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Temporal trends in growth of boys adopted from Russia

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ABSTRACT

Introduction: The objective of this study is to contribute data on the temporal trends in weight, height, body mass index (BMI) and head circumference (HC) in boys adopted from Russia.

Material and methods: Prospective observational study on an initial cohort of 139 Russian boys adopted in Spain between 2001 and 2013. Adverse history was collected by reviewing pre-adoption medical records. Anthropometric parameters were measured and recorded in a standardized way. The measurements obtained were compared with the World Health Organization child growth standards, calculating the corresponding z-scores (Z) and percentiles for age and sex.

Results: Main history: preterm (32.4%), low birth weight (26.6%), prenatal alcohol exposure (19.4%), abandonment at birth (56.1%), abuse/neglect (49.3%). Initial post-arrival evaluation, 3 (1.7) years: weight Z, -1.24; height Z, -2.34; HC Z, -1.27. Significant catch-up growth (Z increase) in the first year: weight, +0.73; height, +1.05; HC, +0.6; in the second year: height, +0.58. Longitudinal growth pattern. Weight: from age 5 years, no relevant differences were observed. Height: at age 6 years a relevant delay persisted, from ages 7 to 11 years a gradual increase was observed, and from ages 12 to 17 years a gradual decrease, no showing relevant differences. BMI: showed that the degree of height delay was always higher than that of weight, balancing after age 14 years. HC: at age 5 years, there was no longer a relevant difference.

Conclusions: These findings suggest that, despite the important delay of weight, HC, and especially height at the time of adoption, and the various adverse factors for growth that they presented, international adoption led to a substantial recovery of all anthropometric parameters, showing plasticity in the physical growth of these children.

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Tendencias temporales del crecimiento de niños adoptados de Rusia

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RESUMEN

Introducción: El objetivo de este estudio es aportar datos sobre las tendencias temporales en peso, talla, índice de masa corporal (IMC) y perímetro cefálico (PC) en niños varones adoptados de Rusia.

Material y métodos: Estudio observacional prospectivo sobre una cohorte inicial de 139 niños rusos adoptados en España entre los años 2001-2013. Se recopilaron antecedentes adversos revisando los informes médicos preadoptivos. Los parámetros antropométricos se midieron y registraron estandarizadamente. Las mediciones obtenidas se compararon con los estándares de crecimiento infantil de la Organización Mundial de la Salud, calculando las correspondientes puntuaciones Z (Z) y los percentiles para edad y sexo.

Resultados: Antecedentes principales: pretérmino (32,4%), bajo peso al nacer (26,6%), exposición prenatal al alcohol (19,4%), abandono al nacimiento (56,1%), abuso/negligencia (49,3%). Evaluación inicial post-llegada, 3 (1,7) años: Z peso, -1,24; Z talla, -2,34; Z PC, -1,27. Crecimiento recuperador significativo (incremento Z) en el primer año: peso, +0.73; talla, +1.05; PC, +0.6; en el segundo año: talla, +0.58. Patrón de crecimiento longitudinal. Peso: desde los 5 años de edad no se observaron diferencias relevantes. Talla: a los 6 años de edad persistía retraso relevante, desde los 7 hasta los 11 años se observó aumento paulatino, y desde los 12 hasta los 17 años una disminución gradual, sin mostrar diferencias relevantes. IMC: mostró que el grado de retraso de la talla fue superior al del peso, equilibrándose a partir de los 14 años de edad. PC: a los 5 años de edad no se observó diferencia relevante.

Conclusiones: Estos hallazgos sugieren que, a pesar del importante retraso del peso, PC y especialmente de la talla en el momento de la adopción, y de los diversos factores adversos para el crecimiento que presentaban, la adopción internacional condujo a una recuperación sustancial de todos los parámetros antropométricos, manifestando una plasticidad en el crecimiento físico de estos niños.

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1. INTRODUCTION

Growth is determined by endogenous factors (genetic, epigenetic, metabolic, and neurohormonal) that interact throughout the entire process with a multitude of exogenous factors (food, nutrition, hygiene, medical care, chronic diseases, emotional climate, psychosocial environment, stress, environmental variables, etc.). In such a way that so that the genetic potential of growth is not altered, all factors must function correctly and balanced [1-4].

