

The effect of bilingual Physical Education on students' Physical Activity. Things are not always as they seem

El efecto de la Educación Física bilingüe sobre la actividad física del alumnado.
No todo es lo que parece

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CÓMO CITAR EL ARTÍCULO:

Salvador-García, C., Chiva-Bartoll, O., & Colomer-Diago, C. (2020). The effect of bilingual Physical Education on students' Physical Activity. Things are not always as they seem. *Cultura, Ciencia y Deporte*, 15(43), 53-61.

Fecha Recepción: junio de 2018 • Fecha Aceptación: diciembre de 2018

Abstract

One of the priorities of ET2020 is to increase the efficiency of teaching through the Content and Language Integrated Learning (CLIL) approach. In Physical Education (PE), it is still not crystal clear whether sessions that involve CLIL undergo such substantial modifications that the amount of physical activity in the lessons is jeopardized when compared with ordinary Physical Education lessons. The objectives of this study were: (1) to determine the difference in Moderate to Vigorous Physical Activity (MVPA) between a CLIL and a non-CLIL group; (2) to analyse the progression of MVPA during a PE unit; (3) to analyse the possible differences in MVPA between males and females. A quasi-experimental design was implemented. The sample consisted of 48 from a Spanish secondary school, divided into a CLIL group and a non-CLIL group. GENEActiv Accelerometers were used to objectively measure their MVPA. The results showed significant differences in favour of the CLIL group, whose average MVPA was higher than that of the non-CLIL group. In conclusion, the results suggest that CLIL may be a valid approach to use in PE without compromising students' physical activity.

Key words: Physical Education, CLIL, Physical Activity, Accelerometers, Approach.

Resumen

Una prioridad del ET2020 es incrementar la eficiencia de la enseñanza mediante el Aprendizaje Integrado de Contenidos y Lenguas Extranjeras (AICLE). En Educación Física (EF) aún no parece claro si las sesiones mediante AICLE se ven tan modificadas como para alterar significativamente la cantidad de actividad física del alumnado en comparación con clases ordinarias. Los objetivos de este estudio fueron: (1) determinar la diferencia de Actividad Física Moderada-Vigorosa (AFMV) entre un grupo AICLE y otro no-AICLE; (2) analizar la progresión de AFMV durante una unidad de EF; (3) analizar las posibles diferencias en AFMV entre chicos y chicas. Se utilizó un diseño cuasi-experimental. La muestra estaba compuesta por 48 estudiantes de un instituto de educación secundaria español, divididos en un grupo AICLE y otro no-AICLE. Para medir objetivamente los niveles de AFMV se utilizaron acelerómetros GENEActiv. Los resultados indicaron diferencias significativas a favor del grupo AICLE, cuya media de AFMV fue mayor que la del grupo no-AICLE. En conclusión, los resultados apuntan a que AICLE podría ser un enfoque válido en EF, puesto que no necesariamente pone en riesgo la actividad física del alumnado.

Palabras clave: Educación Física, AICLE, actividad física, acelerómetros, enfoque pedagógico.

Introduction

Changing trends require adjustments of educative models, which usually come together with shifts in legal frameworks. One of the priorities of ET2020 is to increase the efficiency of teaching through the Content and Language Integrated Learning (CLIL) approach. According to Coyle, Hood, and Marsh (2010, 1), CLIL is defined as a 'dual focused educational approach in which an additional language is used for the learning and teaching of both content and language', and linguistic contents should be naturally integrated within the specific subject matter. Therefore, CLIL has three different goals, which are learning content, language, and skills, all of which have to fit into the context where it is implemented (Mehisto, Marsh, & Frigols, 2008).

