

Improving Adolescent's Physical Activity in Delhi: An Evaluation of Outdoor School
Environments

by

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Thesis submitted in partial fulfillment of
the requirements for the degree of
Master of Science
in the Duke Global Health Institute
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ABSTRACT

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Abstract

Background: India has a large burden of non-communicable diseases (NCDs), one that is only projected to increase in the coming decades. One important risk factor of NCDs is physical inactivity, which can be influenced by the built environment. In order to reduce prevalence and incidence of NCDs, there needs to be an increased focus on preventative measures in adolescents. One way that is possible is through improving the built environment for adolescents – specifically the built environment of school grounds, which is a unique environment that is specific to all adolescents.

Study Objectives: This study sought to understand the built environment of school grounds. Specifically, to analyze how there may be potential ways that the school grounds can be conducive to physical activity.

Methods: This study analyzed the built environment of private school grounds in New Delhi, India (n=16). The analysis used the SPEEDY school grounds audit tool. STATA 12 was utilized to calculate inter-rater reliability. STATA 12 was also utilized to analyze summary scores for each category.

Results: No safety signs were present in the surrounding area of schools. Also, less than 15% of schools had cycle lanes separated from the road, pavements on either sides or both sides of the road, and marked pedestrian crossing. Over 90% of schools had playground equipment, over 50% had courts, and over 50% had quadrangles. Less than 10% had covered bicycle parking. For over 50% of schools, auditors agreed or strongly agreed that the school grounds was shielded from surrounding areas, generally well maintained, and generally free of vandalism.

Conclusions: The surrounding area of schools need to be improved to allow for more safety for students who want to travel to school by bicycle or walking. Also, modal quality for school grounds can be improved from adequate to good.

Overall, this study indicates that more research on this topic needs to be done in order to more rigorously understand how to make school grounds most conducive to physical activity for adolescents. New methods of measuring the built environment in an urban setting in a developing world may be needed.

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1 Introduction

Worldwide, non-communicable diseases (NCDs) cause over 35 million yearly deaths – about two thirds of the world’s deaths (*World Health Organization* 2011). Eighty percent of those deaths come from low- and middle-income countries (*World Health Organization* 2011). Future estimates of global deaths show large increases in the number of deaths due to NCDs (Hughes et al., 2011: *Bulletin of the World Health Organization* 2011). By 2060, it is projected that deaths from NCDs will outnumber deaths from communicable diseases by more than five to one (Hughes et al., 2011: *Bulletin of the World Health Organization*). India is one such country that will be largely affected by these shifts in NCDs.

NCDs are defined as diseases that have slow progression or a long duration (*Centers for Disease Control and Prevention* and *World Health Organization*). They include heart attacks, strokes, cancers, diabetes, chronic respiratory diseases, and other chronic diseases (*Centers for Disease Control and Prevention; World Health Organization*). The risk factors for these NCDs include physical inactivity, unhealthy diets, obesity, harmful uses of alcohol, and tobacco use (*Center of Disease Control and Prevention* and *World Health Organization: Global Health Observatory*). These risk factors are associated with modifiable behaviors that begin or are reinforced during adolescence and carried into adulthood (*World Health Report* 2002). Therefore, in order to reduce incidence of future NCD cases, there should be an increased focus on reducing risk factors in adolescents (*World Health Assembly* 2011).

India has a large burden of NCDs: about 53% of total deaths are attributed to NCDs (*World Health Organization NCD Country Profile - India* 2011). This burden is projected to worsen due to the epidemiological and demographic transition that is taking place in India (*World Health Organization: India Office*). Additionally, more sedentary lifestyles and increased consumption of fatty fast foods are projected to increase the burden of NCDs. Nowhere else are these changes more evident than in large urban centers such as Delhi, India.

Delhi is one of the biggest urban centers in the world – it is the world’s eighth most populated city and is the second most populated city in India (2011 India Census, Government of India). Delhi has a population of over 16,753,235, a number that is only growing (2011 India Census, Government of India). A large proportion of the population is made up of adolescents (2011 India Census, Government of India).

Thus, as a long-term preventative measure, it is important to focus on reducing the modifiable risk factors associated with NCDs in adolescents who reside in these large urban centers. Delhi is area of interest in this study.

One way to address NCDs is through improvement of the built environment. The built environment is generally defined as the human made parts of the environment (Handy et al., 2002; Saelens et al., 2010; Roof et al., 2008). It includes various features such as urban design (defined as the appearance and appeal of public spaces), land uses, and transportation systems such as physical infrastructure including roads, sidewalks, and bike paths (Handy et al., 2002; Centers for Disease Control and Prevention – Healthy Places Terminology, 2012). The definition of “built environment” also includes patterns of human activity within the environment (Handy et al., 2002). There are some environments that are more conducive to physical activity, while others are less conducive. Some environments can even be characterized as “obeseogenic,” defined as an environment that promotes weight gain or is not conducive to loss of weight (Swinburn et al., 1999). Thus, these types of environments may increase the incidence and/or prevalence of obesity in a population. These obeseogenic environments need to be identified, and then, modified in order to improve its favorability towards increased physical activity, reduced sedentary behaviors, reduced weight gain, or increased weight loss.

This study focuses on adolescents’ exposure to built environments on school grounds focusing specifically on physical activity and inactivity. In particular, the school built environment is of notable interest because it is an environment that is unique to students and one where students spend a significant amount of time. Adolescents spend about half of their day, sometimes more, at school. At times, it may be their only opportunity for any physical activity, since time at home may be spent focusing on studies – especially in India where academic pressures from parents and society are extremely high (Verma et al., 2002). Few studies have analyzed the school built environment and assessed its relationship to the physical activity. And, to our knowledge, no study has examined the school built environment in the developing world. This study attempts to address these gaps in the literature. The main aim of this study was to describe the built environment at schools in order to determine whether the school grounds may promote or hinder

children's physical activity. This study attempts to further understand a potential venue to increase physical activity amongst students, and in the future, reduce both incidence and prevalence of NCDs.

2 Background

The impetus for this study came out of the recognition that there are significant gaps in the literature surrounding built environments and its characterization in developing nations. Additionally, there are no studies specifically analyzing the built environment of school grounds in the developing world.

2.1 Non-Communicable Diseases

2.1.1 Non-Communicable Diseases: Globally.

Global trends indicate that the burden of NCDs is increasing and will continue to increase for decades (Hughes et al., 2011). Despite the many differences amongst affected countries, there are many similarities of why these trends are increasing. Increases in sedentary lifestyles and thus increases physical inactivity, unhealthy diets, overweight and obesity, harmful uses of alcohol, and tobacco use all are contributing factors for increased burden of NCDs (Centers for Disease Control and Prevention). Common NCDs include heart attacks, strokes, cancers, diabetes, chronic respiratory diseases and other chronic diseases. Many of the risk factors are behaviors that start or are reinforced during adolescence.

2.1.2 Non-Communicable Diseases: India.

The United States Census Bureau: International Programs projects that India will be the largest population (surpassing China) in 2025, with a population size of 1,396,046,000 while China's population size will be 1,394,639,000 (United States Census Bureau: International Programs). India's population will continue to grow and peak around the year 2060 and then begin to decrease in size for the first time in its history afterwards; China's population, on the other hand, begins to decline in about 2030, which will be about thirty years earlier than India's population decline. It is important to note the enormously large population size of India in the present and future because it is indicative of just how enormous the burden of NCDs can be in the population and how costly it can be if proper attention is not given to preventative measures.

India is also in the midst of the demographic transition. The demographic transition consists of the "movement of death and birth rates in a society, from a situation where both are high (in the pre-transition stage) to one where both are low (post-transition stage) (Rowland, 2003). The transition means that over

time, people are having fewer kids (low birth rates) and people are living longer (low mortality rates). Thus, India's population is getting older. This is another very important consideration because while risk factors and lifestyle choices can be defined in early adolescence and carried over to adulthood, NCDs generally show symptoms and are diagnosed in adulthood and likelihood of diagnosis increases as an adult ages (WHO).

NCDs burden is projected to worsen on a global scale. In India, it seems that the burden will be even worse due to the large population size (projected to only grow) and the demographic transition that projects an increasing population of older individuals who are more prone to be diagnosed with NCDs. Due to these factors, it is especially important to study NCDs in India – especially with a lens towards prevention. A population level approach to prevention in India will be important due to high costs of treatment of NCDs, especially because health care expenditure is largely out of pocket and can be especially costly for individuals (Van Doorslaer et al., 2005).

Table 1 shows WHO NCD mortality data from 2008. Mortality, behavioral risk factors (only physical inactivity is shown because that is the factor of interest in this study), and metabolic risk factors are shown (Table 1); these are all projected to worsen in the next few decades.

Table 1: Data from the WHO fact file India 2008

	Males	Females	Total
NCD Mortality			
Total NCD deaths (000s)	2967.6	2273.8	
NCD deaths under age 60 (percent of all NCD deaths)	38.0	32.1	70.1
Behavioral Risk Factors (2008 estimated prevalence, %)			
Physical Inactivity	10.8	17.3	14.0
Metabolic Risk Factors			
Overweight	9.9	12.2	11.0
Obesity	1.3	2.4	1.9

No aggregate national level data is available that describes obesity or overweight among adolescents. Smaller regional studies have attempted to quantify the prevalence of obesity and overweight among adolescents. However, there is a large amount of variation in the findings (Shrihari et al., 2007). For example, prevalence of overweight ranged from 8.5% to 29% and obesity ranged from 1.5% to 7.4% among youth (Shrihari et al., 2007). These variations can be due to many different reasons such as

location of study, sample size, year of study, and more. From the same review, data showed that percent obese of children 6-18 years of age in Delhi, India in 2001 was 7.4% total, and by age it was 8.3% for boys and 5.5% for girls (Shrihari et al., 2007). The data for percent of overweight was starker with 24.7% overweight total and 23.1% of boys and 27.7% of girls (Shrihari et al., 2007). It would be expected that in 2013, these percentages would be higher.

Physical inactivity, a risk factor for non-communicable diseases, is high among the total population in India with about 29% having inadequate levels of physical activity, specifically with 24% men and 34% women reporting inadequate levels (World Health Survey, 2006). Additionally, a greater percentage of people were physically inactive in urban areas (39%) than rural areas (27%) (World Health Survey, 2006). Differences also existed for low income versus high-income groups with higher income groups having more physical inactivity (29%) and lower income groups having less (25%).

Similar to obese and overweight data, recent data specifically for adolescents in regards to physical inactivity is scarce. The lack of recent consistent data for these risk factors suggests an important limitation of data collection and data quality and can be inaccurate in projecting the full burden of non-communicable diseases in the future.