They have internationally adopted children frequently present factors that can affect growth, highlighting, among others, adverse prenatal exposures (drugs, alcohol, etc.), intrauterine growth retardation, prematurity, perinatal hypoxia, psycho-affective deprivation, abuse and neglect, stress, malnutrition, and micronutrient deficiencies. Furthermore, growth deficiency may be permanent, even if other factors (nutrition, health, psychosocial environment, etc.) improve later [5-8].

Russia has been one of the main countries of origin for

children adopted abroad by Spanish families [9]. Prospective studies on the growth of children adopted from Russia are scarce. They are limited to short-term follow-ups, between 3 weeks and 1 year, evaluating the degree of delay upon arrival in the adoptive country and recovery after adoption [10-13]. To our knowledge, only one study has conducted a 3-year follow-up after adoption [14], with no longer-term prospective studies published. The objective of this study is to contribute data on the temporal trends in weight, height, body mass index (BMI), and head circumference in boys adopted from Russia.

2. MATERIAL AND METHODS

An observational epidemiological study with a longitudinal design was carried out on an initial cohort of 139 Russian boys adopted in Spain between 2001 and 2013, in which growth was monitored in a specialized reference center. All the children resided in orphanages until their adoption. Upon arrival, pre-adoption medical records were reviewed to

collect data on gestational age, birth weight, prenatal alcohol exposure, and reasons for institutionalization. During follow-up, for different reasons, subjects were lost, and two who were diagnosed with fetal alcohol syndrome and one with growth hormone deficiency were excluded. In those adopted after 2006, the follow-up was less than fourteen years.

Weight, height, and head circumference were measured and recorded in a standardized manner in the initial post-arrival evaluation and in the annual follow-up checks, always performed by the same clinician. The technical equipment used consisted of a Seca 708 electronic platform scale (Max 200 kg; d = 0.1 kg) with a built-in stadiometer for height, GC-1104 electronic children's scale (Max 20 kg; d = 10 g), lengthboard Seca (Max 100 cm) for children under 3 years and inextensible millimeter measuring tape. We entered data for the study variables in an Excel spreadsheet, also used to calculate the mean, standard deviation (SD), and body mass index (BMI = kg/m²). The procedures used in the patients were carried out after obtaining the informed consent of the legal guardian. The data were used under Organic Law 3/2018 on the Protection of Personal Data and Guarantee of Digital Rights in force in Spain.

Using the WHO Anthro v3.2.2 (0-5 years) and WHO AnthroPlus v1.0.4 (5-19 years) operating systems [15], we compared the anthropometric measurements obtained in the sample with the World Health Organization (WHO) child growth standards [16]. The corresponding z-scores were calculated, which indicates how many SDs above or below the mean a value is located, and percentiles for age and sex (note: these applications do not calculate the z-score or

percentile of the head circumference from age 5 years or of the weight from age 10 years). A z-score value for any given variable of ± 0.5 SDs or greater to WHO standards was considered as a reference point for anthropometric relevant differences. According to the WHO child growth standards, a z-score of the variable < -2 SD defines severe retardation, and between -1 and -2 SD defines moderate retardation. We defined significant catch-up growth for any given variable as a z-score annual increase of $+0.5$ SDs or greater.

3. RESULTS

The main history of the adopted Russian boys' cohort was born preterm (32.4%), low birth weight (26.6%), documented prenatal alcohol exposure (19.4%), abandonment at birth (56, 1%), and abuse/neglect (49.3%). Table 1 presents the anthropometric measurements obtained in the initial post-arrival evaluation (mean age, 3 years) and during the annual follow-up controls, comparing them with the WHO child growth standards. Figure 1 shows the temporal trends in the height and BMI z-scores using the WHO child growth standards as reference. The main findings are described below.

