

The Impact of Physical Activity Classes on Academic Performance in Lebanese Students Aged 9 to 14 Years: A Quasi-Experimental Study

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Abstract

Background: several studies have revealed the positive effects of daily moderate to vigorous physical activity on student performance and academic achievement. The purpose of this study was to determine the effect of a specific physical activity program on academic performance among children aged 9 to 14 in the Lebanese schools.

Methods: Participants were eligible if they did not participate in any sport activity during the lockdown due to the COVID-19 pandemic in the first semester of the academic year 2020 – 2021 and were able to complete a three-month PA program at the BH CLUB-KYOKUSHIN JAMMAL academy with no psychological or physical limitations. A well-trained physical coach established a PA program consisting of karate and general fitness exercises for three months, three times per week, one hour per session. Academic performance was measured using the official marks from three core academic classes at each school, as well as the overall GPA.

Results: Out of 250 eligible children, only 60 students, 47 males and 13 females, with a mean age of 11.7 ± 1.68 years old, participated in the study. All scores for all participants from both genders improved significantly ($p < 0.05$) with exception of mathematics and science scores of the females. Furthermore, no significant gender differences were observed in any of the variables with $p\text{-value} > 0.05$ and a size effect of Cohen's $d < 0.219$.

Conclusion: PA had a significant impact on academic achievement in children aged 9 to 14 years old, and it may help to offset the unavoidable negative impact of the COVID-19 outbreak. As a result, Lebanon's parents and schools should prioritize PA for their children.

Key Words: Academic achievement, Academic performance, Exercise, Physical activity, School, Karate, General fitness exercises.

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1- INTRODUCTION

Charles Darwin stated that organisms must adapt to the demands of their environment, referring to this as "the war of nature" (1). As a result, rather than being recognized as kinetic activities, physical activities have since their inception been associated with the human orientation towards the basic instinct associated with hunting survival, or self-defense (2).

People are becoming more aware of the impact of sport and physical activities on their bodies, health, fitness, and outward appearance, according to recent studies; and physical education is expected to play an important role in their lives (3, 4).

Accordingly, physical education has been defined as "education through physical" activities in all of its forms (e.g., Swedish / German gymnastics, or even low level of physical activity such as personal hygiene activities) (5). It has an important place in the school curriculum as one of the major learning outcomes for students, and its role in human health is widely acknowledged. More research has recently been conducted to explain the golden network of physical activity and health across all dimensions such as mental, physical, and psychological (3, 4, 6, 7).

Physical education in the school context aims to develop children's cognitive and physical capacity in terms of learning knowledge in academic disciplines to meet accepted academic standards and provide ways to improve general health conditions through a deep understanding and practicing physical activities (7). Accordingly, integrating physical activity into educational methods is a primary goal for any new effective teaching methods (8-10).

More studies on the effect of students' participation in physical education classes on academic performance have recently been conducted (8-11). Solberg et al., in

2021, conducted a study on thirty secondary school students in Norway including three groups: 1) Physically Active group, 2) Don't Worry – Be Happy group, and 3) control group. The results showed a significant improvement in reading abilities in the physically active group (12). Another systematic review concluded that there is strong evidence of the beneficial effects of PA on academic performance in children aged 3–16 years old (13).

However, no convincing evidence was identified in the literature about the impact of participation in routine physical activity programs on the academic performance of students aged between 9 and 14 years. The current study is the first one to shed light on the impact of the reintroduction of specific physical education classes on the academic performance of students in the Lebanese schools after lockdown due to the COVID-19 pandemic. To address the gap in research that focuses on one dimension of academic achievement (i.e. one class's GPA), analytical and general academic results will be explored in this work.

2- MATERIALS AND METHODS

2-1. Design and objectives

This study is a quasi-experimental study in which the academic performance of one group of students was studied as a dependent variable in response to their reintegration into a specific physical activity program. Thus, this study aims to identify the impact of practicing physical activities on the academic performance of students aged between 9 to 14 years old in Lebanese schools.

