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Pilot Study on a Dietary Intervention in Children With Symptoms of Inattention, Hyperactivity, and Impulsivity

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Abstract: Recent research has evaluated diet quality as an alternative treatment to reduce symptom severity in attention-deficit hyperactivity disorder (ADHD). The present study aims to evaluate the changes associated with an 8-week dietary intervention on the severity of inattention (I) and hyperactivity/impulsivity (HI) symptoms, on the characteristic electrophysiological patterns of ADHD, and on attention and memory performance (Digit Span subtest of the WISC-V) in children. An exploratory study with a pre-experimental pretest-posttest design was conducted. Participants included 13 children aged 6 to 13 years presenting with symptoms of I and HI according to the ADHD-5 scale. The results revealed a significant reduction in symptoms of I and HI. In the electroencephalogram, a significant increase in the relative power of the alpha band and a decrease in the theta band were recorded. There were no significant differences in attention and memory. These findings provide preliminary evidence regarding potential behavioral and electrophysiological changes associated with a dietary intervention in children with ADHD symptoms. Due to the pre-experimental design without a control group and the reduced sample size, the results do not allow for the establishment of causal relationships or definitive clinical changes in brain activity; nevertheless, they highlight the relevance of multidisciplinary approaches that include diet in the management of ADHD.

Keywords: ADHD, electroencephalography, healthy diet, elimination diet

Introduction

Attention-deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterised by difficulties in attention, hyperactivity, and impulsivity. It has a prevalence of 5% to 8% (WHO, 2018) and is more frequent in boys than in girls, with an approximate ratio of 4:1 (Saavedra et al., 2019).

Diagnosis is based on the clinical criteria of the DSM-5 and ICD-11, which is supplemented by electroencephalographic recordings. These recordings show characteristic alterations in cerebral electrical activity among children presenting with ADHD symptoms, such as decreased beta and alpha power in frontocentral areas and increased theta power compared with healthy children (Loo & Makeig, 2012; Pa et al., 1997).

The onset and development of ADHD result from the interaction of genetic and environmental factors (Cook et al., 1995). Among these, nutrition is a key factor; it is currently recognised that an adequate diet during pregnancy and childhood crucially influences cognitive development, carrying important implications for future brain health. Nutrients such as folate, omega-3 fatty acids, and iron are particularly relevant (Anjos et al., 2013; Nigg & Holton, 2014; Quintero Gutiérrez del Álamo et al., 2009).

Furthermore, healthy dietary patterns rich in fruit, vegetables, and whole grains, alongside a low intake of processed foods, have been observed to mitigate symptoms and prevent side effects such as abdominal pain, headaches, insomnia, and anxiety caused by medications like methylphenidate (Storebø et al., 2019). These alternatives have been tested especially in cases where medication shows adverse or unsatisfactory effects (Ríos-Hernández et al., 2017).

Despite the aforementioned findings, a gap in evidence persists regarding specific dietary interventions in non-Western populations, particularly in Latin American children. In this population, the changes associated with a combination of an elimination diet and a healthy diet have not been comprehensively evaluated concerning clinical symptoms, cerebral electrical activity, and cognitive functions such as attention and working memory. This lack of studies in our population limits accessible and culturally adapted therapeutic options, especially in cases involving adverse medication effects.

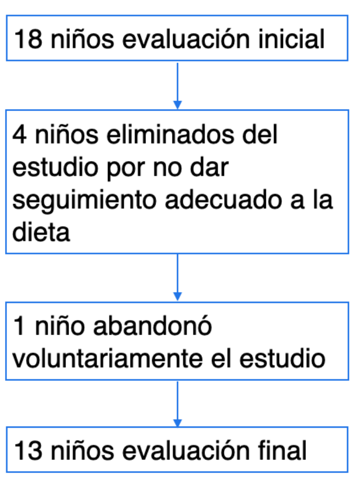
Therefore, the present study aims to evaluate the changes associated with an intervention combining an elimination diet and a healthy diet on ADHD symptoms, cerebral electrical activity, and cognition in Mexican children.

Method

An exploratory pilot study using a single-group pretest-posttest design was conducted. Sampling was completed by convenience, based on responses to a call for participants broadcasted via social media networks.

