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Original Article

Development and Reliability of an Audit Tool to Assess the School Physical Activity Environment across 12 Countries

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Running head: ISCOLE School Audit Tool (ISAT)

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37 **Abstract**

38 **Background/Objectives:** Schools are an important setting to enable and promote physical activity.
39 Researchers have created a variety of tools to perform objective environmental assessments (or
40 “audits”) of other settings, like neighborhoods and parks; yet, methods to assess the school physical
41 activity environment are less common. The purpose of this study is to describe the approach used to
42 objectively measure the school physical activity environment across 12 countries representing all
43 inhabited continents, and to report on the reliability and feasibility of this methodology across these
44 diverse settings.

45 **Subjects/Methods:** The ISCOLE school audit tool (ISAT) data collection required an in-depth training
46 (including field practice and certification) and was facilitated by various supporting materials. Certified
47 data collectors used the ISAT to assess the environment of all schools enrolled in ISCOLE. Sites
48 completed a reliability audit (simultaneous audits by two independent, certified data collectors) for a
49 minimum of two schools or at least 5% of their school sample. Item-level agreement between data
50 collectors was assessed with both the kappa statistic and percent agreement. Inter-rater reliability of
51 school summary scores was measured using the intra-class correlation coefficient.

52 **Results.** Across the 12 sites, 256 schools participated in ISCOLE. Reliability audits were conducted at
53 53 schools (20.7% of the sample). For the assessed environmental features, inter-rater reliability
54 (kappa) ranged from 0.37 to 0.96; 18 items (42%) were assessed with almost perfect reliability (K:0.80–
55 0.96), and a further 24 items (56%) were assessed with substantial reliability (K:0.61–0.79). Likewise,
56 scores that summarized a school’s support for physical activity were highly reliable, with the exception
57 of scores assessing aesthetics and perceived suitability of the school grounds for sport, informal
58 games, and general play.

59 **Conclusions:** This study suggests that the ISAT can be used to conduct reliable objective audits of the
60 school physical activity environment across diverse, international school settings.

61 **Key Words:** children, school environment, physical activity, environmental audit, international

62 **Trial Registration:** ClinicalTrials.gov NCT01722500

63 INTRODUCTION

64 Childhood obesity is an escalating global epidemic that concerns public health professionals
65 worldwide.^{1,2} While levels of childhood overweight and obesity initially increased predominantly in high-
66 income countries, the prevalence is currently growing fastest in lower- and middle-income countries.³
67 Obesity results from an imbalance in energy expenditure (primarily physical activity) and energy intake
68 (food ingested); therefore, current efforts to prevent obesity focus on promoting higher levels of physical
69 activity and/or healthier diets.^{4,5}

70 Because of the large amount of time children spend in schools, schools have been identified as an
71 important setting to enable and promote physical activity and healthy eating.^{4,6-9} Current global
72 strategies recommend enhancing schools' support for physical activity and a healthy diet through
73 changes to their built, or physical, environments. The school built environment can be measured using
74 surveys or objective methods in order to identify features that influence these behaviors.¹⁰⁻¹⁷ While
75 surveys of school personnel are arguably easier to employ and are currently included as a component
76 of several studies,¹⁸ they can be burdensome for school staff, which may result in incomplete data, and
77 may be subject to biased and/or incomplete reporting of school amenities. Objective assessments
78 (often termed "audits") of the school built environment by study staff, on the other hand, pose little-to-no
79 burden on school personnel and result in complete and verified data for all schools. These objective
80 audits, however, are limited by the consistency with which the study data collectors assess the
81 availability and quality of features of the school environment.¹⁹

82 Researchers have created a variety of tools to perform objective environmental audits of other
83 settings, such as neighborhoods and parks; however, methods to assess the school environment are
84 less common.^{19,20} To date, the only published reports of audits of the school environment come from
85 two studies, both in developed countries (US and UK). The International Study of Childhood Obesity,
86 Lifestyle and the Environment (ISCOLE) targeted schools in its sampling scheme, and study staff
87 completed an environmental audit of each participating school.²¹ The purpose of this paper is to
88 describe the feasibility of using a single instrument (the ISCOLE school audit tool, or ISAT) to

89 objectively assess the physical activity environment in schools from 12 countries representing widely-
90 ranging levels of development and to report on the reliability of this methodology across these diverse
91 settings, in order to inform future global work to promote healthy school environments.

