
Social Modeling of friends (students)	.09	.04		2.24	0.025	.01	.17
Social Modeling of caregivers (caregivers)	.02	.05		0.45	0.654	-.08	.13
Case-specific variables							
Public Transport (PT) estimates (base alternative: CAR)							
Environmental							
Neighborhood Safety	-.05	.13		-0.38	0.706	-.30	.20
Psychological							
Self-Efficacy "WC over CAR" (students)	-.03	.08		-0.39	0.698	-.18	.12
Self-Efficacy "PT over CAR" (students)	.17	.07		2.50	0.012	.04	.31
Self-Efficacy "PT over CAR" (caregivers)	.12	.06		1.81	0.070	-01	.24
Independent Mobility (IM)							
IM license (base: not allowed to do) (students)							
3: Allowed to cycle on main roads	-.15	.18		-0.83	0.405	-.50	.20
4: Allowed to use the town bus	.07	.23		0.30	0.764	-.39	.53
IM license (base: not allowed to do) (caregivers)							
1: Allowed to move to different destinations within walking distance	.28	.30		0.97	0.335	-.29	.87
2: Allowed to go out after dark	-.50	.26		-1.91	0.056	-1.01	.01
4: Allowed to use the town bus	.21	.25		0.86	0.389	-.27	.70
IM Farthest Distance (base: home neighborhood) (students)							
School neighborhood	.02	.44		0.05	0.960	-.84	.89
Inside the town	.05	.43		0.13	0.899	-.79	.90
Out of town	.59	.44		1.35	0.176	-.27	1.46
IM Farthest Distance (base: home neighborhood) (caregivers)							
School neighborhood	-.25	.36		-0.71	0.481	-.96	.45
Inside the town	-.25	.36		-0.70	0.483	-.96	.45
Out of town	-.11	.36		-0.31	0.757	-.81	-.59
Socio-demographic							
Town (base: Toyoyama)							

Variables	Coefficient	std. err.	z	P>|z|	[95% conf. interval]	
Minamiise	.35	.28	1.23	0.218	-.21	.91
Kiso	-.03	.32	-0.11	0.911	-.66	.59
Grade (base: third grade)						
First grade	-.31	.22	-1.40	0.161	-.74	.12
Second grade	.04	.20	0.21	0.834	-.34	.42
Having elder siblings (base: not having)	-.38	.17	-2.21	0.027	-.71	-.04
Owning a phone (base: not owning)	-.03	.20	-0.15	0.884	.41	.36
Household construct (base: single parent and children)						
Parents and children	.68	.37	1.85	0.064	-.04	1.40
Parents, grandparent/s, children	.57	.42	1.35	0.178	-.26	1.39
Single parent, grandparent/s, children	.94	.43	2.18	0.029	.09	1.79
Caregivers' age (base: over 50)						
Less than 40	-.24	.28	-.87	0.382	-.79	.30
40-50	-.61	.22	-2.75	0.006	-1.04	-.17
Caregivers' job (base: full-time homemaker or unemployed)						
Full-time employee	-.33	.35	-0.95	0.342	-1.01	.35
Part-time employee	-.23	.34	-0.66	0.512	-.90	.45
Full-time self-employed	-.01	.40	-0.30	0.979	-.79	.77
Number of cars/household (base: three or more)						
One	-.16	.30	-0.55	0.584	-.74	.42
Two	-.50	.21	-2.44	0.015	-.91	-.10
Number of children/household (base: three or more)						
One	-.13	.30	-0.43	0.670	-.71	.45
Two	.14	.17	0.78	0.433	-.20	.48
cons	-1.57	1.00	-1.57	0.117	-3.53	.39
Walking/Cycling (WC) estimates (base alternative: CAR)						
Environmental						
Neighborhood Safety	.20	.09	2.33	0.020	.03	.38
Psychological						
Self-Efficacy "WC over CAR" (students)	.13	.06	2.13	0.033	.01	.24
Self-Efficacy "PT over CAR" (students)	.08	.05	1.68	0.093	-.01	.17
Self-Efficacy "PT over CAR" (caregivers)	.05	.05	1.14	0.256	-.04	.14
Independent Mobility (IM)						
IM license (base: not allowed to do) (students)						
3: Allowed to cycle on main roads	.05	.13	0.36	0.721	-.21	.30
4: Allowed to use the town bus	-.06	.14	-0.42	0.671	-.33	.21
IM license (base: not allowed to do) (caregivers)						
1: Allowed to move to different destinations within walking distance	.07	.19	0.39	0.697	-.30	.45
2: Allowed to go out after dark	.24	.16	1.49	0.135	-.07	.55
4: Allowed to use the town bus	-.12	.15	-0.84	0.402	-.41	.16
IM Farthest Distance (base: home neighborhood) (students)						
School neighborhood	-.18	.35	-0.53	0.593	-.86	.49
Inside the town	-.15	.34	-0.43	0.668	-.82	.53
Out of town	.05	.36	0.14	0.886	-.65	.75
IM Farthest Distance (base: home neighborhood) (caregivers)						

