Exploring Diversity of Activities on Shared-Use Paths: Factors and Implications for Planning and Design

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Abstract: The increased need for active transportation facilities coupled with the limited funding and space have influenced the prioritizing of shared-use paths (SUPs). Unlike other activity-specific facilities, the SUP can accommodate a wide range of users. With SUPs being relatively new facilities, less is known about the characteristics of the users and the key factors associated with the user type. This study explored the influential factors for SUP user diverse activities using multinomial regression on the survey data collected in Edmonton in 2018. The descriptive analysis revealed that walking was the activity with the highest frequency, followed by walking and cycling, and walking with pets, whereas cycling had the lowest priority. The multinomial model showed that as the age increases, residents are less likely to perform activities other than walking or cycling alone. Further, residents with higher education are more likely to either walk and cycle or walk, run, and cycle. Residents whose secondary mode of transportation is bicycle are less likely to walk and walk pets. Residents who own their house are likely to walk and walk pets. Furthermore, male residents, residents with children and those whose primary mode of transportation is not personal vehicles are more likely to walk, run, and cycle but less likely to walk and walk pets, compared with either walking or cycling alone. Planners can utilize the findings to understand the possible utilization of the planned SUPs and design them accordingly. **DOI: 10.1061/JTEPBS.TEENG-8381.**

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Background

Shared-use paths (SUPs) refer to paved off-street routes utilized by pedestrians, cyclists, and others. The SUPs can be constructed along traffic roadways (separated by a buffer) or away from roadways, presenting less risk of collisions with motor vehicles (Delaney et al. 2017; Kutela et al. 2023). In addition to that, SUPs can either freely interact in the same space without separation (unsegregated) or have designated areas for each group marked with surface markings and signs (Delaney et al. 2017). SUPs have emerged as significant and versatile components of modern transportation systems, offering dedicated and safe routes for nonmotorized traffic (Hummer et al. 2006). In addition, SUPs offer a sustainable and inclusive mobility solution while promoting active transportation, healthier lifestyles, and reduced congestion. Environmentally, SUPs, also known as GreenPaths (Beiler and Waksmunski 2015), present multiple benefits because they reduce noise and greenhouse gas (GHG) emissions, improve air quality, and conserve energy. Socially, SUPs promote connectivity, accessibility, and improved health within an area, and economically, SUPs increase tax revenues, local business sales, and the real estate market (Beiler and Waksmunski 2015).

The most common activities along SUPs are walking and cycling. However, other activities such as inline skating, roller skating, skateboarding, wheelchair use, electric bicycle use, scooter riding, and walking pets can also take place on the same shared-use paths. The choice of activity can be influenced by various factors and can greatly influence the planning and design of SUPs. For instance, it is relatively rare to expect that the SUP in an elderly community will have more cycling activities. Further, if the SUP intends to accommodate cyclists and walkers simultaneously, markings and signs for safe and comfortable flow should be provided. However, the literature pertaining to the key factors influencing such activities is relatively scarce.

Therefore, this study explores the social demographic factors influencing activities along SUPs. The findings from this study would benefit planners and engineers who focus on active transportation. The next section presents the study objective. Then, the literature review is given, followed by the methodology applied to understand various studies related to SUPs. The data description is then presented, followed by the modeling results and discussion, where the implications of the key findings are presented. Lastly, the conclusions are made, and future studies are proposed.

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Study Objective

The primary objective of this study is to elucidate the multifaceted dynamics of user activities on SUPs, with a particular focus on the social-demographic factors that influence these activities. By exploring the intricate relationship between users and their environment, this research aims to uncover deeper insights into how diverse user groups interact with SUPs and the extent to which these interactions affect their preferences and satisfaction. The goal is to provide a foundation for informed decision-making in the planning, design, and management of SUPs, ensuring they meet the needs of all users effectively and sustainably.

To achieve this overarching aim, the study is guided by the following specific objectives:

- Analyze user preferences and behaviors on SUPs: Examine the variety of activities undertaken on SUPs, including walking, cycling, scooter riding, skateboarding, and other forms of nonmotorized transport. This analysis will identify prevalent usage patterns and highlight how these patterns vary among different social-demographic groups.
- Investigate the influence of environmental features on user satisfaction: Assess how design elements of SUPs, such as path width, surface material, signage, and proximity to natural features, impact user satisfaction. This objective seeks to understand the role of physical infrastructure in enhancing or detracting from the user experience on SUPs.
- Provide guidelines for the inclusive design and management of SUPs: Develop actionable recommendations for urban planners and policymakers based on the findings from the analysis of user behaviors and environmental influences. These guidelines will focus on creating SUPs that are accessible, safe, and enjoyable for a diverse range of users, thereby promoting active transportation and contributing to the overall well-being of the community.

Through these specific objectives, this study aims to contribute valuable new insights into the dynamics of SUP usage and inform the development of more inclusive and effective urban mobility solutions.

