Health-related Measures of 6- and 10-year-old Irish Primary School Children by Sex and School Socio-economic Status

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Objective: This paper provides an assessment of the health status of Irish children, across sex and school socio-economic status (SES). Methods: Children (N = 655) from 10 schools participated in the evaluation, whereby body composition, blood pressure, cardiorespiratory fitness and physical activity measures were recorded. Results: Children from low SES schools had larger waists and slower run times (p < .05) than children from middle/high SES schools. Six-year-old children from low SES schools had higher body mass index (BMI) scores and resting heart rates; they also were more likely to be overweight or obese (p < .01) compared to their middle/high SES counterparts. Conclusions: Policy efforts to improve the health of Irish children should prioritize low SES schools.

Key words: child health status; body composition; blood pressure; child fitness; physical activity; body mass index (BMI)

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SES and objective markers of health (anthropometry, blood pressure, fitness and PA) of children, particularly younger age groups (5-6-year-olds).

The purpose of this study is to: (1) assess selected measures of health among Irish 6- and 10-year-old primary school children; and (2) compare these measures across sex and school SES. Such data will help to inform the status and effectiveness of existing policies and practices intended to improve the health of Irish children; moreover, they could potentially support the design of new policies to those most at need. The findings also will provide baseline measures to inform an Irish school-based health promotion intervention entitled: 'Project Spraoi' (http://projectspraoi.cit.ie).

**METHODS**

**Sampling Framework**

Information about the Project Spraoi initiative, including design, protocol, and sampling has been published elsewhere. It is derived from a New Zealand (NZ) school-based health promotion intervention entitled 'Project Energize,' (www.projectenergize.org.nz) which has shown measurable improvements in the health of NZ children. Briefly, descriptive data relating to all mainstream primary schools in Cork City and County Cork were obtained from the Department of Education and Skills website (www.education.ie/en/) in 2013. Schools were stratified by sex (male, female, or mixed), low SES versus middle/high SES, area of residence (urban or rural), school size (number of pupils), and proximity (<20km) to the research institute (Cork Institute of Technology, Ireland). Within Ireland, Cork is the largest and most southerly of the 32 counties, accounting for 11% of the population. Children in Cork are found to have similar health characteristics to those from the rest of Ireland.

Principals of stratified schools were contacted and a full outline of the study’s aim, proposed procedures and the requirement for evaluation measures were discussed. Ten schools that expressed a willingness to participate that were not currently participating in another PA and/or healthy eating/nutrition intervention were recruited, using a convenience sampling approach. Although the study is limited in that schools were selected via convenience sampling, all mainstream school types in Cork and Ireland (urban, rural, single-sex girls, single-sex boys, mixed, low SES and middle/high SES) were represented. Three of the participating schools (30%) were classified as being from areas of low SES; having schools above the national figure of 21% allows for reduced class size in low SES schools. Low SES schools in Ireland are referred to as DEIS (delivering equality of opportunity in schools) under the Department of Education and Skills school support program and are classified based on a combination of parent employment status, local authority accommodation (social housing for people who cannot afford to buy their own homes), lone parenthood, travelers (community within Ireland who are traditionally nomadic), free book grants (funding provided to schools for assistance with books) and large families.

**Participants**

A total of 655 children (6-year-olds, \( N = 332 \); 10-year-olds, \( N = 323 \)) from 10 Cork schools participated (52.8% boys; 47.2% girls). These age groups were chosen on the basis that: (1) they mark sensitive periods of growth for the child (mid-childhood & early adolescence); and (2) they allow for international comparison with children evaluated through Project Energize. Of the 655 children, 26.7% attended schools classified as low SES under the Department of Education and Skills school support program.

**Testing Protocol and Measures**

Most Project Energize evaluation methods (anthropometric and physiological) were replicated. In addition, objective accelerometer-measures of PA and sedentary behavior (SB) in a subset of participants (\( N = 442 \)) were collected. All measures were conducted by a team of 5 researchers that were trained in health-related data collection techniques.