Variables	Coefficient	std. err.	z	P>|z|	[95% conf.	interval]
School neighborhood	.13	.29	0.46	0.647	-.44	.71
Inside the town	.16	.29	0.56	0.610	-.44	.74
Out of town	.15	.30	0.51	0.610	-.44	.74
Socio-demographic						
Town (base: Toyoyama)						
Minamiise	-.55	.21	-2.56	0.010	-.97	-.13
Kiso	-46	.23	-2.00	0.046	-.92	-.01
Grade (base: third grade)						
First grade	.24	.16	1.51	0.131	-.07	.55
Second grade	.34	.15	2.21	0.027	.04	.64
Having elder siblings (base: not having)	-.10	.12	-0.83	0.404	-.34	.14
Owning a phone (base: not owning)	-.19	.14	-1.32	0.187	-.47	.09
Household construct (base: single parent and children)						
Parents and children	-.17	.23	-0.74	0.462	-.62	.28
Parents, grandparent/s, children	-.02	.28	-0.07	0.940	-.58	.53
Single parent, grandparent/s, children	-.03	.31	-0.11	0.909	-.65	.57
Caregivers' age (base: over 50)						
Less than 40	-.08	.22	-0.38	0.702	-.52	.35
40-50	-.11	.18	-0.62	0.535	-.47	.24
Caregivers' job (base: full-time homemaker or unemployed)						
Full-time employee	-.58	.23	-2.48	0.013	-1.04	-.12
Part-time employee	-.46	.23	-2.02	0.044	-.91	-.01
Full-time self-employed	-.37	.26	-1.39	0.165	-.89	.15
Number of cars/household (base: three or more)						
One	-.24	.22	-1.10	0.273	-.66	.19
Two	-.11	.16	-0.69	0.489	-.44	.21
Number of children/household (base: three or more)						
One	-.35	.22	-1.60	0.110	-.79	.08
Two	.16	.12	1.26	0.207	-.09	.40
_cons	-.95	.70	-1.35	0.176	-2.34	.43

Only the variables with a significant relationship trend ($p<0.10$) in the preliminary steps were used in making this final model.
For those variables reported by both students and their caregivers, the respondent is mentioned in parenthesis.

Table F 2 The estimated results (exponentiated coefficients) of the general choice model (insignificant estimates are highlighted in grey)