Literature Review

The use of shared-use paths could be categorized as part of Active Transportation. Active Transportation involves utilizing human-powered modes of travel such as walking, cycling, or skating, with a focus on promoting physical activity, reducing traffic congestion, and minimizing environmental impact. Active Transportation has been proven to provide substantial health benefits from increased physical activities (Mueller et al. 2015). Unlike motorized modes of transportation, the use of SUPs is highly affected by various factors including weather and the nature of the surface (Gregory et al. 2024).

As indicated, SUPs can accommodate a variety of activities either at the same or different times. Various studies have explored SUP users' interactions, focusing on safety, choice, and perceptions, among others (Gkekas et al. 2020). Because SUPs accommodate diverse types of users, collisions are expected (Hummer et al. 2006), with pedestrians being most vulnerable compared with other users. A survey study revealed a high frequency of incidents between pedestrians and cyclists along SUPs (Gkekas et al. 2020). Using a sample size of 684 SUP collision records, Aultman-Hall and LaMondia (2005) deduced that skaters had the highest crash rate, followed by bicyclists and pedestrians. The study also reported that falls associated with injuries were more common than collisions along urban SUPs.

Various studies have analyzed the interactions and user perspectives between walking and cycling activities along SUPs. Using data from a heavily utilized shared path in Bristol, UK, Delaney et al. (2017) identified that most pedestrians prefer a segregated shared path, whereas cyclists prefer a nonsegregated path. According to the survey, the majority of cyclists steered clear of busy pedestrian areas to avoid incidents, with both cyclists and pedestrians agreeing that crowding and pedestrian inattention were key contributors to pedestrian–cyclist incidents. However, the two groups held differing opinions regarding the significance of cyclist speed as a factor (Gkekas et al. 2020). In addition, Kang and Fricker (2016) deduced that pedestrians with a less tolerant attitude desired a separation distance of about 1.524 m (5 ft) between them and cyclists.

To estimate the level of service of the SUP, Hummer et al. (2006) and Patten et al. (2006) identified volume, mode split, path width, and the presence or absence of a centerline as the LOS model inputs. This aligns with two user perspective studies that identified trail attributes, such as adequate separation from motor vehicles, surface type, and width, to contribute significantly to SUP user satisfaction.

Various factors influence mode choice among SUP users. For instance, Cox (2013) identified that the level of SUP use among young children is highly influenced by the presence of wildlife along the paths, physical activity, contact with nature, and scenic beauty along the paths. Using a survey to identify the level of service of SUP facilities, Hummer et al. (2005) identified that young, male, and healthier SUP users provided higher scores for the different SUPs observed, whereas older, female, and fair-healthy users provided lower scores. This reflects the fact that the latter group is more sensitive to comfort and safety compared with the other group when it comes to using shared paths (Kiyota et al. 2000).

In a health impact assessment of SUPs, findings revealed that proximity/closeness, availability of facilities, and safety concerns due to lose dogs, substance use, and uneven ground influence residents' use of outdoor spaces, including shared-use paths (Team 2015). Factors influencing cycling rates among adults in Portland, Oregon, included demographic and environmental conditions such as average temperature and street connectivity (Dill and Voros 2007). Another survey study in Bangkok, Thailand, revealed that traveling behavior factors, cycling promotion plans, and legislation pertaining to bicycle usage highly influence the use of bicycles along shared-use paths (Raha and Taweesin 2013).

Using survey, census, and GIS data for a small urban area in Vermont, Bricka et al. (2012) identified that the population's income and education influenced nonmotorized travel, specifically walking, in urban environments, further deduced that physical activity and destination proximity influence residents' decision to walk. Other factors influencing residents to walk include surface quality, services, public transit availability, connectivity, pet walking, safety from traffic and crime, familiarity, aesthetics, and city size (Kim and Heinrich 2016; Ma et al. 2021; Van Cauwenberg et al. 2012). The literature review suggests that most studies have analyzed environmental and social factors influencing SUP activities.

The summary of the literature indicates that various aspects of the SUPs have been studied; however, knowledge of the activities along the SUPs has still not been studied to a great extent. Understanding the activities performed along the SUPs and the influencing factors would facilitate a better design by focusing on the users' expectations. This is, if the SUP is planned to be constructed at a location where users are likely to be walkers only, the designs should be so that the users may feel comfortable. Similarly, for the SUPs whose dominant users will be walking dogs, the facilities should be as supportive as possible to make them enjoy walking their dogs. Therefore, this study explored

various activities performed along the SUPs. The findings will help planners and policymakers to provide conducive environments for SUP users.

