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Interrelationship of physical exercise, perceptual discrimination and academic achievement variables in high school students

A. El Jaziz[1], S. Lotfi[2], A.O.T. Ahami[1]

Key words: Academic achievement, fluid intelligence, resistance, VO2 peak, Raven's Standard Progressive Matrices, Morocco, public health
Parole chiave: Rendimento accademico, intelligenza fluida, picco VO2, Matrici Standard Progressive di Raven, Marocco, sanità pubblica

Abstract

Background. *Many studies results suggest how can we improve the academic performance for our kids. The purposes of this study were to examine how physical activity could affect both academic achievement and fluid intelligence in adolescence.*
Study design. *We measured the three variables (physical, cognitive, academic) and try to find the correlations between them.*
Methods. *A total of 167 adolescents (mean age = 16.34 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. The fluid intelligence was assessed by using Raven's Standard Progressive Matrices. We examined the correlation between all variables.*
Results. *This study indicates that the academic achievement was positively associated with the Fluid Intelligence and also with the Resistance Capacity and not with Cardiorespiratory Fitness (VO2peak).*
Conclusions. *We can conclude that the professionals and researchers in sports and education have to promote physical activity at the school age for a public health purpose.*

Introduction

The World Health Organization (WHO) defines public health as "all organized measures (whether public or private) to *prevent* disease, *promote* health, and *prolong* life among the population as a whole" (1). The physical education (PE) is part of this famous definition because it aims to have a development of motor and sport-specific skills, promotion of health-related fitness and active lifestyles, and personal, social and moral development (2). Indeed, the practice of PE in schools are the most cost-effective public health resource into which to address inactivity (3), which is known as "the biggest

[1] *Department of Biology, Equip of Clinical and Cognitive Neuroscience and Nutritional Health, Faculty of Science, Ibn Tofail University, Kénitra, Morocco*
[2] *Laboratory of Education and Training Sciences - Evaluation of Sport Sciences and Didactic of Physical Activity (ES-SDAP), Department of Physical Education and Sport, Normal Superior School (ENS), Hassan II University, Casablanca, Morocco*

public health problem of the 21st century" (4-6). In addition, it is an important tool in the prevention of multifactorial others diseases (7).

PE is an important academic discipline, that aims to develop the integrity of the human body. It's a priority tool in the prevention of multifactorial diseases. Its benefits in children and adolescents have important public health and educational implications (8). It pursues objectives, such as cognitive, social, and emotional domains. Indeed, the schools can be instrumental in providing the regular physical activity (PA) to progressively build strong body, improve cardiorespiratory fitness, control weight, reduce anxiety and depression, and reduce risks for obesity, high blood pressure, type 2 diabetes, heart disease, cancer, and osteoporosis (9).

Certainly, there is a substantial body of literature suggesting that PA induced by PE has beneficial effects upon cognitive function in adult populations (10, 11). However, less work has been conducted in adolescents. Several attempts have been made to suggest that exercise is also beneficial for cognitive function in this critical age (12-17). Accumulating research with children and young adults suggests that a single session of PE ameliorates different aspects of cognitive function immediately after the end of the exercise period, regardless of fitness level (18-20). More clearly, it was demonstrated that the effect of physical exercise on cognitive performance depends on the intensity and the duration of the exercise (21, 22). Among the tools that measure cognition, we find Raven's Standard Progressive Matrices (RSPM), which is one of the most widely used nonverbal and culture-free tests in the study of Fluid intelligence. The G-factor (Gf) is defined as reasoning ability, and the ability to generate, transform, and manipulate different types of novel information in real time (23). By using RSPM we quantify individual differences in domain-general cognitive abilities such as perception, memory, and reasoning ability (24).

Data from several sources (25, 26) have identified that higher levels of aerobic fitness are also known to predict better academic achievement, during childhood (27-30), and significant improvements in scholastic performance are associated with increased participation in PA during the school day (30-32).

