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

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BACKGROUND

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.

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

Analysis of **387 children** with a mean age of 5.14 years. Males spent more time in vigorous physical activity and in front of a screen 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

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

	B	P	CI Lower	CI Upper	r^2 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

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).

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

	B	P	CI Lower	CI Upper	r^2 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

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

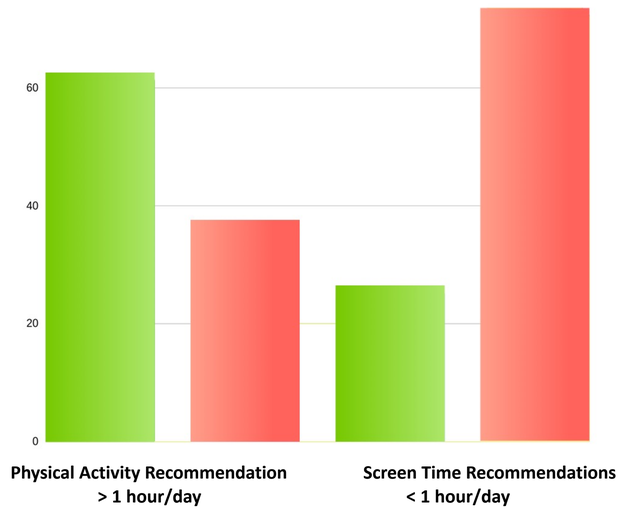

Figure 1: Percentage of 5-year-olds meeting the recommended guidelines for Physical Activity (WHO <1hour/day) and Screen Time (APP >1hour/day)

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

This research suggests that excess screen time could have a detrimental impact on child body composition. As child adiposity was positively associated with heart rate recovery, the step test could be used as a novel measure of fitness in children that is suitable for research and clinical settings. Replication of these findings and further research is required to expand on the importance of physical activity and fitness in young children.

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