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ORIGINAL PAPER

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The factors discriminating the results of screening test aimed at detection of scoliosis and detection of flexibility disorders in group of preterm children at the beginning of school age

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ABSTRACT

Introduction. The threshold of compulsory schooling for prematurely born children is of particular importance. It's a period of intense physical development which may increase the risk of scoliosis.

Aim. The aim of this research is to determine whether age, gender, BMI value and selected elements of perinatal interview discriminate the results of screening test aimed at detection of scoliosis and flexibility disorders in group of preterm children at the beginning of school age.

Material and methods. The study population consisted of 61 preterm children aged 5-8 years. The study included perinatal interview, BMI assessment, screening tests to detect scoliosis and flexibility.

Results. Statistically significant dependence was obtained between age and normal and abnormal results of the screening test aimed at detection of scoliosis and between the result of the screening test for detecting flexibility disorders and: age, number of foetuses, assessment on the Apgar scale.

Conclusion. The results of screening test aimed at occurrence of scoliosis in group of preterm children are significantly correlated with the age and screening test aimed at occurrence of the flexibility disorders are discriminated by age, origin from mono- or multi-foetus pregnancy and assessment on the Apgar scale.

Keywords. development of premature babies, health balance, prematurity, school readiness

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Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

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Introduction

Children who are born between 22nd and 37th week of pregnancy are considered prematurely born.[1] In Poland, as well as other developed countries, the rate of premature labours is 6,3%.[2-4] Because of the amount and diversity of medical problems polish premature children are under a coordinated multi-specialized care during the first 36 months of their lives.[5] Own experience has shown this period is too short and the authors call for extension until the premature children reach school readiness.

School readiness is a functional term and is assessed during a year-long compulsory preschool preparation (class 0) or the first term of 1st class of primary school, right at the start of fulfilling schooling obligation. Health schooling maturity is defined as a balance achieved between schooling requirements and physical, intellectual and socio-emotional development. A group of children being assessed for school readiness might present a diversified age composition. According to a schooling reform carried out between 2015 and 2016 in Poland 5 and 6 year olds attended class 0 and 6 and 7 year olds attended 1st class. The tool which is used to assess school maturity is a specifically designed check-up protocol. One of the elements of the examination is a screening testing for scoliosis and suppleness.

Scoliosis is a three-dimensional spine deformation of a various etiology. Untreated leads to reduced suppleness, deformation and decreased chest movement, has a negative impact on circulatory and pulmonary systems thereby affecting the entire body.[7] Idiopathic scoliosis (of unknown origin) is the kind being diagnosed the most (80% of cases). Its diagnosed in 2-3% of children and adolescent populations. Idiopathic scoliosis occurs in the periods of accelerated length growth of axial skeleton: between 6th and 24th months old, 5 and 8 years old (early school growth spurt), 10 and 14 years old (pubertal growth spurt).[8] The early school growth spurt overlaps with the period of achieving the school maturity.

Performing a screening test for scoliosis and suppleness disorders during ordinary check-ups is necessary as most scolioses' onset is undefinable. Despite being criticised as fragmentary and for its inaccurate record keeping which prevents comparisons between consecutive check-ups, it has its use in medical practice, paediatrics and merely serves determining the symptoms indicative of scoliosis (1st and 2nd stage). It provides an introduction to detailed diagnosis based on instrumental method.[9-11] Radiological review is performed with an x-ray picture of the spine in posteroanterior projection. A change in Cobb's angle (the angle of lateral spinal curvature) during a year is used as a measurement of scoliosis' progression. The risk of further progression decreases as the skeleton develops. The assessment of skeleton's development is made with Risser test.[12] It's worth remembering that idiopathic scoliosis can present itself in patients of all ages.

Researchers investigated the connection between the age, gender, perinatal factors and the results of screening tests for scoliosis and suppleness disorders in prematurely born children who are starting school.

Aim

The aim of the paper is twofold. Firstly, to determine if age, gender, BMI, perinatal factors differentiate the results of screening tests for scoliosis in prematurely born children at the start of school. Secondly, to determine if age, gender, BMI, perinatal factors differentiate the results of screening tests for suppleness disorders in prematurely born children at the start of school.

