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

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Introduction
It has been shown that decreased habitual PA, and also low physical fitness, are two prominent parts of the causality constellation that increase cardiovascular risk. It has also been recognized that identified risk factors may be found in early childhood or adolescence. Since no prospective studies on the relationship between PA during youth and adult morbidity or mortality are available, the amount and type of PA appropriate in adolescents for health and well-being is still being discussed. Recommendations for the general population indicate that young people, like adults, should participate in 30 min of physical activity of at least moderate intensity on most, if not all, days of the week. However, it has been suggested that this amount of PA may not be sufficient in a health perspective for youths, and that all adolescents should also engage in more intense activities for at least 60 min a week. To assess cardiovascular risk factors, analyses of heart rate variability (HRV) are now of increasing interest as decreased level of global HRV and low vagal-related indexes have been associated with increased cardiovascular risk and all-cause mortality prognostic.

The aim of our study was to examine in adolescents the association with health-related indexes of two PA pattern defined as 1) participating or not in moderately intense activities for at least 210 min a week, i.e. the equivalent of 30 min a day, 2) engaging or not in intense activities for at least 60 min a week.

Methods
PA was evaluated by triaxial accelerometry in 67 adolescents, who were successively classified according to 1) their participation or not in moderately intense activities (>4 metabolic equivalents, METs) for at least 210 min a week (4M210) and 2) the practice or not of more intense activities (>6 METs) for at least 60 min a week (6M60). Health-related indexes consisted of cardiopulmonary (maximum oxygen uptake, VO2max) and muscular (lower limb strength assessed from jumping (countermovement jump) and sprinting (10 m sprint time) abilities) fitness parameters and in vagal-related indexes of heart rate (HR) variability (HRV). HR was recorded in the supine position after 15 min of quiet rest, and vagal-related HRV indexes were calculated on 5-min segments, such as 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
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).

Discussion/Conclusion
Since participating in at least 210 min of moderately intense activity a week is associated with significantly higher VO2max, greater HR recovery at the end of exercise (as indicated by the higher HR60) and higher muscular strength (lower 30 m sprint time), this study suggests that this PA level is sufficient to observe beneficial effects on physical fitness. This is important in a public health perspective, because such a level should be within reach of the majority of youngsters. In our study, it was reached by about three-quarters of the adolescents. The second finding of our study is that higher PA intensities may be required to improve autonomic cardiovascular regulation. This agrees with previous studies on adults where moderate intensity training programs had failed to improve HRV and with others that highlighted the importance of high intensity exercise for HRV modification. Our results show that distinct intensity thresholds should be considered when evaluating the effects of physical activity on health-related indexes. While moderate intensity activity may benefit physical fitness, only higher intensities seem to be associated with improved cardiac autonomic control. Our results thus give credit to moderate-intensity recommendations for improving physical fitness and health, but also lend support to guidelines which stipulate that participation in intense activities may induce greater health benefits in youth.

References