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Original article

OBSERVATIONAL STUDY REGARDING THE ASSESSMENT AND IMPROVEMENT OF SPINE MOBILITY IN PRIMARY SCHOOL CHILDREN

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Abstract

Purpose. The purpose of this research was to conduct a study regarding the assessment and improvement of spine mobility in primary school children.

*Methods.*The research methods were established according to the objectives of the research, as follows: the study of the professional literature method, the testing method, the statistical-mathematical method and the graphical representation method (Ababei, 2006).

Results. The results showed that the assessment methodology proposed for the investigation of the group of apparently healthy children have revealed great deficits in their spine mobility, according to the initial data.

Conclusions. At the end of the research, it can be concluded that the proposed assessment methodology has proven its value in regard to establishing the spine functionality, representing the starting point in the elaboration of intervention means for the rehabilitation of the mobility deficit.

*Key words***:** study, assessment, mobility, spine, children.

Introduction

The physical development of children involves an adaptation to their environment, a complex process of mental and physical structuring that leads toward maturation, contributing to the progress of society. The development process is active, dynamic, under the decisive influence of the interrelationship between the external factors on the future adult. In regard to the functionality of the spine, according to various experts, each period tends to influence in some measure both the structure and the evolutive or involutive functionality of the spine, physiologically or pathologically. In regard to pathology, it can be congenital or acquired, the second starting with a simple bad posture (Crețu, T., 2009; Ghețiu, A., 2017).

The sedentary lifestyle, an unprecedented impact of technology on modern society, as well as the encouragement of a lazy conduct in everyday life, leads to a variety of spine pathologies.

According to a 2017 study, conducted by Danielson – Mckeague and Jaimey, published by the College of Health Professions, the sedentary lifestyle in children can lead to a domino effect of bad habits with potentially devastating consequences for the future adult (https://commons.pacificu.edu/cgi/viewcontent.cgi?).

The same study confirms the fact that an increasing number of children nowadays prefer sedentary interactive activities (video games), to the detriment of the ones that demand physical exercise (an important part of a harmonious development), which endangers the health of the future adults.

The measurements for the assessment of mobility must be reproducible, they must be performable in a short amount of time and be based on usual, simple movements, so that they could be performed during every routine examination (https://tampub.uta.fi/bitstream/handle/10024/66942/951-44-5465-0.pdf?seque).

Any position modification in the active elements will cause an imbalance between the agonist and antagonist groups, which will lead, under the influence of the vectorial deviation of forces, to incorrect postures by affecting the distribution of the motor segments. The degenerative phenomenon explained above represents the transformation between the correct posture→ (nonstructural) posture→imbalance→ deficiency (structural modification). This hierarchy of the degenerative phenomenon represents the way in which the postural disorder happen in children and adults (Iaroslav, K., 2009).

Nevertheless, in the case of this subject, the phenomenon has a much more aggressive impact because of multiple reasons, the most important of which being the formation of incorrect

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and unstable postural reflexes that are unable to maintain the inter-segmental relations constant.

According to a 2016 study called*Importanța kinetoterapiei în tratarea tulburărilor de statică vertebrală la copii (The importance of physical therapy in treating vertebral static disorders in children)*that evaluates the spine disorders also epidemiologically in Suceava county, in 2015, the examination has shown a 50% increase from the preceding year of spine disorders among small school children and teenagers

(http://www.jmbucovina.ro/revista_an_2016_nr_3/10_kinetoterapia.pdf).

The predominant goal of this research is trying to clarify certain particular aspects and specify the most effective methods of assessing and maintaining the spine mobility. From what has been previously stated, a reconsideration of norms and standards of assessment is necessary.

Methods

The purpose of this research was to propose a concrete assessment model for the spine mobility in children, based on various types of measurements, aiming to spot and monitor the problems in their incipient stage.This study aims to analyze the data and information about the deficiency-producing mechanisms in order to recommend proper prevention measures.