Since CLIL was launched in the 1990s, the European Commission and the Council of Europe have funded many initiatives to support it, in response to a need in Europe to enhance second-language education and multilingualism (Marsh, 2002). Therefore, CLIL is one of the trendier methodological options in the Foreign Language teaching setting. For example, the Netherlands and Spain have invested a lot in CLIL or similar methodologies that also encourage language learning through content (Coral, Lleixà, & Ventura, 2016; Dalton-Puffer, 2011; van Kampen, Admiraal, & Berry, 2018) and it is also being trialled in non-european countries such as Australia, Taiwan or Thailand among many others (Cross, 2014; Kewara, 2017; Turner, 2013; Yang, 2015).

CLIL is not only a trend in education in general, but also in the Physical Education (PE) field (Baena & Granero, 2015; Brooke, 2015; Ceallaigh, Mhurchú, & Chróinín, 2017; Gruber, 2015). This tendency can be perceived at a scientific level, considering the growing body of research on this topic (see Salvador, Chiva, & Isidori, 2017, for review). Moreover, at a practical level, the European award for languages in 2007 was obtained by a project entitled 'A CLIL Experience in Primary School: Teaching French through a games strand of the PE Curriculum'.

A number of researchers have reported both advantages and disadvantages of using CLIL, which Pérez-Cañado (2016) has called the 'pendulum effect'. Specifically in the case of the subject of PE, Martínez and García (2017) wondered if this area would be distorted and its sessions misused due to the incorporation of CLIL. Similarly, Coral and Lleixà (2016, 16) wondered whether the goals of the PE curriculum would be achieved differently if taught in the first language or through the CLIL approach. In this regard,

some authors have mentioned that this approach might cause learning delays (Coral, 2010, 2012) related to acquiring less knowledge linked to the subject (Hernando, 2015). In this case, if the PE program is not applied properly, it may negatively affect learners' physical activity time (Lynott, 2008), which is a key factor in the acquisition of the contents of this particular subject (Martínez & García, 2017; Sánchez-Bañuelos, 1992).

In light of these questions, research is needed that examines how teaching content in a second language affects the non-linguistic area (Cenoz, Genesee, & Gorter, 2014; Coral & Lleixà, 2016). In the case of PE, movement is one of its key features (Ayuso, Rivero & Izquierdo, 2018; Gill et al., 2016; Larsson & Nyberg, 2017) and promoting physical activity is one of its primary goals (Dodd, 2015; Heikinaro-Johansson, Hasanen, McEvoy, & Lyyra, 2018; Molina, Queralt, Estevan, & Sallis, 2016; Viciano, Mayorga, & Mompeán, 2016), being movement understood in its wide and inclusive sense (Svennberg, 2017). In this regard, Coral et al. (2017) conducted a pilot study that aimed to measure the time that students were physically active in PE with CLIL through an observation tool. They conclude that motor-engaged time is lower than what is recommended by educational authorities and suggest that the shortfall in the amount of physical activity time may be accounted for by the excessive use of language support materials or the types of physical activity involved in the lessons.

Several studies have concluded that PE lessons currently play a decisive role in the amount of physical activity children and adolescents do because these classes may be their only opportunity to engage in a minimal amount of physical activity (Gill et al., 2016; Martínez et al., 2012; Meyer et al., 2011; Molina et al., 2016). Therefore, PE has been highlighted as an important way to promote a healthy and active lifestyle among young people (Hall-López et al., 2017; Lonsdale et al., 2013, Rivera-Sosa & Arras-Vota, 2015). Particularly, previous research states that students should spend 50% of their time in PE lessons engaged in moderate to vigorous physical activity (MVPA) (Fröberg, Raustorp, Pagels, Larsson, & Boldemann, 2017; Ha, Lonsdale, Ng, & Lubans, 2017; Murillo, Julián, García, Abarca, & Zaragoza, 2014) because this is the level associated to health benefits (Martínez et al., 2012). Nevertheless, a review paper concluded that few schools meet international recommendations about the minimum MVPA time per session (Fairclough & Stratton, 2005). In the same vein, in their recent systematic review and meta-analysis of MVPA levels in secondary school PE lessons, Hollis et al. (2017) concluded that students

spend 40.5% of the time in MVPA, which is below the 50% recommended by the US Centre for Disease Control and Prevention and the UK Associations for Physical Education.