2.1.3 Reducing Incidence and Prevalence.

Reducing both incidence and prevalence of NCDs is an important global health initiative. As discussed, this is especially important for India. This study will focus on reducing incidence of NCDs by analyzing a potential preventative measure: increasing physical activity of adolescents by focusing on making school grounds more conducive to physical activity.

2.2 Study location: Delhi, India

The study location was the Delhi, India (Figure 1, Figure 2).



Figure 1. Map of India.

Delhi is made up of nine districts: Northwest, Northeast, North, East, West, Southwest, South, Central, and New Delhi (Figure 2). It is important to note that the Department of Education in India defines twelve districts which include: East, Northeast, North, Northwest A, Northwest B, West A, West B, Southwest A, Southwest B, South, New Delhi, and Central.



Figure 2: Map of all the Delhi districts (<http://www.newdelhischools.co.in/>) in India. The nine districts are: Northwest, Northeast, North, East, West, Southwest, South, Central, and New Delhi.

It is the second largest urban center in India, after Mumbai, and the eighth most populated city in the world with a population of over 16,753,235, a number that is only growing (2011 India Census, Government of India). There are about 243 million adolescents in India (2011 India Census, Government of India), which is why a long-term preventative measure should focus on reducing the modifiable risk factors associated with NCDs in adolescents who reside in these large urban centers.

Studies conducted in urban centers of India to establish burden of disease show large proportions of adolescent populations are overweight and/or obese (Ramachandran et al, 2002; Bhardwaj et al, 2008).

2.3 Environment as means to reduce obesity and NCDs

There are many factors that contribute to NCD and obesity prevalence. Lifestyles of individuals and families can have a major impact in its prevalence. The environment that an individual and/or family reside in can limit lifestyle choices. Individuals living in an environment that promotes sedentary activity or makes it difficult to be active may not lead a healthy lifestyle because they are not given the opportunity. On the other hand, individuals who live in environments that promote active lifestyles may lead healthier lifestyles without having to make many conscious decisions.

Thus, it is largely understood that despite all the other variables involved in the final determination of an individual's obesity level, the environment is a crucial factor that will influence prevalence of obesity and NCDs not only for the individual but also for the population as a whole (Sallis et al, 2011).

Also, environments can be changed and can be built to increase its ability to provide more opportunities for an active lifestyle for individuals, families, and populations (Sallis et al, 2011).

2.4 Built Environment, Physical Activity, and Obesity

The built environment is generally defined as the human made parts of the environment (Handy et al., 2002; Saelens et al., 2010; Roof et al., 2008), which includes various features such as urban design, land use, and transportation system such as physical infrastructure including roads, sidewalks, bike paths (Handy et al., 2002; Centers for Disease Control and Prevention – Healthy Places Terminology, 2012). The definition of built environment also includes patterns of human activity within the environment (Handy et al., 2002).

Studies have shown there exists links between obesity and the area of residence, resources, television, walkability, land use, sprawl, and other features of the built environment (Booth et al, 2005; Sallis et al, 2009; Sallis et al, 2011). Some built environments are being referred to as ‘obeseogenic’ because they promote sedentary behaviors, weight gain, or reduce potential for weight loss (Swinburn et al., 1999). These types of environments may increase the incidence and/or prevalence of obesity in a population independent of the other factors that also influence obesity and NCDs. Thus, these obeseogenic environments should first be identified and then modified to improve its favorability to physical activity, reducing weight gain, or increasing weight loss.

Urban planning can help to promote healthier, more active communities by focusing on a combination of urban design, land use patterns, and transportation systems that promote walking and bicycling (Handy et al 2002). Additionally, studies have shown that creating an environment that is more walkable may yield higher levels of physical activity and less driving and can reduce the obesity prevalence for those who walk rather than drive (Frank et al, 2007). To date the majority of studies examining the built environment have been descriptive or observational in nature, describing associations between the built environment and physical activity (Hardy, 2005). However, analyzing and measuring the built environment is a growing field of research, and current studies are evaluating the effects of changes to the built environment on physical activity levels in adults and children.

2.4.1 Measures of Built Environment

A number of tools have been developed to describe the various features of built environments

Some tools like the Behaviors of Eating and Activity for Children's Health: Evaluation System (BEACHES), System for Observing Fitness Instruction Time (SOFIT), and the System of Observing Play and Active Recreation in Communities (SOPARC), among others, were designed to observe individuals directly, and assess how active they are in certain environments (McKenzie 2010; McKenzie 2002; Brownell et al, 1980).

Other tools have been developed to analyze the walkability of various neighborhoods (Cervero et al, 1997; Kitamura et al, 1997), and some have developed a tool that is utilized in conjunction with geographical information systems (Frank et al, 1994; Handy, 1996). Some instruments assess access to recreation facilities in neighborhoods (Humpel et al 2002; Giles-Corti et al, 2002; Sallis et al, 1997). A walkability index to study the link between built environment and adult physical activity has been developed (Frank et al, 2010). The components of the index included analyzing the net residential density, the retail floor area ratio, an intersection density that measured the connectivity of the streets, and a land use score that indicated the degree to which a diversity of land use types were present in a block group (Frank et al 2010).

Systematic Pedestrian and Cycling Environment Scan (SPACES) is a tool developed in Australia to combine studying walkability with cycling and understand how the built environment influences both (Pikora et al, 2002). SPACES provides 'street-level' data and analyzes about safety, aesthetics, and more in relation to walking and cycling (Pikora et al, 2002).

Other tools have been developed to analyze the aesthetics and landscape quality (Terry, 2001; Berke et al, 2007; Moudon et al, 2003). Environmental Assessment of Public Recreation Spaces (EAPRS) is an instrument developed to measure the physical environment of parks and playgrounds (Saelens et al, 2006). This instrument analyzes the presence, absence, cleanliness, shade, continuity, flatness and others of various factors such as trails/paths, water areas, playground equipment, other amenities and facilities such as grills, fires, vending machines, landscape, presence of trash cans and more.

Some instruments have focused on the built environment of the worksite. Checklist of Health promotion Environments at Worksites (CHEW) (Oldenburg et al, 2002) and Worksite Environment Measure (WEM) (Shimotsu et al, 2007) are two such instruments.

It is evident that there is significant methodological variation among the various published studies. Thus, some argue that greater standardization among the available tools would provide more comparable and conclusive findings (Gebel et al, 2007).

A systematic review of epidemiologic evidence about the relationship between built environment and obesity yielded results that were too heterogeneous to yield any generalizable results (Feng et al, 2010), which may be due to the numerous tools that have been created as measures.

2.4.2 School Environment and Physical Activity

Because students spend most of the day, upwards of six hours, at school, the school is a large part of the student's life. When students return home from school, time is generally dedicated to working on homework, spending time with family, and eating dinner. While at home, students may not have the opportunity to be physically active. Thus, it is important to analyze the school through the lens of being able to provide students with opportunities for all rigors of physical activity.

In order to avoid the risk factors associated with NCDs, it is important for students to be physically active. In the United States, it is recommended that school-age youth get 60 minutes of moderate to vigorous physical activity daily with activities that are age-appropriate, enjoyable, and varied (Strong et al, 2005). It is best that students engage in some physical activity during their time at school (Strong et al, 2005; Jones et al, 2010) because relying on students to be physically active at home may not be practical. Parents may not be equipped with the means (time, energy, knowledge, facilities etc.) to encourage physical activity at home, despite good intentions. Thus, schools can maximize the potential for providing opportunities for physical activity for all students during the day. In India, the Central Board of Secondary Education (CBSE) outlines guidelines for the incorporation of physical activity during the school day (cbse.nic.in, Central Board of Secondary Education, 2012). Some of the specifics outlined by the CBSE include at least 40-45 minutes of physical activity or games period for grades one through ten every day (cbse.nic.in, Central Board of Secondary Education, 2012). For grades eleven and twelve, it outlines that the students must participate in games/mass physical time/yoga with health benefits for at least 90-120 minutes per week (cbse.nic.in, Central Board of Secondary Education, 2012). Additionally, if there are

constraints of space, climate conditions, then there can be indoor activities for health benefits including aerobics/meditation/yoga. (cbse.nic.in, Central Board of Secondary Education, 2012).

In particular, the school built environment is of notable interest because it is an environment that is unique to students and one where students spend a significant amount of time. Adolescents spend about half of their entire day, sometimes more, at school. At times, it may be their only opportunity for any physical activity. For this study, we consider the school environment specifically for students. SPEEDY, described in the next section, is the only developed tool that specifically analyzes the built environment of school grounds; due to this fact, there are no methodological variation concerns as there are with the other created measures and tools (Gebel et al, 2007) as discussed previously.

2.4.2.1 SPEEDY School Grounds Audit Tool

The Sport, Physical Activity and Eating behavior: Environmental Determinants in Young people (SPEEDY) School Grounds Assessment tool, which was developed during the larger SPEEDY longitudinal study to examine individual and environmental factors related to physical activity levels and diet in a large population based sample of British 9-10 year old children (Van Sluijs et al., 2008). The SPEEDY tool measures the built environment of school grounds and can be scored to quantify environmental support for physical activity. The developers of SPEEDY modified an existing tool that assesses quality of urban green spaces as well an existing audit tool of preschool playground were adapted to create SPEEDY (Hillsdon et al., 2006; Cardon et al., 2008; Jones et al., 2010).

As to date, there are no studies that analyze the built environment in developing nations, and specifically none that concentrates on India. Also, there is no study that specifically analyzes the built environment of school grounds in the developing world context, and none specifically in India. Because of our specific interest in understanding the built environment of school grounds that adolescents are primarily exposed to, and due to the lack of studies done in developing nations such as India, the SPEEDY audit tool was the best existing tool to utilize.

3 Research Aims, Objectives, Questions, and Significance

3.1 Research Aims

The aim of the study was to assess the built physical activity environment of school grounds of middle, secondary, and senior secondary schools in Delhi, India.

3.2 Research Objectives

The specific objectives of this study were: (1) To assess the built physical activity environment of schools serving adolescents; (2) To identify characteristics and features of schools and school grounds that might support or hinder physical activity; and (3) To analyze different facets of school demographic characteristics (e.g., number of children, location of school, etc.) as they relate to built physical activity environment.

3.3 Research Questions

- (1) What is the built environment of schools grounds in Delhi, India, in terms of access to school, the surrounding area, the school grounds, aesthetics, usage, and overall features?
- (2) What are the differences amongst the various built environments of school grounds?
- (3) To what extent is the built physical activity environment of school grounds conducive to physical activity for adolescents in Delhi?

3.4 Research Significance

The study of the built physical activity environment is a growing area of research. Assessing the physical activity environment of school grounds is also a growing field of study. To our knowledge, there is no published data on this topic in developing countries, and specifically India, where the burden of NCDs is increasing and projected to increase even more due to the demographic transition at the country-level. This study is a descriptive study to bring some attention to this important issue. Focusing on this issue is important because understanding the built physical activity environment can help indicate ways to promote physical activity amongst youth and adults, and thus, minimize some risk factors, and ultimately help to reduce both incidence and prevalence of NCDs among adults and adolescents.

