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Age of presentation of Denver Test items in the first 4 years of life of children from Morelos, Mexico

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Original article

SUMMARY

The Denver Developmental Screening Test (Denver II) is the most widely used tool internationally for child development surveillance, from which assessments and changes have been made in several countries, from the estimate of the age of presentation of the items, as it constitutes the basis of its structure and validity.

Objective

To identify the age and acquisition sequences of each item of the Denver-II test during the first four years of life in children of low socioeconomic status from a community in Morelos State, Mexico.

Method

Some 2,350 assessments were conducted of children from 0 to 48 months of age. A logistic regression model was used to estimate the age of presentation of each item to the 25th, 50th, 75th and 90th percentiles. Differences were established with values of reference based on confidence intervals up to 95% for the 90th percentile.

Results

Of the 98 items evaluated, 42 were submitted delayed, 23 showed no statistical difference and 33 were acquired at earlier ages in children of Morelos. In the Gross Motor and Personal-Social areas, delays predominated in 19/25 and 11/21 items respectively. By contrast, in Fine Motor-Adaptive and Language, advances predominated in 11/22 and 16/30 items.

Conclusions

There are differences in the age and presentation sequence of the items of the Denver-II test in the population studied. Adjustments are recommended before implementing its use in specific socio-cultural contexts.

Key words: Child development, DSST-II, Denver II Test, developmental screening, psychometrics.

RESUMEN

Uno de los instrumentos más utilizados a nivel internacional en la vigilancia del desarrollo del niño es la segunda versión del Denver Developmental Screening Test (DENVER II), del cual se han hecho evaluaciones y modificaciones en varios países, a partir de la estimación de la edad de presentación de los reactivos, pues constituye la base de su estructura y validez.

Objetivo

Identificar las edades y secuencias de presentación de los reactivos del Test Denver II en los cuatro primeros años de vida en niños de condición socioeconómica baja de una comunidad del Estado de Morelos, México.

Método

Se realizaron 2350 evaluaciones a niños de 0 a 48 meses de edad. Mediante un modelo de regresión logística se estimó la edad de presentación de cada reactivo para los percentiles 25, 50, 75 y 90. Se establecieron diferencias con los valores de referencia del instrumento con base en los intervalos de confianza al 95% para el percentil 90.

Resultados

De los 98 reactivos evaluados, 42 se presentaron con retraso; 23 no mostraron diferencias estadísticas y 33 se lograron antes por los niños del estudio. En las áreas Motor grueso y Personal-social predominaron los retrasos en 19/25 y 11/21 reactivos respectivamente. Por el contrario en Motor Fino-Adaptativo y Lenguaje predominaron los adelantos en 11 de 22 y 16 de 30 reactivos.

Conclusiones

Existen diferencias en las edades y secuencias de presentación de los reactivos del Test de Denver II en la población estudiada. Se recomienda realizar ajustes antes de implementar su uso en contextos socioculturales específicos.

Palabras clave: Desarrollo infantil, Denver II, vigilancia del desarrollo, psicometría.

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INTRODUCTION

The screening of development as part of the actions of vigilance and promotion of childhood health is, by necessity, a growing activity in correspondence with the current orientation of health systems towards early prevention, the promotion of health, and the quality of life of people and families. To this, we can add the greater child survival rate from prenatal events, physical accidents, and various pathologies. In many countries, including Mexico, surveillance of early child development corresponds almost exclusively to the health sector, given that other sectors, such as education or child protection, are not involved in the early care of children in a universal manner.[1,2]

Among the international recommendations for development surveillance is the use of investigations or screening tests, especially those with greater sensitivity to detect alterations and recognize normality in various areas and ages of development.[3] However, very often, these tests are not assessed in respect of specific population standards in those populations where they are used or intended to be used.[4]

The tests can be assessed with various criteria such as the concurrent validity in respect of a gold standard, normalizing its performance in terms of a population sample or assessing whether the items used reflect the ages and sequences of presentation of the population where it is intended to be used. The results of the assessment indicated allow for a respective estimation of whether it is necessary to modify its cut-off points, criteria of interpretation, or adjustments in its composition and structure, before recommending its use.

Sequences in child development tend to be invariable, but when an area of a screening test is defined, only those items that come from various functional sequences are selected,[5,6] which manifest themselves with different rhythms and speeds due to cultural features, child-rearing patters, or generational changes in the population.[5,7-10]

The second version of the *Denver Developmental Screening Test* (DENVER II) dates from 1992[11-13] and continues to be one of the most widely used screening tests in Mexican and worldwide pediatrics, primarily in countries that have not designed their own instruments for development surveillance, among which are included adaptations of the Denver II or other tests, but from their own socio-cultural characteristics and psychometric estimations.[8,14-17]

Studies in the Mexican population show differences between the ages at which behaviors of some instruments would be expected and the ages at which they are actually presented in the population. In 1975, Solomons[7] used the first version of the Denver Test and found differences in the appearances of motor behaviors in Yucatecan Maya children to what was reported for North American children. Sánchez et al.[10] reported differences in the age of acquisition of various behaviors in their population of study with respect to what was expected on the Capute Scales CAT/CLAMS.[18]

In Argentina, Lejarraga et al.[8] analyzed the presentation age of patterns of development, comparing them with those indicated by various tests including the Denver II, and they found 32% of behaviors were delayed, 43% were advanced, and only 25% had no difference.[8] Furthermore, studies have been carried out in other places such as Brazil,[6] China,[16] Alaska,[5] Trinidad and Tobago,[17] Singapore[19] and Sri Lanka,[20] observing in general a variability in the presentation age of Denver behaviors in accordance with the context in which they were assessed.

Screening tests seek to differentiate normal subjects from subjects with alteration. Some base their assessment strategies on children's capacity to resolve a greater number of behaviors close to their age, from a base level on which they can resolve everything that is explored through to older ages at which the child does not show capacity to resolve any more behaviors. But the Denver II only explores the three items immediately prior to their age, with no possibility to compensate or complement the results with achievements from earlier ages. For these cases, the order in which the items are presented as age increases is even more important, given that the major correspondence between the sequence proposed by the test and the population characteristics will determine its greater or lesser capacity for detection.

