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Correlation between VO2max, Weight status, physical exercise and academic achievement in Moroccan high school students

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Abstract

Physical exercise (PE) is an important discipline in the Moroccan education system. In addition to its role in the development of the integrity of human body, it permits to develop the cognitive skills of students. This study aims to examine the correlation between physical exercise and academic achievement in Moroccan high school students. A total of 353 adolescents (186 girls and 167 boys) (mean age = 16 years SD = 1.2) from Morocco are participating in this study. The cardiorespiratory fitness was measured with the20 m endurance shuttle-run test. We also assessed the Resistance capacity with 500m sprint test. The academic achievement was assessed by school grades. We examined the correlation between all variables. The association between physical activity and academic achievement was assessed by Pearson correlation and multiple linear regression predicted model. The current study indicates a positive association between academic achievement and the Resistance Capacity ($p<0.05$, but without correlation with Cardiorespiratory Fitness (VMA). There was a positive association between total fitness and academic achievement, although not statistically significant, r (369) = 0.002, p = 0.49. The regression prediction model was statistically significant ($p < 0.001$) and accounted for approximately 25% of the variance in academic achievement (R [superscript 2] = 0.228, adjusted R [superscript 2] = 0.235). Academic achievement was predicted by total number of absences and gender, and to a lesser extent by socio-economic status, the curl-up, and ethnicity. This study suggests a positive association between physical exercise and academic achievement. These findings constitute a potential relevant to the development of professionals and researchers in sports and education by taking on consideration the importance of the physical activity-academic link, to further support the need for quality physical education curriculum.

Keywords: Physical Exercise, academic achievement, resistance, VMA, high school student, Morocco

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1. Introduction

The health benefits of regular physical exercise are widely acknowledged. For example, a study reported that poor diet and physical inactivity might soon overtake tobacco as the leading cause of death. Other study reported that the key ways to prevent the return of the cancer disease included a healthy diet and exercise [1].

The physical exercise (PE), defined as any bodily movement involving skeletal muscles that requires energy consumption. Extensive evidence highlights the physical, cognitive, and psychosocial advantages associated with regular PE, and these benefits extend to academic achievement (AA). Numerous studies suggest a positive correlation between regular PE and good AA [2,3].

Discrepancies in methodologies used to measure both PE (considering intensity, duration, type, etc.) [4] and AA (utilizing qualifications, standardized tests, observation, etc.), along with variations in sample characteristics, may account for these disparities in study results [5].

The mechanisms through which PA contributes to improved AA are not fully understood [1,6]. Two main theories—the neurophysiological perspective and the psychosocial perspective—offer insights into this relationship [7,8]. The neurophysiological perspective suggests that PE exerts direct positive effects on the brain and nervous system, enhancing brain functioning through increased blood flow, elevated glucose and lipid metabolism, and the release of growth factors like brain-derived neurotrophic factor [7]. This factor influences neural survival,

neurogenesis, synaptic plasticity, and neurotransmitter release, enhancing the brain's efficiency and adaptability [9] . This leads to improved memory, attention, and learning, with an associated increase in hippocampal volume [10]. The psychosocial perspective emphasizes the social benefits of engaging in PA with peers, fostering cooperation, respect for rules, and potentially influencing AA positively [8]. Additionally, PE correlates positively with mental health components, such as self-esteem, resilience, tolerance to adversity, positive acceptance of changes, and emotional well-being, all of which may indirectly enhance cognition and AA [11,12].

While both perspectives contribute to our understanding of the relationship between physical activity and academic achievement, much remains to be clarified and explored. Some studies have attempted to determine if PE benefits specific academic areas, with results varying widely. For instance, Singh et al. [13] found strong evidence for the positive effects of PE on mathematics but inconclusive evidence for language performance. Hillman et al. [14] observed associations between PA and reading comprehension but not with spelling or arithmetic. Some researchers reported associations between PE and academic achievement scores [15].