Material and methods

The studied group consisted of 61 children aged between 5 and 8 born prematurely (x=6,38 years, Me=6 years, s=0,73). The group was functionally uniform - all children were starting school. High age spread derives from some children starting school a year earlier as well as children whose schooling obligation was postponed by a year. Girls consisted 52% (32 children) and boys 48% (29 children) of the group.

The study has been approved by the Bioethical Committee of Medical Faculty of University of Rzeszów (first act: 7th Dec. 2012, last 6th of Feb. 2017). The study was conducted between 2015 and 2016 at the Physiotherapy Institute and the Innovative Anthropometric Methods Laboratory of the Center of Innovative Nature-Medical Studies at the University of Rzeszów.

The study was conducted according to the check-up protocol and performed as per generally accepted rules and standard of conduct as described by well-child care covered by the compulsory pre-school preparation.[6] Medical history of perinatal period was gathered (subsequent pregnancy, labour date, foetus count, delivery method, birthweight, Apgar score) (table 1 A-F). An aggregated number (sum) of detrimental events in the perinatal period was established i.e. occurrence of one of the listed events equals 1 point: respiratory failure, respiratory distress syndrome, bronchopulmonary dysplasia, congenital pneumonia, acquired pneumonia, pulmonary emphysema, ventilation therapy (cmv, imv), infant flow, passive oxygen therapy, hyperbilirubinaemia, anemia, thrombocytopenia, leucopenia, bleeding from digestive/respiratory system/tamponade, serological conflict in major groups, blood or hemocompatible agent transfusion, exchange transfusion, hypoxic ischaemic encephalopathy, evidence of periventricular leukomalacia, I-IV grade stroke, epilepsy, seizures different than epilepsy, apnea, retrolental fibroplasia, patent ductus arteriosus/circulatory failure, TORCH infections, other intrauterine infections, sepsis, purulent meningitis, encephalitis, bacterial gastroenteritis, urinary infections, perinatal necrotizing enterocolitis, gastroesophageal reflux, hypoglycemia, hypocalcemia, osteopenia of prematurity, intravenously administered drugs, parenteral nutrition, tube feeding, procedures under general anesthesia.

Table 1. Baseline characteristics of the group of premature children entering school readiness age

Perinatal history		
A. Birth order	**N**	**%**
First pregnancy	31	51
Second pregnancy	15	25
Third pregnancy	5	8
Fourth pregnancy	5	8
Fifth pregnancy	2	3
Sixth pregnancy	3	5
B. Foetus count	**N**	**%**
Single pregnancy	39	64
Twin pregnancy	13	21
Triple pregnancy	9	15
C. Delivery week	**N**	**%**
24	2	3
25	0	0
26	4	7
27	6	10
28	8	13
29	1	2
30	10	16
31	5	8
32	23	38
33	0	0
34	1	2
35	1	2
D. Type of delivery	**N**	**%**
Natural	10	16
C-section	51	84
E. Apgar evaluation [points]	**N**	**%**
0-3	9	15
4-7	39	64
8-10	13	21
F. Birth weight [g]	**N**	**%**
below 750	3	5
750 - 1000	10	16
1000 – 1500	21	34
1500 - 2500	26	43
above 2500	1	2

Basic anthropometric measurements have been taken. The measuring technique was based on methods utilized in international anthropological research. The following anthropometric characteristics were taken into account: weight (w) and height (h). Instruments used: medical scale (kg), anthropometer (cm). Quetelet II weight-height ratio was calculated (kg/m^2 WQ2, Body Mass Index, BMI). A screening test for scoliosis was conducted with the following criteria: child standing upright, examined from behind: long spinal axis is straight, a plumb hung from the centre of occipital protuberance aims at gluteal cleft, shoulders and shoulder blades on the same height, waist triangles symmetrical, lower limbs the same length, the child during Adams test examined from behind: rib hump absent, muscular prominence in the lumbar area absent. When this criteria were not met the result was considered positive. Next a screening test for suppleness disorder was conducted. A negative result was achieved when a child performing a forward bend test was able to reach the floor with fingertips. When this criteria were not met the result was considered positive

Statistical analysis

The data was analysed statistically. A relation between age, gender, BMI, perinatal factors and correct/incorrect screening test results for scoliosis and suppleness disorders was analysed based on statistical methods. A nonparametric Mann-Whitney U test was used to assess the differences in measurable characteristics of independent variables among two populations. Variables presenting qualitative characteristics were analysed with Pearson's chi-squared test. $p<0,05$ was assumed as statistically significant level.

