DOI 10.26773/jaspe.240104

Journal of Anthropology of Sport and Physical Education

ORIGINAL SCIENTIFIC PAPER

Face-to-face versus online physical education classes: A comparative study

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Abstract

Physical education (PE) curriculum is consisted of specific motor content that requires practice and movement. The main goal of the PE curriculum is development of motor abilities. The objective is to compare the effectiveness of both – face-to-face and online PE classes, in achieving the main goal of the PE curriculum. Data were extracted from the archive of records of the academic transcripts for 118 participants – school adolescents aged 14-15 years: 1) N=56 students (32M & 24F) from the academic year 2018/2019 (face-to-face classes); and 2) N=62 students (34M & 28F) from the academic year 2020/2021 (online classes). Motor abilities (abdominal muscle strength, lower back muscle strength, upper limbs muscle strength, lower limbs muscle strength, explosive leg power and flexibility of lower back and hamstring muscles) were assessed at the beginning and at the end of the second school term. Percentage change between the beginning and the end of the second school term in terms of these particular motor abilities was calculated as proposed by Weir & Vincent (2021). Subsequently, Student's t-test was applied to compare the changes induced by face-to-face and online PE classes. Cohen's D was also calculated to assess the magnitude of the difference between the changes induced by face-to-face and online PE classes. All statistical analyses were performed with SPSS 23 statistical package. Higher improvement in abdominal muscle strength, lower back muscle strength and explosive leg power was induced by face-to-face classes. These findings indicate that face-to-face classes appear to be more effective than the online PE classes.

Keywords: *evaluation, physical education, curriculum, adolescents, face-to-face classes, online classes*

Introduction

Physical education (PE) curriculum is clearly distinct from general knowledge-based subjects since it is mainly based on motor contents which require practice and movement (Ekberg, 2020). PE provides the opportunity for regular and structured physical activity participation (Fairclough & Stratton, 2005). Moreover, for some sedentary children and adolescents, PE classes represent the most important context in which they experience physical exercise and motor challenges (Ramer et al., 2021). Therefore, PE classes are mandatory at both - primary and secondary levels (Ekberg, 2020). However, PE classes require special preparation, communication and delivery in order to achieve the required goals (Jeong & So, 2020).

The main goal of the PE curriculum is to develop motor abilities (Fairclough & Stratton, 2005). Motor abilities are specific abilities that allow performing motor skills, affect performance

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and are also very important for the activities of the daily living (Fairclough & Stratton, 2005). For instance, strength, explosive leg power and flexibility are among the most essential abilities which contribute to the development of locomotor skills and facilitate the activities from everyday life (Liu et al., 2023). During PE classes students take part in sport and physical activities, they gain sufficient knowledge, as well as they get physically literate and motivated to stay physically active outside school and throughout life (Fairclough & Stratton, 2005). In addition, delivered contents during PE classes should provide a diverse range of physical exercise so that students will have the opportunity to improve their motor abilities, skills and performance (Silva et al., 2018). To achieve this, PE teachers are sometimes required to adapt PE classes and modify teaching methods according to: class size, available space, organizational strategies and content (Landi et al., 2016).

During academic 2020/2021, PE classes almost all over the world were held online (Ferri et al., 2020). Along with the coronavirus disease (COVID-19) outbreak and World Health Organization (WHO) declaring a pandemic on 11th of March 2019, many changes in educational environments were initiated as they began teaching online classes (Dhawan, 2020; Ferri et al., 2020). Teachers used digital devices and online platforms in order to deliver educational contents to students (Roe et al., 2021). Digital communication infrastructure was an obvious prerequisite for integrating online education while students were distanced from their classrooms (Ferri et al., 2020). However, many schools faced difficulties to provide one-to-one (1:1) access - meaning one digital device per student (Blikstad-Balas & Davies, 2017; Gil-Flores et al., 2017; Blikstad-Balas & Klette, 2020). Thus, inadequate digital infrastructure was a key barrier for successful implementation of online education (Bingimlas, 2009; Gil-Flores et al., 2017).

Recent study that evaluated the advantages and disadvantages of online and face-to-face PE, reported difficulties in the delivery of the content, as well as reduced movement capability during online classes as compared to face-to-face classes (Nyberg et al., 2022).