The research group consisted of 50 primary school pupils, aged between 6 and 11, from the Borlești School, Neamț county, the study being conducted in the academic year 2017-2018, over the course of 3 months.

Initially, there were practical measurements in order to spot the mobility deficit, aiming to assess the mobility indices in various areas, to correlate the results with the reference values and to create certain intervention means for regaining the lost mobility, to measure and assess the mobility indices in order to establish the new functional status.

A series of tests were performed over the course of the research in order to gather data regarding the spine mobility, such as the functional assessment of the spine mobility on areas.

*Table 1***Assessment methods**
(Balint, T., 2007; Cordun, M., 2009; Manole, V., Manole, L., 2009)

The functional assessment of the spine mobility - on areas:

- **Cervical spine:**

The chin – sternum distance (flexion)

- The distance between chin and sternum was measured, in the maximum point of motion.
  - Normal result – 0

The occiput – wall distance (extension)

- It was measured in a standing position, with the posterior prominences (heels, buttocks, trunk) against the wall. Normal result – 0

The tragicus - acromion distance (lateral inclination)

- It was measured in the maximum point of motion of the head toward the shoulder, the latter being held in a normal position throughout the entire movement.
  - Normal result – 0

- **Thoracic spine**

The Ott sign (flexion)

- It was measured with the patient standing, from the spinous process of the first thoracic vertebra T1, for a distance of 30 cm. The patient performs a maximum flexion of the trunk. The measurement is repeated.
  - Normal result – 33 – 33.5 cm.

- **Lumbar spine**

The Schober index (flexion)

- It was measured with the patient standing. The spinous process of the last lumbar vertebra, L5, was taken as initial point for the measurement. A 10 cm line is traced from the L5 vertebra to the cranium.
  - Normal result (flexion) – 14.5 – 15 cm.

- **Thoracolumbar spine**

The Stibor index

- A line was traced from the last cervical vertebra to the first sacral vertebra, C1-S1. It was performed also with the patient standing, the patient performing a maximum flexion of the spine.
  - Normal result - 10 cm

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The middle finger – inter-articular line of the knee distance (lateral inclination)

- It was done with the patient standing, trying to get the middle finger to get close to the inter-articular line.
  - Normal result - negative if the line is not touched, positive if the finger goes beyond the line.

The middle finger - floor distance

- It was done with the patient standing, trying to get the middle finger to get close to the floor.
  - Normal result – 0 cm

Results

1. The chin – sternum distance

Table 2 presents the results recorded during the assessment of mobility in the flexion of the cervical spine. One can observe that in all of the assessed groups, both the males and females, during the initial and final evaluations, recorded values within the physiological parameters (range of motion percentage - 100%).

Thus, the inability to perform the cephalic extremity flexion corresponds to the first category, expressed percentage-wise directly proportional to the degree of functional limitation. The 75-100% category consists of the patients with an advanced range of motion.

Table 2 **Functional assessment chin – sternum distance**

The chin – sternum distance (Reference values 0- 10 cm)		
Initial	Total no. of subjects Range of motion (cm)	Final
0	10 – 25%	0
0	25 – 50%	0
0	50 – 75%	0
50	75 – 100%	50

