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Examining the role of trip destination and neighborhood attributes in shaping environmental influences on children's route choice

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ABSTRACT

Routes are a common way through which child pedestrians experience the built environment. However, empirical evidence on route-scale environmental influences on children's walking are scarce and mainly concern home-school itineraries. To address this gap, this study aims to identify environmental influences on children's route choice, and to explore how these may vary by trip destination and neighborhood type. One hundred and seven children (10–12 year old) living in inner-city and clustered suburban neighborhoods in Rishon LeZion, Israel participated in the study. Participants were instructed to draw the routes along which they regularly walk from their home to four destinations: School, public facility, retail and park. We then compared the attributes of the built environment for the walking trips reported, relative to the trips that would have taken the shortest path along the street, path, and alley network for each origin-destination pair using conditional logistic regression, while adjusting for the correlation across choices, route length, and individual characteristics. Comparisons of chosen and non-chosen routes suggest that routes with fewer intersections are more likely to be selected, if they have fewer intersections but more compact urban form along the route. The ratio of built-to-lot area and distance remained significant, but residential land uses and the walkability index were differentially associated with route choice when analyses were stratified by destination and neighborhood type. Being the first study to explore route choice by both location and destination and given that environmental influences on walking are context specific, this study provides valuable insights on environment-behavior interactions.

1. Introduction

In recent decades, the adverse health effects of sedentary life-style (Biswas et al., 2015) along with the negative environmental impact of increasing car use (Frank et al., 2003) has led to intensive investment in active mobility as part of a wider urban health agenda (Corburn et al., 2004). Amongst the various types of active mobility, walking may be the easiest to adopt and adhere to, as it has zero cost and requires no special skills or equipment. Walking for transport has positive health impacts throughout the lifespan (Scheepers et al., 2014) and especially during childhood, given the high and rising prevalence of childhood overweight and obesity worldwide (Gupta et al., 2012; Lobstein et al., 2004). Replacing car-trips with walking is highly beneficial for children because it decreases car-pedestrian conflicts (Lyon and Persaud, 2002) as well as traffic-related pollution, to which children are highly sensitive (Jerrett et al., 2008; Schwartz, 2004). Furthermore, children's walking contributes to their socio-emotional development by positively

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affecting their independence and improving self-image and social ties (Kingham and Ussher, 2007).

Despite its clear benefits, children's active mobility and walking for transport has been decreasing over the years throughout the world. In the USA between 1969 and 2009, the percent of children walking or biking to school dropped from 40.7% to 12.7% (McDonald et al., 2011). In Australia, the percent of children who walked to school dropped from 57.7% in 1971 to 25.5% in 1999–2003 (Van der Ploeg et al., 2008). These trends have been attributed to various factors, such as: increased car reliance, low access to schools, and low-density suburban development (Frank et al., 2003).

Neighborhood characteristics play an important role in enhancing active mobility. Accumulating empirical evidence supports the role of the physical environment in enhancing active mobility and transportation walking in particular (Saelens and Handy, 2008; Sallis et al., 2012). Walking was found to be more common in inner-cities compared to suburban neighborhoods (Khattak and Rodríguez, 2005). Among general populations as well as among children, walking has been linked to high walkability (Owen et al., 2007) and other walkability-related characteristics, such as street connectivity (Giles-Corti et al., 2011; Sugiyama et al., 2012), residential density (Carlson et al., 2014), land-use mix/access to destinations (Koohsari et al., 2014; Lee and Moudon, 2006) and sidewalks (Boarnet et al., 2005; Sugiyama et al., 2012).

In addition to neighborhood characteristics, routes attributes play an important role in shaping pedestrians' experience. However, to date, most of studies have focused on neighborhood influences on walking (whether by using external aerial units or home-based buffers) and only recently studies have begun to focus on more micro-scale environmental influences. Amongst these, some studies focused on the actual routes taken by individuals (henceforth: chosen routes) by employing quantitative (Millward et al., 2013), qualitative (Carroll et al., 2015; Van Cauwenberg et al., 2012) or mixed methodologies (Moran et al., 2017). Other studies relied on proxy measures of journeys, consisting of modelled routes that represent the shortest/most direct street-network itinerary between predetermined destinations (e.g., Dalton et al., 2015; Karusisi et al., 2014). While modelled routes were found to be reliable proxy measures (Duncan and Mummery, 2007), the study of chosen routes is essential to the understanding of environment-behavior associations. Ultimately, comparing chosen and non-chosen routes provides valuable insights on environment-behavior interactions and route-choice considerations. This type of comparison has been increasingly used in route choice modelling studies (e.g., Buliung et al., 2013; Harrison et al., 2014; Rodríguez et al., 2015; Tribby et al., 2017; Winter et al., 2010) not only because of its potential to partially overcome concerns about self-selection, but also because of its intuitive appeal, as routes are the way through which pedestrians' experience and relate to the built environment.

Results of studies on route decisions support and further extend previous work by that was largely done at the neighborhood level. Specifically, routes were found more likely to be used if the environment along them was characterized by high levels of density (Dalton et al., 2015; Larsen et al., 2012), access to destinations (Gallimore et al., 2011; Rodríguez et al., 2015) and aesthetics (Dessing et al., 2016). However, route-level studies have also revealed new environmental features related to walking that were less reported at the neighborhood level, such as urban waterscape (Dessing et al., 2016; Moran et al., 2017), openness of streetscapes (Van Cauwenberg et al., 2012), and traffic control features (Rodríguez et al., 2015).

To summarize, attributes of the built environment measured at the neighborhood and route levels have been associated with walking behaviors. However, the vast majority of previous studies have focused on either neighborhoods or routes but haven't examined the synergistic effect between both. Walkable routes in a sea of suburbs are likely to influence behaviors differently than similar routes in a similarly walkable environment. These interactions are important, as they provide cues to pedestrians about the feasibility of reaching other potential destinations through trip chaining, and of using different routes to reach desired destinations. Furthermore, most studies examining route choices have focused on trips to prominent destinations (e.g., home to work, or for children, home to school trips), even though these remain a minority of trips undertaken during a given day and thus fail to represent other routine/discretionary trips that may occur. Given the expectations and emerging evidence that environmental influences on physical activity are likely to be context-specific (Saelens and Handy, 2008; Giled Corti et al., 2005), it is reasonable to expect that route-choice considerations may also vary by context (trips location and purpose). The current study fills this gap in the literature by investigating associations between the built environment and children's route choices, while addressing differences in location and neighborhood characteristics (inner-city vs clustered suburban neighborhoods) and destinations (school, public facility, park, retail). The main questions posed in this research are: What are the associations between route-level environmental attributes and children's route choice? and - Do these associations vary by the journey's destination and general location?

2. Methodology

2.1. Study area and participants

The study was conducted in the city of Rishon LeZion, the fourth largest city in Israel (243,323 inhabitants), located along the central Israeli Coastline plain, 12 km south of Tel Aviv. Two distinct urban areas were selected, broadly characterized by high built footprint, land-use mix and grid street network (henceforth: *Inner-city*), and by the presence of high rises with undeveloped and parking spaces surrounding them, resulting in a low built footprint, segregated land uses and limited street connectivity (henceforth: *Suburban*). The two areas were also chosen so as to have similar socio-economic indicators. For sampling purposes, five neighborhoods were chosen, of which two neighborhoods were located in the inner-city and three were located in the suburban area. A figure ground map of the study area (Fig. 1) shows differences between the inner-city and suburban areas. These differences can also be seen