In order to assess whether the age and sequence at which the items of a test such as the Denver II are explored correspond with what happens in a population, it is necessary to determine the age at which the majority of the population (age of the 75th or 90th percentile) is capable of presenting or resolving each one of the items that match it and establish the order in which they are distributed on the timeline or age of this population. From this, greater clarity can be obtained about the possibilities of the test and eventual need for adjustment to discriminate between normal and altered development. The use of percentile values of the presentation age of the items in the population continues to be a fundamental reference in the surveillance of development,[14] a characteristic that has supported the use of the Denver II Test.[5,6,15,21]

Early detection of alteration in development is a health priority. It is therefore necessary to generate evidence on the validity and use of the tools utilized, or whether modifications or adaptations of those tools are required. In the case of the Denver II, it is based on the estimation of the age at which the majority of the population (90%) is capable of performing each one of the items that make up the test. In this way, we can know whether the test by areas and age adjusts itself to the relevant populations themselves.

The objective of this work is to estimate the acquisition age of each of the items on the Denver II test which are explored during the first four years of life, in children from a low socio-economic status in a community in the state of Morelos in the Mexican Republic.

MATERIAL AND METHODS

An observational, descriptive, transversal, and prolective design was implemented in order to estimate the presence or absence of 98 behaviors in the Denver II Test in children from zero to four years of age, distributed into eight age groups as follows: seven days, and at two; four; seven; 10; 13; 18; 24; 36; and 48 months, according to the estimation described in the technical manual for the Denver II.[22] The sample size for each group was calculated according to the method for estimating proportions considering the 75th and 90th percentiles, which are those on which the test is interpreted and which are analyzed in the present work (n=288 per group, precision of 5%, 95% confidence). Some 2,350 assessments were carried out; each one explored between 24 and 42 Denver II Test behaviors in such a way that each behavior that represents the unit of sample concentration was explored an average of 479 times (minimum 431, maximum 719 times).

The inclusion criteria were: clinically healthy child, low perinatal risk, gestational age at birth between 37 - 42 weeks, Apgar score at one minute and successive minutes ≥7, normal neonatal metabolic screening, no history of jaundice after eight days or morbidity requiring hospitalization for over 24 hours, with somatometric data between the 10th and 90th percentiles, and with no other pathology after birth that affects development. Cases that presented three items of development that were not applicable, the presence of two or more neurological warning signs, or dysmorphia according to Capute criteria were excluded.[18] Upon evaluation, the children were assessed before a pediatrician in order to verify their state of health, including somatometry, and covering other criteria of a healthy child; all cases were assessed in consulting rooms in similar conditions.

The children and their families were of low socio-economic status, established using the Socio-economic Schedule of the National Institute of Pediatrics;[23] they were residents of an urban settlement in the south of Morelos state, at 940 meters above sea level with a hot, semi-humid tropical climate, temperatures averaging between 23.5°c and 35°c. Basic services were available and the socio-economic conditions were common to the majority of the population of the central zone of the Mexican Republic.

Test de Denver II

The Denver II has some 125 items to assess children between two weeks and six years of age; the present study reported the 98 items that correspond to the first four years. The items were presented in an ascending sequence according to the value of the 90th percentile obtained in the reference population of Denver, Colorado.[12,22]

The assessments were made by three psychologists and three nurses, standardized with an intra- and intero-observer reliability greater than 90%, verified at the beginning and every four months during the period in which the assessments were made (August 2009 through July 2010).

The statistical analysis and estimation of the presentation ages were made using the prediction model in an analysis of logistical regression for the presence or absence of each item according to the child's age of assessment.[6,8,22] This allowed the presentation age and confidence intervals of the estimation to be calculated. This is also the method utilized by the authors of the Denver II and by the majority of reports which are comparable to our results. The ages at which the 25th, 50th, 75th, and 90th percentile of the children presented each item were calculated, along with the Confidence Interval at 95% of each item 90 (CIp90) in order to compare it with its corresponding allocation in the Denver II Technical Manual.[22] Two types of possibly significant statistical differences were considered for each item: 1. Delayed, when the upper and lower limits of the CIp90 of the presentation age in our sample were older than the relevant allocation in the manual; 2. Advanced, when the CIp90 were lower than the reference. Consequently, if the CIp90 included the reference value, it was assumed that there were no differences, known as *coincidence or no difference*. According to these criteria, each item was assigned the trait of *advanced, delayed, or no difference* (*coincidence*) in the population of Morelos in respect of the reference in the manual. An estimation was made of the frequency of these traits in each area and in the total of the items explored. The statistical analysis was made using the program JMP 8.0 by SAS.

RESULTS

The average age of the fathers was 28.1±10 years (18 to 48 years) and that of the mothers was 25±6.14 years (16 to 37 years). The socio-demographic data on the parents and the families is shown in Table 1. Some 15.2% of the children were male; 54% were under the sole care of the mother, 31% had two carers, and 15% were under the care of three or more people. Some 31% were a first baby, 33.8% were second, and the rest were third or subsequent babies. The average birth weight was 3,168±448.6g and the length was 50.1±2.74cm. The average gestational age was 39.3±2.25 weeks.

Presentation ages for DENVER II items. Of the 98 items assessed, 23 did not show statistically significant differences; 42 presented *delays* in Morelos children (from 10 days through to 6.5 months), 27 of these with more than a month's delay in terms of that set out in the instrument. In contrast, 33 items were found to be advanced (from nine days through to 9.2 months ahead).

The frequency distribution of coincidences, delays, and advances by areas showed that the *Gross Motor Area* had the lowest number of items with no difference (16%), the greatest number of delays (76%), and the lowest number of advanced items (8%). Of 25 items assessed, four showed no

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Table 1. Socio-demographic characteristics of the parents

Variable	Father	Mother
Age (X * DS)	28.1 ± 1.0	25 ± 6.1
Years of schooling completed	9.5 ± 3.2	9.49 ± 3.1
Level of education reached		
• Upper middle complete	20.7%	24.7%
• Lower middle complete	57.7%	47.7%
• Elementary complete	14.1%	20.3%
• Elementary incomplete	5.6%	5.4%
• Illiterate	1.8%	1.6%
Monthly household income		
• <1999	7.4%	
• > 2000 < 3400	47.2%	
• 3400 - 6000	27.7%	
• > 6000	17.5%	
Household income spent on food		
• < 30%	2.7%	
• 30-50%	49.5%	
• > 50%	47.7%	
Number of family members	X 4.1 ± 1.4	
• 3 or 4 members	69.2%	
• 5	13.1%	
• 6	8.7%	
• 7	6.1%	
• 8 or more	2.6%	

statistical differences ("Symmetrical movements", "Raises head", "No head lag", and "Broad jump"); 19 were delayed for Morelos children. The greatest delays were in the items "Forearms support", "Kicks a ball" and "Walks backwards", with 3.3, 3.4, and 4.4 months' delays, respectively, as well as "Runs" which had the greatest delay (six months) in this area and indeed in the test as a whole. Six other items were acquired with two to three months' delay ("Head at 90", "Noise", "Pushes to remain upright", "Sits down by themselves", "Walks up stairs", and "Hops". Only two items ("Balances on one foot for one second" and "Throws a ball up high" were acquired with delays of 8.6 and 2.7 months (Table 2 and Figure 1).