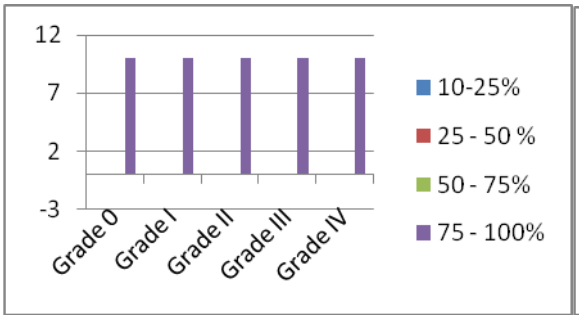

Figure 1 **Chin – sternum distance - initial**

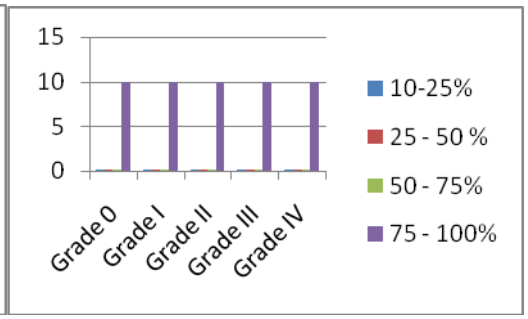

Figure 2 **Chin – sternum distance - final**

2. The occiput – wall distance

Table 3 presents the results recorded during the extension mobility test. Thus, the initial and final results indicate that all groups recorded values within the physiological parameters (range of motion – 75 - 100%).

Table 3 **Functional assessment occiput – vertebral axis distance**

The occiput – wall distance		
Initial	Total no. of subjects Range of motion (cm)	Final
0	10 – 25%	0
0	25 – 50%	0
0	50 – 75%	0
50	75 – 100%	50

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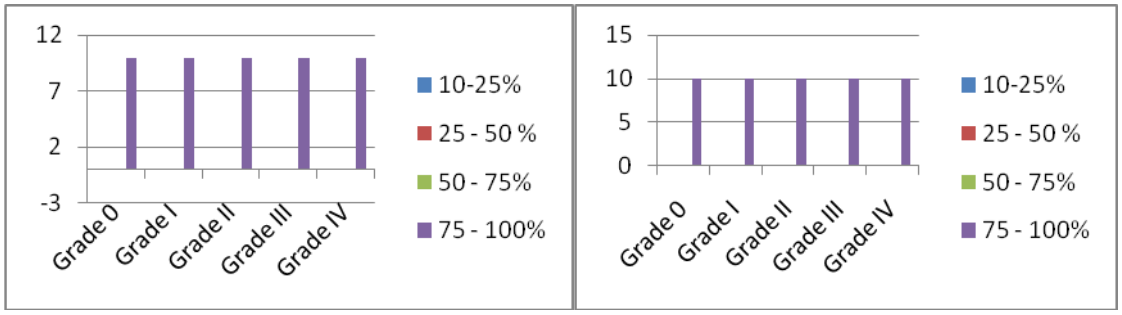

Figure 3 **Occiput - wall distance - initial** *Figure 4* **Occiput - wall distance - final**

3. The tragicus - acromion distance

As seen in table 4, in the initial testing, in the category representing the advanced mobility deficit, category 10 – 25% there are 5 pupils in grade 0. In the functional deficit category 25- 50 % - there are 5 pupils in grade 0, 10 grade I, 10 grade II, 9 grade III and 10 pupils in grade IV. In the moderate mobility deficit category - 50 – 75%, there is 1 pupil in grade III. In the last functional deficit category, represented by 75 – 100% there isn't any pupil.

As one can see in table 5, during the initial testing 13 pupils (26% of the subjects) recorded values indicating reduced mobility (category 10 - 25%) and 37 pupils (74%) recorded values indicating a deficit of 25 - 50%.

During the final testing, there were the following results:50 – 75 % - 3 pupils in grade II, 4 grade III, 4 – grade IV and in the category regarding movement within physiological parameters - 75 – 100% - 10 pupils in grade 0, 10 grade I, 7 grade II, 6 grade III and 6 grade IV. The values are valid for both lateral cervical movements, indicating also the improvement of the mobility dysfunction between left and right.