Conditional logit choice model (Kiso)				No. of observations		6324	
Wald chi2 (40)	371.38			No. of cases		2108	
Log-likelihood -1683.29	Prob>chi2	0.00		Alternatives per case		3	
Variables	**Odds ratio**	**std. err.**		**z**	**P>|z|**	**[95% conf. interval]**	
Alternative-specific variables							
Psychological							
Perceived Benefits	1.19	.09		2.20	0.028	1.02	1.38
Perceived Barriers	.91	.04		-1.93	0.053	.83	1.00
Social Support of friends (students)	1.13	.05		2.73	0.006	1.03	1.23
Social Support of caregivers (caregivers)	1.22	.05		4.64	0.000	1,12	1.33
Social Modeling of caregivers (students)	1.03	.37		0.85	0.395	.96	1.10
Social Modeling of friends (students)	1.10	.04		2.24	0.025	1.01	1.19
Social Modeling of caregivers (caregivers)	1.02	.05		0.45	0.654	.92	1.14
Variables	**Relative risk ratio**	**Std. err.**		**z**	**P>|z|**	**[95% conf. interval]**	
Case-specific variables							
Public Transport (PT) estimates (base alternative: CAR)							
Environmental							
Neighborhood Safety	.95	.12		-0.38	0.706	.74	1.22
Psychological							
Self-Efficacy "WC over CAR" (students)	.97	.07		-0.39	0.698	.83	1.13
Self-Efficacy "PT over CAR" (students)	1.18	.08		2.50	0.012	1.04	1.36
Self-Efficacy "PT over CAR" (caregivers)	1.12	.07		1.81	0.070	.99	1.28
Independent Mobility (IM)							
IM license (base: not allowed to do) (students)							
3: Allowed to cycle on main roads	.86	.15		-0.83	0.405	.60	1.22
4: Allowed to use the town bus	1.07	.25		0.30	0.764	.68	1.70
IM license (base: not allowed to do) (caregivers)							
1: Allowed to move to different destinations within walking distance	1.33	.39		0.97	0.335	.74	2.38
2: Allowed to go out after dark	.60	.16		-1.91	0.056	.36	1.01
4: Allowed to use the town bus	1.24	.31		0.86	0.389	.76	2.02
IM Farthest Distance (base: home neighborhood) (students)							
School neighborhood	1.02	.45		0.05	0.960	.43	2.43
Inside the town	1.06	.45		0.13	0.899	.45	2.46
Out of town	1.81	.80		1.35	0.176	.76	4.30
IM Farthest Distance (base: home neighborhood) (caregivers)							
School neighborhood	.77	.28		-0.71	0.481	.38	1.57
Inside the town	.78	.28		-0.70	0.483	.38	1.57
Out of town	.89	.32		-0.31	0.757	.44	1.81
Socio-demographic							
Town (base: Toyoyama)							

Variables	Relative risk ratio	Std. err.	z	P>|z|	[95% conf. interval]	
Minamiise	1.42	.41	1.23	0.218	.81	2.49
Kiso	.96	.31	-0.11	0.911	.51	1.81
Grade (base: third grade)						
First grade	.73	.16	-1.40	0.161	.48	1.13
Second grade	1.04	.20	0.21	0.834	.71	1.53
Having elder siblings (base: not having)	.68	.12	-2.21	0.027	.49	.96
Owning a phone (base: not owning)	.97	.19	-0.15	0.884	.66	1.43
Household construct (base: single parent and children)						
Parents and children	1.97	.73	1.85	0.064	.96	4.06
Parents, grandparent/s, children	1.76	.74	1.35	0.178	.77	4.03
Single parent, grandparent/s, children	2.57	1.11	2.18	0.029	1.10	6.00
Caregivers' age (base: over 50)						
Less than 40	.78	.22	-0.87	0.382	.45	1.35
40-50	.54	.12	-2.75	0.006	.35	.84
Caregivers' job (base: full-time homemaker or unemployed)						
Full-time employee	.72	.25	-0.95	0.342	.36	1.42
Part-time employee	.80	.27	-0.66	0.512	.40	1.57
Full-time self-employed	.99	**.39**	-0.30	0.979	.45	2.16
Number of cars/household (base: three or more)						
One	.85	.25	-0.55	0.584	.47	1.52
Two	.60	.12	-2.44	0.015	.40	.90
Number of children/household (base: three or more)						
One	.88	.26	-0.43	0.670	.49	1.57
Two	1.15	.20	.78	0.433	.81	1.62
cons	.21	.21	-1.57	0.117	.03	1.48
Walking/Cycling (WC) estimates (base alternative: CAR)						
Environmental						
Neighborhood Safety	1.23	.11	2.33	0.020	1.03	1.46
Psychological						
Self-Efficacy "WC over CAR" (students)	1.13	.07	2.13	0.033	1.01	1.27
Self-Efficacy "PT over CAR" (students)	1.08	.05	1.68	0.093	.99	1.19
Self-Efficacy "PT over CAR" (caregivers)	1.05	.05	1.14	0.256	.96	1.16
Independent Mobility (IM)						
IM license (base: not allowed to do) (students)						
3: Allowed to cycle on main roads	1.05	.13	0.36	0.721	.81	1.35
4: Allowed to use the town bus	.94	.13	-0.42	0.671	.72	1.24
IM license (base: not allowed to do) (caregivers)						
1: Allowed to move to different destinations within walking distance	1.08	.21	0.39	0.697	.74	1.57
2: Allowed to go out after dark	1.27	.20	1.49	0.135	.93	1.73
4: Allowed to use the town bus	.88	.13	-0.84	0.402	.66	1.18
IM Farthest Distance (base: home neighborhood) (students)						
School neighborhood	.83	.29	-0.53	0.593	.42	1.64
Inside the town	.86	.30	-0.43	0.668	.44	1.69
Out of town	1.05	.38	0.14	0.886	.52	2.12
IM Farthest Distance (base: home neighborhood) (caregivers)						