Figure 1

Selection and retention of study participants



A final sample of 13 children was included in the analysis, with an age range of 6 to 12 years (*M* = 9.4 years, *SD* = 2.03). High scores for inattention (I) were obtained by 84.6% of the participants, whereas 92.30% presented with elevated scores for hyperactivity-impulsivity (HI) according to the ADHD-5 questionnaire.

This project followed the ethical recommendations of the CIOMS guidelines and obtained approval from the Ethics Committee of the Faculty of Medicine at the University under protocol number 02/2023-11. Parents signed an informed consent form, and informed assent was obtained from the participating children.

Instruments

First, the ADHD-5 Scale was used, which is an 18-item tool based on the DSM-5 diagnostic criteria, where nine items assess symptoms of inattention (I) and nine assess symptoms of hyperactivity-impulsivity (H). Second, the Digit Span subtest from the Wechsler Intelligence Scale for Children (WISC-V) was administered to evaluate working memory and attention. Third, a food consumption questionnaire was employed to assess dietary changes, considering (a) an elimination diet and (b) a healthy diet.

A dietary intervention was implemented for 8 weeks, combining an elimination diet (excluding allergens and processed foods such as dairy, sausages, wheat, soy, fried foods, and processed beverages). Parents received personalised nutritional instructions and supervision provided by a professional in the field.

Lastly, cerebral electrical activity was recorded using NeuronicMR equipment, with an ElectroCap equipped with Ag/AgCl electrodes positioned according to the 10/20 International System. Short-circuited earlobe electrodes served as references. The sampling rate was 5 milliseconds, and the band-pass filter was set between 0.1 Hz and 50 Hz. Impedance was maintained below 5 kΩ. Recordings were gathered in a resting state with eyes open for 10 minutes. At least 24 windows of a minimum of 2.6 seconds were analysed per recording. Relative power analysis was conducted for the theta, alpha, and beta frequency bands at the Fp (frontopolar), F (frontal), C (central), and FL (frontolateral) electrodes.

Procedure

Recruitment of the participants was conducted through the dissemination of an informative poster on social media networks. Interested parents or guardians were provided with detailed information about the study, and after confirming their participation, the ADHD-5 Scale and a food frequency questionnaire were administered digitally.

Participants who obtained elevated scores on the ADHD-5 Scale were clinically evaluated at the Neuropsychology Laboratory of the Autonomous University of Querétaro, Faculty of Psychology. The Digit Span Forward and Digit Span Backward subtests of the Wechsler Intelligence

Scale for Children (WISC-V) were administered. Subsequently, an electroencephalographic recording was performed in a resting state for 10 minutes.

Upon completion of the baseline evaluation, dietary recommendations were provided to the parents, and weekly follow-ups were conducted for eight weeks to record changes in diet and potential behavioral effects. At the end of the 8-week dietary implementation period, the ADHD-5 Scale, the food frequency questionnaire, the cognitive subtests, and the electroencephalographic recording were re-administered under the same initial conditions.

Results

Following the intervention, the percentage of children with elevated inattention scores decreased significantly from 85% to 31%, and for hyperactivity-impulsivity, from 92% to 61%. Furthermore, a Wilcoxon signed-rank test for repeated measures was conducted between the percentiles of I and HI. Statistically significant differences were found between the pretest and posttest scores in I ($W = 66$, $p < .01$) and in HI ($W = 36$, $p < .05$).

On the Digit Span subtest, which measures attention and working memory, there was an increase in scores, though this did not reach statistical significance according to the Wilcoxon test ($W = 19.5$, $p = .07$).

The mean consumption before and after the intervention was analysed to verify whether differences existed. Regarding the elimination diet, a significant decrease was observed in the consumption of portions (based on the Mexican System of Equivalent Food Products, 2024) of the following foods: sliced bread ($W = 41$, $p < .05$), sweets ($W = 66$, $p < .01$), fried foods ($W = 66$, $p < .01$), and soft drinks ($W = 55$, $p < .01$) (see Table 1). Regarding the healthy diet, significant increases were found in the consumption of vegetables.