Because the PE class is said to be crucial for performing and promoting physical activity, and CLIL approach is currently gaining relevance in many countries (Salvador et al., 2017), researchers should question whether the sessions involved in PE through CLIL undergo such substantial modifications that the amount of physical activity performed in the lessons is jeopardized. The literature has already focused on some factors that may affect the MVPA in PE such as sex, motivation, structure, or content, among others (Mesa, Guzmán, & Vázquez, 2011; Molina et al., 2016). In addition, the use of CLIL may involve some other modifications, such as giving extra instructions (Chiva & Salvador, 2016; Coral, 2013; Gómez & Jiménez, 2012), including the four linguistic skills (Coral, 2012; Hernando, 2015, Salvador & Chiva, 2017) or using language support materials to facilitate communication (Coral et al., 2017), which might alter the time students are engaged in MVPA.

In the present study, we used MVPA levels based on other studies focused on examining physical activity in PE field. Measuring MVPA levels through accelerometry makes it possible to arrange objective data in order to compare the results of the two groups in the present study (CLIL vs non-CLIL), and compare these results to those from previous studies on physical activity in PE lessons. Particularly, this research is focused on Secondary education in the Spanish context, where, due to the introduction of multilingualism in the educational system, the use of CLIL to learn English as a second language is widespread and even legally required in several regions. Currently, Spanish education is particularly sensitive to European initiatives about language policies. In fact, in the last decade, countries such as Finland, Germany or Sweden, seem to have progressively enhanced multilingualism. Therefore, there is a need to understand how the introduction of CLIL approach might affect the essence of PE.

The main aim of this study is to analyse the influence of CLIL on the physical activity of students in PE lessons objectively. To do so, three specific objectives have been established: (1) to study the differences in the MVPA between a CLIL group and a non-CLIL group when learning the same curricular content; (2) to analyse and compare the progression of the amount of MVPA in CLIL and non-CLIL groups during the six lessons of one unit; and (3) to analyse the differences between males and females in their MVPA. We

hypothesized that the non-CLIL group would spend more time in MVPA and its progression of the amount of MVPA during the six lessons would be higher than the CLIL group. Moreover, we also hypothesized that there would be differences between males and females on their MVPA in favour of the males.

Method

Research Design

A quasi-experimental approach was used to objectively test (through accelerometer measures) the intensity of physical activity using a non-equivalent control group design (Campbell & Stanley, 1963). Intact classes were used for assignment to the CLIL and non-CLIL groups. However, classes were randomly assigned to each group by the secondary school. Moreover, similar conditions were established in order to compare them; that is, two intact groups in a public secondary school were taught the same athletic contents by the same PE teacher.

Participants and Settings

This study was conducted in a Spanish public secondary school located in an average socioeconomic area during the 2016/2017 academic year. A convenience sample was used, consisting of 48 13-14-year-old students (born in 2003) divided into the CLIL group (13 females and 9 males) and the non-CLIL group (19 females and 7 males). There were no differences in sex between the two groups, $\chi^2 (N = 48) = 1.05, p = .306$. The CLIL group had never been taught PE through CLIL before. Regarding English language level, students of both groups have the same educational background. One of the students in the CLIL group had a visual impairment, and so his data were excluded from the statistical analyses. However, the results did not change when this student's data were included.

Each group had two PE periods per week; classes were 50 min long, and all of them were held in the morning. Data recruitment took place from January to February 2017. Accelerometer-based outcome measures were taken from all the students in the class. PE classes in both groups were taught by a PE teacher with 12 years of experience who had been teaching through CLIL for several academic years. She has an official certificate that enables her to teach PE through the English language.