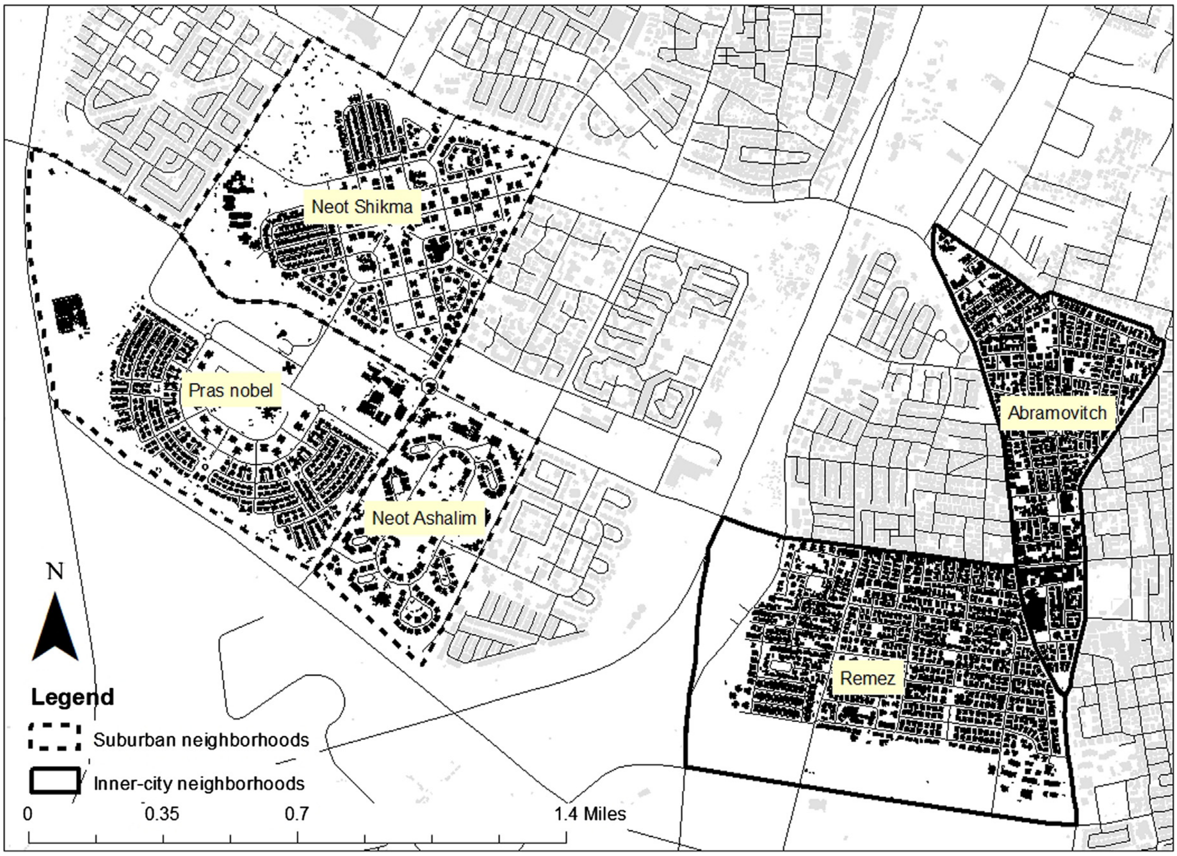

Fig. 1. Figure-ground map of the study area

in the street realm, with the inner city having narrower streets, lower building setbacks, and continuous building fronts compared to the suburban area (Fig. 2)

Israel offers a unique and intriguing setting for this study. First, in Israel, as in many other countries, recent decades have been characterized by high and rising prevalence of physical inactivity, overweight and obesity among children and adults (Gross et al., 2009; Lissau et al., 2004; Sheffer and Calderon-Margalit, 2007). These changes were accompanied by increased car-reliance and suburban sprawl development (Frenkel, 2004; Tzafrir-Reoven, 2006), which are particularly challenging in Israel due to its increasing population confined to the country's limited land availability. Correspondingly, while the common form of housing in north-American and Australian suburbs is single detached houses, the Israeli suburb is likely to include high-rise residential buildings nested within a conventional suburban layout. This enables Israel suburbs to accommodate high densities, despite their suburban layout, consisting of land use segregation and low built-footprint and street connectivity. Such high-density suburbs are also illustrated in our study area as presented in Table 1. For example, the two suburban neighborhoods "Neot Ashalim" and "Neot Shikma" have relatively low intersection densities alongside with high residential densities (nearly as high as in the inner-city).

In addition to the built environment variables, Table 1 presents socioeconomic indicators at the neighborhood level, indicating that residents of both neighborhood types share similar socioeconomic characteristics, except for household car ownership which was slightly higher in suburban neighborhoods. This highlights another unique aspect of this study setting - the upper-middle class characteristics of inner-city residents, which is less common in other areas around the world, and especially in the USA, where inner-city is often associated with poverty.

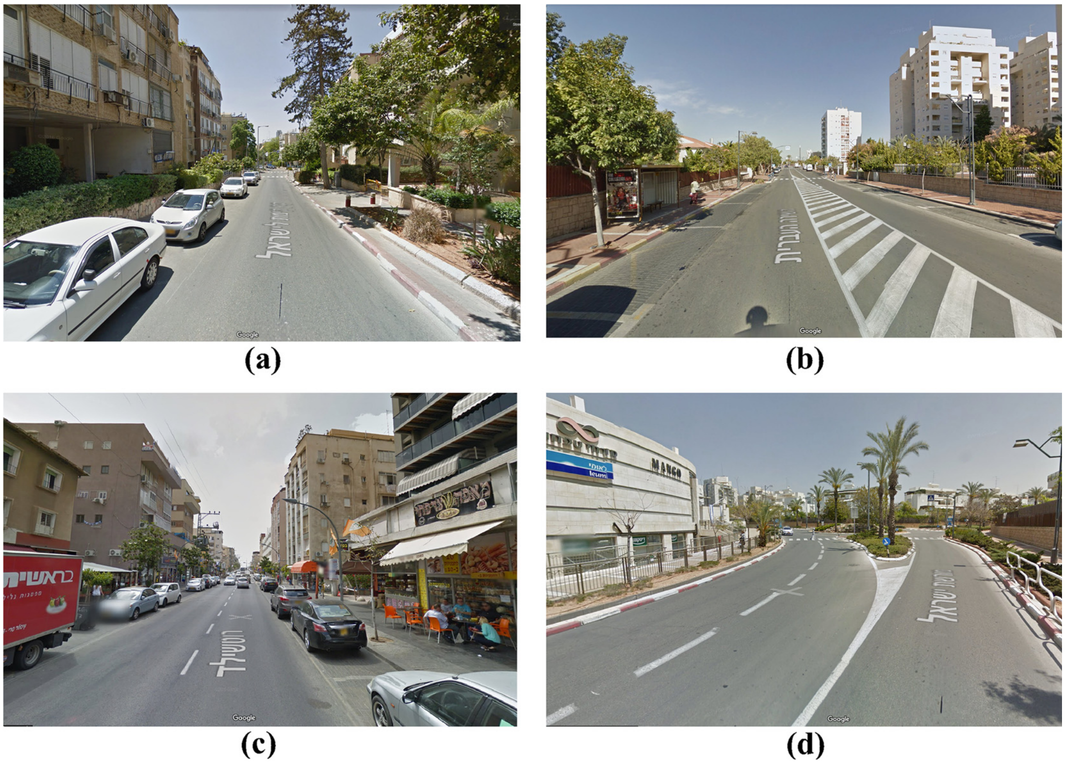

Fig. 2. Street view of residential and retail streets in inner-city and suburban neighborhoods. **(a)** inner-city residential street, **(b)** suburban residential street **(c)** inner-city retail street, **(d)** suburban street adjacent to a mall.
Source: Screen captures of Google Street View panoramic images.

Table 1
Built environment and sociodemographic characteristics of the study area.

	Inner-city area		Suburban area		
	Abramovitch	Remez	Pras Nobel	Neot Ashalim	Neot Shikma
Built environment characteristics[a]					
Intersection density[b]	134.23	63.00	59.06	33.06	48.33
Residential density[c]	17,400	13,440	4,730	11,980	9,800
Lot coverage[d]	0.44	0.37	0.32	0.22	0.25
Building height[e]	10.46	9.10	4.78	10.71	6.27
Green open space[f]	0.02 (3.92%)	0.09 (7.68%)	0.15 (13.63%)	0.07 (15.41%)	0.32 (32.96%)
Public facility[f]	0.07 (13.72%)	0.17 (13.68%)	0.05 (4.54%)	0.10 (22.29%)	0.16 (16.48%)
Retail[f]	0.08 (15.68%)	0.03 (2.71%)	0.003 (0.27%)	0.004 (0.91%)	0.01 (1.45%)
Sociodemographic characteristics[g]					
Area (sq km)	0.73	1.555	1.473	0.545	1.262
Population (n)	15,532	21,203	5,692	8,987	14,297
Pop density (Population/Area)	21,277	13,635	3,864	16,490	11,329
% households with children	34.2%	32.8%	66.8%	44.3%	53.5%
% households with older adults	28.5%	26.7%	16.5%	10.7%	14.7%
% households with one car or more	71%	79.5%	94.6%	82.6%	88.3%
Labor force participation rate	97.3%	98.4%	98.8%	98.5%	97.4%
% of bachelor's or higher degree[i]	31.4%	27.8%	30.7%	24.5%	23.4%

[a] Source: GIS-based variables calculated for census neighborhoods.
[b] Number of intersections per sq km.
[c] Number of households per residential sq km.
[d] Ratio of buildings' footprint area to the buildings' lot area.
[e] Average of buildings' height in meters.
[f] Area in sq km and percent of neighborhood area.
[g] Source: Census neighborhood level data (ICBS, 2008).
[i] Percent of residents aged 15 or older with a bachelor's or higher degree.

