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Child Undernourishment and Development: The Influence of Caregiver Practices

Assol Cortés-Moreno

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Abstract

Children living in poverty are at risk of malnutrition and developmental delays. In addition to environmental constraints, caregiver practices can exacerbate or mitigate effects of economic scarcity on these issues. This study explores the influence of rearing practices and socioemotional caregiver factors on the nutritional status and psychological development in a sample of Mexican children; also, the participation of some sociodemographic variables is analyzed. Sixteen children (9–19 months old) at risk of malnutrition or malnourished and their main caregivers participated. In addition to the nutritional status, infant development was assessed using the Bayley Child Development Scales. The caregiver answered questionnaires on demographics, parenting practice (RPS Questionnaire), and parenting stress (Parenting Stress Index). According to expectations, positive relations between responsive-rearing practices and children-favorable condition were found, and negative associations between parental stress and child indicators of optimal nourishment and development were also found. Some demographic factors were associated with the caregiver and the child variables. Results found have limitations imposed by the sample size to conclude on the direction of the effects in the relationships obtained. Despite this, the results show the relevance of the caregiver's characteristics and practices.

Keywords: caregiving, stunting, child development, poverty, parenting stress

1. Introduction

1.1. Background

As developing countries improve their economies, they increase the availability of food and, theoretically, can meet the food needs of their population. However, the current situation of the

problem shows that the phenomenon of food consumption is intricate; a direct relationship between a country's economic growth and reducing the risk of malnutrition is not always observed [1].

In addition to the macroeconomic factors, other variables of the physical and social context affect the availability of food. The physical approachability is determined by characteristics of a geographical area, such temperature, altitude, and humidity. In the same way, social factors such as population growth, change in the role of women in work and family life, and changes in the perception of the relations between diet and health also define access to food [2, 3]. Moreover, culture as a belief system and customs derived from it influences habits of people, which are concretized in the selection, conservation, and preparation of foods, resulting in the use or waste of food resources. According to Bourges [4], the availability and cultural access to food refer to the way in which customs and traditions delimit the acceptance or rejection of some products or the way in which they should be prepared and consumed.

Eating habits developed from these factors and others of an individual nature act, in a beneficial or harmful way, on the health condition and the people's quality of life. Inadequate habits result in a risk powerfully associated with various conditions of infectious origin and conditions related to nutrient deficiencies and non-hereditary chronic-degenerative diseases (NHCDs). Conversely, when eating habits are correct, they become a protective factor for such problems. The imbalance between food intake and energy expenditure leads to a condition of malnutrition. When this is the result of excessive feeding, overweight or obesity is present, these conditions constitute risk factors for several NHCDs; on the other hand, poor nutrition derived from food sub-consumption is generically known as undernourishment [5].

1.2. Undernourishment sequels

Undernourishment or malnutrition is the result of reduced food intake and repeated occurrence of infectious illness [6]. A low height-for-age or stunting represents a chronic malnutrition, a little weight-for-height or wasting denotes a recent loss, and low weight-for-age is a mixed index influenced by both stunting and wasting. Micronutrient deficiencies, such as iron, iodine, or zinc, may also occur [7].

Undernourishment can have grave consequences on the physiological and psychological development. The magnitude of the sequelae is determined, in part, by the severity, duration, and temporality of specific or generalized gaps. The most sensitive stages to sub-nutrition are gestational age and the first year of life because damage at this period reduces neuronal proliferation, which cannot be compensated later. Likewise, other developmental processes of the central nervous system (CNS), such as myelination, continue during childhood, so the occurrence of a severe nutritional deficit has the potential to modify the rate of integration of neural structures, related to the emergence of different cognitive and behavioral skills [8, 9]. Critical moments in the development of CNS structures are as follows:

1. Myelination begins slowly at 16 weeks in the spinal cord and nerve roots of the brain and continues during infancy and childhood.
2. The vestibuloacoustic system (balance), the parietal cortex (integration of motor responses), and the hippocampus, already myelinated, mature at 12 months of age.

3. The language area of the left temporal lobe is myelinated at approximately 18 months of age.
4. Other structures are more slowly myelinated through infancy and childhood: (a) the structures involved in focusing and maintaining attention (reticular formation, a portion of the nucleus, the superior colliculus, and the lateral part of the thalamus) begin myelination at 10 months, and the process continues during childhood, adolescence, and adulthood.
5. The periods of accelerated development of the frontal lobe (which has a circuit integration function necessary for the higher processes) occur from birth to 2 years, from 7 to 9 years, and in the middle adolescence.

However, when nutrient deficiencies occur at a late stage, the effects may be attenuated as the process of structural development of the CNS is more advanced and it is highly likely that the child already has basic behavioral repertoires, necessary for the acquisition of more complex psychological processes. At that time, the social context surrounding the child can play a crucial role. If the child is given the necessary stimulation and care, the effects of malnutrition can be compensated [10].

In the behavioral dimension, there is apathy and lack of initiative, emotional monotony, poor social interaction, lack of curiosity and exploration of the environment, and physical closeness to the mother. These forms of response condition malnourished children to perform developmental test unwell when compared to children in optimal nutritional status [9, 11–13]. They also limit the forms of interaction with others, which facilitates that the adverse effects remain for years [14].

