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14 *The Open Obesity Journal*, 2013, *5*, (Suppl 1: M2) 14-21

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Feeding Children in a Rural Area: Proper Nutrition and Psycho-Social Development

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Abstract: Children nutrition in early life plays a relevant role not only in general health but also in development, with special regards to school performances and attention. Desarrollo Integral de la Juventud Oaxaqueña (DIJO) is a non-governmental association which since 1993 has developed programs directed towards the education of children, youth and families in and around the city of Oaxaca. This study was performed from February 2009 to July 2011, and involved a total of 286 children from 1st to 6th grade. The principal aim was to assess the results of the Educational intervention performed in the colonies of Monte Alban, Tlalixtac and Xoxocotlan, Oaxaca, Mexico. Two types of questionnaires were administered to children. The first one, shorter, consisted in 16 questions, divided into 4 areas of investigation: communication, comprehension, artistic expression and development. The second questionnaire was an expanded version of the previous one, administered in Monte Alban colony. When considered the data of the whole number of participants, the evaluation of total score of all the groups showed a significant improvement from the initial phase to the final one ($p<0.001$). After performing a multiple comparison of the three phases of the cycle (initial-final, intermediate-final, initial-intermediate), the results indicated a significant improvement when considering all initial phases initial ($p<0.001$). The results were all consistent in showing a significant improvement in all considered domains, proving therefore the successfulness of the method in addressing both facets of the problem.

Keywords: Children, desarollo, educational intervention, nutrition, Oaxaca, questionnaire.

INTRODUCTION

Children nutrition in early life plays a relevant role not only in general health but also in development, with special regards to school performances and attention. Mexico has implemented several public actions in order to overcome the national issue of under nutrition in children [1]. Results published from the ENSANUT 2006 [2], compared to those of 1988's survey [3], showed that the prevalence of underweight decreased by 68.5% (10.8% in 1988, 3.4% in 2006). Considering the effective national effort to provide proper nutrients to children [4], several associations are assisting Mexican children both in fighting malnutrition and fostering social and cognitive development [5]. Desarrollo Integral de la Juventud Oaxaqueña (DIJO) is a non-governmental association which is part of the AVSI (Associazione Volontari per ilServizio Internazionale) international network. Since 1993, DIJO has developed programs directed towards the education of children, youth and families in and around the city of Oaxaca. The main objective of the organization is to support the full development of children, youth and their families living in situations of poverty and marginalization. DIJO offers services in the fields of education, nutrition and health, and psychological counseling.

DIJO provides different services through the five existing educational centers in each of the neighborhoods where DIJO works. These interventions are performed in the fields of Health (referrals and follow-up of cases requiring emergency medical attention and specialized care, complementary food resources to the needy, preventive health measures and good hygiene practices), Education (academic support for children without access to school or in

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1876-8237/13

risk of dropping out, psycho-educational care, in particular for children with learning disabilities and behavioral problems, as well as for those children with socialization difficulties or victims of domestic violence, extra-curricular activities including recreation, culture and sports, computer courses for children and adolescents), Family (home visits to understand the socio-economic dynamics of the communities and to detect problems requiring immediate attention, like psychological care and therapy for parents on an as-needed basis) and Nutrition (providing breakfast (*Comedor*) daily to more than 150 children in the community kitchen called, "La Compañía", where balanced meals are prepared with the support of a volunteer nutritionist, training in the nutritional needs of children and in food preparation is offered to the mothers of beneficiaries, regularly assessing weight and height measures of the children).

In Monte Alban colony, a high degree of school defection was observed, increasing the number school's drop out children. In this background, particular attention was addressed on symptoms like tiredness, weakness and a lack of energy to perform basic daily activities.

This study aimed at assessing the results of the Educational intervention performed from February 2009 to July 2011 in the colonies of Monte Alban, Tlalixtac and Xoxocotlan, Oaxaca, Mexico.

MATERIAL AND METHODS

The study was performed from February 2009 to July 2011, involving a total of 286 children from 1st to 6th grade. Two types of questionnaires were administered to children. The first one, shorter, consisted in 16 questions, divided into 4 areas of investigation: communication (written and oral), comprehension (logic and mathematics), artistic expression (production and understanding) and development (personal and social). This questionnaire was drafted in three variations in order to better suit to specific age groups' skills and knowledge: questionnaire A was meant for 1st and 2nd grade children, B for 3rd and 4th graders, C for 5th and 6th graders. The original questionnaire is presented in Table **1**. The second questionnaire was an expanded version of the previous one, administered in Monte Alban colony (questionnaire D), aiming at deepening knowledge on the same areas previously investigated, and was given in the same format to all age groups.