Table 4 **Tragicus - acromion distance**

The tragicus - acromion distance (left) (Reference values 1 – 15 cm)		
Total no. of subjects Initial	ROM percentage	Total no. of subjects Final
5	10 – 25% (0 – 3.5 cm)	0
44	25 – 50% (3.5 – 7 cm)	0
1	50 – 75% (7.5 – 12 cm)	**11**
0	75 – 100% (12 – 15 cm)	**39**

*Table 5***Tragicus - acromion distance**

The tragicus - acromion distance (right) (Reference values 1 – 15 cm)		
Total no. of subjects Initial	ROM percentage	Total no. of subjects Final
13	10 – 25% (0 – 3.5 cm)	0
37	25 – 50% (3.5 – 7 cm)	0
0	50 – 75% (7.5 – 12 cm)	**11**
0	75 – 100% (12 – 15 cm)	**39**

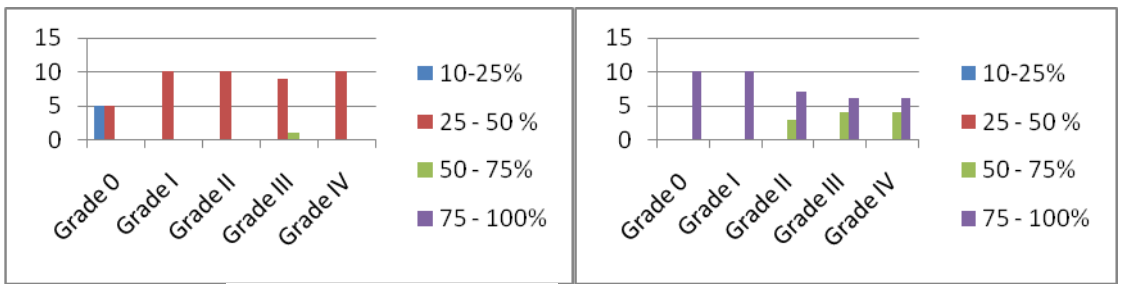

*Figure 5***Tragicus - acromion distance***Figure 6* **Tragicus - acromion distance left - initialleft - final**

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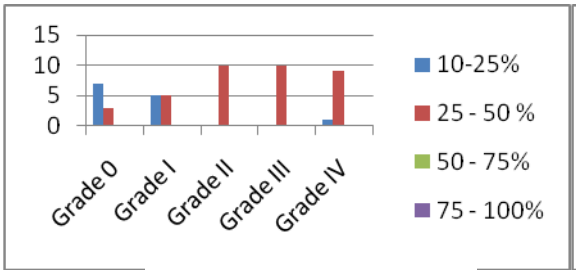

Figure 7 **Tragicus - acromion distance right - initial**

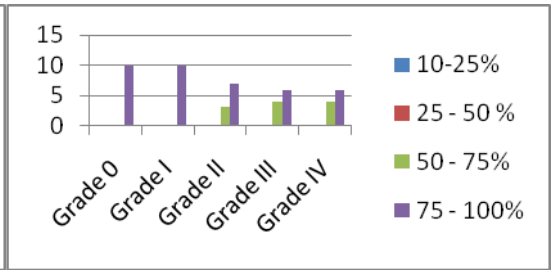

Figure 8 **Tragicus - acromion distance right - final**

4. The Ott sign

As one can see in table 6, which presents the initial and final results for the flexion test, initially, out of the 50 subjects, 22 were in the first category, 18 in the second, 6 in the third, and 4 in the last category, corresponding to the physiological movements that are within normal parameters. Thus, the following initial information was recorded: **0 – 25%** - 4 pupils in grade 0, 4 grade I, 5 grade II, 4 grade III, 5 grade IV; **25 – 50%** - 5 pupils in grade 0, 3 grade I, 3 grade II, 4 grade III, 3 grade IV; **50 – 75%** - 1 grade 0, 0 grade I, 1 grade II, 2 grade III, 2 grade IV; **75 – 100%** - 0 grade 0, 3 grade I, 1 grade II-a, 0 grade III, 0 grade IV.

During the final test, 11 pupils were in category 25 – 50%, 7 in the third, and 32 in the fourth category. Explicitly, one can see the following: **0 – 25%** - 0 pupils; **25-50 %** - 3 pupils in grade 0, 3 pupils in grade I, 2 pupils in grade II, 1 pupil in grade III, 2 pupils in grade IV; **50 – 75%** - 3 pupils in grade III, 4 pupils in grade IV; **75 – 100%** - 7 pupils in grade 0, 7 pupils in grade I, 8 pupils in grade II, 6 grade III, 4 grade IV.