1.3. The caregiver role on undernourishment: isolation hypothesis

Poverty and a disorganized psychosocial environment increase exposure to biological and social risks that affect development through changes in the structure and function of the CNS, as well as through the establishment and consolidation of deficient patterns of interaction between the child and his/her physical and social environment [3, 15, 16]. In this way, different variables of both levels act synchronously, and the scope of each of them will vary according to the characteristics of the individual, the social circumstances, and the moment of the child development. The first factor, the type of lack, can determine the nature of the consequences associated with undernourishment, because each nutrient has different functions in the organism according to its composition. The second factor, the social environment, is equally critical to understanding the problem, since an unfavorable social surrounding alone can constitute a risk factor for the child development, especially when this is conjugated with a nutritional status deteriorated.

Findings reported in the last two decades of the twentieth century that included the observation of the child's reactions in interaction with other people led to revalue the *functional isolation* hypothesis as a conceptual element explaining the processes involved to perpetuate the effects of underconsumption of food. This was formulated by Levitsky and Barnes [17] when they restricted food to newborn rodents during the first 7 weeks of life and underwent a 10-week recovery period where they observed that the adverse effects of malnutrition on performance in several tests were mediated by the decrease in the animal activity level. The additional environmental stimulation provided in the recovery period improved the performance in the tests used.

The *functional isolation* hypothesis applied to human undernourishment suggests the mechanism by which the performance of malnourished children is affected in psychological tests [18]. Equally, it contributes to explain how these effects last: when there is scarce food intake, physical growth is limited and activity is diminished when compared to that of well-nourished children; this appearance means that the contacts of the caregivers are few and that their behavior is the one shown for younger children; the child is less likely to explore their environment and therefore motor, social, and learning abilities do not reach the levels that characterize development under optimum conditions. When these patterns occur recurrently, the effects are cumulative and the child does not acquire the competencies to cope with the demands of the environment (**Figure 1**).

Studies show that attention, emotion, and affection are the behavioral traits that can be recognized as mediators of learning processes and in turn are most affected by malnutrition [18–20]. Changes in these dimensions reduce reactivity and/or motivation and interfere with processes of selective attention, motor exploration, and also alter the response styles in problem-solving tasks [21], or on the other hand, this changes can be attended to the work but their answers are slower in comparison to a eutrophic child. When the analysis of infant behavior was performed using finer observational categories than in previous studies, it was found that the differences between anemic and non-anemic children were mainly in the orientation toward the mother and in the rapidity of reactions: children with low iron levels tended to be less oriented toward the mother when there was a novel stimulus and their answers were more durable than those exhibited by children with normal iron levels [20]. Similarly, social behaviors such as smiling or approaching the mother used to last longer.

Such forms of response affect the synchrony of interactions between the child and his or her primary caregiver by promoting ineffective behavioral patterns to stimulate child development.

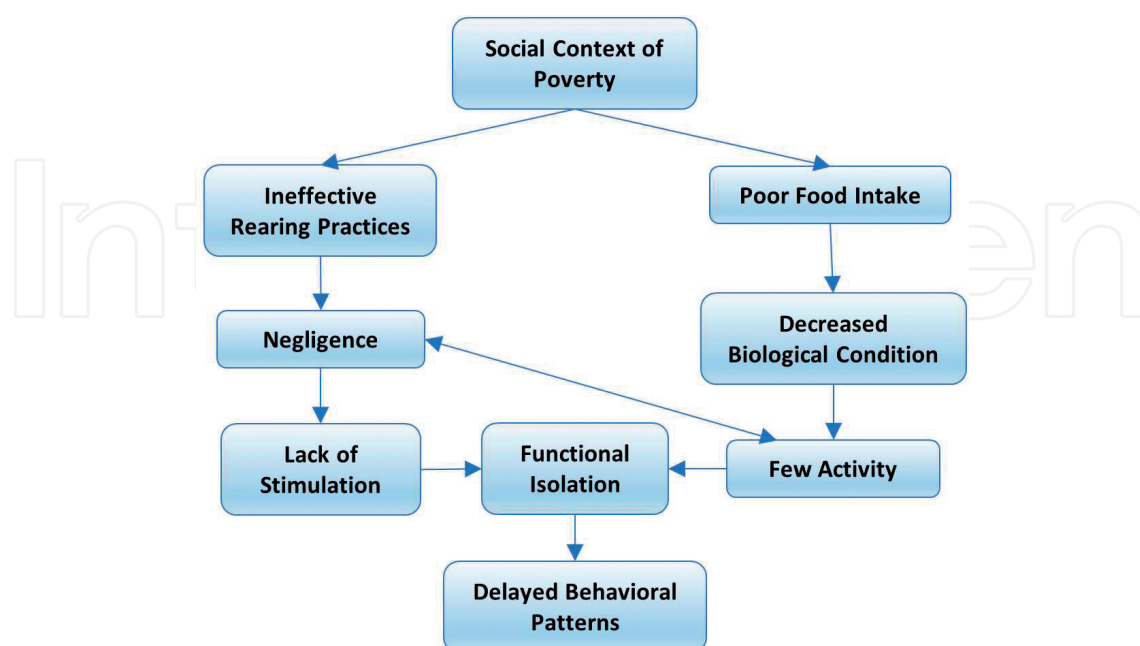


Figure 1. Representation of functional isolation hypothesis.