Indeed, the PA, especially aerobic exercise, improves attention, upgrades the interactions between the learning environment and the cognitive development (33, 28), and enhances the performance during a working memory task (34, 35). As well the cardiovascular exercises improve neuronal plasticity, the neurocognition operation and some brain activities. This cardiovascular endurance described as "the entire body's ability to sustain prolonged, dynamic exercise using large muscle groups" (36), is an obstacle that restraints endurance performance. Indeed, the maximal oxygen uptake (VO2peak), have been traditionally used in the laboratory or in the field to predict the performance potential of runners (37). However, Physical inactivity could lead to alterations in health, such as obesity (38) and disability-associated conditions (31) as heart diseases, stroke, diabetes, and osteoporosis (39), while sedentary behaviors have been found to increase a risk for all-cause mortality, as well as mortality from and incidence of cardiovascular diseases (CVDs) and cancer (40).

The associations of cardiorespiratory and cognitive performance and academic achievement in adolescent have recently been under intensive research. However, the evidence of their independent and combined relationships to cognition in children remains unclear. We therefore investigated the independent and combined associations of cardiorespiratory and cognition with scholastic performance of adolescent athletes. We assume that there is a tridimensional relationship between physical performance, cognition and academic achievement.

Materials and methods

1. Participants

One hundred sixty-seven high school students participated in this study from a total of 1,241 students. There were 95 females and 72 males. The mean age was 16.34 years (SD = 1.2). The target population was all students from the same high school of SIDI TAIBI. It is a rural area bounded to the north by the town of KENITRA, to the east by the rural commune HADDADA, the west by the Atlantic Ocean, and the rural town BOUKNADEL to the south. The rural commune of SIDI TAIBI is known by its agricultural activities. All participants were tested in groups ranging in size from 28 to 35 students in school schedule and in their own classroom. Their participation was voluntary and they were not paid. Data collection was accomplished in spring-summer (April–July 2019).

2. Study design

The first meeting (familiarization sessions) has the aim of the familiarization with the research protocol, the explanation of the physical test procedure (Shuttle Test, Sprint 500 m and Standing Long Jump Test) and the test RSPM (Raven's Standard Progressive Matrices). The following meeting involved measurement of VO2peak. The next meeting was focused on 500 m test. The session before the last was focused on Standing Long Jump Test. The final meeting involved measurement of RSPM scores.

3. Measurement instruments

Academic achievement

The Morocco grading system is coded from 0 (the worst) to 20 (the best). All teachers respect the requirements of the Ministry of National Education. The same teaching program is imposed on each category of students and the modality of the exams is uniform for all participants of the same level. We use the objective measure to evaluate academic achievement. The high school administration was asked to give us all grades for each student, from the first semester (2018-2019). The grade point average was calculated based on the mean of the nine teaching subjects.

20 m Shuttle Run Test (SRT)

This test is a commonly used maximal running aerobic fitness test (41). The protocol consists to run progressively between 2 lines 20 m apart in time to recorded beeps, changing direction every time when the participant hears every beep, that increases progressively. The first level generally corresponds to a speed of 7 to 8.5 km h^{-1}, increasing 0.5 km $^{h-1}$ every stage. When the student can't run with concordance with the beep, then he has reached his VO2 max test (41). The student's score is the level and number of shuttles (20m) reached before they were unable to keep up with the recording. Evaluators were continually encouraging participants so that they give their best performance.

Sprint (500 m)

The student is asked to run a distance of 500 m with the highest possible speed. The test requires a warm-up of 15 minutes to prepare the body for physical exercise (42). Indeed, the resistance exercise is known by the high intensity and shorter duration with acquisition energy from anaerobic glycolysis and phosphorylated supplies (43). It was shown that resistance training can improve cardiovascular health (44-47) and measures of strength, power, and lean body mass (48). Evaluators were continually encouraging participants so that they gave their best performance. The test was passed at 9 am. All performances are noted in seconds.

