Analysis of the prevalence of scoliosis and associated factors in a population of mexican schoolchildren using sifting techniques

Félix Zurita Ortega[1], Luis Ruiz Rodríguez[2], Lorena Zaleta Morales[3], Manuel Fernández Sánchez[4], Rubén Fernández García[4] and Marta Linares Manrique[5]*

[1]Corporal Area, Universidad de Granada, Granada, España; [2]Experimental Area, Universidad de Granada, Granada, España; [3]Health Sciences Area, Universidad de Ciudad del Carmen, Cd. Del Carmen, Campeche, Camp., Mexico; [4]Physiotherapy Area, Universidad de Almería, Almería, España; [5]Universidad de Granada, Granada, España

Abstract

Rationale: *Over the last decade, spinal disorders have been increasing in the children population, and the high concerns produced by this in healthcare and educational areas has been driving the development of preventive strategies to help stopping this trend. This work is intended to take one more step in this direction and to explore factors associated with the presence of scoliosis hump, in order to contribute to a better approach to the treatment and prevention of this condition in Mexican schoolchildren. The purposes of the study were to analyze the prevalence of scoliosis, types of posture, laterality, obesity, onset of development and plantar deformity in schoolchildren aged 9-12 years from Ciudad del Carmen (Mexico), and to establish possible relationships of these factors with the presence of scoliosis hump.* **Methods:** *The sample consisted of 295 Mexican schoolchildren, with a mean age of 10.36 years (standard deviation [SD]: 1.142), who were analyzed in 2012; they were assessed using Adams test, Kendall's postural classification, body mass index (BMI), the Edinburgh inventory, sitting height measure and a plantogram. Data were analyzed using the SPSS 20.0 software.* **Results:** *There were 42 (14.2%) subjects who were found to have scoliosis; improper posture was identified in 123 (41.7%) cases; 158 (53.5%) subjects were obese, 63.7% had not started maturational development, and most were right-handed and had a normal foot type. After the binary logistic regression analysis, the factors with significant level of association with the presence of scoliosis hump were posture (Exp [B]: 5.569 [2.746-11.757]), type of foot (Exp [B]: 0.0151 [0.033-0.652]) and age (Exp [B]: 0.242 [0.192-0.877]).* **Conclusions:** *The prevalence of scoliosis among schoolchildren was similar to that found in other parts of the world. Half the schoolchildren had data indicating obesity and four out of ten students had abnormal posture. Furthermore, the model suggested that subjects with correct posture were five times less likely to develop scoliosis hump, that schoolchildren with normal feet were 14% less likely to have scoliosis and that the risk for developing it increased with age.* (Gac Med Mex. 2014;150:430-6)

Corresponding author: *Félix Zurita Ortega, felixzo@ugr.es; dlinares@ugr.es*

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Introduction

In the school health setting, knowledge on the vertebral spine, the back or spinal deformities is a highly current topic, as reflected by numerous studies that suggest on the importance of preventing and acting upon the onset of different conditions at early ages[1-3]. Scoliosis is a deformity that alters the vertebral spine in a three-dimensional fashion, with the hump being a consequence of vertebral rotation. Such deformities can affect the individual at any stage of life, from the neonatal period, as in congenital scoliosis, to adulthood. Most cases occur initially in childhood and adolescence, and usually evolve asymptomatically[4,5], with this being the moment when they still can be corrected.

Correspondence:
*Félix Zurita Ortega
Facultad de Ciencias de la Educación
Campus de Cartuja, s/n
C.P. 18071, Granada, España
E-mail: felixzo@ugr.es
dlinares@ugr.es

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With regard to the convenience of implementing early detection programs for these disorders, Fernández-Sánchez[5] indicates that organizations such as the American Academy of Pediatrics (AAP), the American Association of Pediatric Surgeons (AAOS) in 2006 or the Scoliosis Research Society (SRS) in 2006 proposed performing yearly explorations in schoolchildren aged between 8 and 14 years, regardless of gender, using the Adams test[4]. In spite of all these indications, the optimal age to perform scoliosis screening studies is currently a subject of debate in numerous forums[6,7].

