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Subjective and objective assessment of physical activity – Influence of newly diagnosed exercise induced bronchoconstriction and gender

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A B S T R A C T

Aim: To investigate if occurrence of newly diagnosed exercise induced bronchoconstriction (EIB) would affect adolescents' ability to assess their physical activity.
Methods: 99 selected adolescents with and 47 adolescents without self-reported exercise induced dyspnea were included. All of the 146 adolescents then performed a standardized exercise challenge test on a treadmill with dry-air inhalation to detect EIB. Free living physical activity was assessed during seven days with both accelerometer (objective assessment) and a validated activity diary (subjective assessment). Height, weight and subjective sleep were recorded.
Results: Out of the 146 adolescents 49 were diagnosed with EIB. Forty-six of the adolescents with EIB (35 girls and 11 boys) and 84 of the control adolescents (45 girls and 39 boys) had complete 7 day activity diary and accelerometer data. There were no differences in age, BMI and sleep between EIB and control adolescents. Boys with EIB overestimated subjective assessment compared to objective assessment more than girls with EIB. No difference was seen between control boys and girls. Furthermore, boys with EIB reported a much higher frequency of high intensity exercise than girls with EIB, but no difference was observed between control boys and girls.
Conclusion: Adolescent boys with newly diagnosed EIB overestimated their physical activity compared to EIB girls. Caution may thus be used when choosing methods measuring level of physical activity in this group and especially when investigating gender differences.

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1. Introduction

Physical activity is important for present and future health in children and adolescents; this applies to both healthy children [1,2] and those suffering from chronic conditions [3–5]. It is therefore important to have valid methods to assess physical activity. One way of categorizing these assessment methods is into objective or subjective methods. Objective methods are, for example heart rate monitors, pedometers, accelerometers or even ambulatory indirect calorimetry measurements. These assessment methods sometimes have added value apart from the assessment of physical activity (e.g sleep pattern assessment). They are however costly, require logistics; and do not provide information about the context of the physical activity [6,7].

With subjective methods, it is the individual who reports activity via some kind of recall, questionnaire or diary. These kinds of subjective assessment methods are inexpensive, flexible and tailored to specific needs; and they also give contextual information [6–8]. However, these methods are subjected to various form of bias, which affect their reliability [6–8]. Various bias factors have been shown influence individual's report physical activity; such BMI, age and gender [7,9,10].

Exercise-induced respiratory symptoms are common among adolescents [11,12]. The most studied reason for respiratory symptoms in conjunction with exercise is exercise-induced bronchoconstriction (EIB) in individuals with or without an asthma diagnosis [13]. However, little is known whether the presence of EIB influences how adolescents perceive their physical activity level. Possibly, the perceived intensity could increase greater than the objective intensity in individuals with EIB as a result of more respiratory problems. This could possibly be even more valid in

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individuals with previously undiagnosed EIB who are not yet fully aware of their disease and have not yet received the correct treatment. The aim of this study was therefore to investigate if occurrence of newly diagnosed EIB would affect adolescents' ability to assess their physical activity.

2. Methods

From a survey investigating the prevalence of self-reported exercise-induced dyspnoea 146 subjects, 13–15 years, were recruited [2]. Classification was based on the question, “Have you had an attack of shortness of breath that came following strenuous activity at any time, in the last 12 months?” The adolescents who responded positively to the question were defined as having exercise-induced dyspnoea and those who responded negatively were defined as controls. By random a total of 199 adolescents with exercise-induced dyspnoea and 123 controls were invited to participate in the study. The first 99 adolescents with exercise-induced dyspnoea and the first 47 healthy controls who agreed to participate were recruited. The exclusion criteria included pulmonary diseases, apart from asthma, cardiac co-morbidity or an inability to perform exercise tests.

The trial preparations, exercise challenges and analyses were performed at the Pediatric Department of Uppsala University Hospital, Sweden.

Data collection began in spring 2012 and was completed a year later. Ethical approval was obtained from the ethical review board in Uppsala, Sweden (Dnr 2011/413). All participants, as well as their guardians, provided written informed consent.

Height and weight were registered and the adolescents filled out a questionnaire about sleeping habits. The questions were: How often do you have problems falling asleep? How often do you wake up several times during the night? How often are you sleepy during the day? How often do you wake up too early in the morning? The range was from 1 (never/seldom) to 5 (almost every day) [14].

