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THE IMPORTANCE OF METHODOLOGY EVALUATION OF SCHOOL FURNITURE FOR CZECH CHILDREN WITH MOBILITY DISABILITY IN RELATION TO CHILDREN'S ANTHROPOMETRY

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Abstract

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The paper presents results of research conducted under the support of the IGA LDF MENDELU project, id. No. 32/2010 (Anthropometry in Disabled Children in Relation to Furniture) and the NIS MPO ČR FR-TI1/050 project (Information System for the Support of Research, Development, Innovation and Furniture Quality). It gives an account of theoretical and methodological foundations, introduces the project's research objectives. Its major objective is to familiarise professional public with the results of the conducted research the focus of which was to determine requirements for furniture designated for children with mobility restrictions. The defined requirements then constitute the grounds of school furniture assessment methodology. These requirements are divided into three levels that are somehow interconnected. Application of the methodology as a whole is highly wide and can be directed at all educational institutions in the Czech Republic with the pupils from the target group. The evaluation outcome is a report of each evaluated product. The questions raised also belong to a broader context of the issue at hand, related to the project of protection and safety standards establishment in relation to health status of children and youth, in the context of the "Long-term programme of the improvement of health status of the Czech Republic population – Health for everybody in the 21st century" paper, objective 4: HEALTH OF YOUTH – TO BUILD CONDITIONS FOR YOUNG PEOPLE TO BECOME HEALTHIER AND APTER TO FULFILL THEIR ROLE IN THE SOCIETY BY 2020. It is recommended to make a proper definition of the dimensional characteristics of children and update their measurements for furniture design in the Czech Republic constantly (including revision of technical regulations and innovation dimensions in the literature). This can be considered as an opportunity to improve the health of future generations.

Keywords: children furniture, education, anthropometry, functional capacity, disability

1 INTRODUCTION

The issues covered by the paper are related to the methods of anthropometric measurements and the research itself conducted in groups of children classified according to school attendance division. Measurement of somatic dimensions constitutes the primary input necessary to define the requirements assessment methodology of school furniture designated for children with mobility restrictions. The terms of functional capacity, disability and health, as defined in the International Classification of Functioning, Disability and Health document

(referred to as ICF) should be particularly highlighted within the conducted research. Depending on the classification of disability, degree of functional ability of children and the somatic measurements taken, correspondence must be sought in order to determine the optimum evolution index to serve as key input to dimensional requirements for school furniture. In principle, children and people with a limited functional capacity and disability must be given a chance to lead dignified lives and should be adequately integrated into society.

Anthropometry is a method which deals with measurements of a the human body – method a set of techniques to measure a human body. The discipline where the intention is to capture the body size of a living person is referred to as **Somatometry**. On the contrary, the discipline where the intention is to reconstruct proportions of a human body based on the skeletal remains is referred to as **Osteometry**.

For the purpose of determination of requirements for school furniture designated for children with mobility restrictions it is important to monitor the relation of basic somatic dimensions on body height (obtained by means of correlation analysis), and, by inference, the **body segment indices**, and/or the ***"evolution index.*** This primarily applies to the ***length of the trunk (height in sitting position***; ***width of the pelvis (bicristal width)***; *eye line height in sitting position; height of popliteal; length of popliteal, etc.* in relation to the use of furniture. In a sitting position the crucial factors include height, width and depth of the seat. The dimensional characteristics mentioned above thus have an effect on the determination of the dimensional requirements for school furniture.

2 OBJECTIVE

Its major objective is to familiarise professional public with the results of the conducted research the focus of which was to determine furniture requirements for children with mobility restrictions. The research results are used within the school furniture assessment methodology for Czech children with mobility restrictions, which is the subject of a dissertation thesis by the author of the present paper. Currently the research is based on the somatic dimensions acquired by measurement of healthy children belonging to several age categories. We look for relationships between these values (represented by corporal indices and their assessment) relationships which influence how requirements for school furniture are established. Children population should be monitored from the perspective of the relation between somatic dimensions and body height.

