

## Artículo Original

### Nutritional status and food consumption in indigenous Mayan children and adolescents with neurodevelopmental disorders Estado nutricional y consumo de alimentos en niños y adolescentes indígenas mayas con trastornos del neurodesarrollo

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#### RESUMEN

**Introducción.** Los trastornos del neurodesarrollo pueden estar asociados con otras alteraciones como los trastornos de la alimentación. **Objetivo.** Evaluar el estado nutricional y el consumo de alimentos en niños y adolescentes con trastornos del desarrollo en una comunidad indígena maya de Yucatán, México. **Métodos.** Se realizó el estudio en una escuela de la comunidad de Maní; fueron aplicados instrumentos para identificar a los niños y adolescentes con trastornos del neurodesarrollo, se evaluó la frecuencia semanal de consumo de alimentos y el índice de masa corporal (IMC) fue evaluado de acuerdo con las recomendaciones de la OMS. **Resultados.** De un total de 230 alumnos, 15 (6.5%) presentaron algún trastorno del neurodesarrollo, diez femeninas y cinco masculinos, de entre 7-10 años. Seis presentaron problemas en la lectura, escritura y aritmética, cinco presentaron trastorno del desarrollo intelectual y cuatro presentaron problemas en la orientación espacial y el habla. La mayoría (73.3%) presentó algún grado de estatura baja. Menos del 50% presentó consumo diario de frutas y más del 50% consumían diariamente azúcares añadidos o galletas. **Conclusión.** Algún grado de baja estatura fue frecuente (73.3%) en estudiantes con trastornos del neurodesarrollo (problemas de aprendizaje y trastorno del desarrollo intelectual), sugiriendo desnutrición crónica. También se encontró alta frecuencia de IMC bajo para la edad sugiriendo desnutrición aguda. La dieta fue ligeramente deficiente en el grupo estudiado.

**Palabras clave:** nutrición, cultura maya, niños, adolescentes, trastornos del neurodesarrollo, dieta.

#### SUMMARY

**Introduction.** Neurodevelopmental disorders could be associated with other alterations such as dietary disorders. **Objective.** Evaluate nutritional status and food consumption of indigenous Maya children and adolescents with neurodevelopmental disorders. **Methods.** A cross-sectional study was done in a public elementary school in the Mayan community of Mani in the state of Yucatan, Mexico. Participants were evaluated by qualified teachers who identified disorders using a standardized test battery. Body mass index (BMI) was evaluated according to the WHO and weekly frequency food consumption was evaluated. **Results.** 15 students from a total of 230 students (6.5%) were identified with neurodevelopment disorder, ten females and five males, ages between 7 to 13 years. Six had problems in learning issues (literacy and arithmetic), five had intellectual developmental disorder and four had learning problems (spatial orientation, expressive speech, articulation, and repetition). Many (26.6%) had low BMI-for-age and most (73.33%) short height-for-age. Less than 50% of students had daily intake of fruits and more than 50% had high weekly consumption of added sugars or cookies. **Conclusion.** Any degree of short stature was frequent (73.3%) in students with neurodevelopmental disorders, suggesting chronic malnutrition. High frequency of low BMI-for-age (26.6%) was found suggesting acute undernutrition. Diet was slightly deficient among the students.

**Keywords:** Nutrition, Mayan culture, children, adolescents, neurodevelopmental disorders, diet.

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## Introduction

Neurodevelopmental disorders are alterations occurring during the developmental period and characterized by deficits that produce limitations in specific areas or general limitations. Difficulties or limitations are present in personal, social, academic and/or occupational functioning (1). Examples of neurodevelopmental disorders include autistic spectrum disorder; attention deficit hyperactivity disorder; motor disorders; communication disorders; eating disorders; excretion disorders; intellectual development disorders; learning disorders; and specific learning disorders. Because they are among the most frequent neurodevelopmental disorders, the latter three have received intense attention in childhood neuropsychology research (2). Their frequency is higher in males (3), and their prevalence is especially worrying in childhood and adolescence. Estimated frequency is between 10 to 15%, although these data are not precise due to the wide variety of disorders included in this category (4). Early detection is critical in their evolution.