Variables	Relative risk ratio	Std. err.	z	P>|z|	[95% conf.	interval]
School neighborhood	1.14	.33	0.46	0.647	.64	2.03
Inside the town	1.18	.35	0.56	0.574	.66	2.10
Out of town	1.17	.35	0.51	0.610	.64	2.10
Socio-demographic						
Town (base: Toyoyama)						
Minamiise	.58	.12	-2.56	0.010	.38	.88
Kiso	.63	.14	-2.00	0.046	.40	.99
Grade (base: third grade)						
First grade	1.27	.20	1.51	0.131	.93	1.74
Second grade	1.40	.22	2.21	0.027	1.04	1.90
Having elder siblings (base: not having)	.90	.11	-0.83	0.404	.71	1.15
Owning a phone (base: not owning)	.83	.12	-1.32	0.187	.62	1.10
Household construct (base: single parent and children)						
Parents and children	.84	.19	-0.74	0.462	.53	1.33
Parents, grandparent/s, children	.98	.28	-0.07	0.940	.56	1.70
Single parent, grandparent/s, children	.96	.30	-0.11	0.909	.52	1.78
Caregivers' age (base: over 50)						
Less than 40	.92	.20	-0.38	0.702	.59	1.42
40-50	.89	.16	-0.62	0.535	.62	1.28
Caregivers' job (base: full-time homemaker or unemployed)						
Full-time employee	.56	.13	-2.48	0.013	.35	.88
Part-time employee	.63	.14	-2.02	0.044	.40	.99
Full-time self-employed	.69	.18	-1.39	0.165	.41	1.16
Number of cars/household (base: three or more)						
One	.79	.17	-1.10	0.273	.52	1.20
Two	.89	.15	-0.69	0.489	.64	1.23
Number of children/household (base: three or more)						
One	.70	.15	-1.60	0.110	.45	1.08
Two	1.17	.15	1.26	0.207	.92	1.50
cons	.38	.27	-1.35	0.176	.10	1.53

Only the variables with a significant relationship trend ($p<0.10$) in the preliminary steps were used in making this final model.
For those variables reported by both students and their caregivers, the respondent is mentioned in parenthesis.

Table F 3 The estimated Average Marginal Effects (AME) for the general choice model (insignificant estimates are highlighted in grey)