International Obesity Task Force age and sex-specific BMI criteria were used to categorize children as thin, normal weight, overweight, or obese and waist circumference percentiles were used to estimate overweight and obesity, using the 85th and 95th percentiles, respectively. Time taken to complete a 550m run was performed on an outdoor surface (grass, artificial turf, weather-synthetic track), after the completion of the anthropometric and physiological test battery.
PA and SB were objectively measured over 7 days using Actigraph triaxial accelerometers (MTI model 7164, Fort Walton Beach, FL) at 30Hz/5 second epochs, on a subsample of 442 children. The minimum wear time criteria was a 600-minute/day threshold, on 3 or more separate days, which has been shown to give adequate reliability and power. Non-wear time was defined as 20 consecutive minutes of zero counts. Minutes of PA of different intensities was calculated using cut points developed by Evenson et al with children of similar ages. Outcome variables calculated for the current study were mean daily minutes in sedentary, low, moderate and vigorous PA. Adherence to the recommended PA guidelines was based on the proportion of children achieving 60 minutes of MVPA per day.

**Data Analysis**

All data were analyzed using IBM SPSS (Statistical Package for Social Studies), Version 22. Data were explored for normality using descriptive statistics, histograms, and Kolmogorov-Smirnov or Shapiro-Wilk normality tests. Means and standard deviations (SD) were calculated for all continuous variables and frequencies were used to summarize categorical variables. Twelve participants were ex-

### Table 1
Mean and Standard Deviation (SD) of Continuous Variable and Percentage of Categorical Variables by Age Cohort and Sex

<table>
<thead>
<tr>
<th>Variable</th>
<th>6-year-old children</th>
<th></th>
<th>10-year-old children</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>Boys</td>
<td>Girls</td>
</tr>
<tr>
<td>Age (years)</td>
<td>N 163</td>
<td>Mean ± SD 6.1 ± 0.4</td>
<td>N 169</td>
<td>Mean ± SD 6.1 ± 0.5</td>
</tr>
<tr>
<td>BMI (kg/m)</td>
<td>N 163</td>
<td>Mean ± SD 16.33 ± 1.60</td>
<td>N 167</td>
<td>Mean ± SD 16.48 ± 2.03</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>N 162</td>
<td>Mean ± SD 54.7 ± 4.2</td>
<td>N 167</td>
<td>Mean ± SD 54.3 ± 5.1</td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>N 148</td>
<td>Mean ± SD 101.1 ± 10.2</td>
<td>N 155</td>
<td>Mean ± SD 102.3 ± 9.5</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>N 148</td>
<td>Mean ± SD 58.7 ± 9.0</td>
<td>N 154</td>
<td>Mean ± SD 61.3 ± 9.6</td>
</tr>
<tr>
<td>Resting HR (bpm)</td>
<td>N 148</td>
<td>Mean ± SD 87.9 ± 11.3</td>
<td>N 154</td>
<td>Mean ± SD 89.7 ± 11.9</td>
</tr>
<tr>
<td>Run Time (secs)</td>
<td>N 153</td>
<td>Mean ± SD 211.0 ± 26.8</td>
<td>N 154</td>
<td>Mean ± SD 228.4 ± 33.5</td>
</tr>
<tr>
<td>MVPA (mins)</td>
<td>N 62</td>
<td>Mean ± SD 64.7 ± 14.4</td>
<td>N 67</td>
<td>Mean ± SD 57.7 ± 16.4</td>
</tr>
<tr>
<td>Sedentary (hrs)</td>
<td>N 62</td>
<td>Mean ± SD 7.5 ± 0.9</td>
<td>N 67</td>
<td>Mean ± SD 7.7 ± 0.9</td>
</tr>
<tr>
<td>% Overweight &amp; Obese (BMI)</td>
<td>N 26</td>
<td>% 16.0</td>
<td>N 33</td>
<td>% 19.8</td>
</tr>
<tr>
<td>% Overweight &amp; Obese (WC)</td>
<td>N 30</td>
<td>% 18.5</td>
<td>N 33</td>
<td>% 19.8</td>
</tr>
<tr>
<td>% Achieving 60 mins MVPA</td>
<td>N 37</td>
<td>% 59.7</td>
<td>N 30</td>
<td>% 44.8</td>
</tr>
</tbody>
</table>