In addition to that, this study has used demographic data to show its relation to activities likely to occur along SUPs. These findings are useful to planners in growing cities and urban areas because demographic information such as could be used to influence the design of the SUPs or green paths in particular areas. Moreover, understanding the demographic characteristics of users can help tailor outreach and programming efforts to ensure inclusivity and accessibility for all community members. By aligning SUP designs with the needs and preferences of local populations, planners can create vibrant, welcoming spaces that encourage active lifestyles and foster community cohesion.

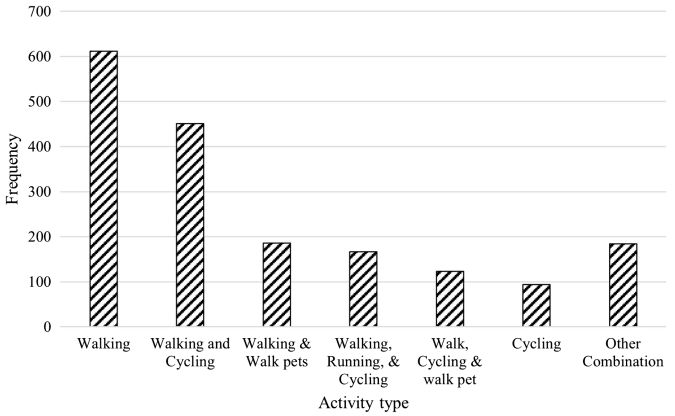

Fig. 1. Distribution of the types of activities in the SUPs.

Study Location and Data Description

Study Location

Edmonton, Canada, serves as an intriguing urban context for the investigation of behaviors and safety concerns related to SUPs. The city is known for its encouraging stance toward cycling as an eco-friendly travel option, with SUPs playing a vital role in Edmonton's overall transport network by serving a diverse mix of users, including cyclists, walkers, and more. This aligns with Edmonton's broader objectives of achieving sustainable and inclusive urban planning (City of Edmonton 2024; Edmonton Police 2024).

Edmonton's commitment to outdoor and recreational accessibility is exemplified by its extensive network of over 160 km of shared-use paths (City of Edmonton 2024). These paths strategically link neighborhoods, parks, and commercial areas, serving dual roles in recreation and as essential nonmotorized commuting conduits.

Data Description

The data used in this study were collected through a survey conducted in Edmonton, Canada, and made available through the city's open data portal. The survey was administered over a 1-week period, specifically from June 12 to June 19, 2018. Survey respondents were from 36 Zip codes within Edmonton. Only two of the 36 Zip codes did not have a network of shared-use paths, two had two short segments of shared-use paths, and 11 had at least eight segments of shared-use paths. On the other hand, about 21 Zip codes had several scattered shared-use paths. The survey covered several aspects, including the frequency of the utilization of shared-use paths. In this case, respondents were supposed to indicate if they have never used them, used them less than once, twice, three to four, and over five times per week (Kutela et al. 2024; City of Edmonton 2018). Although the survey covered several aspects of the SUP, the primary objective of this study was to investigate the usage patterns of SUPs and identify the key factors influencing different categories of SUP users. To achieve this, the study used responses to a specific question to determine the type of activities.

The question stated: How do you use shared-use paths? Respondents were supposed to choose from walking, cycling, scooter, skateboard, running, or rollerblade.

Multiple choices were allowed because the same person might be involved in two or more activities. In addition to the types of activities, respondents were asked about their sociodemographic profiles. Such details encompassed age, gender, income, primary and secondary modes of transportation, education level, home ownership status, and parental responsibilities. These details facilitated a comprehensive understanding of the respondent population (City of Edmonton 2018).

The data were sourced from a survey conducted through the Edmonton Insight Community, a diverse group of Edmonton residents who volunteer to provide input on urban issues. The responses were collected through a call-to-action button on a webpage and anonymous links (City of Edmonton 2018), with a total of 8,431 invitations sent out. The survey yielded a total of 2,356 completed responses, representing a response rate of approximately 27.5%. Among the respondents, 2,323 were members of the Insight Community who received survey invitations, demonstrating active engagement with the study. Additionally, 10 participants were acquired through a call-to-action button featured on the official Edmonton website, indicating interest from a broader audience. Moreover, 23 individuals accessed the survey via anonymous links on edmonton.ca/surveys; however, their demographic information needed to be captured for analysis. After cleaning the data, a total of 1,817 responses, representing a wide array of participants, were retained for further analysis.

The combination of activities was scanned to understand the distribution. According to Fig. 1, it is evident that most respondents engage in either walking or walking and cycling, followed by walking and walking pets. On the other hand, the least common activity is cycling alone, and the combination of walking, cycling, and walking pets had a relatively small proportion of respondents.

Methodology

This section presents the methodological approach utilized in this study. It covers the data description and modeling approach. The data collection and description are presented to better understand the modeling approach because the nature of the data dictates the applied methodology.