2.2. Identifying routes walked

Data collection took place in school days during May-June 2011, and included participants' documentation of routes along which they regularly walk from their home to four common destinations – schools, public facilities (e.g., libraries, community centers), retail and park destinations.

A total of eleven schools were identified within the study area. Among these, five were selected to participate (one school per neighborhood) based on their enrollment zone and on the principals' agreement to participate. Within each school, 5th and 6th graders were recruited to participate in a route mapping exercise. Participants were provided with a street map of their neighborhood (photocopied in black and white on a letter-sized sheet of paper), upon which they were briefly instructed to mark their home, four different destinations to which they regularly walk, and the routes that they most frequently use when walking to those destinations. The four destinations included the school they attend and three types of local destinations that participants regularly walked to on weekdays during the afternoon, including retail destinations (e.g., grocery stores, shops, shopping centers), green open space (e.g., parks, playgrounds) and public facilities (i.e., community centers, libraries). No further instructions were given, except for clarifications as needed. These simple instructions, followed by minimal communication between the researcher and the participants, served to ensure that the route drawing task will be done as authentically as possible and to avoid potential biases that may otherwise be introduced. The route drawing activity lasted approximately 30 min, occurred during school hours in small groups of up to seven children and was facilitated by the first author. Although this activity was conducted in small groups, each participant completed the procedure individually. To avoid interactions and mutual influences among participants, it was clearly stated that this was an individual activity that each participant needs to complete on his/her own.

Prior to data collection, school principals and teachers were provided with information regarding the study, and consent forms were delivered to the children's parents through the school. Children participated in this study only after providing a signed informed consent from their parents. Ethics approval for this study was received from the Technion Ethics Committee and from the Israeli ministry of Education.

2.3. Preparation of geographic data

2.3.1. Route identification

The routes drawn on paper were digitized into GIS. First, the origins (participants' homes) and destinations (school, public facility, retail, and green open space) were geocoded to create a GIS point shapefile. An aerial photo was used to adjust the destinations' locations to the main entrance from which the participants walked. These point shapefiles were then used to create polyline shapefiles of the routes. Reported routes were manually digitized into GIS based on the drawn maps, the point shapefiles, the street network layer and an aerial photo.

Alternative routes were generated using the Network Analyst tool included in ArcGIS 10.1, using the point shapefile and city's street network layer to calculate the shortest route between each pair of origin and destination based on the street and alley network available from the Municipality of Rishon LeZion. Although this approach aimed at identifying the shortest path, it is possible that some routes chosen by participants were even shorter than the routes identified here. This occurred when the chosen route cut through areas with large lots (parking lots, parks, schools). Given the importance of distance in determining route choices, it is not surprising to find considerable overlap between the route chosen and the modelled routes. To further characterize the distance differences between the routes, we used the overlap measure suggested by Harrison et al. (2014) by calculating both the percentage of the modelled route that fell within a 25-m buffer of the chosen routes and the percentage of the chosen route that fell within a 25-m buffer of the modelled route. Because the two were highly correlated ($r = 0.97$, $p < .0001$), we used the latter in the current analysis. To illustrate, the overlap variable used in this study represents the percentage of the chosen route that falls within 25 m of the modelled route. For example, a value of 0% is indicates that there is no overlap between the chosen route and the modelled route, 50% indicates that half of the chosen route falls within 25 m of the modelled route, and 100% indicates that all of the chosen route "falls" within 25 m of the modelled route.

2.3.2. Built environment characteristics of the routes

We calculated measures of the built environment within a 25-meter buffer area along each route (chosen or modelled). This buffer size was found to provide a good representation of en-route pedestrian exposure, as it contained similar proportions of street infrastructure (roads and sidewalks) and other adjacent land uses (e.g., buildings, setbacks, parks). On average, route buffers of 25 m included 37% street infrastructure (roads and sidewalks), compared to 15- and 50-m routes buffers that included 49% and 26% roads, respectively. No differences were observed between the two neighborhood types and the four trip destinations.

GIS data was provided by the Municipality of Rishon LeZion. Several built environment variables were calculated proportionally to the route's buffer area as follows:

Urban form variables: (1) Intersection density – the ratio of the number of intersections to the routes' length; (2) Average residential density – the average number of households per residential building along the route; (3) Average building height – the average height (in meters) of buildings along the route; (4) Average lot coverage – the average ratio of buildings' footprint area to the buildings' lot area; (5) Floor area ratio (FAR) – the average ratio between the gross floor area of buildings to the total area of the buildings' lot regardless of the land use.

Land use variables: Four land use variables were calculated, consisting of the proportion (in percentages) of land area within the buffer area dedicated to each of the following uses (1) residential; (2) retail (malls, stores, and mixed use buildings including retail located below residential units); (3) public facilities (e.g., community centers, libraries, museums, health services, and mixed use buildings including public facilities located below residential units); and (4) green open spaces (e.g., parks, playgrounds, trails, green open areas).

Walkability index: Walkability is defined as overall support for pedestrian travel and has been measured at both neighborhood and route scales by using different approaches. At the neighborhood scale, high walkability is often marked by high levels of density, land used mixed and interconnected street networks (Owen et al., 2007), while at the route scale, walkability has been measured by sidewalk quality, safety and legibility (Brookfield and Tilley, 2016). In this study, as well as in a preceding study (Moran et al., 2017b), we adopt the neighborhood approach to define route level walkability by using the walkability index developed by Frank et al. (2010), which is calculated based upon indicators of land-use mix, residential density and intersection density.

2.4. Data analysis

Data analysis was performed with SPSS (version 21), EXCEL and GIS (ESRI ArcGIS 9.3). Descriptive statistics for chosen and modelled routes overall, by neighborhood type and by trip destination were calculated. Statistical significance of comparisons across neighborhood type was determined using t-tests. Descriptive statistics of the route characteristics are provided in Appendix A.

Preliminary analysis to determine the overlap between chosen and modelled routes was performed using the aforementioned (in Section 2.3.1) overlap variable developed by Harrison et al. (2014). The overlap variable was then used to compute a *path size* variable, which was added to regression models as described below.

To answer the research questions, we used conditional logistic regression, which enables predicting route choice by comparing one-to-one matched pairs of chosen and modelled routes. These models estimate the chances of taking the chosen route (versus the modelled one) based on the values of independent variables (the built environment along both routes). First, the association of each environmental attribute and route choice was examined separately, while adjusting only for distance and the degree of commonality among routes as calculated by a *path size* variable following the specification suggested by Bovy et al. (2008). This resulted in adjusted bivariate associations, which were calculated for the pooled sample, by neighborhood type and by trip destinations. Second, based on these bivariate results, variables were selected for multivariate models that were also adjusted for participants' age and gender. The multivariate models included environmental attributes that were most strongly associated with route choice (p-value $< .05$) in the bivariate analysis, and that were not highly collinear (VIF < 2.5). Pairs of chosen and modelled routes that coincide were eliminated from the sample as they do not reflect route choice. To ease interpretation, the variables for lot coverage, FAR and all land use variables were re-scaled by multiplying their original values by 100. Finally, to determine strength of association, all independent variables were standardized (mean zero and standard deviation one) and the final models re-estimated. Conventional level of $p \leq .05$ was taken to represent statistical significance when interpreting model results.

3. Results

3.1. Participants and route characteristics

Participants were evenly distributed across gender, age (grade) and neighborhood type. A total of 107 children were recruited, of which fifty lived in inner-city and fifty-seven lived in suburban neighborhoods. A similar number of boys and girls participated in the

Table 2
Route sample characteristics (n, %).

	Inner-city area	Suburban area	Total sample
Home-school	27	40	67
	40%	60%	100%
Home-public facility	46	47	93
	50%	50%	100%
Home-store	49	45	94
	52%	48%	100%
Home-park	48	46	94
	51%	49%	100%
Total	170	178	348
	49%	51%	100%

study (50 and 57, respectively). Fifty-nine children were 5th graders, and the remaining forty-eight were 6th graders. All of the route destinations were within the participants' home neighborhood, and participants lived in a variety of different locations within the schools' catchment areas, which covered about a half of the neighborhood area.

Across all participants 348 routes were reported. While participants were instructed to describe routes to four destinations, the number of routes per participant ranged from one to seven. The number and proportion of participants who described more than four routes was significantly higher in inner-city compared to suburban neighborhoods (24% vs 14%). Overall, most of the routes were evenly distributed across neighborhoods and destinations (Table 2), as well as by gender and grade (results not reported). It should be noted that prior to the analysis, 119 pairs of chosen-modelled routes were excluded, in which the participants chose the modelled routes (in those cases the value of the overlap variable was 1.00, reflecting an overlap of 100% between the routes).

