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Are children living on dead-end streets more active? Near-home street patterns and school-going children's time spent outdoors in Dhaka, Bangladesh

Muntazar Monsur [a,*], Mohaimen Mansur [b], Mohammed Zakiul Islam [c]

[a] Natural Learning Initiative (NLI), College of Design, NC State University, Campus Box 7701, 101 Leazar Hall, Raleigh, NC 27695-7701, USA
[b] Alliance Manchester Business School, The University of Manchester, Booth Street West, Manchester M15 6PB, UK
[c] Department of Architecture, Bangladesh University of Engineering and Technology (BUET), Dhaka 1000, Bangladesh

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ABSTRACT

This study aimed to investigate relationships between near-home street patterns and children's time spent outdoors (TSO). Participants were 60 (n = 60) school-age Dhaka children, 7–11 years old (16 girls and 44 boys) selected by a two-phase cluster sampling method. Data were collected from September 2010 to June 2011 by visiting each of 60 children's homes. Children's mean TSOs (in minutes) were reported by parents' face-to-face interviews, and near-home street pattern data were collected by systematic direct observations. The researchers also collected data on seven socio-demographic variables and three neighborhood built-environment variables. A backward selection based multiple linear regression was used to examine association between children's TSO and near-home street patterns. Results (adjusted $R^2 = 0.66$ for weekdays and 0.68 for weekend) suggested that children's TSO were significantly associated with near-home street type: dead-end instead of through streets (28 min on weekdays, $p < 0.01$ and 66 min on weekend, $p < 0.01$). The width of the street, level of its branching and availability of an open space or playground near the house are also positively associated with TSO. Near-home street features significantly contribute to TSO in school-going children of Dhaka.

1. Introduction

Increasing physical activity in youth is considered crucial for public health (Southward et al., 2012). Time spent outdoors (TSO) is an important determinant of children's physical activity (Cleland et al., 2008; Sallis et al., 1993, 2000; Schaefer et al., 2014; Van der Horst et al., 2007). TSO is often considered a potential surrogate measure of children's physical activity (Burdette et al., 2004) and can be critical for achieving the minimum of 60 min of moderate-to-vigorous physical activity (MVPA) daily for youth, recommended by the World Health Organization (2010). Beyond physical activity, increased TSO is also reported as a strategy to reduce the risk of developing myopia in children and adolescents (He et al., 2015; Rose et al., 2008; Sherwin et al., 2012). Several studies expressed concern about the decrease of children's TSO in developed countries (Cleland et al., 2010; Gray, 2011; Hofferth, 2009). However, little is known about children's TSO in developing countries, where children's diminishing outdoor time is equally critical (Luo and Hu, 2002).

Rapid urbanization is often described as one of the key factors behind the global trend of physical inactivity (WHO, 2010b). Rapid urbanization in developing countries typically overburdens the ability of local governments to provide essential services (Alberti and Susskind, 1996). UN-Habitat studies (2014) have also demonstrated that, in many cases, there are no proper mechanisms to ensure the creation, protection, and maintenance of public open spaces in developing countries. Moreover, encroachment of existing public open space is also commonplace, which exacerbates the problem. Dhaka, one of the most densely populated cities in the developing world, suffers from these typical crises of lack of public open space. High population density, inadequate infrastructure, economic pressure on land, poor urban management (Afroz, 2009), encroachment, and antisocial occurrences (Nilufar, 2000) all contribute to shrinking of open spaces in Dhaka. The developed areas under the Dhaka City Corporation (DCC) jurisdiction had only 14.5% open space (SENES, 2007), and during the time span of 11 years (from 1992 to 2003), the land area occupied by vegetation in greater Dhaka diminished to only 5.5% from 13.6% (Dewan and Yamaguchi, 2009). How this cityscape of diminishing accessible public open space and urban green has affected the TSO of its children is not well documented. However, one study (Islam, 2009) conducted with 109 school-going Dhaka

* Corresponding author.
E-mail address: mmonsur@ncsu.edu (M. Monsur).

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children showed that almost 34% of children spent no time outdoors during regular school days. Given the unprecedented urbanization of the mega cities in developing nations, children's TSO needs further investigation. Dhaka is the 16th largest city by population (Worldatlas, 2016) and one of the fastest growing cities in the world (Demographia, 2016) and thus provides a unique setting for research on children's TSO.