Variables	dy/dx	std. err.	z	P>|z|	[95% conf. interval]	
Alternative-specific variables						
Psychological						
Perceived Benefits outcome#alt						
CAR#CAR	.03	.02	2.21	0.027	.00	.06
CAR#PT	-.01	.00	-2.19	0.029	-.02	-.00
CAR#WC	-.02	.02	-2.21	0.027	-.05	-.00
PT#CAR	-.01	.00	-2.19	0.029	-.02	-.00
PT#PT	.01	.01	2.19	0.029	.00	.03
PT#WC	-.00	.00	-2.18	0.030	.01	-.00
WC#CAR	-.02	.01	-2.21	0.027	-.05	-.00
WC#PT	-.00	.00	-2.18	0.030	-.01	-.00
WC#WC	.03	.01	2.21	0.027	.00	.06
Perceived Barriers outcome#alt						
CAR#CAR	-.02	.01	-1.94	0.052	-.04	.00
CAR#PT	.00	.00	1.93	0.054	-.00	.01
CAR#WC	.01	.01	1.94	0.053	-.00	.03
PT#CAR	.00	.00	1.93	0.054	-.00	.01
PT#PT	-.01	.00	-1.93	0.054	-.02	.00
PT#WC	.00	.00	1.92	0.055	-.00	.00
WC#CAR	.01	.01	1.94	0.053	-.00	.00
WC#PT	.00	.00	1.92	0.055	-.00	.00
WC#WC	-.02	.01	-1.94	0.053	-.03	.00
Social Support of friends (students)						
CAR#CAR	.02	.01	2.75	0.006	.01	.04
CAR#PT	-.01	.00	-2.72	0.007	-.01	-.00
CAR#WC	-.02	.01	-2.74	0.006	-.03	-.00
PT#CAR	-.01	.00	-2.72	0.007	-.01	-.00
PT#PT	.01	.00	2.72	0.007	.00	.01
PT#WC	-.00	.00	-2.68	0.007	-.00	-.00
WC#CAR	-.02	.00	-2.74	0.006	-.03	-.00
WC#PT	-.00	.00	-2.68	0.007	-.00	-.00
WC#WC	.02	.01	2.74	0.006	.01	.04
Social Support of caregivers (caregivers)						
CAR#CAR	.04	.01	4.71	0.000	.02	.06
CAR#PT	-.01	.00	-4.54	0.000	-.02	-.01
CAR#WC	-.03	.01	-4.69	0.000	-.04	-.02
PT#CAR	-.01	.00	-4.54	0.000	-.02	-.01
PT#PT	.02	.00	4.53	0.000	.01	.02
PT#WC	-.00	.00	-4.37	0.000	-.01	-.00
WC#CAR	-.03	.01	-4.69	0.000	-.04	-.02
WC#PT	-.00	.00	-4.37	0.000	-.01	-.00
WC#WC	.03	.01	4.68	0.000	.02	.05
Social Modeling of caregivers (students)						
CAR#CAR	.01	.01	0.85	0.395	-.01	.02
CAR#PT	-.00	.00	-0.85	0.395	-.01	.00
CAR#WC	-.00	.00	-0.85	0.395	-.01	.00
PT#CAR	-.00	.00	-0.85	0.395	-.01	.00
PT#PT	.00	.00	0.85	0.395	-.00	.01
PT#WC	-.00	.00	-0.85	0.396	-.00	.00
WC#CAR	-.00	.00	-0.85	0.395	-.01	.00
WC#PT	-.00	.00	-0.85	0.396	-.00	.00
WC#WC	.00	.01	0.85	0.395	-.01	.02
Social Modeling of friends (students)						

