CHILDREN'S INDEPENDENT TRAVEL, THE BUILT ENVIRONMENT, AND HEALTH

by E. Owen Waygood*

1. Introduction

The built environment of North America is likely connected to increases in obesity issues there (Frank *et al.*, 2003). Children as well are suffering the consequences of an adult-focused, auto-oriented development style. The majority of all children's travel is by automobile in the USA (McDonald, 2005) and Canada (Gilbert and O'Brien, 2005; Stefan and Hunt, 2006). They have very limited independent travel (McDonald; Stefan and Hunt) and increasing obesity rates (Active Healthy Kids Canada, 2007; Anderson and Butcher, 2006). Frank *et al.* argue there are health benefits through non-motorized modes as a result of more compact, mixed land-use development and Gilbert and O'Brien recommend that such development would improve independent travel for children. Japan has such a built environment, but recent development has been more auto-oriented (Sorenson, 2002). This paper will highlight results on these questions: the connection between the built environment, exercise, and independent travel.

2. Study Area and Research Questions

The Kei-Han-Shin area has both high density, compact, mixed land-use development and low density development. However, it is not known whether children's travel in Japan has seen a decrease in independence and whether that decrease is considerable or minor. As well, if Frank *et al.*'s assertion that more compact areas support more non-motorized travel is true, we should see a difference across the built environments of the area. Previous work (Sun *et al.*, 2009) categorized the districts of the Kei-Han-Shin area into Highly commercial, Mixed commercial, Mixed residential, Autonomous, and Undeveloped. Using those designations I will show whether the built environment affects mode choice.

The next issue is that of exercise and independent travel. Independent travel by children will involve some non-motorized mode use, which is a form of exercise. Frank *et al.* argue that more compact development encourages non-motorized travel, but such trips are likely short. If, on the other hand, children in low density areas also use non-motorized modes, the distances are likely greater, so they may gain more exercise there.

Another concern with more intense development is the lack of space for children to play. However, children in low density areas may have trouble reaching each other, which may also affect play. In this paper I will show whether a connection exists between population density and vigorous play.

3. Data Sources

Information from the Kei-Han-Shin Person-trip Survey was used to examine trends over the last few decades. Information to examine independent trips and exercise come from a Children's Travel Diary (Waygood and Kitamura, 2009) conducted at five different elementary schools in the Kei-Han-Shin area.

4. Has there been a decrease in children's non-motorized travel in the Kei-Han-Shin area and is it related to the built environment?

The first question investigated is whether there is a measurable decrease in the amount of non-motorized travel in the Kei-Han-Shin area and whether that change is related to the built environment. Children are able to drive motorcycles at sixteen and information was not gathered on children under five, therefore only information for children aged five to fifteen are presented in Table 1.

*Keywords: children, travel behavior, independent, autonomous, built environment, health, exercise, population density

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TABLE 1 Children's (aged 5 to 15) mode split over 1970 to 2000. (N = 690,100)

	1970	1980	1990	2000
Walk	87.9%	74.9%	69.6%	49.4%
Bicycle	5.8%	13.4%	15.6%	20.1%
Bus	3.3%	4.3%	4.3%	4.0%
Rail	0.3%	4.0%	4.4%	14.9%
Motorcycle	0.1%	0.3%	0.1%	1.3%
Car/Truck	1.0%	2.0%	4.6%	8.9%

Table 1 shows that while walking has decreased considerably (-38.5%), cycling has increased 14.3% to an overall decrease of 24.2% of non-motorized mode share. The largest increase in mode share was by mass transit though with a positive growth in mode share of 15.5%. The remaining difference (9.7%) was growth in private motor use. So, we can see that there has been a decrease in non-motorized travel and likely a decrease in independent travel (as private motor travel is automatically not independent).

The next question is with respect to the influence of the built environment. If the built environment does not affect mode choice, then changes should be the same across all areas. Categorizing the children's residential areas using the built environment definitions into five separate categories we can see in Figure 1 that there are differences, although similar trends exist. The greatest gains in private motor use were in the less urban areas. The most urban areas show very little growth with less than a 5% share. However, it should also be noted that even the most auto-oriented areas do not compare to car use in the USA for children (average 73%; McDonald, 2005).