The *Fine Motor Adaptive Area* showed the greatest number of coincidences in terms of the manual (32%), the lowest number of delayed items (18%), and the second highest number of advances (50%). Of the 22 items explored, seven did not show statistically significant differences, four presented a delay, and 11 were advanced in our sample. The items with the greatest delay were "Places blocks" and "Hits two blocks together", with 1.2 and 1.6 months respectively. In contrast, "Mimics vertical lines" was the most advanced item at 7.7 months, and the items "Drop a raisin with demonstration", "Six cube tower", and "Eight cube tower" were acquired with four to five months' advance for the sample studied (Table 2 and Figure 2).

In the *Language Area*, only six items (20%) did not present statistically significant differences, while eight of the 30 items assessed showed a delay (27%). This occurred in the first 16 months; after this age, delays were not observed. The greatest delays were "Vocalize", "Mimic sounds", and "Non-specific Mama/Dada", with 2.3, 2.8, and 3.2 months' delay respectively. These were followed by the items "Laughs", "Specific Mama/Dada", "What is your name", and "One word", with one to two months' delay. This was the area with the greatest proportion of advances, in 16 of the 30 items (53%); in four of these the advance was greater than four months ("50% understandable speech", "Names six body parts", "Uses two objects", and "Uses three objects"). There were four others with advances between two and four months ("Counts once block", "Name a picture", "Knows two adjectives", and "Points to four pictures" (Table 2 and Figure 3).

Finally, the *Personal-Social Area* had the second highest proportion of items with no differences (29%), with six items: "Reaches for an object", "Claps", "Dresses themselves", "Puts on a t-shirt" "Uses cutlery", and "Takes clothes off". This was also the area with the second highest proportion of delays, with 11 of the 21 items assessed (52%), among which stand out "Feeds themselves", "Brushes teeth with help", "Helps at home", and "Names a friend", with 2.0, 2.9, 3.6, and 4.6 months' delay, respectively. Finally, four items (19%) were achieved with an advance: "Goodbye" and "Plays with a ball", both with 1.2 months' advance, "Feeds a dolly" with 3.6 months', and "Regards face", which was estimated as present in more than 90% since birth (Table 2 and Figure 4).

DISCUSSION

The Denver II is a test that orders and refines the items to apply according to the ages they presented in a normative sample in Denver, Colorado, in 1990. As such, part of its utility and validity in other specific contexts depends on the age and order in which the children acquire the items which make up the test.[22]

Although many works exist which use the Denver, few report the presentation age of its items,[5,6,9,16,17,19,20,24-27] which is the central point being discussed in the present report. Other works are also included which refer to the acquisition age of behaviors from other tests, but which are common with the Denver.[8,10,28,29] The methodology utilized corresponds to the procedures employed for the construction of the test and by the primary works reported in previous years. This also allows confidence intervals of the estimations to be established, as well as whether or not statistically significant differences exist.

There was generally very little coincidence (23%) between what was observed in the sample and the ages indicated in the test; delays (43%) and advances (34%) were predominant. Furthermore, the differences were distributed heterogeneously by area and age, from which it can be deduced that it is necessary to make adjustments before rec-

Table 2. Percentiles of presentation ages for the items on the Denver II in children of Morelos and comparison with the 90th percentile in the manual

