

Association between Dietary Patterns and Academic Performance among Primary School Children in Jazan Region, Saudi Arabia

Running Title: Saudi Children Dietary Patterns and Academic Performance

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1. ABSTRACT

Nutrition is a key determinant of cognitive development and academic achievement in school-going children and adolescents. The global shift towards increased consumption of processed and fast foods has led to a reduction in the intake of traditional nutrient-dense foods, potentially impairing learning and school performance. There is limited evidence on how dietary patterns relate to the academic outcomes in primary school children, particularly in Saudi Arabia. This cross-sectional study primarily aimed to identify dietary patterns and examine their association with academic performance of primary school children in the Jazan region of Saudi Arabia. The research study was done among 380 male students aged 10 - 14 years enrolled in primary schools of the Jazan region. A semi-quantitative, validated questionnaire was used to assess background characteristics, dietary habits, and academic performance of enrolled children. The mean age and standard deviation of participants were 11.13 ± 9.98 years and 54% resided in rural areas. Factor analysis identified four different dietary patterns: Western, Prudent, Traditional, and High-Protein. These patterns cumulatively explained 51% of the total variance, with the Western pattern accounting for the largest share (16%). The study found that the western pattern showed a significant

negative association with academic performance, while the remaining patterns showed a negligible, nonsignificant positive effect. The study findings highlighted the importance of promoting nutrient-rich dietary patterns and reducing western food consumption to enhance educational outcomes and support the long-term health and wellbeing of children.

INTRODUCTION

Food and nutrition play an important role in our overall health, development and wellbeing. Adequate nutritional intake during childhood is vital for optimal physical growth and development, brain maturation, and cognitive functioning [22]. While adequate nutrition enhances memory, attention, and learning capacity; nutritional deficiencies and unhealthy diet may negatively affect cognitive processes and educational outcomes among children. Good academic performance opens up professional opportunities for children. It lays the foundation and confidence necessary for long-term career success and personal well-being [21].

This unique relationship between nutrition and academic performance among schoolchildren has gained greater attention in recent years. The association between dietary habits and varied indicators of academic performance was explored by many studies, for instance, consuming breakfast on a regular basis has been linked to improved cognitive performance, attention span, and educational outcomes. A systematic review by Hoyland et al., 2009 examined the effect of breakfast on cognitive performance in children and adolescents and reported that regular breakfast consumption was associated with improved memory, attention, and better academic achievement [19]. Similarly, Adolphus et al., 2013 concluded that breakfast consumption may positively influence learning and school performance in children, especially among the undernourished [1].

Beyond individual meals, broader dietary habits have also been examined in relation to academic outcomes. More recently, researchers have emphasized the importance of examining overall dietary patterns rather than isolated nutrients or single foods. Traditional nutritional research is often focused on individual dietary components; however, food items are consumed in combination, and dietary pattern analysis reflects real-life eating behaviors in a better way [31]. Studying dietary patterns, therefore, allows researchers to record and analyse the cumulative effects of multiple dietary components and their interactions on health and cognitive outcomes [31]. This approach has found its application in nutritional epidemiology and provides a more comprehensive understanding of how habitual eating behaviors influence academic and developmental outcomes in children.

Research suggests that healthier dietary patterns, characterized by higher consumption of fruits, vegetables, and whole grains, may be associated with improved academic achievement, whereas diets rich in fast foods, refined sugars, and ultra-processed foods may be linked with poorer academic outcomes among children. A systematic review by Burrows et al., 2017 appraised the association between diet and academic achievement; a significant positive association between the overall diet quality of children and their academic performance indicators, such as grade point average and standardized test scores, were reported [13]. Thus, it becomes critical to understand the relationship between dietary patterns and academic performance, particularly in regions undergoing rapid development, lifestyle changes and nutritional transitions. In Saudi Arabia, economic development and urbanization have brought about changes in the dietary habits of people, which include high consumption of fast foods, sugary drinks, and processed foods by children and adolescents [3]. These shifts have resulted in an increase in childhood obesity and subsequent heightened concern about their probable impact on physical health and educational outcomes.