Neurodevelopmental disorders have also been associated with other alterations such as dietary disorders (5). An adequate nutritional condition is necessary for normal development but is also vital in those suffering neurodevelopmental disorders. Proper cognitive, motor, and social skills development requires adequate nutrition during childhood and adolescence. This is perhaps even more true in children facing developmental challenges in cognition, behavior and/or interaction, making preventive measures aimed at avoiding deficiencies in nutrition an important element of long-term treatment regimes. Neglecting nutritional status in those with neurodevelopmental disorders can exacerbate their condition. Synergistic occurrence of the disability and inadequate nutrition can place sufferers in an educational bind in which different barriers in school, the classroom or social-family contexts can impede a student's access to, permanence in, learning capacity within, participation in and/or timely completion of a scholastic curriculum.

Intellectual development, learning and specific learning disorders involve difficulty in acquiring the basic academic skills of reading, writing and arithmetic; the possible causes are multifarious and still lack satisfactory explanation (6). In Mexico, an estimated 5,739, 270 people have some disability that may or may not involve challenges in learning. Data from the Ministry of Public Education from 2010 indicate that special education programs had enrolled 501,387 students, of which 188,116 had some learning-related disability (SEP, 2012).

Malnutrition and overweight in children can arise from many factors. Various studies done in different countries have shown that school-age children and adolescents with disabilities or chronic diseases more commonly exhibit overweight or obesity compared to children and adolescents without disabilities (8). There are also reports that children and adolescents with neuromuscular and/or intellectual disabilities tend to have malnutrition, especially if the disability is associated with mastication and swallowing problems (9,10).

Over the last forty years, chronic malnutrition and overall malnutrition have exhibited sustained reductions in Latin America; for example, overall malnutrition decreased significantly from 21% in the 1970s to 7% in 2005. However, progress in the region has not been homogeneous. Mexico is a case in point in that malnutrition has not been eradicated, and has become more prevalent in rural areas, particularly in its southeastern states. The region's nutritional conundrum is further complicated by a 3- to 6-fold higher rate of height deficiency; weight insufficiency can be reversed, but children suffering growth delays are at a greater risk of overweight during adolescence (11). The nutritional profile of the Latin American and Caribbean population is a reflection of inequities in income distribution and the insufficient emphasis assigned food and nutrition policy in national agendas (12).

The present study objective was to analyze the nutritional status and food consumption of school-age children with neurodevelopmental

disorders in a rural population in southeastern Mexico.

### Material and Methods

A cross-sectional study was done in a public elementary school in a Maya community in the town of Maní in the state of Yucatan, Mexico (Coordinates 20°23'N 89°24'W). The participating students were selected from those identified previously by the school's Special Education and Inclusive Education Unit (Unidad de Educación Especial y Educación Inclusiva - UDEEI) as not having reached the educational objectives of a scholastic cycle. The sample selection corresponds to the non-probabilistic (accidental) method. Inclusion criteria were: range was between 7 and 13 years old, children and adolescents with a diagnosis of developmental disorders attending primary school, without endocrine and/or metabolic disease, or treatment with any drug that could modify food intake or nutrient utilization, were included. The only exclusion criterion was lack of school attendance on the days programmed for tests or interviews. Participation was voluntary and required written informed consent from the participant's parents or legal guardians, as well as consent from the potential participating children and adolescents. The entire study was conducted in accordance with the recommendations of the Declaration of Helsinki. Evaluations were done at the UDEEI, a specialized service co-administered by teachers and school administrators. Its mission is to guarantee quality care on an equal basis to students whose timely progress through basic education has been hampered by scholastic, academic and/or social-familial challenges that may have affected their access to education, permanence in school, learning trajectory, and participation in and/or completion of the curriculum. The intent is to promote elimination of the barriers that impede these students' scholastic participation and learning. In the present case, the UDEEI provides technical-operative and administrative support to the regular education area for students exhibiting neurodevelopmental disorders that manifest as

learning problems of diverse etiologies. Teachers were asked to identify students in their classroom with learning problems (i.e. a delay of one to two years in academic progress) in any curriculum area, and especially Spanish and mathematics. The students were referred to the Department of Special Education and Inclusive Education for a diagnosis of individual neurodevelopmental disorders; in the study participants these included intellectual development disorder, learning problems specifically in literacy and arithmetic, and learning problems in spatial orientation, expressive speech, articulation, and repetition.