Item	Morelos p25	Morelos p50	Morelos p75	p90 Morelos +(ICinf-ICsup95%)		p90 manual	Difference assigned
Gross motor							
Symmetrical movements	—	—	RN	RN	(——)	RN	no
Raises head	—	—	RN	0.2	(RN - 0.4)	RN	no
Head at 45	2.7	3.2	3.8	4.3	(4.1 - 4.7)	2.7	delay
Head at 90	3.9	4.5	5.1	5.7	(5.4 - 6.0)	3.6	delay
Sitting with head steady	2.5	3.1	3.7	4.3	(4.0 - 4.6)	3.7	delay
Weight over legs	3.8	4.6	5.3	6.1	(5.8 - 6.5)	4.4	delay
Support on forearms	5.4	6.2	7.1	7.9	(7.6 - 8.3)	4.6	delay
Noise	4.5	5.7	6.8	8.0	(7.6 - 8.4)	5.4	delay
No head lag	4.1	4.8	5.4	6.0	(5.7 - 6.3)	6.2	no
Sits unsupported	5.4	6.0	6.5	7.1	(6.9 - 7.4)	6.8	delay
Standing while gripping	7.5	8.4	9.3	10.2	(9.9 - 10.6)	8.5	delay
Pushes to remain upright	9.1	10.0	10.9	11.9	(11.6 - 12.2)	9.7	delay
Sits up unaided	9.0	10.0	11.0	12.0	(11.6 - 12.3)	9.9	delay
Stands for 2 secs	10.1	11.0	12.0	12.9	(12.6 - 13.3)	11.6	delay
Stands for 10 secs or more	11.9	12.8	13.7	14.5	(14.2 - 14.9)	13.7	delay
Crouches and stops	12.8	13.8	14.7	15.6	(15.3 - 16.0)	14.6	delay
Walks well	13.0	13.9	14.8	15.7	(15.4 - 16.1)	14.9	delay
Walks backwards	16.2	17.8	19.4	21.0	(20.5 - 21.6)	16.6	delay
Runs	19.3	21.7	24.1	26.4	(25.8 - 27.2)	19.9	delay
Walks up stairs	18.3	20.1	22.0	23.8	(23.3 - 24.5)	21.6	delay
Kicks a ball	20.3	22.4	24.5	26.6	(26.0 - 27.3)	23.2	delay
Hops	24.6	27.0	29.3	31.7	(31.1 - 32.5)	28.8	delay
Throws a ball up high	23.5	26.4	29.2	32.1	(31.4 - 32.9)	34.8	advance
Broad jump	29.9	32.5	35.1	37.7	(36.9 - 38.6)	38.4	no
Balances on one foot 1 sec	26.5	28.4	30.3	32.2	(31.6 - 32.9)	40.8	advance
Fine adaptative motor							
Follows to mid-line	RN	0.3	0.8	1.2	(0.9 - 1.8)	1.3	no
Follows past mid-line	1.0	1.4	1.8	2.2	(2.0 - 2.6)	2.8	advance
Grasps rattle	1.9	2.3	2.8	3.2	(3.0 - 3.5)	3.9	advance
Hands together	2.3	2.7	3.2	3.6	(3.4 - 4.0)	4.0	no
Follows180	3.6	4.0	4.4	4.8	(4.6 - 5.1)	4.5	delay
Regards raisin	3.3	3.9	4.4	4.9	(4.7 - 5.3)	5.2	no
Reaches for object on table	4.8	5.1	5.3	5.6	(5.4 - 5.9)	5.6	no
Look for yarn	5.5	6.0	6.5	7.0	(6.8 - 7.3)	7.2	no
Rakes raisin	5.7	6.0	6.4	6.8	(6.6 - 7.1)	7.3	advance
Passes cubes	6.3	7.2	8.1	8.9	(8.6 - 9.3)	7.7	delay
Takes 2 cubes	5.8	6.6	7.4	8.2	(8.0 - 8.6)	9.1	advance
Thumb-finger grasp	8.4	9.1	9.8	10.5	(10.3 - 10.9)	10.2	delay
Hits two blocks together	9.4	10.4	11.4	12.5	(12.1 - 12.9)	10.9	delay
Puts a block in a cup	9.5	10.1	10.8	11.4	(11.1 - 11.7)	13.8	advance
Scribbles	12.9	14.0	15.2	16.3	(15.9 - 16.8)	16.3	no
Drop raisin with demonstration	12.8	13.5	14.2	14.9	(14.6 - 15.3)	19.4	advance
2 cube tower	14.5	15.4	16.3	17.2	(16.9 - 17.6)	20.6	advance
4 cube tower	18.5	19.7	20.9	22.1	(21.7 - 22.6)	23.8	advance
6 cube tower	21.7	23.3	24.8	26.4	(25.9 - 26.9)	31.2	advance
Mimics vertical lines	25.7	27.4	29.0	30.7	(30.2 - 31.3)	38.4	advance
8 cube tower	27.9	30.8	33.7	36.6	(35.8 - 37.5)	42.0	advance
Wiggles thumb	36.5	38.9	41.2	43.5	(42.5 - 44.8)	43.2	no
Languaje area							
Responds to a bell	RN	RN	RN	RN	(——)	0.2	no
Vocalizes	1.7	2.3	3.0	3.6	(3.4 - 4)	0.8	delay
Oooh/aaah sounds	1.1	1.5	2.0	2.4	(2.2 - 2.8)	2.7	no
Laughs	3.4	4.0	4.5	5.1	(4.8 - 5.4)	3.1	delay
Jabbers	2.7	3.1	3.5	3.9	(3.7 - 4.2)	4.3	advance
Turns towards a rattle	3.2	3.6	4.0	4.4	(4.2 - 4.7)	5.6	advance
Turns towards a voice	3.8	4.6	5.3	6.1	(5.8 - 6.5)	6.6	advance

Table 2. Continued

Item	Morelos p*25	Morelos p50	Morelos p75	p90 Morelos +(ICinf-ICsup95%)	p90 Manual	Difference assigned
Isolated syllables	5.9	6.5	7.1	7.8 (7.5 - 8.1)	7.5	no
Mimics talking sounds	8.0	9.1	10.1	11.1 (10.8 - 11.5)	8.8	delay
Mama/dada not specified	8.4	9.7	11.0	12.3 (12.0 - 12.8)	9.1	delay
Combines syllables	6.9	7.9	8.9	9.8 (9.5 - 10.2)	10.1	no
Makes happy noises	5.0	7.6	10.2	12.8 (12.2 - 13.5)	12.1	delay
Mama/dada specified	10.4	12.0	13.5	15.1 (14.7 - 15.7)	13.3	delay
One word	11.9	13.4	14.8	16.3 (15.8 - 16.8)	15.0	delay
2 words	12.9	14.2	15.6	17.0 (16.6 - 17.5)	16.5	delay
3 words	14.0	15.3	16.7	18.0 (17.6 - 18.5)	18.0	no
6 words	15.8	17.2	18.5	19.9 (19.4 - 20.4)	21.4	advance
Points out 2 pictures	19.1	20.4	21.7	23.0 (22.6 - 23.5)	23.6	advance
Combines words	19.2	20.8	22.4	23.9 (23.5 - 24.5)	25.2	advance
Names a picture	20.2	21.7	23.2	24.7 (24.2 - 25.3)	27.6	advance
Names six body parts	19.6	20.8	22.0	23.2 (22.8 - 23.7)	28.8	advance
Points out 4 pictures	21.7	23.2	24.7	26.3 (25.8 - 26.9)	30.0	advance
50% understandable language	24.4	26.3	28.2	30.1 (29.5 - 30.8)	34.8	advance
Names 4 pictures	26.6	28.7	30.8	32.9 (32.3 - 33.6)	34.8	advance
Knows 2 actions	28.8	31.6	34.4	37.3 (36.5 - 38.2)	38.8	advance
Knows 2 adjectives	32.2	35.2	37.6	39.9 (39.2 - 40.9)	43.2	advance
Names a color	34.6	37.9	41.2	44.4 (43.2 - 46.0)	44.4	no
Uses 2 objects	32.8	34.7	36.6	38.5 (37.9 - 39.3)	45.6	advance
Counts 1 block	36.8	39.3	41.8	44.3 (43.2 - 45.8)	46.8	advance
Uses 3 objects	34.4	36.3	38.1	40.0 (39.3 - 40.9)	49.2	advance
Personal social area						
Regards face	RN	RN	RN	RN (———)	0.2	advance
Smiles in response	1.2	1.4	1.6	1.8 (1.6 - 2.1)	1.5	delay
Smiles spontaneously	2.0	2.3	2.6	3.0 (2.8 - 3.3)	2.1	delay
Regards hands	3.1	3.5	3.9	4.3 (4.1 - 4.6)	4.0	delay
Tries to reach a toy	4.2	4.7	5.3	5.8 (5.6 - 6.1)	5.9	no
Feeds themselves	6.1	6.9	7.7	8.5 (8.3 - 8.9)	6.5	delay
Claps	9.0	9.9	10.7	11.6 (11.3 - 12.0)	11.4	no
Indicates wants	10.3	11.4	12.4	13.5 (13.1 - 13.9)	12.9	delay
Waves goodbye	9.9	10.9	11.9	12.8 (12.5 - 13.2)	14.0	advance
Plays with a ball	10.7	11.9	13.2	14.5 (14.1 - 14.9)	15.7	advance
Mimics activities	14.8	15.6	16.4	17.3 (16.9 - 17.7)	16.0	delay
Drinks from a cup	14.5	15.7	16.8	17.9 (17.5 - 18.4)	17.1	delay
Helps at home	17.4	18.5	19.7	20.9 (20.5 - 21.4)	17.3	delay
Uses cutlery	17.0	18.1	19.2	20.2 (19.9 - 20.7)	19.9	no
Removes clothes	19.3	21.0	22.6	24.3 (23.8 - 24.9)	23.9	no
Feeds a dolly	16.9	18.1	19.3	20.4 (20.0 - 20.9)	24.0	advance
Dresses themselves	24.3	26.0	27.8	29.6 (29.0 - 30.2)	30.0	no
Brushes teeth with help	26.8	29.5	32.2	34.9 (34.2 - 35.7)	32.0	delay
Washes and dries hands	30.7	33.2	35.6	38.1 (37.3 - 38.9)	37.2	delay
Names a friend	34.2	36.7	39.3	41.8 (40.9 - 43.0)	37.2	delay
Puts a t-shirt on	32.7	35.3	37.8	40.4 (39.5 - 41.4)	40.8	no