Previous studies identified several socio-demographic correlates of children's TSO. Gender (Islam et al., 2014; Prezza and Pacilli, 2007; Rissotto and Giuliani, 2006) and age (Hofferth and Sandberg, 2001) of children were consistently reported as significant determinants of TSO, showing that boys spent more time outdoors than girls, and older children enjoyed longer TSO than younger ones. Parents' income (Brodersen et al., 2005; Ferreira et al., 2007), education (Tranter and Pawson, 2001), parental encouragement and supervision (Cleland et al., 2010), and parental perception of safety (Molnar et al., 2004; Prezza and Pacilli, 2007; Wilson et al., 2004) were also found to be associated with children's TSO. Immediate neighborhood characteristics were also reported to be associated with children's TSO (Giuliani et al., 1997; Moore, 1990). Lack of recreational infrastructure (Davison and Lawson, 2006) or accessible open space near home (Kyttä, 2002) reduced children's TSO. Shorter home–school distance was found to be positively associated with children's TSO (Cohen et al., 2006; van Oel, 2009). Few studies found associations between children's outdoor activities and design characteristics of the residential buildings they lived in (Prezza et al., 2001; Saegert, 1982). Research also demonstrated that children who lived above the first floor play outside less than those on the ground or first floor (Conway and Adams, 1977).

Few studies have examined the relationship between street design characteristics and children's outdoor activities. Because residential streets are a key component of the built environment, they must be examined as a predictor of children's TSO. Some studies have found a positive relationship between street connectivity and children's biking or walking to school (Braza et al., 2004; Falb et al., 2007). Others have found increased connectivity associated with lower rates of walking or riding to destinations (Timperio et al., 2004). Only one previous study, in the context of a developing country (Islam et al., 2014), found that Dhaka children's average time outdoors on weekdays was likely to be higher when the streets in front of their residences were dead-end streets instead of through streets. Lack of previous studies suggests the need for further investigation into the role of the closest street in front of the child's home in TSO.

2. Methods

2.1. Participants

School going Dhaka children, 7–11 years old (16 girls and 44 boys), and parents volunteered for the study. This is the age range when children are developmentally capable and more likely to roam outdoors than in earlier periods of childhood (Moore, 1990; O'Brien et al., 2000; Prezza and Pacilli, 2007). The study adopted a two-phase, cluster, random sampling method. Because there was no available Dhaka database of individual children 7–11 years old, instead of random sampling, the first phase of sampling started with random selection of schools from an existing list of all Dhaka schools retrieved from the Bangladesh Bureau of Educational Information and Statistics (BANBEIS, 2009). The author visited four schools randomly selected from the list. Permission to visit the schools was obtained from the Directorate General (DG) of the Ministry of Education of the Government of the People's Republic of Bangladesh. The author visited four classrooms (one classroom per school) and gave a slide presentation on a multimedia projector to brief children about the objectives and possible outcomes of the research, in language suitable for children. After the presentation, the author asked the children whether they wish to participate in the study. One hundred percent of the children gave their assent (verbally) to participate. The author also distributed written informed-consent forms to all children of each of the four classrooms. Children were instructed to take the forms home to their parents and bring signed consent forms back to their class teachers. Incomplete or unsigned consent forms were rejected and not considered for inclusion. Fifteen children per classroom (totaling 60 children) were randomly selected from a sample frame of 177 completed and signed consent forms (Fig. 1) of children from the four schools. For data collection, the author visited each of the 60 children's homes by scheduling appointments with parents over the phone. These visits took place on the weekends (Fridays and Saturdays in Bangladesh) and school holidays.

During each visit to a child's home, the author followed this protocol for data collection.

1. The author explained the research to the parent(s) in the presence of the child.
2. The author then administered a parent interview with a structured questionnaire. Initially, it was planned that both parents would participate in the survey separately, but due to conservative values in many households, the mothers denied participation and data from one parent was considered for the final analysis.
3. After the interview, the parent and the child identified the child's route to school on a Google Earth satellite map (Fig. 2).
4. The child, with parent's permission, then led the author to his/her outdoor destination(s) (if any) where he/she spent recreational time daily/frequently.
5. During the child-led field trip, the author interviewed the child with a structured questionnaire.
6. The author also collected built-environment data (e.g., by measuring the width of the near-home street with a measuring tape and the child's help).
7. If agreed, the author collected parents' consent for the test-retest interview in a separate consent form.
8. Parents who agreed and signed the consent were called via phone one week from the day of the site visit and were again asked questions regarding their children's TSO. This data was used to calculate test-retest reliability of the questionnaire instrument.