4 Methods

4.1 Study Design

This study was an observational study of the built physical activity environment of school grounds of middle, secondary, and senior secondary private in the twelve districts defined by the Department of Education of Delhi, India. The study was completed in three phases. Phase I consisted of instrument contextualization and pilot testing of the instrument, and school randomization and selection. Phase II consisted of data collection, which entailed contacting the schools, meeting with the school principal for verbal consent, and completing the contextualized “SPEEDY School Grounds Assessment” and, phase III consisted of data cleaning and analysis, summarizing study results, and dissemination of key findings.

Phases I and II would not be possible without the support from Health Related Information Dissemination Amongst Youth (HRIDAY). HRIDAY is a partner non-governmental organization of the Public Health Foundation of India (PHFI). Both collaborate on programs for NCD prevention among adolescents and school health programs.

4.2 School Audit Tool: Contextualization, Training, Implementation, and Reliability

4.2.1 SPEEDY Audit Tool

The original SPEEDY audit tool consists of forty-four items. There are six categories of the tool which are: (1) Access to the school (2) The surrounding area (3) The school grounds (4) Aesthetics (5) Usage (6) Overall.

The category ‘Access to the school’ consists of two items that specifically record the entrances for cars, pedestrians, and cycles; it also determines whether there is a speed limit and roadside parking available for each entrance. ‘The surrounding area’ consists of eight items and focuses on the presence or absence of various factors such as cycle lanes, area where parents can drop students off, a bus stop pavements, marked pedestrian crossings, traffic calming, and various road signage as is visible from any of the school entrances recorded under the first category. ‘The school grounds’ consists of a total of twenty items. For sixteen of the items, modal quality is also determined. Some of the items included in this section are playground equipment, benches, picnic tables, water coolers, determining whether the school grounds is on split sites, and others. ‘Aesthetics’ consists of six items such as trees for sitting under, ambient noise,

litter, murals, and more. The next category is 'Usage' which has three categories and determines whether the school grounds are generally suitable for sport, games, and general play. The last section is 'Overall' which includes five items. This section determines whether the school grounds are shielded from the surrounding area by trees/fences/hedges, if the grounds are well maintained and free of vandalism. Also, this category categorizes the type of surfaces that children play on and what the area around the school predominantly consists of such as business/retail, open fields, and others. The original user manual detailed some of these items in a bit more detail based on features in England.

In adapting this tool, we assume this is a reliable method of measuring the built environment of school grounds.

4.2.2 Audit Tool and User Manual Contextualization

Since the audit tool has not been used to analyze school grounds in developing countries, and specifically, since it has not been used in India, a panel of nine school based research experts, who were Delhi residents and conduct school based research in Delhi schools from HRIDAY, was consulted to determine the relevance of all of the items. A thorough discussion about potential aspects of the urban Delhi schools not captured by the original instrument took place. Through this discussion and further analysis, modifications to the tool were integrated to yield a final instrument (Appendix A), in which no items were removed out and only one item, an additional comments section, was added to the end.

Examples that were listed in three items were changed to make them more relevant to India.

Modifications were made to the user manual (Appendix B), making it more comprehensive and reflective of India and Indian schools. A final version of both the audit tool and the user manual were circulated amongst all members of the research team and discussed to ensure face validity of the tool.

4.2.3 Audit Tool Training

Each auditor (three in total) and translator (six in total) participated in a five-hour training session. Background information, research significance, aims, objectives, and questions as well as methods and timeline were shared with all. The final tool and user manual were distributed. Each item, in both the audit tool and user manual, was explained and discussed in detail. Participants raised important clarifying questions that were discussed during the training.

4.2.4 Audit Tool Implementation

All three trained auditors completed the audit tool independently at the same school grounds.

Following completion of the three audits, the responses for each question were compared for agreement and disagreement. Thorough discussion of each item, specifically focused on reasons for agreement and disagreement, took place in order to ensure all definitions and coding of every item was clear among all of the trained auditors. Additional relevant and clarifying notes were added to the user manual. These measures were taken in order to ensure consistency of coding among all three auditors.

4.2.5 Reliability Testing

The kappa statistic was calculated using STATA 12 software to measure of the inter-rater reliability. The level of agreement was categorized as: (1) high (0.81-1.00); (2) substantial (0.61-0.80); (3) moderate (0.41-0.60); (4) fair (0.21-0.40); (5) slight (0.00-0.20); or (6) poor (<0.00) (Landis and Koch 1977; Jones et al, 2010). Percent agreements, which indicate the percent of times that raters agreed on scores, were also calculated. Repeat audits, completed independently, were done at one school, which was used to calculate the kappa statistic. The data from each auditor for this school was averaged and that average was used for further calculations in the results. Jones et al, 2010, used similar methodology.

Table 2 shows these values for the categories on the audit.

Table 2: Kappa Statistic and percent agreement between auditors. Mean and range shown here.

Name of Category	# of Items	Kappa Score between pairs of auditors		% Agreement between pairs of auditors	
		Mean (SD)	Range	Mean (SD)	Range
The Surrounding Area	12	1.00 (0.00)	1.00-1.00	100.00 (0.00)	1.00-1.00
The School Grounds – count items only	13	0.79 (0.18)	0.69-1.00	84.61 (13.33)	76.92-100.00
The School Grounds – modal quality	13	0.44 (0.31)	0.18-0.79	61.90 (21.82)	42.86-85.71
Aesthetics	6	0.44 (0.31)	0.18-0.79	61.90 (21.82)	42.86-85.71
Usage	3	0.60 (0.35)	0.40-1.00	77.78 (19.24)	66.67-100.00
Overall	5	0.63 (0.21)	0.44-0.86	73.33 (15.28)	60.00-90.00

Overall, the kappa statistic indicated moderate to substantial inter-rater reliability. The ranges for the kappa statistic were especially high for categories of “Aesthetics” and “The School Grounds – modal

quality” (Table 2). The statistic was especially high for “The Surrounding Area” category where all three auditors were in complete agreement for every item (Table 2).

Percent agreement was greater than 50% for every category (Table 2). Again, for Aesthetics and The School Grounds – modal quality, the range for percent agreement was relatively large. The largest percent agreement was for The Surrounding Area category, which also had the smallest range for percent agreement.

4.3 School Selection, Sampling, and Data Collection

The initial aim was to sample both private and government schools for this study; however, consent to assess government schools was not obtained in time for this study due to time constraints. Thus, only private schools were included.

4.3.1 Inclusion Criteria for Schools

Any private school that has grades six to eight was potentially eligible to be included in this study; these were middle, secondary, and senior secondary schools. Private unaided schools were categorized as private schools because these schools receive no (or very limited) assistance from the government. All schools recognized by the Directorate of Education (<http://www.edudel.nic.in/>) were considered in this study.

4.3.2 Exclusion Criteria for Schools

Private aided schools were not considered in this study due to the fact that these schools were partially funded by the government and thus it was not possible to categorize them as solely private or solely government. Private alternate schools were also not considered because it was expected their policies and practices towards physical activity are likely to differ significantly from the norm since these schools cater to disabled children. The exact number of these private alternate schools was not available but the number was expected to be negligible in comparison to private unaided schools. Unrecognized schools were not considered because either the Directorate of Education or the Central Government did not recognize these schools. Schools governed by the Municipal Corporation of Delhi were also not considered because these were primary schools and did not have grades six to eight. Schools governed by the Central Government were very few (less than 100) and so were negligible in number and were not considered in

this study. State Government schools and schools governed by the New Delhi Municipal Council, both categorized as government schools because they only receive money from the State Government, were not considered due to not having timely consent to contact them.

4.3.3 Sampling

Random sampling of all qualifying schools was done. Applying the inclusion and exclusion criteria to the schools recognized by the Directorate of Education (DOE), Department of Education of the Government of National Capital Territories, generated a complete list of all 1284 qualifying schools.

Then, each qualifying school was given a four digit unique identifier. Using Microsoft Excel's random number generator function, fifty random numbers, a number that was determined to be practical for the length and resources of the study, were generated. The corresponding schools became the initial basis for the further proceedings of the study. From this list of fifty schools, all schools were called using the contact information on the DOE website. If the website telephone or address information was inaccurate or missing (n=18), India's local search engine was called for the missing information. If that information was provided, then that school was contacted as well. During this initial phone conversation with the school reception staff, brief information about the project, based on the school information sheet (Appendix C), was shared and an appointment with the school principal was sought out. At this time, two schools (n=2) refused due to lack of any school grounds. For the remaining schools (n=30), every school was visited. During the visit, the school information sheet was given to the school reception staff. The school reception staff member would give the information to the school principal and a translator from HRIDAY would follow-up with the school reception staff through telephone. If an appointment was made through the initial telephone contact, the school information sheet was shared with the principal and verbal consent was sought out. Then, the trained auditor would complete the audit on the school grounds. From this process, a final sample size of sixteen schools (n=16) was obtained for analysis in this study

4.3.4 Data collection

All audits were completed during school hours while school was in session (Monday through Saturday 8AM – 3:30pm). This fieldwork took place during the month of August 2012.

4.4 Data Analysis

Audit tool data was entered into Microsoft Excel at the end of each day of data collection. It was stored on a password-protected computer that was only accessible to the graduate student. The completed data of the sixteen schools was cleaned and analysed using STATA 12 software (Version 12.0. College Station, TX: Stata Corp: 2012).

4.4.1 Audit Coding.

The data was coded according to the details provided by N.R. Jones et al 2010 whose scheme was based on the coding by Hillsdon et al 2006. For the dichotomous items (items 3-10 and 27-30), a binary code of '0' and '1' was used, corresponding to 'No', the item was not present, or 'Yes', the item was present, respectively (NR Jones et al 2010).

For items that were trichotomous (items 31-39), a ternary code of '0', '1', and '2' was used, corresponding to 'None', 'Some', or 'A lot' (items 31-36) or 'Not at all', 'Somewhat', or 'Very' (items 37-38) or 'Poor', 'Adequate' or 'Good' (items 11-26). Reverse coding was applied to items 33 (noise), 34 (litter), and 36 (graffiti) due to their disruptive nature.

For items 11 through 23, count of the number of facilities was recorded. For these items, a weighted coding was applied in order to prevent large numbers of specific individual items from skewing the summary score. This weighting was defined by first finding the mean number of facilities for the sample. A weighted score of '0' was given if there were no recordings of that facility. A weighted score of '1' was given if the recorded number of facilities was between one and the mean value plus one standard deviation (inclusive). And, a weighted score of '2' was given if the recorded number of facilities was greater than one plus one standard deviation. The quality for each item was also given a ternary code of '0', '1', or '2' which corresponds to 'Poor', 'Adequate', 'Good'. The median quality of schools that had a presence of these items is reported.