Stanfield [22] points out how the dynamics of the mother or caregiver can be altered by interacting with a child who shows less attention and/or little activity and affective monotony: on the one hand, the mother can accept the loss of the interrelation between her and the child or perceive it as a child that does not cause problems, thus developing a neglectful style and an additional form of environmental deprivation; or on the other hand, it may show concern and increase interest in the child by increasing the time of contact with him/her and making him/her more dependent and with less initiative for exploration.

Sensitive, reciprocal, and development-conducive maternal behaviors depend in part on the signals the child emits and on the reactions he or she exhibits to adult attempts to establish an exchange; a hyporeactive child makes it difficult to establish synchrony in caregiver-child interactions, since the adult does not have the necessary keys to adapt his/her behavior and thus satisfies the child's needs [23, 24]. The functional isolation in conditions of poverty or social disorganization can be interpreted as a double-risk model for optimal child development: the biological risk (undernourishment) that restricts the child's response team, necessary to meet the demands provided by the child environment, and social risk, determined by the alteration of the patterns of interaction between the child and the caregivers.

The modification of risk factors to protective factors conducive to a healthy and adequate environment to stimulate child growth and development must necessarily require an understanding of the problem of malnutrition from a broader and more inclusive perspective, multiple dimensions of this health issue highlighting the role of the caregiver as one of the most relevant explanatory variables.

1.4. Rearing practices

The parenting practices used by the primary caregiver determine to a large extent the quantity, quality, and manner in which children receive food. Developing skills to interpret and respond to the child's needs can improve feeding practices even in marginal populations [25]. Therefore, it is necessary to address in a clearer and the more precise way the ecological conditions in which the child develops and the specific demands of the social environment in which he/she participates.

Here, it is necessary to distinguish between what is meant by *parenting styles* and *parenting practices* or *rearing practices*. The first term refers to a compound of relatively invariable attitudes and beliefs that guide the way of communicating with the child and establishing an emotional climate to educate the child. Parenting styles have been extensively studied through Baumrind's original categorization that includes four styles: authoritarian, democratic, permissive, and negligent [26]; there is a broad range of studies, mainly within the areas of clinical and educational psychology, which address the styles of parenting relating them to results on the psychosocial functioning and school achievement of the child and adolescent. By contrast, the term parenting practice has been used to refer to concrete actions that meet parents in education and childcare. Myers [27] defines them as

Generally accepted activities that respond to the survival and development needs of children in their first months and years of life, so as to ensure the survival and maintenance (and sometimes development) of the group or culture as well as of the child (p. 431).

These activities include food, hygiene care, and health preservation, as well as those focused on adjusting social and educational demands. It highlights three characteristics that must be addressed when describing and/or analyzing a practice: action (what it does), the person who performs it (who does it), and how to carry it to term (how it does it). The level of responsiveness or sensitivity to detect signs that account for the needs of the infant is an essential feature of the rearing practice that maintains the correct child nutritional status and favors a better psychological development.

Both the physical and social conditions of a family and the prevailing customs and beliefs in their culture define the set of practices designated for the care of children. The practices used to feed the child are then determined by a number of factors, including the ethnic group of belonging, beliefs about food [28], the educational level of the caregiver, family income, physical housing conditions [29–31], and how the adult perceives the child's health status and the child's ability to perform different activities [15].

Also, there are many factors that can significantly deteriorate child-care patterns related to food, health preservation, and development, such as the family environment characterized by apathy and disorganization [32], and emotional disturbances such as depression and parental stress [33, 34]. Addressing these factors is critical as, as a child health regulatory axis, parenting practices will determine the degrees of exposure to factors that protect or impair health. On the contrary, it is very likely that appropriate raising conditions will operate as a development-promoting element and thereby compensate for the lack of economic resources in the family or the existence of unfavorable environmental factors. Through sensitive practices and quality care, one can ensure proper child feeding to prevent undernourishment, and in the case of having suffered, one can reverse or minimize the adverse impact on psychological development.

From the above, it is evident that the practices of aging should be incorporated in a more systematic way to the analysis of the relationship between the psychosocial conditions of children at risk of malnutrition and the scope in terms of psychological development. Focusing on behavior and socio-emotional conditions of caregivers can provide valuable information to be incorporated into undernourishment prevention strategies and intervention programs aimed at reversing or minimizing their impact on child development.

1.5. Objective and hypothesis

1.5.1. General objective

The present work addresses this problem, from the point of view of Health Psychology, and aims at exploring the influence of rearing practices and socioemotional caregiver factors on the nutritional status and psychological development in a sample of Mexican children. Additionally, some sociodemographic variables involved will be analyzed.

1.5.2. Particular objectives

- a.** Analyzing if relations between nutritional status and development in children are present.
- b.** Examine the relations between the variables of the caregiver, child nutrition, and child performance of mental and psychomotor development test.

- c. To explore if in the studied sample some demographic variables are involved in the parenting, children nutritional condition, and their development.

1.5.3. Hypothesis

It expects to find:

Hypothesis 1: The more obvious undernourishment is, the lower scores on developmental tests.

Hypothesis 2: Levels of parental stress and anxiety in caregiver will be negatively related to indicators of nutritional status and child development.

Hypothesis 3: Scores on the responsive parenting will relate positively to the infant's nutritional status and development.