### Nutritional status assessment

Body mass index (BMI) was measured, and weekly food frequency was evaluated. Anthropometric measurements were taken with participants wearing light clothing and barefoot. Body weight (kg) was measured with an electronic digital scale (Seca Alpha model, range: 0.1-150 kg, precision 100 g) placed on a flat, firm surface. Height (stature) was measured with a Harpenden digital stadiometer (Pfiffter, Carlstadt, NJ, USA, range 70-205 cm, precision 1 mm). Measurements were taken by the project nutritional technician following standard protocols.

After measuring weight and height, the body mass index (BMI;  $\text{kg} / \text{m}^2$ ) was calculated for each child and used to generate the indicators of height / age and BMI / age based on parameters established by the World Health Organization (WHO) (13). The Z scores for the height / age index (low height  $Z \leq -2.0$ ), and body mass index ( $\text{BMI} = \text{weight (kg)} / \text{height (m}^2\text{)}$ ) were estimated by age (thinness: Z of - 2, 0 or less; normal: from -0.9 to 0.9; overweight: from 1.0 to 1.9; obesity: 2 or more). Low height-for-age values reflect past or chronic malnutrition, a condition that may be irreversible in children older than 2 years. It has been identified as an indicator for measuring childhood disorders because of its close association with learning problems (14).

## Results

From 230 students, 15 students (6.5%) five boys and ten girls, with neurodevelopmental disorders were identified, ages between 7 to 13 years and they were in scholar grades ranging from one to six. The assessment was conducted by UDEEI teachers, who identified each disorder with standardized test batteries. From the 15 students, six had problems in learning issues (literacy and arithmetic), five had intellectual developmental disorder and four had learning

problems (spatial orientation, expressive speech, articulation, and repetition) (Table 1).

### Nutritional status assessment

BMI/age showed that 9 students (60%) had normal values, 4 (26.7%) were underweight and another 2 (13.3%) were obese (Table 1). Height-for-age values are presented in Table 1, 11 students (73.3%) presented any grade of low stature In all students (n=230), 33.33% presented slightly short stature, 26.66% short stature,

**Table 1.** Nutritional status and learning problems.

Age (years)	BMI for age Classification	Height for Age		Neurodevelopmental Disorder Diagnosis	
		Boys	Girls	Boys	Girls
7	Low weight	Severely low		Learning Issues (Literacy & Arithmetic Operations)	
7	Normal		Slightly tall		Intellectual development disorder
8	Obesity	Normal		Intellectual development disorder	
9	Normal	Low		Intellectual development disorder	
9	Normal	Slightly low		Learning Problems (Spatial Orientation, Expressive Speech, Articulation and Repetition)	
9	Normal	Slightly low		Learning Issues (Literacy & Arithmetic Operations)	
9	Normal		Normal		Learning Issues (Literacy & Arithmetic Operations)
9	Normal		Slightly tall		Learning Issues (Literacy & Arithmetic Operations)
9	Normal		Slightly low		Intellectual development disorder
11	Under weight		Low		Learning Problems (Spatial Orientation, Expressive Speech, Articulation and Repetition)
11	Normal		Slightly Low		Learning problems (Literacy and Arithmetic Operations)
11	Under weight		Slightly low		Learning Issues (Literacy & Arithmetic Operations)
12	Under weight		Low		Learning Issues (Literacy & Arithmetic Operations)
12	Normal		Severely low		Learning Problems (Spatial Orientation, Expressive Speech, Articulation and Repetition)
13	Obesity		Low		Intellectual development disorder

Source: field notes, 2020

13.33% severely short stature and 13.33% normal stature.