2.2. Measures

Parents reported start and end times of children being outdoors for each of the seven days of a typical school week. The researcher calculated TSO for each day from the start and end outdoor times. Average value of the reported TSOs for the five weekdays (Sunday-Thursday) was calculated to measure weekdays TSO of children. Similarly, the average value of weekend TSO was calculated. The structured interview was also used to collect child data regarding seven socio-demographic variables: gender, age, number of siblings, eldest among siblings, household monthly income, and whether the child walk to school (Table 1). The study included four design characteristics of the near-home street: street type, street width, street level, and number of street crossings along the school journey. During the child-led field trip, the child showed the outdoor destination near home where he/she frequently visited for play/recreational activities. Such destination was not always a park or playground but, rather, a variety of open spaces identified as playgrounds by the participating children. Other built-environment data were collected by systematic direct observations. The variables of the study, their definitions, data collection methods, and units of measurement are described in Table 1.

2.3. Statistical analyses

Multiple linear regression was used to examine relationship between children's TSO and their near-home street type (dead-end or through street). Analyses were controlled for built-environment variables, socio-demographic characteristics of the participants and other

street features that are retained by a step-wise backward selection method. In order to correct for possible bias in inference that may arise due to possible violation of assumptions of ordinary least square estimation, *p*-values and confidence intervals for estimated coefficients were computed using a bootstrap method. Results are further adjusted for school effects.