**Note.**

a: BMI – Body mass index
b: WC – Waist circumference
c: BP – Blood pressure
d: HR – Heart rate
e: MVPA – Moderate to vigorous physical activity
cluded from the BP measurements due to values falling outside the testing protocol on 2 or more occasions and 2 participants were excluded from the cardiorespiratory fitness test measurement due to physical disability. Missing values for all other measurements were due to children being absent on the day of testing. Levene’s test was used as criteria for satisfying the assumption of homogeneity of variance.

A 2-way between-group analysis of variance (ANOVA) explored differences across sex and school classification and was followed up with Bonferroni-corrected post hoc tests to explore subgroup differences. Data are presented as mean ± SD and 95% confidence intervals. A chi-square test compared categorical variables across sex and school classification. All statistical testing was performed at a .05 level of significance and effect size was reported using partial eta squared.

RESULTS

Overview of Health Status

Anthropometric, physiological, and behavioral measures are summarized by age cohort and sex in Table 1. Overall, 129 (58.1%) 6-year-olds and 147 (66.8%) 10-year-olds achieved the minimum accelerometer wear time criteria, respectively. Among 6-year-olds, girls recorded 57.7 ± 16.4 minutes of MVPA per day, and boys recorded 64.7 ± 14.4 mean minutes of MVPA per day. The 10-year-old boys recorded 64.3 ± 20.0 minutes of MVPA per day and 10-year-old girls recorded 48.6 ± 16.7 minutes of MVPA per day.

Categories of selected health-related measures are presented in Table 1. A total of 16.0% of 6-year-old boys and 19.8% of 6-year-old girls were overweight and obese. Among 10-year-old children, 17.9% of boys and 24.3% of girls were overweight and obese. Based on waist circumference centiles, 14 the

<table>
<thead>
<tr>
<th>6-year-old children</th>
<th>10-year-old children</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
<td><strong>Mean ± SD [95% CI]</strong></td>
</tr>
<tr>
<td><strong>BMI</strong> (kg/m²)</td>
<td>163</td>
</tr>
<tr>
<td><strong>WC</strong> (cm)</td>
<td>162</td>
</tr>
<tr>
<td><strong>Systolic BP</strong> (mmHg)</td>
<td>148</td>
</tr>
<tr>
<td><strong>Diastolic BP</strong> (mmHg)</td>
<td>148</td>
</tr>
<tr>
<td><strong>Resting HR</strong> (bpm)</td>
<td>148</td>
</tr>
<tr>
<td><strong>Run Time</strong> (secs)</td>
<td>153</td>
</tr>
<tr>
<td><strong>MVPA</strong> (mins)</td>
<td>62</td>
</tr>
<tr>
<td><strong>Sedentary Time</strong> (hrs)</td>
<td>62</td>
</tr>
</tbody>
</table>

Note:
- a: BMI – Body mass index
- b: WC – Waist circumference
- c: BP – Blood pressure
- d: HR – Heart rate
- e: MVPA – Moderate to vigorous physical activity
prevalence of overweight and obesity was 19.1% for the 6-year-olds and 25.1% for the 10-year-olds. A total of 59.7% of 6-year-old boys versus 44.8% of 6-year-old girls and 53.5% of 10-year-old boys versus 19.7% of girls met daily MVPA recommendations.