#### Food consumption frequency

In the surveyed families the most frequently consumed foods were black beans, eggs, corn tortillas, sugar, pasta, rice, beef, pork and chicken, fruits, and vegetables (Table 2). Fruits were consumed more than vegetables, indeed, most of the participants consumed more fruit daily than vegetables. Tortillas were consumed daily by school children, making it a dietary staple in this community's domestic groups. Of note is that rice was the second most consumed cereal food after corn tortillas (at least 6 out of 15 consumed it once or twice a week). This suggests that consumption of cereals like rice changes daily and is consumed in addition to tortillas rather than as a replacement for them.

Oats may be among the most complete cereals due to their high fiber, iron, and Vitamin B6

contents, but it was not a favorite of the study participants. Only one out of fifteen ate it five times a week, and 6 out of 15 ate it at least once or twice a week. This cereal is clearly present in the diet, but at a relatively low frequency. Pastries and processed food were among the most consumed foods, with ten out of fifteen eating them at least once to twice a week.

In terms of dairy products, 8 out of 15 consumed milks daily, 3 out of 15 consumed it five to seven times a week, and 2 out of 15 consumed it three to four times a week. Most (9 out of 15) of the participants consumed yogurt daily, and the remaining four consumed it one to two times a week.

As for meat consumption, beef is preferred, and 11 out of 15 participants ate it once or twice a week (usually on Wednesdays and Saturdays, the days the butchers slaughter and process cattle). Maní is far from the coast, and fish consumption is consequently infrequent. Fish was available about once a week, most families did not

**Table 2.** Frequency of food consumption among studied schoolchildren with neurodevelopmental disorders in the community of Maní.

Food group	Food	Daily	5-7 times / week	3-4 times / week	1-2 times / week	Never
Fruits and Vegetables	Fruits	7		4	2	2
	Vegetables			7	4	4
Cereals	Tortillas	15				
	Rice			4	11	
	Oat		1	4	6	4
	Egg			7	6	2
Eggs and Meats	Chicken			7	8	
	Meat			1	11	3
	Pork meat		1	4	10	
	Fish				2	13
Dairy products	Sausages			7	8	
	Milk	8	3	2	1	1
	Yogurt	9	1	1	4	
Legumes	Cheese		1	7	7	
	Beans	4	1	6	4	
Fat	Butter			5	6	4
	Sugars	10	1	2	1	1
Processed Foods	Soda	4	2	2	7	
	Fried foods	1	1	1	8	4
	Cookies	7	1	3	4	
	Coffee	3		2	2	8
	Pasta	1		4	10	

Source: Field notes, 2020

consume it, and when they did buy it the children did not eat it since they are unaccustomed to it or do not like it. Chicken was eaten about two to three times a week, and pork an average of once or twice a week; one family reported consuming pork five times a week. Eggs were consumed by all participants three to four times a week, and these were complementary to meat consumption.

Seven out of fifteen of the children ate cookies daily. They did not usually refer to cookies as snacks since they were eaten at breakfast with milk and / or coffee. Some children understood cookies to be only those with high sugar, salt and/or coloring contents, which they ate as a snack and not at breakfast.

Only four out of the 15 children reported drinking bottled soft drinks daily, most (7 out of 15) drank them once or twice a week. Mothers more frequently prepared fresh fruit drinks to accompany lunch, most commonly orangeade and lemonade. Mothers reported a generally low fried snack consumption for their children, and only one said that her child ate them daily. Only 3 children consumed coffee every day.

Butter consumption occurred as part of food preparation. Six of the fifteen children ate it one to two times a week, and only four did not consume butter. Some mothers commented that they did not use it every day but might combine it with oil to "give a little flavor" to the food.

Only two of the fifteen children ate beans daily, and six out of fifteen ate them three to four times a week.

Overall, the children ate four to five meals a day and most purchased snacks at school. Few brought food from home, which is why pasta purchased at school was consumed almost daily. Most mothers were clear about the importance of eating breakfast before going to school. Despite this, one mother mentioned that her daughter had fainted from not having eaten breakfast and generally did not eat when she wakes up because she feels nauseated.

