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Transit Use by Children and Adolescents: An Overlooked Source of and Opportunity for Physical Activity?

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Abstract

Background—The potential for adults to accrue significant physical activity through public transit use is a topic of interest. However, there are no data on analogous questions among children. The goal of this analysis was to quantify patterns of transit use and correlates of transit-related physical activity among children aged 5 to 17 years.

Methods—Data for this cross-sectional study came from the 2012 California Household Travel Survey. Probit regressions modeled the probability of transit use; negative binomial regressions modeled minutes/day in transit-related active travel.

Results—Public transit use accounted for 3% of trips in California in 2012. Older Hispanic youth and those residing in areas with greater housing density and county size had a higher probability of transit use. Driver licensure, home ownership, household income, and vehicles in household were negatively correlated with public transit use. Race/ethnicity, income, and transit type were correlated with time spent in active travel to/from transit.

Conclusions—Given its importance as a source of physical activity for some children, researchers should consider assessment of public transit-related activity in physical activity measurement instruments. Efforts to encourage active travel should consider how to incorporate transit-related activity, both from a measurement perspective and as an intervention strategy.

Keywords

transportation; active travel; walking; youth

Current physical activity guidelines recommend 60 minutes per day of physical activity for children and adolescents.[1] However, a low proportion of US youth accumulate sufficient physical activity to meet these recommendations.[2] In response, a great deal of recent

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scholarship concerning physical activity in children has been focused on understanding or promoting active transportation choices, such as walking or biking, to determine if this is an effective strategy to increase overall physical activity. The general logic underlying this focus on active transport is that if physical activity can be incorporated as part of activities that must be undertaken anyway, physical activity will become a more regular and frequent behavior. However, existing research on active transportation practices among children has been relatively restricted in focus. Researchers have almost exclusively examined trips that are entirely walk- or bike-based, especially those connected to trips to or from school.[3–11]

Unfortunately, this emphasis on school-related trips using selected transport modes neglects the fact that children frequently travel to nonschool destinations, and it does not properly account for public transit use among children. Public transit (eg, bus, light rail, subway, etc) lies in the middle of the active versus motorized travel mode continuum. It generally requires some travel to get from origin (eg, home) to the transit stop and more travel from the subsequent transit stop to the final destination (eg, school, store, or job). Because these access and departure trips to and from transit are frequently accomplished by walking, prior research has shown that among adults a significant amount of physical activity can be accrued each day, in some cases up to 30 minutes of physical activity per day.[12]

Perhaps owing to an assumption that children are infrequent transit users, no research has attempted to answer similar questions regarding transit and physical activity in children. This is problematic for at least 2 reasons. First, the structure of most existing self-report instruments often do not include opportunities for children (or their proxy) to report transit-related physical activity. Because some children may participate in significant amounts of transit-related walking or biking, this omission would result in an underestimation of total physical activity levels. Second, without understanding the potential for children in terms of transit-related physical activity, it is not possible to develop programmatic activities to encourage this behavior.

In response to the current lack of data, the purpose of this article is to describe transportation patterns among children and to characterize associations of demographic and socioeconomic factors with overall transit use and transit-related physical activity. The analyses use a large, cross-sectional, population-based survey of travel behavior among families in California.

Methods

Data Source

For this analysis, data from the 2012 California Household Travel Survey (CHTS) were used. This statewide travel survey enrolled >42,000 households. An address-based sampling frame was used to recruit households via computer-assisted telephone interviewing and a CHTS website. Data collected included a questionnaire and a single-day travel diary. All individuals within a recruited household were asked to complete the individual-level questionnaire and travel diary; 1 person was asked to complete the household-level questionnaire. In general, a proxy responded for children younger than 16 years, whereas those aged 16 years and older responded for themselves. For purposes of this analysis, the dataset was restricted to children and adolescents who were at least 5 years of age but less

than 18 years (ie, school-aged children). The complete CHTS dataset was downloaded from the Transportation Secure Data Center maintained by the National Renewable Energy Laboratory in September 2014. More details on the survey sampling plan and methodology of the CHTS are available elsewhere.[13]

Analysis

Transit-related walking can be considered the product of 2 decisions: first, the decision of whether to use transit, and second, the decision about how to get to and from transit (ie, active vs inactive modes). Therefore, we developed 2 separate regression models. The first was a probit model, with the dependent variable operationalized as transit use on the assigned travel day, yes or no. Independent variables were selected on the basis of prior research of similar questions regarding transit use and physical activity among adults. These variables included age, gender, race/ethnicity, driver license status, employment status, housing density, home ownership, household income, household size, vehicles per licensed driver in the household, presence of at least 1 adult in the house who used transit in the past week, and the degree of urbanization of the census tracts in which participating families resided. The last variable was derived from Rural-Urban Commuting Area Codes from the US Department of Agriculture. The questions referring to the home or household were answered by the designated household respondent (an adult in the home), and the rest were answered directly by the child or their proxy. County size was based on Census figures. For ease of exposition, average marginal effects were calculated, which reflect the probability of transit use associated with each variable.