**Comparison of the Health-related Measures among Boys and Girls**

Across both age categories, boys completed the 550m run in a faster time, had higher mean minutes of daily MVPA, and lower mean hours of daily sedentary time, in comparison to girls (p < .05), (Table 2). Ten-year-old boys were found to have lower resting heart rates than their female counterparts (p = .003); although this trend was not evident in the 6-year-old group (p = .106).

**Comparison of the Health-related Measures among Children in Low SES Schools versus Middle/High SES Schools**

Children from low SES schools had higher waist circumferences and slower run times compared to children from middle/high SES schools, and this trend was evident in both the 6- and 10-year-old groups (p < .05). Among 6-year-old children, body mass, BMI and resting heart rate were higher in the low SES cohort (p < .05). Among 10-year-old children, MVPA was significantly higher among low SES children compared to middle/high SES children (p < .05) (Table 3).

**Post hoc Comparisons**

Where statistically significant differences were found (Tables 2 and 3), follow-up post hoc tests (Ta-
ble 4) revealed that girls from low SES schools had significantly lower systolic BP than girls from middle/high SES schools (p = .011). In middle/high SES schools, boys had significantly lower systolic BP than girls (p = .033). Boys completed the run in a faster time in comparison to girls, regardless of school type. Girls attending middle/high SES schools were significantly faster than girls attending low SES schools (p < .0005) and boys from low SES schools had significantly higher MVPA (9.3 minutes; p = .001) than girls from low SES schools. Additionally, low SES boys had significantly higher MVPA (9.3 minutes; p = .038) than middle/high SES boys.

BMI Categories by Sex and School Classification
Six-year-olds attending low SES schools were more likely to be overweight and obese compared to their middle/high SES counterparts (28.1% vs 14.1%; p = .005). No statistically significant difference in levels of overweight and obesity was found among 6- and 10-year-old participants across sex or among 10-year-olds across school classification (Table 5).

PA Guidelines by Sex and School Classification
Ten-year-old girls were least likely to achieve the recommended 60 minutes of daily MVPA, with only 19.7% reaching the threshold in comparison to 53.5% of 10-year-old boys (p < .0005). A higher percentage of 10-year-old children in low SES schools (55.4%) versus middle/high SES schools (29.7%) achieved these recommendations (p = .003) but this finding was not present among 6-year-olds, across sex or school classification (Table 5).

DISCUSSION
This study is the first of its kind to examine an extensive range of health-related measures of Irish children across sex and school SES. About one in 5 participants were either overweight (13.7%) or obese (5.5%), consistent with previous representative samples of Irish primary schoolchildren and shows Irish children to have among the highest rates of overweight and obesity in Europe. Referencing waist circumference percentiles, however, the prevalence of obesity was higher at 11.6%. This finding is a cause for concern, because evidence
suggests waist circumference is a more relevant health outcome measure than BMI.23

The finding that 10-year-old boys were more active and had higher fitness scores than girls concurs with studies among European24,25 and American26,27 children. The marked age related decline in PA levels found among our participants also supports previous research.24,28 Yet, when comparing the number of children who met daily PA guidelines (45.3%) to previous Irish findings (19% of primary school children and 25% of 9-year-olds), much higher levels of adherence are evident. These studies are poor comparisons, however, because they were carried out among different age groups to those of the present study and only self-report methods were used.4,5 For clear comparisons to be made, more objective data need to be collected among primary schoolchildren.

Both BMI and waist circumference data found in the current study are similar to those reported in Ireland’s Childhood Obesity Surveillance Initiative (COSI).21 Our study revealed that children spend 8 hours per day engaged in SB which supports results from a systematic review that concluded that children spend up to 9 hours per day sedentary.29 Although combined assessment of children’s anthropometric, physiological, and behavioral variables, and SES is sparse both in Ireland and internationally, there is some evidence to suggest that socio-economic inequalities in cardiovascular risk factors exist in childhood.30-32 Children attending low SES schools in NZ have been found to have increased BMI,30 as were those who had lower family incomes in both the United States31 and Europe.32

We found that across both cohorts, boys and girls attending low SES schools were almost 3 times as likely to be obese in comparison to their middle/high SES counterparts. Whereas this finding was not statistically significant, the magnitude is concerning and supported by both a representative study33 and a systematic review34 that show a strong relationship between obesity among children and disadvantaged households. Such findings suggest that policymakers should consider prioritizing the implementation of interventions that target overweight and obesity to children attending low SES schools.