2-2. Participants

The participants included all children of both genders who were registered at the BH CLUB - KYOKUSHIN JAMMAL academy of sport activities in Beirut city, aged 9 to 14 years old, and who did not

have any psychological disorders affecting their academic performance or any physical problems limiting their ability to participate in the academy's predefined physical activity program (fitness exercises and karate). To be eligible for participation, children were to be able to commit to a weekly schedule of sports activities for at least three months. Children who did not want to continue the study or who were unable to participate for any reason during the study period were excluded.

2-3. Procedure

The academic performance (i.e., official marks) of students who did not attend any physical education classes (school-based classes) or physical activities (non-school-based classes) during the first semester of the academic year 2020–2021 due to school lockdown during the COVID-19 pandemic was compared to that of the same students who attended a daily physical activity program at the BH CLUB - KYOKUSHIN JAMMAL academy in Beirut during the second semester.

A letter explaining the study's goals and procedures was sent to the parents of all eligible children in the academy, inviting them to participate. The volunteering parents were required to sign an informed written consent form and provide their children with transcripts of the first semester and, later, the second semester of the 2020-2021 academic year.

In the aforementioned academy, a standardized physical activity program was established. This program included 15-minute general fitness workouts followed by 45-minute karate sessions three times a week for three months. A certified physical coach trained all of the students involved in this study.

Transcripts of records from the first and second semesters of the academic year 2020-2021 were used as an outcome measure in the evaluation of the impact of

physical activities on academic performance. Separate excel sheets were used to track marks for three classes (math, science, and English), as well as the overall GPA.

The first semester's marks were released in January, and the second semester's marks were released in June. The numerical grade range could be 0 to 20.

2-4. Statistical analysis

The results of the Shapiro–Wilk test revealed that outcome measures (i.e. marks) were normally distributed in each group (males and females). Therefore, using a 2-tailed paired sample t-test with a p-value of 0.05 as the level of significance and a confidence interval of 95%, a pre-post analysis was performed to examine the differences in academic performance. Then, considering the independent samples test of unequal variances and the Cohen's *d* measures of size effect were used to detect any significant differences between groups based on gender.

3- RESULTS

Out of 250 eligible children, only 60 students, 47 males and 13 females, with a mean age of 11.7 ± 1.68 years, finished the study. Globally, academic performance of all participants of both genders improved significantly in all three classes as well as in overall GPA. Then, using a 2-tailed paired sample t-test, the comparison between participants based on gender revealed that only mathematics and science scores did not improve significantly with females while other scores did ($p < 0.05$). **Table 1** summarizes the findings of our study.

It is worth noting that participant matching between groups was primarily based on gender, age (ages less than 9 to 14 years), and physical level (same levels of physical activity participation prior to starting the study). In other words, there was no intention to control the allocation of

participants; once the child was eligible to participate (i.e., he/she met the inclusion criteria), he/she was assigned to either the females or males group.

Moreover, the independent samples of unequal variances test revealed no significant differences between males and females in all scores (i.e., mathematics, science, English, and overall GPA) ($p < 0.05$). These findings were confirmed by measuring the effect sizes using Cohen's d which was less than 0.219 reflecting the small differences between groups (**Table 2**).

4- DISCUSSION

The purpose of this study was to determine the effect of regular non-school-based physical activity sessions on the academic performance among Lebanese students aged 9 to 14 years old following a lockdown due to the COVID-19 pandemic. The academic performance in three courses (mathematics, sciences, and English) as well as the overall GPA of the first semester of the 2020-2021 academic year in which students were unable to participate in regular physical activities (class-based or non-class-based PA) due to the lockdown, were compared to that of the second semester of the same academic year when students participated in the weekly sessions of Karate and general fitness program designed for the purpose of this study.

Our findings were consistent with previous research who reported significant positive effects of various PA interventions (recess, school-based PE, free time PA or sport at school) on student academic performance (10, 14-17).

Weekly physical activity sessions, such as karate combined with general fitness, were found to have a positive effect on male participants' overall GPA, mathematics, sciences, and English marks in our study. This significant improvement was also seen in female participants' overall GPA

and English marks. These results corroborated with the findings of Nelson and Gordon-Larsen in that adolescents who participated in regular physical activity and physical education programs were more likely to achieve high marks (18).

Their results in mathematics and English were higher than those of inactive or less active students with a risk ratio of 1.2 and 1.21, respectively. In the same line, Field et al. reported that students who were practicing in high levels of exercises had higher grade point averages than those who were engaged with low level exercises (19).