The second model was of transit-related walking, operationalized as total minutes per day, among those who used any transit on their assigned travel days. The total minutes of transit-related walking is properly thought of as a count variable, as it can only take on nonnegative integer values. Therefore, we modeled this variable using a negative binomial regression, which accounts for the skewed distribution of the outcome. All variables from the probit model were included, plus a variable indicating whether the child used only bus transit, only rail transit, or both on their assigned travel day. Average marginal effects were calculated, which reflect the predicted number of minutes of active travel per day.

In addition to the main regression models, additional models were tested that incorporated all 2-way interactions and the 3-way interaction between age, gender, and race/ethnicity. Interaction terms were tested individually in separate models. The standard errors in both regression models were corrected for clustering of children within household. Survey weights reflecting the complex sampling design of the CHTS were applied for purposes of generating descriptive statistics. All analyses were conducted with Stata v13.1 (StataCorp LP, College Station, TX), and Stata code to replicate the analyses is provided at github.com/durandca/JPAH2016. The authors' institutional review board granted exempt status to this analysis because of the publicly available nature of the data set.

Results

The demographic profile of youth in the sample is described in Table 1. After weighting the sample data, approximately one-half of the sample were Hispanic, there was a roughly equal

split between males and females, <10% were employed or had a driver's license, and most children resided in single-family detached homes, households with incomes of <$75,000 per year, and urban census tracts. Overall, the majority of trips taken by children were by automobile, at almost 72%. Walking was the second most common form of travel at 19%. Transit use accounted for 2.7% of the trips, similar to the portion of trips taken by bike. Among children who used any form of transit, the median time spent in active travel to and from transit on the assigned travel day was 21 minutes (interquartile range = 12–34 minutes).

Results of the probit regression model are shown in Table 2. Age, housing density, and having an adult in the household who used transit were positively associated with probability of using any transit type. Driver licensure, home ownership, household income, vehicles in household per licensed driver, and urbanicity were negatively correlated with probability of any transit use. The marginal effects, which are interpreted as the change in the probability of transit use for each unit change in the independent variables, indicate that the correlations between the predictors and probability of transit use were generally small in magnitude. For example, for each 10 year increase in age, the probability of transit use increases by 0.4 percentage points. The largest associations in terms of probability were observed for children having an adult in the household who used transit, for whom the probability of transit use increased by 4 percentage points compared with those without an adult in the home using transit.

Also shown in Table 2 is the negative binomial regression model of minutes spent in transit-related active travel. Race/ethnicity, having a driver's license, housing type, income, vehicles per licensed driver, presence of a transit using adult in the home, and transit type were significantly correlated with minutes per day spent in active travel to transit. Examining the marginal effects, black/African-American children accrued 14 minutes more of active travel to transit per day as compared with white children. Compared with those without a driver's license, those children with a driver's license achieved 11 minutes less of transit-related activity. Those who resided in a mobile home, compared with a single-family detached house, achieved almost 19 minutes more transit-related activity. Compared with the lowest income category, children in the second highest income category achieved about 12 minutes less per day of active travel to transit. As the number of vehicles per licensed driver in the home increased, the expected minutes per day of transit-related activity declined. Those children with an adult who used transit in the home accrued almost 5 minutes per day more transit-related activity, compared with those without such an adult. Finally, compared with children who used only bus transit, children who used both bus and rail transit achieved 27 minutes more per day of active travel to transit.

Between both regression models, only 1 interaction term was significant: age by race/ethnicity, for the model with transit use as the outcome. Figure 1 shows that the probability of transit use increased with higher age among white, black, and Hispanic children, but not among American Indian or Asian children.

Discussion and Conclusion

To our knowledge, this is the first analysis to quantify the public transit use of children in a large, population representative sample and to further explore the physical activity attributable to transit use in children. Overall, utilization of public transit as a percentage of all trips among children is similar to that of adults, at about 3%, and active travel to public transit is a significant source of physical activity for some children. Given the median transit-related walking time of 21 minutes, at least one-half of children who use transit can be expected to achieve approximately one-third of their daily recommended time of physical activity through transit use alone. We found that many of the correlates of transit use and transit-related physical activity in children are similar to those previously identified among adults, namely, economic factors such as family income and vehicle ownership, race/ethnicity, urbanization, and access to rail transit.[14,15] However, this knowledge should be tempered by the fact that the effect sizes noted in terms of the correlation with transit use were relatively small. The statistical significance of these associations may be due simply to the sheer size of the population included in model 1. This could indicate that variables not included here are more important predictors of transit use in children. The effect sizes in terms of the correlation with minutes per day of transit-related physical activity were more substantial.