Raven's Standard Progressive Matrices (RSPM)

Raven's Standard Progressive Matrices (49) were used as a measure of fluid intelligence (50). The task requires participants to examine a series of images (geometric forms) and select one out of 6 or 8 possible images to complete the pattern. The test has 60 items of progressively increasing difficulty. the psychometric properties of the 60 RSPM items have been thoroughly analyzed and are used as an indicator of general intelligence throughout the world (51, 52). The test was administered in one hour by range of 30-35 students.

4. Data analysis

The Pearson's correlation coefficient was used to analyze the relationships between academic achievements, Raven's Standard Progressive Matrices scores and VO2 max performances ($p<.05$). The ANOVA I, is used to compare gender effect on academic achievements.

The analysis of all these data were carried out with the SPSS-23. Finally, to control for an increased likelihood of Type I error, we used the Bonferroni correction.

Results

Sample characteristics, including physical exercise, perceptual discrimination and academic achievement variables, are shown in Table 1. The correlation matrix table between all parameters (physical, academic and cognitive performance) appears in Table 2. The Several significant correlations between the variables among

Table 1 - Physical exercise, perceptual discrimination and academic achievement variables by gender.

	Sex	Sex effect								
	Female (=95)	Male (=72)	Total	ANOVA						
	Mean	SD	Mean	SD	Mean	SD	F	p	η2	
RSPM scores	40.19	8.17	40.92	8.95	40.50	8.50	.306	.581	.002	
GPA	13.34	2.15	12.11	1.76	12.81	2.08	15.651	.000	.087	
	Math	10.62	3.45	9.97	3.27	10.34	3.38	1.504	.222	.009
	PC	12.65	3.52	11.38	3.38	12.10	3.51	5.577	.019	.033
	ELS	11.52	3.13	10.75	2.52	11.18	2.90	2.928	.089	.017
	PH	13.37	3.03	12.02	2.36	12.79	2.83	9.715	.002	.056
GRADE	Lg1	14.90	4.05	12.92	4.16	14.04	4.20	9.575	.002	.055
	Lg2	12.29	3.73	10.74	3.28	11.62	3.62	7.833	.006	.045
	Lg3	14.21	2.25	12.50	2.36	13.47	2.44	22.594	.000	.120
	RE	14.89	3.68	12.79	3.86	13.98	3.89	12.837	.000	.072
	PE	17.09	1.01	16.91	1.13	17.01	1.07	1.152	.285	.007
VO2peak (ml/min/kg)	36.64	.89	12.26	1.15	11.25	1.34	128.908	.000	.439	
Sprint 500 m (s)	153.75	29.44	118.32	23.12	138.47	32.08	71.015	.000	.301	
BMI (kg/m2)	21.21	3.27	19.38	2.77	20.42	3.19	14.593	.000	.081	

SD: Standard Deviation, p: signification probability (<0.05), F: Fisher, η2 (Eta square): size effect, RSPM: Raven's Standard Progressive Matrices Scores, GPA: Grade Point Average, Math: Mathematics, PC: Physical Sciences and Chemistry, ELS: Earth and life sciences, PH: Philosophy, Lg1: First language, Lg2: Second language, Lg3: Third language, RE: Religion Education, PE: Physical Education, VO2 peak: maximal oxygen consumption, Test. BMI: Body Mass Index.

Table 2 - Correlations Matrix of physical exercise variables, cognitive scores and academic achievement.