Modeling Approach

Activities along the SUPs can greatly vary according to the expected users. However, in this study, users are expected either to walk alone, walk with a dog, run, cycle, or a combination of these activities. That being the case, the nature of the outcome variable calls for the unordered type of model to associate the activities and the socio-demographic factors. Thus, this study utilized the multinomial logit (MNL) model to evaluate the key factors associated with the activities along the SUPs.

To apply the MNL model, the reference category should be defined (Fan et al. 2015, 2016; Salum et al. 2019; Zhao and Khattak 2015). In this study, the reference category is walk or cycle. Suppose that the response variable (i.e., activities) Y has K number of observed categories. Eq. (1) shows the probability of each activity category

$$\text{Prob}(Y = i) = \frac{\exp(\lambda_i)}{\sum_{h=1}^{K} \exp(\lambda_{hi})} \quad (1)$$

where $\lambda_i = \beta_0 + \sum_{h=1}^{H} \beta_{ih} X_{ih}$, where β_0 is the constant term, β_{ih} is the vector of estimable coefficients, and X_{ih} is the vector of explanatory variables.

The model interpretation is based on the relative risk ratio (RRR), which is the exponent of the estimated MNL coefficients. According to Çelik and Oktay (2014), the RRR represents the ratio between the predicted probability of a particular category to the base category. Thus, the relative probability of the other categories ($Y = i$) to the walk category ($Y = 1$) can be estimated using Eq. (2)

$$\text{RRR} = e^{\text{coef}} = \frac{P(Y = i)}{P(Y = 1)} \quad (2)$$

where coef = estimated coefficient in the MNL model.

Thus, the variable with RRR greater than one is associated with an increase in the likelihood of the activity, given the other variables in the model are held constant. The opposite can be inferred if the RRR is less than one (Çelik and Oktay 2014; Kutela et al. 2022).

Descriptive Analysis

Based on the 1,817 responses, the descriptive analysis was prepared and is presented in Table 1. Examining the distribution of activities by age group, it is notable that individuals aged 60 years and above displayed a higher preference (58.3%) for using shared-use paths for walking. In contrast, respondents below 49 years of age tended to prefer walking and cycling activities. Moreover, as age increased, the preference for activities such as running and walking pets decreases. These trends can be attributed to the physical limitations, increased risk of injury, and health considerations typically associated with the older age group.

The respondents' primary and secondary modes of transportation were investigated. The analysis revealed that individuals with personal vehicles (39.9%) exhibited a greater inclination to walk or cycle on shared-use paths compared with those without personal vehicles (36.5%). Additionally, respondents with personal vehicles (12.5%) were more likely to choose to walk their pets

Table 1. Descriptive statistics of the activities in the SUPs

	Walk or cycle alone		Walk and cycle		Walk and walk pets		Walk, cycle, and walk pet		Walk, run, and cycle		Other combination	
Variable	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent
House ownership												
Rent	129	36.6	99	28.1	18	5.1	21	6.0	51	14.5	34	9.7
Own	577	39.4	352	24.0	168	11.5	102	7.0	116	7.9	150	10.2
Gender												
Female	384	38.7	221	22.3	126	12.7	73	7.4	77	7.8	110	11.1
Male	322	39.0	230	27.8	60	7.3	50	6.1	90	10.9	74	9.0
Respondent has child/children												
No	578	40.9	343	24.3	152	10.7	93	6.6	114	8.1	134	9.5
Yes	128	31.8	108	26.8	34	8.4	30	7.4	53	13.2	50	12.4
Primary mode of transportation												
Personal vehicle	504	39.9	297	23.5	154	12.2	91	7.2	97	7.7	121	9.6
Nonpersonal vehicle	202	36.5	154	27.8	32	5.8	32	5.8	70	12.7	63	11.4
Secondary mode of transportation												
Vehicular	310	38.9	158	19.8	106	13.3	57	7.2	64	8.0	101	12.7
Public transit	176	46.3	94	24.7	35	9.2	22	5.8	29	7.6	24	6.3
Bicycle	42	19.5	88	40.9	4	1.9	20	9.3	38	17.7	23	10.7
Walk	178	41.8	111	26.1	41	9.6	24	5.6	36	8.5	36	8.5
Household income												
Below $30,000	42	46.2	23	25.3	2	2.2	6	6.6	9	9.9	9	9.9
$30,000–$49,999	68	48.6	29	20.7	12	8.6	8	5.7	11	7.9	12	8.6
$50,000–$79,999	128	41.8	86	28.1	26	8.5	14	4.6	25	8.2	27	8.8
$80,000–$99,999	95	40.8	52	22.3	20	8.6	14	6.0	30	12.9	22	9.4
$100,000–$149,999	164	39.3	102	24.5	44	10.6	30	7.2	35	8.4	42	10.1
$150,000 and above	108	28.9	95	25.4	46	12.3	32	8.6	40	10.7	53	14.2
Prefer not to mention	101	39.5	64	25.0	36	14.1	19	7.4	17	6.6	19	7.4
Education level												
High school and below	103	46.0	47	21.0	29	12.9	17	7.6	14	6.3	14	6.3
College/technical school	216	48.6	93	20.9	52	11.7	30	6.8	22	5.0	31	7.0
Bachelor's degree	241	35.8	171	25.4	60	8.9	44	6.5	74	11.0	83	12.3
Postgraduate degree	127	31.5	116	28.8	34	8.4	28	6.9%	50	12.4	48	11.9
Professional school graduate	19	26.0	24	32.9	11	15.1	4	5.5	7	9.6	8	11.0
Age												
Below 30 years	58	26.4	66	30.0	14	6.4	14	6.4	37	16.8	31	14.1
30–39	119	27.1	112	25.5	48	10.9	35	8.0	65	14.8	60	13.7
40–49	95	29.4	97	30.0	29	9.0	22	6.8	31	9.6	49	15.2
50–59	178	44.9	78	19.7	53	13.4	34	8.6	24	6.1	29	7.3
60 years and above	256	58.3	98	22.3	42	9.6	18	4.1	10	2.3	15	3.4