Children were assessed in three phases: initial, intermediate and final. The evaluation scale was set at three levels: skill performed with difficulties (ACD), developing skill (AEP), skill developed (AL). In order to perform the statistical analysis, the ordinal scale was considered as an interval scale, with 1 corresponding to ACD, 2 corresponding to AEP and 3 corresponding to AL. An overall score was then calculated by a simple sum of the single items score for both questionnaires at each phase.

Significant differences were assessed with Friedman test with a series of post hoc Wilcoxon tests on each pair. P-value adjustment for multiple comparisons was performed.

The authors performed an in depth analysis of the first questionnaire, evaluating the scores of each of the four domains. In this case, separate evaluations of the 3 variations were performed. The data were analyzed with R version 2.15 [6].

RESULTS

Data of 286 children were considered. The evaluation of total score of all the groups showed a significant improvement from the initial phase to the final one ($p<0.001$), as shown in Table **2**. Children from 1^{st}-2^{nd} grade undergoing the program showed a significant improvement within the cycle ($p<0.001$). After performing a multiple comparison of the three phases of the cycle (initial-final, intermediate-final, initial-intermediate), the results indicated a significant improvement when considering all initial phases ($p< 0.001$). Same considerations could be performed when considering 3^{rd}-4^{th} and 5^{th}-6^{th} grade children as presented in Fig. (**1**). In all three groups, time was significantly associated with skills development, as seen in Fig. (**2**). Age and time interaction was considered in order to assess a significant difference among the three groups. No association was found when considering different school grades. The four areas of development were subsequently analyzed, separated by school grades. Results are given in Table **3**.

The second questionnaire was administered to a smaller group of children in Monte Alban. It presented general improvement ($p< 0.001$), with significantly positive results already at the intermediate evaluation. Results are presented in Table **4**.

DISCUSSION

Ensuring that all children complete primary schooling is among the primary objectives of the United Nations Millennium Development Goals [7]. Many children in developing countries are exposed to multiple risks such as poor development, including poverty, and poor health and nutrition. Grantham-McGregor [8] identified the prevalence of early childhood stunting and the number of people living in absolute poverty, as indicators of poor development. He showed that both indicators were closely associated with poor cognitive and educational performance in children and estimating a worldwide prevalence of over 200 million children under the age of 5 years that were not fulfilling their developmental potential. Disadvantaged children are destined not only to be less educated and have poorer cognitive function than their peers but also to be less productive [8].

Over the last two decades, Mexico has successfully improved national nutritional status, but many challenges still remain [9]. Despite the documented reductions [2, 3], the prevalence of stunting remains high, particularly among lower income and indigenous infants and children. Early malnutrition appears moreover to have late consequences, as considered from Huang [10], that analyzed the effect of early life conditions on functional health status in adulthood. His retrievals showed that childhood nutritional deprivation and poor health as well as low socio-economic status of the family of origin were significant predictors of adult dysfunctionalities. An interesting finding from a study conducted by Galler [11] was that early malnutrition (with its accompanying conditions during infancy) and not

Table 1. Original Questionnaire Utilized for Children Evaluation

Cuestionario A	
Comunication Verbal y Escrita	
Q01	Desarrollo de la percepción visual
Q02	Desarrollo de la percepción auditiva
Q03	Comprende y expresa la información oral y escrita
Q04	Logra comunicarse a través de escritos de manera convencional y no convencional.
Comprensión Lógica-Matemàtica	
Q05	Resuelve problemas aditivos que implican cálculo mental
Q06	Desarrolla la habilidad para trazar grecas y mosaicos con figuras geométricas
Q07	Desarrollo de la habilidad mental a partir de juegos
Q08	Clasificar y ordenar , agrupar, desagrupar, figuras u objetos (Tamaño, colores, formas,etc)
Expresión y Apreciación Artística	
Q09	Desarrollo de la habilidad motriz, fina y gruesa
Q10	Coordinación de movimientos corporales con ritmos a partir de cantos y rimas
Q11	Utiliza su imaginación y creatividad para desarrollar las artes plásticas
Q12	Logra controlar su cuerpo y su mente al escuchar música
Desarrollo Personal y Social	
Q13	Reconoce y respeta las normas establecidas en el centro educativo
Q14	Muestra respeto al interactuar con otras personas
Q15	Cuida su higiene personal y de los espacios que utiliza
Q16	Asiste diariamente y puntual al curso
Cuestionario B	
Comunicación Verbal y Escrita	
Q01	Idenfica por su estructura diversos tipos de textos
Q02	Comprende y expresa de forma oral y/o escrita diversas situaciones
Q03	Reconoce y aplica reglas ortográficas básicas
Q04	Comprende diversos tipos de textos
Comprensión lógica-matemática	
Q05	Comprende y utiliza las unidades de medida
Q06	Domina las operaciones matemáticas básicas y las utiliza en situaciones cotidianas
Q07	Expresa las cantidades hasta decena de millar
Q08	Comprende y utiliza las fracciones en situaciones cotidianas
Expresión y Apreciación Artística	
Q09	Utiliza su imaginación y creatividad para expresar ideas y sentimientos
Q10	Realiza movimientos corporales para expresar habilidades artísticas
Q11	Representación de ideas y sentimientos a través del modelado de figuras en distintos materiales

