INFLUENCE OF SCHOOL SCHEDULES ON PHYSICAL ACTIVITY PATTERNS IN PRIMARY SCHOOLCHILDREN: A CASE STUDY IN ITALY

Running head: School schedule and Physical Activity in children

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BRIEF REPORT

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Abstract

Background: Considering the relevant amount of time spent by children at school, it is essential to ensure that suitable levels of physical activity (PA) are guaranteed. This study aimed to assess possible changes induced in the amount and type of PA performed following the two schedules in Italian primary schools, namely regular and full time (30-40 h/week respectively).

Methods: A sample of 169 children wore a tri-axial accelerometer 24h/day for 7 consecutive days. Raw data were processed to calculate the number of steps, amount and intensity of the PA performed in morning, afternoon and evening time slots.

Results: During weekday afternoon times (1:30 – 4:30 PM), children attending the full-time schedule spent significantly less time in sedentary behavior with respect to those who attend the regular time (54.7% vs. 60.0%, $p<0.001$) and more time in moderate-to-vigorous activity (18.0% vs. 15.0%, $p=0.004$). No differences between morning and evening times were found.

Conclusions: The structure of the full time schedule, which includes a second recess, promotes higher and more intense levels of PA during the afternoon. Such information represent a useful input in planning differential PA activities for children attending the regular time to achieve similar PA levels for the whole school population.

The analysis of primary school time organization in European countries reveals the existence of a wide variety in the number of daily and yearly lesson hours. Although the prevalent schedule is based on 4-5 daily hours 5-6 days/week,[1-2] the timetable can be arranged in either one or two lesson periods that may take place in the morning only or in both morning and afternoon. In the latter case, the two lesson periods are interspersed by a midday break for lunch, which can be taken at home or directly at school. In some countries, afternoon time slots are reserved for extra-curricular activities only.

In this context, the situation in Italy is quite peculiar because, at the time of enrollment, parents are free to choose between two schedules, i.e. “regular time” (30 h/week Monday to Saturday, 8:30 AM to 1:30 PM) and “full time” (40 h/week Monday to Friday, 8:30 AM to 4:30 PM). The latter option was introduced in 1971 basically to meet two specific needs of families, namely the impossibility of parents to leave their workplace at midday to take children from school and the difficulties (especially in the case of low-education family environments) in properly supporting children during homework tasks. Since its introduction, the full time schedule has gained increasing popularity so that currently approximately one third of the primary school population opts for this kind of schedule.[3] In northern and central regions of the country, children attending the full time schedule are the majority.

Although there are no differences in terms of time dedicated to frontal lessons (which amounts for all children to 27 h/week not considering the recesses), after 1:30 PM children who attend the full time schedule follow a fixed timetable that includes lunch (1h), a second recess (1h) and 2 additional hours of afternoon lessons, while regular time leaves families free to organize their children’s activities. It is unknown to what extent these differences impact physical activity (PA) patterns, as structured activities (e.g. attending a sport training session) typically start in early afternoon. Thus the full-time school schedule may represent a sort of barrier against participation in PA or, at very least, a reduction of the allowable time slot for this purpose. Unfortunately, no specific studies have thus far targeted this issue.

Objective quantitative measurement and classification of both amount and intensity of PA in primary schoolchildren are often performed using wearable miniaturized accelerometers,[4] which are currently available at an affordable price and allow continuous data acquisition up to several weeks. A number of studies have been carried out with this technique to assess the extent of sedentary behavior,[5-7] which is closely related to obesity, to investigate the effects of specific changes in PA levels,[8] to analyze the influence of the school setting and environmental factors[9-11] and verify the differences in PA patterns referring to lessons/recess and in/out school time.[12-16]

This approach appeared suitable for this study, whose main purpose was to quantify PA levels in a sample of primary schoolchildren to clarify whether a different school-schedule could originate different patterns of PA during different periods of the day while keeping unchanged the other external variables associated with the school environment. Our hypothesis was that while the morning time is characterized by the same activities for all children, and thus no differences in PA levels would be expected, some alterations would be evident in the afternoon-evening periods.