3 THEORETICAL FOUNDATIONS

The furniture used by children with mobility restrictions should be "tailor made". Both in terms of the material used in production, shapes, weight, dimensions, colouring and functionality in use, or for children who are "disadvantaged" by a certain degree of disability in terms of their increased operability and linkage to the aforementioned aspects.

The ICF document informs it is not only ethical and moral but also cost efficient to objectively and at the earliest opportunity evaluate the functional capacity of patients following illness, injury or inborn defect and reduce or moderate their disability by physiotherapy. In the event that the defects persist, the people concerned should be given an opportunity to lead a dignified life and be optimally integrated into society (National Council of People with Disabilities of the Czech Republic, 2010). The same applies to children and their mobility restrictions. In this perspective we have the obligation to provide children with standard children furniture that will optimally integrate them into the group of their peers and will not pose barriers in regular usage not only in the school environment.

3.1 Disability

First of all the degree of physical handicap must be ascertained for the individual concerned and their handicap = disability must be classified. Recently a more apt definition of a handicap is being used and that is the term of disability, which is one of the main pillars of the ICF document by the World Health Organisation (WHO). The ICF document defines disability as follows: *Disability denotes reduced functioning on the level of the body, individual or society, which emerges when one encounters external barriers as a result of their health state (heath condition)* (National Council of People with Disabilities of the Czech Republic, 2010, p. 9). The ICF document does not classify persons but rather describes and classifies the situations of each individual in a number of circumstances relating to their health. This may be considered to imply that each individual has a specific health state that confronts them with various life situations and therefore often gets them into diversely disadvantaging positions.

The above mentioned definition of disability complies with the requirements of one of the essential standards, also adopted in the Czech Republic, i.e. ***Standard Rules on the Equalization of Opportunities for Persons with Disabilities, OSN 1993.***

According to the World Health Organisation, people with disabilities account for 9 to 13% of Europe's population. The number reveals that people with disabilities account for a **sizeable minority of the population** (National Council of People with Disabilities of the Czech Republic, 2010).

3.2 Functional Capacity

It refers to all body functions, activities and participations as an overarching term; similarly, disability is used to express disorders, reduced activity or limited participation. The ICF also

registers environmental factors that contribute to all constructions. In a simplified sense they have an impact on all aspects of functional capacities and disability itself and are organised across the range from the individual's immediate vicinity to the environment in general (National Council of People with Disabilities of the Czech Republic, 2010).

The society's objective should be to focus on children functional capacity after **illness**, **injury** or **inborn defect** and to help reduce or moderate their disability by means of rehabilitation. In many cases the dynamic interaction between health issues (illnesses, defects, accidents, injuries) and co-factors occurs.

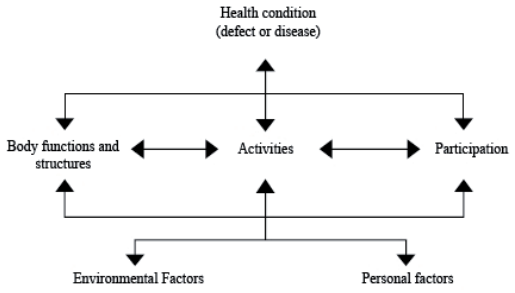
3.3 Heath / Disability Classification

According to ICF, health and health-related states are associated with any type of health problems. The unit applied in the classification is a ***category*** within each health domain and health-related state. Situations of individuals are described rather than personal classification. The description is created in the context of the environment and personal factors (National Council of People with Disabilities of the Czech Republic, 2010).

3.4 Co-factors – according to ICF Document

Represent the integral background of an individual's life. They consist of two components: ***environmental factors and personal factors***, which may have an impact on the individual's health problems and health-related states (see: Chart in Fig. 1).

The environmental factors form the physical, social and positional environment in which people live their lives. These involve external factors to which the individual may be exposed and which may either have a positive or negative impact on the specific manner in which the individual performs their activities as a member of the society, or on their capacity or functions of the body, or the structure of the given individual. The environmental determinants co-factor alongside the components of bodily functions and structures and activities and participation. Disability is regarded as an outcome or result of a complex relationship between health problems of an individual and personal and external factors that represent the circumstances surrounding the individual (National Council of People with Disabilities of the Czech Republic, 2010).