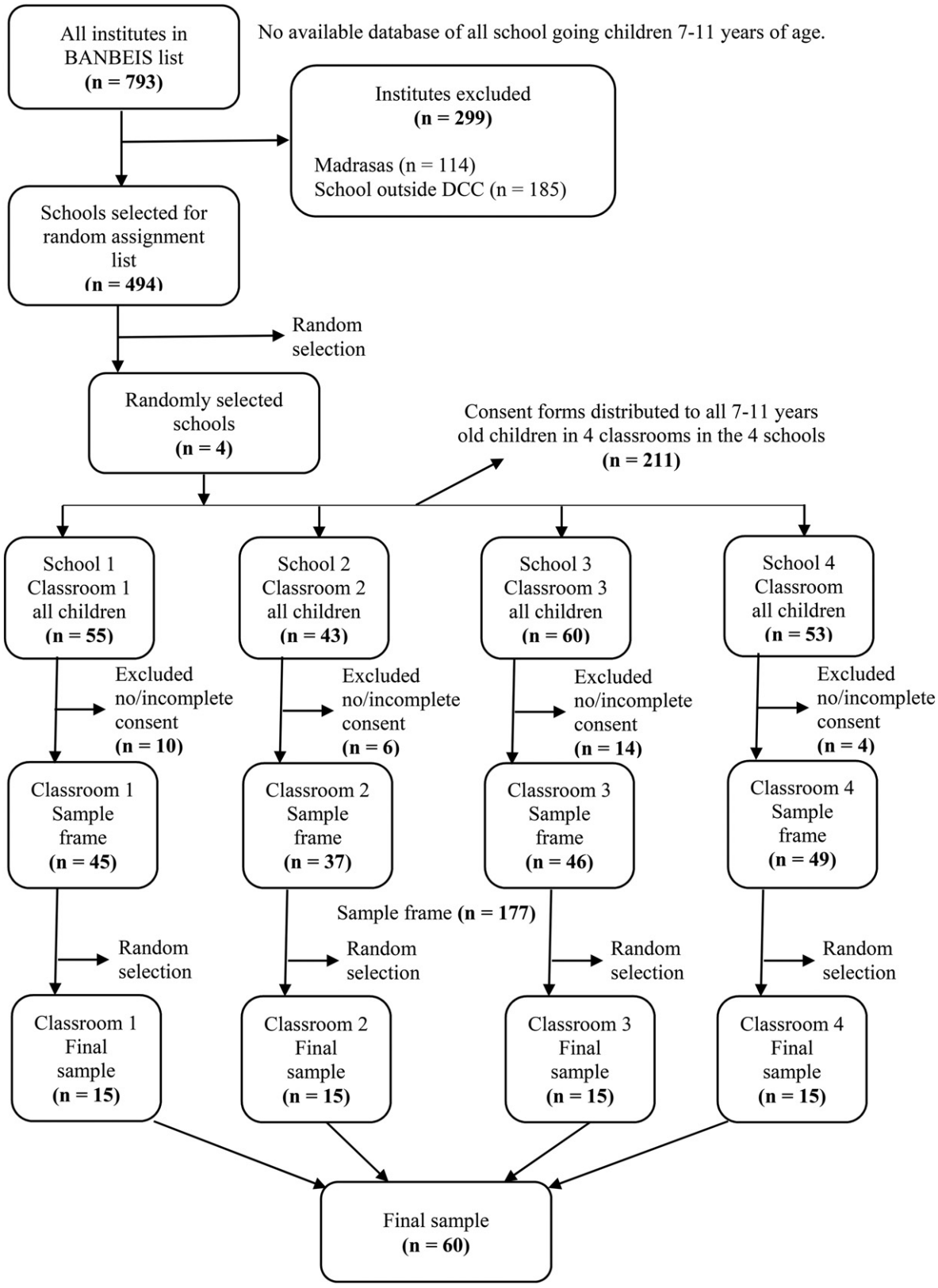

Fig. 1. Participation selection process. A list of all Dhaka institutes (total 793 institutes) was retrieved. Residential madrasas (religious institutes) and schools outside the Dhaka City Corporation (DCC) was excluded (total 299 institutes) from the list. Four schools were randomly selected from the list of the remaining institutes (total 494 institutes). Consent forms were distributed in 4 classrooms in the 4 schools (1 classroom/school). A total of 177 consent forms were properly filled and returned. The researcher randomly selected 15 children from each of the classrooms for final data collection (total 60 children). Data was collected from September 2010 to June 2011 in Dhaka, Bangladesh.

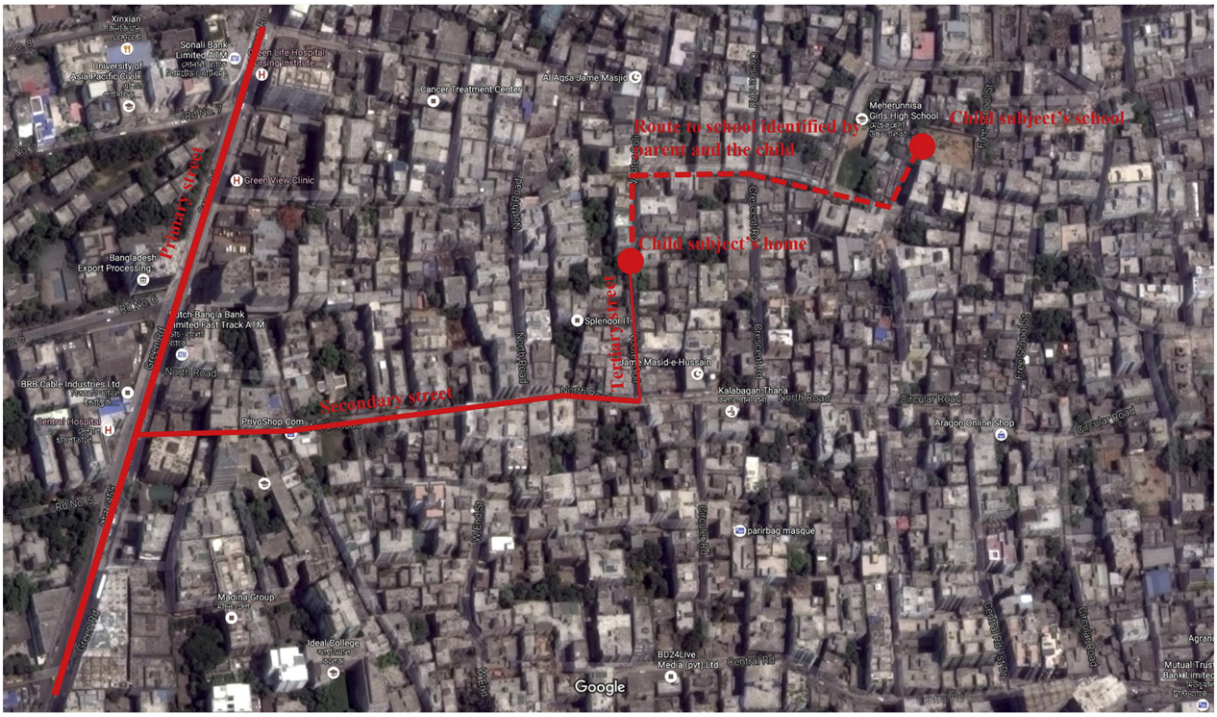

Fig. 2. Satellite view of a typical Dhaka neighborhood. A respondent child's home and the near-home street has been marked on the image. The image also explains how primary, secondary and tertiary streets were identified and how a parent/child identified the home-school route on the satellite map.

