# Investigation of physical activity, sedentary behaviour and cardiovascular fitness: association with child body composition Findings from the ROLO Kids Study

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## Introduction

In 2020, an estimated 39 million children under the age of 5 were overweight or obese globally, and one in five children in Ireland are currently overweight or obese[1,2]. The growing childhood obesity epidemic has coincided with lower physical activity levels and higher sedentary time. Cardiovascular fitness is also declining in children, linked with multiple metabolic risk factors[3]. However, research on these aspects of physical health and the assessment of fitness is limited in young children. Identifying modifiable factors to address these adverse child behaviours is vital for the improvement of future health trajectories.

## Aims

1. To assess associations between parental-reported physical activity and screen time with child body composition at 5 years of age.
2. To investigate whether fitness, as measured using a Step Test, is associated with child body composition at 5 years of age.

## Study Design and Methods

- Analysis was performed on **387 5-year-old children** from the ROLO Kids study, a longitudinal follow-up of the ROLO study[4].
- The **CLASS questionnaire** collected parental-reported measures of physical activity, along with information on screen time.
- 272 children completed a **Step Test**, by stepping up and down off a 25cm step as many times as possible for 3 minutes.
- Resting heart rate was measured before stepping commenced, immediately after 3 minutes, and every 30 seconds until heart rate returned to baseline to provide an estimate for heart rate recovery.
- Anthropometry including child height, weight, circumferences and skinfold thickness were collected along with blood pressure.
- **Statistical analysis** involved t-Tests, Mann-Whitney U, Chi-square tests and regression models controlled for confounders.

## Results

This is a secondary analysis of **387 children** with a mean age of 5.14 years. Males had higher vigorous physical activity levels and screen time than females (Table 1, P < 0.05). **At 5 years of age male children** had a **lower heart rate** after the step test than females and a **faster recovery** time (112.5 seconds vs 128.8 seconds, Table 1).

