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GENDER DIFFERENCES IN HEART RATE RESPONSES TO DIFFERENT TYPES OF PHYSICAL ACTIVITY IN PHYSICAL EDUCATION CLASSES

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ABSTRACT

The purpose of this study was to investigate gender differences in children's physical activity levels during physical education (PE) classes. Specific attention was paid to differences between genders in the heart rate responses to different types of activities in PE classes. Activity levels were assessed by monitoring continuous heart rates, with results indicating that girls were significantly more active during PE than boys. Team sports in both sexes, and tennis in the case of the girls, fulfil the recommendations to occupy at least 50% of PE class time doing moderate and vigorous physical activities (MVPA). The results suggest that structured PE classes may provide different amounts of physical activity for both genders.
Key Words: adolescent, health promotion, moderate and vigorous activity.

RESUMEN

El objetivo de este estudio fue investigar las diferencias de género en los niveles de actividad física (AF) de una muestra de adolescentes, durante las clases de educación física (EF), prestando especial atención en las diferentes respuestas de la frecuencia cardíaca, en relación con diferentes tipos de actividades durante las clases de EF. Los niveles de AF fueron evaluados mediante la monitorización de la frecuencia cardiaca, obteniendo unos resultados en los que las chicas fueron significativamente más activas durante las clases de EF que los chicos. Los deportes colectivos en ambos sexos y el tenis en el caso de las chicas, cumplieron las recomendaciones, al menos el 50% del tiempo de la sesión realizando AF moderada o vigorosa (AFMV). Los resultados sugieren que las clases de EF pueden favorecer el aumento de los niveles de AF en ambos géneros.
Palabras Clave: adolescentes, promoción de la salud, actividad moderada o vigorosa.

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Introduction

As in many countries, inactivity is prevalent among the youth population in Spain (Ministry of Health and Consumer Affairs, 2006). The school setting provides important opportunities for children to be active, informally through play during school breaks, and formally through physical education (PE). Schools serve as an excellent venue to provide students with the opportunity for daily physical activity, to teach the importance of regular physical activity for health, and to build skills that support active lifestyles. Evidence which indicates that children's physical activity (PA) levels may have declined over time (Tremblay, Barnes, Copeland & Esliger, 2005) has led to an increased focus on the quantity and quality of PA that children experience during school PE lessons.

The significant role of PE in promoting health and enhancing PA is exemplified in the US Health of the Nation targets. These include three PE-related objectives, two of which are associated with increasing the number of schools providing and students participating in daily PE classes. The third objective is to increase the number of students engaged in moderate and vigorous physical activity (MVPA) for at least 50% of lesson time (Fairclough & Stratton, 2005). However, research evidence suggests that this criterion is somewhat ambitious. Young people in PE classes are spending too much time being physically inactive and many PE programs at school are not meeting the recommendations. Children, particularly boys, may be more active during recess than during PE classes (Sarkin, McKenzie & Sallis, 1997). Although PE classes can provide young people with a substantial percentage of the PA recommended for health purposes (Cavill, Biddle & Sallis, 2001), PE is not an important subject on the school curriculum in Europe (Gavarry, Giacomoni, Bernard, Seymat & Falgairette, 2003). Young people in PE classes are spending too much time being physically inactive and many PE programs at school are not meeting the recommendations. Children, particularly boys, may be more active during recess than during PE classes (Sarkin, McKenzie & Sallis, 1997).

Research indicates that children are engaged in MVPA for a relatively low proportion of PE time. In Britain, PA levels in PE lessons give cause for concern, with MVPA amounting to between 8% and 32% of lesson time (Simons-Morton, 1994). The American picture is similar, with MVPA amounting to between 18% and 37% of lesson time (McKenzie, Marshall, Sallis & Conway, 2000). These figures are markedly lower than the objective for at least 50% of PE lesson time to be spent on MVPA. In Portugal, boys and girls spend 51.6% and 48% of lesson time respectively on 45-min indoor PE doing MVPA (Wang, Pereira & Mota, 2005). No data exist for PA in PE lessons in Spain, and it is unclear what contribution these lessons really make towards recommended PA levels.