Table 1
Predictors of TSO, definitions, data collection methods, and units of measurement.

	Predictors	Definition	Data collection method	Units of measurement/code
Dependent variable	TSO	Time spent outdoors: the daily average of 5 days (Sun–Thu) for weekdays TSO and the daily average of 2 days (Fri–Sat) for weekend TSO (of a regular school-going week)	Interview	Minutes per day
Near-home street variables	Near-home street type	Whether the near home street is dead-end	Systematic direct observation	1 = yes 0 = no
	Near-home street width	Total width of the child's home front street, including sidewalks	Measuring tape	Feet
	Near-home street level	City bus route was considered primary and a branching from primary was labeled secondary and so on	Systematic direct observation	1 = primary 2 = secondary 3 = tertiary 4 = level four
	Number of street crossings on school journey	How many streets a child must cross to get to school (one way)	Interview and Google earth software	Count
Other built-environment variables	Neighborhood type	Whether the child lives in a community	Systematic direct observation	1 = yes 0 = no
	Adjacent accessible open space	"Yes" if vacant land or a parking area, yard, playground, or park is attached to the child's residence. Accessibility was checked during the interview.	Systematic direct observation and interview during child-led fieldtrip	1 = yes 0 = no
	Level of residence floor	The level of the child's residence floor	Systematic direct observation	0 = ground floor 1 = 1st floor 2 = 2nd floor, etc.
Socio-demographic	Gender	Gender of the child	Interview	1 = boy 0 = girl
	Age	Age of the child	Interview	Number of full months
	Number of siblings	Number of siblings of the child	Interview	Count
	Eldest among siblings	Whether the child is the eldest	Interview	1 = yes 0 = no
	Household monthly income	Total household monthly income of the child's family	Interview	BDT (Bangladeshi Taka)
	Residency duration	How long the family is living at the present address	Questionnaire	Number of full months
	Walk to school	Whether the child walks to school	Questionnaire	1 = yes 0 = no

3. Results

3.1. Descriptive statistics

The key characteristics of the study sample of 60 school going children are presented in Table 2. Average daily TSO was substantially greater on weekends (106 min) than TSO on weekdays (38 min). One-third of the children did not spend any time outdoors at all. For more than half of the children, the nearest streets to home were through-traffic streets. Less than one-third of them lived in a community-type neighborhood and had at least one open space or playground close to their home. Almost three-fourths of the participants were boys and 40% walked to school. Monthly incomes of the participants' households varied substantially on average.

3.2. Regression results

Results of multiple linear regression for both weekdays and weekends are presented in Table 3. The models explained 66% of the variation of children's time spent outdoors on weekdays and 68% of the variation on weekends. Near-home street characteristics, availability of open spaces near home, and whether a child walks to school appeared to be significantly important predictors of children's TSO with large effects, regardless of whether it was a weekday or not. Other street features such as width and level of near-home streets also predicted some of the variations in children's TSO. Provided that children were likely to spend more times outdoor on weekends than on weekdays, it is not surprising that the effect of predictors were larger in the former instances. For example, during a weekday children living on dead-end streets were expected to spend 30 min more time outdoor daily compared to those living on through-traffic streets. On a weekend, however, this difference was as large as an hour. Children who lived on lower-level streets (tertiary and level four) were more likely to enjoy longer TSO compared to those living on a relatively higher-level street (secondary). Compared to participants who did not have an open space or a playground near their home, those who had at least one such area were predicted to spend around 37 min more outdoors on a weekday and 55 min more on weekend. On a weekday, children who walked to school were expected to spend 40 min more outdoors than compatriots who used some means of transport, the disparity being three times more on a weekend. While whether a child walks to school might have a direct effect on TSO on a weekday, it can be seen as a proxy for how independent a child was and therefore, found relevance for weekend analysis as well. Elderly children were predicted to spend more time outdoors on weekends. Effects of household income and duration of occupancy of residence were negligible.