These findings support those of Landry and Driscoll (2012) and other researchers who reported that physical activity improves cognitive function and academic achievement (20). According to Beck et al. (2016), incorporating gross motor activity as a type of physical activity is associated with improvements in children's mathematical performance and academic achievement (21).

Furthermore, the time of exercise has been shown to have a significant impact on academic achievement. Despite this, there were significant differences in the literature regarding the amount of time allotted for physical education and physical activity sessions in schools. It is worth noting that Howie and colleagues proposed that 10-20 minute physical activity breaks had a positive effect on math achievement (22).

We did not, however, conduct a separate statistical study to examine the relationship between the period of physical activity practice and academic performance. Therefore, we might anticipate that one hour per session, three times per week for three months, could have a positive impact on our participants' overall GPA improvement.

Table-1: Paired Samples Test for pre-post scores

Gender			Means	SD	Paired Differences					t	df	Sig. (2-tailed)
					Mean Difference	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
								Lower	Upper			
Male N=47	Mathematics	Before	8.97	2.07	-1.95745	2.4668	0.35982	-2.68173	-1.23317	-5.44	46	0.00
		After	10.9	1.95								
	English	Before	8.5	1.98	-3.06383	3.79017	0.55285	-4.17667	-1.95099	-5.542	46	0.00
		After	11.59	3.6								
	Science	Before	8.3	2.65	-2.34043	3.34454	0.48785	-3.32242	-1.35843	-4.797	46	0.00
		After	10.68	1.9								
	GPA	Before	10.19	1.8	-2.44681	1.86278	0.27171	-2.99374	-1.89988	-9.005	46	0.00
		After	12.6	1.7								
Female N=13	Mathematics	Before	9.46	1.6	-1.38462	3.0697	0.85138	-3.23962	0.47039	-1.626	12	0.13
		After	10.8	2.2								
	English	Before	8.15	1.7	-3.61538	4.62851	1.28372	-6.41236	-0.81841	-2.816	12	0.016
		After	11.76	4.36								
	Science	Before	8.61	2.5	-1.69231	3.35123	0.92947	-3.71744	0.33282	-1.821	12	0.094
		After	10.3	1.75								
	GPA	Before	9.7	1.4	-2.30769	2.01596	0.55913	-3.52593	-1.08946	-4.127	12	0.001
		After	12.07	2.1								
All	Mathematics	Before	9.08	1.98	1.83333	2.59182	0.33460	1.1638	2.5029	5.479	59	0.000
		After	10.9	1.98								
	English	Before	8.45	1.92	3.1833	3.95093	0.51006	2.1627	4.2040	6.241	59	0.000
		After	11.6	3.7								
	Science	Before	8.4	2.6	2.20000	3.32836	0.42969	1.3402	3.0598	5.120	59	0.000
		After	10.6	1.88								
	GPA	Before	10.1	1.7	2.41667	1.88024	0.24274	1.9309	2.9024	9.956	59	0.000
		After	12.5	1.8								

Table-2: Paired Samples Test for pre-post scores

Variable		Levene's Test for Equality of Variances		t-test for Equality of Means							Cohen's d
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
									Lower	Upper	
Mathematics	Equal variances assumed	1.453	0.233	0.702	58	0.485	0.57283	0.81570	-1.05998	2.20564	0.219726
	Equal variances not assumed	-	-	0.620	16.532	0.544	0.57283	0.92430	-1.38148	2.52714	0.19406
English	Equal variances assumed	1.387	0.244	-0.442	58	0.660	-0.55155	1.24662	-3.04694	1.94383	-0.138346
	Equal variances not assumed	-	-	-0.395	16.714	0.698	-0.55155	1.39770	-3.50430	2.40119	-0.123635
Science	Equal variances assumed	0.005	0.941	0.618	58	0.539	0.64812	1.04851	-1.45070	2.74693	0.193434
	Equal variances not assumed	-	-	0.617	19.144	0.544	0.64812	1.04972	-1.54785	2.84408	0.193121
GPA	Equal variances assumed	0.026	0.871	0.234	58	0.816	0.13912	0.59399	-1.04987	1.32811	0.073242
	Equal variances not assumed	-	-	0.224	18.074	0.825	0.13912	0.62165	-1.16654	1.44478	0.070112

To better understand the reasons behind this improvement in academic performance, three main hypotheses were reported in the literature; (a) the improvement in attention induced by physical activity (23), (b) the weight loss induced by physical activity, and thus the improvements in performance across various cognitive domains (24), and (c) the increase in hippocampal volume that is related to increased memory functions following exercise (25).