Results

Based on perinatal history it was established that the children were born from pregnancies of different order (table 1A), foetus count (table 1B), delivered prematurely (table 1C), naturally or by C-section (table 1D), in various general condition and birth weight (table 1F). In the perinatal period premature children were encumbered with numerous adverse perinatal events (table 2A). A screening test for scoliosis presented negative results in 54% of children (table 2B) whereas suppleness disorder screening test presented negative results in 64% examined children (table 2C). BMI was analysed with statistical method (table 2D).

Table 2. Baseline characteristics of the group of premature children entering school readiness age based on the gathered data

A. Combined amount (sum) of adverse perinatal events				
$\bar{x}$	Me	Min	Max	s
11,93	12,00	0	26	5,75
B. Screening test for scoliosis				
Result	N	%		
Negative	28	46		
Positive	33	54		
C. Screening test for suppleness disorders				
Result	N	%		
Negative	22	36		
Positive	39	64		
D. Body Mass Index BMI [kg/m^2]				
$\bar{x}$	Me	Min	Max	s
15.36	15.26	10.46	27.80	2.43

Table 3. Differentiation of scoliosis screening test results in the group of premature children entering school readiness age

A. Scoliosis screening test results according to gender

Variables	Female		Male		Chi^2/p
	N	%	N	%	
Negative result	18	30	10	16	Chi^2 =2,90
Positive result	14	20	19	32	p=0,88

Pearson's Chi-squared test

B. Scoliosis screening test results according to age

Variables	Age[years]			Z/p
	$\bar{x}$	Me	s	
Negative result	6,14	6,00	0,71	Z=-2,44
Positive result	6,58	7,00	0,71	p=0,015

Mann-Whitney U test (Z)

C. Scoliosis screening test results according to birth from first/subsequent pregnancies

Variables	Birth from first, second… sixth pregnancy			Z/p
	$\bar{x}$	Me	s	
Negative result	2,11	1,50	1,52	Z=0,26
Positive result	1,97	1,00	1,36	p=0,78

Mann-Whitney U test (Z)

D. Scoliosis screening test results according to foetus count

Variables	Single pregnancy		Twin pregnancy		Triple pregnancy		Z/p
	N	%	N	%	N	%	
Negative result	??????	26	6	10	6	10	Chi^2 =1,93
Positive result	23	38	7	11	3	5	p=0,38

Pearson's Chi-squared test

E. Scoliosis screening test results according to delivery week

Variables	Delivery week: from 24 to 35			Z/p
	$\bar{x}$	Me	s	
Negative result	30,25	30,50	2,40	Z=0,85
Positive result	29,70	30,00	2,51	p=0,39

Mann-Whitney U test (Z)

F. Scoliosis screening test results according to type of delivery

Variables	Natural		C-section		Chi^2 / p
	N	%	N	%	
Negative result	24	40	4	6	Chi^2 =0,16
Positive result	27	44	6	10	p=0,68

Pearson's Chi-squared test

G. Scoliosis screening test results according to Apgar score

Variables	0-3 p.		4-7 p.		8-10 p.		Chi^2 /p
	N	%	N	%	N	%	
Negative result	4	7	16	26	8	13	Chi^2 =1,66
Positive result	5	8	23	38	5	8	p=0,43

Pearson's Chi-squared test

H. Scoliosis screening test results according to birth weight

Variables	<750 g		750-1000 g		1000-1500 g		>1500 g		Chi^2/p
	N	%	N	%	N	%	N	%	
Negative result	2	3	4	6	11	18	11	18	Chi^2 =1,30
Positive result	1	2	6	10	10	16	16	27	p=0,72