The presence of scoliosis has been studied in numerous occasions, associated with other factors such as gender, age, posture, obesity and nutritional effects[5,8,9], onset of maturational development[10], laterality[11], or plantar deformity[12]. In this sense, in a population of schoolchildren, undergoing several physiological and anatomical changes, it becomes necessary knowing which factors interact directly in order to tackle and prevent possible spinal-type abnormalities that might occur in later years. Studies conducted on the relationship between scoliosis and the series of previously mentioned parameters are scarce. We must not obviate that physical education teachers, school doctors and physiotherapists are primary responsible on how to perform screenings and early detection of any abnormality, as well as on how to proceed upon its presence.

This work is intended to take a further step and look more concretely into the relationship of the presence of scoliosis hump with other parameters, individually or in combination, in Mexican scoolchildren.

The specific objectives of this work are to analyze the prevalence of scoliosis, posture, laterality, obesity, onset of development and plantar deformity in schoolchildren aged 9-12 years from Ciudad del Carmen (Mexico), and to determine the risk of developing scoliosis hump according to socio-demographic, postural, obesity, lateral dominance, growth and plantar parameters.

Subjects and method

Design and participants

This was an observational, descriptive, cross-sectional study. A total of 295 schoolchildren aged from 9 to 12 years (Mean [X]: 10.36 years; Standard Deviation [SD]: 1.142) from two schools of Ciudad del Carmen (Mexico) took part in this study; there were 169 (57.3%) female participants and 126 (42.7%) male students. The sample selection was made using a one-stage random sampling by clusters, with the children (from 9 to 12 years of age) being considered as a sampling unit, and with a sample error of 0.05 over the entire schoolchildren population of Ciudad del Carmen.

Measuring instruments

Several validated instruments were used to assess the different analyzed parameters:

- Adams test: is the most widely employed maneuver for the detection of scoliosis in non-clinical settings, since it is a simple, inexpensive and non-invasive test, able to differentiate between scoliotic attitude and structured scoliosis as well. For its application, the examiner sits behind the child, who is in the standing position, asks him for a 50-60º flexion of the trunk and looks for an increase of the relief lateral to the spinal axis; if so, the test is identified as being positive (presence of scoliosis hump) and if, conversely, no relief is observed, the test is defined as negative or "absence of scoliosis"[4,13-15].
- Kendall Posture: to assess the posture, the classification proposed by Kendall et al.[16] in 1985 was used. This classification established 5 types of posture based on exploration of the sagital plane: ideal, swayback, kypholordotic, flatback and lordotic posture. In our study, participants were classified as having an ideal posture or an incorrect posture. The used instrument was the plumb line test: with the individual in the standing position, with the back naked, the examiner stands on the side to detect the swayback category and behind the subject to explore the remaining types of posture (ideal, kypholordotic, flatback and lordotic). Afterwards, the correspondent kyphotic and lordotic index was applied.
- Body mass index: to determine the obesity indices, the BMI value was calculated and checked against the tables of the en-Kid study[17-19]; initially, 4 categories were established: low weight, normal weight, overweight and obesity, but in the subsequent analysis, they were reduced to two: overweight and non-overweight.
- Sitting height measure: the pubertal development onset was assessed using the sitting height measure, by having the child seated on a chair with a known height, the head on the Frankfurt plane, the trunk straight, making a 90º angle with the thighs, and these, in turn, making a 90º angle with the knees. The measurement of this variable is expressed in centimeters and is performed taking

as 0 the surface of the chair they are sitting on; for that, the height of the chair has to be substracted from the final reading[20]. The assessment of this test consists in determining the onset of the subject's development taking into account that, in boys, puberty starts from 78 cm on in the sitting position, and in girls, from 75 cm on[10,21].

- Edinburgh inventory: in order to establish hand laterality, the Edinburgh inventory, employed by Oldfield[22] and modified by Bryden[23], was applied. This instrument assesses hand preferences with 10 items and, after establishing the corresponding summations[5], two categories are determined: right-handed and left-handed.
- Plantogram: this test, described by Hernández-Corvo[24] and used by authors such as Zurita et al.[12] (2007), is performed to establish the type of foot. The subject is placed on the podoscope and his foot print is analyzed. The foot is classified in 3 categories (normal, valgus and varus), but we established two: normal foot and pathological foot.