Based on previous findings and taking in consideration the specificity of PE content, our objective is to compare the effectiveness of face-to-face and online PE classes in achieving the main goal of the PE curriculum, i.e., development of motor abilities in school adolescents. More precisely, we will examine muscle strength (abdominal, lower back, upper limbs and lower limbs), explosive leg power and flexibility (lower back and hamstring muscles).

Methods

In order to realize the particular objective, an approval to access the archive of records of the academic transcripts of students at 9th grade was obtained from the principal of the Elementary School Dimkata Angelov Gaberot - Vatasha, Kavadarci (Macedonia). Participation consents from the parents of each student that participated in the study were obtained as well. The study was realized in accordance with the Helisnki Declaration.

Participants

Data were extracted for 118 participants – school adolescents from the Elementary School Dimkata Angelov Gaberot - Vatasha, aged 14-15 years (14.67±0.72). N=56 students (32M & 24F) from the academic year 2018/2019 who attended face-to-face classes, and N=62 students (34M & 28F) from the academic year 2020/2021 who attended online classes. All measurements and evaluations were performed by the PE teacher as regular evaluations required by the PE curriculum, and with respect to all prevention and protection protocols due to COVID-19. They were performed twice – at the beginning and at the end of the second school term of the corresponding academic year.

Instruments

Anthropometric characteristics (height, body mass and BMI) were measured according to WHO manual (WHO, 2007). Participants were barefoot and wearing light clothes during the measurement procedure. Height was measured using a wall mounted stadiometer (SECA SE206). Body mass was measured with a calibrated digital scale (TANITA TBF 300). BMI was calculated from height and body mass as follows: .

Muscle strength (abdominal, lower back, upper limbs and lower limbs), explosive leg power and flexibility (lower back and hamstring muscles) were assessed by applying the modified EUROFIT testing battery (EUROFIT, 1993) proposed by Jovanovski (1998): (1) Abdominal muscle strength test (AMST): abdominal crunches in 1 min; (2) Lower back muscle strength test (LBMST): back extensions in 1 min; (3) Upper limbs muscle strength test (ULMST): push-ups in 1 min; (4) Lower limbs muscle strength test (LLMST): squats in 1 min; (5) Standing long jump (SLJ): standing long jump (cm); (6) Flexibility test (FT): flexibility of lower back and hamstring muscles (cm).

Online PE classes

During the academic year 2020/2021 PE classes were held online. PE teachers were delivering content through video demonstration on the online platform "Microsoft Office Teams". Teachers were using free videos that were available online in order to visualize the specific content. After demonstrating and verbally explaining the content to the students, the class continued with an interactive discussion and implementation of the current content in "home exercising" conditions.

Face-to-face PE classes

During the academic year 2018/2019 PE classes were held face-to-face. PE teachers were delivering content in-person, and students were attending PE classes at the sports establishments of the school. At the beginning of each class, students were doing the general and the specific warm-up consisted of activities that aimed to prepare the cardiovascular system for the up-coming effort during the class, as well as exercises that increased the range of motion of the particular parts of the body that are going to be implied during the main curricular activity of the current class.

Data analysis

Kolmogorov-Smirnov test was applied to test the normality of the distribution. Appropriate statistical methods were used to calculate descriptive statistical parameters. Percentage change between the beginning and the end of the second school term in terms of motor abilities was calculated as proposed by Weir & Vincent (2021). Subsequently, Student's t-test was applied to compare the changes induced by face-to-face and online PE classes. Cohen's D was also calculated to assess the magnitude of the difference between the changes induced by face-to-face and online PE classes. All statistical analyses were performed with SPSS 23 statistical package (SPSS Inc, Chicago, IL, United States). Significance level was set to $p<0.05$.

Results

According to Table 1, 2, 3 and 4, data of students attending face-to-face and online classes are normally distributed, with a normal asymmetry considered when values for Skewness are in range between -1.00 to 1.00, and Kurtosis values that are in range between -3.00 to 3.00 as proposed by Kallner (2013).