Perhaps the most important conclusion from this analysis concerns physical activity measurement. Self-report instruments to measure physical activity in children should seek to specifically quantify minutes spent in transit-related walking, especially if the participant population has lower income, is minority, and resides in a more populous, denser urban environment served by both rail and bus, all characteristics associated with higher transit use and/or transit-related physical activity among children. To our knowledge, only 1 instrument developed for use in children explicitly accounts for this form of activity, and even then only in the context of travel to and from school.[16] To the extent this mode of travel is not accounted for, instruments will tend to undercount physical activity, especially the light-to-moderate intensity activities (eg, walking and cycling) that characterize transit-related active travel.

An additional implication is for physical activity interventions. Policy and programmatic interventions to promote walking and biking to school have been developed, but our results suggest these could be extended to further promote transit use as a way to get to school and simultaneously accrue physical activity.[17,18] This would make these programs more inclusive, because they could potentially target children who live too far away to walk the entire trip to and from school, but who may be able to use transit for part of the trip. In addition, trips to other destinations besides school could be targeted, such as recreational destinations or after-school/summer jobs. The issue of transit use among children is, of course, more complex than among adults because it is likely that for many of the children, the decision to use transit is not under their control; it is rather more likely that they are using transit under the direction of their parent or guardian. Therefore, future research is needed regarding how parents feel about their children using public transit, especially if they are unaccompanied; at what age it is acceptable for a child to use public transit alone; and

what environmental factors can influence or be changed to promote safe use of public transit by children.

This study was strengthened by the large, diverse sample included. The design of the CHTS enabled us to include trips of all types, rather than restricting to trips for a specific purpose such as getting to school. We are limited to some degree by an inability to account for environmental effects beyond a basic measure of housing density. The built environment presumably plays a significant role in the decision to use transit and how to get to transit among children, and future research in this area should account for this influence. We are also limited by an inability to incorporate a meaningful metric of transit accessibility, such as distance to the nearest transit stop that travels to one of the child's usual destinations. Future research should determine the best way to calculate this metric for children and account for its influence in transit use/transit-related activity models.

To conclude, transit use and transit-related physical activity have previously been underexamined as modes of travel and sources of activity, respectively, among children. There is a great deal still to be learned about this topic, but researchers should begin to account for this specific form of travel and activity in future measurement and intervention work.