Table 6 **The Ott sign**

The Ott sign (Reference values 3.5 - 4 cm)		
Initial	Total no. of subjects Range of motion (cm)	Final
22	10 – 25% (≤ 1cm)	0
18	25 – 50% (≤ 2 cm)	11
6	50 – 75% (< 3 cm)	7
4	75 – 100% (3.5 – 4 cm)	32

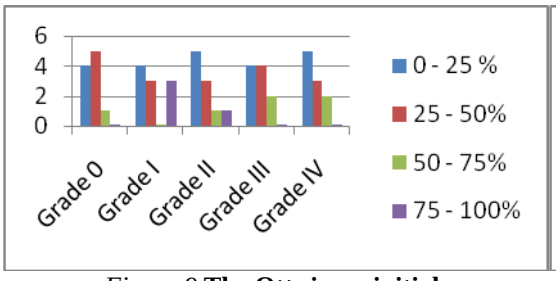

Figure 9 **The Ott sign – initial**

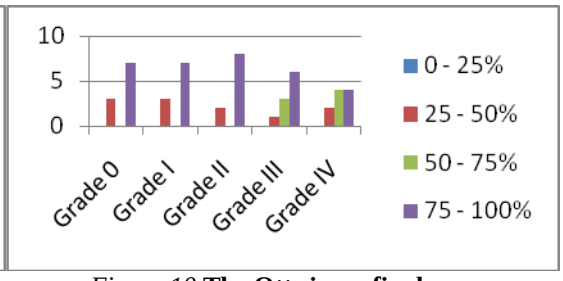

Figure 10 **The Ott sign – final**

5. The Schober index

Table 7 shows that during the first testing there was 1 subject who could only perform lumbar flexion movements up to 25% of the total range of motion, there were 8 subjects with 50%, 14 - 75%, and 27 with 75-100%. Thus, the results in figures 11 and 12 on grades can be summed up as follows: **10 – 25 %** - 1 grade III; **25 – 50 %** - 1 grade 0, 1 grade I, 1 grade II, 3 grade III, 2 grade IV; **50 – 75%** - 2 grade 0, 3 grade I, 3 grade II, 3 grade III, 2 grade IV; **75 – 100%** - 6 grade 0, 6 grade I, 6 grade II, 4 grade III, 6 grade IV.

Table 7 **Schober index**

The Schober index (Reference values 4.5 – 5 cm)

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Initial	Total no. of subjects Range of motion (cm)	Final
1	10 – 25% (≤ 1 - 2cm)	0
8	25 – 50% (≤ 2 - 3cm)	11
14	50 – 75% (< 3.5 – 4.5 cm)	7
27	75 – 100% (4.5 - 5 cm)	32

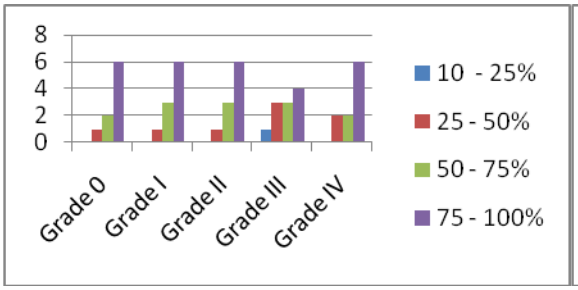

Figure 11 **Schober index – initial**

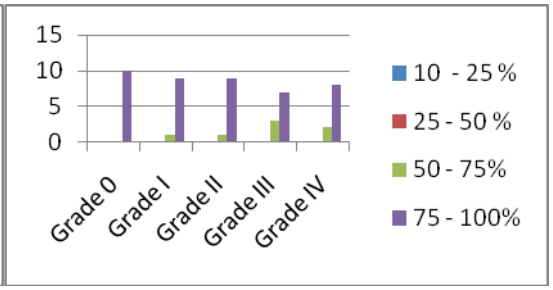

*Figure 12***Schober index – final**

The figures show that there are 0 patients in the first category, 11 in the second, 7 in the third, and 32 in the last one:**0 – 25%** - 0 pupils; **25- 50 %** - 0 pupils; **50 – 75%** - 1 grade I, 1 grade II, 3 grade III, 2 grade IV; **75 – 100%** - 10 grade 0, 9 grade I, 9 grade II, 7 grade III, 8 grade IV.