2. Method

2.1. Participants

Non-random sampling was used. The sample is part of a longer study whose objective is to assess an intervention strategy, based on the responsive parenting, to reverse child undernourishment and its effects on motor and cognitive development. Participants were invited through outpatient clinics of the State of Mexico Health Institute (ISEM) located in marginalized areas at the municipality of Tlalnepantla. Thirty-three caregiver-child dyads were involved in this research, but only 16 of them completed all measures. Children were 9–19 months old ($M = 10.9$): 68.7% ($n = 11$) girls and 31.3% ($n = 5$) boys, and they were at risk of undernutrition ($n = 10$) or were moderately undernourished ($n = 4$). Fourteen of caregivers were child's mothers ($M = 23.9$ years old), and two more were their grandmothers ($M = 48$ years old). All participants came from economically deprived families: three were income vulnerable, nine had moderate multidimensional poverty, and four extreme multidimensional poverty. In two households, the father was absent.

2.2. Measures and instruments

2.2.1. Sociodemographics and health history

An interview questionnaire was applied to obtain information about schooling and age of the mother, father and the main caregiver—when not the mother—type of work, and family structure. There are also questions on child and family health status, and child appetite perceived by the caregiver. In addition, the *National Council for the Evaluation of Social Development Policy (CONEVAL) Instrument* was used to obtain the Wellness Index. CONEVAL [35] proposes a set of indicators complementary to those used in the Multidimensional Measurement of Poverty Methodology, which aim to determine if a family's income is insufficient to meet their needs and if there are scarcities in each of the six indicators in order to identify the population in a situation of multidimensional poverty. The Wellness Index show five levels: extreme multidimensional poverty, moderate multidimensional poverty, vulnerable by social scarcity, vulnerable by income, and nonvulnerable.

2.2.2. Anthropometrics

Once the child measures of weight and supine length were obtained, according to the technique suggested by the World Health Organization (WHO) [36], z-scores were calculated for body mass index (BMI), body weight (BW), and body height (BH), using the tables included in the ANTHRO 2005 software as a reference measure [37]. All children whose measurements fell between ≤ 1 and 2 standard deviations below the median in any of the parameters, BMI, BW, or BH, were considered at risk of malnutrition (wasting, underweight, and stunting, respectively). Children whose measurements were 2 standard deviations below the median in any of the three parameters were considered cases of undernourishment.

2.2.3. Child development

Bayley Scales of Infant Development (BSID) Spanish-language version of these scales was used, designed to assess developmental status in children aged 1–40 months [38]. This instrument provides the child's assessment base through two components: (1) The Mental Development Scale that assesses sensory-perceptual acuity, discrimination, and responsiveness to stimuli; memory and solution; early vocalizations, as well as first classification and generalization. The results of this scale are expressed in standardized scores or Mental Development Index (MDI) and (2) the Psychomotor Scale provides information on the degree of body control, coordination of large muscles, and fine coordination of hands and fingers. The results of this scale are expressed in standardized scores or Psychomotor Development Indexes (PDI).

2.2.4. Parenting Stress Index (PSI)

This instrument provides a measure of maternal discomfort related to child-rearing work: higher scores, greater worry, and inadequate parenting to promote child development [39]. It comprises three dimensions: child characteristics, parent characteristics, and life stressors. The first two are constructed as a Likert scale and composed of the following subscales: (1) child characteristics: Adaptability, Acceptability, Demandingness, Mood, Distractibility/Hyperactivity and Reinforcement of Parents and (2) parent characteristics: Depression, Attachment, Role Restriction, Sense of Competence, Social isolation, Relationship with the Spouse, and Parental Health. A version adapted for children from northern Mexico [40] was used, with 38 items for child dimension, 35 for parent dimension, and 21 of stressors related to vital events. In this study, some lexical changes were made to suit the population of central Mexico. The internal consistency showed the following values of Cronbach's α : $r = 0.75$ for child subscales, $r = 0.78$ for parent subscales, and $r = 0.84$ for the whole instrument.

2.2.5. Anxiety

Trait-State Anxiety Inventory (IDARE). The Spielberger and Díaz Guerrero [41], Anxiety Inventory: Status—Index (IDARE) consists of two separate self-assessment scales used to measure two different dimensions of anxiety: (1) Anxiety-Trait (A-Trait) and (2) Anxiety-State (A-State). The self-assessment inventory, IDARE, ranges from a minimum score of 20 to a maximum score of 80, on both the A-State scale and the A-Trait scale. The interpretation of both scales is according to the following scores: <30 low anxiety, 30–44 moderate, and >45 high.

2.2.6. Rearing practices

This aspect was assessed using the *Responsive Practice and Stimulation Questionnaire (RPS-Q)*; this instrument allows to detect the sensitivity and effectiveness of the caregiver to meet the basic physical and psychological child needs, and care patterns adopted by adults in daily situations to meet the needs of children at complementary feeding age. It is made up of 23 Likert items, ranging from 1 for the “never” answer to 5 for the “always” option. The items are grouped into four factors: Stimulation from Play, Responsive Practice, Skills Promotion, Planned Attention, and Willingness to childcare. The internal consistency of the instrument yields Cronbach’s alpha of 0.83 and correlations with the total score between 0.26 and 0.61 [42].