Pearson's Chi-squared test

I. Scoliosis screening test results according to combined amount of adverse perinatal events

Variables	sum of the events			Z/p
	$\bar{x}$	Me	s	
Negative result	11,00	12,00	6,41	Z=-0,8
Positive result	12,73	12,00	5,09	p=0,40

Mann-Whitney U test (Z)

J. Scoliosis screening test results according to BMI

Variables	BMI [kg/m^2]			Z/p
	$\bar{x}$	Me	s	
Negative result	14,97	15,11	1,62	Z=-0,85
Positive result	15,68	15,43	2,94	p=0,36

Mann-Whitney U test (Z)

A statistically significant relation between age and positive/negative result of scoliosis screening test (p=0,0015, Mann-Whitney U test). Older age correlates to a negative test result (table 3B).

Additionally a statistically significant relation was observed between negative/positive screening test result for suppleness disorder and:

- age (p=0,007, Mann-Whitney U test) - younger age correlates with positive test result (table 4B),
- number of foetuses (p=0,030, Pearson's Chi-squared test) - being born from pregnancies having higher foetus count correlates with positive test result (table 4D),
- Apgar score (p=0,008, Pearson's Chi-squared test) - higher Apgar score correlates with positive test result (table 4G).

No statistically significant relation was observed between negative/positive results of a screening test for scoliosis and gender (table 3A), birth from first/subsequent pregnancy (table 3C), fetus count (table 3D), delivery week (table 3E), type of delivery (table 3F), Apgar score (table 3G), birth weight (table 3H), combined amount of adverse perinatal events (table 3I), BMI (table 3J).

No statistically significant relation was observed between negative/positive results of a screening test for suppleness disorders and gender (table 4A), birth from first/subsequent pregnancies (table 4C), delivery week (table 4E), type of delivery (table 4F), birth weight (table 4H), combined amount of adverse perinatal events (table 4I), BMI (table 4J)

Discussion

During growth span the risk of scoliosis progression is at its highest.[13] The time gap between regular check-ups is widely criticised.[9] In paediatrics the check-ups are conducted every several years.[14-20] In the studied group of prematurely born children who are starting school the age correlated significantly with the screening tests for both scoliosis and suppleness disorders. Older age corresponds to the positive test result. It is worth noting that the children are between 5 and 8 years old which coincides with – widely described in literature – first critical postural development period as well as early school growth spurt.[21,22] Research carried out in Spain have shown that pupils 8,5 years old, among the studied 6 to 12 year olds, are susceptible to increased risk of developing scoliosis.[23] That confirms the necessity of conducting annual check-ups in that age group as well as in prepubertal period.

The development of the abilities needed to maintain correct posture and fulfilling complex motoric standards is a reflection of a maturing central nervous system.[24] Children with low birth weight present decreased motor skills including suppleness.[25] It is believed that in conjunction with the progression of gestational age at the delivery time the survival rate increases, the prognosis of motoric and cognitive development improves.[26] In prematurely born children the posture control is disturbed. It may result from the immaturity of the cortex processes related to motoric control and proprioception.[27] Motoric disorders starting at the first year of age are often connected to decreased neurodevelopment results at 6-7.[28] Nevertheless, no significant differences in the occurrence frequency of postural disorders in torso area between children born prematurely and their peers were noted. Before entering 12 years of age the posture control systems are not fully developed hence the deficits might not be spotted as a child develops. The entire scope of postural disorders can be fully observed during puberty and adulthood.[24,30]

The examined group of prematurely born children shown the following statistically significant dependencies: older age corresponds to negative suppleness disorder test, which is also confirmed by Touwslader et. al. research.[31] The same dependency was observed in screening test performed on 6-7 year old children entering schooling obligation age.[32] In contrast to the work of other authors who performed screening tests in schools no relationship between female gender and suppleness disorders was found.[33] Increased body weight in relation to body height did not affect the test results however obesity in later life may significantly increase a chance a positive suppleness disorder test.[34] Moreover, being born from a pregnancy with higher foetus count and higher Apgar score correlates to a positive suppleness disorder test.