Variables	dy/dx	std. err.	z	P>|z|	[95% conf. interval]	
CAR#CAR	.02	.01	2.25	0.025	.00	.04
CAR#PT	-.00	.00	-2.23	0.025	-.01	-.00
CAR#WC	-.01	.01	-2.24	0.025	-.02	-.00
PT#CAR	-.00	.00	-2.23	0.025	-.01	-.00
PT#PT	.01	.00	2.23	0.025	.00	.01
PT#WC	-.00	.00	-2.22	0.027	-.00	-.00
WC#CAR	-.01	.01	-2.24	0.025	-.02	-.00
WC#PT	-.00	.00	-2.22	0.027	-.00	-.00
WC#WC	.02	.01	2.24	0.025	.00	.03
Social Modeling of caregivers (caregivers)						
CAR#CAR	.00	.01	0.45	0.653	-.02	.03
CAR#PT	-.00	.00	-0.45	0.654	-.01	.00
CAR#WC	-.00	.01	-0.45	0.653	-.02	.01
PT#CAR	-.00	.00	-0.45	0.654	-.01	.00
PT#PT	.00	.00	0.45	0.654	.01	.01
PT#WC	-.00	.00	-0.45	0.654	.00	.00
WC#CAR	-.00	.01	-0.45	0.653	-.02	.01
WC#PT	-.00	.00	-0.45	0.654	-.00	.00
WC#WC	.00	.01	0.45	0.653	-.01	.02
Case-specific variables						
Environmental						
Neighborhood Safety _ outcome						
CAR	-.03	.02	-1.65	0.098	-.06	.00
PT	-.01	.01	-0.88	0.376	-.03	.01
WC	.04	.01	2.49	0.013	.01	.07
Psychological						
Self-Efficacy "WC over CAR" (students) _outcome						
CAR	-.02	.01	-1.55	0.121	-.04	.00
PT	-.01	.01	-0.90	0.367	-.02	.01
WC	.02	.01	2.27	0.023	.00	.04
Self-Efficacy "PT over CAR" (students) _outcome						
CAR	-.02	.01	-2.51	0.012	-.04	-.00
PT	.01	.00	2.21	0.027	.00	.02
WC	.01	.01	1.16	0.245	-.01	.02
Self-Efficacy "PT over CAR" (caregivers) _outcome						
CAR	-.01	.01	-1.71	0.087	-.03	.00
PT	.01	.00	1.62	0.105	-.00	.02
WC	.01	,01	0.78	0.435	-.01	.02
Independent Mobility (IM)						
IM license (base: not allowed to do) (students)						
3: Allowed to cycle on main roads _ outcome						
CAR	.00	.02	0.11	0.916	-.04	.05
PT	-.01	.01	-0.92	0.356	-.04	.01
WC	.01	.02	0.55	0.582	-.03	.05
4: Allowed to use the town bus _ outcome						
CAR	.00	.03	0.17	0.867	-.05	.06
PT	.01	.02	0.39	0.694	-.03	.05
WC	-.01	.02	-0.51	0.612	-.06	.03
IM license (base: not allowed to do) (caregivers)						
1: Allowed to move to different destinations within walking distance _ outcome						
CAR	-.03	.03	-0.78	0.433	-.10	.04
PT	.02	.02	0.97	0.332	-.02	.10
WC	.01	.03	0.18	0.854	-.06	.10
2: Allowed to go out after dark _ outcome						
CAR	-.01	.03	-0.37	0.715	-.07	.05

Variables	dy/dx	std. err.	z	P>|z|	[95% conf. interval]	
PT	-.04	.02	-2.65	0.008	-.08	-.01
WC	.05	.03	1.91	0.056	-.00	.11
4: Allowed to use the town bus _outcome						
CAR	.01	.03	0.22	0.829	-.05	.06
PT	.02	.02	1.10	0.273	-.02	.06
WC	-.03	.02	-1.06	0.290	-.08	.02
IM Farthest Distance (base: home neighborhood) (students)						
School neighborhood _outcome						
CAR	.03	.06	0.44	0.660	-.09	.15
PT	.00	.03	0.18	0.860	-.06	.07
WC	-.03	.06	-0.54	0.591	-.15	.09
Inside the town _outcome						
CAR	.02	.06	0.32	0.746	-.10	.14
PT	.01	.03	0.24	0.814	-.05	.07
WC	.03	.06	-0.45	0.656	-.15	.09
Out of town _outcome						
CAR	-.04	.06	-0.68	0.497	-.17	.08
PT	.05	.03	1.55	0.122	-.01	.12
WC	-.01	.06	-0.11	0.914	-.13	.12
IM Farthest Distance (base: home neighborhood) (caregivers)						
School neighborhood _outcome						
CAR	-.00	.05	-0.05	0.962	-.10	.10
PT	.03	.03	-0.78	0.437	-.10	.04
WC	.03	.05	0.62	0.537	-.10	.12
Inside the town _outcome						
CAR	-.01	.05	-0.14	0.888	-.11	.10
PT	-.03	.03	-0.79	0.427	-.10	.04
WC	.03	.05	0.73	0.468	-.06	.13
Out of town _outcome						
CAR	-.01	.05	-0.27	0.788	-.12	.09
PT	-.01	.03	-0.43	0.670	-.08	.05
WC	.03	.05	0.59	0.553	-.07	.13
Socio-demographic						
Town (base: Toyoyama)						
Minamiise _outcome						
CAR	.06	.04	1.48	0.138	-.02	.14
PT	.05	.02	1.93	0.053	-.00	.10
WC	-.11	.04	-2.87	0.004	-.19	-.03
Kiso _outcome						
CAR	.08	.04	1.69	0.091	-.01	.16
PT	.01	.02	0.38	0.706	-.04	.05
WC	-.08	.04	-2.00	0.045	-.17	-.00
Grade (base: third grade)						
First grade _outcome						
CAR	-.02	.03	-0.57	0.568	-.07	.04
PT	-.03	.02	-1.78	0.075	-.07	.00
WC	.05	.03	1.84	0.065	-.00	.10
Second grade _outcome						
CAR	-.05	.03	-1.84	0.066	-.11	.00
PT	-.00	.02	-0.32	0.747	-.04	.03
WC	.06	.02	2.23	0.025	.01	.11
Having elder siblings (base: not having) _outcome						
CAR	.04	.02	1.69	0.092	-.01	.08
PT	-.03	.01	-2.07	0.039	-.06	-.00
WC	-.01	.02	-0.37	0.713	-.05	.03
Owning a phone (base: not owning) _outcome						
CAR	.03	.03	1.13	0.258	-.02	.08