Despite growing interest in nutrition among children in Saudi Arabia, very few studies have been done to explore the influence of children's overall dietary patterns on their academic performance, particularly among primary school students. Evidence from the Jazan region in Saudi Arabia remains limited, although the region has unique socio-economic and lifestyle characteristics that may influence both dietary habits

and educational outcomes among children. Understanding and observing these unique relationships can provide valuable insights for designing school and community-based interventions aimed at improving both nutritional health and academic achievement among children. Therefore, the present research study examines the association between dietary patterns and academic performance among primary school children in the Jazan region of Saudi Arabia.

2. METHODOLOGY

2.1. Study participants and design

This cross-sectional study was done between January and April, 2025. The study participants included boys in the age range of 10 -14 years who attended primary school in the Jazan region. Willingness to participate in the research study was taken from both students and parents through a written form. Children with specific learning disabilities, cognitive impairments and those who refused to participate or give consent to participate in the study were excluded from the study.

2.2. Data collection instrument

A study tool or questionnaire was developed using a validated tool [6]; minor changes were made in the tool to ensure the relevance to the study population. The questionnaire consisted of 3 domains – background characteristics, dietary information, and academic performance. The study tool was translated into the Arabic language, followed by a standardized forward-backward translation process using independent bilingual translators. A pilot study was undertaken with 25 school-age children to assess the face validity of the questionnaire; students were asked to comment on the clarity, wording, and understanding of each item in the study tool. Slight linguistic improvements were made based on the feedback received from the pilot study. The value of Cronbach's alpha (0.81) indicated the acceptable internal consistency of the study tool. Reliability of the study questionnaire was assessed using the test-retest method, in which a sample of 25 school children completed the questionnaire twice within a period of two weeks. The correlation coefficient for the two outcomes showed a good stability coefficient, suggesting a good test-retest reliability.

Content validity of the study tool was evaluated by the experts from the clinical nutrition field. The threshold of factor loading was greater than 0.2, the comparative fit index was 0.90, and the root mean square error of approximation was 0.07 through the confirmatory factor analysis, supporting the construct validity of the questionnaire, and the final version of the questionnaire was approved by the Committee for Research Ethics at Jazan University, Saudi Arabia.

2.3. Sample size

The sample size for the research study was calculated to be 380 students using Raosoft software, based on a single proportion for a finite population size, with an allowable margin of error of 5% and a 95% confidence level. In the Jazan Education sector, there are a total of 34,777 primary school children in the 2024 academic year; the response distribution was assumed to be 50%. It was assumed that the minimum number of children in the age group of 10-14 years in a school situated in the Jazan region was 100; so, the required number of schools to be engaged for the study was calculated to be four.

2.4. Sampling frame and technique

The region of Jazan consists of 13 governorates and has 200 primary schools for boys (having 34,777 primary school children) in the academic year 2024. Out of 13 governorates, 2 (two) - Jazan and Abu Arish governorates were chosen from both urban and rural areas, respectively, using simple random sampling. Two schools were chosen, one each from Jazan and Abu Arish localities. In total, 400 primary school children participated in the study. Lists of school children, between 10 and 14 years of age, were collected from the school management, and the children were enrolled in the study using a systematic random sampling method. From the obtained list, every Kth child ($K = \frac{\text{Total eligible children in the selected school}}{100}$) was systematically selected and included in the research study until the desired number of children was reached from each selected school. If any child and/or parent was not willing to participate in

the research study, then the following child in the list was included. After the removal of students with missing information, a total of 380 students were included in the study with a 95% response rate.

2.5. *Data collection*

A comprehensive data collection training program was organized for students from the Clinical Nutrition Department, College of Nursing and Health Sciences, Jazan University. They underwent rigorous training on administering the Food Frequency Questionnaire (FFQ), which was used to gather dietary data for weekdays. For each food item listed, school children could select from six frequency categories: never, once a week, 2-4 times per week, 5-7 times per week, 8-10 times per week, and more than 10 times per week. The questionnaire included 103 commonly consumed local food items. These food items were further categorized into 16 groups based on their inherent characteristics, such as nutritional composition and functional similarity.