92 **METHODS**

93 **The International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE)**

94 ISCOLE collected data on obesity, physical activity, dietary patterns, and other lifestyle behaviors in
95 7 341 9-11-year-old children across 12 urban/suburban study sites.²¹ Each ISCOLE study site was
96 responsible for recruiting and enrolling at least 500 children, and the primary sampling frame was
97 schools, which was typically stratified by an indicator of socio-economic status in order to maximize
98 variability within sites.²¹ The Institutional Review Board at the Pennington Biomedical Research Center
99 (coordinating center) approved the overarching ISCOLE protocol, and the Institutional/Ethical Review
100 Boards at each participating institution also approved the local protocol. Written informed consent was
101 obtained from parents or legal guardians, and child assent was obtained as required by local
102 Institutional/Ethical Review Boards. Further details on the study methods are available in the
103 supplemental materials and elsewhere.²¹ Data were collected from September 2011 through December
104 2013.

105 **Development of the ISCOLE school audit tool (ISAT)**

106 The ISCOLE school audit tool (ISAT; see Supplementary file 1: ISCOLE School Audit Too (ISAT))
107 measured the following aspects of the school environment linked to physical activity: support for active
108 transportation; sports and play facility provision; other facility provision (e.g., benches, drinking
109 fountains); aesthetics; and perceived suitability of the school grounds for sport, informal games, and
110 general play. The component of the ISAT addressing the school built environment was largely based on
111 the school audit tool used in the SPEEDY (Sport, Physical activity and Eating behaviour: Environmental
112 Determinants in Young people) study.^{10,11} However, in some cases, response categories were altered
113 in an attempt to reduce potential subjectivity, and items were changed or added based on feedback
114 from site investigators. For example, an item to assess the presence of a vegetable garden was

115 added. Finally, the wording of choices, including examples of environmental features (e.g. “sidewalk”
116 vs “footpath”) and customary food items, were adapted to colloquial language and understanding as
117 necessary across ISCOLE sites.

118 **Training of ISAT data collectors**

119 Site principal investigators and key study staff were trained (and ultimately certified) in a series of
120 regional training sessions conducted by the ISCOLE Coordinating Center in advance of data collection
121 at each study site. Prior to the training, site personnel were expected to review all training materials and
122 to successfully pass an on-line examination designed to assess practical understanding of the ISAT
123 protocol and methods. Training sessions were conducted by experts and tool developers from the
124 ISCOLE Coordinating Center and incorporated a thorough review of the school audit protocol and
125 methodology (see Supplementary file 2: ISAT Manual of Procedures). Participants were encouraged to
126 ask questions and initiate discussion to enhance clarification. Additionally, trainees conducted a school
127 audit at a nearby school as a hands-on field-based training exercise and case study. School audit data
128 collectors were certified only after 1) completing on-line modules, 2) attending and participating during
129 all modules of the training, and 3) successfully completing the training school audit (evaluated by
130 achievement of satisfactory percent agreement on all measures relative to the expert who conducted
131 the training). Satisfactory agreement was defined as at least 89% agreement with the certifier on each
132 of the five sections of the ISAT.

133

134 **ISAT supporting materials**

135 The ISCOLE Coordinating Center developed materials and resources to support the school audit
136 and to assist with quality control of the data collected.

137 School aerial image and grid

138 To facilitate systematic completion of the ISAT, the ISCOLE Coordinating Center required that sites
139 obtain an aerial image of each study school’s entire school grounds (e.g. from Google Earth) and
140 overlay a pre-designed 10x10 grid with labels “A-J” on the x-axis and “1-10” on the y-axis (see Figure 1

141 for an example). Data collectors were instructed to visit each grid square within the school grounds map
142 and mark each as completed after the area was completely investigated. The map also served to allow
143 data collectors to indicate location-specific data regarding features of the built environment, such as the
144 location of entrances to the school.