Table 1. contd…

Q12	Manifiesta sus emociones a través de la música y las artes plásticas
Desarrollo Personal y Social	
Q13	Reconoce y respeta las normas establecidas en el centro educativo
Q14	Convive sanamente prácticando los valores sociales
Q15	Muestra cuidado en su higiene personal y aspecto fisico
Q16	Cumple con responsabilidad en acciones cotidianas
Cuestionario C	
Comunicación Verbal y Escrita	
Q01	Se comunica de manera oral y escrita con claridad y coherencia
Q02	Identifica, utiliza, escribe, analiza y comprende diversos tipos de textos
Q03	Lee en voz alta con ritmo, claridad y entonación respetando signos ortográficos
Q04	Revisa sus escritos y corrige las dificultades ortográficas y de narración
Comprensión Lógica-Matemática	
Q05	Explica y utiliza eficientemente las reglas del sistema decimal
Q05	Resuelve problemas usando las operaciones elementales en unidades de medida
Q06	Obtiene, organiza, analiza y representa información numérica
Q07	Clasifica, relaciona, construye figuras y cuerpos geométricos
Expresión y Apreciación Artística	
Q08	Utiliza diversas formas artísticas para expresar ideas, pensamientos y emociones.
Q09	Utiliza diversos materiales crear formas y figuras artísticas
Q10	Coordina sus movimientos con cantos, ritmos y melodías
Q11	Interpreta personajes utilizando imaginación y creatividad
Desarrollo Personal y Social	
Q12	Reconoce y respeta las normas establecidas en el centro educativo
Q13	Reconoce y practica los valores con sus compañeros
Q14	Muestra buenos hábitos de higiene
Q15	Participa activamente en todas las actividades

Table 2. Evaluation of Total Scores Measured within a Full Cycle. The Number of Evaluated Children is Shown in Brackets

	Initial	**Intermediate**	**Final**	**Trend Test**
Cuestionario A	(N=125)	(N=125)	(N=125)	
	1.19/1.38/1.95	1.73/2.09/2.28	2.27/2.88/3.000	p<0.001
Cuestionario B	(N=101)	(N=101)	(N=102)	
	1.27/1.50/1.69	1.75/2.00/2.25	2.34/2.75/2.97	p<0.001
Cuestionario C	(N=59)	(N=59)	(N=59)	
	1.30/1.56/1.88	1.88/2.06/2.19	2.31/2.75/3.00	p<0.001

