CHAPTER 6. OBJECTIVE MEASUREMENT OF PHYSICAL ACTIVITY

Measurement of Pupils' Physical Activity levels with Accelerometers: Aims and Method

To complement Physical Activity (PA) findings stemming from self-reports with objective measures of PA, across three countries, from the larger sample of pupils participating in T1 and T2 measurements of the main study, a random sample of pupils was selected to assess their PA through accelerometers. The aim was to investigate:

- Overall levels of youth physical activity assessed through objective measures
- Age and gender differences in objective measures of physical activity
- Possible differences between experimental and control group pupils due to the implementation of the IMPACT Project Intervention.

Two measures were conducted in 3 European countries (France, Greece, and Italy). Time 1 (T1) accelerometer measure took place between October-November 2018, while the T2 accelerometer measure was conducted between March-April 2019.

Table 6.1. Participants in each Country at T1 and T2 Accelerometer Measures

	T1 Measure		T2 Measure	
Countries	***N***	**%**	***N***	**%**
France	60	31.9	37	28.5
Greece	75	39.9	56	43.1
Italy	53	28.2	37	28.5
Total	**188**	**100**	**130**	**100**

Table 6.2. Male and female pupils at T1 and T2 Accelerometer Measures

	T1 Measure		T2 Measure	
Countries	***N***	**%**	***N***	**%**
Boys	74	39.4	51	39.2
Girls	114	60.6	79	60.8
Total	**188**	**100**	**130**	**100**

Table 6.3. Participants' school grades at T1 and T2 Accelerometer Measures

	T1 Measure		T2 Measure	
Countries	***N***	**%**	***N***	**%**
Primary school	37	19.7	30	23.1
Secondary school	82	43.6	52	40
High school/ College	69	36.7	48	36.9
Total	**188**	**100**	**130**	**100**

Participants wore an accelerometer for seven consecutive days (GT3X+ Actigraph) at their waist. A 15-second epoch, Evenson equation to calculate pupils' PA cut-points (Sedentary Time: <100 counts per minute (cpm); Light PA: 100 - 2295 cpm; Moderate PA: 2296 - 4011 cpm; Vigorous PA: ≥ 4012 cpm and MVPA: ≥ 2296 cpm), and a minimum of three valid days with 8 hours of wear time per day were used to accurately monitor PA intensities (e.g., Evenson et al., 2008; Fenton et al., 2016; Kim et al., 2012; Trost et al., 2011). Participants were excluded from subsequent analyses for failing to meet the above wearing time criteria. Pupils'

anthropometric characteristics (height and weight) were also measured to the nearest point (0.1 cm and 0.1 kg respectively) using a balance and a portable stadiometer.

During anthropometric measures, participants wore light clothes and no shoes. Body Mass Index (BMI) was calculated using the equation of weight (kg) / height $(m)^2$. Pupils were classified as normal BMI, overweight or obese based on the International Obesity Task Force (IOTF) cut-off points for BMI (Cole et al., 2000). Accelerometer data were analyzed using the Actilife Software (versions 5 or 6; Actigraph, Pensacola, FL). All statistical analyses were conducted with PASW Software version 18.0. The *p*-value was set at .05. Means and standard deviations of pupils' objectively measured PA levels are presented in Table 32.

Pupils' objective Physical Activity: Results

The majority of pupils (87.2%) in the three countries did not fulfill daily step-recommendations (Tudor-Locke et al., 2011; Figure 6.1).