Table 5 Percentage of Categorical Variables by Age Cohort, Sex and School Socio-economic Status (SES)

<table>
<thead>
<tr>
<th>Age Cohort</th>
<th>Boys</th>
<th>Girls</th>
<th>p-value ( ^a )</th>
<th>Boys</th>
<th>Girls</th>
<th>p-value ( ^a )</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-year-olds</td>
<td>% Overweight &amp; Obese (BMI)</td>
<td>26</td>
<td>16.0</td>
<td>33</td>
<td>19.8</td>
<td>.448</td>
</tr>
<tr>
<td>10-year-olds</td>
<td>% Achieving 60 mins MVPA ( ^c )</td>
<td>37</td>
<td>59.7</td>
<td>30</td>
<td>44.8</td>
<td>.129</td>
</tr>
<tr>
<td>Low SES</td>
<td>Mid/High SES</td>
<td>Low SES</td>
<td>Mid/High SES</td>
<td>% Overweight &amp; Obese (BMI)</td>
<td>25</td>
<td>28.1</td>
</tr>
<tr>
<td></td>
<td>% Achieving 60 mins MVPA ( ^c )</td>
<td>21</td>
<td>58.3</td>
<td>46</td>
<td>49.5</td>
<td>.479</td>
</tr>
<tr>
<td>10-year-olds</td>
<td>% Overweight &amp; Obese (BMI)</td>
<td>32</td>
<td>17.9</td>
<td>34</td>
<td>24.3</td>
<td>.207</td>
</tr>
<tr>
<td></td>
<td>% Achieving 60 mins MVPA ( ^c )</td>
<td>46</td>
<td>53.5</td>
<td>12</td>
<td>19.7</td>
<td>&lt; .0005</td>
</tr>
</tbody>
</table>

Note.
\( ^a \): p-value for difference in health categories using the Chi-squared test
\( ^b \): BMI – Body mass index
\( ^c \): MVPA – Moderate to vigorous physical activity

There was a statistically significant simple main effect for 6-year-old children between sex and school classification for systolic BP, cardiorespiratory fitness, and MVPA. Girls from middle/high SES schools had higher systolic BP than those from
low SES schools and boys from middle/high SES schools. The high BP in the middle/high SES girls is not readily explained by sex or SES and differs from previous research that found sex differences to originate only during adolescence.\textsuperscript{35} In a review article, Colhoun et al concluded that low SES status is associated with higher BP in adults, most consistently in women, but found in most cases, a lack of association in studies conducted with children.\textsuperscript{36} When reviewing the findings by school location, however, Rush et al found no statistically significant difference in systolic and diastolic BP across SES, but did find higher values in rural compared to urban children,\textsuperscript{30} which was also found in the current study and in research undertaken by Groth et al.\textsuperscript{57} Potential reasons for this difference between urban and rural children should be explored in future research.

The difference in systolic BP we found could partly be influenced by the higher levels of MVPA among low SES girls and potential lowering effect this may have on BP levels. Leary et al reported such a finding when they found an association between higher levels of PA and lower levels of BP among 11-12-year-old children from the United Kingdom.\textsuperscript{38} Encouraging children to increase their MVPA also may help to reduce their systolic BP and could potentially benefit long-term cardiovascular health.