on shared-use paths, as opposed to respondents without personal vehicles (5.8%).

Considering the respondents' education levels, individuals who have completed high school (46%) or college education (48.6%) were more likely to use shared-use paths for walking or cycling. On the other hand, professional school graduates preferred using shared-use paths for walking pets and cycling, potentially as a means to unwind after their professional activities. Therefore, they exhibited a lower preference for walking than individuals with lower education levels.

Regarding household income, a negative correlation was observed between income levels and the preference for walking or cycling on shared-use paths. Those with lower incomes demonstrated a greater inclination toward using shared-use paths for walking or cycling, potentially due to financial constraints associated with pet ownership. Conversely, higher-income individuals preferred walking pets (25.4%) and other activities (14.2%) on shared-use paths, likely due to fewer financial and time constraints.

Analyzing respondents with and without children, it was evident that both groups preferred walking or cycling on shared-use paths. However, respondents without children had a slightly higher preference (40.9%) than those with children (31.8%). The responsibilities associated with parenthood may limit the availability of time for walking or cycling, but individuals with children may choose to walk pets and engage in other activities on shared-use paths to fulfill their need for physical activity during leisure time.

Lastly, when considering gender, there was no substantial difference in the preference for using shared-use paths for walking or cycling between males (39%) and females (38.7%). However, the analysis revealed that more females (12.7%) preferred walking pets on shared-use paths than males (7.3%). This difference may be influenced by safety concerns because females may be more inclined to avoid using shared-use paths alone. It is important to note that these findings are based on descriptive statistics analysis, and further research and analysis may be necessary to draw more definitive conclusions. The forthcoming section will provide a comprehensive account of the multinomial logit model conducted to examine the utilization of SUPs, leveraging the responses received.

Model Results and Discussion

Table 2 presents the multinomial logit model results for the activities that occur in the SUPs. Seven variables, which are house ownership, gender, having children, primary and secondary mode of transportation, income, education level, and age of respondents, are presented in the table. The magnitude of the influence of these variables is assessed using the RRR, and the p-values are used to evaluate their statistical significance at the 95% confidence level.

Gender

According to the results in Table 2, in comparison with walking alone, males were more likely to walk, run, and cycle but less likely to walk and walk pets compared with females. This was revealed by the RRR values of the variable for the two activities. In fact, male respondents were about 39% more likely to walk, run, and cycle than female respondents. On the other hand, people of the same gender were about 42% less likely to walk and walk pets. The observation can be attributed to the fact that males are more likely to be physically active compared with women (Giustino et al. 2020). Similarly, women were more likely to walk pets compared with males in almost every environment. Females are more likely than males to feel safer walking with their dog in their neighborhood (Christian et al. 2016); thus, this observation on the SUP is likely.

Compared with respondents who walk alone, those with children demonstrated a higher propensity for walking, running, and cycling, while exhibiting a lower inclination towards walking and walking pets. This trend is evident from the RRR values associated with walking, running, and cycling, and walking and walking pets, as indicated in Table 2. Specifically, respondents with children were approximately 65% more likely to engage in walking, running, and cycling than those without children. Conversely, the same group of respondents with children was approximately 43% less likely to participate in walking and walking pets. These results imply that the demands of parenting, including childcare responsibilities and time constraints, can limit their ability to engage in activities that are primarily focused on pet-related tasks unless walking is combined with more physical activities such as running and cycling (Hutchens and Lee 2017).