For the EEG analysis, a repeated-measures analysis of variance (ANOVA) was performed with four within-subject factors: treatment, band, electrode, and hemisphere. Electrodes from the frontocentral region were selected for analysis (Fp1, Fp2, F3, F4, C3, C4, F7, F8). A significant main effect of treatment was obtained, $F(1, 11) = 8.59, p = .014, \eta_p^2 = .43$, with no significant interactions found. A significant increase was observed in alpha relative power, whereas a decrease was noted in the theta band (Figure 2).

Discussion

The present work represents a pioneering pilot study in Mexico, integrating changes in dietary patterns followed for 8 weeks in children with symptoms of inattention (I) and hyperactivity-impulsivity (HI) related to ADHD. The results show a significant decrease in the percentage of children with elevated scores for I (from 85% to 31%) and HI (from 92% to 61%) according to the ADHD-5 questionnaire, based on parental perception when comparing pretest and posttest parameters. These findings are similar to those previously reported in other countries, where dietary interventions reduced clinical symptoms (Lange, 2020; San Mauro Martín et al., 2022).

Regarding cognitive functions measured via the Digit Span subtest of the WISC-V, which evaluates attention and working memory, an increase in post-intervention scores was observed, albeit without statistical significance. This positive though inconclusive trend is consistent with previous research implementing diets rich in omega-3 and micronutrients, which reported modest improvements in executive functions alongside small sample sizes (Nigg, 2013).

Changes were also found in electroencephalographic patterns compatible with functional improvement, as evidenced by an increase in the Z-score of the relative power of the alpha band and a reduction in the theta band post-intervention. This aligns with patterns reported in studies comparing children with and without ADHD. The literature has consistently indicated that ADHD is associated with a relative excess of theta activity and a reduction in alpha activity, particularly in frontocentral regions, which has been interpreted as a marker of cortical immaturity or lower functional activation (Barry et al., 2003; Loo & Makeig, 2012). Therefore, the observed changes in the relative power of the alpha and theta bands are consistent with patterns previously described in a pediatric population without ADHD. Furthermore, reducing the theta band has been a common target of neurofeedback intervention protocols for individuals with ADHD (Albert et al., 2017). However, due to the pre-experimental design without a control group, it is not possible to attribute these changes exclusively to the dietary intervention, as uncontrolled external conditions could have influenced the observed results.

Dietary changes were evident; within the elimination diet, there was a significant decrease in the consumption of portions (measured using the Mexican System of Equivalent Food Products, 2024) of sliced bread (*W* = 41, *p* < .05), sweets (*W* = 66, *p* < .01), fried foods (*W* = 66, *p* < .01), and soft drinks (*W* = 55, *p* < .01) (see Table 1). Concurrently, vegetable consumption increased within the healthy diet framework. These behavioral findings are consistent with recent literature indicating that healthy dietary patterns, characterised by a higher intake of fruit, vegetables, and pulses, and a reduction in ultra-processed foods, are associated with lower ADHD symptom severity.

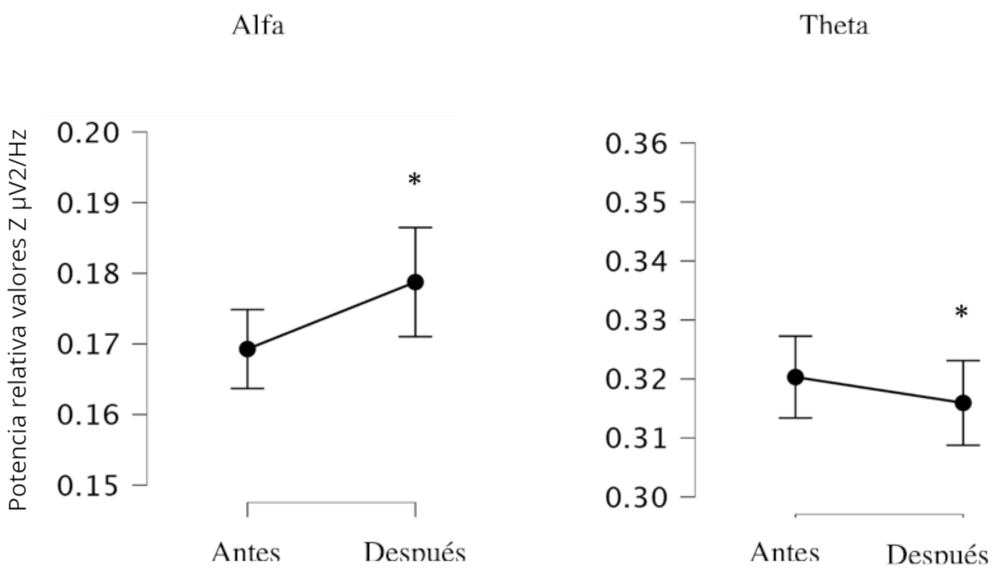
Table 1: Mean Food Consumption Before and After the Dietary Intervention