Interestingly, 10-year-old participants and 6-year-old boys attending low SES schools had significantly higher MVPA than their middle/high SES counterparts. Previous studies from other countries report mixed results concerning the relationship between SES and objectively measured PA.\textsuperscript{39,40} Scottish 6-year-olds\textsuperscript{39} from both affluent and deprived groups were found not to differ in time spent being physically active, whereas low SES Swedish 6-year-olds\textsuperscript{40} had higher PA levels than higher SES groups. A reason behind this difference could be due to low SES children having greater freedom to play,\textsuperscript{41} which in turn could contribute to higher MVPA. Further research in this area is warranted, which also considers mode of transport to school, given the finding elsewhere that as household income increases, the likelihood of active commuting to school decreases,\textsuperscript{42} thereby reducing what could be an ideal opportunity of increasing daily MVPA.

Girls from low SES schools took longer to complete the 550m run than girls from middle/high SES schools and all boys completed the run in a faster time to that of girls. Few studies have examined, in-depth, the influence of SES on physical fitness, and the findings are, so far, contradictory.\textsuperscript{33,44} The discrepancies among studies could be due to the different methods used to assess fitness alongside SES factors. Jin et al found that 2-9-year-olds with lower family income were less physically fit than those with higher family income but this study assessed physical fitness using the Fitnessgram protocol.\textsuperscript{31} A possible reason for differences in fitness could be that children who attend middle/high SES schools are more accustomed to structured sport\textsuperscript{4} which requires more adherence to structured fitness programs or testing. Such activities may be cost-prohibitive for the parents of children attending low SES schools,\textsuperscript{45} which may reflect the finding which shows participation in after school sport in Ireland to be lower among children from lower social classes.\textsuperscript{4} Although our aim was not designed to ascertain such differences, it does confirm the need for translational research into equitable and cost-effective approaches that target the fitness levels of girls attending low SES schools in Ireland.

A strength of our study is the extensive range of objective health measures undertaken among children across sex and school classification, which have not been reported in Ireland. It is important to recognize, however, that the identification of designated disadvantaged schools in Ireland is a measure of deprivation for the school’s geographical area.\textsuperscript{8} Providing a measure of SES for each individual participant may be more accurate and should be considered in the design of future studies.

**Conclusion**

We provide evidence to show health inequalities present in Irish children as young as 6 years of age. One in 5 Cork primary schoolchildren are overweight or obese and a substantial part of their waking day is being spent sedentary. Furthermore, less than half of participants reached the daily national PA guidelines, with girls being identified as particularly at risk. Further research is warranted to understand why children attending low SES schools record higher levels of MVPA but still, have higher BMI, waist circumference and lower fitness scores than children attending middle/high SES schools.
IMPLICATIONS FOR HEALTH BEHAVIOR OR POLICY

Our evidence provides a clear case for action in addressing the health inequalities evident in Irish primary school-aged children. Policymakers need to consider targeting interventions for those as young as 6 years of age that are aimed at improving PA and fitness and preventing overweight and obesity. They should also prioritize the distribution of resources to girls and children attending low SES schools. At the school level, developing policies that place greater emphasis and opportunity for increasing MVPA and cardiorespiratory fitness across the school day, particularly for girls, should be re-examined. As school resources may be limited, we encourage school principals to engage and seek assistance from national health and education departments along with institutions of higher learning who have a shared vision to reduce health inequalities and improve the overall health of children. Such partnerships have the potential to bring intervention, evaluation, and resources to schools.

Our results can be summarized in 2 policy recommendations:

• Whole school interventions need to be designed and evaluated that target the prevention of overweight and obesity through the promotion of cardiorespiratory fitness and MVPA among primary school aged children that pay special attention to girls and children attending low SES schools.

• Schools, should develop policies that provide children with increased opportunity for MVPA and fitness across the school day and seek support from multi-stakeholders to implement strategies that successfully engage girls and address school SES differences.

Human Subject Approval Statement

Ethical approval was attained from the Cork Institute of Technology’s Research Ethics Committee in September 2013.

Conflict of Interest Disclosure Statement

All authors of this article declare that they have no conflicts of interest.

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