Earlier a study was published on diversification of results of orientating questionnaire of motoric and psycho-social development in regard to the level of educational maturity (school readiness) in the same group of prematurely born children. The study established that post-natal Apgar score differentiates the results of the questionnaire on the indicative study of motor and psychosocial development in terms of school readiness in the in the areas of child's functioning – high motor skills, visual-motor coordination, memory and total score.[35]

In recent years an increase in the percentage of prematurely born children has been observed.[36] This is why the issue of preterm children medical care is important and requires further and deeper research.

Conclusion

In conclusion, age differentiates the result of scoliosis screening test in prematurely born children entering schooling obligation age which shows the necessity of performing the check-ups more frequently. The studied characteristics (age, being born from single- of multiple pregnancy and Apgar score) differentiate the result of the screening test for suppleness disorders in premature born children.

Table 4. Differentiation of suppleness disorder screening test results in the group of premature children entering school readiness age

A. Suppleness disorder screening test results according to gender

Variables	Female		Male		Chi^2 /p
	N	%	N	%	
Negative result	10	16	12	20	Chi^2 =0,67
Positive result	22	36	17	28	p=0,41

Pearson's Chi-squared test

B. Suppleness disorder screening test results according to age

Variables	Age[years]			Z/p
	$\bar{x}$	Me	s	
Negative result	6,73	7,00	0,77	Z=2,71
Positive result	6,18	6,00	0,64	p=0,007

Mann-Whitney U test (Z)

C. Suppleness disorder screening test results according to birth from first/subsequent pregnancies

Variables	Birth from first, second… sixth pregnancy			Z/p
	$\bar{x}$	Me	s	
Negative result	1,68	1,50	0,95	Z=-0,78
Positive result	2,23	1,00	1,61	p=0,43

Mann-Whitney U test (Z)

D. Suppleness screening test results according to pregnancy foetus count

Variables	Single pregnancy		Twin pregnancy		Triple pregnancy		Chi^2/p
	N	%	N	%	N	%	
Negative result	18	30	4	6	0	0	Chi^2 =6,95
Positive result	21	34	9	15	9	15	p=0,03

Pearson's Chi-squared test

E. Suppleness screening test results according to delivery week

Variables	Delivery week: from 24 to 35			Z/p	
	$\bar{x}$	Me	s		
Negative result	29,50	30,00	2,60	Z=-1,20	p=0,22
Positive result	30,21	31,00	2,36		

Mann-Whitney U test (Z)

F. Suppleness disorder screening test results according to type of delivery

Variables	Natural		C-section		Chi^2/p
	N	%	N	%	
Negative result	20	33	2	3	Chi^2 =1,34
Positive result	31	51	8	13	p=0,25

Pearson's Chi-squared test

G. Suppleness disorder screening test results according to Apgar score

Variables	0-3 p.		4-7 p.		8-10 p.		Chi^2/p
	N	%	N	%	N	%	
Negative result	5	8	17	28	0	0	Chi^2 =9,77
Positive result	4	7	22	36	13	21	p=0,008

Pearson's Chi-squared test

H. Suppleness disorder screening test results according to birth weight [g]

Variables	<750		750-1000		1000-1500		>1500		Chi^2/p
	N	%	N	%	N	%	N	%	
Negative result	1	2	4	6	9	15	8	13	Chi^2 =0,98
Positive result	2	3	6	10	12	20	19	31	p=0,80

Pearson's Chi-squared test

I. Suppleness disorder screening test results according to combined amount of adverse perinatal events

Variables	Sum of the events			Z/p	
	$\bar{x}$	Me	s		
Negative result	12,50	12,00	5,52	Z=0,25	p=0,80
Positive result	11,62	12,00	5,93		

Mann-Whitney U test (Z)

J. Suppleness disorder screening test results according to BMI

Variables	BMI [kg/m^2]			Z/p	
	$\bar{x}$	Me	s		
Negative result	16,18	15,49	2,87	Z=1,61	p=0,11
Positive result	14,89	15,07	2,04		

Mann-Whitney U test (Z)

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