Appendix A contains descriptive statistics of all environmental variables along both chosen and modelled routes. The average length of chosen routes in the pooled sample was 525.32 m, with the routes to public facilities being the longest (601.88 m), followed by routes to parks (544.85 m), to school (497.75 m), and to retail (449.85 m). While route length did not differ by neighborhood type in the pooled sample, routes to school were significantly longer in suburban compared to inner-city neighborhoods (562.31 vs. 402.11, $p = .023$). Chosen (as well as modelled) routes seem to be accurate reflections of the built environments in which they are located, and thus highlight differences between the two neighborhood types (Appendix A). Compared to those in suburban neighborhoods, chosen routes in the inner-city had attributes associate with a more compact urban form, such as higher residential density (M = 561.97 vs M = 182.54, t = 19.91, p < .0001), building height (M = 4.95 vs M = 2.07, t = 20.38, p < .0001), built footprint (M = 35.09 vs M = 16.97, t = 19.67, p ≤ .0001), FAR (M = 136.99 vs M = 89.32, t = 20.38, p < .0001) and a walkability index (M = 0.12 vs M = −0.56, t = 5.27, p < .0001). Inner-city chosen routes also had more residential (M = 68.87 vs M = 56.82, t = 6.34, p < .0001) and retail land uses (M = 11.33 vs M = 5.77, t = 4.27, p < .0001), but less green open spaces along the route (M = 5.27 vs M = 20.71, t = −11.86, p < .0001). Similar differences were observed for modelled routes in inner-city and suburban neighborhoods (results not shown).

3.2. Comparability between chosen and modelled routes

Appendix B presents descriptive statistics of the overlap measure in the pooled route sample (median, IQR, mean, SD). On average, chosen and modelled routes overlapped by 64% in the pooled sample, indicating that on average 64% of chosen routes fell within 25 m of their alternative modelled route and the remaining 36% fell elsewhere. This average overlap was slightly, but not significantly, higher in inner-city compared to suburban neighborhoods (67% vs 61%). These differences increased and turned significant when looking at routes to schools (77% vs 55%, t = 2.78, p = .006) and to public facilities (and 68% vs 52%, t = −2.22, p = .029). Although the overlap did not vary significantly by the route's destination, descriptive comparisons across the four destinations yielded different results for the two neighborhood types. In the inner-city, the average overlap was greatest in routes to school (77%), followed by routes to public facilities (68%), retail (66%) and parks (63%). However, this was not the case in suburban neighborhoods, where the average overlap was greatest in routes to parks (69%), followed by routes to retail (66%), schools (55%), and public facilities (52%).

Chosen routes were consistently longer than those modelled (Appendix A). In the pooled sample chosen routes were 8.5% longer than those modelled in GIS. This gap was slightly greater in inner-city compared to suburban neighborhoods (9.84% vs 7.33%). The average length gap between chosen and modelled routes was greatest in routes to parks (9.6%), followed by routes to public facilities (8.9%), to retail (8.5%) and to school (6.3%).

It should be noted that 18% of the chosen routes (n = 63) were shorter than their modelled alternative. These routes passed through areas not included in the city's street network layer, such as: parking lots (n = 40), parks and private area (n = 11), trails (n = 6) and schools (n = 6). Interestingly, some of these (supposedly) short-cuts varied by neighborhood type, as cutting through parking lots was more common in suburban neighborhoods (33 vs 7), while cutting through school parcels was mostly common in inner-city neighborhoods (5 vs 1).

3.3. Route choice as a function of route environmental attributes

Tables 3–5 show the adjusted-bivariate and multivariate associations between route choice and route characteristics in the pooled sample, by neighborhood type, and by trip destination, respectively.

3.3.1. Bivariate associations

According to the adjusted-bivariate analysis in the pooled sample (Table 3), participants chose routes with lower intersection density (OR = 0.83, CI = 0.77–0.89), but higher values of the other urban form measures, including: Building height (OR = 3.48, CI = 2.36–5.13), lot coverage (OR = 1.13, CI = 1.08–1.19), FAR (OR = 1.04, CI = 1.03–1.05) and residential density (OR = 1.01, CI = 1.007–1.014). Compared to modelled routes, routes chosen by participants contained more retail and residential land uses (OR = 1.06, CI = 1.02–1.10 and OR = 1.02, CI = 1.001–1.1034, respectively), but fewer public facilities (OR = 0.96, CI = 0.93–0.98) and green open spaces (OR = 0.97, CI = 0.95–0.99). No significant differences were observed between chosen and

Table 3
Associations between walking route choice and built environment attributes, 5th and 6th graders, 2011 (n = 348).

	Adjusted bivariate*		*p*-value	Multivariate**		*p*-value
	OR (CI)	B (SE)		OR (CI)	B (SE)	
Length of route (meter)	**1.012 (1.008–1.016)**	**3.94 (0.71)**	< .0001	**1.012 (1.007–1.016)**	**3.73 (0.77)**	< .0001
Urban form						
Intersection Density	**0.83 (0.77–0.89)**	**−1.10 (0.21)**	< .0001	**0.87 (0.81–0.94)**	**−0.83 (0.23)**	< .0001
Residential Density	**1.01 (1.007–1.014)**	**2.67 (0.48)**	< .0001	–	–	–
Building height	**3.48 (2.36–5.13)**	**2.45 (0.39)**	< .0001	–	–	–
Lot coverage	**1.13 (1.08–1.19)**	**1.61 (0.28)**	< .0001	–	–	–
FAR	**1.042 (1.03–1.05)**	**2.30 (0.30)**	< .0001	**1.042 (1.03–1.06)**	**2.36 (0.34)**	< .0001
Land uses						
% Residential	**1.02 (1.001–1.034)**	**0.34 (0.16)**	.04	–	–	–
% Retail	**1.06 (1.02–1.10)**	**0.67 (0.21)**	.001	1.03 (0.98–1.08)	0.41 (0.26)	.285
% Public facility	**0.96 (0.93–0.98)**	**−0.62 (0.18)**	.001	1.02 (0.99–1.05)	0.41 (0.25)	.0.96
% Green open space	**0.97 (0.95 − 0.99)**	**−0.43 (0.20)**	.029	–	–	–
Composite measures						
Walkability index	0.81 (0.60–1.09)	−0.25 (018)	.17	–	–	–
Pseudo R^2				61%		

Bold values indicate statistical significance.
* Adjusting for path size and route length.
** Adjusting for path size, route length, gender, class (5th or 6th grade) and all covariates in the table.

modelled routes in terms of the composite measure of walkability.

Consistent with the results from the pooled sample, the adjusted-bivariate analysis by neighborhood type shows that compared to those modelled, chosen routes had lower intersection density, but were longer and had more compact urban form en-route, i.e., higher values of residential density, building height, lot coverage and FAR (Table 4). Interestingly, the walkability index and residential land use variables were associated with route choice in opposite directions in the two neighborhood types. To illustrate, inner-city participants chose routes that passed through areas with higher walkability (OR = 1.76, CI = 1.04–2.98) and fewer residential land uses (OR = 0.97, CI = 0.94–0.99), while suburban participants chose routes that were less walkable (OR = 0.51, CI = 0.33–0.78) and passed through more residential areas (OR = 1.06, CI = 1.03–1.08). Additionally, some exposures differed significantly between chosen and modelled routes only in suburban neighborhoods (residential density, public facility uses en-route), while other exposure differed significantly only in inner-city neighborhoods (retail uses en-route).

Table 5 shows the same associations but by destination. Bivariate findings suggest that for nearly all destinations, chosen (versus modelled) routes had lower intersection density and higher values of residential density, building height, lot coverage and FAR. While these findings are in line with those in the pooled sample and the neighborhood analysis (Tables 3 and 4, respectively), the results for other attributes were less consistent across destinations. For example, compared to modelled routes, residential land uses were more common along chosen routes to schools and to public facilities (OR = 1.11, CI = 1.04–1.86 and OR = 1.04, CI = 1.004–1.08, respectively), but less common along chosen routes to retail (OR = 0.94, CI = 0.91–0.98). Also, some attributes were found to be associated with route choice to certain, but not all destinations. For example, trips to retail were significantly positively related to the percent of retail area en-route (OR = 1.24, CI = 1.10–1.40), and trips to school and to public facilities were significantly negatively related to the walkability index en-route (OR = 0.21, CI = 0.07–0.61 and OR = 0.52, CI = 0.29–0.94, respectively). While the first finding regarding retail is tautological, the latter findings are worthy of notice. Overall, these findings

Table 4
Associations between walking route choice and built environment attributes, 5th and 6th graders by neighborhood type, 2011.