Table 2
Characteristics of the sample of school-going children in Dhaka city (n = 60).

	Mean (std. dev) or %
Dependent variable	
Time spent outdoors (min/day)	57.77 (58.87)
Weekdays	38.13 (44.90)
Weekends	106.47 (102.90)
% of children with 0 min of TSO	33.3
Near-home street variables	
Near-home street type	
% dead-end street	46.7
% through street	53.3
Near-home street width (feet)	13.60 (6.27)
Near-home street level	
% primary	0
% secondary	48.3
% tertiary	43.3
% level four	8.3
Number of street crossings on school journey	1.07 (0.90)
Other built-environment variables	
Neighborhood type	
Child lives in a community, % yes	28.3
Adjacent accessible open space, % yes	23.3
Level of residence floor	2.95 (1.94)
Socio-demographic variables	
Gender	
% boy	73.3
Age (in years)	9.74 (1.03)
Number of siblings	1.42 (0.91)
Eldest among siblings, % yes	38.3
Household monthly income (BDT, Bangladeshi Taka)	15,091.67 (7890.94)
Residency duration (number of full months)	47.80 (33.25)
Home-school travel mode	
% walk to school	40.0

Table 3
Unstandardized regression coefficients and 95% confidence intervals for predictors of time spent outdoor (TSO) of school-going children in Dhaka city (n = 60).

	Time spent outdoor (TSO)	
Independent variables	Weekdays	Weekends
Near-home street type		
Dead-end street	28.07 (12.95, 47.65)**	65.93 (30.75, 104.16)**
Near-home street width	1.42 (0.37, 3.26)*	5.57 (2.97, 8.11)**
Near-home street level		
Tertiary	12.89 (−2.46, 27.26)*	31.96 (2.70, 67.04)*
Level four	–	50.99(7.66, 100.56)*
Adjacent accessible open space, yes	36.51 (11.71, 58.61)**	53.91 (2.44, 99.16)*
Age	8.77 (2.06, 15.31)**	18.12 (3.92, 33.74)*
Eldest among siblings, yes	14.46 (−3.15, 31.81)*	–
Household monthly income	−0.001 (−0.003, 0.001)*	–
Residency duration	−0.32(−0.57, −0.01)*	–
Walk to school, yes	41.82 (26.15, 58.99)**	120.16 (83.72, 160.47)**
F-statistic	13.67**	19.02**
Adjusted R^2	0.66	0.68

All 14 predictors were included in the regression and backward selection was followed. Only the variables that were significant in the final model, for either weekdays or weekends, are reported. Computation of confidence intervals and significance (p values) are based on 1000 bootstrap samples.
** $p < 0.01$.
* $p < 0.05$.

3.3. Further analysis: role of gender

Considering that Bangladesh largely holds a conservative look toward girls, a natural expectation was that girls spend significantly less time outdoors than boys, a conjecture not confirmed by our regression results. Further investigation showed that almost all the girls in our sample took some form of transportation to school as opposed to walking, when 50% of the boys walked to school. The results of a chi-square test reported in Table 4 showed significant association between gender and whether a child walks to school.

A possible explanation of gender's absence from the regression results is that its effect on children's TSO was attenuated from including

Table 4
Distribution of children who walk to school by gender.

	Walk to school		
Gender	Yes	No	Total
Girl	2 (3.3)	14 (23.3)	16 (26.7)
Boy	22 (36.7)	22 (36.7)	44 (73.3)
Total	24 (40)	36 (60)	60 (100)
Chi-square	6.875**		

0 cells (0.0%) have expected frequency <5. Minimum expected count is 6.40.
Percent of total in parentheses.
** $p < 0.01$.

Table 5
Unstandardized regression coefficients and 95% confidence intervals for predictors of time spent outdoor (TSO) of school-going children in Dhaka city (n = 60).