Items 40 through 42 were coded using a five point Likert scale, which ranged from '-2' for 'Strongly disagree' to '+2' for strongly agree and '0' for 'Neither'. This coding was used to find the summary scores for each school.

Like the NR Jones et al 2010 method, a 'school physical activity suitability' category, which summed the walking, cycling, and sports and play provisions and the design of the school grounds, was

calculated. The weighted averages, as defined above, were used for the relevant categories. This new suitability category directly focuses on items of the audit tool that is most closely related to physical activity of the school grounds (NR Jones et al 2010).

4.5 Human Subjects Considerations

No human subject data was collected at any point in this part of the study and proposed less than minimal risks for schools participating. The contextualized audit tool utilized was strictly observational of the school grounds and infrastructure. Thus, this study was exempt from Institutional Review Board consideration through Duke University and from the Institutional Ethics Committee at the PHFI.

Schools were de-identified at every point in the study. The code key was shared only amongst the principal investigators. The data compiled from the audits were stored on a password-protected computer only accessible to the graduate student. Any reports stemming from this research reported group-level (aggregate) data only.

Verbal consent from school principals was received in person to conduct the audit at each school. Only if this consent was received in person, was the audit completed. If the school principal felt more comfortable, a school administrator or teacher accompanied the trained auditor while the auditor and research team were on the school grounds.

5 Results

The schools that participated in the study were located in nine of the twelve districts in Delhi (all districts were represented in the original fifty random numbers that were generated). No schools from the New Delhi, North and West B districts made it to the final sample. Four schools were from Southwest A, two were from Northwest A, two were from Northwest B, three were from South, two were from Northeast, and one was from West A, Central, and East districts each. The largest number of schools sampled came from the Southwest A district.

40% (n=6) of schools were located in a residential area (Figure 3), 20% (n=3) were in business or retail building areas (Figure 4), 20% (n=3) were in a mixture of business or retail buildings, residential (Figure 5), 12.5% (n=2) were in open fields or commons or parks (Figure 6), one school was surrounded by hospitals, and one was surrounded by a combination of these settings.



Figure 3: An example of a school surrounded by a residential area. This photograph was taken from the front entrance of a school. 40% of schools were located in residential areas similar to the one shown here.



Figure 4: An example of a business/retail area. This photograph was taken from the front entrance of a school. 20% of schools were surrounded by businesses and/or retail.



Figure 5: An example of a mixture of business/retail and residential areas. This photograph was taken from the front entrance of a school. Here, the ground floor consists of the business/retail while the upper floors are areas of residences. For example, there is a sweet store on the ground floor here, which is a business/retail. The upper levels are residences. 20% of schools were located in this type of area. In this photograph, it is also important to note the high traffic levels in front of the school.



Figure 6: An example of open field areas. This photograph was taken from the front entrance of a school. Farming took place in this particular open field. Here, it is evident that there were hardly any cars, trucks, and motorcycles meaning very low levels of traffic and very low levels of loud noises.

5.1 The Surrounding Area

The surrounding area was defined as the area that was visible from any of the entrances of the school. 87.5% of the schools had somewhere parents could stop and drop children off (Table 3). 87.5% of schools also had a place where parents could park their cars (Table 3). 62.5% of schools had a school bus stop (Table 3).

One school had cycle lanes separated from the road. And, two schools had cycle lanes on the road. Also, only two schools had pavements on both sides of the road and only one had pavements on one side of the road. Additionally, only one school had a marked pedestrian crossing to assist access to the school.

Table 3: Percent (%) of schools with presence of corresponding item under 'The surrounding area' category.

'The Surrounding Area' Items	Percentage (%) of schools with item
Somewhere where parents can stop and drop children off	87.5
Somewhere where parents can park their car	87.5
A school bus stop	62.5
Cycle lanes separated from road	6.25
Cycle lane on the road	12.5
Pavements on both sides	12.5
Pavements on one side of the road only	6.25
Marked pedestrian crossing	6.25
Traffic calming	25.0
Signage: school warning signs for road users	0
Signage: road safety signs	0
Signage: route signs for cyclists	0

Four schools had some sort of traffic calming such as speed bumps or traffic islands (Table 1, Figure 7).



Figure 7: Speed bump, an example of traffic calming, in the front of a school.

None of the schools sampled had any signage including school warning signs for road users, road safety signs, or route signs for cyclists (Table 1). However, one school did mention in faded letters, “Do Not Horn” on a larger street sign. This was not formally recorded on the audit tool because this is not a sign recognized by the Delhi police (<http://www.delhipolice.nic.in/>, Appendix B) (Figure 8).



Figure 8: This is a street sign in front of the school. The black box (inset) highlights the faded words ‘Do Not Horn’. This was not recorded as signage on the audit tool because this informal sign is not recognized by the Delhi police; however, it does indicate that people concerned about horns in areas where schools are present despite the actual visibility of Delhi police recognized signs.

5.2 The School Grounds

On the school grounds, many different features were counted and the modal quality observed. Column 1 of Table 4 lists the different items on audit tool under this specific category (Table 4). Column 2 lists the mean values and standard deviations for each item (Table 4). Column 3 displays the percent of schools that did not have any of the given item and column 4 shows the mean and standard deviation of

only the schools that had one or more of the item present (excludes schools with none) (Table 4). For seven out of the thirteen items considered, over 50% of schools did not have any of that item present (Table 4). For the schools that did have the items, generally the modal quality was adequate (Table 4). Playground equipment was present at almost every school, 93.75% of schools had the facility (Table 4).

One school had visible dog remains where children could play. Also, all schools except one had school grounds on split sites. School grounds were predominantly flat for schools sampled; only one school had sloping/undulating school grounds. And, all but one school had a hard surface playground.

Table 4: Prevalence and quality of physical activity facilities in school grounds category of sixteen secondary schools in Delhi, India.

Activity Facilities	Mean Number (SD)	Percentage (%) of schools with none	Mean Number excluding schools with none (SD)	Median Modal Quality
White chalk powder markings on play surfaces	0.81 (1.87)	75.0	3.25 (2.63)	Adequate
Playground equipment	5.13 (4.27)	6.25	5.47 (4.19)	Adequate
Pitches	0.77 (1.17)	56.25	1.76 (1.18)	Adequate
Athletic tracks	0.625 (0.96)	62.50	1.67 (0.82)	Adequate
Courts	1.06 (1.34)	43.75	1.89 (1.27)	Good
Benches	1.63 (2.92)	68.75	5.20 (2.95)	Adequate/Good
Picnic Tables	0.56 (2.25)	93.75	9.00 (0)	N/A
Water coolers	4.96 (6.17)	37.50	7.93 (6.10)	Adequate
Wildlife garden	0.13 (0.34)	87.50	1.00 (0)	Adequate/Poor
Uncovered cycle parking	6.23 (8.88)	43.75	11.07 (9.35)	Adequate
Covered cycle parking	7.56 (30.25)	93.75	121.00 (0)	Adequate
Assault Course	0.69 (0.79)	43.75	1.22 (.67)	Adequate
Quadrangle	0.79 (0.70)	43.75	1.22 (.44)	Adequate

As Table 4 indicates, there was a mean of about five pieces of playground equipment with 93.75% of schools having some sort of playground equipment on the grounds. Figure 9 provides an example of playground equipment that has ‘Good’ modal quality at one of the schools in the sample while Figure 10 shows an example of a school with ‘Poor’ modal quality of playground equipment. Although the

playground equipment is generally present for students in the primary schools, for schools that had equipment available, adolescents were seen utilizing the equipment and area.



Figure 9: An example of ‘Good’ modal quality playground equipment at one school from the sample. There are slides, swings, and other play equipment for children. Also, there are trees surrounding the entire play area making the play area more appealing and also provides shading. Also, there is fencing around the entire area so children feel secure while playing; additionally, teachers feel secure allowing children to play freely.



Figure 10: An example of ‘Poor’ modal quality playground equipment at one school from the sample. This equipment was located inside the quadrangle of the school and consisted of only one small slide highlighted by the black box (inset). It is important to note that the small size of the slide, which indicates that the older children would not play with this equipment since it is aimed for the younger children. Also, notice the quantity, there is only one.

Also, on average, there was about one court present per school; however, 43.75% of schools did not have any (Table 4). For the schools that did have a court present, it was usually in ‘Good’ modal quality. Figure 10 shows a large basketball court within a large quadrangle at one particular school. 56.25% of schools had quadrangles present (Table 4).



Figure 11: An example of both a basketball court and a quadrangle at a sampled school. At this particular school, the quadrangle contained a basketball court. In addition to basketball, students at this school and others also participated in various activities such as karate, cricket, and yoga in the quadrangle.

One school had covered cycle parking, which is shown in Figure 12 below. Many students at this school utilized their bicycles. More schools had uncovered cycle parking (56.25%, Table 4). Usually, there was no special infrastructure or markings for the uncovered cycle parking.



Figure 12: Covered bicycle parking on the school grounds for students at a particular school in the sample. At this particular school, there were over 100 cycles parked at the time of auditing (Table 4).

One other study (Jones et al 2010) utilized this audit tool for schools in Britain, a developed country. The relevant ‘School Grounds’ category items for comparison are shown in Table 5 below. Standard deviation was not reported by Jones et al and thus is not included in the table. This table compares the different reported values between the two studies. For all categories except for playground equipment

there was a higher percentage of Indian schools that did not have the item. However, for playground equipment, only 6.25% of sampled Indian schools did not have any equipment while over half (53.3%) of sampled British schools did not have any equipment. Also, after excluding the schools with none, the mean values for three items (white chalk powder markings on play surfaces, athletic tracks, and assault course) are very comparable between the two (Table 5). British schools had greater number of items with a modal quality of 'Good' than Indian schools (Table 5).

Table 5: Comparison of school ground items from this study to the Jones et al 2010 study.

Activity Facilities	Mean Number (SD): this study	Mean Number: NR Jones et al 2010	% Schools with none: this study	% Schools with none: NR Jones et al 2010	Mean number (SD) excluding schools with none: this study	Mean number excluding schools with none: NR Jones et al 2010	Median Modal Quality : this study	Modal Quality: NR Jones et al 2010
White chalk powder markings on play surfaces	.81 (1.87)	7.21	75.0	4.3	3.25 (2.63)	3.24	Adequate	Adequate
Playground equipment	5.13 (4.27)	1.26	6.25	53.3	5.47 (4.19)	2.70	Adequate	Good
Pitches	0.77 (1.17)	1.64	56.25	25.0	1.76 (1.18)	2.19	Adequate	Adequate
Athletic tracks	0.625 (0.96)	.88	62.50	26.1	1.67 (0.82)	1.19	Adequate	Good
Courts	1.06 (1.34)	3.10	43.75	4.3	1.89 (1.27)	3.24	Good	Adequate
Assault course	0.69 (0.79)	.76	43.75	34.8	1.22 (.67)	1.17	Adequate	Good

A few schools from the sample did not have any school grounds, one example of a sampled school shown below in Figure 12. As can be seen, this school is directly on the main road and the main entrance of the school opens directly to the road (Figure 13). The two edges of the school (which is not seen in the photograph) were surrounded by business/retail. From the initial contacts of the fifty randomized schools, two schools refused to participate citing the lack of presence of any school grounds as seen in Figure 13.