Given the diversity of findings, our study aims to contribute additional insights. Its objective was to assess the extent to which PE, along with other variables of interest, contributes to students' AA scores, including areas that have not been extensively explored by researchers. This includes instrumental subjects and overall AA.

2. Materials and methods

2.1 Studied population

A total of 353 adolescents (186 girls and 167 boys) (mean age = 16 years SD = 1.2) from the high Schools of Meknes city were participated in this study.

2.2 Measure of academic achievement

Academic performance was represented by the general average obtained for the following subjects, mathematics (Math), Physics and chemistry (PC), Life and Earth sciences (LES), Philosophy (Ph) and Physical and sports education (PE) During the 2022-2023 school year, this snotes were distributed according to the other parameters, Gender, BMI, VMA.

2.3 anthropometric characteristics

Participants' height was measured in a standing position using a vertical rod, and their weight was determined with a precision electronic personal scale. Body Mass Index (BMI) was then calculated as the weight-to-stature squared ratio. BMI, recognized by the WHO as a standard for evaluating corpulence, strongly correlates with total fat levels and growth. The study utilized International Obesity Task Force (IOTF) reference curves to assess adolescents' corpulence, emphasizing the importance of removing shoes during anthropometric measurements.

2.4 Measure of Cardiorespiratory Fitness

Aerobic fitness was assessed using the 20 m shuttle run test with 1-minute stages, a globally recognized method for evaluating adolescents' physical condition. Participants ran back and forth between two lines, synchronized with an increasing sound signal. The test started at 8.5 km/h, escalating by 0.5 km/h per minute, with the final level representing Maximum Aerobic Speed (MAS). The MAS, converted into linear running speed, was determined using an equation by Léger et al., 1993. VO2max (ml min-1 kg-1) was calculated from an equation involving maximum speed, gender, and weight:

$$VO2max = 25{,}8 – (6{,}6 * sex) – (0{,}2 * Weight) + (3{,}2 * MAS)$$

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2.5 Statistical analysis

Descriptive statistics were calculated, including weighted frequency and proportions for categorical and weighted average variables, and standard deviations for continuous variables.

3. Results and Discussions

The table 1 present the main finding results of academic achievement and the physical exercise. The study includes 353 adolescents (186 girls and 167 boys) (mean age = 16 years SD = 1.2) from the city of Meknes participated in this study. The general characteristics, physical activity profile (VO2max) and academic results in Mathematics, Physics-Chemistry, Life and Earth Sciences, Philosophy and Physical Education of the participants are presented in Table 1. The results obtained show that the average age of adolescents presents a statistically significant difference according to sex ($p<0.001$). We note that the highest academic scores are recorded among women with a significant difference ($p<0.01$) (table 2), compared to boys. But, regarding physical exercise and cardiorespiratory fitness (VO2peak), boys are significantly ($p<0.05$) better than girls (figure 1).

Table 1: VMA, BMI and academic achievement of participants.

		Female		Male		Total		p
		Mean	sd	Mean	sd	Mean	sd	
Grade	Math	14	2.5	13.5	3	13.76	2.73	0.13
	PC	15	2	14	2.5	14.52	2.23	0.25
	ELS	13.5	1.5	13.75	1.6	13.61	1.54	0.145
	PH	14.5	2	12.5	2.5	13.55	2.23	0.045
	PE	15	1	17	1	15.94	1	0.011
VO2max) (ml/min/kg)		33.25	2.31	38.52	3.2	35.73	2.73	0.015
BMI		29.34	5.91	25.35	4.65	20.27	5.31	0.032

Math: Mathematics, PC: Physics-Chemistry; ELS: Earth and Life Sciences; PH: Philosophy; PE: Physical Education