Methods

Participants

The study was performed from November 2015 to February 2016 in an inner city public primary school located in Cagliari (Sardinia, Italy 154,478 inhabitants). Initially, the whole school population (473 families of 1st to 5th grade children) was informed about the purposes of the study through dedicated meetings and flyers. Of these, 202 (43%) expressed interest in participating and signed an informed consent form after a detailed explanation of the methodology to be used. The study was carried out in compliance with the ethical principles

for research involving human subjects expressed in the Declaration of Helsinki, and was approved by the local ethics committee (authorization no. PG/2015/16965).

As the primary goal of the study was the objective quantification and classification of PA, the main exclusion criterion was the existence of severe musculoskeletal or neurological diseases that could impair everyday activities (in particular walking). However, none of the potentially interested children was affected by such conditions, as reported by their parents.

Participants were enrolled in both school schedules, namely regular and full time. Table 1 shows the detailed schedules of the two options.

Please insert Table 1 approximately here

Data collection and processing

A tri-axial accelerometer (Actigraph GT3X, Acticorp Co., Pensacola, USA) was employed to collect data on PA. Each child was supplied with a unit on a Monday morning and asked to wear the device on the dominant wrist for 7 consecutive days 24h/day, instructing him/her to remove it only for showering, water-based sports (i.e. swimming, water polo etc.) and contact sports in all cases in which the accelerometer might possibly cause injury to the child or the performed activity might damage the device. The choice of the wrist as the site of placement was made to increase wear time compliance and provide data on sleep.[17-18] Having 20 devices available, each week we randomly selected 10 children attending regular time and 10 attending full time schedules.

The accelerometers were set to collect data using 10-s epochs and 30 Hz frequency. At the end of the measurement period, raw data were processed using ActiLife software v6.13.2 to perform step counts and PA classification on the basis of the cut-points defined by Crouter, Flynn & Bassett[17] for the acceleration vector magnitude (VM) defined as follows:

$$VM = \sqrt{x^2 + y^2 + z^2}$$

where x, y and z are the accelerations recorded by the device in each of the three directions. In particular, we used the VM regressive model that classifies PA as follows: sedentary (SB, VM ≤ 100), light (LPA, VM = 101-609), moderate (MPA, VM = 610-1809) and vigorous (VPA, VM>1809). Moderate-to-vigorous PA (MVPA) was calculated by summing MPA and VPA. The weekday percentage of time spent on each PA category and the number of steps were calculated for morning (8:30 AM – 1:30 PM), afternoon (1:30 – 4:30 PM) and evening (4:30 – 10:30 PM) time slots. During the morning, students attending both types of schedule perform the same activities, while only full time students are at school in the afternoon slot.

Anthropometric data necessary to initialize the device (i.e. stature and body mass) were recorded using an ultrasonic digital height meter (Soehnle 5003, Soehnle Germany) and a digital scale (RE310, Wunder, Italy). The Body Mass Index (BMI = weight/stature^2) was calculated and children were classified as normal weight, overweight or obese according to the cut-off points defined by Cole et al.[19]

If daily wear time exceeded 16 h/day for the entire week of the test, the acquired data were deemed valid, and the child participated in the subsequent analysis. Non-wear time was defined as a time interval of at least 60 consecutive minutes of zero counts.

Statistical Analyses

The differences in PA induced by the school schedule were assessed using one-way multivariate analyses of variance (MANOVA) performed using SPSS software (v.20, IBM, Armonk, NY, USA). The independent variable was schedule (regular/full time) while the 4 dependent variables were the number of steps and the percentage of time spent in SB, LPA and MVPA.

The level of significance was set at p=0.05 and effect sizes were assessed using the eta-squared coefficient (η^2). Follow-up analyses were conducted using one-way ANOVAs for each dependent variable by setting the level of significance at p =0.0125 (0.05/4) after a Bonferroni adjustment for multiple comparisons. The analysis was performed for each time slot.