Figure 13: A school from the sample that had no school grounds. The main entrance of the school, shown on the ground floor center, opened directly to the street. Two school reception staff members, during initial communication with the schools, refused to participate citing lack of school grounds at school site as shown here.

One school had an outdoor yoga platform shown below in Figure 14. Also, many school reception staff and principals mentioned the presence of yoga rooms and yoga instruction inside the school during school hours. The audit tool could not formally record these mentioned facilities since the tool is designed to measure only the outdoor grounds. The emphasis on yoga shows the importance of this activity in India.



Figure 14: Outdoor yoga platform at one school. This platform was present in the back of the school. Yoga is very common in Indian culture.

5.3 Aesthetics

Most schools (75%, n=12) had some, and one school (6.25%, n=1) had a lot of planted beds containing flowers or shrubs or small trees, while some schools (18.75%, n=3) had none. About half of the schools had no trees for sitting under (n=8), while some schools (n=7) had some trees for sitting under and one school (n=1) even had a lot of trees for sitting under. And, most schools (87.5%, n=14) had no graffiti on school grounds. Additionally, 68.75% of schools had a lot of murals and outdoor art, while 25% had some and 6.25%, or one school, had none. See Table 6.

Table 6: Aesthetics Category. Presence (in %) of items in the aesthetics category of the school grounds.

Items for Aesthetics	Percentage (%) of Schools with a lot	Percentage (%) of Schools with some	Percentage (%) of Schools with none
Planted beds containing flowers/shrubs/small trees	6.25	75	18.75
Trees for sitting under	6.25	43.75	50
Ambient noise	31.25	43.75	25
Litter	0	43.75	56.25
Murals/outdoor art	68.75	25	6.25
Graffiti	6.25	6.25	87.5

31.25% of schools had a lot and 43.75% had some ambient noise from traffic, trains, and industry; the majority of schools (75%) had either a lot of noise or some noise. This ambient noise was not present for 25% of schools (Table 6). Through auditor observations, it was noted that most of the noise for many

schools with some or a lot of ambient noise came from high levels of traffic on the surrounding streets of the school; Figure 15 shows an example of a busy and loud street that was directly in front of a school.



Figure 15: Busy and loud due to large amounts of traffic in front of a school's main entrance.

Most schools had either some (43.75%, n=7) or no (56.25%, n=9) litter on the school grounds. No school had a lot of litter. Below, Figure 16 shows a school that was very well maintained and hardly had any litter. Meanwhile, Figure 17 (a) and (b) shows a hard surface play area for the students that had some litter present.



Figure 16: Well-maintained school grounds with no litter.



Figure 17: (a) Hard surface play area with some litter and (b) another hard surface playground (with two levels and benches) that have some litter. Both are areas that students utilize for general play.

5.4 Usage

This section asked about whether the grounds were generally suitable for sport, informal games and general play. Four schools (25%) were generally very suitable for sport (organized or not), eight schools (50%) were somewhat suitable, while four schools (25%) were not at all suitable. In regards to the suitability of grounds for informal games, five schools were categorized as very suitable; nine schools were somewhat while two were not at all suitable. Finally, there were six schools very suitable, eight schools somewhat suitable, and two schools not at all suitable for general play. See Table 7.

Table 7: Usage Category. Determination of whether school grounds were generally suitable for sport (organized or not), informal games, and general play. Three categories of 'Very', 'Somewhat', and 'Not at all' are present.

Items for Usage	Percentage (%) of schools categorized as 'Very'	Percentage (%) of schools categorized as 'Somewhat'	Percentage (%) of schools categorized as 'Not at all'
Sport (organized or not)	25	50	25
Informal games	31.25	56.25	12.5
General play	37.5	50	12.5

5.5 Overall

Overall, for over half of the schools (81.25%), the trained auditors strongly agreed or agreed that the grounds were shielded from the surrounding area by hedges or trees or fences; however, for 18.75% of schools, trained auditors disagreed or strongly disagreed (Table 8).

Auditors strongly agreed or agreed that over half (62.5%) of the grounds are generally well-maintained while 18.75% disagreed or strongly disagreed and 18.75% were neutral. 93.75% agreed or strongly agreed that the school grounds were generally free of vandalism while 6.25% disagreed or strongly disagreed and none were neutral. See Table 8.

Table 8: Overall Category. Determines percentage of schools for these general categories in regards to the school grounds. Percentage schools are shown here.

Item	Percentage (%) of schools categorized as either strongly agree or agree	Percentage (%) of schools categorized as either strongly disagree or disagree	Percentage (%) of schools categorized as neutral
Grounds are shielded from surrounding area by hedges/trees/fences	81.25	18.75	0.00
Grounds are generally well maintained	62.5	18.75	18.75
Grounds are generally free of vandalism	93.75	6.25	0.00

6 Discussion

This study showed that private schools in Delhi have very diverse school grounds. It also showed that there are many potential areas of improvement to make the grounds more conducive to physical activity for students. There were also insights about designing a more suitable audit tool to measure built physical activity environments in urban centers in a developing country.

Most schools that were sampled were located in residential settings. This indicated that although the schools were all within the districts of 'urban' Delhi, most schools were located in a residential setting within the larger urban environment. Despite being in a residential setting, there was significant traffic and noise recorded around the surrounding area.

Over half of the schools had somewhere parents could stop and drop children off, where parents could park their cars, and a school bus stop. For some schools that did not have these facilities, it may be due to a lack of need. Some schools cater only to local school children who mostly walk to and from school with their parents; thus, drop off areas and buses were unnecessary. Additionally, some schools catered to families from lower socioeconomic backgrounds who may not be able to afford cars, thus rendering space for car parking unnecessary.

The surrounding area infrastructure such as the presence of cycle lanes, pavements, marked pedestrian crossing, traffic calming, and signage of the surrounding areas was not very high – over half of the sample did not have these features (Table 3). These features likely have a direct influence on the safety of children who are walking or cycling to school and the lack of these features may stymie a parent's willingness to let their child commute actively to school in this manner. The lack of these features in the surrounding area in so many schools highlights a necessary area of improvement - an area that the city of Delhi is primarily responsible for rather than the school.

Active school transport (AST) is a prominent concept in the physical activity literature. Active school transport consists of features that are considered to be active modes of transportation to reach the school, such as walking, cycling and other non-motorized personal mobility (Stewart, 2011). Active school transport is considered to be an effective non-curricular method to increase the levels of physical activity for students (Faulkner et al, 2009; Stewart, 2011) and also attenuate effects of air, noise and other forms of pollution due to decreased utilization of cars for transportation (Environmental Protection Agency EPA,

2003). One study has shown a link among physical activity, decreased traffic and improvements in air quality: with decreased levels of traffic, there is more physical activity, and an improvement in air quality (Frank et al, 2007). Additionally, AST is important because it could reduce traffic especially during the school opening and closing times, since it has been estimated that over 20 to 30 percent of local morning traffic during the school year in the United States is due to parents driving their children to school (Hubsmith et al, 2006); it can be reasonably extrapolated that for Delhi, an urban environment that is extremely populated, that estimated percent may be much larger than seen in the United States. There are four main factors that influence AST, which are: distance, income, traffic and crime fears, and parental attitudes and schedules (Stewart, 2011).

If the safety of the surrounding area is increased (one way to increase safety according to SPEEDY is to increase the presence of the items in 'The surrounding area' category), parents may be more willing to allow their child to walk to school or ride their bicycle to school if the student lives close enough to make this a feasible option. Walking and biking to school can be easy and important ways that students can stay physically active. Studies have shown that creating an environment that is more walkable, may yield higher levels of physical activity (Owen et al 2012) and less driving (Frank et al, 2007), which can influence the reduction in the prevalence of obesity for those who walk rather than drive (Frank et al, 2007). Additionally, changing perceptions is also important since one study showed that perception about limited public transportation, lack of lights on streets for crossings were associated with decreased levels of parents allowing their children to walk or cycle to local neighborhood play areas (Timperio et al, 2004) suggesting that not only does reality have to change but perceptions have to change as well. It is important to note that just because reality may in fact change does not indicate that perceptions necessarily change in accordance, especially during the short term.

One study completed in Britain shows that providing road safety features, such as cycling infrastructure or a crossing guard to allow for safe crossing of the street, help to support maintenance of moderate to vigorous activity levels in school children and prevent sedentary behavior (Mantjes et al, 2012); these factors can also increase AST. In India, where the density of traffic and burden of road injuries is high (Dandona et al, 2008), signage, presence of cycle lanes among the other surrounding area are

features that may be even more important than in other countries like Britain and the United States where there is not as high of a burden of road injuries. Programs such as ‘Safe Routes to School’, which started in Denmark in the 1970s and now has spread globally to the United States and other countries, aim to increase safety and rate of AST through both improvements of infrastructure and non-infrastructure activities. This is a kind of program that the Delhi government may be interested in implementing at a district-wide level to not only increase physical activity but also to decrease traffic and even potentially to improve air quality due to the decreased traffic. In Delhi, promoting more walking and cycling for children as a means of transportation to school is possible, but it is contingent on increasing prominence of safety features of the surrounding area.

Features directly on the school grounds are especially important in promoting physical activity among students. Overall, over 50% of sampled schools did not have seven out of the thirteen items under ‘The school grounds’ category (Table 4). Further, for the schools that did have one or more of the item, the general modal quality was adequate (Table 4).

The lowest mean numbers were for wildlife gardens with only one school actually having the presence of one (Table 4). The concept of the wildlife garden is becoming popular in many developed countries (Stratton et al, 2005) but may not be relevant or feasible in the developing country context especially since there are many other more prominent issues that require imminent action than the presence of a wildlife garden. Also, we noted that there was little room at some schools for the presence of such a garden (Figure 13, as one example). Athletic track, assault course, and quadrangle all had similar lower mean numbers. Again, limited space could be an issue. Additionally, these three facilities are all part of the structural environment and may be harder to influence and change. Playground equipment scored pretty highly, which is a positive since it indicates that there is equipment for children to play with. Also, Figures 9 and 10 both show that the equipment is generally brightly colored, which could be a way to promote physical activity amongst students (Stratton et al, 2005). Also, the presence of quadrangles seemed especially important in this study context for reasons including limited space, safety for the kids, and limited interactions with traffic and poorer air quality closer to the streets.