		RSPM scores	GPA	Math	PC	ELS	PH	Lg1	Lg2	Lg3	RE
PE	r	.227	.423	.265	.167	.251	.435	.439	.397	.219	.458
	p	.003	.000	.001	.031	.001	.000	.000	.000	.004	.000
VO2peak (ml/min/kg)	r	.157	-.146	.031	-.138	.020	-.148	-.137	-.150	-.130	-.176
	p	.043	.060	.687	.075	.800	.056	.079	.053	.093	.023
500 m (s)	r	-.152	.205	.006	.136	-.016	.200	.247	.166	.186	.263
	p	.050	.008	.940	.079	.837	.010	.001	.032	.016	.001
BMI (kg/m2)	r	-.094	.037	.007	-.005	-.090	.038	.151	.007	.020	.135
	p	.229	.635	.930	.945	.246	.626	.051	.929	.802	.083

r: Pearson's correlation coefficient, p: signification probability (<0.05), RSPM: Raven's Standard Progressive Matrices Scores, GPA: Grade Point Average, Math: Mathematics, PC: Physical Sciences and Chemistry, ELS: Earth and Life Sciences, PH: Philosophy, Lg1: First language, Lg2: Second language, Lg 3: Third language, RE: Religion Education, PE: Physical Education, Test. BMI: Body Mass Index.

Table 3 - Correlations coefficient (r) of physical variable with cognitive score and academic achievement among the female gender.

N=95		RSPM scores	GPA	Math	PC	ELS	PH	Lg1	Lg2	Lg3	RE	PE	V_{2Peak}	500 m (s)
PE	r	.296	.468	.284	.093	.346	.513	.644	.416	.277	.468			
	p	.004	.000	.005	.370	.001	.000	.000	.000	.007	.000			
$VO2_{peak}$	r	.009	.052	.030	.029	.162	-.005	-.021	-.025	.147	-.009	.049		
(ml/min/kg)	p	.928	.620	.773	.782	.118	.959	.838	.809	.156	.931	.636		
500 m (s)	r	-.094	.050	-.015	.003	-.115	.094	.126	.070	.004	.154	.123	-.511	
	p	.366	.631	.887	.976	.267	.365	.223	.501	.968	.136	.235	.000	
BMI (kg/m2)	r	-.082	-.062	-.016	-.079	-.095	-.061	.070	-.099	-.079	.060	.002	-.167	.002
	p	.429	.553	.874	.447	.360	.558	.498	.342	.448	.566	.984	.106	.986

r: Pearson's correlation coefficient, p: signification probability (<0.05), Math: Mathematics, PC: Physical Sciences and Chemistry, ELS: Earth and life sciences, PH: Philosophy, 1LNG: First language, 2LNG: Second language, 3LNG: Third language, RE: Religion Education, PE: physical education, Grade Point Average, Test. BMI: Body Mass Index.

gender were identified lastly in Table 3 et 4.

Mean variation of physical exercise, perceptual discrimination and academic achievement by gender.

One-way ANOVA revealed that there were no significant differences ($p > .05$) among the gender in Raven score, ($F = 0.306$, $\eta 2 = 0.002$, $p = 0.581$); Mathematics grade, ($F = 1.504$, $p = 0.222$, $\eta 2 = 0.009$); Earth and life sciences grade ($F = 2.928$, $p = 0.089$, $\eta 2 = 0.017$); and physical education grade, ($F = 1.152$, $p = 0.285$, $\eta 2 = 0.007$). We can therefore conclude that gender does not influence these variables. One-way ANOVA revealed that there were significant effects of gender on grade point average ($F= 15.651$, $p = 0.000$, $\eta 2= 0.087$), physical sciences and chemistry grade ($F= 6.422$, $p = 0.012$, $\eta 2= 0.033$), Philosophy grade ($F= 9.715$, $p = 0.002$, $\eta 2= 0.087$), First language grade ($F= 9.575$, $p = 0.002$, $\eta 2= 0.055$), Second language grade ($F= 7.833$, $p = 0.006$, $\eta 2=$

Table 4 - Correlations coefficient (r) of physical variable with cognitive score and Academic achievement among the male gender.