145 ISAT worksheet

146 The school audit worksheet (see Supplementary file 3: ISAT Worksheet) was used by the data
147 collectors to write down the grid locations where specific school audit items were located. After visiting
148 all areas of the school grounds, the data collectors completed the ISAT based on the notes recorded on
149 the school audit worksheet.

150 ISAT questions sheet

151 During one of the early trainings, site personnel recommended that a “Questions Sheet” be
152 developed to assist school audit data collectors to record any questions arising during the audit (e.g.,
153 how a certain area is used) that would require clarification with school personnel. School audit data
154 collectors used the ISAT Questions Sheet to record such questions and to follow-up with the school’s
155 contact person or the ISCOLE Coordinating Center after the audit.

156 ISAT specific item dictionary

157 Each item in the school audit was defined in a document titled the “Specific Item Dictionary” (see
158 Supplementary file 4: ISAT Specific Item Dictionary). The definitions were developed by the ISCOLE
159 Coordinating Center and a new version of the dictionary was uploaded to the data management
160 website if an item definition was altered or updated. The dictionary also included tips and quality control
161 suggestions to reduce ambiguity of the item definitions and facilitate efficiency of school audit data
162 collection.

163 ISAT photodictionary

164 A photodictionary served as a pictorial resource to provide additional clarification for school audit
165 items (see Figure 2 for an example). The photodictionary was available to all study sites via the
166 ISCOLE data management website, and sites were encouraged to submit additional photos. Pictures in

167 the photodictionary displayed examples of real-world scenarios within the built environment that would
168 or would not be counted for particular school audit items.

169 ISAT forum

170 The ISCOLE data management website included a virtual/web-based forum for ISAT data collectors
171 to post questions and pictures if they were uncertain if and/or how to properly account for the feature or
172 item definition in question. The Coordinating Center experts, as well as other sites' school audit data
173 collectors, were expected to actively participate in forum discussions and ultimately come to a
174 consensus about the decision proposed for each question posted on the forum.

175 **Timing of ISAT data collection**

176 ISCOLE data collection occurred during the school year and covered all spanned seasons. ISAT
177 data collection for a particular school occurred at the same time as the other ISCOLE data collection at
178 that school, which ensured that the ISAT provided information on the school conditions concurrent with
179 the accelerometry.

180 **Assessing reliability of ISAT items**

181 For each ISCOLE site, a minimum of two schools or 5% of their school sample was simultaneously
182 and independently audited by two certified data collectors to assess inter-rater reliability of school audit
183 items, as well as to identify any local quality control issues related to data collection. In 10 of the 12
184 ISCOLE sites, the schools associated with the reliability audits were the first two schools at which
185 ISCOLE data collection occurred. In the other two ISCOLE sites (i.e., U.S. and Colombia), reliability
186 audits were performed for 67% and 95% of schools, respectively, with the reliability audit being
187 determined by the availability of a second data collector and the objectives of the ISCOLE site..

188 **Statistical analysis**

189 The ISAT collected information about availability and, in some cases, quality of various school
190 amenities. For analysis, responses were dichotomized to correspond to "present and functional" versus
191 "present and not functional or not available."

192 Item-level agreement between data collectors was assessed with both the kappa statistic and

193 percent agreement. Because of the multilevel nature of the data, the kappa statistic was calculated
194 using a regression technique,²² in which the regression models incorporated random effects
195 corresponding to the ISCOLE sites. Level of agreement was evaluated as follows based on the value
196 of the kappa statistic:²³ almost perfect (K 0.80–1.00), substantial (K 0.60–0.79), moderate (K 0.40–
197 0.59), fair (K 0.20–0.39), slight (K 0–0.19). Percent agreement was calculated as a weighted average
198 that gave equal weight to each study site (i.e., the two sites that conducted reliability audits in more
199 than two schools were not over-represented in the measure).