Study approval was obtained from the University and the school district. The principal and the PE teacher

agreed to participate through the establishment of a memorandum of understanding. Informed written consent was obtained from the adolescents' parents or guardians.

Procedure

Prior to the beginning of the study, the PE teacher attended a 120-minute meeting with the researchers to clarify all the instructional and experimental procedures related to the study. The teacher was responsible for both the CLIL intervention group and the non-CLIL control group in an attempt to control for potential 'teacher-related' confounds. She was told to teach the same content to both groups, but one of them would be taught through CLIL approach. An experienced external observer conducted practice observations of the lessons of both groups to verify that they were carried out as planned. Moreover, through this observation, the 'planning and observation checklist' for CLIL (Mehisto et al., 2008) was completed to ensure that the *hard* CLIL approach applied was accurate (Ball, 2009; Griva & Kasvikis, 2015). The students and teacher were aware of the different methodologies used, but they were blind to the specific objectives of this study. The idea was that they were to act as naturally as possible in order to gather authentic data.

To control for differing durations of PE lessons, physical activity data were collected during the entire 50-minute lesson because the English language was used with the CLIL group during this period of time. Prior to starting each PE session, accelerometers were distributed to students and worn for the entire class time.

The unit

Both the CLIL and non-CLIL units were focused on athletics combining *discovery teaching*, *self-check teaching* and *direct teaching styles* (Kirk, McDonald, & O'Sullivan, 2006). This content has been implemented before through CLIL approach (Griva & Kasvikis, 2015; Hortigüela & Hernando, 2015), and it was selected in this study because it is considered one of the most common and widespread contents in PE curricula around the world (Ginciene & Matthiesen, 2017), therefore it enables the replicability of the investigation. Each unit consisted of six lessons presented in the same order and in the same setting (indoors/outdoors). The specific content of each session was the following: session 1 (S1) race and race walking techniques, (S2) relays, (S3) hurdles, (S4) long jump

and triple jump, (S5) triple jump and shot put, (S6) review of all the events practiced. Each lesson consisted of a 10-min warm-up, followed by skill-related practice, and ending with a 5-min self-assessment task in both groups. Nevertheless, the CLIL group usually added a couple of tasks focused on communication and language use that were often performed during waiting time periods. Lessons were developmentally appropriate for the designated grade level, and their scope and order were arranged to build skills and abilities sequentially. Evaluation was based on effort, improvement, and performance scores. All the lessons were taught independently by the class teacher while a researcher acted as observer. All the sessions were held in the morning.

Instrument

Accelerometers have been found to be one of the most objective tools to measure the amount of physical activity (Calahorro et al., 2015), and they have been increasingly used to measure the physical activity of school children (Rowlands et al., 2014). In fact, there has recently been an increased use of wrist-worn devices to measure physical activity in different settings (Fairclough et al., 2016). We assessed physical activity using the GENEActiv Original triaxial accelerometer worn on the left wrist. Accelerometers are easy to move, very accurate, and do not interfere with the lessons (Calahorro et al., 2015), and they are valid and reliable tools (Molina et al., 2016). In fact, accelerometers have been validated for both children and adolescents, and they are considered the most appropriate tool to measure physical activity (Martínez et al., 2012). A number of studies have already used them for this purpose (Calahorro et al., 2015; Lopes, Santos, Mota, Pereira, & Lopes, 2017; Martínez et al., 2012; Molina et al., 2016; Murillo et al., 2014). In this particular study, the GENEActiv accelerometers were configured with a sampling frequency of 100 Hz, data uploaded, and the .bin files converted to 1s epoch .csv files using GENEActiv PC software version 3.1. The 1s epoch files were imported into custom-built spreadsheets in Excel. Laboratory-based studies have developed cut-off points (sedentary, light, moderate, and vigorous) for the wrist-worn GENEActiv, and supported its validity for estimating energy expenditure and time spent at different activity intensities in adults (Esliger et al., 2011; Pavey, Gomersall, Clark, & Brown, 2016) and children (Phillips, Parfitt, & Rowlands, 2013). The time spent on MVPA was calculated applying previously calibrated and validated cut-off points from Phillips et al. (2013).