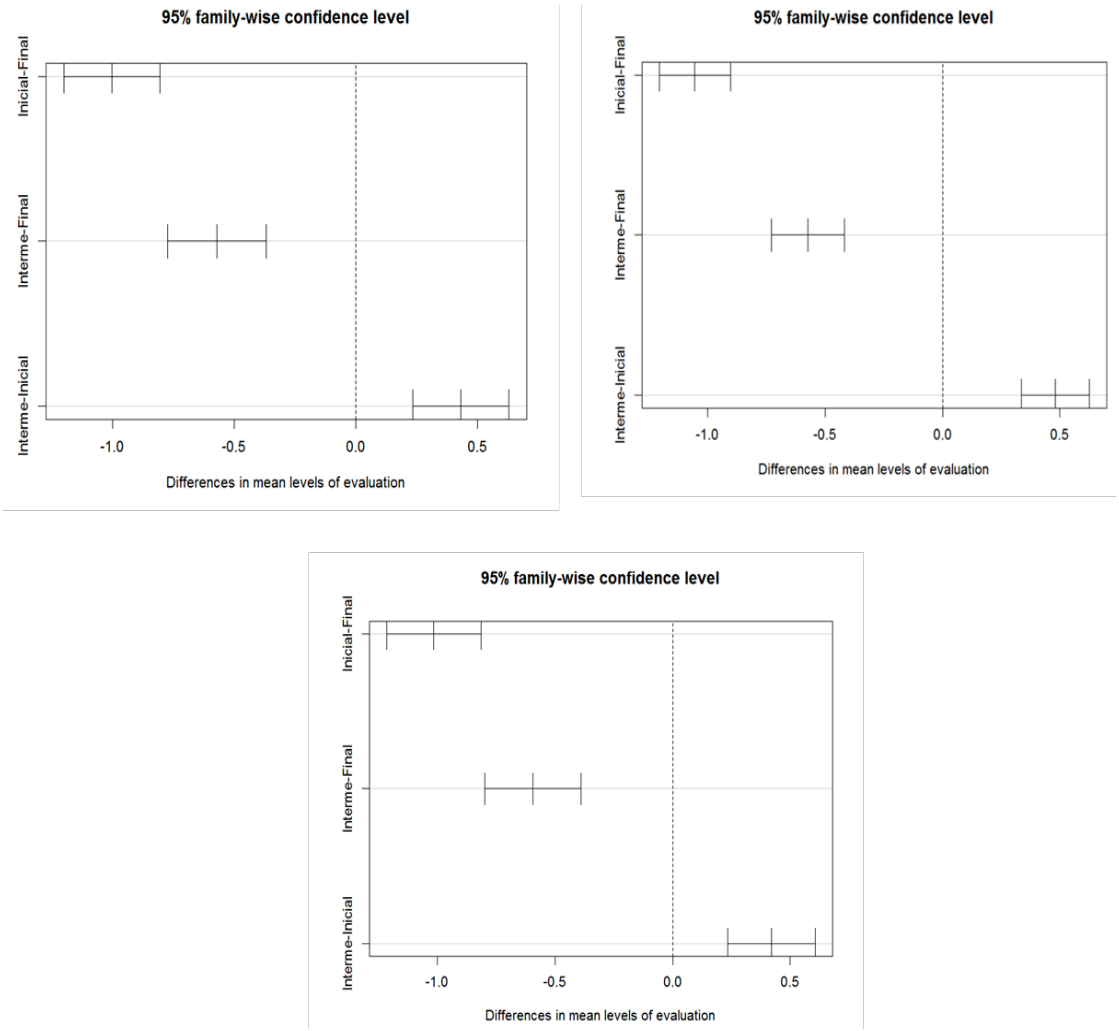

Fig. (1). Multiple comparison between program phases. The graphics picture (clockwise starting from the left) the evaluations of questionnaires A, B and C.

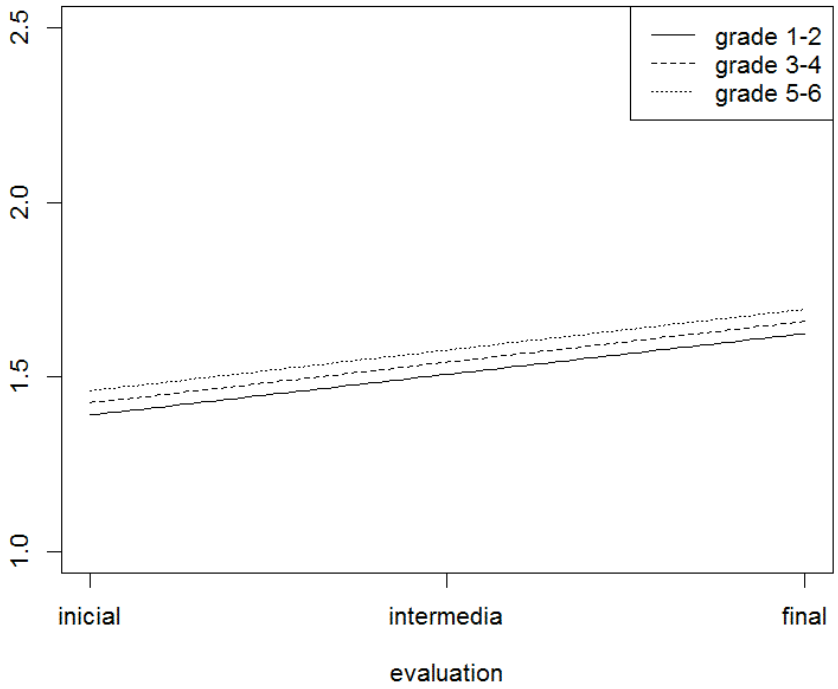

Fig. (2). Age and time interaction. Questionnaire A, B and C were considered as a whole.