200 The results of the audit were also summarized as scores corresponding to the domains assessed
201 by the ISAT: support for walking to school; support for biking to school; provision of sports and play
202 facilities; provision of other features supporting physical activity; aesthetics; and perceived suitability of
203 the school grounds for sport, informal games, and general play. Each component score was calculated
204 as the sum of the items within each domain, with the following exceptions where two items measured
205 separately were treated as a single item in the component score: having an entrance
206 accessible/designed for pedestrians/cyclists (neither=0, accessible but not designed for=0.5, designed
207 for=1), pavements (i.e., sidewalks/footpaths) on one/both sides of the street (neither=0, one side=0.5,
208 both=1), bicycle lanes on/separated from the road (neither=0, on road=0.5, separated from the road=1),
209 and uncovered/covered bicycle parking (neither=0, uncovered=0.5, covered=1). For component scores,
210 reliability was summarized as the intra-class correlation coefficient (ICC; and associated 95%
211 confidence interval), which was calculated within an ANOVA framework as the ratio of the difference
212 between the between-school variation and the within-school (inter-rater) variation and the sum of the
213 variance components.²⁴ The ICC was summarized separately for those ISCOLE sites performing
214 reliability audits on the minimum of two schools within the site-specific sample and those sites that
215 performed reliability audits on the majority of their school samples. Agreement for the component
216 scores was evaluated as follows based on the value of the ICC:²⁵ excellent (ICC 0.80–1.00), good (ICC
217 0.60–0.79), fair (ICC 0.40–0.59), and poor (ICC 0–0.39). All analyses were conducted using SAS
218 version 9.4.

219

220

221 RESULTS

222 Across the 12 sites, 256 schools were audited as part of the ISCOLE study. Except for the China
223 and India sites, which enrolled six and ten schools, respectively, each site enrolled 24 schools on
224 average. Reliability audits were conducted in 53 schools (21% of the school sample). By site, this
225 ranged from 7% to 95% of schools.

226 While the ISCOLE study targeted 10-year-old children, the school settings for these children were
227 variable within and across sites (Table 1). Schools contained three to 16 grade levels, and the number
228 of children enrolled in the participating school ranged from 50 to 5 200.

229 Likewise, the availability of school features supportive of physical activity differed both across sites,
230 and across schools within a site (Table 2). However, some items (e.g., availability of pedestrian
231 entrances, presence of planted beds, and assessed suitability of the school grounds for general play)
232 showed little variability both within and between countries, with these features being present in over
233 90% of schools in the sample and in over 71% of each of the site-specific samples. Other items, like
234 the availability of running tracks, varied considerably between sites, but relatively little between schools
235 within a site. Across the school features assessed, only six varied across all site-specific samples
236 (bicycle parking, school warning signs, trees for sitting under, wildlife/nature gardens, murals/outdoor
237 art, and ambient noise).

238 Of the 43 items comprising a school's physical activity environment, 18 items (42%) were assessed
239 with almost perfect reliability (K:0.80–0.96), and a further 24 items (56%) were assessed with
240 substantial reliability (K:0.61–0.79) (i.e. a total of 98% of items had substantial to almost perfect
241 reliability) (Table 3). Only one item (suitability of school grounds for general play) was not reliably
242 assessed (K=0.37). Across all items, percent agreement between the two local data collectors ranged
243 from 83.9% to 100%.

244 Reliability was good to excellent for scores corresponding to the following domains assessed by the

245 ISAT: support for walking to school, support for biking to school, provision of sports and play facility,
246 and provision of other features supporting physical activity (Table 4). Although the reliability of the
247 scores for aesthetics and perceived suitability of the school grounds was excellent across the ten
248 ISCOLE sites that performed reliability audits in two schools, the reliability for these schools was lower
249 in the two ISCOLE sites that performed reliability audits in the majority of their schools.

250 On average, school audits took 57 minutes to complete, ranging from 15 to 160 minutes. The time
251 to complete the audit increased with the number of students at the school and declined over time (data
252 not shown), presumably as data collectors became more familiar with the method. For example, for an
253 average-sized school, a site's first school audit took an average of 61 minutes to complete, while a
254 school audit completed six months later took an average of 51 minutes to complete.

255 **DISCUSSION**

256 This study supports that it is possible to conduct reliable objective audits across international
257 settings of features of the school built environment related to physical activity. Nearly all features of the
258 school environment were assessed with high reliability. Likewise, scores that summarized a school's
259 support for physical activity were highly reliable, with the exception of scores assessing aesthetics and
260 perceived suitability of the school grounds for sport, informal games, and general play.