	Inner-city area (n = 170)				Suburban area (n = 178)			
	Adjusted bivariate[a]		Multivariate[b]		Adjusted bivariate[b]		Multivariate[b]	
	OR (CI)	B (SE)	OR (CI)	B (SE)	OR (CI)	B (SE)	OR (CI)	B (SE)
Length	**1.014‡ (1.007–1.022)**	**4.68‡ (1.24)**	**1.017‡ (1.008–1.026)**	**5.44‡ (1.51)**	**1.011‡ (1.006–1.016)**	**2.61‡ (0.90)**	**1.02‡ (1.007–1.024)**	**5.17‡ (1.41)**
Urban form								
Intersection density	**0.773† (0.67–0.90)**	**−1.52† (0.45)**	**0.77† (0.66–0.90)**	**−1.51‡ (0.47)**	**0.853‡ (0.79–0.92)**	**−0.93‡ (0.24)**	**0.90* (0.81–0.99)**	**−0.70* (0.29)**
Residential density	1.003 (1.000–1.007)	0.86 (0.46)	–	–	**1.045‡ (1.03–1.06)**	**11.71‡ (2.04)**	–	–
Building height	**1.88** (1.21–2.93)**	**1.24** (0.44)**	0.94 (0.50–1.78)	−0.15 (0.65)	**13.36‡ (5.18–34.51)**	**5.09‡ (0.95)**	**10.80‡ (3.62–32.25)**	**4.85‡ (1.10)**
Lot coverage	**1.12‡ (1.06–1.19)**	**1.39‡ (0.35)**	–	–	**1.16‡ (1.07–1.25)**	**1.80‡ (0.49)**	1.04 (0.96–1.14)	0.51 (0.54)
FAR	**1.03‡ (1.02–1.04)**	**1.57‡ (0.37)**	–	–	**1.07‡ (1.04–1.09)**	**3.23‡ (0.60)**	–	–
Land uses								
% Residential	**0.97* (0.94–0.99)**	**−0.63* (0.28)**	0.97 (0.93–1.009)	−0.63 (0.40)	**1.06‡ (1.03–1.08)**	**1.06‡ (0.26)**	0.98 (0.93–1.03)	−0.47 (0.51)
% Retail	**1.16‡ (1.08–1.24)**	**1.58‡ (0.39)**	**1.12* (1.02–1.22)**	**1.26* (0.52)**	1.02 (0.98–1.06)	0.20 (0.22)	–	–
% Public facility	1.03 (0.99–1.07)	0.43 (0.27)	–	–	**0.87‡ (0.83–0.92)**	**−1.88‡ (0.35)**	**0.92* (0.86–0.98)**	**−1.33* (0.47)**
% Green open space	0.95 (0.90–1.002)	−0.73 (0.22)	–	–	0.98 (0.95–1.01)	−0.29 (0.22)	–	–
Composite variables								
Walkability index	**1.76* (1.004–2.98)**	**0.68* (0.32)**	–	–	**0.51** (0.33–0.78)**	**−0.82** (0.27)**	–	–
Psudo R^2	NA		62%		NA		50%	

Bold values indicate statistical significance as follows: * = < .05; ** = < .01; † = < .001; ‡ = < .0001.
[a] Adjusted for: path size, route length.
[b] Adjusted for: path size, route length, gender, class (5th or 6th grade) and all covariates in the table.

suggest that in addition to route-level environmental attributes, destinations may also exert an influence on whether route attributes impact route decisions.

3.3.2. Multivariate associations between route choice and route environmental attributes

Results for the pooled sample (Table 3) suggest that route choice was most strongly predicted by intersection density (OR = 0.87, CI = 0.81–0.94), followed by FAR (OR = 1.044, CI = 1.03–1.06) and the route length (OR = 1.012, CI = 1.007–1.017). Land uses en-route were no longer significantly related to route choice in the pooled sample. It should be noted that the route's length and intersection density remained significant predictors of route choice in both neighborhood types, as well as in most of the destinations.

Route choices in inner city trips were associated with intersection density (OR = 0.68, CI = 0.57–0.83), % retail (OR = 1.14, CI = 1.03–1.26) and route length (OR = 1.017, CI = 1.007–1.026), while in suburban neighborhoods, route choice was associated with building height (OR = 8.78, CI = 2.92–26.43), intersection density (OR = 0.86, CI = 0.81–0.99), % public facility (OR = 0.93, CI = 0.87–0.99) and route length (OR = 1.02, CI = 1.007–1.024).

By destination, route choice for trips to retail was associated with % retail (OR = 1.17, CI = 1.007–1.351) and the route's length (OR = 1.015, CI = 1.004–1.026). Route choice for trips to public facilities was associated with intersection density (OR = 0.82, CI = 0.70–0.96), FAR (OR = 1.057, CI = 1.026–1.088) and the route length (OR = 1.014, CI = 1.002–1.026), with length having the strongest effect on route choice, followed by FAR and intersection density (results not shown). For trips to school and to parks, route choice was associated with FAR (OR = 1.14, CI = 1.04–1.25 and OR = 1.04, CI = 1.02–1.07, respectively) and route length (OR = 1.03, CI = 1.005–1.058 and OR = 1.011, CI = 1.002–1.021, respectively).

Table 5
Adjusted uni- and multivariate conditional logistic regression to predict route choice by environmental exposure en-route across different route destinations.

	Home-school (n = 67)		Home-public facility (n = 93)		Home-store (n = 94)		Home-park (n = 94)	
	Adjusted Univariate[a]	Multivariate[b]	Adjusted Univariate[a]	Multivariate[b]	Adjusted Univariate[a]	Multivariate[b]	Adjusted Univariate[a]	Multivariate[b]
Length	**1.017**** **(1.005–1.029)**	**1.03*** **(1.005–1.058)**	**1.012**** **(1.004–1.021)**	**1.014*** **(1.002–1.026)**	**1.01*** **(1.002–1.018)**	**1.015**** **(1.004–1.026)**	**1.011**** **(1.004–1.018)**	**1.012*** **(1.002–1.021)**
Urban form								
Intersection density	**0.76**** **(0.62–0.93)**	0.64 (0.401–1.029)	**0.83**** **(0.72–0.95)**	**0.82*** **(0.70–0.96)**	**0.77**** **(0.66–0.89)**	**0.80*** **(0.61–0.99)**	0.91 (0.80–1.03)	–
Residential density	**1.02**** **(1.008–1.033)**	–	**1.009**** **(1.002–1.015)**	–	1.006 (1.000–1.012)	–	**1.01**** **(1.004–1.018)**	–
Building height	**3.01**** **(1.33–6.84)**	–	**2.60**** **(1.32–5.10)**	–	**4.18**† **(1.89–9.24)**	–	**4.77**† **(2.02–11.28)**	–
Lot coverage	**1.44**** **(1.17–1.77)**	–	**1.20**** **(1.06–1.35)**	–	**1.11**** **(1.03–1.20)**	–	**1.08**** **(1.02–1.15)**	–
FAR	**1.10**** **(1.04–1.6)**	**1.14**** **(1.04–1.25)**	**1.06**† **(1.03–1.09)**	**1.057**† **(1.026–1.088)**	**1.02**** **(1.005–1.034)**	1.013 (0.99–1.033)	**1.04**† **(1.02–1.07)**	**1.045**† **(1.021–1.071)**
Land uses								
% Residential	**1.11**** **(1.04–1.86)**	1.03 (0.84–1.27)	**1.04*** **(1.004–1.08)**	0.99 (0.94–1.048)	**0.94**** **(0.91–0.98)**	**0.93*** **(086–1.00)**	1.01 (0.98–1.05	–
% Retail	0.93 (0.77–1.13)	–	0.96 (0.88–1.05)	–	**1.24**† **(1.10–1.40)**	**1.17*** **(1.007–1.351)**	1.01 (0.94–1.09)	–
% Public facility	**0.89**** **(0.83–0.96)**	1.03 (0.78–1.36)	0.96 (0.92–1.005)	–	0.98 (0.92–1.05)	–	0.99 (0.94–1.04)	–
% Green open space	0.94 (0.87–1.021)	–	0.97 (0.91–1.034)	–	0.98 (0.92–1.037)	–	0.98 (0.94–0.127)	–
Composite measures								
Walkability index	**0.21**** **(0.07–0.61)**	–	**0.52*** **(0.29–0.94)**	–	1.91 (0.97–3.75)	–	1.42 (0.77–2.64)	–
Pseudo R^2		31%		55%		54%		47%

Bold values indicate statistical significance as follows: * = < .05; ** = < .01; † = < .0001.
[a] Partially adjusted for: path size, route length.
[b] Adjusted for: path size, route length, gender, class (5th or 6th grade) and all covariates in the table.