Table 3. Questionnaires Domains and Calculated Scores. The Number of Evaluated Children is Shown in Brackets

	Initial	Intermediate	Final	Trend Test
Communication (Written and Oral)				
1st and 2nd grade	(N=125)	(N=125)	(N=125)	
Score	1.00/1.00/2.00	1.69/2.00/2.06	2.00/3.00/3.00	p<0.001
3rd and 4th grade	(N=101)	(N=101)	(N=102)	
Score	1.00/1.50/1.750	1.50/2.00/2.00	2.00/2.50/3.00	p<0.001
5th and 6th grade	(N=59)	(N=59)	(N=59)	
Score	1.30/1.56/1.88	1.88/2.06/2.19	2.31/2.75/3.00	p<0.001
Comprehension (Logic and Mathematics)				
1st and 2nd grade	(N=125)	(N=125)	(N=125)	
Score	1.00/1.25/2.00	1.75/2.00/2.06	2.00/3.00/3.00	p<0.001
3rd and 4th grade	(N=101)	(N=101)	(N=102)	
score	1.00/1.25/1.75	1.75/2.00/2.00	2.00/2.75/3.00	p<0.001
5th and 6th grade	(N=59)	(N=59)	(N=59)	
score	1.00/1.25/1.75	2.00/2.00/2.00	2.00/2.75/3.00	p<0.001
Artistic Expression (Production and Understanding)				
1st and 2nd grade	(N=125)	(N=125)	(N=125)	
score	1.00/1.25/2.00	1.75/2.00/2.00	2.00/3.00/3.00	p<0.001
3rd and 4th grade	(N=101)	(N=101)	(N=102)	
score	1.00/1.38/2.00	2.00/2.00/2.00	2.06/3.00/3.00	p<0.001
5th and 6th grade	(N=59)	(N=59)	(N=59)	
score	1.25/1.50/2.00	0.00/2.00/2.00	2.25/3.00/3.00	p<0.001
Development (Personal and Social)				
1st and 2nd grade	(N=125)	(N=125)	(N=125)	
score	1.38/2.00/2.50	2.00/2.00/2.00	2.50/3.00/3.00	p<0.001
3rd and 4th grade	(N=101)	(N=101)	(N=102)	
score	1.50/2.00/2.25	0.00/2.00/2.75	2.50/3.00/3.00	p<0.001
5th and 6th grade	(N=59)	(N=59)	(N=59)	
score	1.50/2.00/2.31	2.00/2.25/2.75	2.75/3.00/3.00	p<0.001

Table 4. Evaluation of the Total Score of the Questionnaire D

	Initial	Intermediate	Final	Trend Test
Questionnaire D	(N=32)	(N=32)	(N=32)	
	1.31/1.67/1.92	1.75/1.89/2.03	2.53/2.67/2.76	P=0.002

socioeconomic conditions at the time of the study, was the major contributor to poor academic performance in school-aged children. DIJO's program is set in extremely poor environments, with the specific aim to promote children development within difficult socio-economic and social conditions. As similarly seen in India's poor environments, where the attempts are being made to help schoolchildren learning about nutrition issues and facilitating transfer of knowledge to the children through a set of model lessons [12].

A number of micronutrients are therefore required for optimal physical growth and neuromotor development. Isolated deficiencies of micronutrients are considered as rare in clinical practice and instead, habitually deficiencies of multiple micronutrients co-exist [13]. The influence of early malnutrition affects not only physical well-being but also behavioral and intellectual developments [14]. In 2010, Benton [15] considered the influence of dietary status on the cognitive performance of children, presenting an overview of the present knowledge on brain development and its linkage to malnutrition. Gross malnutrition resulted in problems affecting both short- and long- term cognitive and behavioral problems, especially when considering developing countries, where evidences were supporting adequate diet's significant and lasting implications for cognitive functioning. Moreover, early malnutrition has an almost irreversible effect on growth, both physical and mental. As considered in that research [15] certain dietary deficiencies during the first 2 years of life, for example iodine and iron, create problems that are not reversed by a later adequate diet. Community-based food and nutrition programs have been broadened with the aim of promoting children development also at other levels, focusing on academic performances and social skills [16]. Breakfast load is considered as fundamental to enhance and foster academic development, taken its influence on attention [17].