6. The Stibor index

As one can see in table 8, the Stibor index shows the different grouping of the subjects, as follows: 17 pupils who initially could perform 25% of their maximum range of motion, 23 pupils – 50%, 9 pupils – 70%, 1 pupil – 75- 100%.

Table 8 **Stibor index**

The Stibor index (Reference values – 10 cm)		
Initial	Total no. of subjects Range of motion (cm)	Final
17	10 – 25% (≤ 2- 4cm)	0
23	25 – 50% (4– 6 cm)	1
9	50 – 75% (6 – 8 cm)	19
1	75 – 100% (8 -10 cm)	30

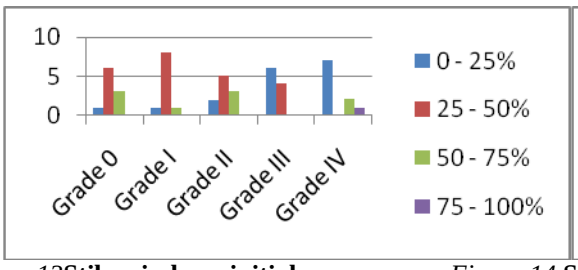

*Figure 13***Stibor index – initial**

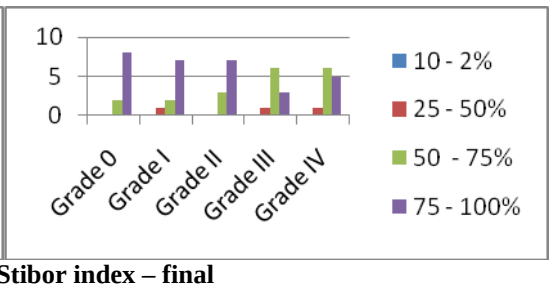

Figure 14 **Stibor index – final**

Figures 13 and 14 show the following: **10 – 25%** - 1 grade 0, 1 grade I, 2 grade II, 6 grade III, 7 grade IV; **25 – 50%** - 6 grade 0, 8 grade I, 5 grade II, 4 grade III, 0 grade IV; **50 – 75%** - 3 grade 0, 1 grade I-a, 3 grade II, 0 grade III, 2 grade IV; **75 – 100%** - 1 grade IV.

The same index (Stibor) shows that during the final testing, 11 pupils can perform 50% of their range of motion, 7 - 75% and 32 can perform using their full range of motion: **10 – 25%** - 0 subjects; **25 – 50%** - 0 grade 0, 1 grade I, 0 grade II, 1 grade III; **50 – 75%** - 2 grade 0, 2 grade I, 3 grade II, 6 grade III, 6 grade IV; **75 – 100%** - 8 grade 0, 7grade I, 7 grade II, 3 grade III, 5 grade IV.

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7. The middle finger – inter-articular line of the knee distance (lateral inclination)

Table 9 and its corresponding figures, 15 and 16, show that none of the assessed subjects has recorded modifications in their left or right inclination range of motion. The author also took into account the possibility of negative results (beyond the inter-articular line, which would have proven a hypermobility in the tested motions). One can observe that in the case of the middle finger – inter-articular line distance, 100% of the subjects have recorded values within the normal physiological parameters.