Results

Of the 202 children wearing the accelerometer, 33 (16.3%) did not meet the required wear-time criterion and were excluded from the analysis. In most cases, non-compliant participants reported that they were sick or forgot to wear the device after personal hygiene or a training session and then put it on again after a few days. Thus, the subsequent analysis refers to 169 children (76 boys, 93 girls, age 8.6±1.5) all Caucasian. Their main anthropometric features and device wear times are shown in Table 2. The sample included 16 overweight and obese children (7 boys, 9 girls, 9.5% of the whole sample). The whole study took approximately 11 weeks to be completed.

Please insert Table 2 approximately here

Summary results are provided in Table 3 for Monday through Friday. MANOVA revealed a significant effect of school schedule for the afternoon [$F_{(4,164)} = 2.74$, p =0.03, Wilks λ= 0.94, $\eta^2 = 0.06$] and morning [$F_{(4,164)} = 4.99$, p =0.001, Wilks λ= 0.89, $\eta^2 = 0.11$] but not the evening [$F_{(4,164)} = 1.17$, p =0.33, Wilks λ= 0.97, $\eta^2 = 0.03$].

Please insert Table 3 approximately here

Follow-up ANOVA carried out for the afternoon slot showed that significant differences involved the time spent in SB, which was less in the full-time students (54.7% vs. 60.1, $p<0.001$), while they were characterized by a higher percentage of MVPA (18.0% vs. 14.9%, $p=0.004$). For the morning slot, ANOVA revealed that no parameter reached statistical significance after the Bonferroni correction.

Discussion and conclusions

Examining the overall PA patterns in the accelerometric data, one notes that the number of daily steps (~12600) and the average time spent in SB by the children tested calculated on the whole day basis (~ 63%) agree well with those of similar studies.[5-7,20] Interestingly, the percentage of MVPA in our sample (~14%) is higher than the average values by 6-8% reported in large European and American epidemiologic studies.[5,6,20,21] Two possible reasons for such differences are the limited presence in our cohort of overweight/obese children, who are usually characterized by the lowest percentage of MVPA[22] and favorable environmental conditions (Cagliari has a mild climate throughout the year) that allow recess mostly outdoors, so children can participate in more intense activities.[11]

Our hypothesis of the existence of differential patterns of PA depending on the school schedule is partly confirmed by our data: full-time schoolchildren spend significantly less time in SB and more time in MVPA in the afternoon. This can be associated with differences in the way the post-lunch time is arranged by families compared to the structured activity organized by the school. The presence of a second 1h long recess is likely to result in more intense PA levels for children still at school, in agreement with previous studies, in which recess time was found to be one of the main contributors to overall MVPA.[12-14] In contrast, regular time schoolchildren appear to use this time basically to do their homework or relax, play videogames or watch TV. This results in larger proportions of SB, thus making after-school time (or out-

of-school time in general) the most critical periods in which interventions targeted to increase PA levels should be directed.[16,23]

Some limitations of the study are to be acknowledged: firstly, as previously mentioned, the tested sample included a suspiciously limited number of overweight/obese children. In fact, a previous study, recently performed by the authors on a larger sample of children of the same school, showed that the percentage of overweight/obese individuals was 30%,[24] a value much higher than the 9.5% that was observed in the present investigation. We hypothesize that overweight children (and possibly their families) might have been somewhat reluctant to be evaluated, as their condition embarrasses them, similarly to what was observed in previous studies as regards anthropometric measurements.[25] Secondly, as only 20 devices were available, it was impossible to test all the participants in the same week. Although we took care to deliver the accelerometers to an equal number of full and regular time children each week (i.e. 10 of full time and 10 of regular time), changes in environmental conditions while passing from autumn to winter may have influenced the results, at least in absolute terms. Moreover, the fact that water and accidental impacts may damage the accelerometer certainly influenced the quality of collected data, as children engaged in swimming, waterpolo and contact sports were asked to remove the device during their training. This likely resulted in underestimation of their PA levels. However, considering the fast advancements in the technology of wearable activity trackers, we think that it will soon become possible to overcome some of these limitations. At last, unfortunately we did not have access to socio-economic status data of the families of the tested children, and this factor is known to have a relevant influence on PA levels, as demonstrated in previous studies.[26-27] For all these reasons, and also considering that the sample here tested refer to an inner city residential area, our results may not be generalizable to different geographic and socio-economic contexts, such as rural areas. Future studies should investigate the effects of such variables (i.e. obese/overweight, low/high income, urban/rural area) on the overall PA levels for children who attend different school schedules, and also