*p= percentile, (+)CIinf=lower confidence interval (1-alfa=0.95), CIsup=higher confidence interval (1-alpha=0.95).

ommending its use. In contrast, the number of children with alterations due to failures in the Motor and Personal-Social Areas was overestimated, and that in the Fine Motor-Adaptive and Language Areas was underestimated. But given that for the test, finding delay in two or more items is sufficient, independent of area, in general this led to an overestimation of children with probable alterations in development. Some authors have indicated the inconvenience of using limited behaviors in order and with a strict age criteria,[6] not allowing the child's executions to appear with variations in respect to the test, and worse still, that the child's score is restricted to the three behaviors closest to their age in each area, as is the case with the Denver II. We consider that the results of the present study demonstrate the limitations of this criteria, reducing its validity in various contexts.

The sequence of items presented in each area of the Denver II is built from a statistical criterion and takes several indicators from various functional sequences. By the same

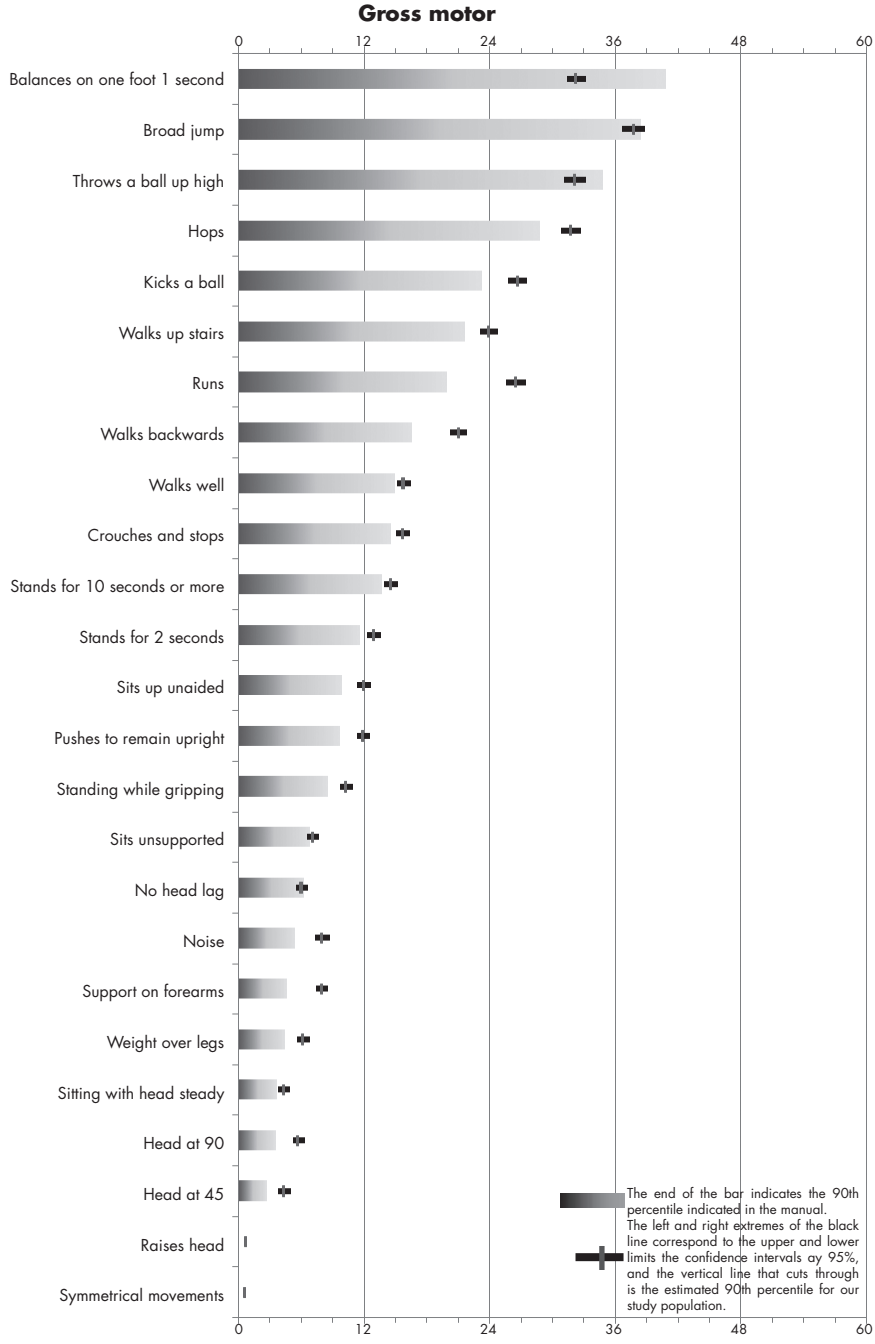

Figure 1. Ages in months that children acquire the items on the Denver II in the area of Gross Motor according to the references in the manual and in the Morelos sample.

token, this staging does not determine the whole sequence; the criteria finally used is the estimation of the age at which 90% of children perform the behavior, but this sequence is modified if the 75th or 50th percentile is considered, and can also vary by upbringing and other environmental or cultural factors existing in the population.[5,8,10,16] For example, in a study carried out in Hong Kong,[16] the behavior "*Rolls from back to front*" is observed before "*Rolls from front to back*" - the opposite of what was observed in Canada.[30] In a study in Brazil,[6] the behavior "*No head lag when brought to a sitting position*" was present before "*Sitting with head steady*", contrary to the Denver II order and to our own results. Even between estimations of the first and second versions of the Denver Test, there were changes in the ages and sequences of the common items.