Variables	dy/dx	std. err.	z	P>|z|	[95% conf. interval]	
PT	.00	.02	0.16	0.875	-.03	.03
WC	-.03	.02	-1.31	0.190	-.08	.02
Household construct (base: single parent and children)						
Parents and children _outcome						
CAR	-.01	.04	-0.17	0.862	-.09	.08
PT	.05	.02	2.52	0.012	.01	.09
WC	-.04	.04	-1.09	0.275	-.13	.04
Parents, grandparent/s, children _outcome						
CAR	-.02	.05	-0.43	0.666	-.13	.08
PT	.04	.03	1.49	0.136	-.01	.09
WC	-.02	.05	-0.32	0.750	-.12	.08
Single parent, grandparent/s, children _outcome						
CAR	-.04	.06	-0.78	0.436	-.16	.07
PT	.07	.03	2.24	0.025	.01	.14
WC	-.03	.05	-0.55	0.583	-.14	.08
Caregivers' age (base: over 50)						
Less than 40 _outcome						
CAR	.03	.04	0.73	0.467	-.05	.11
PT	-.02	.03	-0.79	0.427	-.08	.03
WC	-.01	.04	-0.17	0.861	-.08	.07
40-50 outcome						
CAR	.06	.03	1.70	0.088	-.01	.12
PT	-.05	.02	-2.38	0.017	-.10	-.01
WC	-.00	.03	-0.05	0.963	-.06	.06
Caregivers' job (base: full-time homemaker or unemployed)						
Full-time employee _outcome						
CAR	.11	.05	2.35	0.019	.02	.20
PT	-.01	.03	-0.39	0.694	-.07	.04
WC	-.10	.04	-2.22	0.026	-.18	-.01
Part-time employee outcome						
CAR	.08	.05	1.86	0.062	-.00	.18
PT	-.01	.03	-0.20	0.842	-.07	.05
WC	-.08	.04	-1.84	0.065	-.16	.00
Full-time self-employed outcome						
CAR	.06	.05	1.09	0.276	-.05	.16
PT	.01	.04	0.31	0.756	-.06	.08
WC	-.07	.05	-1.41	0.158	-.16	.03
Number of cars/household (base: three or more)						
One _outcome						
CAR	.04	.04	1.11	0.268	-.03	.12
PT	-.01	.03	-0.32	0.750	-.07	.05
WC	-.03	.03	-1.00	0.317	-.10	.03
Two _outcome						
CAR	.05	.03	1.61	0.108	-.01	.11
PT	-.04	.02	-2.22	0.026	-.08	-.00
WC	.01	.03	-0.21	0.833	-.07	.05
Number of children/household (base: three or more)						
One _outcome						
CAR	.06	.04	1.50	0.132	-.02	.13
PT	-.00	.02	-0.11	0.912	-.05	.04
WC	-.05	.03	-1.61	0.106	-.12	.01
Two _outcome						
CAR	-.03	.02	-1.37	0.171	-.08	.01
PT	.01	.01	0.52	0.603	-.02	.04
WC	.02	.02	1.12	0.262	-.02	.07

Note: dy/dx for factor levels is the discrete change from the base level.