Several studies (Fairclough & Stratton, 2005; Kulinna, Martin, Lai & Kliber, 2003) noted a difference between boys and girls in daily PA levels in PE. Generally, boys spent a greater proportion of lesson time involved in MVPA than girls (Armstrong, 1998; Stratton, 1996).

Activity levels varied according to the content of PE classes (McKenzie, Sallis, Faucette, Roby & Kolody, 1993). Team games and fitness activities provided the highest percentage of MVPA during PE classes (Fairclough & Stratton, 2005; Laurson, Brown, Cullen & Dennis, 2008).

The purpose of this study was to assess adolescent PA levels during PE classes. The data were examined in relation to recommended levels of PA in order to ascertain whether or not PE could be effective in helping young people meet health-related goals. Specific attention was paid to differences between genders in the heart rate responses to different types of activities in PE classes. The specific research questions were: a) How active are students in PE lessons in terms of MVPA? b) How does the PA level vary with lesson context (focus of lesson) during PE? c Are the PA levels for boys higher than for girls during PE lessons?

Method

Participants

37 secondary school children (19 boys, with a mean age of 14.1 ± 0.4 years, and 18 girls, with a mean age of 14.3 ± 0.5 years) took part in this study. The school was selected because of their convenient accessibility to the researcher, and because it offered a structured health-related physical education curriculum taught by certified physical education specialists. Written informed consent to participate in this study was obtained from the subjects and their parent/guardian. The University of Zaragoza provided ethical approval for this research protocol.

Instruments

Anthropometric measures: Body mass index (BMI) was measured with a height-measuring device, the KaWe Personenmessgerät, Model no. 4444, and a SOEHNLE electronic scale, with an accuracy of +/-100g, model 7720, and calculated as the ratio of weight (kilograms) to standing height (meters) squared (kg/m2). The percentage of body fat was obtained from skin fold thickness measured at three sites (biceps, triceps and calf). All subjects were measured on the right side of the body with a Lange Skinfold Caliper (Cambridge Scientific Instruments, Cambridge, MA) by the same research worker. The percentage of body fat (% BF) was calculated using a prediction equation recommended for adolescents (Durnin & Womersley, 1974).

Heart rate data: The intensity of PA was estimated from continuous heart rate monitoring (HRM). We used HRM, (Polar Accurex, Polar Electro, Kempele, Finland), programmed to record heart rate (HR) at 5-s intervals. HRM has proved to be a valid and reliable measure of young people´s PA and an invaluable tool in the quantification and characterization of young people's PA patterns, and this has been demonstrated in young people (Achten & Jeukendrup, 2003; Freedson & Miller, 2000).

Physical education lessons: The frequency of PE lessons was twice a week, with a duration of 44.5 ± 3.4 minutes per class. PE class time included 10-min changing periods at the beginning and end of class.

The classes were directed by a specialist PE teacher, with an average of 10 years teaching experience. Teachers received no specific guidelines and followed their preplanned curriculum throughout the length of the study. All the classes took place between 9am and 2pm.

The different activities included fitness activities designed for health enhancement (e.g. resistance training, aquatics, interval running, medicine ball, abdominal workout), team sports (football, basketball and volleyball), dance (including all forms of dance such as jazz, tap, salsa, etc.), traditional games, outdoor activities (e.g. mountain bike, skiing) and tennis. In order to allow statistically meaningful comparisons between different types of activities, students were classified as participants in activities with similar characteristics. These were team games, fitness and individual activities.

Procedure

Data were collected throughout one academic year, from September 2008 to June 2009. Resting Heart Rate (RHR) was obtained on non-PE days, measured while the students lay in a supine position (radial pulse) over a 1-minute period and throughout seven consecutive days. The average heart rate recorded was defined as the RHR.

