

Analysis of the Quality of Diet and Academic Performance in Rural Primary School Students

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Abstract

The aim was to analyze the relationship between the quality of diet and academic performance in rural primary school students, a cross-sectional study made up of 181 rural schoolchildren (8.75 ± 1.79 years) from the island of Fuerteventura. Academic performance was calculated through the average grade in the subjects described in Royal Decree 126/2014, February 28th. The quality of the Mediterranean diet was assessed through the KIDMED questionnaire. The one-way analysis of variance (ANOVA) test did not reflect statistically significant differences in academic performance as a function of the quality of the Mediterranean diet, neither in men nor in women ($p > .005$). The multinomial logistic regression test after adjusting for sex and age, reflected that schoolchildren with a higher quality of diet were more likely to have passed the areas of Social Sciences and Natural Sciences when compared to their failed peers ($p < .05$). Thus, a higher quality of the diet in rural primary schoolchildren seems to be associated with passing the areas of Social Sciences and Natural Sciences. Health promotion professionals in the school environment must consider the positive role that diet can play in academic performance and start programs to promote healthy eating among schoolchildren.

Keywords: academic performance; cognitive health; diet; schoolchildren

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Introduction

From the current Organic Law for the Improvement of Educational Quality (LOMCE) it is extracted that one of the main objectives of the educational system in Spain is the improvement of educational quality in order to increase employability, improve results in international evaluations, unify results between communities, promote multilingualism, enhance orientation, and reduce school failure. This factor is perhaps the most significant symptom of the lack of success of the educational system (Sanz Ponce, Serrano Sarmiento, & González Bertolín, 2020).

The fact is that, in Spain, there was 24.4% administrative failure and 19% State Agency for Tax

Administration (AET) in 2016 (according to the Ministry of Education and Eurostat, respectively), and that almost one in five students was below level two in PISA (in 2015). There are important individual and social consequences from compromising a generation of human capital and significantly reducing the opportunities of young people in relation to their future in the workplace (Yserte, Gallo-Rivera, & Martínez-Gautier, 2020).

In this scenario, it is especially important to focus on the processes of accumulation of knowledge and skills that occur in the successive educational stages. Also, is important to analyze what factors can explain situations of school dropout or low academic performance (AP). Since the

schoolchildren will have to function as their own advocates in a world of work where low AP will translate into the development of nonroutine jobs or tasks, with low added value and, therefore, framed in a more unstable, less protected and with lower wages (Garrido-Yserte, Gallo-Rivera, & Martínez-Gautier, 2019).

In this sense, school or academic failure may be subject to different organic and environmental conditions that determine the skills and experiences of each student (Lamas, 2015). One of these factors may be the lifestyle and health behaviors adopted in childhood, since the available scientific evidence suggests that a healthy lifestyle could positively influence brain structure and function during childhood (Portolés Ariño & González Fernández, 2015; Rosa Guillamón, García Canto, & Carrillo López, 2019).

A healthy lifestyle that is suffering progressive abandonment in these age groups is the Mediterranean diet (Castells, 2008; García Cantó, Carrillo López, & Rosa Guillamón, 2019), which has been recognized as intangible heritage characterized by having a wide variety of foods rich in carbohydrates, proteins, and healthy fats such as whole grains, olive oil, legumes, nuts, fruits, and vegetables (Estruch & Ros, 2020). Some studies have described that an optimal, quality

Mediterranean diet acts as a powerful indicator of cardiovascular health (Ramón-Arbués et al., 2020). Likewise, it encourages correct psychomotor and cognitive development (Bleiweiss-Sande et al., 2019; Schwingshackl, Morze, & Hoffmann, 2020).

Importantly, nutrients are critical for the developing brain; recent research on brain neurogenesis and plasticity confirms that good nutrition is important for optimal brain function throughout the lifecycle (Nyaradi, Li, Hickling, Foster, & Oddy, 2013). Figure 1 gives a diagrammatic overview of the model that informs this (Parletta, Milte, & Meyer, 2013).