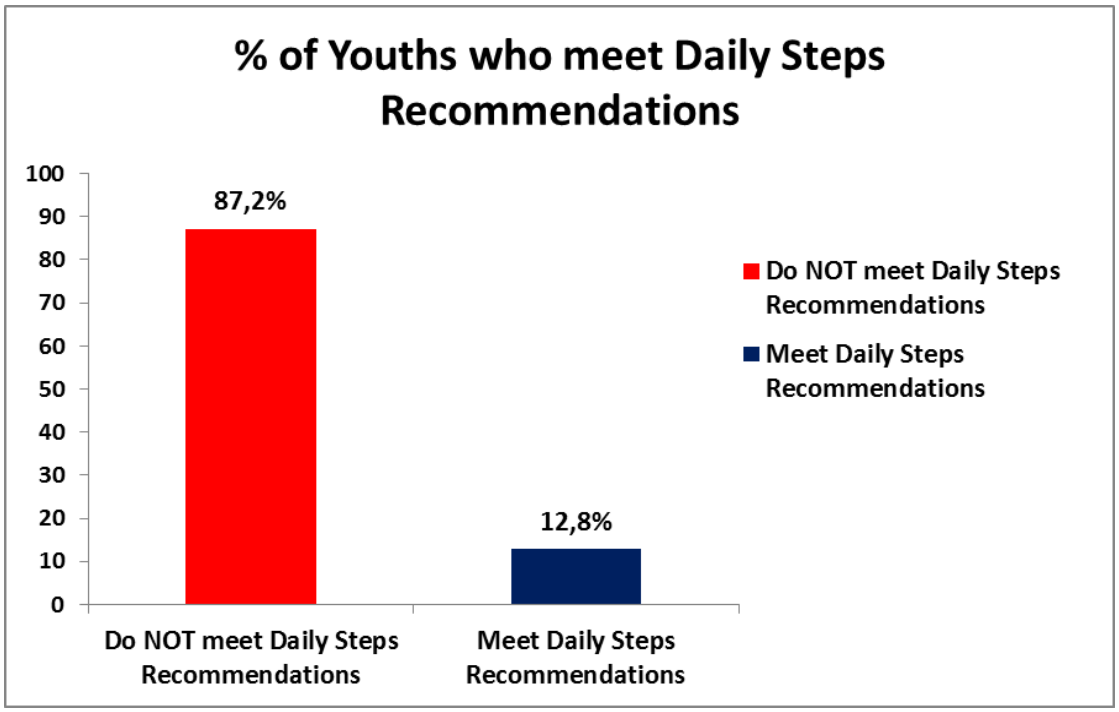

Figure 6.1. Percentage (%) of youths who meet daily steps recommendations

When findings were examined in relation to World Health Organization's (WHO) guidelines, the results revealed that only one boy (0.5%) met the 2010 WHO's recommendation for 60 minutes of moderate to vigorous PA (MVPA) daily. Unfortunately, 26.1% of the pupils never exceeded the threshold of 60 minutes of daily PA while more than half of the pupils (54.3%) were very inactive, that is, they were doing 0-1 days of at least 60 minutes MVPA per week; Figure 6.2). Just 14.9% of pupils were doing 4-6 days MVPA above the 60 minutes threshold in a specific day. Thus, these findings also confirm that the majority of adolescents from these European countries do not meet the minimum amount of MVPA recommended by WHO and other health authorities.