The maximal heart rate (HR_{max}) was the highest heart rate value measured during the 20-m Shuttle Run Test (Léger & Lambert, 1982). HR was continuously monitored during the 20-m Shuttle Run.

The heart rate reserve (HRR) was calculated as a percentage of the difference between the RHR and HRmax. Using HRR values, 50%-85% HRR thresholds were calculated. The 50%-85% HRR threshold represents MVPA (Stratton, 1996), which is the recommended intensity of health-related activity (Biddle, Cavill & Sallis, 1998). The percentage of lesson time spent in MVPA was calculated for each child and for every PE lesson by adding the time spent with a 50%-85% HRR threshold.

The children's heart rates were measured during PE classes. The subjects were trained for two weeks in the use of HRM. A total of 64 physical education classes were analyzed. For data to be considered valid criteria, it was established that monitoring should take up at least 30 minutes of every PE lesson. At the end of the lessons, HRM was withdrawn and the data downloaded for analysis.

Data processing and statistical analysis

The data were processed using the SPSS for Windows (v 15.0) statistical package. Student gender and activity type were the two independent variables in the statistical analysis. The percentage spent with a threshold of 50%-85% of HRR were analyzed using analysis of variance (ANOVA), (gender X activity type).

Simple effects analysis was used to determine where differences occurred within interactions, as appropriate. Follow-up one-way ANOVAs were used to examine the differences in any significant main effects, using the Scheffe post-hoc test to identify where significant differences occurred. The alpha level was set at $p<0.05$ for all statistical analyses.

Results

Descriptive statistics of the participants are shown in Table 1. There were no significant sex differences in age, weight, height, BMI, HRmax and 50%-85% HRM, but girls had a significantly greater sum of skin folds and RHR than boys ($p<.05$).

Table 1
Anthropometric values and HR subjects. Mean (DS).

	Boys (n=19)	**Girls** (n=18)
Age (years)	14.0 (0.4)	14.0 (0.5)
Height (m)	1.6 (0.8)	1.5 (0.5)
Weight (Kg)	53.0 (9.3)	52.1 (7.5)
BMI (Kg.m^2)	19.8 (1.8)	20.3 (2.2)
Sum of skin folds (mm)	18.7 (3.6)	22.2 (2.6)*
RHR (bpm^{-1})	60.0 (5.2)	64.0 (7.4)*
HR_{max} (bpm^{-1})	208.0 (7.1)	205.0 (6.8)
50% HRR (bpm^{-1})	134.0 (9.0)	134.5 (9.3)
85% HRR (bpm^{-1})	185.8 (6.6)	183.8 (5.0)

Note. Values are mean values (standard deviation) *$p<0.05$ boys vs. girls. Abbreviations: RHR: Resting Heart Rate; HR_{max}: Maximal heart rate; HRR: Heart Rate Reserve

Table 2 shows mean values for HR, minutes and percentage between 50%-85% HRR by gender across activity during PE classes.

TABLE 2
Mean (SD) heart rate, minutes and percentage between 50%-85% HRR by gender across activity

Activity type	Gender	HR (bpm^{-1})		MIN MVPA		% MVPA	
		M	SD	M	SD	M	SD
Fitness	Boys	134	10.5	16.4	6.1*	37.0	1.8*
	Girls	141	11.3	20.4	7.0	46.0	5.0
Team sports	Boys	124	10*	25.4	5.2	57.3	3.0
	Girls	154	9.9	26.7	5.0	60.0	4.0
Dance	Boys	112	13.7*	8.4	8.0*	19.1*	3.5*
	Girls	127	21.3	17.9	14.0	40.4	2.0
Games	Boys	124	20.8	13.4	10.6	30.3	2.9
	Girls	125	18.6	14.9	12.0	33.7	3.3
Outdoor Activ.	Boys	128	17.4*	14.4	11.4	32.5	2.0
	Girls	137	17.0	16.4	9.0	37.0	2.9
Tennis	Boys	132	10.3*	18.9	10.0*	42.6	3.0*
	Girls	140	11.1	22.9	9.0	51.6	5.0
	Boys	128.8	19	16.0	20.0	35.9	8.8
Total	Girls	134.6	20*	19.0	22.0*	42.6	9.0*