Table 9 **Middle finger – inter-articular line distance**

The middle finger – inter-articular knee line (Reference values 15 – 0 cm)		
Initial	Total no. of subjects Range of motion (cm)	Final
0	10 – 25% (15 - 10 cm)	0
0	25 – 50% (10 - 5 cm)	0
0	50 – 75% (5 – 2 cm)	0
0	75 – 100% (0 - 1 cm)	50

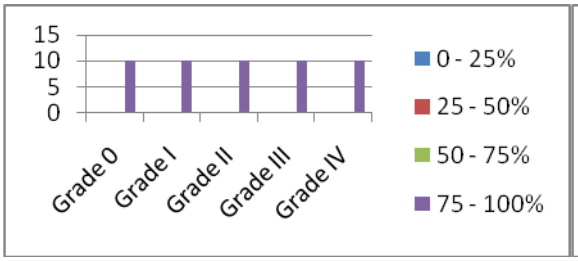

Figure 15 **Middle finger – inter-articular line initial**

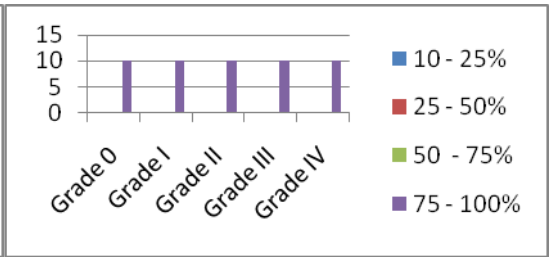

Figure 16 **Middle finger – inter-articular line final**

8. Themiddle finger - floor distance

Table 10 presents the results recorded during the spine flexion mobility test. The initial and final results indicate the values recorded by the 50 patients. At the beginning of the study, there were 0 subjects in the first two categories, 26 (52%) in the third, indicating that they could perform 75% of the flexion, and 24 (48%) in the category of 100%. Explicitly: **10 – 25%** - 0 subjects;**25 – 50%** - 0 subjects;**50 – 75%** - 6 pupils in grade 0, 4 grade I, 5 grade II, 5 grade III, 6 grade IV;**75 – 100%** - 4 pupils in grade 0 , 6 grade I, 5 grade II, 5 grade III, 4 grade IV.

During the final testing, 50 patients (100% of the group) were in the category that indicates the flexion is performed in its entire range of motion (100%). Explicitly:**10 – 25 %** - 0 subjects; **25 – 50%** - 0 subjects; **50 – 75%** - 0 subjects; **75 – 100%** - 10 grade 0, 10 grade I, 10 grade II, 10 grade III, 10 grade IV.

*Table 10***Middle finger – floor distance**

The middle finger - floor distance (Reference values – 0cm)		
Initial	Total no. of subjects Range of motion (cm)	Final
0	25% (≥10 cm)	0
0	50% (10 - 2 cm)	0
26	75% (≥ 2 - 1 cm)	0
24	100% (0 cm)	**50**

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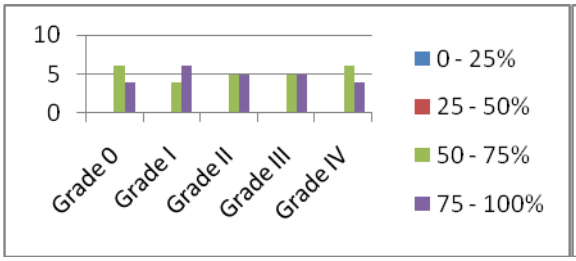

Figure 17 **Middle finger – inter-articular line initial final**

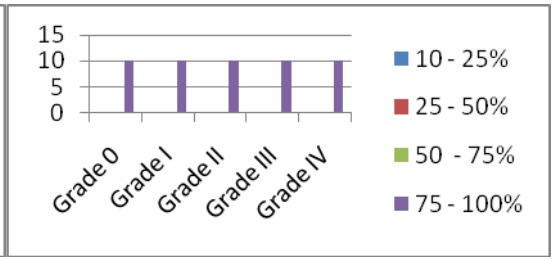

Figure 18 **Middle finger – inter-articular line**

This study was used to examine the performance of each subject in relation to their best individual result. The author proposes that a study complementary to this one should be conducted, which would benefit from large enough data so that it could validate the present interpretations by including them in a mathematical equation of the parameters conditioning the values. The following interpretation can be issued, in relation to the recorded results.