Independent variables	Time spent outdoor (TSO)	
	Weekdays	Weekends
Near-home street type		
Dead-end street	40.80 (22.72, 60.76)**	78.61 (30.75, 104.16)**
Street width	–	2.95 (0.06, 5.82)*
Adjacent accessible open space - yes	26.93 (11.71, 58.61)*	42.23 (−0.43, 84.89)*
Gender		
Boy	23.20*	103.88 (60.45, 147.31)**
Age	7.31 (2.06, 15.31)*	–
Eldest among siblings, yes	16.44 (−3.15, 31.81)*	–
Household monthly income	−0.001 (−0.003, 0.001)*	–
Residency duration	−0.32(−0.57, −0.01)*	–
F-statistic	13.67**	19.02**
Adjusted R^2	0.55	0.52

All predictors except whether a child walks to school were included in the regression and backward selection was followed. Only the variables that were significant in the final model, for either weekdays or weekends, are reported. Computation of confidence intervals and significance (p values) are based on 1000 bootstrap samples.
** $p < 0.01$.
* $p < 0.05$.

walking-to-school status as a predictor. The issue was further examined by excluding gender and repeating the regression process. Results reported in Table 5 confirmed that gender had a statistically significant impact on TSO after controlling for other significant near-street features and socio-economic variables. Compared to girls, boys were predicted to spend on average 23 min more on weekdays and 103 min more in weekends. The goodness of fit of the models was, however, decreased by around 15% confirming once again that whether a child walks to school is crucial in predicting children's TSO.

4. Discussion

This study found significant relationships between near-home street features and children's outdoor time. Weekdays or weekend, street type (dead-end street or through street) of the immediate residential street of the child's home was a significant predictor of his or her time spend outdoors (TSO), even after controlling for other significant variables such as age, gender, household monthly income, and availability of accessible open space or playgrounds. The result supports similar findings of a previous study (Islam et al., 2014) done on school-going Dhaka children's ($N = 109$) daily TSO on weekdays only. However, the previous study predicted children living on dead-end streets to spend 15 min more daily outdoor on weekdays than children who lived on through streets, whereas this study finds this difference to be twice as large (28 min). The effect size was much larger for weekend TSO, predicting over an hour (65.93 min, $p < 0.01$) of additional daily outdoor time for children living on dead-end streets. This is an important finding considering that children are likely to spend more times outdoors on a weekend than on a typical school day. Other than street-type, near-home street width and street level (branching) were also found to be significant predictors of TSO. Wider (by each foot) near-home streets predicted 1.42 min longer TSO ($p < 0.05$) on weekdays and around 6 min longer TSO ($p < 0.01$) on weekend. On a typical weekend a child who lived on level four street was expected to spend 51 min more outdoors ($p < 0.05$) than one who lived on a relatively less branched secondary street. The associations between different near-home street characteristics and children's TSO can be explained by the traffic conditions and consequent parental perceptions of safety on the near-home streets. Fears about traffic are often described as a key reason parents do not allow children to play outside (Singer et al., 2009). Dead-end streets are generally associated with less traffic and protected opportunities for TSO of children (Carver et al., 2008; Hochschild, 2012). Similarly, more branching of near-home streets is associated with less connectivity and less traffic, which may ensure more recreational outdoor activities (and TSO) of children (Timperio et al., 2004). Although a negative relationship was expected between near-home street width and children's TSO (assuming more traffic in wider streets), this study found a positive relationship. Almost 47% of the participating children in the study lived on a dead-end street, and a majority of them reported their near-home streets as popular outdoor play destinations during the field trips. It is believed that the wider dead-end streets were favorable for play and were associated with longer TSO of children, but due to a small sample size, it is beyond the scope of this study to draw such a conclusion. Among other built-environment variables, availability of near-home accessible open space or a playground was a significant predictor of children's TSO (Table 3).

4.1. Study limitations and strengths

The field has advanced to newer methods for more objective measures of TSO of children. For example, portable accelerometers with built-in light sensors can accurately calculate children's outdoor time (Tandon et al., 2013). During the study period (2010−2011), such sophisticated devices were not available in Bangladesh. It is often argued that survey data on outdoor time and physical activity are subject to social desirability bias, or other recall errors, and are likely to be inaccurate. However, two studies (Bacardi-Gascón et al., 2012; Burdette et al., 2004) have compared questionnaire results with the measures of accelerometer for children's activities and found significant association between objective (accelerometer) data and questionnaire data. Also, large-scale national and international surveys and studies (Burdette and Whitaker, 2005; Larson et al., 2011; Singer et al., 2009) were identified that relied on parental survey for investigating children's TSO. Although accelerometers with built-in light sensors may accurately calculate children's outdoor time, the objective of the study was to investigate TSO relevant to physical activity of children, not just any outdoor time. Using survey data instead of accelerometer data ensured that the study did not over-calculate children's TSO.