Note. HR mean heart rate; percentage range 50% to 85% HRR; M= mean; SD= standard deviation; Outdoor Activ. = outdoor activities; MIN MVPA minutes in moderate and vigorous physical activity; % MVPA, percentage in moderate and vigorous physical activity
Asterisks (*) indicate significant differences by gender within activity groups.

During PE classes, the average daily monitoring (HR) period was significantly different ($p<.05$) between sexes, with a mean value for boys of 128.8 ± 19 bpm^{-1} and for girls of 134.6 ± 20 bpm^{-1}.

Simple effects analysis for gender and activity type revealed that boys and girls' HR differed significantly during team sports and individual activities (dance, outdoor activities, tennis), (Table 2), with girls reporting a greater HR in PE classes than boys in team sports (154 ± 9.9 vs. 124 ± 10.0 bpm^{-1}), dance (127 ± 21.3 vs. 112 ± 13.7 bpm^{-1}), outdoor activities (137 ± 17.0 vs. 128 ± 17.4 bpm^{-1}), and tennis (140 ± 11.1 vs. 132 ± 10.3 bpm^{-1}), ($p< .05$).

When all PE activities were considered together, the students engaged in MVPA for 40.6 ± 3.2 minutes (min) of lesson time. The girls engaged in MVPA for 44.7 ± 3.7 min of lesson time whereas the boys´ value was 36.4 ± 2.7 min ($p<.05$).

The students (boys and girls) participated in most MVPA during team sports: 25.4 ± 5.2 min (boys) and 26.7 ± 5.0 min (girls); tennis 18.9 ± 10.0 min (boys) and 22.9 ± 9.0 min (girls); fitness, 16.4 ± 6.1 min (boys) and 20.4 ± 7.0 min (girls).

PA recommendations for health (i.e. 50% of the PE class time spent on MVPA) were achieved for both boys and girls (Table 2). In general the PE class does not meet established recommendations. However, the ratios were higher for girls than for boys during team sports activities (57.3% ± 3.0 (boys) and 60.0% ± 4.0 (girls), and for girls only during tennis lessons (51.6% ± 5.0). Significant gender differences were evident in fitness, dance and tennis. Girls participated in more MVPA during fitness (46.0 ± 5.0% of PE lesson time p<.05), dance (40.4 ± 2.0%, p<.05) and tennis (51.6 ± 5.0, p<.05) than boys.

When all PE activities with similar characteristics were considered (Figure 1), significant gender differences were evident in fitness and individual activities. Girls spent a greater proportion of lesson time involved in MVPA than boys, in fitness activities (46.0 ± 5.0%) and individual activities (40.6 ± 3.3%) than boys (p<.05).