2.3. Procedure

All persons with a child younger than 24 months in outpatient clinics, who attended the child’s vaccination, were invited to participate in talks on health, nutrition, and child development. At conferences, the child’s primary caregivers were called to take part in the research. Once the caregivers were informed about the purpose of the study and the type of participation that they and their children would have, then each couple was evaluated by two psychology interns previously trained in the use of the instruments. In the first instance, the child’s weight and height measurements were taken; then both observers applied the development scales with caregiver collaboration. It was preferred first to use the Psychomotor Scale since this order facilitates the child’s responses on the Mental Scale; an evaluator presented the tests and another noted the answers. In case the child showed signs of fatigue or distress, a new appointment was arranged to continue with the application of the scales. The evaluation of child development was videotaped for later review by those responsible for the research. The RPS Questionnaire was applied as an interview at the health center after evaluating the child. Subsequently, a home visit of the participants was carried out for the application of the Demographic data questionnaires, corroborating the conditions of family life. It also applied the instruments that evaluate parental stress and anxiety. After qualifying the instruments, the report was given to the caregiver and an appointment was made to be involved in an intervention program, not reported in this work and which is in progress.

2.4. Data analysis

Descriptive statistics were obtained for sociodemographic, nutritional and child development, and parental variables. Non-parametric Mann-Whitney *U*-tests were used to observe the effects of nominal dichotomous variables and Kruskal-Wallis for nominal variables with more than two values. The relationship between parental variables, anxiety and parenting stress with effective parenting practices, as well as between parenting and child variables, was evaluated using a Spearman Rho correlation test. All analyses were performed using the statistical software SPSS, version 20 [43].

3. Results

Sociodemographic characteristics of the sample are presented first. Subsequently, based on the nutritional state and the level of mental and psychomotor development, the characterization of the child variables and the demographic variables related to the variability of these measures.

Descriptive statistics corresponding to the RPS-Q and the variables of the socio-affective adjustments (Parenting Stress Index (PSI) and IDARE) are shown, as well as the demographic variables that are related to these variables are addressed. At the last point of the data presentation, the relationships between the caregiver’s variables, the effective parenting practices, as well as the socio-affective variables with the child’s nutritional status and scores obtained on the Bayley Infant Development Scales are presented.

3.1. Sociodemographics and general health

Although all the families of the participants had some degree of lack, from being vulnerable by income to having extreme multidimensional poverty, there were no differences attributable to this variable in terms of family structure, the degree of mother or father studies, father absence, or the child’s usual health. In the same way, children gender was not associated with the child’s health, nor the perceived appetite. The results of child health and disease management by the caregiver indicated that 18.8% of the children had suffered diarrhea in the last 2 weeks, 62.5% of caregivers approached management of the disease adequately, and 37.5% inadequately; while 50% of children had respiratory disease in the previous 2 weeks, 81.2% with adequate management and 18.8% with poor management, 56.3% of caregivers reported using home remedies to treat children’s illnesses.

3.2. Child variables

A criterion for inclusion in the study was that the children were at risk of malnutrition or already present. In **Table 1**, it can be seen that the parameter most affected is body height, which indicates a history of nutrient deficiencies. However, in all three parameters there were cases of moderate malnutrition: one was wasting, one was underweight, and nine were stunting. None of the participating children were severely malnourished.

Regarding the developmental scales, it was found that the average of the children is with the expected values for a healthy child on both the psychomotor scale and the mental scale. However, it can be observed in minimum values that there were cases in which the execution

Measures	Min	Max	M	SD
Anthropometrics				
Body Mass Index	-2.23	1.93	-0.45	1.14
Body Weight	-2.53	0.85	-1.01	0.69
Body Height	-2.82	1.81	-1.25	1.33
BSID				
Mental	81	119	101.81	12.96
Psychomotor	75	119	102.13	14.29

Note: Out-of-range values are shown in bold.

Table 1. Descriptive values of ant and child anthropometrics and Bayley Scales of Infant Development scores.

of the infants was lower than expected: three children showed a slight psychomotor retardation and three others low score on the mental scale.

When calculating the correlation between the nutritional status scores and results on the developmental scales, a statistically significant positive correlation was found between the psychomotor development index and the body mass index ($r = 0.52, p < 0.05$), and negative with the body height parameter ($r = 0.46, p < 0.05$).

The non-parametric analysis based on different demographic variables did not reveal any difference in the child's nutritional status associated with demographic variables like child's gender, family or caregiver type, birth order, age or schooling of both parents, but a statistically significant correlation was found between the age of the child and the BW parameter ($r = -0.56, p < 0.05$), the older the child, the less weight gain was observed.

Concerning the developmental tests, the PDI scores showed a positive correlation with the Wellness Index ($r = 0.502, p < 0.05$) and with the BW, showing better scores as this parameter approaches typical values ($r = 520, p < 0.05$), while the MDI was affected by the child's gender ($U = 7.5, p < 0.05$), with girls showing higher scores ($M = 108.81$) compared to boys ($M = 90.80$). No other sociodemographic variables showed an effect.

3.3. Caregiver variables

Table 2 shows the descriptive statistics of the variables related to parenting. It can be seen that the means of the total RPS-Q score and the scores of the five factors that make up the instrument were within the range of an adequate rearing practice. However, in each factor there are cases within the values of less effective practices: two cases related to Stimulation from Play, Responsive Practice, and Skills Promotion; three corresponded to the Willingness to attend the child and four to Planned Attention. In the total score, two caregivers are observed with values of little effective practice and one that corresponds to inadequate practices.