All of the 146 adolescents then performed a standardized exercise challenge test on a treadmill with dry-air inhalation to detect EIB [15]. EIB was defined as a decline ≥10% in FEV_1 from baseline at least at one time point within 30 min after the exercise challenge [16].

2.1. Activity registration

In immediate conjunction to the EIB-test the adolescents simultaneously conducted two different activity registrations that took place in the adolescent's everyday environment (home, school etc.). The adolescents were instructed to fill out an activity diary and to wear an activity monitor for seven consecutive days. Diary and the activity monitor were returned by mail to the laboratory at the end of the registration period. The activity diary report covered seven days, and each day (24-h period) was divided into 15-min periods [17]. For each such period, the adolescent entered a number that corresponded to a particular type of graded activity. The activities were divided into nine categories according to their energy expenditure (Physical activity ratios, PAR) in multiples of basic metabolic rate (BMR). The lowest category corresponds to the number one, which means sleep and lying still. The highest category is represented by the number nine, which means sports and work of very high to maximal intensity. The day was dived into 96 15-min blocks. All the values of every 15-min period in the same category were summarized and the result was multiplied by the PAR value for the categories concerned. The BMR was added to the diary by using Schofields equation [18], which is based on the subject's age, gender, height and weight. PAR and BMR were then used to calculate the total energy expenditure per day.

The adolescents wore the activity monitor, an accelerometer (Actical™ Mini Mitter CO, Bend, OR, USA) over their right ankle, secured with a flexible strap. They were instructed to wear the accelerometer seven days and to remove the device only when bathing or showering. The ActiCal accelerometer is a small device that collects data regarding the subject's physical activity and energy expenditure levels. The accelerometer detects triaxial information of different intensity, duration and frequency of motion. The adolescents were blinded to the data while wearing the devices. Following the seven-day period, the accelerometer was collected, and the data were downloaded and archived. The same Schofield formula for BMR was used when calculating total energy expenditure based on accelerometer measurements.

2.2. Statistical analysis

All data are expressed as mean ± SD and controlled for normality with the Shapiro Wilks test. Data were analyzed using factorial ANOVA with “exercise induced bronchoconstriction (EIB)” as main categorical fact. Secondary categorical factors were “gender”, BMI and sleep. In other words, three analyses were performed: 1) with EIB and gender as categorical factors; 2) with EIB and BMI as categorical factors; and 3) with EIB and sleep as categorical factors. Significant results were analyzed with the Tukey HSD post hoc test. BMI was divided into quartile of non-age-adjusted BMI; and sleep was divided into quartiles, based on the combined response from the questionnaire [14]. Data were analyzed with Statistica 12 (StatSoft, Tulsa, USA). Significance level was set to $\alpha = 0.05$.

3. Results

Out of the 146 adolescents who performed the exercise challenge test on a treadmill 49 were diagnosed with EIB (42 adolescents in the exercise-induced dyspnoea group and seven adolescents in the control group). Study controls are defined as the adolescents without a diagnose of EIB. Forty-six of the adolescents with EIB (35 girls and 11 boys) and 84 of the control adolescents (45 girls and 39 boys) had complete 7 day activity diary and accelerometer data; and were included in the study. There were no differences in age, BMI and sleep between adolescents with EIB and controls (Table 1).

In contrast, when analyzing the primary outcome variable, the difference between activity diary and accelerometer during the whole seven day period, there was an EIB x gender effect ($p < 0.05$; Fig. 1). Post hoc test revealed that boys with EIB showed a bigger difference between activity diary and accelerometer, compared to girls with EIB (Fig. 1); i.e., the boys overestimated their physical activity. No difference was seen between control boys and girls (Fig. 1). The same EIB x gender pattern was observed when looking at weekdays or weekends separately (Fig. 1). One boy diagnosed with EIB reported very high energy expenditure during the weekend, and statistical analyses were also performed without this subject. However, the main results did not change materially (data not shown), so further analyses and discussion are based on the whole data set. Neither BMI nor sleep (as assessed by questionnaire) influenced the observed activity diary minus accelerometer difference, either directly or via interaction effects (data not shown).

The predicted FEV_1% and, predicted FVC % at baseline (i.e. lung function before the exercise challenge) and Delta FEV_1 are presented in (Table 1). In Table 2, the data from the activity diary and the accelerometer is presented, divided into week, weekend and total 7 day period.

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