### **Discussion**

The group of children and adolescents with neurodevelopmental disorders studied here exhibited high frequencies of malnutrition

indicators such as low BMI for age (26.6%) and short height for age (73.33%). Comparable studies of children and adolescents with neurodevelopmental disorders in similar communities in Mexico have not been published to date. However, similar studies in other countries report lower frequencies of malnutrition as defined by BMI or weight for height. In a study done in China, 8.1% of autistic children were found to suffer malnutrition (15). In South Korea, 12.2% of children with intellectual disorders were reported to be malnourished (16), while in Turkey 16.8% of children with attention deficit hyperactivity disorder (ADHD) were malnourished (17). Much lower malnutrition frequencies have been reported in industrialized countries, about 3% to 4% in children with intellectual disorders (18, 19). In a similar group of children and adolescents with intellectual disabilities in Turkey, Hakime (20) reported 15.4% of those 10-13 years of age had low weight for age and 25% had short stature, while 14.3% of those 10-18 years of age were underweight and 28.6% had short stature. High frequency of short, slightly short and severely short stature suggests chronic malnutrition. This may have affected their cognitive capabilities, leading to lack of academic progress, a situation that could be particularly troublesome in pre- adolescence (e.g., girls aged 11 to 13 years).

Obesity was present in 13% of the children and adolescents in the present study, which is slightly lower than the 20% reported in Chile (21), Turkey (20) and the United States of America (22).

In a study of children without developmental disorders in a similar community in Yucatan, Mexico (23), 8.35% of school-age children were found to have low BMI, and 82.2% of children under 5 years of age from a nearby community had short height-for-age (24). These are higher frequencies for these malnutrition indicators than observed in the present results, but direct comparisons should be made cautiously. In the same study (23), no obesity was identified in school-age children, but it was present in adolescents, with a higher rate in males (35.7%) than females (14.2%). Overweight was observed

in 16.7% of males and 33.3% of females, which contrasts with the absence of overweight in the children or adolescents in the present study. Among the children and adolescents studied here, their diet can generally be characterized as slightly deficient. Overall food intake was similar to that reported in other studies in similar communities in Yucatan, Mexico (23, 25). Notable differences in the present study are that 1) yogurt and cookies were more frequently eaten daily; 2) regular consumption of eggs, sugar and bottled beverages was less frequent; and 3) chicken was eaten somewhat more frequently. Despite similarities with the previous studies, anthropometric indicators differed, with a higher rate of acute malnutrition (low BMI) and a slightly lower rate of obesity. Chronic malnutrition (short stature) was also quite frequent, although this did not differ from the previous studies. The dietary pattern observed in the present results is similar to that reported in another study in Yucatan, with 76% of children under five years of age exhibiting deficient caloric intake and low weight-for-age, but without any deficiencies in protein intake (24). Several studies have linked malnutrition with deficient reading and writing in schoolchildren (26), general developmental delays (27) and neurobehavioral disorders (28). Learning deficiencies have also been associated with lower intake of some specific nutrients such as docosahexaenoic acid (29), and with conditions such as anemia (30). In addition, the higher frequency of diarrheal events in children with developmental disorders such as autism may further deteriorate nutritional status (31), as can some eating behaviors such as picky eating (32). Analysis of children and adolescents with neurodevelopmental disorders in a marginalized population in Yucatan, Mexico, showed them to have high values for indicators of acute and chronic malnutrition. These values were higher than those reported for children and adolescents without neurodevelopmental disorders from the same region in Mexico under the project "Promoting child development and nutritional status through participatory actions in girls, boys and their families in Maní, Yucatán", with

registration FMED-2015, with funding from the Kellogg Foundation. Obesity and eating patterns frequencies did not differ between children and adolescents with or without neurodevelopmental disorders.

In conclusion, any degree of short stature was frequent (73.3%) in students with neurodevelopmental disorders, suggesting chronic malnutrition. Less than 50% of students had daily intake of fruits and they had high weekly consumption of added sugars and cookies.

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