1: *Chart – mutual interactions of components (source: International Classification of Functioning, Disability and Health: ICF)*

3.5 Disability Classification

The most common internal differentiation of people with disabilities employs a model based on the prevailing disability into:

- **physical**;
- mental;
- visual;
- auditory;
- speech.

Physical disability therefore corresponds to a single group only. The issue of subdivision within the physical disability group may be conceived according to a number of criteria. The most common classification is the one that employs the ***depth (degree)*** of disability. A number of criteria, including the official, employ a division of physical disability to:

mild – moderate – severe.

According to Michalík it is a very generic classification in principle since each of the aforementioned groups includes a very diverse group of states, illnesses, disabilities and, in particular their bearers = the individuals (Michalík *et al.*, 2011).

Tracing the results of the selected investigation among people with disabilities conducted in 2007 by the Czech Statistical Office, we reach the conclusion that the number of people with disabilities as of the end of 2006 was 1 015 548 in total. Out of that number, **46 208 disabled persons** belonged to the group 0–14 years. There were **16 687 individuals** with ***physical disabilities*** within this age group (CSO, 2007).

For the group of 0–14 years, there were 26 264 people with inborn disabilities. On the other hand, people with acquired disability had 19 944 representatives in the group. Inborn disability within the said group accounted for 56.84% (CSO, 2007).

Physical disabilities may be further subdivided into:

- inborn and acquired musculoskeletal defects;
- inborn upper limbs defects;
- finger deformations;
- pelvis defects;
- deformations of the femoral neck;
- lower limbs defects, knee defects;
- foot defects;
- acquired spinal deformity – scoliosis;
- acquired through injury, operation – infections of bones and joints, etc.

3.6 Requirements for Furniture for Children with Disabilities

The requirements for table and seating furniture are looked upon from the following viewpoints: workmanship, testing, structure, materials, dimensions, safety, hazards, financial costs, durability, variability, repairability, design, ergonomics, equipment, main defects and conditions etc.

The general requirements define that marketed furniture must reliably, safely and reasonably meet the purposes for which it has been designed. It must be constructed in such a way as to guarantee its utility properties in the long run. At the same time, it must be constructed using materials and joints customary for the given typological group of products, or verified by an accredited testing centre, or at least such that possess a material certificate. The product structures and components must adequately allow for the replacement of the elements crucial for its utility properties. In addition to the utility parameters and the prescribed features, the furniture must also display adequate resistance to dynamic loading when used (Brunecký *et al.*, 2011).

If the defined requirements are met fully in accordance with the suggested assessment methodology, the school furniture for children with mobility restrictions should be fully functional, easily operable – accessible, so as to ensure easy usage for the children = pupils.

Building on a thorough investigation among children = pupils and provided these requirements are taken into account, the principles may easily be adhered to in the relation between the school furniture and children with mobility restrictions with a view of removing the "*barrier*" the children must overcome so as to be able to use the furniture in at least the same way as their peers, classmates or brothers and sisters.

4 MATERIAL AND METHODS

4.1 Material

The supporting expertise used throughout the paper consists of the following specialised interdisciplinary documents, standards, methodologies and other specialised literature used as sources:

- Methods of Anthropological Research [academic support Biology UJEP];
- Basic human body dimensions for technological design [ČSN EN ISO 7250-1];
- The long-term programme to improve the health status of the population of the Czech Republic – Health for everyone in the 21st century [Resolution of the Government of the Czech Republic no. 1046, 2002];
- Information concerning assessment of the degree of dependence for persons aged 18 or less [Ministry of Labour and Social Affairs];
- International Classification of Functioning, Disability and Health [ICF];
- International Classification of Diseases [ICD];
- Information System for the Support of Research, Development, Innovation and Furniture Quality [NIS 1 - 8];
- Anthropometric data according to the division of school attendance (shifting into age groups).

Measured probands come from Brno and its surroundings. So far 172 probands have been measured to June 2013. The measured values are processed into summarizing statistics of children according to school attendance (4–7 years, 7–11 years, 11–15 years, 15–18 years).

The aforementioned sources were used by the authors of the paper to obtain information they complement their own views regarding the issues of pupils with mobility restrictions and discuss the need for determining (dimensional) requirements for school furniture with regard to the needs of pupils with mobility restrictions.