N=72		RSPM	GPA	Math	PC	ELS	PH	Lg1	Lg2	Lg3	RE	PE	$VO_{2\ peak}$	500 m
PE	r	.16	.357	.23	.234	.098	.317	.188	.362	.119	.438			
	p	.178	.002	.052	.048	.414	.007	.114	.002	.318	.000			
VO_{2peak}	r	.324	.093	.234	-.083	.132	.033	.073	.001	.138	.014	.163		
(ml/min/kg)	p	.005	.436	.048	.49	.271	.785	.544	.991	.246	.905	.172		
Sprint 500 m	r	-.251	.065	-.129	.12	-.09	.07	.181	.043	-.021	.129	-.152	-.73	
	p	.033	.586	.282	.315	.454	.557	.128	.722	.864	.281	.202	.000	
BMI	r	-.091	-.031	-.029	-.03	-.212	.028	.122	.016	-.104	.068	-.132	-.21	.341
	p	.448	.794	.808	.799	.074	.818	.306	.895	.385	.568	.268	.071	.003

r: Pearson's correlation coefficient, p: signification probability (<.05).
RSPM: Raven's Standard Progressive Matrices Scores; Math: Mathematics, PC: Physical Sciences and Chemistry, ELS: Earth and Life Sciences, PH: Philosophy, Lg1: First language, Lg2: Second language, Lg3: Third language, RE: Religion Education, PE: Physical Education (/20pts): GPA: Grade Point Average(/20pts), RSPM: Raven's Standard Progressive Matrices Scores, VO2 peak: maximal oxygen consumption; GPA: Grade point average; BMI: Body Mass Index (kg/m2); SRT: 20 m Shuttle Run Test.

0.045), Third language grade (F= 22.594, p = 0.000, η2= 0.045), VO_{2peak} (F = 128.908, p = 0.000, η2= 0.439). We can therefore conclude that gender influences statistically all these variables. Lastly, there were significant effects of gender on Resistance (F = 71.015, p = 0.000, η2 = 0.301), VO_{2peak} (F = 128.908, p = 0.000, η2= 0.439), body mass index (F = 14.593, p = 0.81, η2= 0.000). So, we can conclude that gender influences statistically all these physical variables (Table 1).

The correlation matrix table (Table 2) presents the correlation between 16 parameters (physical, academic and cognitive performance). We noticed that, out of the 60 coefficients of correlations calculated, 25 relationships were significant (p <0.05), or 41.66%.

The Raven's score shows 2 (3.3%) significant correlations: as it can be seen at the top of the Table, Raven's Score, is significantly related with PE grade, $VO2_{PEAK}$ and Resistance. Indeed, The Spearman's correlation coefficient r=0.157 (p=0.043), implies that a negligible positive correlation, yet statistically significant linear relation, is present between Raven's score and PE grade.

The coefficient of determination, r^2=0.023, implies that The Raven's score explains 2.31% variation in the physical education grade. Also, $VO2_{PEAK}$ is associated positively and significantly with raven's score but with negligible correlation r=0.157 (p=0.043). The coefficient of determination, r^2=0.024, implies that The Raven's score explains 2.46% variation in $VO2_{PEAK}$ values.

The resistance capacity shows 7 (11.66%) significant correlations. In fact, The Pearson's correlation coefficient r=0.200 (p=0.010), implies that a negligible positive correlation, yet statistically significant linear relation, is present between Resistance capacity and Philosophie grade. Same remark for the Second language grade r= 0.166 (p=0.032), Third language grade r=0.186 (p=0.016), First language grade r=0.247 (p=0.001), Religion education grade r=0.263 (p= 0.001), grade point average r=0.205 (p= 0.008).

The coefficient of determination implies that the resistance capacity explains 4%

variation in Philosophy grade (r^2=0.04), 2.75% variation in Second language grade (r^2=0.0275), 3.45% variation in Third language grade (r^2=0.0345), 6.10% variation in language Arabic grade (r^2=0.0610), 6.91% variation in Religion education grade (r^2=0.0691) and 4.2% variation in Grade point average (r^2=0.042).