Weight: in the initial post-arrival evaluation they showed moderate delay (15.1% < -2 SD); in the first year post-adoption, significant catch-up growth was observed (z-score increase, $+0.73$); at age 4 years, relevant delay persisted; from age 5 years, in the longitudinal analysis, no anthropometric relevant differences were observed to WHO standards. Height: in the initial post-arrival evaluation, they

Table 1: Weight, height, body mass index and head circumference in boys adopted from Russia in the initial post-arrival evaluation and during annual follow-up checks. Comparison with the World Health Organization child growth standards

Initial post-arrival evaluation	n	Weight (Kg)			Height (cm)			BMI			Head circumference (cm)		
		Mean \pm SD	Z	PCTL	Mean \pm SD	Z	PCTL	Mean	Z	PCTL	Mean \pm SD	Z	PCTL
Age mean \pm SD													
3 \pm 1.7 years	139	12.35 \pm 3.34	-1.24	10.7	87.43 \pm 12.99	-2.34	1.0	16.2	0.44	67.0	47.66 \pm 2.24	-1.27	10.2
Annual follow-up checks	n	Weight (Kg)			Height (cm)			BMI			Head circumference (cm)		
		Mean \pm SD	Z	PCTL	Mean \pm SD	Z	PCTL	Mean	Z	PCTL	Mean \pm SD	Z	PCTL
Mean age/follow-up													
4 years/+1 year	139	15.33 \pm 3.66	-0.51	30.5	97.95 \pm 11.66	-1.29	9.9	16.0	0.50	69.1	49.23 \pm 1.76	-0.67	25.1
5 years/+2 years	131	17.92 \pm 4.86	-0.17	43.2	106.68 \pm 11.21	-0.71	23.8	15.7	0.41	65.8	50.15 \pm 1.77	-0.39	34.7
6 years/+3 years	123	20.22 \pm 5.26	-0.11	45.7	113.34 \pm 11.56	-0.53	29.8	15.7	0.32	62.5	50.73 \pm 1.76		
7 years/+4 years	103	23.14 \pm 6.61	0.08	53.1	120.23 \pm 11.54	-0.29	38.8	16.0	0.36	64.1	51.21 \pm 1.71		
8 years/+5 years	97	26.15 \pm 6.68	0.19	57.7	127.30 \pm 11.82	0.00	50.1	16.1	0.26	60.2	51.73 \pm 1.50		
9 years/+6 years	94	29.70 \pm 8.12	0.35	63.8	132.74 \pm 11.97	0.03	51.1	16.9	0.47	68.1	52.26 \pm 1.57		
10 years/+7 years	77	33.57 \pm 9.96	0.45	67.2	138.09 \pm 12.59	0.05	51.9	17.6	0.61	72.9	52.78 \pm 1.69		
11 years/+8 years	63	37.89 \pm 11.80			144.92 \pm 13.80	0.27	60.6	18.0	0.54	70.5	53.21 \pm 1.94		
12 years/+9 years	58	41.91 \pm 11.86			150.30 \pm 12.02	0.17	56.7	18.5	0.46	67.9	53.57 \pm 2.10		
13 years/+10 years	54	44.76 \pm 12.20			154.87 \pm 10.99	-0.16	43.6	18.7	0.19	57.6	53.81 \pm 2.15		
14 years/+11 years	50	47.12 \pm 8.86			160.68 \pm 9.07	-0.33	37.2	18.3	-0.34	36.6	54.14 \pm 2.10		
15 years/+12 years	45	51.42 \pm 8.26			166.10 \pm 7.11	-0.37	34.5	18.6	-0.50	30.9	54.62 \pm 1.99		
16 years/+13 years	36	55.36 \pm 10.12			169.97 \pm 7.27	-0.38	35.3	19.2	-0.56	28.8	54.97 \pm 2.12		
17 years/+14 years	28	59.20 \pm 9.24			172.40 \pm 5.57	-0.36	35.9	19.9	-0.49	31.3	55.06 \pm 2.10		

n: number; BMI: body mass index; SD: standard deviation; Z: z-score; PCTL: percentile.



Figure 1: Height and body mass index (BMI) z-scores in boys adopted from Russia over a 14-year period. Comparison with the World Health Organization child growth standards.

showed severe delay ($47.5\% < -2$ SD). In the first and second year post-adoption, significant catch-up growth was observed (z-score increase, $+1.05$ and $+0.58$, respectively); at age 6 years, relevant delay persisted; in the longitudinal analysis, from ages 7 to 11 years a gradual increase was observed, and from ages 12 to 17 years a gradual decrease, no showing anthropometric relevant differences to WHO standards. BMI: the longitudinal analysis showed that the degree of height delay was always greater than that of weight, balancing after age 14 years. Head circumference: in the initial post-arrival evaluation they showed moderate delay ($7.2\% < -2$ SD); in the first year post-adoption, significant catch-up growth was observed (z-score increase, $+0.6$); at age 5 years, no anthropometric relevant difference was observed to WHO standards.