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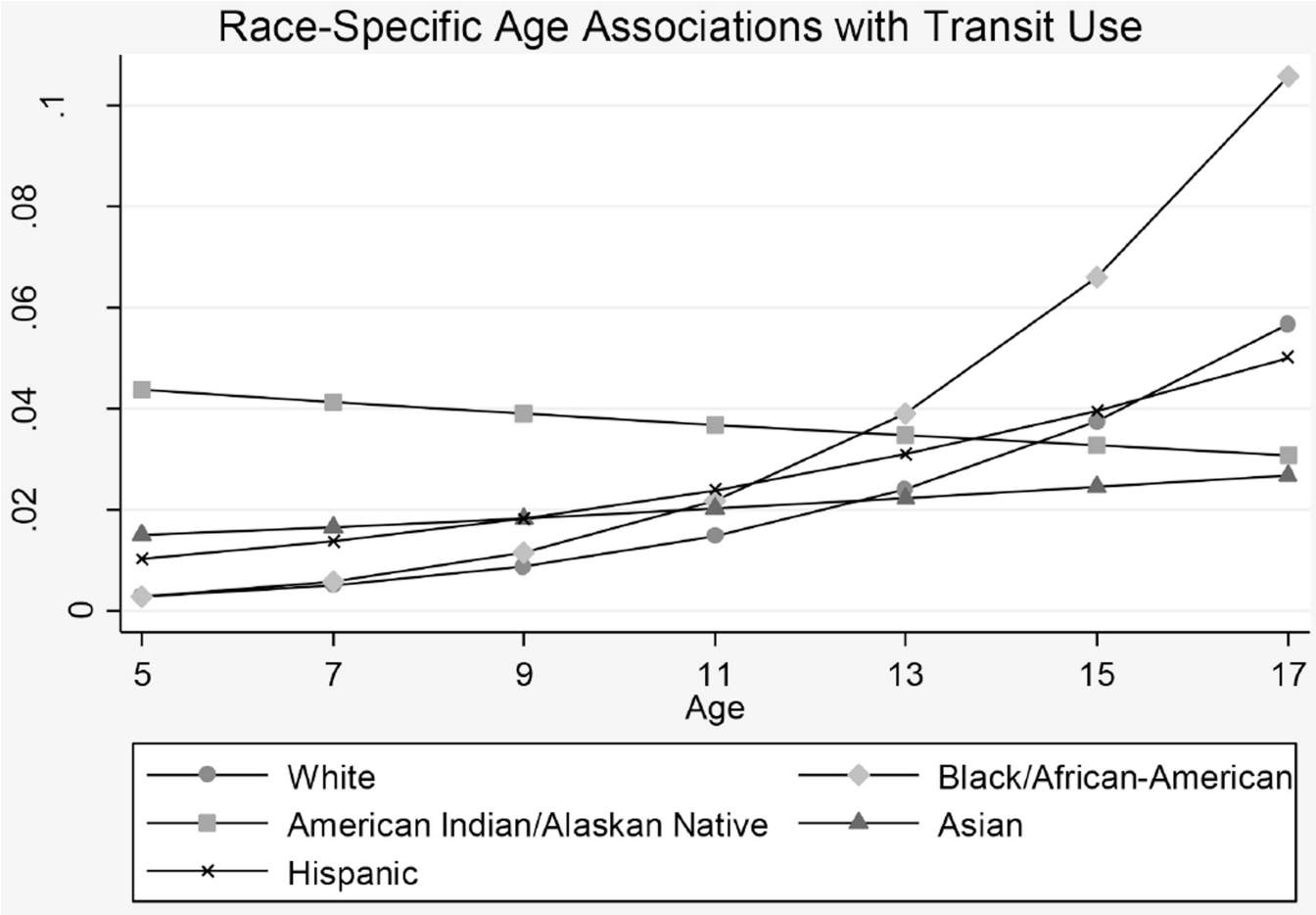

Figure 1.
Interaction between race and age for model with transit use as outcome.

Table 1

Mode of Travel (Weighted Percentages of Trips) by Individual and Household Characteristics

	Walk	Bike	Transit	Automobile	Other[a]	Overall sample characteristics (weighted N of individuals = 7,022,863)
Age, years						
5–10	17.8	2	1.7	75	3.5	42.9
11–15	20.2	2.6	2.6	69.8	4.8	39.6
16–17	21	2.5	5.2	68.1	3.2	17.5
Gender						
Female	19.4	1.7	2.7	72.7	3.5	48.5
Male	19.2	2.9	2.6	70.8	4.4	51.5
Race/Ethnicity						
White	11.7	3.1	1	81	3.3	33.6
Black/African-American	20.3	1.5	5.2	68	5	4.6
American Indian/Alaskan Native	24.5	0.7	2.7	59.8	12.3	0.1
Asian	13.7	2.3	1.3	80.2	2.5	11.3
Native Hawaiian/Pacific Islander	6	2	0	91.8	0.2	0.2
Hispanic	26	1.9	3.9	63.5	4.7	50.2
Driver license						
No	20.1	2.4	2.8	70.7	4.1	94.5
Yes	7.9	1.5	1.2	87.7	1.7	5.5
Employed						
No	19.3	2.3	2.7	71.7	4	98.6
Yes	15.7	2.3	2.8	77.7	1.4	1.4
Residence type						
Single-family detached	14.5	2.7	1.4	77.7	3.8	72.8
Duplex/triplex	29.6	1.5	5.7	59.6	3.7	8.7
Mobile home	18.9	1.5	1.5	71.2	6.9	2.5
2–4 unit building	39.4	0.9	7.4	47.3	5	5
5–19 unit building	38.5	1.3	5.8	50.4	4	5.6
20+ unit building	30.1	1.1	7.4	56.4	5	5.3