Food	**Before Mean ± SD**	**After Mean ± SD**
Healthy diet		
Vegetables	11.8 ± 9.2	28.7 ± 30.9**
Pulses	2.5 ± 2.3	2.9 ± 2.7 ns
Fruits	19.3 ± 27.5	28.6 ± 19.9 ns
Elimination diet		
Dairy products +	7.5 ± 8.8	3.6 ± 4.6
Eggs	3.6 ± 5.0	2.6 ± 2.6
Sausages	2.9 ± 2.3	2.9 ± 2.3
Seafood	0.1 ± 0.1	0.1 ± 0.1
Breakfast cereals	2.3 ± 4.8	0.4 ± 0.7
Sliced bread	5.6 ± 13.3	0.9 ± 1.6*
Sweets	4.3 ± 3.5	0.7 ± 0.8**
Fried foods	1.6 ± 1.8	0.1 ± 0.3**
Soft drinks	2.0 ± 2.3	1.0 ± 2.0**
Sugary milk-based beverages	10.7 ± 6.7	7.4 ± 5.7

Note: + Includes dairy derivatives, excluding milk. ns = non-significant, *p < .05, **p < .01. Comparisons performed using the Wilcoxon signed-rank test.

Figure 2

Relative power Z-scores (μV^2/Hz) in alpha and theta bands before and after the dietary intervention



* p < .05

Behavioral studies and pilot trials have reported that such diets, including those inspired by the Mediterranean diet or elimination protocols, can be linked to improvements in attentional and behavioral regulation in children, though generally presenting modest effect sizes and high methodological heterogeneity (San Mauro Martín et al., 2021).

Limitations of this study include the reduced sample size (*n* = 13), which limits the generalisability of the results and the direct attribution of the observed changes to the dietary intervention. Additionally, the follow-up period was relatively short (8 weeks); thus, it is not possible to determine the long-term stability of the observed effects. These findings must be replicated with larger samples and long-term monitoring to confirm and extend these results.

This pilot study contributes relevant preliminary evidence, showing behavioral and electrophysiological changes associated with a dietary intervention in children with ADHD symptoms within a Latin American context. The results emphasise the necessity of integrating nutritional strategies inside a multidisciplinary approach for the management of ADHD. Moreover, they highlight the need for future studies with larger sample sizes and long-term follow-up to clarify the potential effect of nutritional interventions in the multidisciplinary management of ADHD.

Ethical Considerations

Ethics committee approval and informed consent statement for research involving human or animal subjects. All procedures performed in this study involving human participants were in accordance with the ethical standards of the Ethics Committee of the Universidad Autónoma de Querétaro. The parents or legal guardians of the participants provided written informed consent prior to the start of the assessments, and informed assent was obtained from all participating minors.

Author Contributions

Alma Cristina Moreno Villagran: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft. Elizabeth Rodríguez: Conceptualization, Supervision, Project administration, Validation, Writing – review & editing. Cesar Antonio Campos Ramírez: Methodology, Formal analysis, Visualization, Writing – review & editing. Gloria Nélida Avecilla Ramírez: Resources, Supervision, Validation, Writing – review & editing.

Conflicts of Interests

The authors declare that the research was conducted in the absence of any commercial, professional, or financial relationships that could be construed as a potential conflict of interest.

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