4.2 Methods

4.2.1 Research Method – Anthropometry

Anthropometric methods are subject to global standardisation drawing on precisely defined anthropometric points (Řeháková *et al.*, 2010). These anthropometric points can be easily found by touch against a bone background at specifically defined spots where a human skeleton is only covered by skin, i.e. on spots with no muscles. The measured dimension is precisely defined and set by standards. Standardised anthropometric tools are used to determine standardised anthropometric points and measures.

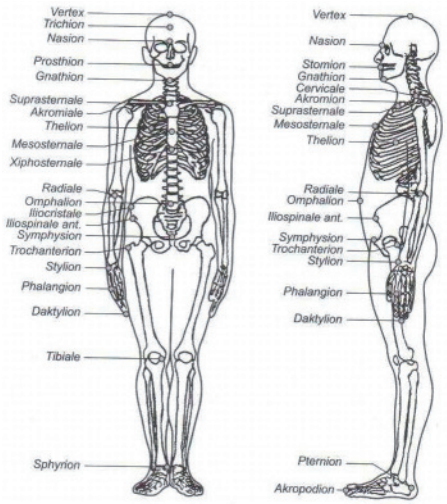
4.2.1.1 Anthropometric Instrumentation

Anthropometric instrumentation is required for the measurements of body dimensions to be measured, which is comprehensively processed in the methodogical guide "Antropometrický instrumentář a metodika měření antropometrických parametrů". The guide also contains definitions of selected anthropometric points and measurement methodology (Kopecký *et al.*, 2013).

4.2.1.2 Measured Indicators – Somatic Dimensions

Taking the measurements on children is carried out using indicators recorded in the measurement report for each individual. In addition to the measured indicators, the measurement record states an identification code, date and time of examination and date of birth of the proband.

Examples of measured indicators: *body mass; chest circumference; width of the pelvis – (bicristal); body height in sitting position, eye line height in sitting position; elbow height in sitting position; width of elbows; height of popliteal;*



2: *Anthropometric points (source: ŘEHÁKOVÁ et al., Metody antropologického výzkumu; Zach)*

height of thigh above seat; arm length bent in elbow; length buttock-popliteal in sitting position; reach distances, etc.

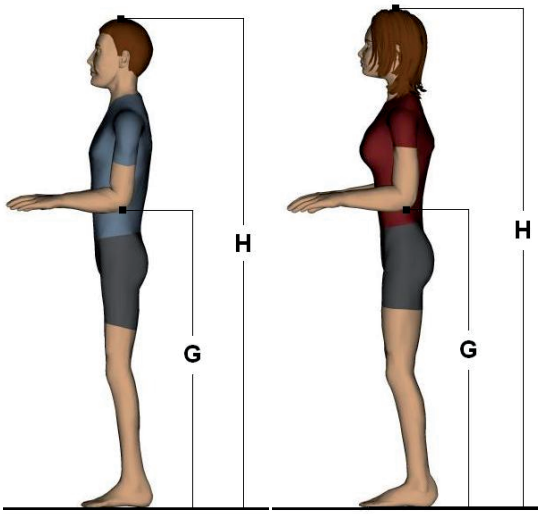
The indicators are based on anthropometric points that are identical with the points defined in a human skeleton (see: Fig. 2) and are reflected on the surface of a human body.

The anthropometric points are generally measured at:

- trunk and limbs;
- head.

Somatic dimensions based on the anthropometric points are divided into height, width and circumferential points. The modified sliding anthropometer is used in measuring the height dimensions. The width dimensions on a trunk