Table 2 : Matrice de corrélation

		BMI	**VMA**	**Math**	**PC**	**LES**	**Ph**	**PE**
BMI	r de Pearson	—						
	valeur p	—						
VMA	r de Pearson	-0.574 ***	—					
	valeur p	< .001	—					
Math	r de Pearson	-0.781 ***	0.764 ***	—				
	valeur p	< .001	< .001	—				
PC	r de Pearson	-0.889 ***	0.727 ***	0.889 ***	—			
	valeur p	< .001	< .001	< .001	—			
LES	r de Pearson	-0.032	0.225 ***	0.129 *	0.102	—		
	valeur p	0.543	< .001	0.015	0.056	—		
Ph	r de Pearson	-0.091	0.194 ***	0.116 *	0.135 *	-0.012	—	
	valeur p	0.088	< .001	0.029	0.011	0.818	—	
PE	r de Pearson	-0.890 ***	0.717 ***	0.867 ***	0.952 ***	0.108 *	0.145 **	—
	valeur p	< .001	< .001	< .001	< .001	0.044	0.006	—

Note. * p < .05, ** p < .01, *** p < .001

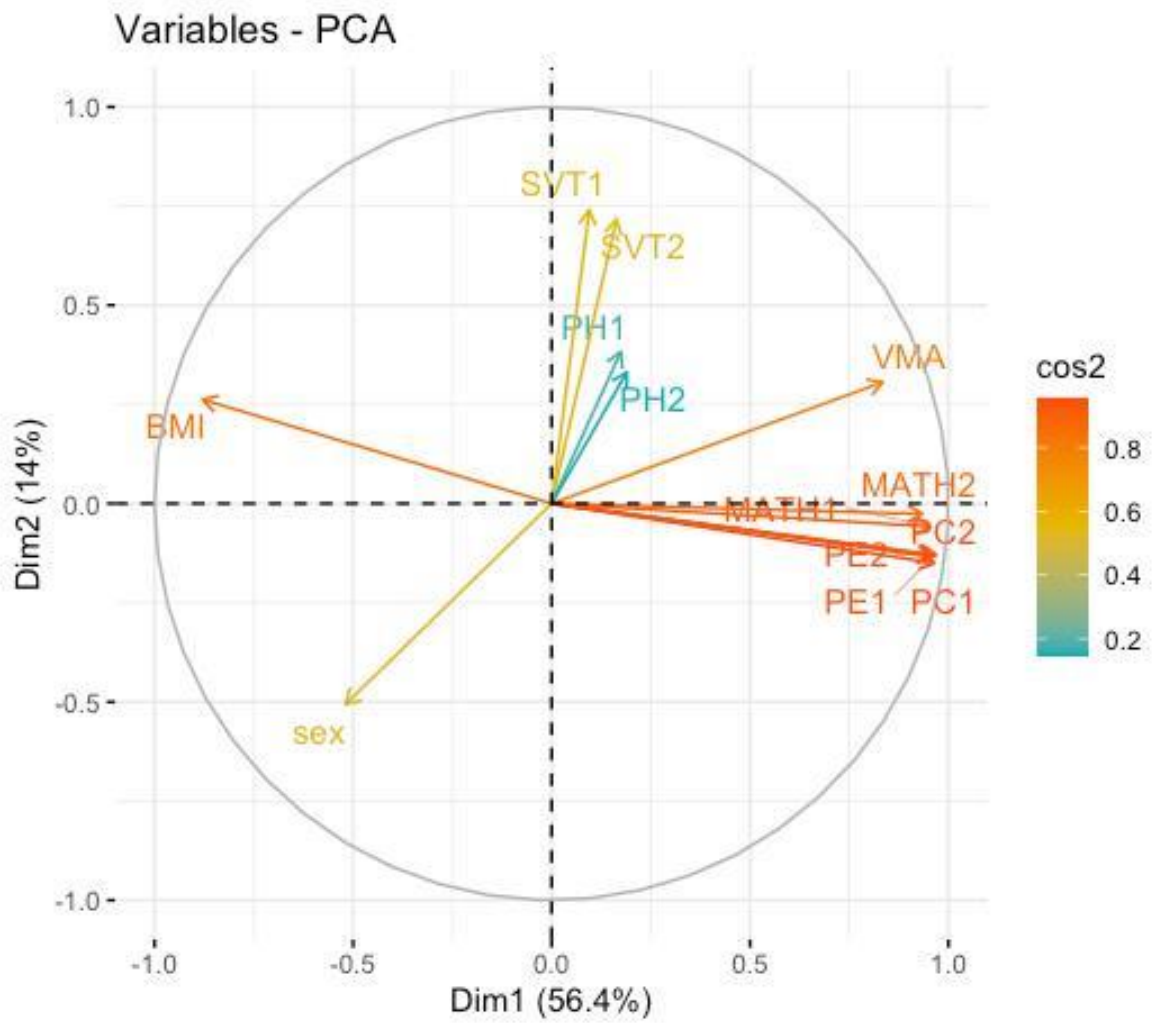

Figure 1 : Cercle of correlation including all variables.

The current study aims to determine the impact of physical exercise on academic achievement in a sample of High School students from Meknes city (Morocco). The results show a positive correlation between physical exercise and academic achievement recorded in scientific subjects. But no significance was observed in the relation between PE and AA.

Physical and sports education is expected to contribute to the balanced and integral formation of the personality [16], to the biological, cognitive, affective and relational [17], that it promotes self-knowledge and self-control and that it arouses qualities such as generosity, loyalty, the desire to excel, the spirit of cooperation, perseverance [11,12,18], more particularly, sports practice and physical exercise must promote the development of self-concept [19]. The self-concept plays a key and central role in the development of the personality, as underlined by the great psychological theories: a positive self-concept is the basis of good social and professional functioning and depends on it, for a good hand, personal satisfaction and the feeling of being good with oneself.

Even though the benefits of physical exercise are acknowledged, physical education in public schools is viewed as an extracurricular activity and physical education teachers have experienced first-hand when money is tight and/or when there is pressure to improve test scores, physical education is one of the first activities to be cut back or eliminated. However, if there is evidence that physical education has a direct positive effect on important educational domains such as reading and mathematics, it could be argued that physical education is not extracurricular. Rather, it is a vital component in students' academic success.