Procedure

Collaboration was asked from sampling-wise selected schools to participate in the research through the Ciudad del Carmen University (Mexico) and the Granada University (Spain), which sent a letter to each one of the schools, briefly explaining the purpose of the study and asking for their collaboration; an authorization model was attached for the children's legal guardians asking for their informed consent to, in this way, together with the protocol approved by the University's Ethics Committee, establish the ethical parameters required by the 1975 Declaration of Helsinki on the handling of underaged persons data. The performance of the tests was carried out during the months of September and October 2012, following the steps of the implementation protocol, and stakeholders were informed on the complete anonymity of answers and data. The investigators (physicians, physiotherapists and physical education teachers) were present during the data collection to confirm the correct execution of the measurements or tests. The collection was carried out without any type of abnormalities and, once concluded, the pupils returned to their class routine. At the end, the people responsible were thanked for their collaboration, and were informed on the future reception of the report on the results obtained at the end of the study.

Statistical analysis

It was conducted using the SPSS 20.0 for Windows. The participation index was 95.46%, with a total of 14 invalidated questionnaires for not attending on the data collection day or for not having performed the tests correctly. The techniques used for the data analysis were primarily of the descriptive type by determination of frequencies. To test to what extent the presence of scoliosis or not was conditioned by the rest of the analyzed variables, and taking into account that all variables were categorical (non-parametric), a binomial logistic regression analysis was used. The introduction of variables was done manually, with the significance criterion obtained in previous bivariate analyses by means of contingency tables. The goodness of fit of the model was verified using the Hosmer-Lemeshow test.

Results

Forty-two (14.2%) participants were detected as having a positive Adams test (presence of scoliosis). Schoolchildren with an incorrect posture according to Kendall's method were 123 (41.7%). There were 158 (53.5%) subjects with obesity levels. Hundred and eighty-eight children (63.7%) were found not to have started their maturational development; most participants were right-handed (84.4%; n = 249) and practically all (74.2%; n = 219) had normal-type feet (Table 1).

Table 2 shows the relationships between all variables under study, where scoliosis was found to have significant differences ($p < 0.05$) associated with sex, posture and foot type. For age, a Student's t-test was used ($t = 4.275$; $p < 0.01$), which also revealed significant differences between age groups.

The Hosmer-Lemeshow test, as an estimate of the model's goodness of fit that analyzes differences between observed and predicted values, showed a $p = 0.796$; i.e., there were no statistically significant differences and, therefore, the model predicted appropriately. In the table of coefficients (Table 3) for the different developmental variables of the model, we observe that the only factors that were significant, in order of importance, were: posture, age and foot type.

If we select the automatic variable entry option, the results were those shown in table 4.

Finally, it should be noted that associations were found ($p > 0.05$ in the adjusted regression model) between scoliosis and posture (Exp [B]: 5.569 [2.746-11.757]), foot type Exp [B]: 0.0151 [0.033-0.652]) and age Exp [B]: 0.242 [0.192-0.877]), as shown in table 5.

Table 1. Descriptive analysis of the study variables

Descriptive	
Scoliosis	
– Absence	42 (14.2%)
– Presence	253 (85.8%)
Posture	
– Ideal posture	172 (58.3%)
– Incorrect posture	50 (16.9%)
	23 (7.8%)
	39 (13.2%)
	11 (3.7%)
BMI	
– Without obesity	9 (3.1%)
	128 (43.4%)
– With obesity	57 (19.3%)
	101 (34.2%)
Onset of development	
– With development	107 (36.3%)
– Without development	188 (63.7%)
Hand laterality	
– Right-handed	249 (84.4%)
– Left-handed	46 (15.6%)
Foot type	
– Normal	219 (74.2%)
– Pathological foot	24 (8.1%)
	52 (17.6%)

Discussion

In this study, similar to those conducted in other children populations[25-28], scoliotic posture or positive Adams maneuver figures were found to be similar to those in other pupulations of the world[28-30]. It should be taken into account that in many studies on scoliosis using screening techniques almost 40% of the subjects classified as being positive do not display any abnormality when subjected to thorough radiologic and orthopedic testing[4].