A total of 95 female (mean age, 16.22±1.07 years) participants were recruited (Table 3). Indeed, we found a positive correlation of the grade point average with all teaching subjects that assessed academic achievement. However, Raven's score is correlated with the Earth and life sciences grade (r=0.273, r^2=7.45%, p=0.004), Philosophy (r=0.328, r^2=10.75%, p=0.004), the first language grade (r=0.229, r^2=5.24%, p=0.004), the second language grade (r=0.284, r^2=8.06%, p=0.004), and physical education grade (r= 0.296, r^2=8.76%, p=0.004). In addition, there was positive association of VO_{2PEAK} and the resistance (r=-0.511, r^2=26.11%, p=0.000).

A total of 72 male (mean age, 16.50 ± 1.17 years) participants were recruited (Table 4). Indeed, the Physical Education presents 4 (2.94% = 4/136 x 100%) significant correlations. It presents a very significant positive relationship with the grade point Average (r=0.357, r^2=12.74%, p=0.002), Philosophy (r=0.317, r^2=10.05%, p=0.007), the Second language grade (r=0.362, r^2= 13.10%, p=0.002), and with the grade of Religion Education (r=0.438, r^2=19.18%, p=0.000). However, it was correlated negatively with the resistance (r=-0.609, r^2=37.09%, p=0.000). While, the body mass index (BMI) has only one positive correlation with the resistance (r=0.341, r^2=11.62%, p=0.003).

Discussion and conclusions

Physical inactivity has been identified as the fourth leading risk factor for global mortality (6% of deaths globally). This follows high blood pressure (13%), tobacco use (9%) and high blood glucose (6%). Overweight and obesity are responsible for 5% of global mortality (53). This means more than 5.3 million of the 57 million deaths that occurred worldwide were attributable to physical inactivity (54). This also applies to Morocco just like other countries. In 2016, the Global School-based Student Health Survey reported that only 11.0% of Moroccan school-age adolescents are active (55). Indeed, teaching PE is the most cost-effective public health resource in which to address inactivity and that physical educators are uniquely well positioned to provide and promote PA (3). So, the aim of this study is to understand more the effect of physical exercise on the human body by investigating the possible associations between the physical parameters, cognition and school outcomes.

The main finding was that there were no significant differences among the genders in Raven score, (F = 0.306, $\eta 2$ = 0.002, p = 0.581) (56-57) even if girls are less active than boys (58-59). These results are in line with those of previous studies (46-50). But they don't support other studies that show a male advantage (51-52), or female advantage (60-61). So, since the cognitive performance does not differ by gender, why then do boys practice PA more than girls? In fact, a recent study found that there are many barriers and facilitators in adolescents which are organized into six themes that belong to different levels of the social-ecological model (62). Thus, the physical education teachers may need to develop different pedagogical strategies to be effective in promoting increased physical activity among girls.

On the question of the link between academic achievements and the physical parameters, this study found that the resistance capacity is correlated with Grade point average r=0.205 (p=0.008), especially with literary subjects. These results can be explained by previous studies which showed that resistance activity improves attention, and facilitates interdependence between the learning context and cognition (19, 55). It can reduce the risk of cardiovascular disease (63), diabetes (II) (64), and cancer (65).

On the other side, indeed, the present results didn't confirm any relationship between VO2peak or the cardiorespiratory (assessed by using the 20-m shuttle run test.) and academic achievement. It is somewhat surprising that no correlation was founded because other studies confirm that aerobic fitness has an effect on the academic achievement (66) during childhood (27-30) and in primary school (32, 67). However, the aerobic performance can be influenced by other non-cognition factors like motivation, school demographic characteristics and classroom practices (68, 69).