Data analysis

In accordance with the literature, the analyses were conducted by unifying the moderate and vigorous categories into the MVPA variable. The general MVPA variable showed a normal distribution, so a Mixed-model Analysis of Variance (mixed ANOVA) was conducted to examine whether the time spent in MVPA differed between groups (first objective) and sessions (second objective), with group as between-subject factor (2 levels: CLIL and non-CLIL) and sessions as within-subject factor (6 levels: sessions 1-6), followed by Bonferroni-adjusted pairwise comparisons. Finally, sex effects were analysed with a Factorial 2x2 ANOVA, using group and sex as independent variables, and time spent in MVPA as dependent variable.

Results with p values $<.05$ were considered statistically significant. Partial eta squared effect sizes (η^2) were reported. The data analyses were performed using IBM SPSS Statistics, Version 23 (SPSS Inc., Chicago, IL).

Results

The mixed ANOVA conducted to evaluate the effect of group and sessions on MVPA showed a statistically significant main effect for Group ($F(1,46) = 24.58$, $p < .001$, $\eta^2 = .348$), Session (Wilk's Lambda (Λ) = .038, $F(5, 42) = 211.46$, $p < .001$, $\eta^2 = .962$), and the Group x Session interaction (Wilk's Lambda (Λ) = .211, $F(5, 42) = 31.32$, $p < .001$, $\eta^2 = .789$).

Regarding the first objective, the significant effect for Group indicates that adolescents in the CLIL group ($M = 1034.29$, $SD = 138.28$) spent significantly more time in MVPA than those on the non-CLIL group ($M = 816.12$, $SD = 128.52$).

The second objective focused on the session effect and the group x session interaction. Regarding the session effect, post-hoc analyses showed statistically significant differences between all the sessions ($p < .001$), except the last two (S5 and S6), which were also the sessions where more time was spent on MVPA. For the interaction effect, post-hoc analyses showed statistically significant differences between the CLIL and non-CLIL groups in the last three sessions: S4 ($p < .001$), S5 ($p < .001$), and S6 ($p < .001$), whereas there were non-significant differences in S1 ($p = .431$), S2 ($p = .257$) and S3 ($p = .053$). The CLIL group had higher mean scores than the non-CLIL group on the significant variables, which means that the CLIL group spent significantly more time in MVPA than the non-CLIL group in the last three sessions (see Figure 1).

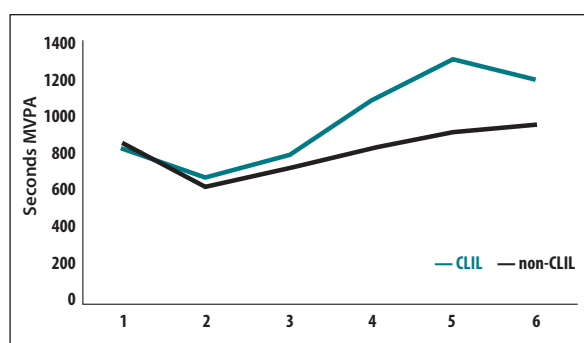


Figure 1. Time (seconds) spent in MVPA by CLIL and non-CLIL groups during the six lessons of the Unit.

Finally, the Factorial ANOVA conducted to test the third objective showed that there was a sex effect ($F(1,44) = 13.31$, $p = .001$, $\eta^2 = .232$). MVPA was higher in males ($M = 1025.11$, $SD = 203.32$) than in females ($M = 861.62$; $SD = 123.98$). The Group x Sex interaction for MVPA did not reach statistical significance ($F(1,44) = 2.93$, $p = .094$, $\eta^2 = .062$). It is worth noting that the MVPA mean of CLIL females ($M = 955.50$; $SD = 62.16$), was higher than the MVPA of non-CLIL males ($M = 866.95$, $SD = 158.63$).