Table 1. Descriptive statistical parameters of school-children at the beginning of the school term – face-to-face PE classes

	N	Min	Max	X	SD	Skewness	Kurtosis	K-S
Body mass (kg)	56	43.00	88.00	56.97	13.21	0.72	-0.16	p > 0.20
Height (cm)	56	160.00	185.00	169.70	6.87	0.84	1.28	p > 0.20
BMI	56	15.67	26.73	20.28	4.49	0.79	-0.46	p > 0.20
AMST (rep)	56	20.00	42.00	30.63	6.89	0.32	-1.18	p > 0.20
LBMST (rep)	56	10.00	35.00	22.75	6.81	-0.03	-0.55	p > 0.20
ULMST (rep)	56	3.00	17.00	10.44	3.83	-0.04	-0.55	p > 0.20
LLMS (rep)	56	25.00	40.00	35.13	4.10	-0.99	1.19	p > 0.20
SLJ (cm)	56	105.00	240.00	168.44	36.41	0.28	0.28	p > 0.20
FT (cm)*	56	29.00	64.00	42.25	11.19	0.75	-0.60	p > 0 .20

*Variable with an opposite metric orientation

Table 2. Descriptive statistical parameters of school-children at the end of the school term – face-to-face PE classes

	N	Min	Max	X	SD	Skewness	Kurtosis	K-S
Body mass (kg)	56	43.00	86.00	56.48	14.26	0.81	-0.15	p > 0.20
Height (cm)	56	160.00	185.00	169.70	6.87	0.84	1.28	p > 0.20
BMI	56	15.67	25.90	20.14	4.43	0.76	-0.44	p > 0.20
AMST (rep)	56	20.00	42.00	30.63	6.89	0.32	-1.18	p > 0.20
LBMST (rep)	56	10.00	35.00	22.75	6.81	-0.03	-0.55	p > 0.20
ULMST (rep)	56	3.00	17.00	10.44	3.83	-0.04	-0.55	p > 0.20
LLMS (rep)	56	25.00	40.00	35.13	4.10	-0.99	1.19	p > 0.20
SLJ (cm)	56	105.00	240.00	168.44	36.41	0.28	0.28	p > 0.20
FT (cm)*	56	29.00	64.00	42.25	11.19	0.75	-0.60	p > 0.20

*Variable with an opposite metric orientation

Table 3. Descriptive statistical parameters of school-children at the beginning of the school term - online PE classes

	N	Min	Max	X	SD	Skewness	Kurtosis	K-S
Body mass (kg)	62	41.00	90.00	57.69	14.26	0.81	-0.15	p > .20
Height (cm)	62	158.00	185.00	167.56	7.03	0.95	1.34	p > .20
BMI*	62	14.70	28.80	20.45	4.43	0.81	-0.44	p > .20
AMST (rep)	62	20.00	42.00	31.00	6.58	0.32	-1.07	p > .20
LBMST (rep)	62	15.00	30.00	21.13	5.18	0.49	-0.82	p > .20
ULMST (rep)	62	3.00	17.00	10.56	4.11	-0.17	-0.92	p > .20
LLMS (rep)	62	25.00	40.00	33.75	4.84	-0.62	-0.56	p > .20
SLJ (cm)	62	105.00	240.00	171.88	37.50	0.11	0.01	p > .20
FT (cm)*	62	26.00	60.00	42.81	11.31	0.07	-1.29	p > .20

*Variable with an opposite metric orientation

Table 4. Descriptive statistical parameters of school-children at the end of the school term - online PE classes

	N	Min	Max	X	SD	Skewness	Kurtosis	K-S
Body mass (kg)	62	44.00	90.00	57.78	13.77	0.73	-0.35	p > 0.20
Height (cm)	62	158.00	185.00	167.56	7.03	0.95	1.34	p > 0.20
BMI	62	14.77	28.93	20.47	4.31	0.79	-0.41	p > 0.20
AMST (rep)	62	20.00	42.00	29.63	6.35	0.27	-0.16	p > 0.20
LBMST (rep)	62	15.00	30.00	21.69	4.01	0.10	-0.02	p > 0.20
ULMST (rep)	62	3.00	20.00	11.06	4.65	0.38	-0.52	p > 0.20
LLMS (rep)	62	25.00	42.00	35.06	5.16	-0.34	-0.96	p > 0.20
SLJ (cm)	62	115.00	225.00	168.13	34.39	0.32	-0.66	p > 0.20
FT (cm)*	62	24.00	60.00	42.88	11.06	-0.09	-1.12	p > 0.20

*Variable with an opposite metric orientation

Figure 1 presents a comparison of percentage change in terms of motor abilities between students that attended face-to-face and online classes. According to Figure 1, higher change in terms of: (1) abdominal muscle strength; (2) lower back muscle strength; (3) upper limbs muscle strength; (4) lower limbs muscle strength; (5) explosive leg power; and (6) flexibility of lower back and hamstring muscles was induced by the face-to-face classes.