261 Our results are similar to those of two other studies that have reported on the development of
262 school audit tools. Jones et al.¹¹ tested the reliability of the SPEEDY instrument in 17 schools in
263 Norfolk, UK, and Lee et al.¹⁶ assessed reliability of the TCOPPE instrument in 12 schools in Texas, US.
264 Both studies report moderate to excellent reliability for items, with the exception of items measured with
265 ordinal (Likert) responses and those requiring data collectors to subjectively rate their perceptions (e.g.,
266 attractiveness, quality).

267 A unique feature of this study is the diversity of school settings in which the ISAT was used; to our
268 knowledge, this is the first study to conduct objective audits of the school environment in less-
269 developed countries. A further strength of this study is the large sample size of schools that contributed
270 to the reliability estimates. Prior studies^{11,16} noted low variability in some measures, which limited

271 assessment of reliability. In contrast, because the current study assessed school environments across
272 widely different settings, all items showed some variability, whether within or between sites. However,
273 the current study is limited by the fact that inter-rater reliability of school audit items was the only
274 reliability measure evaluated. Lee et al.¹⁶ also measured test-retest reliability to assess the stability of
275 the item measures over time and reported good-to-outstanding test-retest reliability in their use of the
276 TCOPPE instrument in Texas schools. While not investigated formally within ISCOLE, feedback from
277 ISCOLE data collectors suggests that in countries with high seasonal variation, test-retest reliability for
278 particular audit items measured across seasons would likely be low. For example, in a country with
279 high amounts of winter snow accumulation, a feature like the presence of bright marking on play
280 surfaces could be assessed as “functional” some of the year; however, a data collector would be
281 unable to determine its presence if covered by snow, and would therefore consider it “not present.”
282 Similarly, there may be features present during winter, like snow hills, that are not present during other
283 seasons. Measures derived from a school audit are generally used in two ways: to summarize the
284 overall healthfulness of a school’s environment (e.g., the number of features supportive of physical
285 activity that the school provides its students), and to provide objective measures of the school
286 environment against which concurrent levels of student physical activity can be evaluated for
287 associations. In situations like the examples provided above, a single point-in-time audit may not
288 suffice for both intended uses if high seasonal variability occurs across the measurement of
289 participating schools. An additional limitation of the current study is the fact that the reliability schools
290 were generally the first two participating schools. This approach was chosen so that potential
291 measurement issues could be identified and resolved early in the data collection process; however,
292 because the reliability audits occurred most proximate to the training, this may have biased reliability
293 estimates upward. If, on the other hand, reliability improves with time and experience, then these
294 estimates may be considered conservative. Within the two sites with more than two reliability audits,
295 there was no evidence of drift, or a decline in consistency over time, between the two data collectors
296 (data not shown).

297 The current study did not assess relationships between in-school physical activity and the assessed
298 features. The SPEEDY instrument on which the ISAT was based showed good construct validity,
299 however, being able to differentiate the most supportive and least supportive schools on the basis of
300 child physical activity levels. Besides construct validity, the amount of variability in an item, or
301 component, affects the relationship with physical activity. In the current study, the availability of school
302 features supportive of physical activity differed both across sites, and across schools within a site, and
303 several items showed little within-site variability. Therefore, it is likely that the relationships between
304 specific features of the school environment and in-school physical activity may differ across countries.

305 ISCOLE used several strategies to promote high reliability: data collectors were required to be
306 certified after completing a rigorous training, the audit was supported by the availability of specific item
307 definitions and a photodictionary to reduce ambiguity or subjectivity in scoring of features, data
308 collectors used a school map and grid to facilitate a systematic approach to the audit, and a forum was
309 available that encouraged questions and discussions about situations requiring clarification. Despite
310 differences in local expertise and resources, all ISCOLE sites were able to conduct the school audit
311 according to protocol. This success suggests that the ISAT is feasible to include in future research on
312 child health, and the ISAT results for the 12 sites represented in ISCOLE provide a valuable benchmark
313 for this future work.