4. DISCUSSION

Measurements of weight, height, and head circumference are a simple method of assessing growth, providing a useful index of child health and development [16]. Furthermore, the measurement of head circumference is directly related to brain size, with its development during early childhood

being a key determinant of later cognition, learning, and behavior [17].

Russia is a very large country in which genetic growth potential can vary between different geographic regions and socioeconomic environments. Martinchik et al. [18] compared the mean values of weight, height, and BMI of the Russian child population with the WHO child growth standards. Analysis of z-score values of the anthropometric parameters showed that the most relevant difference was the high positive mean values of BMI z-score in the age of 0-6 years. They concluded that the use of WHO standards could be recommended for assessing the growth and nutrition of children in Russia.

Growth delay at the time of adoption is a common finding in children adopted from Russia. Observational studies indicate that the cause is probably related to late adoption and adverse pre-adoption factors, primarily prenatal alcohol exposure, prematurity, low birth weight, psycho-affective deprivation, stress, and malnutrition. [9-14]. The drastic change that occurs after adoption means that they generally experience significant catch-up growth [10, 11, 13, 14] but this can lead to an acceleration of pubertal development [8, 19] and an increased risk of developing puberty precocious

[20]. The pathophysiological mechanisms are unclear and possibly involve various endogenous and exogenous factors [21].

In adopted Russian children, regression analysis studies [10, 12, 13] and a meta-analysis study [22], have determined that prenatal alcohol exposure, low birth weight, a higher degree of malnutrition at the time of adoption, and late adoption, are independent predictors of greater delay in height and head circumference in the initial evaluation after adoption. In addition, that early adoption, a greater degree of initial growth retardation, and greater caloric intake after adoption are associated with better and more complete catch-up growth.

In the studied cohort of adopted Russian boys, the prevalence of prematurity, low birth weight, and initial malnutrition was 8, 5, and 7 times higher, respectively, than in the general Russian child population [23]. The prevalence of documented prenatal alcohol exposure was 2 times lower than that observed in institutionalized Russian children [24]. The prevalence of fetal alcohol syndrome was 7 and 5 times lower, respectively, than that observed in institutionalized [25] or adopted Russian children [12]. Finally, the mean age at adoption was 2 times later than that observed in other studies of Russian adopted children [12-14].

Regarding the growth pattern of the adopted Russian boys' cohort, in the initial evaluation after adoption, moderate delay in weight and head circumference, and severe delay in height, were observed. Compared with observations by other researchers [12, 14], the mean value of the weight z-score was similar, the mean value of the height z-score was 2 times lower, and the mean value of the head circumference z-score was intermediate. According to other researchers [10-14, 22], it is likely that the interaction of adverse factors (prematurity, prenatal alcohol exposure, low birth weight, abuse and neglect, initial malnutrition, and late adoption), observed with frequency in this cohort of adopted Russian boys, explain the severe delay in height and moderate delay in head circumference at the time of adoption.

In the first year after adoption, significant recovery growth in weight, height, and head circumference was observed. In the second year, recovery growth was observed in all anthropometric parameters, although it was only significant for height. In the third year after adoption, they no longer presented relevant delays in weight and head circumference, and in the fourth, neither in height. These findings were similar to those observed by other researchers [10, 11, 13, 14, 22], although the recovery of height was later probably due to its greater delay at the time of adoption.

During the longitudinal analysis, the BMI z-score showed that the degree of delay in height was always greater than

that of weight, balancing after age 14 years; the height z-score showed a gradual increase from age 7 to 11 years, and a gradual decrease from age 12 to 17 years, no showing relevant differences to WHO standards. During the study period, despite the rapid, intense, and prolonged catch-up growth, no child developed precocious puberty.

5. CONCLUSIONS

In the cohort of boys adopted from Russia, these findings suggest that, despite the important delay in height, weight, and head circumference at the time of adoption, and the various factors adverse to growth, international adoption led to a substantial recovery of all anthropometric parameters, manifesting plasticity in the physical growth of these children.

6. CONFLICT OF INTERESTS

The authors have no conflict of interest to declare. The authors declared that this study has received no financial support.

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