As for the posture, more than half the participants were found to have an ideal posture, a figure that was similar to that indicated by Aragunde et al.[31]. The literature refers that body posture is a problem that requires more attention and education[32,33], and that it affects and is determined by factors such as personality, mental attitude, occupation, postural habits, genetics, clothing, age, nutrition, health status, physical activity and socio-cultural models[34-35]; Yuing et al.[36] even refer that postural-type abnormalities produce serious complications at the musculoskeletal and joint level in adulthood.

In the Ciudad del Carmen population, more than half the children had obesity indices. This data is increased with respect to other studies conducted in similar populations worldwide[37-40]; however, there are studies performed in Mexico that offer similar figures, such as the study by Bojórquez et al.[41]; with 50% obesity in his Mexican schoolchildren population. This suggests that urgent measures have to be taken in order to palliate such elevated values currently found in the country, since in adut populations, the obesity index can even be as high as 80%[42].

Most participants of the analyzed sample had not reached the onset of their maturational development, which confirms what numerous scientists propose, who place the onset of maturational development at between 10 and 14 years of age[10,43,44].

Most participants were right-handed (values were identical to those found in other studies[45-47]) and three quarters of the schoolchildren had feet considered to be normal, the same as in other studies[48,48], which places the Ciudad del Carmen population in similar levels to those observed in other places.

The study reported statistically significant differences ($p < 0.05$) between scoliotic posture and sex, age, posture and foot type. Female participants showed higher positive Adams maneuver indices than males, which is consistent with different studies that indicate that most curvatures higher than 20°(on scoliosis) occur in girls and with a lower proportion in boys[5,50-55], and is also consistent with figures proposed by Rosales et al.[56] for Mexico.

There was also an association between the finding of positive hump in the Adams test and age, data that are consistent with those published by Franco et al.[52] and Álvarez et al.[3], who suggest that this scoliotic posture process makes its appearance in the middle or by the end of the childhood period, and is increased upon the arrival of puberty, over the age of 12 years; they also suggest that there is a similar relationship of the patients' sex with thoracic scoliosis, and that in most of them, scoliosis is detected after 10 years of age[57].

With regard to the type of posture and the presence or absence of lateral deviation of the spine, a number of differences were found to exist, driven by the fact that the presence of scoliosis is equal or higher in the four types of abnormal posture, whereas in ideal posture, absence of this deformity is predominant.

According to the data, among the subjects with positive hump according to Adams maneuver, almost no case was found to occur in participants with pathological

Table 2. Relationships between the scoliosis variable and the remaining parameters

Variables		Scoliosis		
		Absence	Presence	Sign.
Sex				
– Female	Count	135	34	0.001
	Scoliosis	54.7%	70.8%	
– Male	Count	112	14	
	Scoliosis	45.3%	29.2%	
Age				
– Less than 10 years	Count	118	36	0.001
	Scoliosis	47.8%	75.0%	
– More than or equal to 10 years	Count	129	12	
	Scoliosis	52.2%	25.0%	
Posture				
– Ideal posture	Count	160	12	0.000
	Scoliosis	64.8%	25.0%	
– Incorrect posture	Count	87	36	
	Scoliosis	35.2%	75.0%	
BMI				
– Without obesity	Count	111	26	0.241
	Scoliosis	44.9%	54.2%	
– With obesity	Count	136	22	
	Scoliosis	55.1%	45.8%	
Onset of development				
– With development	Count	91	16	0.644
	Scoliosis	36.8%	33.3%	
– Without development	Count	156	32	
	Scoliosis	63.2%	66.7%	
Hand laterality				
– Right-handed	Count	207	42	0.519
	Scoliosis	83.8%	87.5%	
– Left-handed	Count	40	6	
	Scoliosis	16.2%	12.5%	
Foot type				
– Normal	Count	173	46	0.000
	Scoliosis	70.0%	96.8%	
– Pathological foot	Count	74	2	
	Scoliosis	30.0%	4.2%	