In this regard, recent research in primary school students has analyzed the relationship between the quality of the diet and AP (Alfonso Rosa, Álvarez Barbosa, & del Pozo Cruz, 2018; Esteban-Cornejo et al., 2016; Faught et al., 2017; Iglesias, Planells, & Molina López, 2019; Mclsaac, Kirk, & Kuhle, 2015; Nyaradi et al., 2016; Pearce et al., 2018; Vassiloudis, Yiannakouris, Panagiotakos, Apostolopoulos, & Costarelli, 2014). A systematic review reflects that there are moderate associations between the dietary intake characterized by the consumption of foods rich in energy and poor in nutrients and the general quality of the diet with respect to the results of the AP (Burrows, Goldman, Pursey, & Lim, 2017).

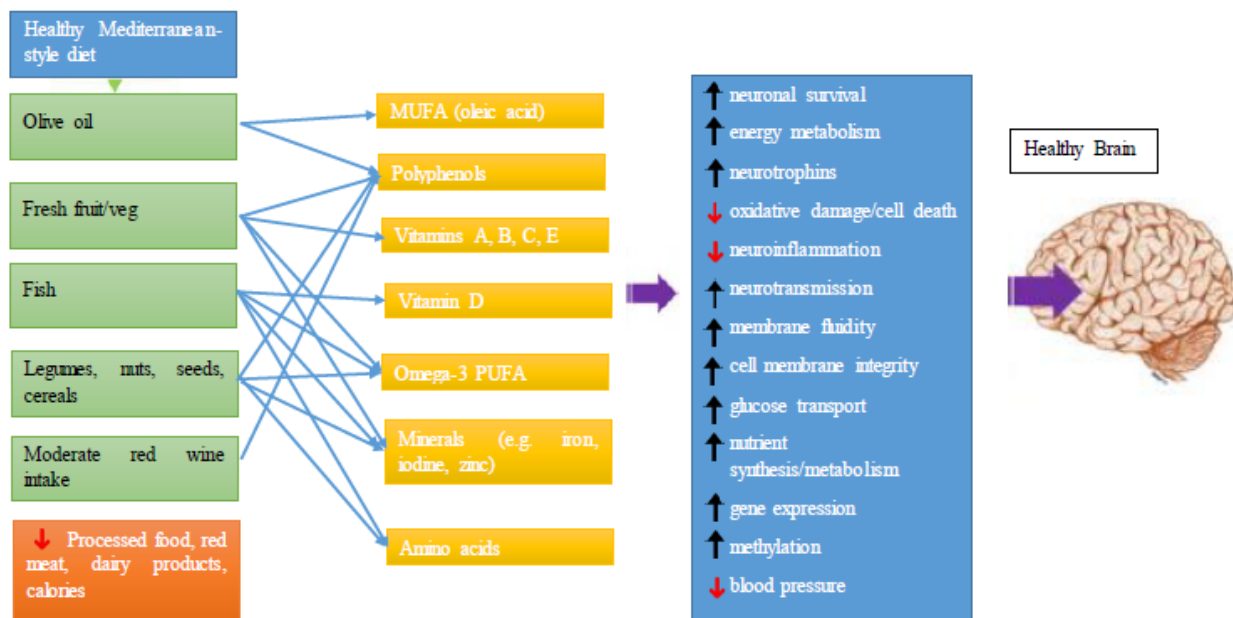


Figure 1. Overview of links between Mediterranean-style diet and healthy brain function via plant compounds/nutrients. Source: Own elaboration adapted from Parletta, Milte, and Meyer (2013).

However, there is limited evidence on the relationship between diet quality and AP in rural residence settings, in primary school children, and in AP measured over a long period of time (Bleiweiss-Sande et al., 2019), so additional research is needed (Attuquayefio, Stevenson, Oaten, & Francis, 2017; Dumuid et al., 2017; Haapala et al., 2017). Based on these precedents, the aim of this research was to analyze the relationship between the quality of the diet and the academic performance in rural primary school children of Fuerteventura.

Methods

Study Designs

A descriptive cross-sectional was designed *ex post facto* with a sample of schoolchildren belonging to a public Compulsory Education center located in a rural area (< 5000 inhabitants; LAW 45/2007, December 13th, for the development of sustainable rural environment) of the Island of Fuerteventura (Spain). The sample was made up of 181 students (99 men [54.7%] and 82 women [45.3%], with an age range between 8 and 13 years old (mean $M \pm$ standard deviation SD : 8.75 ± 1.79 years) selected in a nonprobabilistic, intentional way.