Validity of the questionnaire data could not be tested by objective measures such as pedometer, accelerometer, or GPS tracker for the previously mentioned reason. However, the TSO data communicated by parents were compared with the self-reported TSO data by children. Although this is not a solid measure of validity (survey data compared with another survey's data), the agreement (0.76) between children's and parents' reported TSO indicated legitimacy of the survey data. Also, the test–retest reliability coefficient of the questionnaire instrument was very high. Average measures of the Intraclass Correlation Coefficient (ICC) between the two data sets (n = 21): (a) survey data and (b) phone interview data (after 1 week of the survey) was calculated to be as high as 0.94.

Very few previous studies have look into both children's weekdays TSO and weekend TSO separately. The school days of a child can be extremely regulated; hence, the scope for TSO may be limited on weekdays. The present study found that the average TSO on weekends (106.47 min) is more than an hour longer than the average TSO in weekdays (38.13 min). Separate in-depth analyses for weekdays TSO and weekend TSO is a key strength of this study.

Objective measures for the built-environment variables were not readily available for Dhaka during the study period (2010–2011). Population density or land-use pattern data or GIS data for accessible open space were not available at neighborhood level. Administering built-environment assessment tools developed in the context of developed countries were not applicable in the context of Dhaka. Presence (and condition) of sidewalks, which is an important determinant of TSO (Davison and Lawson, 2006) and commonly included as an important factor of most walkability indices in developed countries, is largely absent in Dhaka neighborhoods (Fig. 3).

Fig. 3. Sidewalks were absent in all 60 respondents' near-home streets, regardless of the variations of other physical aspects of their neighborhoods.

The nature of the open space varied greatly, and the only way to tell whether the child had access to an open space to play outdoors daily or regularly was to visit the child's home and arrange a child-led field trip. Although the lack of objective measure is a limitation of this study, observational methods such as the child-led field trip provided in-depth perspective toward the uniqueness of Dhaka children's TSO.

The proportion of boys (73.33%) and girls (26.67%) in the sample resulted from drawing a random sample from the four schools, which had a larger population of boys. The difference of mean TSO among boys and girls of the sample implies that future research studies are needed to investigate the indicators of TSO of only girls (or boys) separately.

5. Conclusion

Findings of this research are of considerable value because very few studies have attempted to investigate the relationship between near-home street-pattern and children's TSO. Decreasing the TSO of children is not only a concern in developed countries. In fact, one large-scale study (Singer et al., 2009) conducted in 16 countries showed that the situation in developing countries was even worse. Although this is a global concern, there is a striking difference between the context of children's poor TSO conditions in developing countries and that in developed countries. Dhaka urban expansions are implemented without a clear public space plan, and it is hard to extract public space from private landowners. This tendency has led to poor urban living conditions for children in Dhaka, which is not only complex but unique. For example, increased street connectivity was found to be positively associated with children's biking or walking to school (Braza et al., 2004; Falb et al., 2007) in western cities, whereas the finding of this study in the context of Dhaka is just the opposite (Table 3). Therefore, policies that may be effective in developed countries to improve children's TSO may not work in the context of Dhaka. In the intense battle for land, suggesting comprehensive design changes is impractical. Western policies like the *Complete Streets* which demands sidewalks, bike lanes (or wide paved shoulders), special bus lanes, etc. (NCDOT, 2012) may not be a suitable solution to improve children's TSO in Dhaka. Rather, policies regarding planned activities seem to have greater potentials. World Health Day campaign *1000 Cities*, *1000 Lives* (WHO, 2010a) calls upon cities to open up public spaces for health activities. Many cities have planned activities such as *walk to school day* or *walk to school month* or closing off portions of streets to motorized traffic. Dhaka needs to adopt planned activities which would allow children to enjoy longer TSO in their home neighborhoods. Findings of this research can be of great value for designing and implementing such planned neighborhood level activities for children. This study highlights how dead-end streets have become Dhaka children's last refuge for play (See Fig. 4).

Future research may use GIS-based technology to map dead-end play streets (or similar urban refuges) in the dense neighborhoods of Dhaka and investigate their usage pattern from the perspective of children's TSO.

Fig. 4. Dead-end streets, Dhaka children's last refuge for play.

Transparency document

The Transparency document associated with this article can be found, in online version.

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