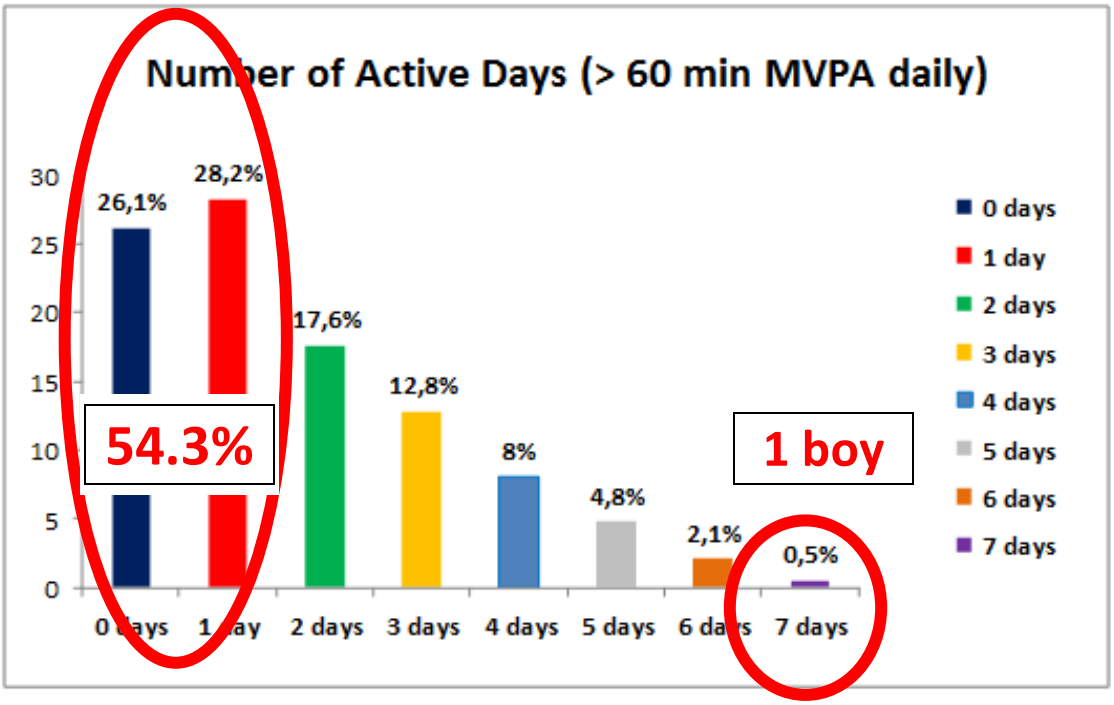

Figure 6.2. Percentage (%) of pupils who meet PA recommendations for 60 minutes of Moderate to Vigorous PA (MVPA) per day

Moreover, 17.6% of pupils were classified as overweight or obese (Figure 6.3).

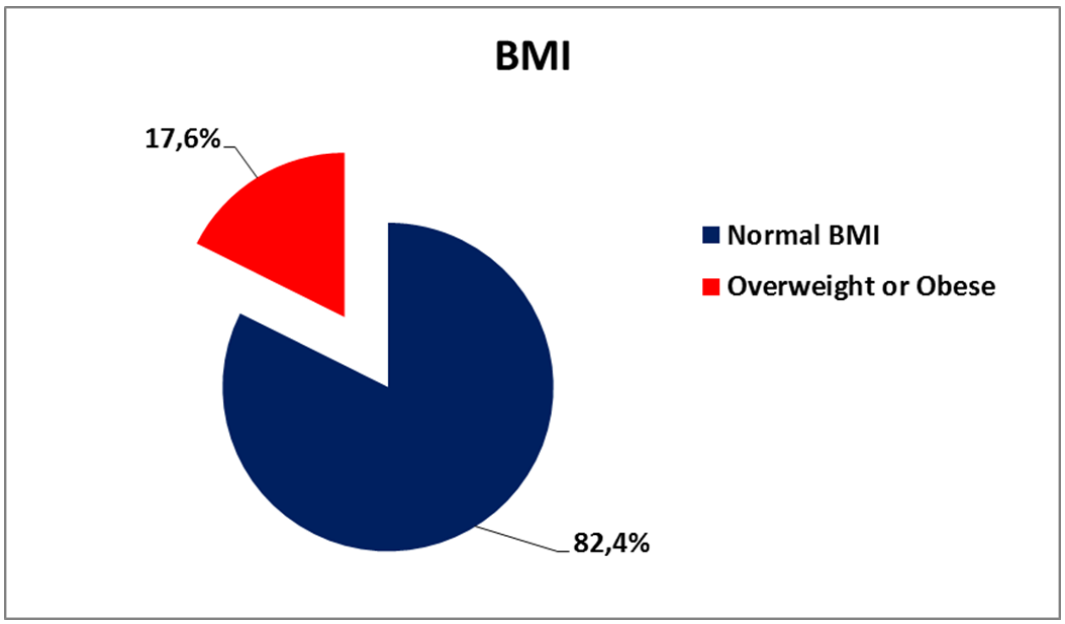

Figure 6.3. Participants Body Mass Index (BMI)

Gender differences in objective measures of Physical Activity

Results showed that boys (M = 55.54 ± 19.53) had higher levels of Moderate to Vigorous PA (MVPA) compared to girls (M = 42.03 ± 16.54) (t_{186} = 5.092, p < .001; Figure 6.4).