2.6. *Academic performance*

To determine the academic performance of children, examination scores in four core subjects, including Quran, English, Science, and Mathematics, were obtained from the school authorities. Scores of two semesters of the year 2024 were considered, and average scores were calculated for each student.

2.7. *Statistical analysis*

Data was coded and analyzed using RStudio-2024.12 for Windows 10 and 11. Quantitative variables were elaborated using descriptive statistics, while frequencies with percentages were used to describe qualitative variables. Scores for academic performance were divided into tertiles.

Exploratory factor analysis was used to identify the dietary patterns among the primary school students. Regression analysis was used to investigate the association between academic performance and the derived dietary patterns of primary school children, with a p-value <0.05 set as the statistical significance. Percentages and factor loadings have been presented to one decimal place.

2.8. *Ethical approval*

Ethical approval was taken from the Local Committee for Research Ethics at Jazan University (Reference No.: REC-46/11/1530). The study was done in coordination and collaboration with school officials from the Jazan region, Saudi Arabia. All participants were informed about the aims and objectives of the research study. Participation in the study was entirely voluntary; it was assured to all the participants that they had the right to decline or withdraw from the study at any point in time with no further consequences. Participants were assured of the privacy and confidentiality of the shared information.

3. RESULTS

3.1. *General background characteristics of the study participants*

In total, 380 primary school children participated in the research study. Students' mean age and standard deviation were 11.13±9.98. More than half of the students, that is 205 (54.00%), resided in rural areas. More than three-quarters of students' parents' marital status was stable, 340 (89.47%). The majority of students, 164 (43.16%), had family income higher than 10,000 (ﷲ). About 134 (35.26%) students were in fourth grade, 131 (34.47%) were in fifth grade, and 115 (30.26%) were in sixth grade, ensuring adequate representation across the three grade levels (see Table 1 for further details).

Table 1: General background characteristics of study participants (n=380)

Variable	Category n (%)	
Age (years)	Mean± SD (11.13±9.98)	
Residence	Urban	175 (46.00)
	Rural	205 (54.00)
Family status	Divorce	29 (7.63)

	One parent deceased	11 (2.90)
	Stable	340 (89.47)
Family income (in Saudi Riyals (ﷲ))	Less than 5000	90 (23.68)
	5000-10000	126 (33.16)
	More than 10000	164 (43.16)
Grade level	Fourth	134 (35.26)
	Fifth	131 (34.47)
	Sixth	115 (30.26)

3.2. *Academic performance of the school children*

The mean scores demonstrated a substantial improvement across tertiles in all the core subjects. Students exhibited the ceiling effect among the core subjects (Quran, Mathematics, Science, and English) in the third tertile. The Overall Grade also followed the same pattern, increasing from 89.18 at the first tertile to 99.48 at the third tertile. These results indicate strong and uniform academic improvement over time across all the core subjects (Table 2).

Table 2: Academic performance of the students (n=380)

Subject	First Tertile	Second Tertile	Third Tertile
	Mean (Minimum-Maximum)		
Quran	82.78 (45-93)	96.89 (94-99)	100 (100-100)
Mathematics	78.73 (59-87)	92.17 (88-96)	99.37 (97-100)
Science	82.76 (10-94)	97.02 (95-99)	100 (100-100)
English	79 (10-90.5)	96.33 (91-99.5)	100 (100-100)
Overall Grade	89.18 (76.18-94.4)	96.53 (94.47-98.35)	99.48 (98.37-100)

3.3. *Dietary patterns of school children*

In total, four major dietary patterns were recognized among students, which collectively explained 51% of the total variance. The western food pattern, which accounted for 16% of the variance, was characterized by high factor loadings for fast and fried foods, instant noodles, sweets and desserts, soda drinks, biscuits and cakes, tea and coffee, pastries and pizza. The prudent food pattern, explaining 13% of the variance, was mainly composed of vegetables, fruits, legumes, nuts and seeds. The traditional food pattern, accounting for 11% of the variance, included rice, pasta and potatoes, as well as traditional foods such as kabsa, gareesh, harees, areeka, and maasoob. Lastly, the high-protein food pattern explained 10% of the variance and consisted of milk and milk products, meat, chicken, seafood, eggs, and breakfast cereals (see Table 3).