**Table 1. Characteristics of the 5-year-old children in the ROLO cohort**

| | Total | | Male | | Female | | |
|---|---|---|---|---|---|---|---|
| | n | | n | | n | | P |
| RCT group (Intervention, n(%)) | 387 | 198 (51.2) | 186 | 96 (51.6) | 201 | 102 (50.7) | 0.945 |
| Birth weight (mean, SD, kg) | 387 | 4.03 0.45 | 186 | 4.11 0.49 | 201 | 3.96 0.4 | **0.001*** |
| Birth weight centile (median, IQR) | 357 | 79.7 34.85 | 170 | 80.05 35.48 | 187 | 78.1 33.9 | 0.643 |
| Smoked during pregnancy (n(%)) | 387 | 10 (2.6) | 186 | 3 (1.6) | 201 | 7 (3.5) | 0.402 |
| Breastfed (n(%)) | 365 | 230 (63.0) | 176 | 106 (60.2) | 189 | 124 (65.6) | 0.339 |
| **5 Year Follow-up** | | | | | | | |
| Age (mean, SD, years) | 387 | 5.14 0.15 | 186 | 5.14 0.16 | 201 | 5.14 0.14 | 0.823 |
| Weight (mean, SD, kg) | 387 | 20.31 2.57 | 186 | 20.58 2.47 | 201 | 20.05 2.64 | **0.045*** |
| Weight centile (median, IQR) | 386 | 68 41 | 185 | 69 39.5 | 201 | 66 41.5 | 0.122 |
| Height (mean, SD, cm) | 386 | 111.7 4.55 | 185 | 112.34 4.31 | 201 | 111.14 4.7 | **0.01*** |
| Height centile (median, IQR) | 385 | 61 48.5 | 184 | 62.5 41.75 | 201 | 59 58 | 0.362 |
| BMI (mean, SD, kg/m²) | 386 | 16.22 1.33 | 185 | 16.26 1.25 | 201 | 16.19 1.4 | 0.609 |
| BMI centile (median, IQR) | 385 | 67 42 | 184 | 68 45 | 201 | 66 40 | 0.314 |
| Chest circ. (mean, SD, cm) | 384 | 56.55 2.82 | 185 | 57.04 2.65 | 199 | 56.09 2.9 | **0.001*** |
| Abdominal circ. (mean, SD, cm) | 384 | 55.42 3.93 | 184 | 55.41 3.64 | 200 | 55.42 4.19 | 0.964 |
| Waist to height ratio (mean, SD) | 384 | 0.5 0.03 | 184 | 0.49 0.03 | 200 | 0.5 0.03 | 0.108 |
| Sum of skinfolds (mean, SD, mm) | 351 | 38.49 10.29 | 173 | 36.59 9.93 | 178 | 40.33 10.32 | **0.001*** |
| **Cardiovascular Health (mean, SD)** | | | | | | | |
| Heart rate | 350 | 91.95 12.08 | 167 | 91.18 11.19 | 183 | 92.64 12.83 | 0.255 |
| Respiratory rate | 252 | 19.17 2.55 | 129 | 19.1 2.48 | 123 | 19.24 2.62 | 0.656 |
| Systolic blood pressure | 335 | 99.83 10.17 | 163 | 100.79 10.52 | 172 | 98.92 9.77 | 0.094 |
| Diastolic blood pressure | 335 | 60.25 8.65 | 163 | 60.55 9.58 | 172 | 59.97 7.69 | 0.544 |
| **Physical Activity (median, IQR)** | | | | | | | |
| Moderate PA (mins/week) | 275 | 285 230 | 136 | 280 250 | 139 | 300.0 230 | 0.529 |
| Vigorous PA (mins/week) | 275 | 185 215 | 136 | 227.5 232.5 | 139 | 165.0 170 | **0.003*** |
| Total PA (mins/week) | 275 | 495 350 | 136 | 510 383.75 | 139 | 470.0 305 | 0.301 |
| Screen time (mins/week) | 258 | 640 540 | 129 | 690 585 | 129 | 600.0 510.0 | **0.043*** |

Normally distributed data is reported as mean, SD or non-normal data is median, IQR (interquartile-range). BMI: Body Mass Index,
Statistical comparisons by student T-test, Mann-Whitney U or Chi-square tests. *Significant at P < 0.05



Figure 1: Percentage of 5-year-olds meeting the recommended guidelines for Physical Activity (WHO <1hour/day) and Screen Time (APP >1hour/day)

**37.5%** were not meeting the WHO physical activity guidelines and **73.4%** were exceeding the AAP screen time guidelines (Figure 1).

**Table 2. Multiple linear regression models for activity levels and child body composition**

| | B | P | CI Lower | CI Upper | r² adj | F | P |
|---|---|---|---|---|---|---|---|
| **Weight (kg)** [a] | | | | | | | |
| Vigorous Physical Activity (mins/week) | 0.002 | 0.047* | 0.000 | 0.003 | 0.059 | 2.55 | 0.021 |
| **Weight Centile** [b] | | | | | | | |
| Vigorous Physical Activity (mins/week) | 0.015 | 0.043* | 0.000 | 0.029 | 0.028 | 1.75 | 0.14 |
| **BMI (kg/m²)** [a] | | | | | | | |
| Vigorous Physical Activity (mins/week) | 0.001 | 0.036* | 0.000 | 0.002 | 0.031 | 1.30 | 0.256 |
| **Waist: Height Ratio** [a] | | | | | | | |
| Screen time (mins/week) | 9.32E-06 | 0.044* | 0.000 | 0.000 | 0.048 | 0.90 | 0.082 |

CI: Confidence interval 95%, BMI: Body Mass Index * Significant at P < 0.05
[a] model adjusted for RCT group, child sex, child age at appointment, breast-feeding, maternal education level
[b] model adjusted for RCT group, breast-feeding, maternal education level