The variability of the values of the effective practice was affected by the Wellness Index, since to better living conditions, the scores were more favorable in Responsive Practice ($r = 0.625, p < 0.01$), Promotion of Skills ($r = 521, p < 0.05$), Willingness ($r = 0.520, p < 0.05$), and total score ($r = 0.515, p < 0.05$). Willingness correlated positively to child's age ($r = 0.503, p < 0.05$). A significant difference was also found in the values of the Responsive Practice according to child's gender ($U = 8, p < 0.05$), caregivers show higher scores with girls ($M = 4.7$) than children ($M = 4.06$). The other sociodemographic variables did not show significant effects on the RPS-Q.

Results in the PSI showed high levels of parental stress related to the child's characteristics. The subscales whose values exceeded adequate coping scores for childcare were the following: adaptability that gives information about the parent's perception of the child's ability to adjust to changes in the physical and social environment; demandingness, where high values indicate that the caregiver perceives that the child requires too much attention and care; and Reinforcement of Parents, in this subscale values higher than expected report distress generated by not finding the relationship with the child as a source of gratification. Parents characteristics dimensions show that the averages in all subscales are within a suitable range. However, it is necessary to note that in both the dimensions, child and parent, the maximum

Measures	Min	Max	M	SD
RPS-Questionnaire				
Stimulation from Play	3	5.00	4.31	0.69
Responsive Practice	3.67	5.00	4.52	0.50
Promoting skills	2.33	5.00	3.96	0.86
Planned Care	4	5.00	4.66	0.44
Willingness	3	5.00	4.00	0.75
Total score	3.13	5.00	4.26	0.49
Parenting Stress Index				
<i>Child characteristics</i>	92.64	155.50	116.87	14.69
Adaptability	19.05	44.45	32.15	3.91
Acceptability	7.02	23.40	13.09	7.89
Demandingness	13.5	45.00	22.08	8.39
Mood	6	17.00	11.12	3.75
Distractibility/Hyperactivity	20.64	34.83	26.53	2.75
Reinforcement of parents	9	14.50	11.90	1.25
<i>Parent characteristics</i>	83.50	133.75	114.15	14.30
Depression	10.5	25.50	18.84	4.38
Isolation	6	22.00	12.69	6.36
Attachment	8.75	24.50	14.76	5.90
Role Restriction	8.75	28.00	18.92	6.95
Competence	10	34.00	20.25	4.65
Spouse	8	29.00	16.50	4.14
Health	7.5	23.75	12.19	4.88
Total score	187.9	273.75	219.94	21.23
IDARE				
State Anxiety	23	69.00	43.13	12.48
Trait Anxiety	21	55.00	38.25	9.21

Note: Out-of-range values are shown in bold.

Table 2. Caregiver descriptive values.

values found to exceed the cutoff point of the accepted stress levels in all the subscales, and in the parent dimension there are several that show shallow values.

Again, the gender of children marked differences. In this case, it was the Adaptability subscale, where caregivers present stress above the cutoff point in the parenting of the girls ($M = 35.21$), while distress generated from care of boys is within the typical ($M = 25.4$); this

Measures	BMI	BW	BH	MDI	PDI
RPS-Questionnaire					
Stimulation from Play	-0.205	-0.049	0.059	0.386	0.136
Responsive Practice	0.544*	0.188	-0.378	0.487*	0.457*
Promoting skills	0.301	0.169	-0.124	-0.001	0.440*
Planned Care	0.141	0.048	-0.089	0.198	0.063
Willingness	-0.090	-0.248	-0.075	0.121	0.502*
Total	0.171	0.043	-0.138	0.344	0.346
Parenting Stress Index					
<i>Child characteristics</i>	-0.259	0.100	0.085	0.438	0.166
Adaptability	0.199	0.277	-0.145	0.234	0.192
Acceptability	0.091	0.034	0.058	-0.752**	0.102
Demandingness	-0.438*	-0.264	0.125	-0.116	-0.512*
Mood	0.098	0.064	-0.241	0.299	0.058
Distractibility/Hyperactivity	-0.473*	0.070	0.507*	0.176	-0.257
Reinforcement of Parent	0.071	0.219	0.170	-0.108	-0.129
<i>Parent characteristics</i>	0.150	0.181	0.062	0.100	-0.032
Depression	-0.371	-0.006	0.324	-0.445*	-0.538*
Isolation	0.135	0.376	0.076	-0.051	-0.100
Attachment	-0.154	0.211	0.265	0.039	-0.366
Role Restriction	0.311	-0.034	-0.497*	0.045	0.327
Competence	0.284	-0.226	-0.331	-0.021	0.194
Spouse	-0.033	0.067	0.089	-0.358	-0.093
Health	0.274	0.375	0.139	-0.125	-0.213
Total	0.132	0.193	-0.132	-0.324	-0.056
IDARE					
State Anxiety	0.056	0.013	0.004	-0.441*	-0.122
Trait Anxiety	-0.119	0.111	0.409	-0.324	0.083

BMI = Body mass.*<0.05.
 **<0.01.