Table 3: Dietary patterns of school children

Food item	Western	Prudent	Traditional	High-Protein
Fast and fried foods	0.49	-	-	-
Instant noodles	0.68	-	-	-
Sweets and desserts	0.50	-	-	-
Soda drinks	0.56	-	-	-
Biscuits and cakes	0.57	-	-	-
Tea and coffee	0.66	-	-	-
Pastries and pizza	0.58	-	-	-
Vegetables	-	0.71	-	-

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Fruits	-	0.57	-	-
Legumes	-	0.74	-	-
Nuts and seeds	-	0.63	-	-
Rice, pasta and potatoes	-	-	0.85	-
Kabsa, gareesh, harees, areeka, and maasoob	-	-	0.79	-
Milk and milk products	-	-	-	0.70
Meat, chicken, seafood and eggs	-	-	-	0.48
Breakfast cereals	-	-	-	0.58
Proportion Variance	0.16	0.13	0.11	0.10
Cumulative Variance	0.16	0.29	0.41	0.51

3.4. Association between dietary patterns and academic performance

Four-panel scatterplots were developed (as shown in Figure 1), which showed a significant association between the dietary patterns and academic performance of school-going children. Panel A demonstrates a highly significant negative association between the western dietary pattern and the academic performance of school children. In total, 16% of the variation was evident in the western dietary pattern and school children's academic performance. Further, prudent, traditional, or high-protein dietary patterns had positive linear relationships with the academic performance of school children. (see Figure 1 B–D).