Procedure

Parents of participating students were informed about the aim of the study, risks and benefits, confidentiality of data, and privacy of information. Parents were asked if they were willing to participate in the study and were told that they had the right to refuse to participate or that they could interrupt the question at any time if they felt uncomfortable answering the question. The signed and written informed consent to participate in this study was obtained from parents and guardians since our study population was children under 18 years old.

Academic performance was assessed by means of the average grade obtained by the students in the first and second evaluation of the academic year 2019/2020, carried out in the different compulsory subjects to be taken according to what is indicated in the Primary Education curriculum (Royal Decree 126/2014, February 28th): Natural Sciences, Social Sciences, Spanish Language and Literature, Mathematics, and English. The values of all the variables ranged between a score between 1 and 10 points. Depending on the grade they obtained, the students were categorized into failed (A; ≤ 4 points) and passed (B; ≥ 5 points).

On the one hand, through the KIDMED questionnaire the quality of the Mediterranean diet

was assessed (Serra-Majem et al., 2004). This questionnaire, composed of 16 dichotomous questions, has been widely used in the infant and young population (García Cantó et al., 2019; Rosa Guillamón et al., 2019). Its score can have a range between 0 and 12 points. Questions with a negative connotation acquire a negative value of one point, which are then summed with the positive scores; the sample is classified into three levels according to its diet quality: (I) ≥ 8 , optimal; (II) 4–7, to improve; (III) ≤ 3 , low quality.

The KIDMED questionnaire was completed by the participants in a large room with the presence of the research doctor from the Department of Plastic, Musical and Dynamic Expression of the University of Murcia, Spain. This expert on the subject explained and resolved all doubts before distributing the instrument, which also contained the sociodemographic variables: sex, age, and school year.

The protection of personal data was taken into account in order to safeguard the rights, safety, and well-being of the respondents. All of the students participated voluntarily, respecting the Helsinki research ethics agreement (2013), the current Spanish legal regulation 118 that regulates clinical research in humans (Royal Decree 561/1993 on clinical trials) and the ethical code of good practices in internships at the University of Murcia.

Data Analysis

The mean (M) and standard deviation (SD) are reported for all quantitative variables. The normality of the distributions was verified by the Kolmogorov-Smirnov test with Lilliefors correction, as well as the homogeneity of the variances by the Levene test. Subsequently, when observing a normal distribution in part of the distributions of the registered values, a parametric analysis has been chosen. A simple analysis of variance (one-way ANOVA) was used to analyze the AP values as a function of the quality of the Mediterranean diet (*Low, Medium, High*). The effect size was calculated using Cohen's d (.20, small; .50, medium; and .80, large effect). In addition, an analysis of bivariate and partial correlations (Pearson's test) was carried out between the quality of the diet and the different academic subjects grouped and without grouping. Finally, it was decided to perform a multinomial logistic regression to observe the probability of obtaining different results depending on whether the students failed or passed the subject. This analysis was set to an adjusted odds ratio (OR), without adjusting for the variables of age and sex. The data

were analyzed with the statistical program SPSS (v.25.0). Statistical significance was set at $p < .05$.

Results

Data on age and mean score obtained in academic subjects according to adherence to MD are shown in Table 1, for both men and women. The only statistically significant differences were found for age, being in favor of women ($p = .032$; $d = .22$).

Table 2 shows the different bivariate and partial correlations observed according to the KIDMED index score and the academic subjects, adjusting

and without adjusting for age and sex. No statistically significant correlation was found between the KIDMED index score and adjusted academic subjects or without adjusting for age and sex.

Finally, Table 3 presents the results of the multivariate analysis to provide a predictive analysis of the quality of the diet on academic performance. Adjusting and without adjusting for age and sex, having a higher quality of diet is associated with a greater probability of passing the areas of Natural Sciences ($p < .05$) and Social Sciences ($p < .05$).

Table 1

Sample descriptive data according to the quality of the Mediterranean diet.