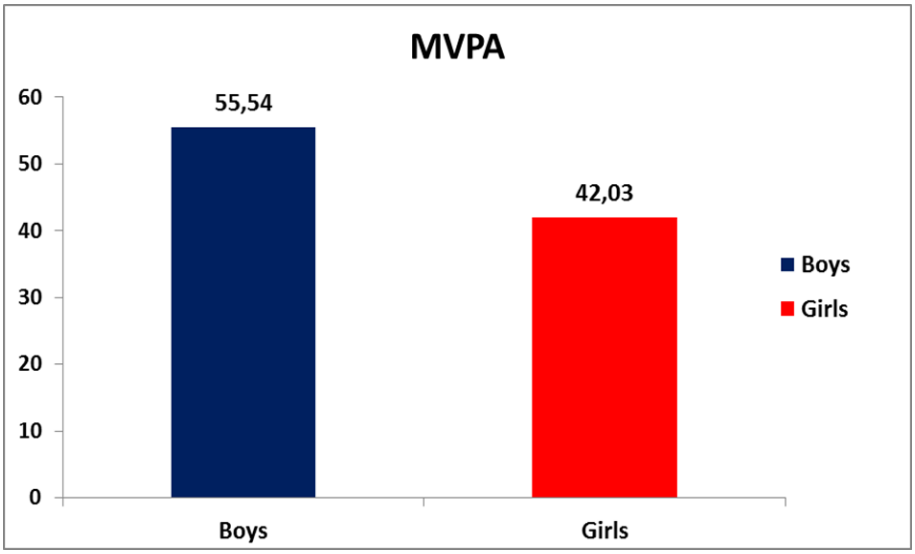

Figure 6.4. Differences in MVPA between boys and girls

Age differences in objective measures of Physical Activity

Primary school pupils (children; M = 59.22 ± 22.41) had higher levels of MVPA compared to secondary (M = 42.24 ± 17.05) and high school pupils (adolescents; M = 47.05 ± 16.25) ($F_{2,186}$ = 11,435, p < .001; Figure 6.5). The findings of the present study are in line with previous research in the area of youths' PA assessment (e.g., Van Hecke et al., 2016).