Primary Mode of Transportation

Interesting trends emerged when comparing respondents who walk alone with those whose primary mode of transportation is not a personal vehicle. The latter group demonstrated a higher inclination toward walking, running, and cycling but showed a decreased likelihood of engaging in regular walking and walking pets, in contrast to respondents who rely on personal vehicles for commuting. In fact, those whose primary mode of transportation is not a personal vehicle were approximately 44% more likely to participate in walking, running, and cycling compared with their counterparts who use personal vehicles. Conversely, this same group exhibited a significant decrease of about 58% in their likelihood to engage in regular walking and walking pets. The findings suggest that individuals for whom a personal vehicle is not their primary mode of transportation are more likely to rely on bicycles for their daily commuting needs (Zhu and Mason 2014).

Additionally, this group of respondents demonstrated a higher propensity for engaging in physical activities such as running or cycling for leisure purposes (Engbers and Jm Hendriksen 2010). These observations indicate a correlation between transportation choices and increased participation in physical activities among those without personal vehicles. Table 2 further highlights that respondents who depend on personal vehicles for their daily commute exhibited a higher likelihood of engaging in walking and walking pets, in contrast to those who do not use personal vehicles as their primary mode of transportation. Such respondents prefer relatively less intense activities. This preference could be attributed to their prioritization of convenience, comfort, and time-saving aspects typically associated with using personal vehicles (Chaix et al. 2014).

In contrast to respondents who walk alone, respondents whose secondary mode of transportation is a bicycle had a significantly higher likelihood, ranging from two to seven times, of engaging in various combinations of activities such as (1) walking and cycling, (2) walking, cycling, and walking pets, and (3) walking, running, and cycling, as well as other combinations as opposed to solely walking and walking pets. In fact, respondents who use bicycles were 74% less likely to walk and walk pets compared with those who use vehicles. This finding is intuitive because relying on a bicycle as the second transportation mode increases the likelihood of cycling, decreasing the likelihood of walking alone or walking and walking pets, compared with respondents who use vehicles as the second option (Monterde-I-bort et al. 2022). In contrast, individuals for whom walking serves as the secondary mode of transportation exhibited a substantial 54% higher likelihood of engaging in walking and cycling compared with those who rely on vehicles as their secondary mode of transportation. This disparity becomes evident when comparing them with respondents who walk alone.

Table 2. Multinomial logit model for activities in the SUPs

	Walk and cycle			Walk and walk pets			Walk, cycle, and walk pet			Walk, run, and cycle			Other combination		
Variable	Coefficient	RRR	*p*-value	Coefficient	RRR	*p*-value	Coefficient	RRR	*p*-value	Coefficient	RRR	*p*-value	Coefficient	RRR	*p*-value
Intercept	−0.741	0.48	0.047	−1.936	0.14	0.016	−1.163	0.31	0.045	−1.714	0.18	0.001	−1.031	0.36	0.045
House ownership															
Own	−0.042	0.96	0.823	**0.544**	**1.72**	**0.071**	0.051	1.05	0.868	−0.339	0.71	0.174	0.278	1.32	0.288
Gender															
Male	0.181	1.20	0.164	***−0.541***	***0.58***	***0.003***	−0.247	0.78	0.234	**0.331**	**1.39**	**0.079**	−0.205	0.81	0.257
Respondent has child/children															
Yes	0.121	1.13	0.485	***−0.566***	***0.57***	***0.017***	−0.117	0.89	0.650	***0.498***	***1.65***	***0.029***	−0.125	0.88	0.570
Primary mode of transportation															
Nonpersonal vehicle	0.230	1.26	0.130	***−0.874***	***0.42***	***<0.001***	−0.324	0.72	0.194	**0.362**	**1.44**	**0.090**	−0.144	0.87	0.481
Secondary mode of transportation															
Public transit	0.161	1.17	0.351	***−0.580***	***0.56***	***0.011***	−0.337	0.71	0.230	0.019	1.02	0.942	***−0.796***	***0.45***	***0.002***
Bicycle	***1.554***	***4.73***	***<0.001***	***−1.359***	***0.26***	***0.012***	***1.019***	***2.77***	***0.002***	***1.888***	***6.61***	***<0.001***	***0.646***	***1.91***	***0.034***
Walk	***0.430***	***1.54***	***0.011***	−0.336	0.71	0.126	−0.142	0.87	0.606	0.418	1.52	0.099	−0.223	0.80	0.340
Household income															
$30,000–$49,999	−0.120	0.89	0.742	1.107	3.02	0.167	−0.163	0.85	0.785	0.017	1.02	0.975	−0.130	0.88	0.800
$50,000–$79,999	0.385	1.47	0.228	1.132	3.10	0.140	−0.335	0.72	0.537	0.263	1.30	0.576	−0.076	0.93	0.868
$80,000–$99,999	0.199	1.22	0.561	1.042	2.84	0.183	−0.025	0.98	0.965	**0.842**	**2.32**	**0.079**	−0.019	0.98	0.968
$100,000–$149,999	0.260	1.30	0.424	1.253	3.50	0.101	0.122	1.13	0.816	0.386	1.47	0.414	−0.003	1.00	0.994
$150,000 and above	**0.571**	**1.77**	**0.092**	***1.710***	***5.53***	***0.026***	0.615	1.85	0.249	**0.950**	**2.59**	**0.051**	0.624	1.87	0.178
Prefer not to mention	0.520	1.68	0.126	***1.677***	***5.35***	***0.029***	0.409	1.51	0.451	0.611	1.84	0.232	0.108	1.11	0.825
Education level															
College/technical school	−0.127	0.88	0.576	−0.189	0.83	0.490	−0.200	0.82	0.552	−0.346	0.71	0.366	0.106	1.11	0.766
Bachelor's degree	0.227	1.25	0.288	−0.252	0.78	0.350	−0.048	0.95	0.882	0.489	1.63	0.143	***0.695***	***2.00***	***0.033***
Postgraduate degree	***0.563***	***1.76***	***0.015***	0.033	1.03	0.914	0.270	1.31	0.442	0.913	2.49	0.010	***0.997***	***2.71***	***0.004***
Professional school graduate	***0.818***	***2.27***	***0.028***	0.642	1.90	0.157	−0.007	0.99	0.991	0.786	2.20	0.159	***1.061***	***2.89***	***0.046***
Age (years)															
30–39	−0.310	0.73	0.192	0.298	1.35	0.411	0.066	1.07	0.861	−0.355	0.70	0.217	−0.257	0.77	0.382
40–49	−0.351	0.70	0.175	−0.043	0.96	0.914	−0.325	0.72	0.436	***−1.062***	***0.35***	***0.002***	−0.317	0.73	0.326
50–59	***−1.104***	***0.33***	***<0.001***	−0.341	0.71	0.354	−0.537	0.58	0.166	***−1.685***	***0.19***	***<0.001***	***−1.437***	***0.24***	***<0.001***
60 years and above	***−1.232***	***0.29***	***<0.001***	***−0.955***	***0.38***	***0.010***	***−1.477***	***0.23***	***<0.001***	***−2.805***	***0.06***	***<0.001***	***−2.441***	***0.09***	***<0.001***