verify the propensity of the schools in encouraging them to be engaged in PA activities during recesses.

In conclusion, the results presented here highlight the role of the school schedule as an important determinant of PA levels in primary schoolchildren, especially in terms of time spent in SB and MVPA. While in the specific case of the Italian school system the imbalances observed between full-time and regular-time children could be corrected with proper measures, which should include a suitable afternoon PA program dedicated to regular-time students, it is reasonable to hypothesize that other kinds of flexible schedules existing in other countries may create similar phenomena.

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Table 1 Details of the two school schedules available for primary schoolchildren in Italy

School Schedule		
	Regular Time (RT)	**Full Time (FT)**
Entry	8:25 AM	8:25 AM
Lessons (1st block, RT, FT)	8:30 - 10:30 AM	8:30 - 10:30 AM
First Recess (RT, FT)	10:30 - 10:45 AM	10:30 - 10:45 AM
Lessons (2nd block)	10:45 - 1:30 PM	10:45 - 12:30 AM
Lunch (FT)	-	12:30 - 1:30 PM
End of Lessons (RT)	1:30 PM	-
Second Recess (FT)	-	1:30 - 2:30 PM
Lessons (3rd block, FT)	-	2:30 - 4:30 PM
End of Lessons (FT)	-	4:30 PM

Table 2 Anthropometric and demographic aspects of the participants. Values are expressed as mean±SD.

	Regular Time	**Full Time**	**p-value**
Participants # (M,F)	90 (42M, 48F)	79 (34M, 45F)	-
Age	8.7 ± 1.5	8.4 ± 1.5	0.226
Stature (cm)	131.7 ± 11.3	130.3 ± 11.0	0.428
Body Mass (kg)	28.7 ± 7.4	28.6 ± 8.2	0.883
Body Mass Index (kg m^{-2})	16.3 ± 2.2	16.5 ± 2.4	0.642
Weekly Accelerometer Wear time (min)	9219 ± 686	9156 ± 627	0.153

Table 3 Physical activity patterns for the morning, afternoon and evening time slots during weekdays. Values are expressed as mean±SD. The symbol * denotes statistical significance after Bonferroni correction ($p<0.0125$)

Physical Activity Patterns

	Morning (8:30 AM - 1:30 PM)			Afternoon (1:30 PM - 4:30 PM)			Evening (4:30 PM - 10:30 PM)		
	Regular Time	*Full Time*	*p-value schedule*	*Regular Time*	*Full Time*	*p-value schedule*	*Regular Time*	*Full Time*	*p-value schedule*
Sedentary (%)	65.11 ± 9.16	64.94 ± 10.13	0.910	60.04 ± 9.93	54.73 ± 11.11	**<0.001***	65.04 ± 9.25	63.48 ± 9.81	0.291
Light (%)	23.89 ± 5.50	25.55 ± 6.49	0.074	24.96± 6.05	27.26 ± 5.94	0.014	19.44 ± 4.96	20.90 ± 5.14	0.062
MVPA (%)	10.99 ± 4.72	9.5 ± 4.64	0.041	14.99 ± 6.12	18.00 ± 7.68	**0.004***	15.52 ± 5.97	15.61 ± 6.51	0.926
Steps (#)	4358 ± 933	4237 ± 894	0.394	2971 ± 699	3242 ± 728	0.014	5188 ± 1275	5266 ± 4143	0.705

* denotes statistical significance after Bonferroni correction ($p<0.0125$)