	Walk	Bike	Transit	Automobile	Other[a]	Overall sample characteristics (weighted N of individuals = 7,022,863)
Family owns home						
Rent	32.1	1.5	6.1	55.1	5.2	34
Own	13.1	2.7	1	79.8	3.3	66
Household income						
<$25,000	35.3	1.6	6.4	51.3	5.5	23.5
$25,000–$49,999	21.4	2.1	2.9	68.2	5.4	22.2
$50,000–$74,999	12.4	2.4	1.2	81	3	12.8
$75,000–$99,999	10	2.8	0.6	83.1	3.5	12.5
$100,000+	11.7	2.7	0.9	82.1	2.6	28.9
Household size						
1–2	18.8	2.3	3.7	69.3	5.8	2.1
3–6	18.8	2.3	2.6	72.5	89.4	90
7+	24.9	2.2	3	64.3	5.5	8.5
Vehicles at home per licensed driver						
None	62.6	2	15.3	14.8	5.2	6.4
>0–1	16.4	2.3	1.8	75.6	3.9	92.2
>1	50.6	4.9	9.6	31.1	3.9	1.3
Adults using transit in household						
None	13.6	2.4	0.7	79.3	4	67.3
1 or more	29.9	2.1	6.3	57.7	4	32.7
Urbanicity						
Metropolitan	19.2	2.3	2.8	71.9	3.7	93.9
Micropolitan	22.7	2.1	1.1	67.4	6.7	4.3
Small town/rural	15.1	1.3	0.2	73.7	9.7	1.8
Total	19.3	2.3	2.7	71.8	4	—

Note. Weighted N of trips = 23,233,925.

[a]Includes private shuttle, school bus, taxi, and nonmotorized modes besides walking and biking.

Table 2

Regression Models of Transit Use and Minutes of Transit-Related Active Travel and Average Marginal Effects

	Model 1: Transit Use (n = 16,459)			Model 2: Transit-Related Active Travel Time (n = 400)		
	Parameter estimate	**SE**	**AME**	**Parameter estimate**	**SE**	**AME**
Age	0.08[a]	(0.01)	0.00362	0.01	(0.02)	0.154
Gender	−0.03	(0.05)	−0.00159	−0.09	(0.10)	−1.429
Race/ethnicity						
White	Ref			Ref		
Black/African-American	0.23	(0.14)	0.0115	0.69[a]	(0.32)	13.65
American Indian/Alaskan Native	0.27	(0.29)	0.0139	0.20	(0.27)	2.962
Asian	0.03	(0.13)	0.00117	−0.36	(0.32)	−4.127
Hispanic	0.13	(0.07)	0.00581	0.22	(0.19)	3.449
Driver license	−0.44[a]	(0.13)	−0.0203	−0.63[a]	(0.31)	−10.62
Employed	0.14	(0.18)	0.00628	−0.74	(0.60)	−12.41
Residence type						
Single-family detached	Ref			Ref		
Duplex/triplex	0.28[a]	(0.10)	0.0145	0.14	(0.17)	2.253
Mobile home	0.12	(0.20)	0.00560	0.81[a]	(0.37)	18.79
2–4 unit building	0.35[a]	(0.13)	0.0192	0.20	(0.18)	3.284
5–19 unit building	0.14	(0.13)	0.00625	−0.07	(0.18)	−0.995
20+ unit building	0.24	(0.13)	0.0123	0.38	(0.23)	6.846
Family owns home	−0.21[a]	(0.08)	−0.00998	0.16	(0.18)	2.633
Household income						
<$25,000	Ref			Ref		
$25,000–$49,999	−0.13	(0.09)	−0.00660	−0.15	(0.15)	−2.533
$50,000–$74,999	−0.24[a]	(0.12)	−0.0110	0.45	(0.24)	10.12
$75,000–$99,999	−0.33[a]	(0.13)	−0.0143	−1.05[a]	(0.38)	−11.55
$100,000+	−0.11	(0.10)	−0.00550	−0.21	(0.24)	−3.341

	Model 1: Transit Use (n = 16,459)			Model 2: Transit-Related Active Travel Time (n = 400)		
	Parameter estimate	**SE**	**AME**	**Parameter estimate**	**SE**	**AME**
Household size	−0.04	(0.03)	−0.00183	−0.01	(0.04)	−0.122
Vehicles in household per licensed driver						
None	Ref			Ref		
>0–1	−0.58[a]	(0.11)	−0.0408	−0.18	(0.14)	−3.130
>1	−0.86[a]	(0.39)	−0.0501	−0.83	(0.40)	−10.69
Adults using transit in household	0.68[a]	(0.06)	0.0350	0.32[a]	(0.13)	4.924
Urbanicity						
Metropolitan	Ref			Ref		
Micropolitan	−0.24	(0.17)	−0.00954	0.02	(0.24)	0.365
Small town/rural	−1.07[a]	(0.36)	−0.0232	−0.38	(0.20)	−5.312
Transit type						
Bus	–	–	–	Ref		
Rail	–	–	–	0.22	(0.18)	3.882
Bus and rail	–	–	–	1.00[a]	(0.39)	27.14
Constant	−2.39[a]	(0.21)	–	2.29[a]	(0.35)	–

[a] $P < .05$.

Abbreviations: AME, average marginal effect, Ref, reference; SE, standard error.