It is not the intention of this paper to argue that the importance of physical education is its benefit to academic achievement. The overall health benefits of organized physical activity are probably much more important than possible academic benefits. However, when policy makers need to make difficult decisions about where to spend public funds and administrators need to make decisions about where

to focus resources in a climate of academic accountability, a proven relationship between physical fitness and academic achievement could be used as an argument to support, retain, and perhaps even improve physical education programs.

At this time little research has examined the relationship between physical fitness and academic achievement. One study that reported a consistent and significant relationship between fitness and achievement had several threats to validity [20,21]. First, there were validity concerns with the academic achievement indicator. Academic achievement was based on a non-standardized, subjective five- point rating scale. Therefore, the meaning of achievement could vary from site to site. Second, the reported correlations, although statistically significant (i.e., at 0.001, 0.01, & 0.05 levels of significance) were not impressive. For example, the average correlation between sit-ups and achievement for girls age 7 to 15 was 0.13. Third, there were unexplained inconsistencies. Sit-ups showed a statistically significant relationship with achievement for some girl age classes. Different studies performed in animal models have shown dimorphism responses on the behavior and brain functions according to environment factors [22,23]. The study's conclusion of a consistent and significant relationship between fitness and academic achievement was based on the fact that there were more statistically significant correlations than there were not [24,25].

One review of research that concluded a positive relationship between physical and mental skills expressed concern that reviewed studies did not demonstrate causality. Most reviewed studies used correlation designs. Reviewed experimental studies had design weaknesses. One study with an experimental design in that the independent variable was manipulated did not use random assignment or matching to control for preexisting group differences. Another experimental study employed random assignment but failed to find a statistically significant difference in academic achievement between experimental and control subjects.

4. Conclusions

This study suggests a positive association between physical activity and academic achievement. It constitutes a potential relevant to the development of professionals and researchers in sports and education by taking on consideration the importance of the physical activity-academic link, to further support the need for quality physical education curriculum.

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