Measurements taken in the standing position: Junior school age 7–11 years

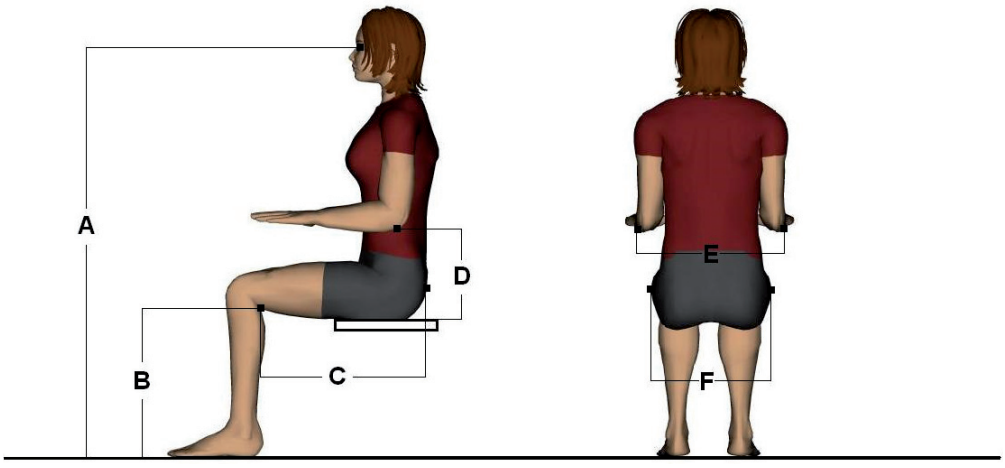


3: *Dimensional characteristic no. 2 – Body height = H; dimensional characteristic no. 5 – Elbow height = G; The picture displays a boy and a girl of junior school age (source: Zach)*

are measured by a small and large contact calliper = pelvimeter. The width dimensions on the limbs are measured by a modified sliding calliper – within our research, limb widths were not measured. Circumferential parameters are measured using a tape meter (the tape meter resembles a measuring tape but is made of soft steel or waxed canvas) while a standardised peg is used for measuring the reach distance.

Selected key anthropometic points are graphically presented argonomic software Tecnomatix Jack and

Measurements of a sitting child: Senior school age 11–15 years



4: *Dimensional characteristic no. 14 – Eye line height in sitting position = A; dimensional characteristic no. 17 – Elbow height in sitting position = D; dimensional characteristic no. 22 – Width over elbows = E; dimensional characteristic no. 23 – Seat width = F; dimensional characteristic no. 24 – Height of popliteal = B; dimensional characteristic no. 49 – Length of popliteal in sitting position = C; The picture displays a boy and a girl of senior school age (source: Zach)*

I: *Key anthropometic points defined by the ČSN EN ISO 7250-1 standard (source: Zach)*

Dimensional characteristic	Anthropometric Instrumentation	Dimension order number / Dimension name
Height dimensions and dimensions measured in standing position		
Body height	Anthropometric sliding calliper	2 / H
Elbow height	Anthropometric sliding calliper	5 / G
Total body mass	Digital personal scale	1 / -
Width dimensions at trunk	Small and large contact calliper = pelvimeter	
Width dimensions at limbs	Modified sliding calliper	
Circumferential dimensions	The tape meter	
Measurements of a sitting child		
Eye line height in sitting position	Anthropometric sliding calliper	14 / A
Elbow height in sitting position	Anthropometric sliding calliper	17 / D
Width over elbows	Anthropometric sliding calliper	22 / E
Seat width	Anthropometric sliding calliper	23 / F
Height of popliteal	Anthropometric sliding calliper	24 / B
Reach distances + functional dimensions	+ Standardised peg	
The forward reach toward the grip	Anthropometric sliding calliper	45 / -
Length elbow – grip	Anthropometric sliding calliper	46 / -
Length of popliteal in sitting position	Anthropometric sliding calliper	49 / -

presented (see: Fig 3 and Fig 4). Another dimensions are clearly and defined in Tab. I.

Measuring a human body is based on the so-called basic anatomical position. Healthy individuals (probands) are measured on the right half of the body standing upright next to a wall with the heels, buttocks, shoulder blades, head and the feet close together. The head is in the so-called reference plane, which is defined by the edges of the ear canal circumference (tragion) and the lower edge of the orbit (orbitale). The plane is horizontal. The anthropometer is always held perpendicular to the ground when determining the dimensions (Řeháková *et al*., 2010).