314 **CONCLUSIONS**

315 The ISAT is the first instrument to objectively assess the physical activity environment in a global
316 sample of schools. The ISAT is feasible to implement across diverse, international settings and
317 provides reliable information about aspects of the school environment thought to be supportive of
318 physical activity. The availability of a single audit instrument suitable for use in schools around the
319 world can facilitate global work to promote healthy school environments. Future research will evaluate
320 associations between measures derived from the school audit and children's in-school physical activity.

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328

329 **Conflicts of Interest**

330 MF has received a research grant from Fazer Finland and has received an honorarium for speaking for
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395 **Figure Legends**

396 **Figure 1.** Aerial image of participating ISCOLE school with grid overlay

397 **Figure 2.** Example page from ISAT photodictionary

Supplementary files**Supplementary file 1:** ISCOLE School Audit Tool (ISAT)**Supplementary file 2:** ISAT Manual of Procedures**Supplementary file 3:** ISAT Worksheet**Supplementary file 4:** ISAT Specific Item Dictionary

Table 1. Descriptive characteristics of schools participating in ISCOLE

Country (Site)	N (schools)	N (reliability schools)	No. of days per year students attend school, mean (SD)	No. of students per school, mean (SD) [range]	No. of grades at school, %			No. of students per grade, mean (SD)
					3-6	7-8	9-16	
Australia (Adelaide)	26	2	195.3 (4.4)	404.5 (308.0) [50 – 1200]		81%	19%	43.8 (27.1)
Brazil (Sao Paulo)	24	2	200.3 (1.2)	717.7 (572.0) [136 – 2900]	21%	29%	50%	85.5 (46.7)
Canada (Ottawa)	26	2	190.8 (5.5)	388.7 (191.8) [165 – 894]		81%	19%	50.0 (21.3)
China (Tianjin)	6	2	195.8 (9.2)	1660.3 (820.8) [700 – 2900]	100%			276.7 (136.8)
Colombia (Bogota)	20	19	197.8 (7.3)	1572.8 (825.0) [441 – 3400]			100%	127.2 (67.5)
Finland (Helsinki, Espoo & Vantaa)	25	2	190.0 (7.6)	426.3 (142.1) [172 – 760]	68%	4%	28%	62.2 (18.3)
India (Bangalore)	10	2	215.5 (43.2)	1860.0 (1464.4) [440 – 5200]	10%		90%	140.6 (98.6)
Kenya (Nairobi)	29	2	193.1 (38.2)	865.2 (511.1) [120-1800]	10%	21%	69%	103.4 (62.1)
Portugal (Porto)	23	2	165.7 (13.9)	781.5 (309.1) [239 – 1598]	56%	35%	9%	127.1 (55.4)
South Africa (Cape Town)	20	2	203.4 (4.8)	822.5 (326.5) [320 – 1350]	5%	80%	15%	107.3 (53.1)
United Kingdom (Bath & NE Somerset)	26	2	190.5 (4.5)	293.1 (141.6) [90 – 720]	19%	81%		46.9 (31.4)
United States (Baton Rouge)	21	14	179.2 (1.7)	620.5 (300.2) [235 – 1374]		76%	24%	74.2 (25.1)

Table 2. Availability of school features related to opportunities for physical activity