In the cervical spine there were modifications in the range of motion only in regard to the left-right lateral movements.

- **Initially**, **the chin-sternum** and **occiput-wall** distance index (analyzing the flexion and extension of the

cephalic extension) recorded values within the physiological parameters of 100% per each examination. In regard to the **tragicus - acromion** distance, the entire group recorded mobility deficits of various degrees (75% - 50% - 25%). Also, there were important imbalances between the two antagonistic movements.

- **Finally** - after the application of the intervention measures, it was noticed that in all

movements, the mobility is normal, at a cervical level. There is a significant improvement in the homeostasis deficit in the left/right lateral movements.

The thoracic spine mobility has also deficits, which were evident during the initial examination, 92% of the subjects having difficulty in flexing their spine (**Ott sign**).

- During the **final** examination, only 36% of the entire group still presented mobility deficits;

however, their range of motion was improved.

The examination of the lumbar spine revealed, like in the other two segments, a functional mobility deficit in the 25 – 75% category, present in 46% of the subjects, recorded during the **Schober index** test (flexion); during the **final** tests, the number of children with functional deficit was reduced to 36%.

The global assessment of the spine mobility put it into the deficit group of 25-75%, out of which:

- **The Stibor index** (flexion) indicated that 34% of the group had a mobility deficit of 75%; 46 % with a deficit of 50%;

and 18% with a deficit of 25%. Finally, the percentages revealed an improvement, thus 38% have remained with a mobility deficit of 25%, while 64% were within normal parameters.

- **The middle finger – knee inter-articular line distance** (lateral inclination) recorded values within

normal physiological parameters, initially and finally.

- **The middle finger – floor distance** – initially, 52% of the subjects recorded a mobility deficit of 25%, the rest

being able to perform the movement on the entire range of motion. At the end, all patients were able to perform the movements within normal physiological parameters (100%, for each group).

Conclusions

After establishing the functional status, applicative intervention methods were established to improve the mobility deficits. The final testing shows an improvement in the spine mobility overall, which confirms the importance of the assessment for a diagnosis of the spine functionality.

As final conclusions, it can be said that the assessment methodology proposed in the investigation of a group composed of apparently healthy children, has revealed deficits in the spine mobility, according to the initial data that was presented in tables and figures; the therapeutic intervention means were based on the recorded information, which confirms not only their effect on the progress of the rehabilitation of mobility, but also the importance of establishing the initial functional deficit.

At the end of the research, it can be concluded that the proposed assessment methodology has proven its value in regard to

establishing the spine functionality, representing the starting point in the elaboration of intervention means for the rehabilitation of the mobility deficit.

Discussions

The assessment is a crucial component of the rehabilitation process, playing mainly a regulatory role in both the functional assessment (in this case, of primary school children) and the improvement of therapeutic strategies. The assessment is a necessary and mandatory act in the medical conduct, which has precise goals. It is conducted in order to know the subjects, their results and their progress in regard to the goals. Thus, the assessment shows also the effectiveness of the methodology.

The main purpose of the assessment is to highlight the functional modifications that exist as states of adaptation, caused by a sedentary lifestyle and school activities that impose asymmetrical postures, due to low interest for ergonomic design of school furniture.

This research presents a part of the methodology for improving the harmonious physical development, preventing physical deficiencies, which is very important in the relation between physical development and health.

Playing a primary role in standing and moving, the axial segment is exposed to a high number of traumatic or non-traumatic risks. Regardless of the initial pathology, the result is almost always the same: diminished articular range of motion, functional pain, modifications in the biomechanics, with invalidating neuromotor implications. Each of these could have an insidious, asymptomatic beginning, and the moment when it becomes worse happens suddenly, when the pathological morpho-functional modifications have most probably became definitive. Thus, the high incidence of axial deviations and the particularities of rehabilitation were the motivation for this research.

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