Note: Bolded numbers are statistically significant at a 90% confidence level; and Italicized numbers are statistically significant at a 95% confidence level.

Household Income

When comparing respondents who walk alone, those with an annual household income of $150,000 and above demonstrated a substantial 77% higher likelihood of engaging in walking and cycling, in contrast to those with a household income below $30,000. Furthermore, individuals in the higher income bracket showed an increased propensity, ranging from three to six times, for activities such as walking, running, and cycling, as well as walking and walking pets.

Several factors could potentially explain the findings observed in this context. Firstly, individuals with higher household incomes may have more resources available, allowing for greater access to recreational facilities, parks, and pedestrian-friendly environments that encourage walking and cycling (Sallis et al. 2016). Additionally, they may prioritize physical fitness and wellness, and have more leisure time to engage in these activities (Chudyk et al. 2017). On the other hand, because of the economic disparities, individuals with lower household incomes may face greater time constraints or have limited access to safe and well-maintained walking and cycling infrastructure (Sallis et al. 2016).

A significant difference emerged in the comparison between respondents who walk alone and those who opted not to disclose their household income. Respondents who preferred not to reveal their income were approximately five times more likely to engage in the combined activities of walking and walking pets, compared with individuals earning less than $30,000. This finding suggests that the decision to withhold income information may be associated with a higher inclination toward participating in walking and pet-related activities (Chudyk et al. 2017).

Education Level

The education level of individuals has been found to influence their engagement in SUP-related activities. A study conducted by Kuhn et al. (2021) examined the associations between teachers' physical activity practices and teacher-level factors, including their own physical activity, and school-level factors. The study found that teachers who spent more time in moderate-vigorous physical activity (MVPA) reported implementing more physical activity–promoting practices.

Interestingly, other individual-level factors, such as teachers' years of full-time experience and education level, were found to positively predict teacher physical activity–promoting practices. This suggests that individuals with higher education levels might have a better understanding of the importance of physical activity, leading to a higher likelihood of engaging in walking and cycling activities. Furthermore, the study also found that school-level factors, such as school type, school socioeconomic status, school racial/ethnic composition, and school urbanicity, could affect physical activity opportunities for students. This indicates that the environment in which individuals find themselves can also influence their engagement in SUP-related activities (Kuhn et al. 2021).

Age

When considering the age of respondents, some differences emerged in comparison with walking alone. Respondents aged between 40 and 49 years were 65% less likely to participate in the combined activity of walking, running, and cycling compared with individuals aged 30 years or younger. These findings highlight the decreasing likelihood of engaging in these activities as respondents move into higher age brackets, suggesting age-related factors that influence participation in specific SPU combinations (Schroé et al. 2020). Respondents aged 60 years and above exhibited a significant decrease, ranging from 60% to 94%, in the likelihood of engaging in various combinations of activities, including walking and cycling, walking and walking pets, walking, cycling, and walking pets, and walking, running, and cycling, as well as other combinations. Physical limitations, lifestyle preferences, safety concerns, and health considerations (Willumsen and Bull 2020) could explain these findings.