The median modal quality for most of the activity facilities that were present was almost always 'Average'. This average modal quality indicates that not only should there be an emphasis on increasing the number of facilities at all private schools in Delhi, there also needs to be a focus on ensuring that good quality facilities are present at all private schools as well.

It is important to recognize that there is a bit of a difficulty in interpreting these mean values especially because there is no target number that has been determined or recognized that ensures a promotion of physical activity. Additionally, because utilization of these facilities was not measured in this study, a mean number, in isolation, is even harder to interpret. One way to mitigate these issues surrounding interpretation was to compare the findings of this study to other findings that have been published. One published study that used the original SPEEDY School Grounds Audit Tool for British schools exists in the literature (Jones et al, 2010). This published study (already comprehensively cited in this paper) reported data similar to data in this study (Jones et al, 2010).

Table 5 shows an interesting comparison of some facilities reported in both studies. Indian schools had a higher percent of schools with no facility present for all facilities in Table 5 except playground equipment; however when looking at the mean number, the British and Indian schools are comparable since the mean numbers from British schools is within one standard deviation of the Indian schools. Also, after excluding schools with none, the mean values for white chalk powder markings, athletic tracks, and assault course were very similar between the two studies. Because we are comparing a developed and developing country, and the mean values are similar, it may reemphasize the original concern that the actual number of the facility, in isolation of other considerations such as utilization, number of children, and others, may not be a very important indicator. Indian schools have a lower mean number of pitches, however like playground equipment, the British data is within one standard deviation of the Indian data. For courts, the difference between the two may be more important because the British schools have more courts and it does not fall within one standard deviation of the Indian schools; although this may seem important, our conclusions are limited because standard deviations of the British data was not reported.

The modal qualities for the facilities for British were categorized as ‘Good’ a greater number of times than for Indian schools (Table 5). This discrepancy emphasizes the importance of good quality facilities to be present as well as a greater number of facilities.

Recommending an increase in the number of facilities may not be the best recommendation for schools because increased presence of facilities does not necessarily mean increases in utilization by the children. Additionally, increased number of facilities may be potentially detrimental because it takes away free space that the children could utilize for informal games and team sports. Thus, recommendations based on the items in ‘The school grounds’ category have to be more nuanced and will need to be specific to individual schools rather than an over-arching recommendation for all schools.

Aesthetics of the grounds is important because it can influence the appeal of the school grounds, which can influence a child’s wanting to be active on the school grounds. Studies have shown variations of this fact in different situations: one study showed that signs, artwork, and music (all variations of aesthetic appeal) could promote the use of stairs in public buildings (Boutelle et al, 2001). A study of Australian men and women showed that those who reported a less aesthetically pleasing or less convenient environment were less likely to report walking for exercise or recreation in the past two weeks (Ball et al, 2001). This study found the trend in adults; and similar studies show these trends in children (Ball et al, 2001).

For the sampled schools we saw that a lot or some ambient noise is present for the majority of schools, which can reduce the appeal of physical activity for students. Thus, reducing noise levels around schools is an important area of focus for schools and the government. If more students are able to participate in AST, this might be one potential way, among others, to reduce some noise around schools. Brainstorming of other methods to reduce noise levels will also be important. It is important to note that the noise levels may change throughout the day at each school and the tool did not capture this variation. This potential noise level variation is important to bear in mind especially when discussing mechanisms for reductions in noise levels.

As expected, reduced vandalism increases the aesthetic appeal of a school (Pablant et al, 1975). For schools in this sample, most schools had no litter and graffiti both leading to increased aesthetic appeal of the school grounds. Maintaining low levels of vandalism and graffiti and lack of presence of litter over

time will be especially important to maintain appeal for students and for potentially promoting physical activity. Also, most schools had at least some planted beds containing flowers or shrubs or small trees, animal remains were not visible where children could play for most schools, and the grounds were not on split sites. These factors all contribute to increasing the aesthetic appeal of the grounds to students and can contribute to promoting physical activity.

In the aesthetics category, an item that is included is trees for sitting under. This does correspond to aesthetic appeal but its correlation to physical activity seems a bit more ambiguous than the other items. Trees for sitting under could also be viewed as a way to provide shade on the school grounds; viewing this item through the lens of providing shade renders the presence of this item even more important in a hot and humid environment like India's.

About half of the schools sampled were considered to be somewhat suitable for sport, informal games, and general play (Table 7). Improvements in the grounds can be made to improve the categorization to 'very' not just 'somewhat' suitable. For the schools that were in the 'not at all' categorization, it will be important to further understand what specific features and what combinations of features of the grounds is causing them to be categorized in the lowest category. A nuanced approach, focused on specific reasons for the given categorization for every school, will be needed. The specific focused approach will allow for faster improvements to potentially reach a categorization of 'Very' for all schools.

For most schools it was strongly agreed that the grounds were shielded from the surrounding areas. This determination of shielding is an especially important feature, like mentioned above, for schools in Delhi due to large amounts of traffic and noise. One study in the literature shows another important feature of the importance of shielding – it has been shown that children who are free to roam around areas that are shielded from the surrounding areas, serving as protection, and thus, do not require hands-on adult supervision, and are actually able to accumulate more physical activity than those who do not (Schoeppe et al, 2012). Thus, shielding can also reduce the necessity of hands-on adult supervision and allow for students to increase their levels of physical activity. Also, it was strongly agreed for over half of the schools that the grounds were generally well maintained. Both of these are good especially since they can indicate increased physical activity.

A study done in England showed there is no significant variation in the physical activity of students based on days and seasons at school (Ridgers et al, 2006). No such study has been done in India. It may be reasonable to believe that weather and seasons play a much more significant role in India, a country where the heat can be extreme, upwards of 115 degrees Fahrenheit, during a typical summer, than in England, where weather and climate are relatively more moderate.

There are important limitations to consider in this study. One significant limitation is the small sample size (only 16 schools of 1284 qualifying schools, which is less than 5%, were sampled). Not only that but also, only private schools, and no government schools were considered (due to lack of time for appropriate approval from the Directorate of Education in Delhi). The external validity is limited due to this small sample size. Also, schools that participated in the study came from only seven of the nine districts in Delhi, a factor that also limits the external validity of the study. Future studies should aim to have larger sample sizes in all districts in order to increase the external validity of findings and to increase the rigor of the analyses. Also, future studies should aim to include government schools. Inclusion of government schools will be important especially to determine whether there are significant differences between these schools and private schools.

The third objective of the study was to look more closely at the demographic characteristics of the school such as number of children, location of the school, and other indicators in order to understand the built physical activity environment. All auditors were trained to ask the school reception staff or principal for the number of children at the school. However, most of the time when asked, the school reception staff or principals did not have this information or the principal had a very general idea of the number of students, rather than an exact number. Also, comparing the location of the school beyond comparison at the district level was difficult. Additionally, the size of the school was not determined. All schools differ in size and the number of students it caters to. Principals did not know any information about the size of the school and it was not feasible for the trained auditors to measure the school size by hand. Additionally, we were not able to record family income levels of matriculated students, a feature that is being shown to be an important factor in the socio-cultural characteristics of schools and physical activity for children (Martin et al, 2013). These unmeasured items, also not present on the audit tool, reveal significant weaknesses of this

analysis. One such weakness is that this analysis is not able to understand why there are differences among the schools (i.e., do some schools have more playground equipment because that school has a much larger student body or is it because there is a larger area so the equipment can fit, or is it because that school has more available funding).

As mentioned, a very focused and fruitful effort was made to contextualize the audit tool and user manual. However, limits exist, since there are aspects of school grounds that may be specific to Indian schools, which were not considered. Further research needs to be done to determine these various aspects.

Despite the benefits of the SPEEDY tool, it may be necessary to develop a new tool that better addresses the developing world context, and specifically urban school environments in the developing world. In the potential development of a new tool, it will be important to include measures that account for the indoor school grounds as well as the outdoor school grounds. Many school reception staff members and principals had mentioned the presence of an indoor gym, indoor yoga and dance rooms; however, we were unable to record these facilities due to the fact that they were located inside the school. Also, measuring and recording indoor facilities in India is especially important due to the especially hot and humid climate (as mentioned earlier). Particularly during the hot months, it is generally forbidden for students to be outside at any time due to increased incidence of heat strokes, weakness, and dehydration; thus, potentially rendering outdoor facilities much less important as compared to the indoor facilities especially during certain times of the year.

Also, because of limited space in populous urban centers like Delhi, it may be necessary to consider the size of the school grounds and number of students at the school in order to determine some sort of 'projected density of utilization' of the various physical activity equipment at each school. This is important because some schools have more enrolled students while others have fewer. It would be important to determine if schools with larger enrollments have more facilities to appropriately accommodate for their larger school. Or, a new method of weighted scoring needs to take place that gives appropriate weights to the number of facilities in accordance with the number of children who could potentially utilize those facilities.

In order to more completely determine whether a school grounds is conducive to physical activity, utilization of the facilities and school physical activity curriculum need to be determined and measured; two variables not measured in this study. Measuring utilization is important because the presence of facilities does not mean that students are actually utilizing those facilities. Additionally, it will be important to characterize the level of intensity of the physical activity that is possible for the facilities and what level of activity is actually achieved by students who utilize these.

The school curriculum and other activities provided by the school are important to consider. As discussed earlier, the CBSE outlines school requirements for physical activity. The outline requires schools to have a daily 40-45 minute activity period for all students in grades one through ten and twice a week for grades eleven and twelve. Many schools have different and innovative ways to incorporate this CBSE requirement into the curriculum. For example, some schools have a weekly schedule of yoga for all students while other schools have a biweekly dance schedule for only students in 6th grade and above. Both of these activities take place inside and do not need any formal type of infrastructure – it only requires some free space, which can even be made within a classroom by moving the desks. Some schools have a health education class where students learn about the importance of physical activity – they may not be active during this class but they are learning life long lessons that can carry with them for their entire life, which is especially important because these adolescents become the future adults in society (Fairclough et al, 2002). It was also noted during informal conversations with the principal that some schools have before school and after school mandatory and non-mandatory programs related to physical activity. A systematic analysis of these features will be important to fully understand the relationship between the school and physical activity for its students.

A review of the United States literature reveals that many schools incorporate physical activity as a class in students' schedules (Strong et al, 2005; Sallis et al, 2011; Fairclough 2004). In the United States, it is also generally widely accepted that schools can be a valid entity to promote and incorporate physical activity for all students (Strong et al, 2005; Fairclough 2004). Further, some state level legislature mandates that schools incorporate physical activity into the school curriculum (Strong et al, 2005; Fairclough 2004; Sallis et al, 2011; Jones et al, 2010).