4. Discussion

Examining the environment along walking routes has been identified as a promising approach to explore environmental influences on walking behavior. While the literature of children's route choice has largely focused on routes to school, in this study, we investigate children's walking route choices across different locations (inner-city vs suburban areas) and trip destinations (school, public facility, park, retail) in the context of a medium-sized Israeli city. By doing this, the current study extends existing literature and allows a more nuanced and contextualized understanding of children's route choice.

Results regarding length appeared initially surprising given prior evidence suggesting that pedestrians are highly sensitive to distance (Yang et al., 2012; Rodríguez and Joo, 2004). We found that as the length of a route increased, the odds of selecting it increased. This can be explained by the way that the route choice set was constructed in this study. Cases in which participants took the modelled path were excluded because we could not identify a comparison, non-taken route. Individuals who took a longer route than the one modelled were included in the sample. Also included were a few participants (18%) who picked a route that was shorter than the shortest route because they took shortcuts through parking lots, trails etc. This is reflected in the fact that the average length of routes selected was greater than the length of the non-taken shortest path (Appendix A). Hence, this result has to do more with how the comparison routes were constructed than with children actively going out of their way to walk longer distances. The fact that taking shortcuts through parking lots, was relatively common in suburban neighborhoods raises intriguing questions about pedestrian safety because of the high injury risk that pedestrians face in those locations (Brison et al., 1988). The findings merit consideration of interventions in parking lots where pedestrian exposure is high, for example by providing alternative paths adjacent to parking lots, providing better marked paths, and improving visibility.

Our findings suggest that some environmental attributes are consistently associated with route choice, while others have varying and opposite effects on route choices across different destinations and locations. In the majority of locations and destinations, children chose routes with significantly lower intersection density, but more compact urban form (as represented by higher values of FAR and building height). These findings are in line with and further extend previous studies by showing that urban form is not only associated with walking (Giles-Corti et al., 2011; Carlson et al., 2014; Lee and Moudon, 2006), but also with the choice of walking route. From a more practical perspective, these findings pose a challenge for planners and developers as the aforementioned variables tend to coexist with high rather than low intersection density. A possible strategy to overcome this challenge is to make intersections safer for pedestrians, for example by adding traffic lights, elevated and well painted crossing, railing etc.

Our findings regarding intersection density run counter to previous studies associating high intersection density with children's walking behavior (e.g., Giles-Corti et al., 2011; Koohsari et al., 2014), other studies suggesting fewer intersections may be safer (Yu, 2015), and even to studies derived from a similar study population and setting (Moran et al., 2016). However, while these studies focused on walking behavior as a mode choice (e.g., Khattak and Rodríguez, 2005; Schlossberg et al., 2006), the current study focuses on pedestrians' route choice. A possible explanation may be related to safety and/or wayfinding considerations. It may be that children choose routes with less intersections in order to avoid car-pedestrian encounters. Rodríguez et al. (2015) found that routes that had more traffic control devices, less traffic, and more pedestrian safety amenities were preferred by adolescent girls that walk. From a wayfinding perspective, routes with less intersections may be more easily planned, learned and memorized. It is also very likely that the different scales used across studies may also explain the differing results regarding intersection density. To date, the majority of evidence suggesting positive associations between intersection density and walking behaviors have used area-based metrics (Frank et al., 2005, 2008; Koohsari et al., 2014; Owen et al., 2007). These findings conform with theoretical expectations that connectivity decreases distance and provides variety of choices. However, like the current study, other studies focused at the route level (e.g., Buliung et al., 2013) also have found opposite results. This discrepancy may be pointing to an ecological paradox: At the level of an area (like a neighborhood) connectivity is positively associated with walking, but at the individual level, as individuals seek to choose routes to complete a walking trip, connectivity detracts from walking. These different speculative explanations are not mutual exclusive and could be fruitfully explored in future research in different settings and populations.

Unlike intersection density and the other urban form variables, land use variables had fewer, weaker and less consistent associations with route choice in multivariate analysis across the majority of destinations and locations. These findings complement previously published data from the same study area (Moran et al., 2016), suggesting that children's self-reported walking for transportation was found to be more strongly associated with objectively measured urban form than it was with land use variables. The current study supports and further extends these findings by suggesting that, compared to land uses, compact urban form is more strongly associated not only with whether and/or how frequently children walk, but rather also with where children choose to walk.

A similar pattern emerged in our results concerning green open space. In the current study, route choice was not associated with green open space along the route, regardless of the route's destination and/or location. These findings are consistent with, and add to, previous findings from this setting pointing at null associations between green open space and children's reported walking (Moran et al., 2017b). However, they do differ with findings for adolescent girls, who were more likely to select walking routes with parks (Rodríguez et al., 2015). Given that these findings are all from limited settings, future research in different settings is needed in order to decide whether these findings are generalizable, or simply reflect unique local conditions. Either way, the current and previous findings suggest further investigation regarding the well-established role of green open space in enhancing walking (Larsen et al., 2012; Sugiyama et al., 2009), and in pedestrian route choice (Moran et al., 2017; Rodríguez et al., 2015; Van Cauwenberg et al., 2012).

A few differences emerged across the different multivariate models, suggesting that intersection density was the strongest predictor of route choice in inner-city neighborhoods, building height was the strongest predictor in suburban neighborhoods, FAR in routes to school, public facilities and parks (in both neighborhood types) and % retail in routes to retail (in both neighborhood types). While the latter is likely tautological (i.e., trips to retail are likely to pass through retail uses), the rest of the findings suggest relevance of location and destination in children's route choice. The similarity of results for multivariate models estimated for the four trip destinations is fairly remarkable, with FAR and length consistently associated with route choice. These results suggest that higher intensity of development along a route was favored, regardless of the type of destination being accessed. Future research may benefit from further exploring this using different populations and setting, which may enable comparing finer sub-groups defined by both destination and location (e.g., suburban/route to school, inner-city/route to school, suburban/route to park, inner-city/route to park, etc.).

Our comparison between the modelled and the chosen paths also provide useful evidence for future studies aiming to use modelled paths as surrogates for the actual paths chosen. Our findings were similar to those observed in studies that were conducted among children in different settings, such as the Netherlands (Dessing et al., 2016), the UK (Harrison et al., 2014), and Canada (Buliung et al., 2013). Our findings suggest that modelled routes to school can serve as a surrogate to those chosen in more compact environments, like inner-cities, but less so in suburban neighborhoods. By exploring additional destinations other than schools, the current study further extends these insights by suggesting that the modelled route method may be a reliable surrogate for actual routes in inner-cities when examining trips to school and to public facilities, and in suburban neighborhoods when concerning routes to parks or to stores.

This study is innovative in that it examines routes, which precisely show how pedestrians experience the built environment, as opposed to points (origins, destinations) or polygons (neighborhoods). This is particularly important for children, as early exposure to walking in these environments may have lifelong consequences. Also innovative is that we examine associations by neighborhood (inner-city and clustered suburb). While such comparisons have been recently conducted by Buliung et al. (2013) and Harrison et al. (2014), their studies focused solely on routes to school and less is known on routes to non-school destinations in these aspects. Therefore, the current study fills this gap in knowledge by including of different types of daily destinations, other than school. The study setting is also unique, as it does not represent the traditional city-suburb dichotomy. Instead, it represents the town center vs. peripheral dense housing contrast, which is more relevant to European, Asian, and Latin American contexts. These comparisons are valuable as environmental influences on walking and route choice are known to be context-sensitive.

Despite its strengths, the study also has some limitations. First, the lack of objective route tracking and the reliance on self-reports is biased as participants may have reported routes that they did not use. To prevent this bias, data was collect in small groups in the presence of the first author. Overall, such false reports of routes are unlikely given that participants were highly invested in the mapping activity (i.e., orienting their street maps, identifying landmarks, and memorizing their routes). Although a fair number and variety of environmental exposures were included, other potentially relevant exposures were not included, such as aesthetics, traffic- and crime-related safety. Similarly, individual variables included only gender and age, and thus, other potential influences could have not been identified, such as: Household income, number of cars per household, number of siblings and order among siblings. While some socioeconomic indicators were available at the neighborhood level (e.g., household car ownership, academic education), other relevant indicators were not (e.g., household income), and thus some of the variables that are associated with SES or income may be biased. This study included a socioeconomically homogenous population in a restricted geographical study area, which served to minimize potential intervening effects. However, the combination of the limited geographical setting, sample size and narrow age group reduces the generalizability of our findings. Future research should endeavor upon this limitation by using a sampling model based on combinations of neighborhood and socioeconomic characteristics (e.g., inner-city/high-income, inner-city/low-income, suburban high-income, suburban/low-income). Perhaps the most important limitation is that the comparison of routes taken and routes not taken teaches us about where children walk or avoid walking but fall short in explaining why they do so. It also falls short in providing causal estimates, as routes may have certain attributes precisely because pedestrians walk there. These questions are essential to the understanding of the environment-behavior nexus, and thus should be addressed in future studies.

