

Habitual physical activity, physical fitness and heart rate variability in adolescents

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Purpose

The amount and type of habitual physical activity (PA) that is appropriate in adolescents for health and well-being is still being discussed. The aim of our study was to examine in 12-year-old adolescents the association between habitual physical activity patterns and health-related indexes.

Methods

- PA was evaluated by triaxial accelerometry (RT3, Stayhealthy, Monrovia, CA, USA). The 67 adolescents were classified according to:
 - their **spontaneous participation or not in moderately intense activities** (>4 metabolic equivalents, METs) for at least 210 min a week (4M₂₁₀)
 - the **spontaneous practice or not of more intense activities** (>6 METs) for at least 60 min a week (6M₆₀).
- Health-related indexes were:
 - cardiopulmonary fitness**, evaluated by maximum oxygen uptake (VO₂max) estimated by the 20 m shuttle run test of Léger and Lambert¹,
 - muscular fitness** evaluated through lower limb strength assessed from jumping (countermovement jump, Ergojump, Globus Italia, Codogne, Italy) and sprinting abilities (10 m sprint time, Wireless Timing-Radio Controlled, Brower timing system, Matsport, St. Ismier, France),
 - vagal-related indexes of heart rate (HR) variability (HRV)**. HR was recorded in the supine index after 15 min of quiet rest (Polar 810s HR monitor, Polar Electro, Kempele, Finland), and vagal-related HRV indexes were calculated on 5-min segments: the root-mean-square of successive normal R-R interval differences (RMSSD), high frequency (HF) power and the normalized HF ratio (HF/(LF+HF)), where LF stands for low frequency power.

Results

- Total energy expenditure due to PA was not significantly associated with any health-related index.
- Adolescents who reached 4M₂₁₀ displayed higher VO₂max ($P < 0.05$) and muscular strength indexes ($P < 0.05$) than those who did not, but HRV indexes were not different.
- Reaching 6M₆₀ was associated with both higher VO₂max ($P < 0.05$) and higher vagal-related indexes ($P < 0.05$).

Anthropometric and physical activity parameters		
Anthropometric data		
Age (yr)		11.4 ± 0.1
Body Fat (%)		18.0 ± 0.8
Body mass index (weight.height ⁻²)		17.9 ± 0.3
Energy expenditure and physical activity level		
RMR (kcal.min ⁻¹ .kg ⁻¹)		0.96 ± 0.01
TEE (kcal.day ⁻¹)		1891.1 ± 28.1
PAEE (kcal.day ⁻¹)		511.1 ± 19.8
PAL		1.46 ± 0.01
Time devoted to different intensities		
<2 METs (hr.wk ⁻¹)		73.8 ± 1.0
2 - <4 METs (hr.wk ⁻¹)		18.0 ± 0.6
4 - 6 METs (hr.wk ⁻¹)		4.2 ± 0.3
>6 METs (hr.wk ⁻¹)		1.9 ± 0.2

Table 1. Anthropometric data and physical activity patterns assessed by accelerometry in the 67 adolescents. Mean (±SE) anthropometric data and physical activity patterns of the adolescents. Resting metabolic rate (RMR); total energy expenditure related to physical activity (PAEE); global energy expenditure including PAEE and RMR (TEE); physical activity level (PAL); and total time spent at various intensities (MET, metabolic equivalent).

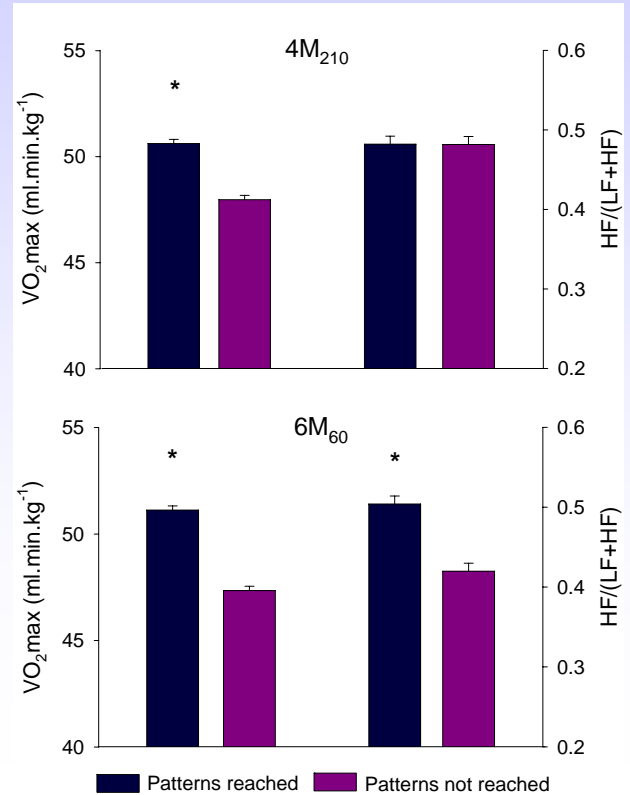


Figure 1. Means (±SE) values of age-, sex- and percentage body fat-adjusted VO₂max (ml.min.kg⁻¹) and HF/(LF+HF) in adolescents reaching or not moderate- and high-intensity patterns of physical activity. 4M₂₁₀: participation in moderately intense activities (>4 metabolic equivalents, METs) for at least 210 min a week, and 6M₆₀: practice of more intense activities (>6 METs) for at least 60 min a week. *: significant differences ($P < 0.05$).

Health-related indexes		
Physical fitness parameters		
VO ₂ max (ml.min ⁻¹ .kg ⁻¹)		48.3 ± 0.7
30 m (sec)		5.6 ± 0.1
CMJ (cm)		30.0 ± 0.5
HRV indexes		
HR (bpm)		82.7 ± 1.2
SDNN (msec ² /Hz)		57.4 ± 2.5
RMSSD (msec)		50.4 ± 3.0
HF (msec ² /Hz)		1989.6 ± 256.4
HF/(LF+HF)		0.48 ± 0.01

Table 2. Health related indexes. Estimated maximal oxygen uptake (VO₂max); heart rate recovery index (HR60⁰); 30 m sprint running time (30 m); vertical jump height (countermovement jump, CMJ); heart rate (HR); standard deviation of normal R-R intervals (SDNN); root-mean-square of successive normal R-R interval differences (RMSSD); high frequency (HF) power, and normalized high frequency power HF/(LF+HF), where LF is low frequency power.

References

- Leger, L.A. et al. (1981) Eur J Appl Physiol Occup Physiol, 49: 1-12.
- Blair, S. N., et al (1989), In Perspectives in Exercise Science and Sports Medicine, 401-430.
- Sallis, J. et al. (1994), Pediatric Exercise Science, 6:299-463.

Conclusions

- Moderate physical activity in average 30' a day is sufficient to observe beneficial effects on physical fitness. This is important in a public health perspective, because such a level should be reach by the majority of youngsters.
- Higher physical activity intensities may be required to improve autonomic cardiovascular regulation (at least 60' a week).

Our results lend support to guidelines that recommend moderate-intensity physical activities for improving fitness and health². They confirm that participation in intense activities may induce greater health benefits in adolescents³.