Recess periods can be used to promote physical activity by increasing the facilities and equipment available to students (Ridgers et al, 2012). We were not able to measure the length of the recess that students were provided during a typical day. In the future, this would be important to measure. Jago et al 2004 reports the importance of recess, considered to be a non-curricular activity, as a mechanism to incorporate physical activity into a students' schedule every day. Thus, focusing on curricular and non-curricular activities will be important to maximize the levels of physical activity.

In Delhi, more research needs to be done in order to understand how physical activity can be incorporated into the curriculum in Indian schools. Based on this research, it will be interesting to determine whether there are relevant policy implications for incorporating physical activity into school curriculum. The school is a very important area of research and can be utilized further to promote physical activity amongst students.

Despite its limitations, this study contributes a significant amount of information to the literature. It is the first study to describe the built environment of school grounds environment in Delhi, India. Through this analysis, many insights about future venues of research have been identified. Also, areas of improvements of the school grounds have been indicated. Additionally, insights into appropriate methods for measuring the various items of interest have been elucidated. Overall, more research needs to be done in this growing field in order to more fully describe the built environment of schools in India and assess the relationship between the built environment and children's physical activity.

7 Appendix A

SPEEDY School Grounds Audit tool.

SPEEDY School Grounds Assessment Tool			
WEATHER (Describe: include temperature):			
SCHOOL IDENTIFIER:			
ASSESSORS NAME:		DATE:	/ /
START TIME:	COMPLETE TIME:		
Access to the school			
1	Please locate each entrance to the school and record its grid reference and whether it is for pedestrians, cyclists, or cars. <i>(Tick all that apply)</i>		
		Cars	Pedestrians
		Cyclists	
1, Grid Ref:			
2, Grid Ref:			
3, Grid Ref:			
4, Grid Ref:			
5, Grid Ref:			
2	For each entrance please record the speed limit, in kilometers per hour, on the adjacent road. <i>(If the entrance does not open onto a road then enter n/a)</i>		
		Tick if roadside parking is available	
1, Speed limit:			
2, Speed limit:			
3, Speed limit:			
4, Speed limit:			
5, Speed limit:			

The surrounding area			
	Are the following visible from any of the entrances?		
		Yes	No
3	Somewhere where parents can stop and drop children off	<input type="checkbox"/>	<input type="checkbox"/>
		Yes	No
4	Somewhere where parents can park their cars	<input type="checkbox"/>	<input type="checkbox"/>
		Yes	No
5	A school bus stop	<input type="checkbox"/>	<input type="checkbox"/>
6	Cycle lanes:	Yes	No
	a) Separated from the road	<input type="checkbox"/>	<input type="checkbox"/>
	b) On the road	<input type="checkbox"/>	<input type="checkbox"/>
7	Pavements:	Yes	No
	a) On both sides	<input type="checkbox"/>	<input type="checkbox"/>
	b) On one side of the road only	<input type="checkbox"/>	<input type="checkbox"/>
		Yes	No
8	A marked pedestrian crossing (e.g. zebra/pelican/light controlled crossing) to assist access to the school	<input type="checkbox"/>	<input type="checkbox"/>
		Yes	No
9	Traffic calming (e.g. speed bumps, width restrictions, traffic islands)	<input type="checkbox"/>	<input type="checkbox"/>
10	Signage:	Yes	No
	a) School warning signs for road users	<input type="checkbox"/>	<input type="checkbox"/>
	b) Road safety signs (e.g. "look both ways")	<input type="checkbox"/>	<input type="checkbox"/>
	c) Route signs for cyclists	<input type="checkbox"/>	<input type="checkbox"/>

The School Grounds

Please indicate whether the following are present, and rate their quality:					
		Number	Quality		
			Good	Adequate	Poor
11	White chalk powder markings on play surfaces (e.g. kabaddi, kho-kho)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
12	Playground equipment (e.g. swings, slide)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
13	Pitches (e.g. football, softball, cricket)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
14	Athletics track (grass or hard-surface)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
15	Courts (e.g. tennis, basketball including half court, badminton, multicourt area)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
16	Benches	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
17	Picnic tables	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
18	Water coolers	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
19	A wildlife garden	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
20	Uncovered cycle parking (number of bikes)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
21	Covered cycle parking (number of bikes)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
22	An assault course	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
23	A quadrangle	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
24	Other ()	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

25	Other ()	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
26	Other ()	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
		Yes	No		
27	Are any remains visible in the areas where children could play?	<input type="text"/>	<input type="text"/>		
		Yes	No		
28	Are the school grounds on a split site?	<input type="text"/>	<input type="text"/>		
		Flat	Sloping/undulating		
29	Are the school grounds predominantly ... ?	<input type="text"/>			
		Yes	No		
30	Does the school have a hard surface playground?	<input type="text"/>	<input type="text"/>		

Aesthetics

	Please indicate whether the following are present:			
		None	Some	A lot
31	Planted beds containing flowers/shrubs/small trees	<input type="text"/>	<input type="text"/>	<input type="text"/>
		None	Some	A lot
32	Trees for sitting under	<input type="text"/>	<input type="text"/>	<input type="text"/>
		None	Some	A lot
33	Ambient noise (e.g. traffic, trains, industry)	<input type="text"/>	<input type="text"/>	<input type="text"/>
		None	Some	A lot
34	Litter	<input type="text"/>	<input type="text"/>	<input type="text"/>
		None	Some	A lot
35	Murals / outdoor art	<input type="text"/>	<input type="text"/>	<input type="text"/>
		None	Some	A lot
36	Graffiti	<input type="text"/>	<input type="text"/>	<input type="text"/>

Usage					
	Are the school grounds generally suitable for ... ?				
		Very	Somewhat	Not at all	
37	Sport (organised or not)	<input type="text"/>	<input type="text"/>	<input type="text"/>	
		Very	Somewhat	Not at all	
38	Informal games (judo, kabbadi, kho-kho, marbles, tug of war etc.)	<input type="text"/>	<input type="text"/>	<input type="text"/>	
		Very	Somewhat	Not at all	
39	General play	<input type="text"/>	<input type="text"/>	<input type="text"/>	
Overall					
	To what extent do you agree or disagree with the following statements?				
		Strongly Agree	Agree	Neither	Disagree
40	The grounds are shielded from the surrounding area by hedges/trees/fences	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
		Strongly Agree	Agree	Neither	Disagree
41	The grounds are generally well maintained	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
		Strongly Agree	Agree	Neither	Disagree
42	The grounds are generally free of vandalism	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<hr style="border-top: 1px dashed blue;"/>					
43	Please estimate the total percentage cover of different surfaces where children could play				
	a) Tarmac	<input type="text"/>			
	b) Paving	<input type="text"/>			
	c) All weather surface	<input type="text"/>			
	d) Grass	<input type="text"/>			
	e) Bark / other safety surface	<input type="text"/>			
	f) Other (State:.....)	<input type="text"/>			
	Total:	100%			

44	Is the area around the school predominantly...? <i>(tick one)</i>		
	Residential	<input type="checkbox"/>	
	Open fields/commons/parks	<input type="checkbox"/>	
	Business/retail	<input type="checkbox"/>	
	A mixture of the above	<input type="checkbox"/>	
45	Additional Notes (also include, if possible, number of students in school and specifically in grades 6-8 and types of activities related to physical activity):		

8 Appendix B

Modified User Manual:



SPEEDY

Quality of School Grounds Assessment Tool

Observers' Manual
[Modified]

Preparation

Prior to undertaking a school grounds audit ensure that you have read this manual fully and read through the audit tool. Audits should only be undertaken at schools where prior permission has been obtained.

In order to undertake a school grounds audit make sure that you have:

- Informed your line manager of your whereabouts for the day with estimated timings;
- Appropriate clothing for the day;
- Mobile phone;
- Clipboard;
- Pens;
- Sufficient copies of the audit;
- Maps of each school (if available);
- Address of school and Google map of school grounds (specifically for the first question);
- Contact information of school;
- This manual.

Conducting an audit

Each item on the form should be completed fully and accurately. This will require you to walk around each school ground thoroughly to assess the environment and the facilities. Some schools may have a split site, for example where there is a road crossing the grounds or where parts of the grounds are some distance from the main school building. You may have to ask a member of staff at the school for information on this.

You are generally required to put ticks () in the relevant boxes, although occasionally you will be required to write a number or some text. Whenever an item has an 'other' option always describe the item in the brackets. Always use a biro (pen). If you make a mistake, cross out the incorrect answer and tick the new choice. Be sure to write clearly to make data entry easier. The sections below provide more information/clarity for particular items. Not all items are covered, as some do not require further explanation.

In some sections you will be asked to rate the 'quality' of a facility, amenity or some equipment. In all cases where you do this your judgement should consider a combination of the level of cleanliness, maintenance, suitability for purpose and general upkeep. Some of these factors will be more relevant than others dependent on the feature being assessed, e.g. drinking fountain versus swings or picnic tables versus wildlife garden.

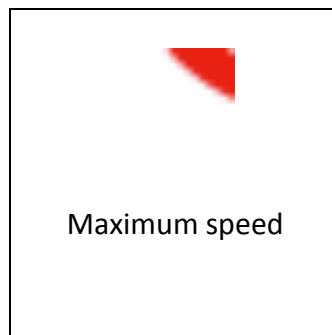
Notes on Assessment Items:

Access to the school

- Record grid references for each entrance to the school grounds. For each entrance mark whether it is for use by cars, pedestrians or cyclists (tick (☑) all that apply). When considering the use of the entrance, you should bear in mind what kind of access it appears to be *designed* for e.g. it may be possible to wheel a cycle through a narrow entrance with a chicane (an artificial narrowing or turn on a road or auto-racing course.), but this type of entrance would not be intended for cyclists.
- Normal speed limits for cars are given in **Error! Reference source not found.** However, alternate speed limits may be in place on the roads around the school. If this is the case there will be signs indicating what the local speed limit is. You may have to walk some way up and down the street to check these. **Error! Reference source not found.** shows some of the speed limit signs you might see, along with their meaning.

		Elsewhere	
	Build up areas (with street lighting)	Single carriageways (road with 1, 2 or more lanes arranged within a single roadway with no median to separate opposing flows of traffic)	Dual carriageways (two roadways for traffic travelling in opposite directions separated by a median)
Speed limit (kmph)	20-40	30-70	30-70

Normal speed limits (for cars)



Selected speed limit signs and meanings

The surrounding area

For items 3-10, tick 'yes' (☑) if the feature is visible from any of the school's entrances. (e.g. if you can see a bus stop from the main entrance, but not from any other entrance, tick yes). Only tick 'no' (☒) if the feature cannot be seen from any entrance.