5. Conclusions

This study examines children's route choices in two distinct neighborhood settings and for various trip destinations in a medium-sized city in Israel, a geographical area less studied in this field.

Urban form and intersection density were found to have conflicting influences on children's route choice. We found that routes were more likely to be selected if they had fewer intersections, but a more compact urban form along the route. The results confirm the general importance of particular built environment attributes, and of specific urban form attributes that appear to influence the street-level experience of pedestrians.

Taken together, the findings highlight the challenge that planners and developers frequently face: Create environments that are walkable and pedestrian-friendly, while attempting to minimize conflicts between pedestrians and motor vehicles. Slowing down traffic and providing amenities to decrease the negative impact of street crossings on routing decisions, are likely to be strategies that are successful for improving walkability. Furthermore, given children's vulnerability as road users, it is highly important for planners to invest in safe infrastructure, especially in compact urban areas with potential daily destinations of children (e.g., residential areas, schools, public facilities, parks).

We also found differences in associations across neighborhood settings and destination types. To understand these findings, we emphasize the role played by neighborhood and destination characteristics in shaping children's route choices and raise the need for more contextualized planning recommendations by tailoring them to specific scenarios (e.g., routes to stores in inner-cities, routes to parks in suburbs). Finally, the results of the current study suggest that regardless of land uses, compact urban form is positively related to children's route choice; this complements prior research showing that similar attributes also increased overall walking in children.

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Appendix A

Routes characteristics by neighborhood and destination type [Mean (SD)] and unadjusted univariate conditional logistic regression to predict route choice by environmental exposure en-route across different route destinations.

	All routes (n = 348)			Home-school (n = 67)			Home-public facility (n = 93)			Home-store (n = 94)			Home-park (n = 94)		
	Modelled	Chosen	OR	Modelled	Chosen	OR	Modelled	Chosen	OR	Mod	Ch	OR	Modelled	Chosen	OR
Length															
Overall study area (n = 348)	484.05 (304.63)	525.32 (348.42)	**1.007**†	468.23 (260.46)	497.75 (297.43)	**1.008**†	552.92 (353.74)	601.88 (374.15)	**1.009**†	414.27 (264.42)	449.70 (310.83)	**1.005**†	496.96 (307.22)	544.85 (377.48)	**1.008**†
Inner-city area (n = 170)	472.60 (326.15)	519.10 (371.52)	**1.008**†	374.86 (227.04)	402.11 (244.59)	1.014	514.43 (369.80)	573.04 (397.68)	**1.012***	400.75 (297.25)	463.72 (365.99)	**1.012***	560.85 (335.07)	589.73 (394.97)	1.004
Suburban area (n = 178)	494.98 (283.04)	531.27 (325.77)	**1.006**†	531.25 (265.19)	562.31 (314.99)	1.007	590.58 (336.98)	630.10 (351.59)	**1.006***	428.99 (225.75)	434.44 (240.06)	1.001	430.30 (262.49)	498.02 (356.60)	**1.023****
Urban form															
Intersection Density (count/sq km)															
Overall study area (n = 348)	14.41 (6.17)	13.07 (5.50)	**0.85**†	14.68 (6.77)	13.44 (6.01)	**0.87***	13.23 (7.16)	12.05 (5.54)	**0.90***	14.75 (5.82)	13.05 (5.56)	**0.77**‡	15.02 (4.79)	13.86 (4.90)	**0.85***
Inner-city area (n = 170)	14.04 (6.08)	12.93 (5.66)	**0.75**†	15.69 (6.37)	14.33 (6.87)	**0.38***	13.84 (5.68)	11.94 (5.59)	**0.49****	14.15 (7.54)	13.28 (6.44)	0.84	13.19 (4.37)	12.75 (3.82)	0.89
Suburban area (n = 178)	14.75 (6.26)	13.20 (5.35)	**0.89**†	14.00 (7.03)	12.83 (5.35)	0.92	12.63 (8.39)	12.15 (5.55)	0.98	15.41 (2.96)	12.79 (4.47)	**0.72****	16.93 (4.50)	15.01 (5.63)	**0.84***
Residential Density (households' count/sq km)															
Overall study area (n = 348)	339.08 (270.47)	367.89 (259.94)	**1.008**†	304.32 (274.99)	353.40 (248.76)	**1.018**†	307.43 (230.03)	336.92 (223.13)	**1.009****	406.28 (307.52)	421.85 (297.87)	1.004	327.98 (256.52)	354.90 (256.87)	**1.007***
Inner-city area (n = 170)	551.81 (237.60)	561.97 (229.37)	1.002	580.53 (229.26)	599.61 (196.02)	1.004	484.16 (201.01)	496.92 (189.33)	1.002	636.39 (261.66)	631.18 (267.62)	0.99	514.17 (226.84)	532.47 (222.75)	1.003
Suburban area (n = 178)	135.91 (67.32)	182.54 (107.30)	**1.03**†	117.88 (66.82)	187.21 (93.87)	**1.096***	134.47 (67.07)	180.33 (117.71)	**1.043****	155.73 (45.04)	193.91 (86.44)	**1.025****	133.69 (81.78)	169.60 (125.74)	**10.2***

OR – yielded in conditional logistic regression to predict route choice by each exposure.
Bold values indicate statistical significance as follows: * = < .05; ** = < .01; † = < .0001.

	All routes (n = 463)			Home-school routes (n = 95)			Home-public facility (n = 93)			Home-store (n = 94)			Home-park (n = 94)		
	Modelled	Chosen	OR	Modelled	Chosen	OR	Modelled	Chosen	OR	Modelled	Chosen	OR	Modelled	Chosen	OR
Building height (m)															
Overall study area (n = 348)	3.08 (1.96)	3.48 (1.95)	**2.73**†	2.87 (1.80)	3.44 (1.63)	**3.18****	2.86 (1.85)	3.10 (1.88)	**2.26****	3.04 (1.94)	3.36 (1.87)	**2.36****	3.50 (2.17)	3.99 (2.20)	**3.43**†
Inner-city area (n = 170)	4.78 (1.28)	4.95 (1.40)	**1.62***	4.78 (0.99)	4.81 (0.85)	1.14	4.35 (1.29)	4.54 (1.32)	1.30	4.61 (1.40)	4.69 (1.37)	1.92	5.38 (1.09)	5.66 (1.49)	1.93
Suburban area (n = 178)	1.46 (0.75)	2.07 (1.23)	**6.22**†	1.58 (0.77)	2.51 (1.36)	**7.68****	1.30 (0.69)	1.60 (0.98)	**5.12****	1.50 (0.85)	2.07 (1.29)	**51.08****	1.46 (0.69)	2.17 (1.16)	**2.83***
Lot coverage (%)															
Overall study area (n = 348)	23.19 (11.92)	25.82 (12.48)	**1.14**†	21.37 (7.40)	23.95 (7.56)	**1.46**†	23.38 (9.80)	25.57 (10.57)	**1.22****	27.48 (14.71)	29.57 (14.51)	**1.11****	19.99 (12.17)	23.65 (14.07)	**1.09****
Inner-city area (n = 170)	31.48 (10.99)	35.09 (10.91)	**1.13**†	29.41 (4.60)	31.51 (4.99)	**1.26***	30.11 (9.91)	33.63 (9.19)	**1.20****	38.50 (10.82)	40.28 (11.48)	1.07	26.80 (11.45)	33.20 (12.56)	**1.13****
Suburban area (n = 178)	15.26 (5.81)	16.97 (5.52)	**1.16**†	15.95 (1.94)	18.85 (3.73)	**1.75****	16.81 (2.57)	17.68 (3.53)	1.28	15.49 (6.87)	17.92 (5.90)	**1.19***	12.88 (8.25)	13.69 (6.75)	1.03
FAR (%)															
Overall study area (n = 348)	91.76 (55.17)	112.61 (57.85)	**1.04**†	72.54 (36.46)	101.76 (35.98)	**1.08**†	83.53 (41.92)	104.60 (44.71)	**1.06**†	122.19 (65.03)	132.89 (64.63)	**1.02****	83.18 (55.67)	107.99 (69.48)	**1.04**‡
Inner-city area (n = 170)	119.08 (52.11)	136.99 (55.91)	**1.03**†	105.89 (33.60)	115.94 (34.60)	1.05	100.70 (42.03)	118.51 (38.96)	**1.05****	157.28 (55.03)	165.46 (60.65)	1.01	105.12 (46.94)	137.50 (62.72)	**1.04****
Suburban area (n = 178)	65.67 (44.41)	89.32 (49.60)	**1.06**†	50.03 (14.40)	92.19 (34.40)	**1.13***	66.72 (34.70)	90.99 (46.16)	**1.07****	83.99 (52.65)	97.43 (48.47)	**1.03***	60.28 (55.27)	77.19 (63.00)	**1.05****

Bold values indicate statistical significance as follows: * = < .05; ** = < .01; † = < .0001.