	Overall	Aus.	Brazil	Can.	China	Col.	Finland	India	Kenya	Port.	S. Afr.	UK	US
Walking provision													
Has entrance designed for pedestrians ¹	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	95%	100%	71%
Pavements ¹	87%	96%	100%	100%	83%	95%	100%	60%	31%	96%	90%	100%	81%
Marked pedestrian crossings ¹	64%	81%	88%	69%	50%	45%	100%	50%	7%	96%	85%	23%	76%
Traffic calming ¹	41%	50%	29%	35%	0%	45%	72%	60%	31%	57%	40%	38%	10%
School warning signs ¹	65%	92%	75%	96%	50%	65%	80%	60%	10%	48%	30%	69%	95%
Road safety signs ^{1,†}	39%	92%	54%	77%	50%	0%	36%	70%	3%	9%	30%	19%	52%
Cycling provision													
Has entrance designed for cyclists ¹	51%	62%	29%	8%	100%	50%	76%	100%	3%	87%	5%	96%	67%
Cycle lanes separated from the road ¹	19%	38%	4%	4%	67%	10%	100%	0%	0%	0%	10%	12%	5%
Pavements ¹	87%	96%	100%	100%	83%	95%	100%	60%	31%	96%	90%	100%	81%
Marked pedestrian crossings ¹	64%	81%	88%	69%	50%	45%	100%	50%	7%	96%	85%	23%	76%
Traffic calming ¹	41%	50%	29%	35%	0%	45%	72%	60%	31%	57%	40%	38%	10%
School warning signs ¹	65%	92%	75%	96%	50%	65%	80%	60%	10%	48%	30%	69%	95%
Road safety signs ¹	39%	92%	54%	77%	50%	0%	36%	70%	3%	9%	30%	19%	52%
Route signs for cyclists ¹	16%	8%	8%	23%	0%	5%	92%	0%	0%	0%	5%	12%	19%
Cycle parking ²	49%	96%	8%	46%	17%	35%	84%	50%	3%	61%	20%	85%	57%
Sports and play facilities													
Bright markings on play surfaces ³	52%	92%	54%	54%	17%	35%	56%	0%	24%	48%	30%	92%	57%
Playground equipment ²	59%	100%	38%	42%	33%	40%	100%	60%	45%	0%	90%	42%	100%
Outdoor sports fields ³	60%	77%	4%	23%	100%	25%	64%	100%	97%	91%	50%	73%	52%
Running track ³	19%	15%	0%	0%	100%	0%	8%	100%	0%	91%	0%	15%	5%
Paved courts for sport ³	68%	100%	100%	23%	67%	85%	24%	100%	28%	91%	70%	88%	71%
Assault course/fitness course ³	16%	8%	4%	0%	33%	20%	0%	20%	7%	0%	0%	88%	24%
Outdoor paved area ³	84%	100%	75%	73%	17%	95%	64%	100%	66%	100%	90%	100%	95%
Grassy/soft surface play area ³	73%	100%	17%	69%	0%	65%	84%	100%	100%	35%	70%	92%	100%
Other facility provision													
Benches ²	79%	100%	83%	77%	50%	75%	95%	90%	41%	100%	35%	100%	90%
Picnic tables ²	45%	96%	96%	35%	17%	15%	21%	0%	7%	22%	20%	88%	67%
Drinking fountains ²	59%	100%	96%	0%	50%	5%	60%	100%	62%	65%	60%	31%	95%
Wildlife/nature gardens ³	30%	35%	54%	4%	50%	5%	4%	50%	24%	78%	5%	46%	33%
Vegetable gardens ³	39%	73%	17%	8%	0%	25%	4%	20%	55%	74%	25%	73%	43%
Aesthetics													
Planted beds ⁴	91%	100%	75%	81%	100%	90%	88%	100%	93%	100%	95%	96%	90%
Trees for sitting under ⁴	74%	96%	46%	85%	67%	55%	16%	90%	83%	87%	80%	96%	90%

Ambient noise ⁴	25%	27%	8%	31%	33%	60%	24%	20%	28%	43%	5%	8%	19%
Litter ⁴	34%	19%	25%	19%	0%	15%	48%	30%	41%	100%	30%	0%	57%
Murals/outdoor art ⁴	62%	81%	88%	35%	50%	70%	32%	60%	62%	65%	60%	81%	48%
Graffiti ⁴	21%	12%	13%	38%	0%	60%	32%	60%	3%	35%	0%	0%	10%
Suitability of school grounds													
For sport ⁵	83%	100%	92%	38%	100%	95%	88%	80%	97%	87%	60%	85%	81%
For informal games ⁵	91%	100%	83%	73%	50%	90%	100%	80%	97%	96%	95%	100%	95%
For general play ⁵	96%	100%	92%	77%	83%	100%	100%	80%	100%	100%	100%	100%	100%

Response categories for items:

¹ Yes/No

² Assessed as Number of examples, Overall quality of features (1= Entirely or almost entirely broken down and non-functional to 5 = 100% or almost 100% functional), or Not Available; Recoded for analysis as Present and Functional (i.e., Number of examples>0 and Quality>1) vs. Present and Non-Functional

³ Assessed as Present and Functional, Present and Non-Functional, or Not Available; recoded for analysis as Present and Functional (1) vs. Present and Non-Functional or Not Available (0)

⁴ Assessed as None vs. Some/A lot

⁵ Assessed as Not at all vs. Somewhat/Very

† Road safety signs did not include normal traffic signs like stop signs.