3. This could be anywhere where it is possible for parents to stop for a short time even if parking is not permitted. This would include roads where there are no "No Stopping" signs.
4. This could be a layby, road, or car park where parents can park and leave their cars. Do not include roads, which are 'permit only' parking.
5. This may not be clearly labelled. If it is not labelled, potentially could informally ask a school official. Otherwise specify that it is not marked.
6. Cycle lanes separated from the road include shared footpath/cycle paths, which are for use by both cyclists and pedestrians and should be labelled as such.
7. Pavements include shared footpath/cycle paths
8. No additional notes
9. No additional notes
10. Signage:
 - a. School warning signs for road users are signs for road users warning them that there is a school nearby.



School Ahead Sign (cautionary sign)
(Source: Delhi Traffic Police)



Horn Prohibited
(Source: Delhi Traffic Police)

- b. Road safety signs are signs emphasising road safety, for pedestrians, cyclists, or drivers.



Compulsory Cycle Track
(Source: Delhi Traffic Police)



Pedestrians Prohibited
(Source: Delhi Traffic Police)

c. Route signs for cyclists are signs directing cyclists along specific routes



No Stopping or Standing
(Source: Delhi Traffic Police)



Cycle Crossing
(Source: Delhi Traffic Police)



Pedestrian Crossing
(Source: Delhi Traffic Police)

The School Grounds

For items 11-25 you are asked to assess the number and quality of the feature. Quality should be assessed in terms of the fitness for use of the feature. For example 'good' would indicate that the feature is well maintained with no damage visible, and is clearly fit for its purpose. An 'adequate' rating should be given to features that may show some damage/maintenance failure, but where this does not impair use. If an feature is damaged/ worn to the extent that it is no longer useable, or full fit for purpose, it should be given a 'poor' rating.

For example, when assessing a football pitch:

Good: Flat, grass well kept, lines clearly marked, posts and nets show no signs of damage

Adequate: Mostly flat, lines visible, goals and nets not badly damaged (e.g. a bit of chipped paint/small holes)

Poor: Uneven ground, large bare patches, lines not visible in places, goals badly damaged.

11. No additional notes

12. Include individual stand-alone pieces of equipment only. (see item 22, Assault course, for sequences of equipment)

a. This study is focusing on middle and high schools and so this question may not be relevant for this age group. Some middle and high schools have grades 1-5 and so those schools will probably have this playground equipment present. If this is present, then utilization is usually restricted for children in grades 1-5 and so the older kids cannot use it. Schools that do not have grades 1-5, most probably will not have this playground equipment.

i. Basically, for the audit, mark this question as is stated on the tool. In the discussion portion of the write up, it will be an important point to make when describing the data. We would need to clarify that the lack of presence of playground equipment is not necessarily a negative aspect of school grounds in terms of the built physical activity environment because it is not common to have this kind of equipment for the adolescent age group; and, for the schools that have the presence of this kind of equipment, we may need to mention that it is most probably only utilized by students in grades 1-5.

13. Include only pitches that are marked and/or have associated furniture (e.g. goals)

14. No additional notes.

15. Include all marked courts, even where they overlap (e.g. a netball court with three tennis courts marked across it would count as 4 courts.)
16. No additional notes.
 - a. In the team discussion, it was mentioned that these might not be common. For this audit, we will leave this on there and if it is not common then that will just be recorded through the audits.
17. No additional notes.
 - a. In the team discussion, it was mentioned that these might not be common. For this audit, we will leave this on there and if it is not common then that will just be recorded through the audits.
18. Water coolers may be present inside schools. For this audit, we are only interested in water coolers that are accessible from the outside of the school
19. A wildlife garden should be maintained as such (e.g. it should not just be a wild part of the grounds). It does not need to be freely accessible to be included here.
 - a. Wildlife garden: An environment that is attractive to various forms of wildlife such as birds, amphibians, reptiles, insects; usually contains a variety of habitats that have either been deliberately created by the gardener or allowed to self-establish by minimizing maintenance and intervention (Source: National Wildlife Magazine 2010).
20. Record the number of cycle spaces provided, rather than the number of stands, for each of these categories.
 - a. The parking may not contain bike racks as is typically thought of in the West. This parking may just be flat land with no specific line designations.
21. Record the number of cycle spaces provided, rather than the number of stands, for each of these categories.
 - a. The parking may not contain bike racks as is typically thought of in the West. This parking may just be flat land with no specific line designations.
22. An assault course refers to a sequence of pieces of equipment designed to be used together.
 - a. Assault course: also called trim trail or obstacle course: special sort of trail that combines running and exercising; these can include balance beams, sit-up bars, parallel bars and others (Source: Google).
 - b. This may not be very common for schools here but we will leave this on the audit
23. If the school has a quadrangle it will be enclosed by the school buildings and may not be visible from the grounds. Look at the map to see whether a quadrangle is present.
 - a. If school map is not available, determine if it is visible on the Google map.
 - b. If cannot determine it from either of these then specify that on the audit.
24. Some considerations: swimming pool, skating rink, common room (utilized for aerobic classes, yoga, martial arts, dance), indoor facilities like indoor badminton courts, platforms (for performing yoga outside) etc. Another important consideration is 'open field for indigenous games' – as discussed, for

adolescents, there are many games that do not need anything but a field (i.e., kabaddi, kho-kho, marbles)

- a. For the common room, consider it if it is visible from the outside. If not, then do not consider. But, it is important to mention in the discussion that there are common rooms for physical activity used by adolescents.

25. See #24 above

26. See #24 above

27. Specifically look for dog and cow waste

28. Split site: the middle school and high school are on different school grounds

29. No additional notes

30. A playground is a space for informal play. It does not include areas specifically designated for certain sports (e.g. tennis courts)

Aesthetics

Items 31-36 require you to assess how numerous various features are on a scale of 'none' to 'a lot'.

31. A planted bed is a clearly delineated area, upon which walking is restricted. 'A lot' of planted beds is enough that its presence impacts on the look and feel of the grounds. 'Some' is more than 'None' but less than 'A lot'.

32. Trees for sitting under are trees under which children could sit, either on the ground or on seating. 'A lot' of trees for sitting under is enough that its presence impacts on the look and feel of the grounds. 'Some' is more than 'None' but less than 'A lot'.

33. 'A lot' of ambient noise is enough to disturb or irritate you during your visit. 'Some' indicates that background noise can be heard, but not enough to irritate or disturb you during your visit.

34. 'A lot' of litter is enough that you are conscious of it most of the time. 'Some' is more than 'None' but less than 'A lot'. 'None' can include the very occasional piece of paper.

35. 'A lot' of 'Murals/outdoor art' is enough that they are visible on more than one wall or vertical structure. 'Some' is more than 'None' but less than 'A lot'.

36. 'A lot' of graffiti is enough that more than one wall or vertical structure has been tagged or fouled. 'Some' is more than 'None' but less than 'A lot'.

Usage

These items refer to the general usage of the grounds.

37. 'Very' means that the grounds are particularly suitable for that activity whilst 'somewhat' means that the activity could certainly be undertaken although the

conditions are imperfect. 'Not at all' means that it would be difficult and not at all enjoyable to undertake the activity. Sports require facilities like basketball hoops, tennis courts, pitches etc. Informal games do not require facilities but can be undertaken if the landscape is suitable

38. See above

39. School grounds are 'very' suitable for general play if they have different areas where children can play during break time. They are 'somewhat suitable' if there is a single restricted space for children to play in, and 'not at all' suitable if play space is very limited or absent.

Overall

These items relate to the perceptions and feel of the school grounds that you have built up during your visit and they should be answered last, shortly before you leave. Spend a little time relating your experience of the grounds to each statement before you decide which box to tick.

40. No additional notes

41. No additional notes

42. No additional notes

43. Mark and clearly label on the map where the different surfaces are located.

a. Tarmac is asphalt concrete; it is referred to as tar-penetration macadam

44. No additional notes

45. Additional comments.

If during the meeting with the principal, the principal says that the school uses community facilities for physical activity, then that would need to be clearly noted under #45. Then, it would be appropriate to complete the audit for the community facilities that are utilized.

During the team meeting, it was also mentioned that some schools transport students to other facilities (and it may not be feasible to go to that facility). Thus, it would be important to find this information from the principal and clearly note it.

The designations that are relative to each other (i.e., Good, Adequate, Poor) will need to be further defined after piloting.

9 Appendix C

School information sheet that was provided to every school about the research project:

SCHOOL INFORMATION SHEET

August 6, 2012

Principal,
School Address

Dear Principal,

Health Related Information Dissemination Amongst Youth (HRIDAY) is a non-profit organization engaged in school, home and community-based learning activities intended to promote health awareness and informed health action by school students. HRIDAY is collaborating with the Duke University (Duke Global Health Institute), USA to conduct a research project entitled "Assessing the Built Physical Activity Environment of Middle, Secondary, and Senior Secondary School Grounds in Delhi, India".

The intent of this study is to assess school grounds and how they support physical activity for adolescents. Physical inactivity is a risk factor for many non-communicable diseases (NCDs), which are diseases that have slow progression and/or long duration such as heart attacks, strokes, cancers, diabetes and other chronic diseases. A large part of the Indian population is affected by NCDs, which is projected to worsen (*World Health Organization: India Office*). Currently NCDs in India mostly affects individuals of higher socioeconomic status; but this is slowly shifting towards individuals of lower socioeconomic status. As a preventative measure, it is important to focus on reducing risk factors (such as physical inactivity) amongst adolescents.

This study will be conducted in middle, secondary and senior secondary private and government schools. The study consists of completing an observational assessment, the SPEEDY tool, on school grounds, but not inside the schools. The instrument documents characteristic of school grounds and assesses how well this supports adolescent's physical activity. It considers access to the school, the surrounding area, the school grounds, aesthetics, usage, and overall features of the school grounds. The instrument can be provided upon request. We will not need to enter the school classrooms or any office premises to conduct the observations.

At this time, we would like your permission to allow us to conduct this observational tool at your school grounds. The data obtained from this study will not specifically identify your school. Any reports stemming from this research will report only group-level data.

Description of the Study

Purpose: To assess the physical activity environment of school grounds of middle, secondary, and senior secondary private and government schools in Delhi, India.

Procedure: Subsequent to your approval for participation, we will conduct observations on school grounds. Completing these observations requires one observer from HRIDAY to be on school grounds outside of the school for about sixty minutes. If you feel more comfortable, a school administrator or teacher can accompany the observer while the observer is on school grounds.

The results of this study will provide insights for bettering physical activity facilities for school grounds.

Questions:

If you have any questions or concerns about the study, please feel free to call *Dr. Monika Arora*, at 46046012 or 64546720. We will be glad to assist you.

Sincerely,

Samiksha Tarun, Master's Candidate, Duke University

Dr. Monika Arora,
Senior Director,
HRIDAY
&
Head: Health Promotion and Tobacco Control,
Public Health Foundation of India

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