	All routes (n = 463)			Home-school routes (n = 95)			Home-park routes (n = 124)			Home-community center routes (n = 116)			Home-store routes (n = 128)		
	Modelled	Chosen	OR	Modelled	Chosen	OR	Modelled	Chosen	OR	Modelled	Chosen	OR	Modelled	Chosen	OR
Land uses															
% Residential															
Overall study area (n = 348)	60.82 (20.54)	62.70 (18.70)	**1.016***	55.12 (22.80)	64.94 (15.97)	**1.108**†	60.58 (19.43)	60.24 (19.23)	0.99	57.37 (20.12)	61.78 (18.61)	**1.042***	68.55 (18.22)	64.50 (19.94)	**0.95****
Inner-city area (n = 170)	70.96 (16.04)	68.87 (15.59)	**0.98***	70.22 (17.79)	70.30 (14.67)	1.002	68.74 (14.37)	67.38 (14.45)	0.98	68.69 (16.71)	69.30 (15.14)	1.005	75.67 (15.41)	69.12 (17.78)	**0.88****
Suburban area (n = 178)	51.14 (19.71)	56.82 (19.55)	**1.046**†	44.93 (20.11)	61.32 (15.97)	**1.24****	52.05 (20.47)	52.78 (20.85)	1.005	46.28 (16.80)	54.41 (18.87)	**1.143****	60.80 (18.03)	59.46 (21.12)	0.99
% Retail															
Overall study area (n = 348)	7.38 (9.07)	8.49 (12.46)	**1.04****	3.77 (5.65)	3.06 (5.70)	0.88	6.90 (7.22)	6.78 (8.53)	0.99	5.78 (6.92)	5.05 (8.47)	0.95	12.03 (12.27)	17.45 (17.18)	**1.21**†
Inner-city area (n = 170)	9.63 (11.36)	11.33 (12.95)	**1.089****	5.35 (7.19)	6.26 (7.66)	1.24	8.47 (8.19)	9.39 (8.85)	1.04	6.90 (8.40)	7.95 (10.33)	1.09	15.69 (14.70)	19.20 (17.00)	**1.12***
Suburban area (n = 178)	5.24 (5.88)	5.77 (11.36)	1.016	2.71 (4.08)	0.90 (2.01)	0.40	5.27 (5.70)	4.05 (7.32)	0.93	4.69 (4.94)	2.22 (4.73)	**0.84***	8.04 (7.17)	15.55 (17.35)	**2.20****
% Public Institute															
Overall study area (n = 348)	18.07 (14.77)	15.64 (13.01)	**0.96**†	<u>28.06 (17.55)</u>	20.94 (16.21)	**0.88**†	<u>13.17 (9.85)</u>	12.89 (10.24)	0.99	<u>24.14 (15.48)</u>	20.60 (13.76)	**0.95***	<u>9.84 (7.72)</u>	9.71 (8.08)	0.99
Inner-city area (n = 170)	13.11 (12.46)	14.53 (11.63)	1.03	20.67 (14.57)	20.49 (11.99)	0.99	9.84 (9.65)	12.71 (11.64)	**1.08***	19.39 (13.54)	19.30 (10.22)	0.99	6.23 (6.29)	8.56 (9.27)	1.10
Suburban area (n = 178)	22.81 (15.27)	16.70 (14.16)	**0.87**†	33.04 (17.79)	21.25 (18.67)	**0.85**†	16.63 (8.89)	13.09 (8.66)	**0.90***	28.79 (15.99)	21.86 (16.53)	**0.87****	13.76 (7.26)	10.97 (6.40)	**0.88***

Bold values indicate statistical significance as follows: * = < .05; ** = < .01; † = < .0001.

	All routes (n = 463)			Home-school routes (n = 95)			Home-park routes (n = 124)			Home-community center routes (n = 116)			Home-store routes (n = 128)		
	Modelled	Chosen	OR	Modelled	Chosen	OR	Modelled	Chosen	OR	Modelled	Chosen	OR	Modelled	Chosen	OR
% Green open spaces															
Overall study area (n = 348)	13.73	13.17	0.99	13.05	11.06	0.95	19.35	20.09	1.008	12.71	12.58	0.99	9.58	8.34	0.96
	(14.01)	(14.38)		(14.11)	(11.90)		(15.33)	(16.96)		(12.55)	(13.78)		(12.23)	(10.97)	
Inner-city area (n = 170)	6.30	5.27	0.95	3.76	2.94	0.91	12.94	10.52	1.03	5.02	3.45	0.89	2.41	3.12	1.06
	(9.97)	(7.92)		(9.43)	(5.11)		(11.91)	(10.77)		(9.18)	(4.70)		(4.39)	(5.83)	
Suburban area (n = 178)	20.81	20.71	0.99	19.32	16.54	0.96	26.04	30.08	0.94	20.24	21.51	1.03	17.39	14.02	0.87
	(13.65)	(15.11)		(13.33)	(12.08)		(15.74)	(16.55)		(10.74)	(13.90)		(13.24)	(12.40)	
Walkability															
Overall study area (n = 348)	−0.14	−0.23	0.78	−0.11	−0.39	**0.22****	−0.10	−0.07	1.08	−0.19	−0.42	**0.54***	−0.16	−0.06	1.39
	(1.14)	(1.25)		(1.08)	(1.30)		(1.13)	(1.21)		(1.17)	(1.24)		(1.18)	(1.25)	
Inner-city area (n = 170)	0.05	0.12	1.35	0.31	0.42	3.69	0.006	0.14	1.58	−0.12	−0.24	0.69	0.11	0.29	2.27
	(1.29)	(1.38)		(1.48)	(1.53)		(1.19)	(1.21)		(1.36)	(1.45)		(1.23)	(1.34)	
Suburban area (n = 178)	0.32	−0.56	**0.52****	−0.39	−0.94	**0.07****	−0.20	−0.29	0.81	−0.25	−0.60	**0.43***	−0.45	−0.45	1.008
	(0.94)	(1.02)		(0.56)	(0.72)		(1.07)	(1.18)		(0.95)	(0.98)		(1.06)	(1.02)	

Bold values indicate statistical significance as follows: * = < .05; ** = < .01; † = < .0001.

Appendix B

Degree of overlap between chosen and modelled routes.

	Degree of overlap between chosen and modelled routes					p-value
		Median	IQR	Mean	SD	
Pooled sample (n = 348 routes)		0.67	0.32–1.00	0.64	0.67	NA
Neighborhood type	Inner-city (n = 170)	0.75	0.33–1.00	0.67	0.33	.059
	Suburban (n = 178)	0.62	0.31–0.97	0.61	0.33	
Destination type	Home-School (n = 67)	0.67	0.34–1.00	0.64	0.34	.572
	Home-PF (n = 93)	0.62	0.30–1.00	0.60	0.34	
	Home-Store (n = 94)	0.68	0.32–1.00	0.66	0.34	
	Home-Park (n = 94)	0.71	0.35–0.99	0.66	0.32	
Home-School	Inner-city (n = 27)	1.00	0.61–1.00	**0.77**	0.29	.006
	Suburban (n = 40)	0.58	0.22–0.90	**0.55**	0.34	
Home-Public Facility	Inner-city (n = 46)	0.81	0.32–1.00	**0.68**	0.34	.029
	Suburban (n = 47)	0.66	0.29–0.80	**0.52**	0.33	
Home-Store	Inner-city (n = 49)	0.77	0.28–1.00	0.66	0.36	.936
	Suburban (n = 45)	0.62	0.44–1.00	0.66	0.30	
Home-Park	Inner-city (n = 48)	0.66	0.32–1.00	0.63	0.32	.344
	Suburban (n = 46)	0.83	0.38–0.98	0.69	0.32	

Bolded values are statistically significant ($p < .05$).
NA = Not Applicable.

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