Variables	Males ($n = 99$; 54.7%)					Females ($n = 82$; 45.3%)				
	(Mean \pm SD)					(Mean \pm SD)				
	Low QD $n = 13$ (%)	Medium QD $n = 59$ (%)	High QD $n = 27$ (%)	p	d	Low QD $n = 12$ (%)	Medium QD $n = 49$ (%)	High QD $n = 21$ (%)	p	d
Age (years)	7.85 \pm 1.4	8.92 \pm 1.8	9.15 \pm 1.5	.071	.03	9.83 \pm 1.6	8.29 \pm 1.9	8.81 \pm 1.6	.032	.22
Natural Sciences	6.76 \pm 1.5	6.28 \pm 2.1	6.18 \pm 2.2	.702	.02	7.16 \pm 1.6	7.10 \pm 1.9	6.19 \pm 1.9	.164	.16
Social Sciences	6.46 \pm 1.7	6.32 \pm 2.2	5.96 \pm 2.5	.737	.01	6.75 \pm 2.0	7.22 \pm 2.0	7.04 \pm 1.8	.747	.02
Spanish Language and Literature	6.38 \pm 1.7	6.28 \pm 1.9	5.91 \pm 2.2	.701	.03	7.33 \pm 1.4	6.67 \pm 2.2	6.52 \pm 1.9	.542	.08
Mathematics	6.84 \pm 1.7	6.52 \pm 2.0	6.40 \pm 2.3	.827	.01	7.58 \pm 1.3	6.95 \pm 2.0	6.57 \pm 2.0	.366	.11
English	6.76 \pm 1.7	6.52 \pm 2.2	6.55 \pm 2.1	.936	.01	7.41 \pm 1.7	7.04 \pm 1.8	6.81 \pm 2.0	.691	.09
Artistic education	5.92 \pm 1.0	6.00 \pm 1.1	6.29 \pm 1.0	.444	.10	6.66 \pm 0.9	6.59 \pm 0.8	6.47 \pm 0.8	.810	.02
Physical education	7.61 \pm 1.1	7.96 \pm 0.9	8.03 \pm 0.8	.423	.10	8.25 \pm 0.8	8.24 \pm 0.8	8.19 \pm 0.8	.967	.01
Core subjects	6.64 \pm 1.5	6.39 \pm 1.9	6.21 \pm 2.0	.795	.05	7.25 \pm 1.5	7.00 \pm 1.8	6.62 \pm 1.7	.579	.09
Specific Subjects	6.87 \pm 1.1	6.92 \pm 1.1	7.07 \pm 1.0	.802	.06	7.47 \pm 1.0	7.42 \pm 0.9	7.33 \pm 0.9	.909	.01

Note. One-way ANOVA statistical test.

Table 2

Bivariate and partial correlations between the mean score of the KIDMED index and the different variables of the study.

Variables	Not Adjusted <i>R</i> (<i>p</i> -value)	Adjusted * <i>R</i> (<i>p</i> -value)
Natural Sciences	.080 (.283)	.075 (.317)
Social Sciences	.025 (.738)	.039 (.603)
Spanish Language and Literature	-.072 (.820)	-.068 (.367)
Mathematics	-.065 (.384)	-.060 (.428)
English	-.012 (.868)	-.060 (.428)
Artistic education	.111 (.138)	.119 (.113)
Physical education	.067 (.371)	.078 (.298)
Core subjects	-.045 (.550)	-.038 (.617)
Specific Subjects	.059 (.431)	.076 (.314)

Note. Adjusted for sex and age *

Table 3

Academic performance according to the quality of the Mediterranean diet.

Variables	Model I	Model II
	OR (IC 95%) <i>p</i> -value	OR (IC 95%) <i>p</i> -value
Natural Sciences	0.556 (0.37–1.07) .053	0.535 (0.29–0.97) .041
Social Sciences	1.867 (1.04–3.20) .030	2.131 (1.17–3.87) .013
Spanish Language and Literature	0.836 (0.47–1.46) .529	0.758 (0.42–1.35) .347
Mathematics	0.779 (0.46–1.30) .342	0.776 (0.46–1.29) .334
English	0.940 (0.61–1.40) .773	0.934 (0.60–1.43) .754
Artistic education	1.331 (0.57–3.09) .507	1.211 (0.49–2.97) .676
Physical education	1.694 (0.72–3.96) .225	1.686 (0.71–3.96) .231
Core subjects	0.621 (0.22–2.60) .456	0.635 (0.28–3.10) .779
Specific Subjects	0.966 (0.23–3.97) .966	1.235 (0.28–5.37) .799

Note. Multinomial logistic regression considering the approved category. Model I: not adjusted for sex and age. Model II: adjusted to the sex and age of the participants.