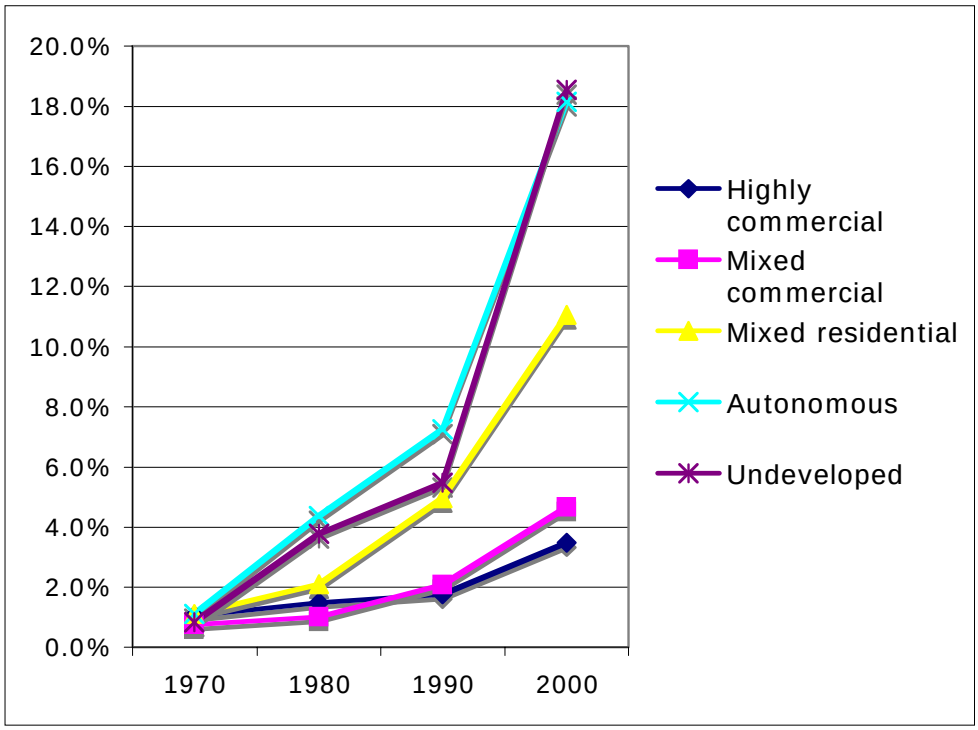

FIGURE 1 Children's (five to fifteen) private motor mode share. (N = 641,204)

5. Population Density, Exercise, and Independent Travel

This section will answer questions related to exercise and independent travel with respect to population density. The information comes from a Children's Travel Diary that was completed over the 2007-2008 school year. The first questions are whether there are connections between the population density and four measures related to exercise and independent travel. They are: known person seen on trip, independent trips, vigorous activity, and exercise through travel (minutes by non-motorized modes). The results of both analysis of variance (ANOVA) and Pearson's correlation coefficients are shown

in Table 2 for weekdays and Table 3 for weekends.

TABLE 2 Results of ANOVA Analysis for Weekdays.

	Population Density							
	Low*	Medium*	High*	Very High*	Sum of Squares	Mean Square	F-ratio	Correlation Coefficient
	(N=37)	(N=34)	(N=112)	(N=82)				
	Value (Std. Err.)	Value (Std. Err.)	Value (Std. Err.)	Value (Std. Err.)			DF (4, 261)	
Known person seen on trip (% of all trips/day)	64.3% (5%)	74.0% (5.3%)	67.7% (2.9%)	78.3% (3.4%)	135.5	33.9	359.6	0.135
Independent Trips (% of all trips/day)	58.3% (3.8%)	86.7% (3.9%)	88.5% (2.2%)	90.8% (2.5%)	193.6	48.4	920.4	0.369
Vigorous Activity (times/day)	1.54 (.24)	1.27 (.25)	1.38 (.14)	1.02 (.16)	442.8	110.7	54.1	-0.061
Exercise through travel (min./day)	40.6 (3.97)	43.7 (4.14)	33.6 (2.28)	27.3 (2.66)	313135.4	78283.9	134.6	-0.15

Significant at $p < 0.001$ for all dependent variables

* "Low" is less than 2000 people/km^2, "medium" is from 2000 to up to 3999 people/km^2, "high" is from 4000 up 6499 people/km^2, and "very high" is from 6500 people/km^2 and above. These correspond to population density quartiles for the Kei-Han-Shin area.

TABLE 3 Results of ANOVA Analysis on Main Questions for a Sunday.

	Population Density							
	Low* (N=37)	Medium* (N=34)	High* (N=112)	Very High* (N=82)	Sum of Squares	Mean Square	F-ratio	Correlation Coefficient
	Value (Std. Err.)	Value (Std. Err.)	Value (Std. Err.)	Value (Std. Err.)			DF(4, 198)	
Known person seen on trip (% of all trips/day)	41.7% (6.7%)	42.2% (6.4%)	37.3% (4.2%)	61.3% (5.8%)	41.1	10.3	68.3	0.126
Independent Trips (% of all trips/day)	23.9% (6.9%)	24.5% (6.6%)	30.4% (4.3%)	53.9% (6.1)	25	6.25	38.9	0.226
Running-level Activity (times/day)	1.44 (.20)	.84 (.19)	.75 (.13)	1.05 (.18)	193.2	48.3	34.7	-0.106
Exercise through travel (min./day)	11.5 (4.5)	15.7 (4.3)	19.6 (2.8)	23.7 (3.9)	71772	17943	26.3	0.153

Significant at $p < 0.001$ for all dependent variables

* "Low" is less than 2000 people/km^2, "medium" is from 2000 to up to 3999 people/km^2, "high" is from 4000 up 6499 people/km^2, and "very high" is from 6500 people/km^2 and above. These correspond to population density quartiles for the Kei-Han-Shin area.

In Table 2 and 3 we see that although there are positive correlations for seeing a known person and independent travel, the results for exercise are not clear. The correlation for weekday vigorous activity is too low to make a conclusion, and the negative correlation for Sundays is just barely low. The result for exercise through travel changes from negative on weekdays to positive on weekends. This is likely related to the walk to school.

However, what if we look at the percentage of vigorous activities that were at a destination reached

independently of an adult? From that we see that 84% of weekday and 64% of Sunday vigorous exercise occurred when a child reached the destination without a parent. This suggests that enabling children to travel freely improves their health.

6. Conclusions

This paper showed that there has been a decrease in non-motorized mode's share in the Kei-Han-Shin area for children five to fifteen over the past forty years and that less urban areas saw the greatest growth in private motor's share. Vigorous exercise most frequently on an independent trip and independent rips occur most often in more urbanized areas. However, there was no clear correlation between population density and vigorous exercise. Walking to school plays an important role in the amount of exercise gained by children in less urbanized areas. Future research should use pedometers or other such objective measures to examine the amount of exercise actually gained in different built environments.

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