As an example, somatic dimensions may be used to determine the maximum reach zones for storage furniture, height and width of the seat, the minimum space per person for dining purposes, etc. The current average human body dimensions are laid down in related standards while furniture designing is governed by ČSN EN ISO 7250-1 Basic human body measurements for technological design (Brunecký *et al*., 2011). In spite of this, current dimensional requirements for furniture set in technological regulations draw on out of date values that were measured around 1970 and have not been updated since. This reseach should also contribute to the gathering of fresh dimensional characteristics of Czech children that can further be incorporated into respective regulations.

The ČSN EN ISO 7250-1 standard defines the dimensions to be measured when standing upright and in a sitting position, dimensions of the individual body parts (such as palm length, head width, etc.), functional dimensions (such as the forward reach toward the grip, chest circumference, gripping height, etc.), and mass. The standard follows the total of 56 anthropometric dimensions. As part of the measurements, 35 somatic dimensions are investigated while 31 somatic dimensions are based on the ČSN EN ISO 7250-1 standard, and the following dimensions to be measured are added: height of the suprasternale, elbow height in 90° flexion, stylion point height and arm span (Brunecký *et al*., 2011).

People/children with mobility restrictions generally exhibit impaired mobility due to the disability. With regard to furniture and its operation this applies to: ***seating depth and height***, ***maximum reach while using storage furniture***, etc.

4.2.2 Statistics – Percentile Method and T-test Method

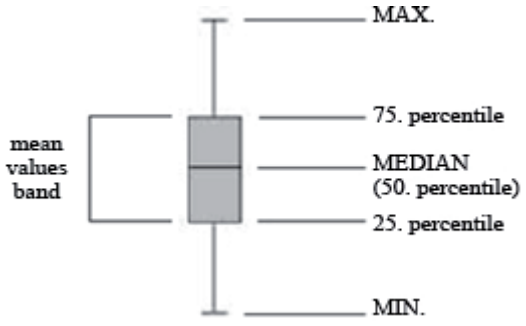
The measurements of dimensional characteristics in children are assessed and processed in the forms of tables for both young school age and older school age and for pre-school and adolescent age, the tables provide the stated details. By means of the obtained results children are checked for positive secular trend. In current children population in the Czech Republic an increse in the population height and mass is evident and simultaneously the difference between the maximum and minimum values is growing in comparison with the previous measurements (year 1970, 1985).

Evaluation of the measurement results conveniently utilizes the T-test method which is based on testing by means of nonparametric correlation. Results are further processed by the Percentile method which is an alternative to

statistic data processing. Use of the Percentile method, an alternative to statistic data processing, is recommended for evaluating the measurement results. The average values are insufficiently applicable as a result of major differences in the individual body parts, and therefore, a range must be worked with instead. It was proven statistically that measuring a human body in any given population sample will be distributed in such a way that (majority) will fall somewhere to the middle while a small number of extreme measurements will alternatively be recorded in either end of the spectrum. As it is impossible to carry out the design for the entire population sample, it is crucial that the segment be chosen out of the middle segment. As a result, it is nowadays customary to ignore the extreme results on both ends of the range and work with the 90% of the population group. Most anthropometric data is therefore expressed in terms of percentiles.

On the basis of correlation relations and dimensional characteristics statistical frequency of occurrence percentile values can be ascertained which state the given interval of dimensions in the mean values band.

For the purposes of the present study, the children population is divided into 100 percentage categories ranked from the smallest to the biggest with regard to some specific types of body measurements. The initial percentile for the figure or height, as an example, indicates that 99% of the population sample the study deals with is of a bigger height. And similarly, the 95th percentile implies that only 5% of the studied population is of a bigger height and 95% of the studied population is of either the same or smaller height. The percentiles indicate the percentage of persons within the population (population sample) the body dimensions of which are of a certain size (or smaller) (Brunecký *et al.*, 2011).



5: *Percentile (source: Zach of NIS)*

For the purpose of children population evaluation an interval of standard dimensions was set between the **25 and 75th** percentile defining the **mean values band** (see: Fig 5).

A series of national anthropometric research was carried out in 10-year intervals, with the last one taking place in 2001. In principle, no other anthropometric measurements are performed in children at the time being in the territory of the Czech Republic.