Discussion

The current study was designed to determine the effect of the implementation of CLIL approach on the amount of MVPA performed by the students during PE lessons. The results are discussed, taking into account the three specific objectives established.

The first hypothesis established that the time spent in MVPA would be higher in the non-CLIL group than in the CLIL one. Our results indicate that the overall amount of MVPA time of the CLIL and non-CLIL groups presented a significant difference. However, unexpectedly, the CLIL group presented higher levels of physical activity than the non-CLIL group. It is interesting to understand and discuss this result because some authors have argued that CLIL would negatively affect learners' physical activity time (Coral, 2013; Coral et al., 2017; Lynott, 2008). Some of the explanations for our results are related to linguistic adjustments by the teacher, such as using shorter and less complex utterances (Gruber, 2015, Salvador & Chiva, 2017) or giving clear and simple instructions (Gómez & Jiménez, 2012). Moreover, according to Zindler (2013), the use of a foreign language may force the teacher to limit him/herself to the essential message, and at the same time, students have to listen more carefully. Another possible explanation for this result is the fact that because students are more mo-

tivated by participating in CLIL programs (Doiz, Lasagabaster, & Sierra, 2014; Salvador & Chiva, 2017), they might be more willing to participate in their PE lessons.

Independently from the non-CLIL group, the current study found that the group that attended PE classes with CLIL approach devoted 17.24 minutes of the lesson (34.48%) to MVPA on average. This finding is consistent with other studies that have also measured the levels of physical activity in PE lessons; for example, primary school children in Switzerland spent 16.7 minutes on MVPA (Meyer et al., 2011), primary and secondary school students in Brazil spent 12.3 minutes (Kremer, Reichert, & Hallal, 2012), and secondary school students in Spain spent 11.8 minutes (Molina et al., 2016). All of them measured MVPA in non-CLIL lessons with similar durations to ours (50 minutes). Moreover, the meta-analysis conducted by Hollis et al. (2017) concluded that secondary school students spend 34.7% of the lesson in MVPA. Although there are subtle differences, it can be perceived that the amount of MVPA time spent by the CLIL group in PE seems to agree with previous research that studied regular PE lessons. Thus, it can be suggested that CLIL approach does not notably alter students' MVPA time.

However, we should be cautious about our results because physical activity levels during PE sessions might depend on a range factors. Several studies have been carried out to measure the amount of physical activity in different settings (Molina et al., 2016). For example, in a PE with CLIL setting, Coral et al. (2017) found that, on average, students spent 41,8% of the class physically engaged in the fifteen lessons analysed. Nevertheless, they conducted the study using an observation tool and, although they provide very interesting results, their study did not identify the intensity level. Taking into account non-CLIL settings and focusing on a specific content, Harvey et al. (2016) developed TGM basketball sessions of 50 minutes each and concluded that they provided between 25-35 minutes of MVPA over the course of a week. This finding agrees with our results because the two sessions implemented every week involve up to 32.77 minutes of MVPA for CLIL students. Moreover, Murillo et al. (2014) found that in the lessons devoted to athletics, the average MVPA time was 14.2 minutes for a secondary school group. Therefore, this study may serve as a mirror for our analysis, and CLIL approach does not seem to have decreased the amount of MVPA.

Another factor that might influence physical activity levels is class size. Whereas Molina et al. (2016) mentioned that groups with more than 25 pupils are related to more time spent in MVPA, McKenzie

et al. (2000) stated that large class size negatively affects MVPA time. Our study included only two classes with similar sizes: CLIL group (n=23), non-CLIL group (n=26). Studies with more groups should be conducted to analyse the influence of class size on CLIL. When comparing groups in general, class-level factors such as the sex distribution might enhance or diminish activity levels during PE class (Aelterman et al., 2012). However, these explanations cannot be used in our case because the sex distribution does not differ significantly, and the class topic was exactly the same.