Discussion

The aim of this study was to analyze the relationship between the quality of the Mediterranean diet and academic performance in rural schoolchildren on the island of Fuerteventura considering and without considering sex and age. The main findings of the study show that, after adjusting for sex and age, schoolchildren with a higher quality of diet were more likely to pass the areas of Social Sciences and Natural Sciences when compared to their failing peers.

These results coincide with those found in other investigations both in primary school students (Dumuid et al., 2017; Mclsaac et al., 2015; Vassiloudis et al., 2014) and secondary education (Ibarra Mora, Hernández Mosqueira, & Ventura-Vall-Llovera, 2019), as well as in the university stage (Gimeno Tena & Esteve Clavero, 2020), where they detected a higher AP in the group of schoolchildren with the highest quality of diet.

It should be noted that in another investigation only an association was found between adherence to the Mediterranean diet and the grades obtained in Art Education, Mathematics, and Social Sciences in schoolchildren in Spain (Alfonso Rosa et al., 2018); while in Australian schoolchildren, a better quality diet was only associated with significantly higher scores in math, reading, writing, and spelling (Nyaradi et al., 2016). Considering compliance with international nutritional recommendations, (Faught et al., 2019) reflected that children who met current recommendations for protein-rich foods obtained an average of 5.67% and 3.45%, respectively, better in exams. Although the results indicated that adherence to dietary recommendations was beneficial for girls' AP, no results were statistically significant.

In a systematic review, only moderate associations were found between lower intakes of energy-rich and nutrient-poor foods and overall diet quality with respect to AP results (Burrows et al., 2017), and unlike Pearce et al. (2018) where they only found that AP was negatively associated with a nutrient-poor, energy-dense diet, but not with a nutritious diet. In this sense, Esteban-Cornejo et al. (2016) reflected that the benefits of adherence to the Mediterranean diet over AP seem to be stronger as young people adhere to the optimal levels of the Mediterranean diet. For example, Iglesias et al. (2019) only found that a low consumption of fruits, vegetables, and dairy products was related to a worse AR.

In this regard, a systematic review of micronutrient supplementation evaluated through randomized controlled trials suggested that only certain micronutrients appear to be associated with a marginal increase in fluent intelligence (based on reasoning skills, comparable to mathematics) but not with crystallized intelligence (verbal comprehension and vocabulary, comparable to ELA; Eilander et al., 2010). For its part, a dietary intervention rich in saturated fat for 4 days caused reductions in learning and memory dependent on the hippocampus and interoceptive sensitivity

(Attuquayefio et al., 2017). In addition, the Mediterranean diet has been shown to be antioxidant, given the high consumption of fruits and vegetables. Highly toxic molecules can lead to alterations in cell lipid membranes and cellular functions, and oxidized proteins, DNA, RNA, and cell death, contributing to a variety of chronic degenerative diseases, including cardiovascular disease, cancer, and premature aging (Gandhi & Abramov, 2012). Figure 2 gives a diagrammatic overview of the model that informs this.