Our observation of items with the greatest delay in the *Gross Motor Area* in the first two years of life was also reported in studies in Yucatan,[7] Brazil,[6] and Cardiff, Great

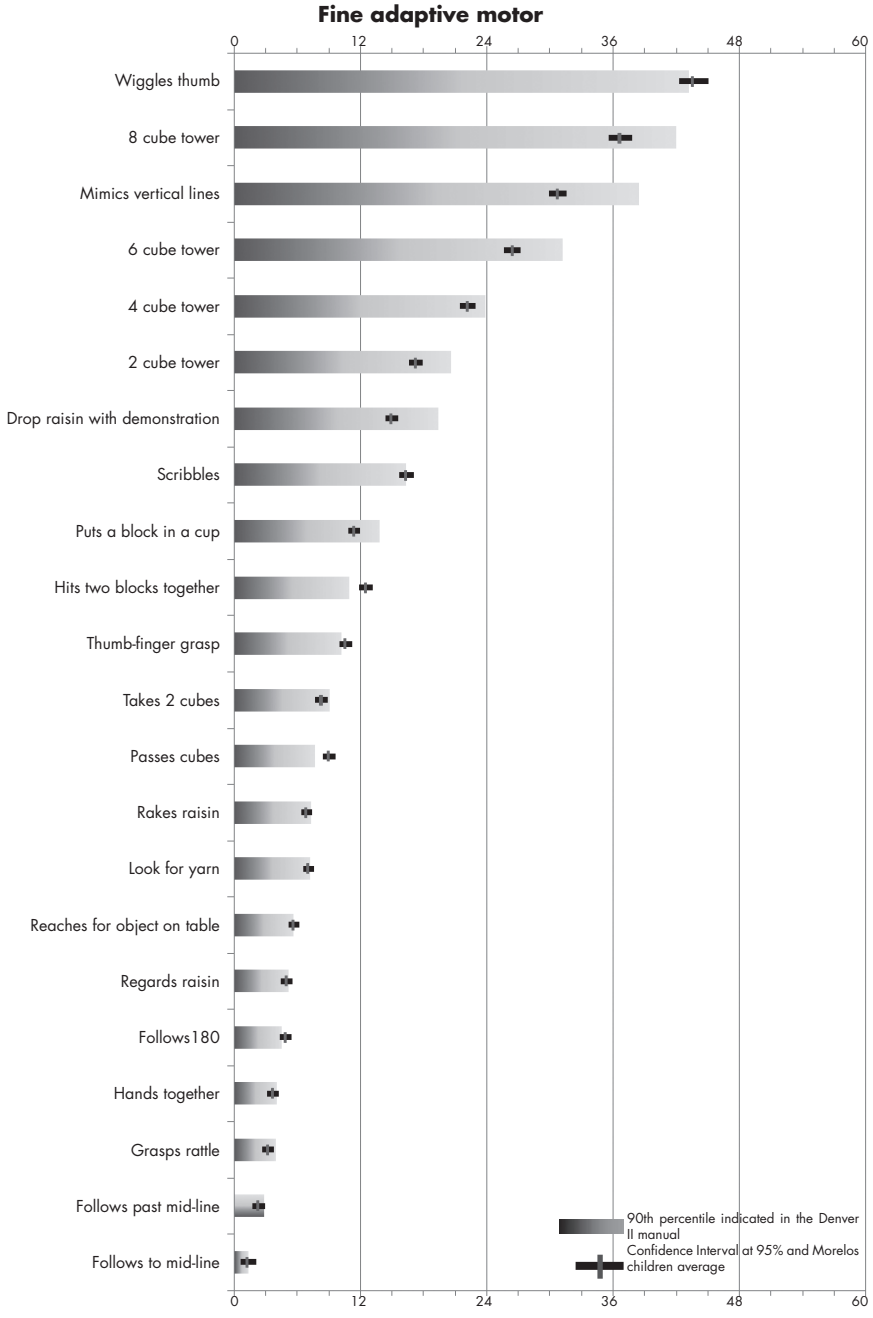

Figure 2. Ages in months that children acquire the items on the Denver II in the area of Fine-Adaptive Motor according to the references in the manual and in the Morelos sample.

Britain,[24] which suggests that this area reflects the role performed by caregivers and cultural influences on development.[9,16] For example, it has been reported that children in Alaska[5] are given more freedom to physically explore their environment, which could explain the earlier presentation ages than those observed in our sample, where putting children on the floor to crawl or play was often avoided due to many houses having earth floors, or for fear of contact with animals or poisonous insects common to the area. Carrying babies is also less common in Morelos due to the heat, and almost never on the back like in Alaska, which allows the child to receive the same visual information as its parents, which facilitates spatial orientation.[5]

Like in Singapore9 and Sri Lanka,[20] some 90% of the children in Morelos acquire the item "Raise head to 90°" at 5.7 months of age, which shows a delay in comparison to the ages reported by other tests such as Gesell and Capute, which report it at four months.[18,28] The item "Forearms sup-