Table 3. Show correlation values between child and caregiver variables.

difference was statistically significant ($U = 9, p < 0.05$). It was found that at older children, caregivers perceived that raising the child made them more problematic with the couple ($r = 0.529, p < 0.05$) and higher levels of father's schooling, the less gratification the parents felt about the relationship with the infant ($r = 0.658, p < 0.05$). By contrast, the Wellness Index showed a negative relation with the difficulties seen by the caregiver to capture and understand the child's needs, obtaining lower scores in the Attachment subscale ($r = -0.563, p < 0.05$).

Averages anxiety state and trait found at moderate levels. Six caregivers showed high anxiety-state and two anxiety-trait levels. The only sociodemographic variables associated with IDARE scores were the age of the mother ($r = -0.533$, $p < 0.05$ for anxiety-state and $r = -0.528$, $p < 0.05$ for anxiety-trait) and of the father ($r = -0.703$, $p < 0.05$ for anxiety-state and $r = -0.845$, $p < 0.01$ for anxiety-trait).

3.4. Parenting variables and child nutritional status and development

Best scores on the RPS-Q correlate with better indicators in the child. In particular, Responsive Practice is positively associated with body mass index, mental development, and psychomotor development. The PDI also correlates with the Skills Promotion and Willingness factors, as can be seen in **Table 3**.

Following the values in the same table, some negative correlations, moderate or high, can be observed between parenting stress scores and child variables. Lower values of the BMI were associated with two subscales: Demandingness denoting distress generated by the appreciation that the demands of the children are too much, and Distractibility/Hyperactivity related to discomfort because child behavior is valued as erratic and lacking attention. The parameter who can indicate chronic malnutrition (BH) finds a negative correlation with the subscale Role Restriction that shows the interpretation of its role of caregiver as a restriction to its freedom, and positive with Distractibility.

The child's mental development shows a negative correlation with the values of Acceptability—the high scores in this subscale result when children possess physical, intellectual, and/or emotional characteristics that do not harmonize with what parents expect—and Depression, as well as with IDARE scores for state anxiety. On the other hand, the psychomotor development was related, also negatively, with Demandingness and Depression.

4. Discussion

Fitting to the objective, this work explored the influence of rearing practices and socioemotional caregiver factors on the nutritional status and psychological development in a sample of Mexican children. At the outset, it is important to mention that relevant relationships were found between the variables under study; however, the reduced size of the sample requires assessing the findings with due caution.

All children who participated in this study lived in conditions of economic and social scarcities [35] and were at risk of undernourishment or suffer it. Because of this, the variability of the values of the different measures is not very wide. Given the relative homogeneity of the sample in the sociodemographic variables, the possible contribution of parenting in the results on nutrition and child development was highlighted.

The parameter that was most affected was BH whose low values indicate a history of malnutrition and/or diseases, although the means of the other two parameters did not reach the values corresponding to emaciation and low weight, there were cases of mild and moderate undernourishment which corresponded to emaciation and low weight. According to the first

hypothesis, it was expected that if the anthropometric parameters were adversely affected, this would be reflected in levels of mental and psychomotor development. This hypothesis was partially corroborated since the prediction is supported by BMI, a needle of recent faltering, data that correlate positively with the PDI, but the same was not true for parameter BH, an indicator of chronic malnutrition because the results pointed to a negative correlation of this parameter with the PDI. That is, at more height for age a lower development score was found.

This finding does not harmonize with most of the antecedent literature that demonstrates the existence of adverse effects of nutrient deficiencies on different indicators of psychomotor development in early ages [9, 10, 18, 19, 44]. There are three possible alternative explanations for this result. The first has to do with the size of the sample and the method of non-random extraction, given with small sizes the samples can be affected by very few atypical cases; in a previous study, carried out with a similar population in the State of Mexico that included a larger sample, stunting highlighted as one of the factors with greater weight to explain development deficits [45]. The second possibility is related to the lack of information on the specific children's nutritional deficiencies, since many of the developmental deficit caused by malnutrition, mainly those that corroborate the functional isolation hypothesis, consider the deficiency of anemia [18, 19]; in this study, we did not have the possibility of having information about serum iron levels. The third possibility relates to the explanation of David Seckler, and recovered by Pollitt [46], to understand cases where there is child malnutrition and development is not affected. It is an idea where the evolutionary principles of biological adaptation are applied, which argues that food deficiencies slow the child's growth rate in order to maintain a functional physiological balance, and therefore children with mild or moderate malnutrition maintain the capacity of adaptation to adverse circumstances. Considering that the children in the sample had mild (risk) and moderate undernourishment, the assumption of biological adaptation is plausible and could help to understand why, despite the slow growth, infants present adequate levels of psychomotor development.

With respect to the second hypothesis where it was predicted that at higher levels of parenting stress and anxiety the caregiver would have worse outcomes in the child's nutrition and development, the results point to its confirmation. Except for the distractibility factor, the relationships between the parenting stress factors with BMI parameters and BH were negative. Then, we may consider the possibility that in this sample the stress concerning the child caregiving is connected with the state of nutrition, although perhaps not directly. Some studies on this aspect [47, 48] have found associations between alterations in caregiver-child interactions at the mealtime, where the refusal to eat in the infant and the negative effect in both the caregiver and the child prevail, and high levels of parenting stress [34, 49, 50]. It can be assumed here that the parenting stress is the result of insufficient caregiver practices to promote child feeding. As long as their instrumental behavior is ineffective for the childcare, it can generate the distress regarding the nurturing and thus impede its future practices. In other studies, a decrease in parenting stress or anxiety following interventions aimed at reducing problematic behavior at mealtime [51, 52] has been described. The same can happen with regard to the development of the child, since the strongest relationships between anxiety and PSI scores and delay in psychomotor and mental scales occurred with the perception of a dependent child making many demands toward his caregiver, and also with the discomfort generated by the child's failure to meet expectations in terms of physical, intellectual, or emotional characteristics.