Additionally, in comparison with respondents aged 30 years or younger, respondents in the age range of 50–59 years exhibited a substantial decrease in the likelihood of engaging in some activities. Specifically, they were 67% less likely to participate in walking and cycling, and 81% less likely to engage in walking, running, and cycling. Moreover, this same age group demonstrated a 76% lower likelihood of using other combinations of activities, in contrast to their younger counterparts. These findings could be attributed to a combination of factors like physical changes (Willumsen and Bull 2020), lifestyle factors such as additional responsibilities, personal preferences and priorities, and health considerations.

Household Ownership

In comparison with walking alone, respondents who are homeowners exhibited a higher propensity for engaging in walking and walking pets. They were approximately 72% more likely to participate in these activities compared with those who do not own a house. This finding suggests a correlation between homeownership and an increased likelihood of engaging in walking and walking pets (Sallis et al. 2016).

Conclusions and Future Studies

This study intended to understand the pattern of activities along the SUPs. The study used survey data collected from Edmonton, Canada, between June 12 and June 19, 2018. In addition to the activities performed along the SUPs, the respondents were asked about their sociodemographic details, which made it possible to associate the two. The association of these factors was performed using the multinomial regression model. According to the results, walking was the activity with the highest frequency, followed by walking and cycling, and walking with pets, whereas cycling had the lowest priority. Further, the multinomial model showed that as age increased, residents were less likely to either walk or cycle alone. Furthermore, residents with higher education were likely to perform various combinations of activities, which include walking and cycling and running and cycling compared with walking or cycling alone.

Other great variations in the SUP activities were observed for residents whose secondary mode of transportation is a bicycle, male residents, residents with children, and those whose primary mode of transportation is not personal vehicles. Based on the analysis and the findings, policymakers, city planners, and engineers who want to provide SUPs for their communities can consider the following key takeaways. Planners, policymakers, and engineers should first learn the population characteristics. Upon understanding their population, the following should be done for each group the SUPs are intended for:

- Adaptive design for age-inclusive SUPs: Recognizing the significant impact of resident age on SUP activities, designs should incorporate adaptive features that cater to all age groups. This includes wider paths to accommodate mobility devices, gentle slopes rather than stairs, and benches at regular intervals for rest. Paths in areas with a higher concentration of older residents should incorporate tactile paving to aid those with visual

impairments and ensure all signage includes large, high-contrast lettering for readability.

- Educational and professional area integration: SUPs intersecting with educational and professional zones must prioritize safety and efficiency to support the high-traffic volumes expected during peak times. Implementing dedicated cycling lanes within these paths, separated by physical barriers, can reduce conflicts between cyclists and pedestrians. Additionally, providing bike parking and repair stations near entrances to these institutions encourages cycling as a viable commute option.
- Enhanced amenities for high-income neighborhoods: To address the needs of residents in high-income areas, SUPs should feature comprehensive pet waste management solutions, including strategically placed waste stations with biodegradable bags and disposal bins. Introducing green landscaping elements like shrubs and flowers along these paths not only enhances aesthetic appeal but also promotes environmental stewardship among users.
- Multimodal transport integration: For users relying on various modes of transportation, SUPs should offer seamless connectivity to public transport hubs, bike-share stations, and parking areas for e-scooters. Signage should clearly direct users to these facilities, incorporating QR codes for real-time transport updates. In areas with mixed activities, creating distinct zones for different speeds and activities—such as slow zones for pedestrians and high-speed lanes for cyclists—enhances safety and user experience.
- Technology-enhanced SUP management: Implementing smart technology solutions, such as sensor-based lighting that adjusts based on the time of day and user presence, can significantly improve safety and energy efficiency. Mobile apps that provide users with information on SUP conditions, congestion levels, and alternate routes can enhance the user experience.
- Community engagement and feedback mechanisms: Establishing platforms for community feedback on SUP design and maintenance ensures that the paths continually meet user needs. This could include digital suggestion boxes, community workshops, and interactive planning sessions with local government and planning bodies.
- Sustainability and resilience focus: Incorporating sustainable design principles, such as permeable surfaces for water management and the use of recycled materials in construction, contributes to the environmental resilience of SUPs. Planting native vegetation along the paths not only provides shade and beauty but also supports local biodiversity.

Although this study addressed various activities expected in the SUPs, more studies may be needed. More specifically, the inclusion of variables such as the proximity of the SUPs to the roadway, downtown areas, and so on, may improve the applicability of the findings.

Data Availability Statement

Some or all data, models, or code that support the findings of this study are available from the corresponding author upon reasonable request.

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