Table 3. Table of coefficients

	B	E.T.	Wald	gl	Sig.	Exp (B)	95% CI for Exp (B)	
							Lower	Upper
Sex	–0.234	0.408	0.328	1	0.567	0.791	0.355	1.762
Laterality	–0.602	0.515	1.366	1	0.243	0.548	0.199	1.504
Onset of development	0.843	0.510	2.728	1	0.099	2.324	0.854	6.320
Posture	1.829	0.385	22.531	1	0.000	6.226	2.926	13.247
Feet	–1.888	0.772	5.984	1	0.014	0.151	0.033	0.687
Age	–1.421	0.507	7.866	1	0.005	0.242	0.090	0.652
Constant	–1.991	0.396	25.346	1	0.000	0.137		

Table 4. Regression model and Hosmer-Lemeshow test

Step	–2 log of verisimilitude	Cox and Snell square R	Nagelkerke square R	Hosmer-Lemeshow test		
				χ^2	gl	Sig.
1	235.761*	0.085	0.145	0.000	0	
2	218.340†	0.138	0.234	0.692	2	0.708
3	212.672†	0.154	0.262	10.436	5	0.920

*Estimation has ended in iteration number 5 because estimates for the parameters have changed by less than 0.001.
†Estimation has ended in iteration number 6 because estimates for the parameters have changed by less than 0.001.

Table 5. Variables of the four-step model

		B	E.T.	Wald	gl	Sig.	Exp (B)	95% CI for Exp (B)	
								Lower	Upper
Step 1[a]	Posture	1.708	0.359	22.637	1	0.000	5.517	2.730	11.150
	Constant	–2.590	0.299	74.897	1	0.000	0.075		
Step 2[b]	Posture	1.717	0.367	21.935	1	0.000	5.569	2.714	11.424
	Feet	–2.301	0.744	9.550	1	0.002	0.100	0.023	0.431
	Constant	–2.279	0.304	56.106	1	0.000	0.102		
Step 3[c]	Posture	1.737	0.371	21.925	1	0.012	0.147	0.033	0.652
	Feet	–1.920	0.762	6.357	1	0.012	0.147	0.033	0.652
	Age	–0.892	0.388	5.281	1	0.022	0.410	0.192	0.877
	Constant	–2.006	0.319	39.473	1	0.000	0.135		

foot (varus or valgus), similar data to those detected in the study with Mexican adolescents by Nájera et al.[49], which indicate scarce association of foot abnormalities with spinal problems. Conversely, our results are opposed to those published by Machado et al.[58], who report that vertebral spine lesions are associated with legs and feet, since the postural balance that allows for the body to be mantained in a standing position is based on a series of factors ranging from the inferior members to the head, and if one of these is altered, this impacts on the entire organism and they even suggest that although idiopathic scoliosis is one of the most common deformities in adolescence, it is associated with signs of feet deformity.

Finally, with regard to the logistic regression analysis, the Hosmer-Lemeshow test, as an estimate of the goodnes of the model that analyzes differences between observed and predicted values, indicated the non-existence of statistically significant differences and, therefore, the model predicted adequatelly in the third step, where it reached a p-value of 0.920. During the development of the model, only the significant variables were chosen and, in order of importance, these were: posture, age and foot type, thus establishing that children with a correct posture were five times less likely to develop scoliotic hump. Similarly, the model revealed that schoolchildren with normal feet were 14% less likely to have scoliosis and that being older than 10 years increased by 41% the possibility of having scoliotic curvatire.

From the point of view of practical application, this work presents a simple method for the detection of possible spinal-type deformities, applicable to school aged samples; furthermore, it serves as an indicator to guide the execution of strategies and interventions oriented to prevent the development of scoliosis hump, and reports information on factors that may be causing this abnormality to appear and at which rates.

In the development of this strategy, we have detected some limitations, such as not having used any confirmatory instrument for possible positive cases that would have further complemented the technique we used and, therefore, we recommend that detected participants with humps should visit their pediatrician in order to confirm the diagnosis and to take appropriate measures for their recovery.

The main conclusions of the conducted research were:

- Approximately one of each 10 schoolchildren aged between 9 and 12 tested positive in the Adams test (scoliosis hump) in the Ciudad del Carmen (Mexico) population.
- According to the obtained data, having a correct posture entails lower probability of developing scoliosis hump.

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