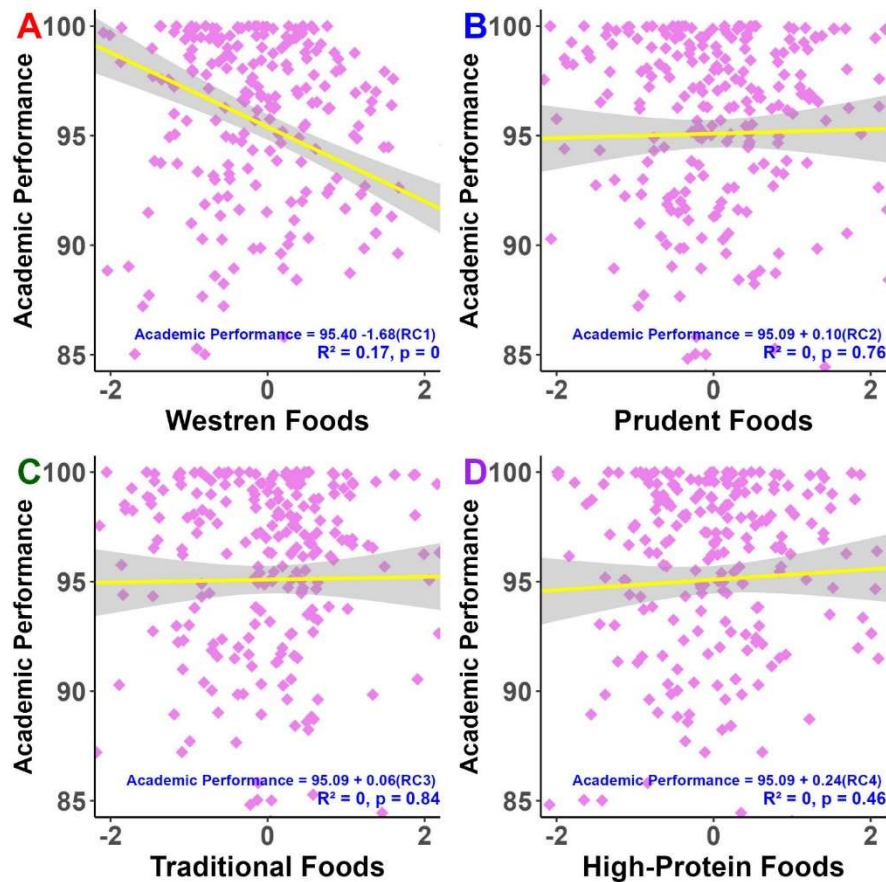


Figure 1: Association between dietary patterns and academic performance

4. DISCUSSION

This research study is among the first to explore the relationship between dietary patterns and academic performance of children in the primary schools in the Jazan region, Saudi Arabia. The findings reinforce the well-established evidence of the negative effect of the Western food pattern, characterized by high calorie count, refined, ultra-rich in sugars and fats, on the performance in academics of primary school children. The other three dietary patterns (prudent, protein-rich, and traditional) showed a positive effect on academic performance, although not significant.

The western dietary pattern, which consisted primarily of fast and fried foods, instant noodles, sweets and desserts, soda drinks, biscuits and cakes, tea and coffee, pastries and pizza, was significantly inversely associated with academic performance ($p < 0.01$). In agreement with the findings of this study, the link between poor diet quality and impaired cognitive functions, along with lowered academic performance, was reported in other research studies as well [22, 24, 26]. A longitudinal study done by Jacka et al. [20] which showed that adherence to a western dietary pattern was significantly associated with a high risk of depression and anxiety, both of which may adversely affect cognitive functioning and academic achievement. Diets rich in refined sugars and saturated fats have demonstrated impaired hippocampal function, reduced neuroplasticity; they negatively influence attention and working memory [14, 16]. Ultra-processed foods are similarly associated with behavioral difficulties, reduced attention span, and poor academic outcomes [15, 23]. This was also observed in Chile, where children consuming a western-style diet underperformed in all the studied cognitive domains [28]. Consistent with the global evidence, studies from Saudi Arabia also report that frequent consumption of fast foods is associated with lower academic performance among school-aged children [4].

Other dietary patterns, such as prudent, traditional, and high-protein patterns, have also been studied for their association with children's academic performance. The prudent pattern, characterized by high intake of vegetables, fruits, legumes, nuts and seeds, accounted for 13% of dietary variation, showed no significant association with academic performance of children. The prudent diet pattern identified in the current study is similar to a Mediterranean-style diet, which has been widely linked to better cognitive outcomes and academic performance in children and adolescents. Evidence from a systematic review and meta-analysis showed that higher adherence to a Mediterranean diet was consistently associated with greater academic achievement in youth [21]; however, the effect size was weak. Similarly, findings from the Cogni-Action Project indicated that adolescents who follow a Mediterranean-style eating pattern demonstrated superior cognitive function and academic performance across all four studied domains (cognitive flexibility, working memory, fluid reasoning and inhibitory control) as compared to their peers [28]. Other studies also suggest that the Mediterranean diet positively affects academic performance [7, 10, 29, 30]. A systematic review by Parletta et al., 2019 reported that adherence to a plant-based dietary pattern, that is rich in fruits, vegetables, legumes, and nuts, was associated with enhanced cognitive performance and improved academic outcomes [27]. Granziera et al., 2021 [17] did not find any association when continuous data were used; however, when participants were divided into tertiles, similar to the approach of this study, a positive association between Mediterranean and academic performance was observed, even after adjustment for maternal IQ and socio-economic status. Bleiweiss-Sande et al., 2019, on the other hand, found no significant association between 'healthful diet' containing fruits, vegetables, unsweetened beverages and academic performance [11].