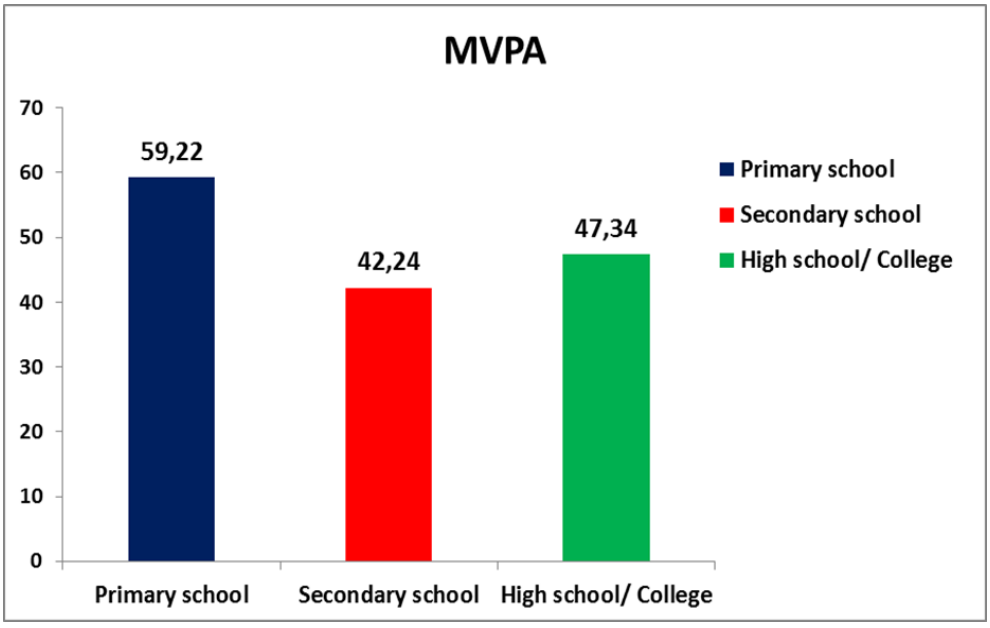

Figure 6.5. Differences in MVPA between school grades

Differences in objective measures of PA between countries

In this sample, Greek pupils (M = 57.35 ± 19.62) had higher levels of MVPA compared to French (M = 38.03 ± 14.61) and Italian pupils (M = 43.73 ± 15.47) after adjusting for gender & age ($F_{2,183}$ = 23.592, p < .001; Figure 6.6).

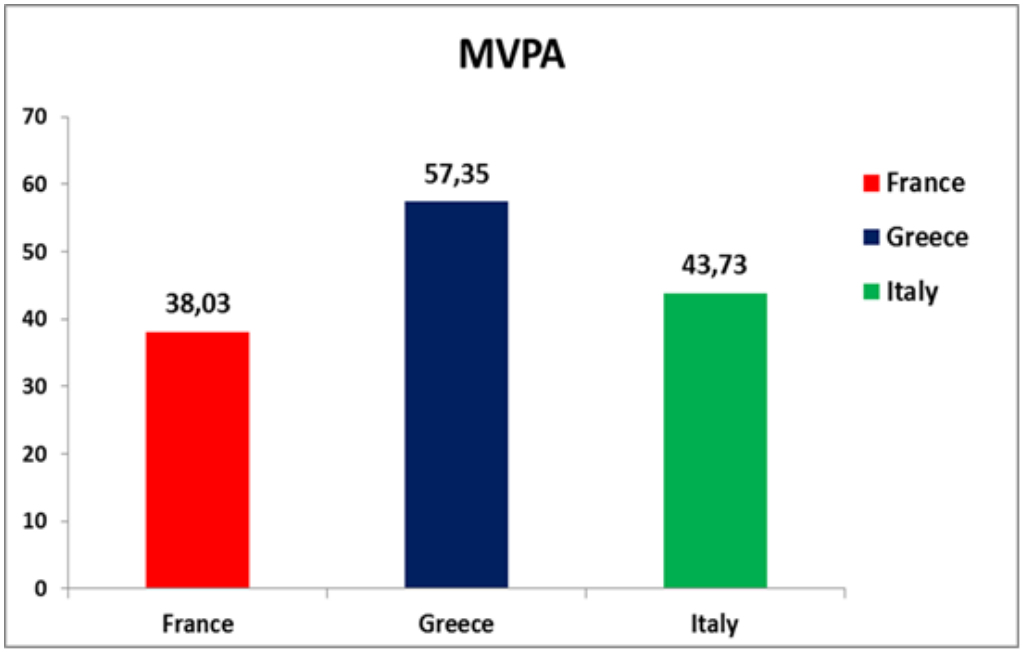

Figure 6.6. Differences in MVPA between the three countries

Days of Physical Education (PE) per week and objective Physical Activity (PA)

To investigate the relationship of days of PE per week with objective measure Moderate Vigorous PA (MVPA) a sample of pupils who wore the accelerometers in T1 (before intervention) for at least 6 days per week was selected. Moreover, to control for age effects on MVPA, from this sample only pupils aged 14-17 years old were selected, because in this subsample no age differences in MVPA emerged.