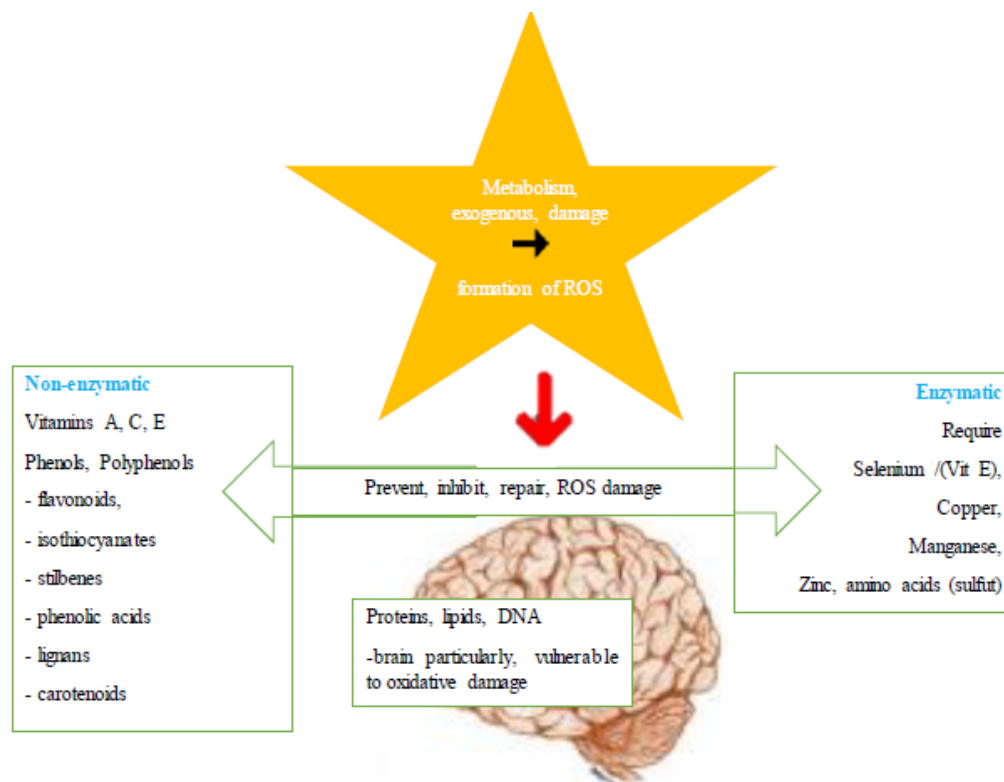


Figure 2. Antioxidant and brain overview. ROS = reactive oxygen species. Source: Own elaboration adapted from Parletta, Milte, and Meyer (2013).

Therefore, the results obtained in this study may be due to the fact that within the brain, the hippocampus is particularly sensitive to the modulation of lifestyle factors such as the Mediterranean diet. It is known that this brain structure is essential for learning and memory and for progress in the classroom, which is why it can condition AP (Hassevoort, Khan, Hillman, & Cohen, 2016).

In this sense, in schools where programs to improve the quality of the diet have been included, an

improvement in AP has been obtained (Nathan et al., 2016). However, and inconsistent with this substantial evidence base, there has been a growing trend to decrease the encouragement of activities in school that promote health and to view these activities as nonessential rather than activities fundamental to the academic activity of schools (Schwingshackl et al., 2020). Therefore, the results of this study add to the growing understanding of the associations between health behaviors and AP and provide further justification for the importance of health promotion interventions to support learning

goals and health in schools. In turn, it should be noted that our current study has several strengths, including the use of a population-based sample of rural schoolchildren aged 8 to 13 years and the use of academic performance scores obtained during an entire academic quarter.

However, our findings should be interpreted with caution due to the fact that this study was not interventionist but was based on data reported by schoolchildren, with an unknown quality and quantity of the food consumed daily by them. In turn, it is difficult to infer a cause-and-effect relationship between diet and AR, since there are confounding factors that probably influence AR that were not considered in this study, which would explain why our study did not find any partial or bivariate correlation between AP and diet quality. In this sense, Sørensen et al. (2016) reflected that the effects of healthy school meals on reading, impulsivity, and inattention were modified according to gender, education home, and reference reading skills. Therefore, these differential effects could be related to environmental aspects and deserve to be further investigated in future school meal trials. Likewise, the disparity of results in the set of investigations on these relationships may come as a consequence of the way of measuring or quantifying the AR.

Conclusion

The present study contributes to the scientific literature that investigates the relationship between healthy lifestyle habits, such as the quality of diet, and academic performance. Based on these results, it is concluded that a lower quality of the diet is associated with a lower academic performance in the areas of Social Sciences and Natural Sciences in rural primary school students. Future studies should shed more light on this association. Mainly, long-term and intervention studies are needed. Meanwhile, health promotion professionals in the school environment must consider the positive role that diet can play in academic performance and initiate programs to promote healthy eating among schoolchildren.

Author Disclosure

Authors have no grants, financial interests, or conflicts to disclose.

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