**Table 3. Linear regression model for sum of skinfold measures in the ROLO Kids study**[a]

| | B | P | CI Lower | CI Upper | r² adj | F | P |
|---|---|---|---|---|---|---|---|
| Child sex | 4.483 | 0.002* | 1.63 | 7.33 | | | |
| Age at follow-up | 7.848 | 0.143 | -2.68 | 18.37 | | | |
| Breastfed | 1.136 | 0.453 | -1.85 | 4.12 | 0.134 | 4.59 | 0.001 |
| Step Test Effort (Good or Poor) | 2.005 | 0.493 | -3.76 | 7.77 | | | |
| Heart Rate Recovery (seconds) | 0.034 | **0.007*** | 0.01 | 0.06 | | | |

CI: Confidence interval, *Significant at P < 0.05
[a] model adjusted for child sex, child age at appointment, breast-feeding and perceived effort in the Step Test

After controlling for confounders, **vigorous physical activity** was positively associated with **child weight and BMI**, while **screen time** was positively associated with **waist to height ratio** (Table 2, 95% CI: 0.00, 0.00 P < 0.05).

After adjusting for confounders (including child sex and effort in the step test), each **1-SD (1cm)** increment in sum of skinfold thickness corresponded to **3.4 seconds** of an increase in heart rate recovery time (Table 3, 95% CI: 0.01, 0.06; P < 0.01).
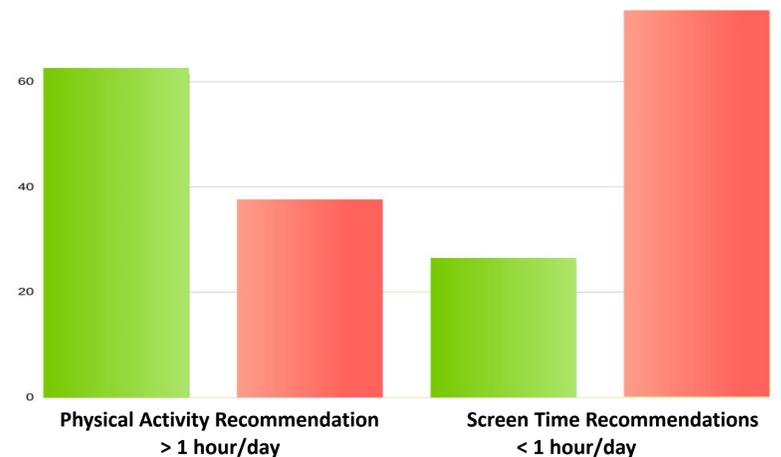
## Conclusion

Excess screen time could have a detrimental impact on child body composition and higher adiposity may be linked with longer heart rate recovery time following a fitness test in children. Further research is needed to expand on the importance of physical activity and fitness in young children.

## Translational & Innovative Aspects

These findings suggest that parental reports about their child's screen time, along with a fitness assessment using the novel step test may be a comprehensive estimate of fitness and physical health at 5 years of age, suitable for both research and clinical settings.

References: 1. World Health Organisation. Obesity and overweight [Internet]. 2020 [cited 2021 Nov 22]. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight 2. Mitchell L, Bel-Serrat S, Stanley I, et al. The Childhood Obesity Surveillance Initiative (COSI) in the Republic of Ireland - Findings from 2018 and 2019. Dublin, Ireland: Health Service Executive, 2020. 3. Ruiz, J.R., Ortega, F.B., Meusel, D. et al. Cardiorespiratory fitness is associated with features of metabolic risk factors in children. Should cardiorespiratory fitness be assessed in a European health monitoring system? The European Youth Heart Study. J Public Health. 2006;14: 94–102.4.Walsh JM, McGowan CA, Mahony R, et al. Low glycaemic index diet in pregnancy to prevent macrosomia (ROLO study): Randomised control trial. BMJ. 2012; 345:e5605.