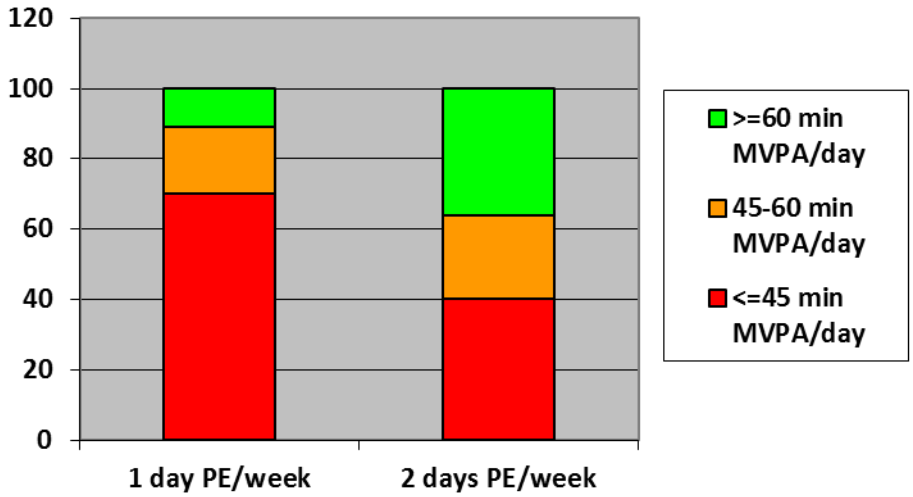

Figure 6.7. Relationship of days of PE/week with Moderate Vigorous PA for a sample of pupils 14-17 years old who wore the accelerometers for 6-8 days/week.

The resulting sample consisted of 62 pupils (n_1 = 37 pupils with one hour PE/week; n_2 = 25 pupils with two hours PE/week). As shown in Figure 6.7, in n_1 group of pupils (1 hour PE per week) there was larger percentage (70%) of quite inactive pupils (<= 45 minutes MVPA average per day) than the corresponding percentage (40%) of quite inactive pupils in n_2 group (2 hours PE per week) ($p < .02$). On the other hand, the percentage of physically active pupils (>=60 minutes MVPA average per day) was higher (36%) in n_2 group (2 hours PE per week) than the corresponding percentage (11%) of physically active pupils in n_1 group. This finding alongside the corresponding results concerning the relationship of days of PE per week and self-reports of PA (main Study in Chapter 4), underscore the importance of PE for adolescents' PA.

Differences between intervention and experimental group pupils in objective Physical Activity

Pupils were divided into two groups: experimental (*n* = 78) and control group (*n* = 52) based on whether their PE teacher took part on the online webinars and the implementation of the IMPACT project tasks or not respectively. Separate two-way analyses of variance with repeated measures, having as covariance pupils' age and gender, revealed no significant differences in all examined variables of PA (Sedentary time, LPA, MPA, VPA, MVPA, steps) due to time (pre, post), condition (experimental, control) or interaction between time and condition. Descriptive statistics (mean and standard deviation) of T1 and T2 accelerometer variables are presented in Table 6.4.

Table 6.4. Descriptive statistics between T1 and T2 accelerometer variables

	T1 Measure (Pre)		T2 Measure (Post)	
Variables (values per day)	**Experimental Group**	**Control Group**	**Experimental Group**	**Control Group**
MVPA	50.42 ± 19.03	44.95 ± 21.06	45.26 ± 20.46	41.06 ± 18.34
Steps	8432.51 ± 2605.70	7644.77 ± 2754.39	7956.42 ± 2828.54	7427.80 ± 2440.03

Notes. MVPA: Moderate to Vigorous Physical Activity

Seventy seven (n = 77) of those pupils who wore accelerometers both in Time 1 and 2 had also responded on Time 2 measure and the two items asking them whether their PE teachers implemented goal-setting programs in their classes (description is provided in Chapter 5). Based on their responses to these items we classified these pupils in four groups:

(1) Experimental and goal-setting (n = 20)
(2) Experimental and no goal-setting (n = 20)
(3) Control and goal-setting (n = 19)
(4) Control and no goal-setting (n = 17).