Results concerning parenting practices, measured using the RSP-Q, showed a positive relationship between the BMI and the Responsive Practice factor, which describes the caregivers' sensitivity and her/his resources to detect and react to needs based on the signals provided by the infant. This finding is in agreement with previous research on the importance of responsive parenting on child feeding [22–24]. An even clearer relationship was observed between this variable and child development, as the results showed positive correlations between developmental test scores and Responsive Practice, in addition to the factors of skill promotion and Willingness. These results replicate what was found in other studies and support the third hypothesis of this research. The level of sensitivity to detect signals that account for the infant's needs and the ability to respond to them in a timely and fitting manner are essential features of the parenting practice, which allows the child to maintain adequate nutritional status and favor a better psychological development; otherwise negligence or little skill in childcare is a further risk for malnutrition to occur with its adverse effects on child development [18, 45, 53].

Among the sociodemographic variables, the Wellness Index stood out as an important factor, since the results showed positive relationships with the variables of the child weight for the age and the index of psychomotor development. It also had a presence on the results about caregiver characteristics, mainly on the effective parenting practices related to the skills promotion and the responsiveness to child demands [28]. Another relevant demographic factor was the child gender, as it was found that caregivers were more responsive to the needs of girls, who scored better than children on the mental scale, despite being perceived as having difficulty adapting to the demands of the environment.

The children age also appeared as an important variable, the older infants showed greater affectation to the weight gain, despite showing a positive association with the caregiver's willingness for their care. An element that could explain weight loss according to the child's age is that caregivers are facing more problems feeding the child, related to neophobias and rejection. Even though they are responsive and encourage the child to eat, but many sometimes do not use the appropriate strategies for the child to accept the food [54]. Although it found an only association with a characteristic of the caregiver, the age of both parents seems to be attenuating the levels of anxiety, which were linked with those resulting from the mental development of the children.

Although the sample of this study is small and made with Mexican population, it can be assumed that the results found here can be extended, conserving the cultural peculiarities of each region, to other populations where the problem of malnutrition is present together with precarious living conditions and where caregivers of developing children face situations of high demand. The variables explored have also been relevant in studies carried out in different latitudes, such as poverty and malnutrition [1]; a low sociocultural level associated to affective instability and malnutrition [33, 55]; likewise, relations between ineffective parenting practices and malnutrition [24, 56] or disadvantages in psychological development [18].

However, these relationships were analyzed in this research from the use of different measurement instruments, particularly the Wellness Index and the RPS-Q. Likewise, adapted and validated versions for the Spanish-speaking population of instruments of extended use were employed, such as the BSID, the IDARE, and the Parenting Stress Index. The Wellness Index is a World Bank proposal that has recently been used to measure poverty on a large scale; unlike previous ordinal

measures where the greatest weight fell on family income, it is based on a cardinal measurement with different axes to determine the degree of people's economic and social deprivation, social support and rights. Thus, a multidimensional poverty index reflects incidence, intensity, and composition picture of acute poverty [57, 58]. Because this way of measuring poverty is indicated for developing countries, several of them have already developed an index adapted to their specific conditions [59]. Recovering this measure for an investigation, such as that described here, represents an advantage due to the profusion of information obtained.

Regarding the extension of the use of the RPS-Q as a rearing practice measure in different contexts, it is suggested that this methodology can be used in other country settings making cultural adaptations. Despite its reliability and validity was performed in the Mexican population, the questionnaire was built considering basic principles of the rearing process that can be generalizable to diverse populations. The underlying sensitivity and responsiveness of caregiving constructs have been described as the ability to recognize and interpret the signals which the other emits about their needs and also respond to them in an appropriate and timely mode [23, 25].

Responsive parenting has been identified in observations of caregiver-infant interactions in different countries [60, 61]. This characteristic is identified through indicators of attention to the other, the relevance and contingency of responding, as well as the amount of socioemotional support provided to the child; these dimensions are present in every care interaction. The RPS-Q made it possible to obtain one of the most important contributions of this work showing relations between affective and emotional aspects with the effective caregiver practices that, ultimately, mediate the child's feeding behavior, as well as the exposure of stimuli environmental factors that contribute to their motor and mental development.

In this study, it was possible to describe several relationships between variables that may constitute risk factors or protection for child development problems associated with malnutrition. It is necessary to confirm these relationships with a larger sample that allows, at the same time, to test models that propose the directionality of the variables of the child and the caregiver, as well as the possible role as mediators or moderators of the characteristics of the caregiver and their rearing practices, between the effects of malnutrition on the development of the child.

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Author details

Assol Cortés-Moreno

Address all correspondence to: assol@unam.mx

National Autonomous University of Mexico, Faculty of Higher Education Iztacala, Mexico

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