Many studies have confirmed the hypothesis regarding the brain structure modifications, suggesting that the increase in gray matter hippocampal volume leads to a decrease in frontal cortex gray matter thickness (26, 27). Chaddock et al. discovered that higher-fit activities in preadolescent children may result in these changes. Other studies have discovered that neurotrophins influence neuroplastic processes which are also related to memory formation (28) and partial repair of neural damages (29) as a result of PA practice.

Furthermore, Skriver et al. (2014) stated that brain changes are accompanied by the release of several biomarkers such as BDNF, nerve growth factor (NGF), and IGF-1, all of which have a positive impact on brain functions (30). As a result, these brain changes may result in improved cognitive and academic performance.

On the other hand, our findings were not in line with some studies that reported non-significant impact of adding physical activity to schools' schedules on students' academic performance (31-35). In our study, only the females' results of scientific courses (i.e. math and science) showed no significant changes after participating in physical activity sessions ($p > 0.05$). These findings agreed with those of other studies published in the literature. Lindner et al. discovered no correlation between PA participation and overall GPA of students aged 13 to 17, implying that physical

activity had no effect on children's academic performance (36). Similarly, Tremblay et al. reported that their findings revealed a weak correlation between the level of physical activity and academic performance in grade 6 for 6923 participants of both genders, aged 11 years old (37). Based on an in-depth review of the available research in the literature, Sneek et al. stated in 2019 that increasing the number of traditional PE classes did not appear to have a positive effect on mathematics learning, whereas more intensive PA classes did (11). Accordingly, Raspberry et al. suggested that different variables should be considered when interpreting this relationship, including students' attitudes and behaviors, types of questionnaires used, and time and amount of PA practice (38).

Despite the increasing evidence that school-based PA classes improve youth students' academic performance, some schools tend to reduce the time allotted for PA classes in their daily schedules (38) in order to respond to the increasing challenges that schools face in improving standards-based test scores by increasing the instructional time for mathematics, English, and science (39). James S. Coleman hypothesized that academic achievement would suffer if time was taken from physical education classes to allow other pursuits (40). Based on the results of the current study, PA had an influential impact on the academic achievement of children aged between 9 and 14 years old.

Accordingly, our study supports what Coatsworth and Conroy suggested as a solution to these challenges (41); students have a good opportunity to practice regular non-school-based PA (e.g., sport academies or community sports) in their youth, in order to maintain their physical and health states as well as taking benefit from the positive impact of PA on their

academic performance, particularly in mathematics, English, and science classes.

5- CONCLUSION

Despite the small sample size of our study, we may suggest that our findings imply that the positive impact of PA on students' academic achievement may counterbalance the negative impact of distance learning, which was widely used during the COVID-19 pandemic era, on students' mental health, as manifested by depressive symptoms and impairment in concentration and learning, resulting in a decrease in academic performance (42).

Thus, parents and schools in Lebanon should pay more attention to physical activity for their children.

6- STRENGTH AND LIMITATIONS

The main strength of this study is that it is an attempt to understand and analyze the impact of physical activity participation on academic performance of students, particularly those aged 9 to 14 years, as this age group has not been extensively studied, previously. Otherwise, the current study's limitations should be acknowledged. First, due to a lack of parental cooperation, the sample size was small, particularly among female participants. Second, the reduced number of participants in non-school-based physical activity classes such as Karate and general fitness, due to the current economic crisis and the COVID-19 pandemic, represents a further limitation for generalizability.

7- ETHICAL CONSIDERATIONS

This study was approved by a local research committee of the University of Arts and Sciences in Lebanon (USAL) in June 2021. In addition, informed written consent was signed by the parents of all participants.

8- ACKNOWLEDGMENT

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9- COMPETING INTERESTS

None.

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