Table 3. ISAT inter-rater reliability

School grounds component/item	Kappa	Agreement
Walking provision		
Has entrance accessible for pedestrians	0.66	99.4%
Has entrance designed for pedestrians	0.75	98.8%
Pavements on one side of the street	0.92	99.1%
Pavements on both sides of the street	0.93	99.1%
Marked pedestrian crossings	0.77	93.3%
Traffic calming	0.72	92.7%
School warning signs	0.69	85.6%
Road safety signs	0.61	83.9%
Cycling provision		
Has entrance accessible for cyclists	0.67	90.6%
Has entrance designed for cyclist use	0.74	96.3%
Cycle lanes on the road	0.79	99.4%
Cycle lanes separated from the road	0.80	100.0%
Pavements on one side of the road	0.92	99.1%
Pavements on both sides of the road	0.93	99.1%
Marked pedestrian crossings	0.77	93.3%
Traffic calming	0.72	92.7%
School warning signs	0.69	85.6%
Road safety signs	0.61	83.9%
Route signs for cyclists	0.83	95.2%
Covered cycle parking	0.91	100.0%
Uncovered cycle parking	0.91	100.0%
Sports and play facilities		
Bright markings on play surfaces	0.89	94.6%
Playground equipment	0.82	91.2%
Outdoor sports fields	0.79	90.0%
Running track	0.87	99.4%
Paved courts for sport	0.63	89.0%
Assault course/fitness course	0.94	99.6%
Outdoor paved area	0.85	99.6%
Grassy/soft surface play area	0.78	94.5%
Other facility provision		
Benches	0.96	95.8%
Picnic tables	0.96	100.0%
Drinking fountains	0.91	95.8%
Wildlife/nature gardens	0.82	94.6%
Vegetable gardens	0.96	99.4%
Aesthetics		
Planted beds	0.64	98.4%
Trees for sitting under	0.64	94.2%
Ambient noise	0.64	93.1%
Litter	0.70	91.8%
Murals/outdoor art	0.63	84.2%
Graffiti	0.69	92.7%
Suitability of school grounds		
For sport	0.61	93.3%
For informal games	0.66	98.7%
For general play	0.37	95.0%

Table 4. ISAT reliability of scores summarizing components of the school environment

School grounds factor or subscale	Mean (SD) (n = 256)¹	ICC (95% CI) (n = 33)²	ICC (95% CI) (n = 20)³
Walking provision (6 items)	3.9 (1.5)	0.75 (0.56, 0.87)	0.73 (0.38, 0.90)
Cycling provision (9 items)	4.2 (2.0)	0.83 (0.69, 0.91)	0.87 (0.66, 0.95)
Sports and play facilities (8 items)	4.3 (1.7)	0.86 (0.74, 0.93)	0.82 (0.55, 0.93)
Other facility provision (5 items)	2.5 (1.4)	0.97 (0.94, 0.98)	0.93 (0.81, 0.98)
Aesthetics (6 items)	3.1 (1.1)	0.46 (0.15, 0.69)	0.88 (0.69, 0.96)
Suitability of school grounds (3 items)	2.7 (0.7)	0.35 (0.02, 0.61)	1.00

¹ Mean (SD) of component scores across entire ISCOLE school sample

² Reliability of component scores within the sample of reliability schools from two ISCOLE sites that performed reliability audits on the majority of schools in the sample.

³ Reliability of component scores within the sample of reliability schools from ten ISCOLE sites that performed reliability audits on two schools within each site-specific sample.

Figure 1. Aerial image of participating ISCOLE school with grid overlay



Figure 2. Example page from ISAT photodictionary

10. Signage
a. School warning signs for road users



Sign indicating presence of a school near a school entrance (US)



Sign indicating presence of a school (UK)



Sign indicating presence of a school (India)