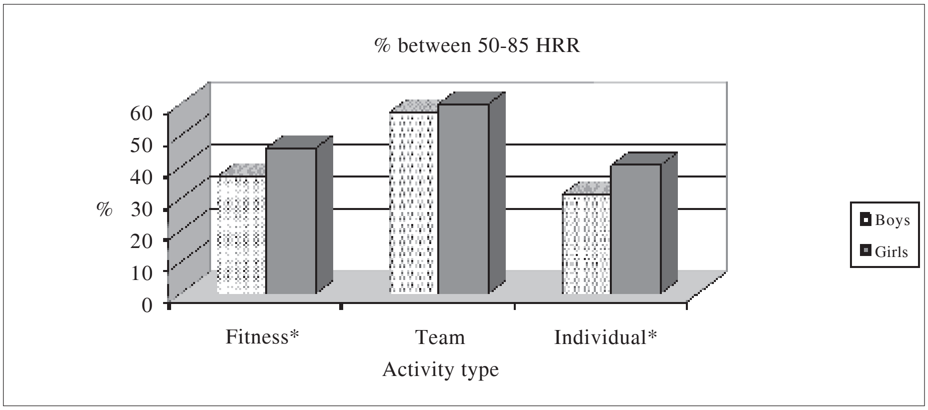

FIGURE 1. Percentage between 50%-85% HRR in PE classes by gender

Asterisks (*) indicate significant differences within the activity type with a percentage range of 50%-85% HRR for male and female students.

DISCUSSION

This is a cross-sectional study using HR telemetry to assess PA levels during a range of high school PE lessons. The study has provided the first accurate estimates for Spain of adolescents' PA in the PE setting and demonstrates that PE is falling short in meeting Healthy People 2010 goals for PE. The results of our study show that girls have more MVPA than boys during PE classes. Only PE classes whose didactic content concerns team sports in both sexes, along with tennis in the case of the girls, fulfil the recommendations to spend at least 50% of their PE class time on MVPA.

PE is the only legislated program where, at least in principle, children have equal and equitable access to PA. School PE programs have a dual challenge to provide students with opportunities to be active and an ordered sequence of educational experiences that lead them to choose active lifestyles as adults. MVPA of at least 50%-

85% HRR is considered to be appropriate for PE curriculum goals for promoting PA, but the mere presence of PE in the curriculum does not guarantee activity. As PA decreases, likewise the frequency of PE classes has also been shown to be less than desirable (Booth, Bauman, Owen & Gore, 1997). The physical inactivity problem does not begin at the school gate and does not end on the way out of school. Nevertheless, school PE is the societal program responsible for training and socializing the nation's youth to be physically active.

In our study during PE lessons, girls reached a 4.5% higher mean HRR than boys. These results were similar to those found in other studies (Gavarry et al, 2003). These differences might be explained by a higher percentage of body fat in girls (Baquet, Berthoin & Van Pragh, 2002).

Studies carried out regarding intensity in the PE class show different results. The PE class offers neither enough volume nor intensity for PA according to the latest recommendations (Cavill et a., 2001), as a significant part of each class is dedicated to low intensity activities, along with other activities such as getting changed, showering and organization.

Although several studies (Fairclough & Stratton, 2005; Kulinna et a., 2003; Stratton, 1997) have noted a difference between boys and girls in daily PA levels in PE, or studies that show insignificant gender differences (Sarkin, McKenzie & Sallis, 1997; Wang, Pereira & Mota, 2005), our results regarding a greater participation of girls - similar to some previous studies - show that girls exercise more frequently and intensely in organized activities such as PE classes (Gavarry et al, 2003). These results suggest that the structure of this environment helps to improve PA engagement in the case of girls.

While girls achieved their highest HR scores during team sports and fitness activities, boys achieved their highest HR values during fitness activities and tennis. Our results do not differ from those previously reported by Kulinna et al, (2003), who found that HR differed with gender and activity type. In contrast, Fairclough and Stratton (2005) found no association between gender and activity type.

Levels of MVPA during PE classes were similar to those reported in previous studies (Fairclough, 2003) and did not meet the U.S. Department of Health and Human Services criterion (50% of lesson time). Student activity and intensity vary according to the content of PE lessons, as our study demonstrates. Lesson context, length and child gender also appear to influence PA levels in PE (McKenzie et al., 1995).

While other studies (Laurson et al., 2008) show that fitness and game activities account for the longest periods of time between 50%-85% HRR, our study shows that these activities correspond to team sports and tennis in both sexes. This was also true for other studies (Fairclough & Stratton, 2005, Stratton 1996), in which it was found that most of the activities meeting the guideline were team sports.