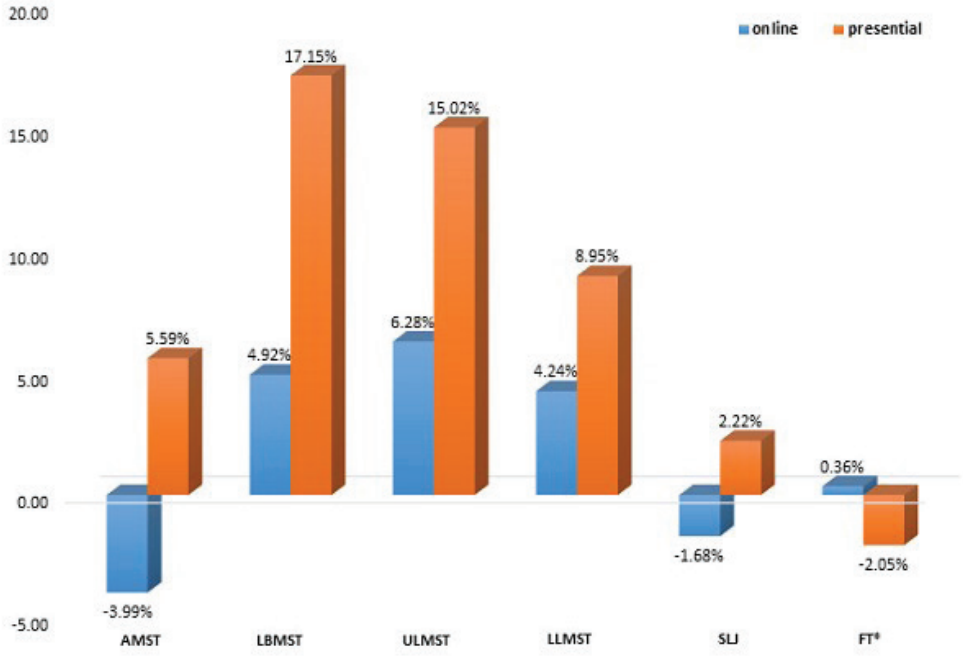

FIGURE 1. Comparison of the percentage change (%) in terms of motor abilities between students that attened face-to-face and online classes

Based on Table 5, there is large magnitude of the difference in percentage change for: (1) abdominal muscle strength; (2) lower back muscle strength; and (3) explosive leg power, and medium magnitude of the difference in percentage change for: (4) upper limbs muscle strength; (5) lower limbs muscle strength; and (6) flexibility of lower back and hamstring muscles. However, it was statistically significant only for: (1) abdominal muscle strength; (2) lower back muscle strength; and (3) explosive leg power.

Table 5. T-test. significance level and effect size of the percentage change (%) in terms of motor abilities between students that attened face-to-face and online classes

	percentage change (%)				
	online	face-to-face	t-test	p-level	Cohen's D
AMST	-3.99	5.59	-2.35	0.03	0.83
LBMST	4.92	17.15	-2.53	0.02	0.89
ULMST	6.28	15.02	-1.21	0.23	0.43
LLMST	4.24	8.95	-1.40	0.17	0.49
SLJ	-1.68	2.22	-2.67	0.01	0.94
FT*	0.36	-2.05	1.55	0.14	0.55

*Variable with an opposite metric orientation

Discussion

The outcome of this study showed that higher improvement in terms of abdominal muscle strength, lower back muscle strength and explosive leg power was induced by face-to-face classes. These findings indicate that face-to-face classes are more effective than the online classes in achieving the main goal of the PE curriculum.

To the best of authors' knowledge, there are no previous studies that compared the effectiveness of face-to-face and online PE classes in achieving the main goal of the PE curriculum, i.e., development of motor abilities in school adolescents. However, recent study investigated the advantages and disadvantages of online and face-to-face PE (Nyberg et al., 2022). Authors found that there were certain difficulties for the PE teachers to deliver the content, as well as they observed reduced movement capability during online classes as compared to face-to-face classes (Nyberg et al., 2022). Another study evaluated the effectiveness of online PE classes during the COVID-19 pandemic in university students (Yu et al., 2021). In line with the findings of the presents study, authors reported that the implemented online learning interventions were not feasible neither effective (Yu et al., 2021). Moreover, during the implementation phase, students reported that they were uncertain about the accuracy of the exercises they do (Yu et al., 2021). PE teachers also reported unenthusiastic involvement of their students (Yu et al., 2021).