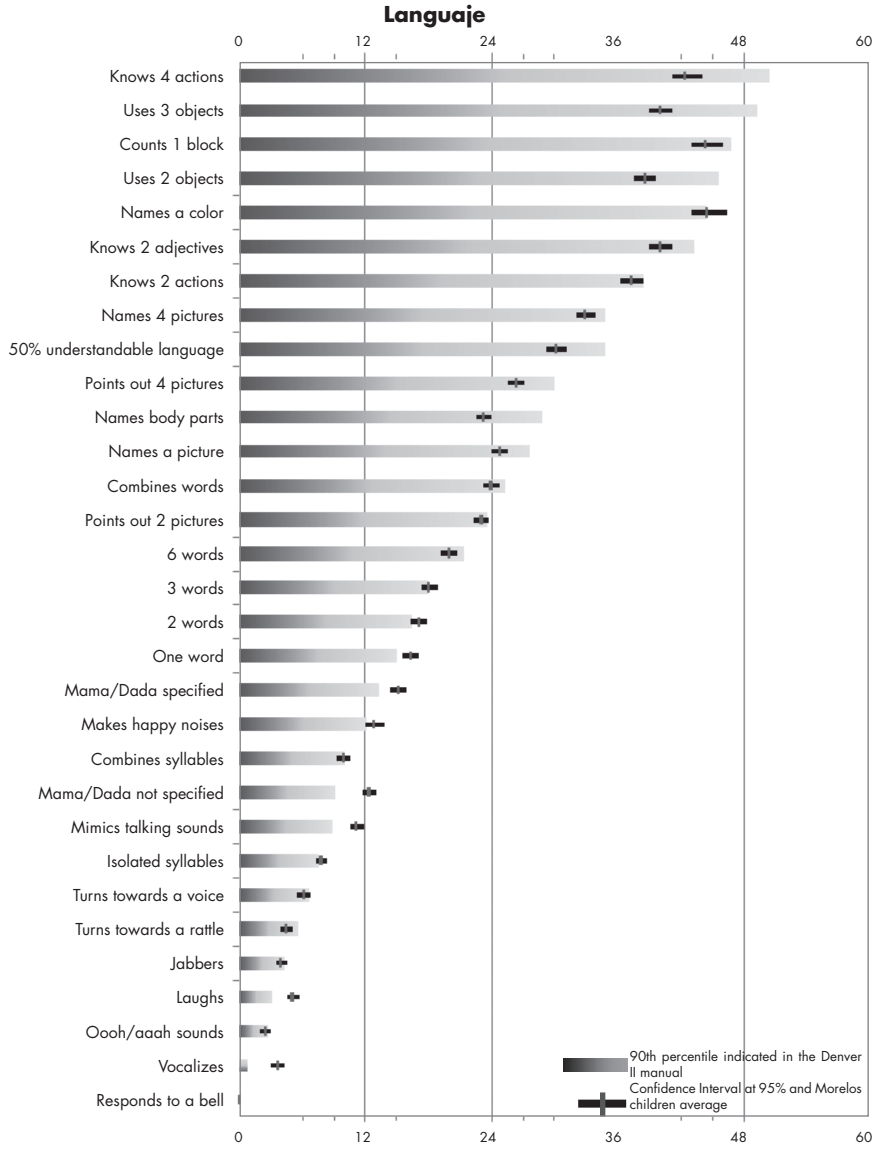

Figure 3. Ages in months that children acquire the items on the Denver II in the area of Language according to the references in the manual and in the Morelos sample.

port" is reported at five months in Gesell;[28] Singapore and Sri Lanka report it at six, and in our population it presented at 7.9 months. The item "Noise" is acquired with a delay of more than two months in the Morelos population with respect to the reference, the study in Brazil,[6] and to Gesell.[28] Although these results can indicate specific peculiarities, a certain population lag should be considered in the acquisition of Gross Motor development during the first year of life, derived from the lack of exposure to the prone position, the freedom of movement, and the frequent use of baby bouncers and strollers which are characteristics specific to the population.[9,16,27]

The item "Runs" showed a considerable delay in comparison with the age referred to by the instrument and for the populations of Trinidad and Tobago[17] and Alaska[5] (6.8, 7.4, and 11.4 months later, respectively. However, Gesell refers to 24 months; 2.3 before the Morelos children.[28] Ontiveros et al., found differences between gender in the items "Crawls" and "Runs", and they concluded that a high socioeconomic level and the stimulation available in the home both favor the early acquisition of motor behaviors.[29]

The items in the *Personal-Social Area* presented later in our study than indicated in the Denver II and in studies in Alaska,[5] Brazil,[6] Trinidad and Tobago,[17] and Singapore.[19] This could be explained by differences in the interest of parents in promoting independence and learning for decision-making at early ages. It has been established that in Mexican families, maternal over-protection and paternal