DIJO's work sets itself in this framework, ensuring proper meals to children and providing an educational intervention for elementary school children, followed in a yearly cycle during school time. DIJO daily provided a balanced breakfast for children, divided in three groups according to their nutritional status (normal BMI, slightly underweight, markedly underweight). Starting from a basic daily breakfast of 400 Kcalories (Kcal), meals were composed by 60% carbohydrates, 15% proteins and 25% lipids, with a fair distribution of mono- and polyunsaturates fats, vitamins, minerals and dietary fiber. Each child received a meal with an energetic intake equal to the 35% of the daily ratio, as recommended from the Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán (INNSZ): small portions/450 Kcal (for children from 1 to 5), medium portions/630Kcal (for children from 6 to 11) and big portions/900 Kcal (for children from 12 till 18 years).

As considered by Grantham-McGregor et al., who reviewed a series of studies assessing the relationship between mental development and severe malnutrition [18], it is reasonable to attribute a causal relationship to early childhood malnutrition and poor performance on cognitive tests in later childhood. In their review, the authors stated in addition that there was a certain possibility that previously malnourished children who received little nutritional supplementation coped less well with frustrating or competitive situations. Same considerations were established by Strupp in 1995's theoretical reappraisal of the literature on the enduring effects of early malnutrition [19].

In the present study, all analyses showed a substantial improvement in all the considered domains (communication, logic, artistic skill and social and personal development) from the first phases of the intervention, and already between the initial and the intermediate evaluation a positive development of all domains was recorded. These progresses appeared to be significantly enhanced when children attained the course for a full period (from the initial phase to the final phase), especially for the younger kids belonging to 1st and 2nd grades. As hypothesized, children appeared to profit the most from the academic support offered from DIJO assistants, presenting a significant improvement in logic and mathematics comprehension.

An important element in DIJO's program is the coexistence of a double sided vision of children's sustainment. On the one hand, a balanced breakfast is daily provided, while on the other, academic and social help is offered from the first years of school. This methods is in line with previous consistent considerations, stating that malnourished children show a deficit in tests of cognitive function or intelligence if they return to poor environments [18]. In Eilander systematic review of trials held to understand the influence of a multiple micronutrient supplementation on academic performance, results showed a marginal increase in performance [20]. Similarly, Benton considered in several studies the influence of micronutrients on schoolchildren and their performances [21-23], with a significant increase in non-verbal intelligence in the groups receiving supplementation. DIJO's intervention positively influenced this domain as well, with both artistic and logic skills boosted throughout the period. Wang, more recently, performed a study on 220 students from 8-12 years, reaching the same considerations [24]. Verbal learning and memory, as found here, were enhanced also in NEMO (Nutrition Enhancement for Mental Opti- mization) study group's trials [25].

The present program aimed moreover to improve social skills in children, as the capacity of well behave among groups and the achievement of prolific relationship among children, in order to increase school performances.

A fundamental achievement of DIJO's program has certainly been the capacity to deliver sustainment for a long period of time, strongly committing to boost children regular attendance. As seen from Ramakrishnan [26], the benefits of providing nutrients supplements during critical periods of growth and development can be seen only when supplements are consumed regularly.

Overall, the literature suggests that good regular dietary habits are the best way to ensure optimal mental and behavioral performance at all times. As considered by Bellisle [27], it is fundamental to consider that beside nutritional factors affecting cognition and behavior development, numerous individual (e.g. psychological, emotional), familial and social factors can affect scholastic achievement and successful integration. DIJO's intervention was therefore analyzed in order to establish the efficacy of the intervention on elementary children who adverted to their centers in 3 different colonies in Oaxaca. Results were all consistent in showing a significant improvement in all considered domains, proving therefore the successfulness of method in addressing both facets of the problem.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

ACKNOWLEDGEMENTS

This research was partially funded by an unrestricted grant of the University of Padova and of Prochild ONLUS. The work has been partially supported by an unrestricted grant of the Italian Ministry of Foreign Affairs under the program "Programmi di alta rilevanza scientifica e tecnologica Italia-Messico".

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Received: January 23, 2013 Revised: January 30, 2013 Accepted: March 04, 2013