It is obvious that PE thematic content requires correct instruction and practical application (Mercier et al., 2021). However,

these aspects were challenging during the online PE classes (Jeong & So, 2020). Most of the teachers have never used video instructions to deliver class before the pandemic (Mercier et al., 2021). The sudden shift to online classes left teachers unprepared and struggling with unfamiliar teaching methods (Jeong & So, 2020). It seems that inadequate online teaching strategies and low teachers' and students' preparation for this type of education, resulted in difficult transition (Do, 2020). Moreover, previous study reported that 20% of the PE teachers were less effective during online teaching than face-to-face teaching (Mercier et al., 2021). Even though teachers were seeking and introducing online resources that have the capability to be tailored to the contextual needs of the PE curriculum (such as online training programs to improve specific motor abilities: strength, explosive power of legs, flexibility, etc.), these resources were not sufficient to satisfy students' needs (D'Agostino et al., 2021). In this line, the findings of our study also indicate that online classes were not as effective as face-to-face classes in achieving the main goal of the PE curriculum.

Students engaged in online PE classes at the present study were also complaining that are not able to follow and effectively take part in activities and tasks assigned during the class because of the limited space and limited access to supplies and equipment in their homes. Limited access to sports equipment and facilities may affect the effectiveness of the delivered class (Jeong & So, 2020). Accordingly, previous study has reported that students' access to online learning as well as conditions at their home were also challenging during the COVID-19 pandemic (Pavlovic et al., 2021).

Taking everything in consideration, students were probably able to gather only the basic theoretical knowledge for the concepts that are part of the thematic plan of the PE curriculum during the online PE classes. However, there were common limitations for students that did not allow them to follow the practical part of the class appropriately. Also, we believe that it has been difficult for the PE teachers to deliver the correct instructions for the exercises, and to accurately monitor students while performing the exercises in front of the computer camera. As a result, changes in terms of motor abilities during the online classes were not induced to the same extend as changes during the face-to-face classes. We assume that higher frequency, intensity, and volume than the ones applied during "home exercising" conditions might be necessary to induce higher changes in terms of motor abilities.

Conclusion

A better improvement in terms of abdominal muscle strength, lower back muscle strength and explosive leg power was induced by the face-to-face classes. These findings indicate that face-to-face classes are more effective than online classes, probably due to the specificity of the PE content that requires correct instruction, practice and movement.

Limitations

Potential limitation of this study may be the lack of PA questionnaire or accelerometer records that would register children's extra scholar physical activity. Further studies should take this in consideration because extra scholar activities may potentially contribute to the development of motor abilities as well.

Acknowledgements

Authors are grateful to all students that took part in the study, their parents that gave consent for participation, and the school's principal that gave an approval and a proper authorization for the study to be realized.

Funding

Authors declare no funding sources for the present study. However, FV holds a fellowship from the Secretariat for Universities and Research of the Ministry of Business and Knowledge of the Government of Catalonia and the European Social Fund (2022FI_B1 00074).

Competing interests

Authors have no relevant financial or non-financial interests to disclose.

Authors' contributions

FV conceived and designed the study, collected data, performed the statistical analyses, analyzed data, interpreted results and wrote the first draft of the manuscript. SG conceived and designed the study, analyzed data, interpreted results, edited and critically reviewed the manuscript, and supervised the research. AP-P interpreted results, edited and critically reviewed the manuscript. RF-L interpreted results, edited and critically reviewed the manuscript. AV collected data, interpreted results, edited and critically reviewed the manuscript. VL-R interpreted results, edited and critically reviewed the manuscript. DB interpreted results, edited and critically reviewed the manuscript. BK interpreted results, edited and critically reviewed the manuscript. GG conceived and designed the study, analyzed data, interpreted results, edited and critically reviewed the manuscript, and supervised the research. All authors approved the final version submitted for publication.

Received: 07 October 2023 | **Accepted**: 05 December 2023 | **Published**: 15 January 2024

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