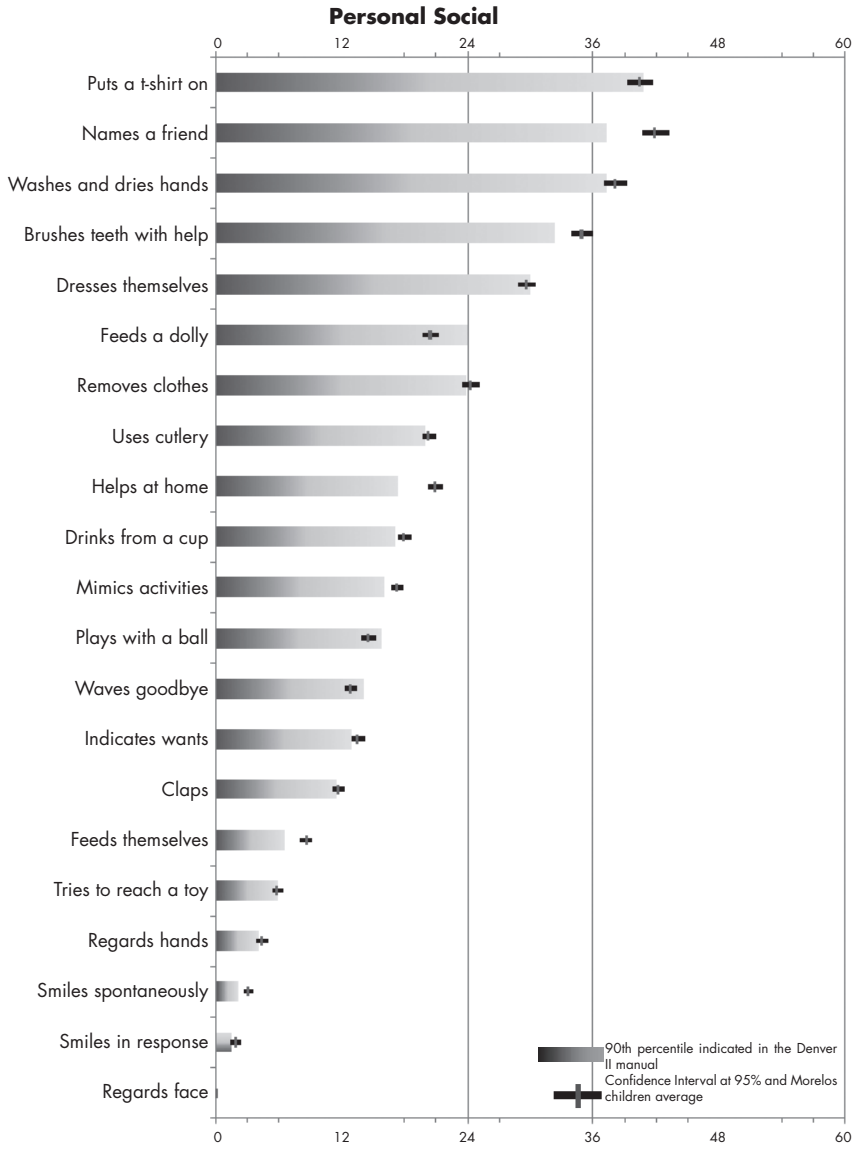

Figure 4. Ages in months that children acquire the items on the Denver II in the area of Personal-Social according to the references in the manual and in the Morelos sample.

authoritarianism are predominant, which limit the child's spontaneous expression.[31] One study reported that in 61% of Hispanic-Mexican families of a low socio-economic status, the parents are warm-hearted and over-protective, tending to restrict autonomy and the individual expressions on children within the family.[32] Consequently, the delay in certain items in the *Personal-Social* area could be related to a lesser disposition of parents to favor structures of socialization, autonomy, and self-care in their children.[2] For example, the items "Helps at home" and "Brushes teeth" were acquired with a delay of 3.6 and 2.9 months in Morelos children, although the literature reports the item "Helps at home" with variations from 15 to 30 months of age.[5,6,8,27,28]

Attending a day-care center with adequate infrastructure and pedagogical methodology contributes to the early development of motor and social skills.[33] The lack in almost the whole sample of these conditions could explain the late presentation of items such as "Name a friend", with a delay of 4.6 months in comparison to the reference, and 10.1 months in comparison with Trinidad and Tobago.[17] However, the populations of Sri Lanka[20] and Singapore[19] reported this item at similar ages to ours (45 and 48 months respectively).

In terms of the *Language Area*, we thought that delayed behaviors predominated and that this would be the area with the least resemblance to the sequence proposed by the Denver II in terms of what was reported in the literature.[34] Less speech development has been described in conditions of poverty and it is one of the areas that is most sensitive to cultural and language characteristics. In our study we found

delays between nine and 16 months of age, but advances predominated, especially after 18 months. Furthermore, in general there were few coincidences in the ages of presentation, but the sequence order was very similar to that proposed by the Denver II. One of the most important delays in respect of that indicated by the Denver II and in the studies in Argentina[8] and Brazil[19] was in the item "Non-specific Mama/Dada", which was reported as present at 9.6 and 10.4 months respectively. In other words, nearly two and three months before Morelos, and one month in respect of the CAT/CLAMS that assesses it at 11 months.[18] In terms of "Specific Mama/Dada", as with our samples, those in Argentina[35] and Sri Lanka[20] presented it between one and two months after the time referred to in the Denver II. In a study carried out in Sri Lanka,[20] the authors found less delay in the areas of *Personal-Social* and *Language*. They supposed that this situation is due to children growing up in extended families and relying on support from other family members, which provides a more stimulating environment than for those who live in nuclear families. This findings were supported by Raikes[36] in a study with Central American children. An additional element that could explain these advances is the changes in the communication with children that have taken place over the last few decades.

In the *Fine Motor Adaptive Area*, the sample showed the lowest proportion of behaviors with delay and the second lowest in number of advances, being the area in which the population showed greatest correspondence with that proposed by the test. However, other authors have described that children do present behaviors in this area late. For example, Wijedesa[20] estimated delays from 10 months of age with more than a month's difference compared to the Denver II.

In terms of the sequences in acquisition, it corresponds to the way in which the items are ordered, independently of whether or not they coincide with the ages indicated in the manual: the Fine Motor-Adaptive and Personal-Social areas were the most similar to that proposed by the Denver II, although Fine Motor-Adaptive deviated towards the right in the timeline by the advances (figure 2 and Personal-Social towards the left (figure 4). The Gross Motor Area, by contrast, had the highest number of variations in the sequence, primarily due to delays in the prone position and the bodily skills in the standing position, and in the Language Area the sequence was modified by advances in behaviors related to expressive and denominative aspects. The changes in sequence comply in an important way with the temporal variation of the acquisition of the items and the functional sequences they come from, which are found to be superimposed on the organization of each area of the Denver Test. Delays or advances in one of these functional sequences modify the organization and global sequence of the area, and the more extensive the time and the number of indicators, the greater the variation in terms of that proposed in the instrument.

Further to the socio-cultural factors that explain some of the variations in the presentation age of the items, environmental factors such as the ambient temperature should also be taken into account. It has been described that hot temperatures lead to the use of light clothing for the child, which favors early freedom of bodily movement.[27,37] However, when the heat is excessive, this causes a reduction in activity in both the child and the parents, which results in less motion experience and exploration of the environment, and as such, less stimulation.[38]

Our investigation adds to others that show the need to have particular parameters for development surveillance. It is limited in that it expresses aspects of development of a sector of the population, and it is necessary to broaden the samples to other socio-economic and geographic sectors. The data offered can later be added to other reports and contribute to an appreciation of something that is normally sidestepped by those who use these tools: that its possibilities change according to age, area of development, and the context in which they are used. However, having tables or graphics generated in the contexts themselves allows us to make adjustments and estimate the precautions that should be taken in order to obtain specific results.

The instruments for screening early development that are most widely used by health and education professionals, including those recommended in official guidelines of Mexico, have not been sufficiently assessed for its prevalent cultural and social contexts. we therefore conclude that the presentation or acquisition ages of the behaviors in the Denver II Test shown by the studied population were not given at the same age and in some cases, in a sequence different to that stipulated from the normalization performed in a sector of the state of Colorado, USA. It should therefore be used with caution in a Mexican population, as it has its own different environmental, cultural, and child-rearing characteristics. The scoring method used by tests such as the Denver II restricts the assessment of a specific number of items for each age, and does not allow achievements from prior ages to be added, which reduces the capacity to absorb population variations in the sequences, as in the case of the sample studied. Because of the above, as well as adjusting the order and time in which the items in the test are available, it is important to propose strategies that do not restrict the assessment of small sections of rigid sequences.[1,21]

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