Traditional pattern, which consisted of rice, pasta and potatoes, along with traditional foods such as kabsa, gareesh, harees, areeka, and maasoob, accounted for 11% of the variance; this diet pattern presented a more balanced source of energy and nutrients [4, 5]. Evidence from many observational and cross-sectional studies suggests that overall diet quality and nutritionally balanced dietary patterns are positively associated with academic performance of children and adolescents, including improved school performance and grade point average in diverse populations [18, 33]. However, in our study, no significant difference was observed between the consumption of traditional foods and academic performance.

Lastly, the high-protein pattern, which consisted of milk and milk products, meat, chicken, seafood and eggs, and breakfast cereals, accounted for 10% of the variance and did not have a significant effect on academic performance in the current study, while some other studies have positively linked this diet to improved academic performance. Some studies reported that high-protein dietary patterns were linked to better cognitive ability in children [32, 33]. These findings are in coherence with an ever-increasing evidence indicating that the quality of diet plays a critical role in students' academic achievements [8, 9, 25]. Similar findings have been reported in a systematic review by Burrows et al., 2016 [12] and a study by Akhittouch et al. [2]; a significant association was observed between healthy dietary patterns and improved academic performance among school-aged children and adolescents.

5. LIMITATIONS

The study has a few limitations, such as its cross-sectional design, which obviate conclusion about causation. Generalization to other contexts should be made with caution, as the study captures the eating habits of males and that too from a definitive population. The eating habits and food patterns identified in the research study are based on the answers received from school-going children in response to the food frequency questionnaire, which might be subjected to recall bias.

The patterns and correlations between the identified food groups and academic performance of primary school children have been derived through statistical methods and analyses; consequently, the resulting patterns might not entirely represent actual eating patterns and behaviour of primary school children and may vary across populations, time-periods and research studies. In addition, the effects of other modifiable and non-modifiable covariates, such as sleep quality, physical activity, and family income, have not been accounted for in the present research study.

6. CONCLUSION

This research study demonstrates a significant negative association between the 'Western' dietary patterns and academic performance in upper primary school children in the Jazan region. Furthermore, no significant association was observed with respect to prudent, traditional, or high-protein dietary patterns and academic performance in upper primary school children.

In line with the Kingdom of Saudi Arabia's Vision 2030 and Strategic Health Sector Transformation Programme, the research findings highlight the importance of overall good diet quality and academic performance in school-going children. In addition, the study emphasizes the need to significantly reduce the consumption of refined, ultra-processed, western foods by school-going children. Policymakers must reflect upon programmes and/or interventions that limit the accessibility of fast foods, which are refined, calorie-dense and poor in nutrients in and around school environments.

Positive interventions can be developed to educate and make the parents aware about the importance of consuming a balanced, healthy and nutritious diet, while highlighting the ill effects of regular consumption of western foods, especially by school-going children.

Further longitudinal studies are recommended on this topic, while the results of this cross-sectional study seem to be quite compelling. Future research should take into account a broader range of covariates—such as socio-economic status, educational level of parents, physical activity levels, sleep patterns, etc.—to comprehensively map the relationship between nutrition, academic performance and cognitive outcomes.

ABBREVIATIONS

SSBs = Sugar-Sweetened Beverages, FFQ = Food Frequency Questionnaire

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

DATA STATEMENT

For a reasonable request, the corresponding author will provide the data that supports the results of this research.

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AUTHOR CONTRIBUTIONS

F.A.E.: research conceptualization, administration, resources, supervision, validation, investigation, writing- original draft, review and editing; R.M.C.: research conceptualization, methodology, data curation, validation, investigation, writing- original draft, review and editing; A.H.A., J.A.N., and A.M.O.: research conceptualization, data curation, validation, investigation, writing- original draft; H.E.K.: data validation, investigation, review, and editing. F.A.E., R.M.C., A.H.A., J.A.N., A.M.O., and H.E.K contributed to the drafting and revision of the research article. All authors have read and agreed to the published version of the manuscript.

INSTITUTIONAL REVIEW BOARD STATEMENT

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Local Committee for Research Ethics at Jazan University (Reference No.: REC-46/11/1530).

INFORMED CONSENT STATEMENT

Informed consent was obtained from all the subjects involved in the study.