The second hypothesis established that the progression of the amount of MVPA during the six lessons of the PE unit would be more accentuated in the non-CLIL group. The results show that both groups progressively increased the amount of MVPA during the six lessons; however, the CLIL group's progression was significantly different from the non-CLIL group. More specifically, in the first three lessons, both groups had a similar MVPA, whereas in the last three lessons, the CLIL group spent more time than the non-CLIL group in MVPA. The unexpected difference in the evolution of the MVPA of the CLIL and non-CLIL groups during the sessions of the unit might be explained by the fact that the experimental group was not familiar with CLIL approach in the beginning. Ha et al. (2017) determined that their experimental group was not familiar with teaching rope skipping activities (a new content) initially. Moreover, these authors mentioned that 'teachers had to spend more time to manage students while implementing rope skipping activities' (p. 192), which might provide some possible explanations for our findings. In this regard, our CLIL group might have been unfamiliar with CLIL approach during the first sessions; as they became used to it, the physical activity time could have been optimized. In the same vein, Emmanouilidou and Laskaridou (2017) found that after a few weeks of using CLIL approach, students began to feel safer, more confident, and more used to using language for and through learning, which in our case might be related to having the chance to spend more time engaged in MVPA.

The third hypothesis, that established that males would spend more time on the MVPA than females, was confirmed. Our results corroborate the findings of a large amount of previous work in this field, since it seems that boys tend to be more active than girls on average (Harvey et al., 2016; How, Whipp, Dimmock, & Jackson, 2013; Kremer, et al., 2012; Meyer et al., 2011; Molina et al., 2016). However, some studies did not find such clear differences (Fröberg et al., 2017; Ha et al., 2017). Ha et al. (2017) perceived that

females increased their physical activity more than males, although they concluded that it was due to the content (rope skipping). Moreover, it is interesting to point out that girls in the CLIL group presented a higher MVPA-level mean than the boys in the non-CLIL group.

Generally, girls and boys tend to show a discrepancy in their attitudes and motivation when learning a foreign language (Clark, 1995; Doiz, et al., 2014). Girls usually show more motivation and involvement in learning tasks requiring verbal interaction. Therefore, as CLIL seems to present a more motivating challenge for girls (Fernández-Barrionuevo, 2017; López Rúa, 2006), its implementation in PE could have positively influenced their commitment to the subject and, consequently, increased their levels of MVPA.

All these assumptions should be interpreted taking into account certain limitations to overcome in future investigations. First, the results should be interpreted with caution because the sample size was small, and only two groups were included. Second, the findings refer to a specific unit within a specific content, and so they might not be transferable to every group and/or school using CLIL. Third, our study obtained the data by measuring a short period of time. Nevertheless, to minimize these limitations, our research objectively measured all the students in both groups (which few studies do).

Conclusion

Educational research must guarantee new educative models. Regarding the topic that concerns us, language learning, and particularly the use of CLIL approach, has achieved an undeniable relevance. One of the main concerns that has received the use of this approach in PE subject is related to the reduction of physical activity levels. In this regard, we have studied the effects of CLIL on physical activity during PE classes. The results show promising preliminary evidence for the use of the CLIL approach in PE classes. The use of a second language in PE classes through CLIL does not necessarily entail a decrease in the physical activity level; indeed, in our results it is increased. Nevertheless, further research might explore some issues that remain unclear, such as MVPA measured with different curricular contents and its evolution over longer periods of time. Another possible progression in this line of research could focus on complementing its design with observational methodology.

Funding

This work was supported by SPIEDA project of the University Jaume-I (Reference number-3256); and UJI-PRE-DOC Grant FPI-UJI (Programa 541-A).

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