Repeated measures analyses of variance revealed that pupils in experimental and goal-setting PE classes slightly increased their vigorous PA in Time 2 while pupils' vigorous PA decreased in Time 2 in all other groups (Figure 6.8), but due to small sample size this difference is marginally significant $F(3, 13) = 2.17$, $p < .10$. No other significant differences emerged among the four groups.

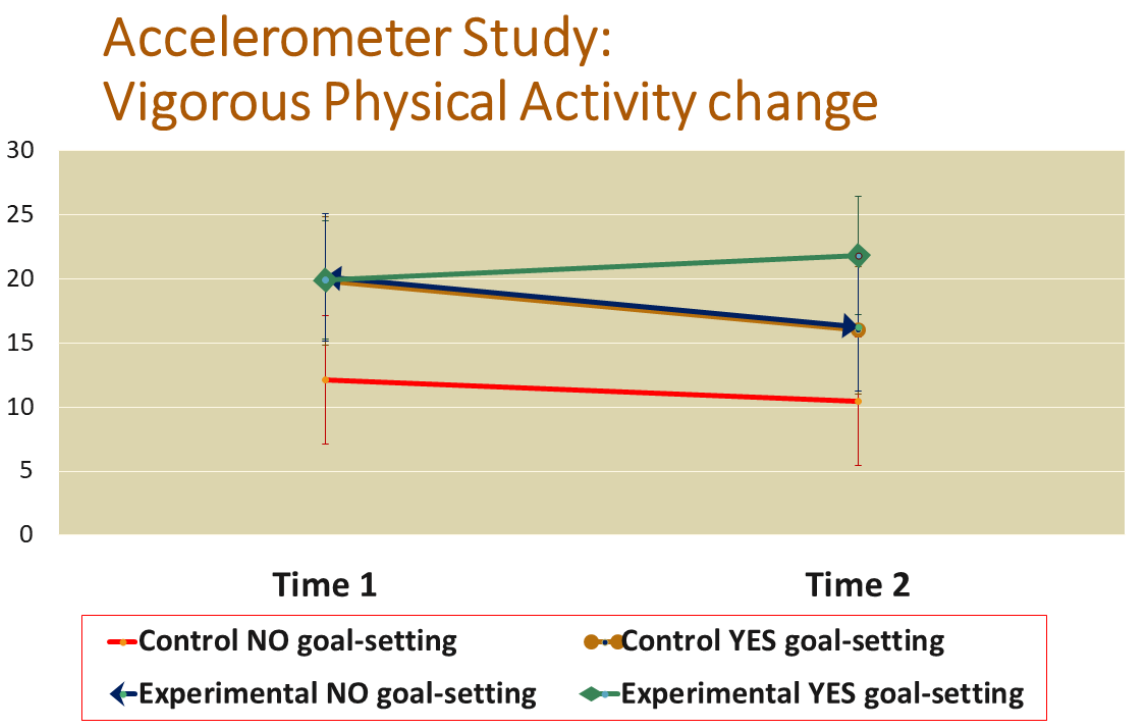

Figure 6.8. Average minutes per day of Vigorous Physical Activity in Time 1 and Time 2 across four groups differing on experimental condition and adoption of goal-setting program

Summary

The findings of the accelerometer study also revealed a disappointing picture about adolescents' physical activity in these three European countries.

- The percentage of pupils who almost never (0-1 days per week) reached the 60 minutes of daily MVPA was 54.3%.
- The percentage of pupils who did 60 minutes of daily MVPA for a minimum of three days in a week was just 28.2%.
- The trends in the accelerometer study were the same as in the preliminary study and in the main study involving much larger numbers of participants who reported PA on self-reports.
- Girls were even more inactive than boys.
- Older adolescents were even more inactive than pre-adolescents, whatever measure of physical activity was used, either objective or subjective.
- Days of PE per week was positively linked with objective measures of MVPA.
- There is some evidence that PE teachers in experimental groups who implemented the goal-setting program had more positive effects on adolescents' objective vigorous PA than PE teachers who did not implement goal-setting programs and PE teachers in control groups.