Our results differ from those previously reported (Mota, 1994; Trost et al, 2002; Stratton, 1997), which show that boys are more active than girls at all ages and that girls tend to be habitually less active than boys, in a different activity context, such as structured sports and PE.

Despite the acknowledged importance of PE, trends from several studies suggest that PE is in decline (Pratt et al., 1999). These trends are troubling considering the potential benefits of enhanced PE programs for children. The continual challenge is that other competing pressures in schools get more attention and funding (Welk et al., 2006). Currently there is a strong argument for more time to be committed to the «core academic» learning areas of literacy, numeracy and information technology (Sibley & Etnier, 2003). The lack of documentation of program effectiveness for PE and the increasing pressures for improved academic performance have made it difficult for decision-makers to position PE strongly enough in the school hierarchy. Research has consistently shown that additional time spent on PA does not detract from academic performance (Sibley & Etnier, 2003).

Curricula in PE have shifted to focus more directly on the promotion of lifelong PA. Contemporary curricular programs now emphasize training in the physical and behavioral skills that children need to acquire so as to be physically active later in life. PE education as an institution has been targeted by public health agencies as a promising setting for youth PA interventions.

Recent surveys have confirmed the longstanding domination of the secondary school PE curriculum by competitive team games (Cale, 2000). With the exception of football for boys, none of the major competitive team games feature in the top five activities young people aged 6 to 16 prefer to participate in during out-of-school time (Welsman & Armstrong, 2000). In fact it is worth noting that the activities preferred by both boys and girls are either individual sports or require one opponent, with cycling and swimming, for instance, being the two most popular activities regardless of sex, with skating, walking and tennis also proving to be popular. This discrepancy between preferred out-of-school activities and activities offered in school is significant in light of the view expressed by members of the ICCPAGA panel (Sallis & Patrick, 1994) that one of the key rationales for promoting PA in adolescents is to promote PA on order to enhance future health by increasing the probability of remaining active in adult life.

In view of the reduction in PE in European schools, scepticism about the extent to which school-based PE is really in a position to solve the current problems of sedentary habits is justified. Although PE is still mandated in Spain's state schools, high-school levels of participation in school PE are declining, both in terms of enrolment and the number of classes students have per week. This reduction in curriculum time limits the potential of physical education to influence adolescents' PA.

The results of the current study should be interpreted in the light of the following limitations. The use of focus groups and restricting participant demographics to certain school levels and specific ethnic groups limit the generalizability of our findings to other young people. The cross-sectional nature of the study may limit our ability to make causal inferences. Therefore, caution should be exercised in interpreting the results of a cross-sectional study in the absence of longitudinal data.

Another limitation in the use of HRR to estimate children's participation in PA, however, is that HR is also influenced by cardio-respiratory fitness, psychological state, and temperature, and in the cardiopulmonary stress of PA, so that over short periods of time brief elevations in heart rate may be caused by stressors other than PA, such as transient emotional responses, for instance.

This study supports the theory that boys and girls need special intervention to provide adequate levels of PA and additional intervention strategies may be required, especially for boys during PE classes. These results also support continued advocacy to improve the PE curriculum to allow more opportunities for PA during school hours.

Allowing student input in determining the content of PE classes may help ensure that PE provides a more positive PA experience, especially for females (Hoepa et al., 2006). Both the quantity and the quality of school PE need to improve in order to encourage children to engage in a substantial amount of PA. These include activities favored by boys, single-sex activities, and different motivational and instructional techniques. The mismatch between young people's preferred physical activities and those offered in the school curriculum may be one of the keys for promoting PA in adolescents. Quality/improved physical education programs are needed to increase physical competence, health-related fitness, self-esteem and enjoyment of physical activity for all learners so that they can be physically active throughout their entire lifetime. Increasing PA levels in adolescents is vital to improve the health of the future population of Spain.

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