Nevertheless, VO_{2peak} is correlated with the ability of reasoning or fluid intelligence. These results are in agreement with other studies (70) which showed that the aerobic exercise combined with cognitive training improved fluid intelligence. Also, it seems to be consistent with other research which found that aerobically-trained participants performed significantly better on the fluid intelligence task than untrained or inactive participants (71).

From a public health view, PE is a vital source of PA and its lifelong promotion. Our study has shown that PE may have a relationship with academic outcomes and with the cognition. From others research (72-73) we found that habitual PA by adolescents is positively associated with most health-related fitness components, and increases in PA are related to improved measures of health. Additionally, it is suggested that fitness (74) and PA habits established early in life track into adulthood (75). In addition, reviews show that PA reduces the risk for Type 2 diabetes, and vigorous activity helps increase the strength, density of bones and reduces back pain and fractures in adulthood (76).

All scientific evidence supports the role of PA in promoting children's harmonic growth and psychological development (7, 77). However, in Morocco there is still a gap with WHO's recommendations which require at least 60 minutes of PA per week for the maintenance of metabolic health (78). Indeed, only 38.8% of the children and adolescents meet the recommendation of ≥ 60 (min/day) (79).

Thus, we confirm the necessity of investing in policies and operational interventions (80) by qualified researchers (81) to promote active lifestyles. Finally, we assert that PE is a bridge from gyms to stadiums, from school to the workplace; it needs the implementation of rigorous methods, quantifiable outcomes and qualified management (6). Research and training activities in this sector must be strongly supported to prepare the adolescents of today to become the adults of tomorrow.

Limitations

The present study has several limitations. Firstly, the small sample size used. Indeed, the rural commune of SIDI TAIBI has 3 schools with a total of 2,538 students. Then the next study should cover a larger sample (more than 167 students). Secondly, we did not include many tests to assess more dimensions of the cognition. This is due to lack of funding for the purchase of tests. Nevertheless, there are a number of policy implications stemming from this study. Indeed, the number of hours of physical education must be increased in high school because it has a direct effect on learning. Thus, it's beneficial for later success in career attainment and other major aspects of adulthood.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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Riassunto

Interrelazione tra esercizio fisico, discriminazione percettiva e variabili dei risultati accademici negli studenti delle scuole superiori

Introduzione. I risultati di numerosi studi ci indicano come possa venir migliorato il rendimento accademico dei nostri figli. Scopo della presente indagine è stato lo studio di come l'attività fisica possa influenzare sia il rendimento accademico che l'intelligenza fluida durante l'adolescenza.

Disegno dello studio. Abbiamo misurato le tre variabili in gioco (fisica, cognitiva, accademica) ed abbiamo cercato di identificare le possibili correlazioni tra di loro.

Metodi. Sono stati arruolati 167 adolescenti marocchini, con età media 16,34 anni (SD = 1,2 anni). L'idoneità cardio-vascolare è stata valutata con il test di resistenza allo shuttle-run test di 20 m. Abbiamo anche misurato la resistenza degli adolescenti allo sprint test sui 5000 m. Il rendimento accademico è stato misurato sulla base del punteggio di merito. L'intelligenza fluida è stata valutata con le Matrici Standard Progressive di Raven. Sono state studiate tutte le correlazioni possibili tra le variabili.

Risultati. L'indagine ha rivelato che il rendimento accademico è associato positivamente con l'intelligenza fluida ed anche con la capacità di resistenza, ma non con l'idoneità cardiovascolare (picco VO2).

Conclusioni. È possibile concludere che coloro che si occupano per motivi professionali dei rapporti tra sport ed educazione, ed anche coloro che svolgono ricerche nello stesso campo, devono promuovere l'attività fisica nell'età scolare per motivi di Sanità Pubblica.

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Corresponding author: Anas El-Jaziz, Department of Biology, Equip of Clinical and Cognitive Neuroscience and Nutritional Health Faculty of Science, G6, Rue164 N160, Kénitra, BP 14000, Morocco
e-mail: asjaziz@gmail.com