5 RESULTS AND DISCUSSION

The classification of children from whom the following measurements have been acquired was processed in correspondence with the values used for the classification for the purposes of school attendance (age groups):

- **pre-school age** (4–7 years);
- **junior school age** (7–11 years);
- **senior school age** (11–15 years);
- **Adolescenns** (15–18 years).

35 somatic dimensions were investigated while 31 somatic dimensions are based on the ČSN EN ISO 7250-1 standard and the following dimensions to be measured were added: *height of the suprasternale*, *elbow height in 90° flexion*, *stylion point height* and *arm span* (see: Tab. II).

The outcome of the conducted anthropometric measurements was summary statistics of somatic dimensions of healthy children divided as per the classification for school attendance purposes to be used for further research and development of a model example for both healthy children and, by inference, children with limited functional capacity and disability (child with a wheelchair). The output values gained by measurement indicate an **increase in the median** values for the basic somatic dimensions within the development of the individual groups of children divided as per the classification used for school attendance purposes.

The processed results of measured dimensional characteristics for individual children groups enable identification of maximum reach distances of pupils, height – width of a seat, minimum space required for educational purposes, etc.

The values obtained by means of measurements may only be applied as long as they are regarded as aggregate statistics for children divided as per the classification used for school attendance purposes (4–7 years; 7–11 years; 11–15 years; 15–18 years) as only 172 probands have been measured by June 2013. The subjected probands were from Brno and close vicinity. The measured values are not statistically valid ((since individual age categories

II: *Additional measured anthropometric points (source: Zach)*

Additional measured somatic dimensions of a standing child – not following the ČSN EN ISO 7250-1			
1	Height of the suprasternale	3	Stylion point height
2	Elbow height in 90° flexion	4	Arm span

of children do not reach a sufficient number of members: pre-school age N = 17; junior school age N = 39; senior school age N = 54; Adolescenns N = 62), if for no other, than for the reason that the statistical sample within the measurement is insufficient (proband = an individual subjected to the research). Once a sufficient number of children have been subjected to the measurements in all of the age groups (6–18 years), adequate values for all measured somatic dimensions may be obtained for all individual categories defined by year units. Then the somatic dimensions, on the basis of which it is possible to determine current **dimensional requirements for school furniture, and/or children furniture in general**, will be regarded as statistically proven.

At this time it is virtually impossible to ensure the measurement are statistically valid. This is due to a number of factors referred to below:

- consent of the parents is required for the measurement;
- the staff of the health care establishment and the anthropologists must be trained to carry the measurements out (and the consent of their superior must be obtained);
- children may no longer be measured at educational establishments as the latter introduce restrictions that prevent anybody else from touching the children. In a health care setting, that is a part of the medical profession.

These facts render it impossible for us to complete the research in the short run and still arrive at a valid sample. Therefore, the measurements take place gradually and individually with an account taken of the aforementioned facts.

The values that have been measured so far under the aggregate statistics for the individual age groups of Czech children imply that the number of **N** values is not identical for all somatic dimensions measured. The reason is that the proband concerned had injuries during the measurements that made it impossible to measure the given somatic dimension. The **SD** value determines the standard deviation for each somatic dimension measured. The ***Median*** value – a range of mean values – is used to process the indices and dimensional requirements for children furniture (see: Fig. 5). It is given by the 50th percentile of the series of measured values (see: Tabs. III–VI) and for explanation of the method see chapter 4 Material and Methods, and subchapter 4.2.2 Statistics – Percentile Method and T-test Method.

The development of children in terms of anthropometry is highly variable in time. After all, development of somatic dimensions (body height and others) may be monitored for the individual age groups of Czech children on the Charts 3 and 4 below. The variability is also observed within ethnicities, which is beyond the focus of this research. If the attempt to determine dimensional requirements for school furniture is based on the currently measured somatic values, an account must be taken of the variability of Czech children development (secular trend) in the time frame of the upcoming decades.

The measured values are the input for a model example that may be applied to school children furniture (a pupil sitting by a school desk – division as per the classification for school attendance purposes).

The following tables show key anthropometic points and their measured values at individual age groups of children (see: Tabs. III–VI).

III: *Pre-school age 4–7 years (source: Zach)*

Summary Statistics All children 4–7 years	N	Average	Median	Minimum	Maximum	SD
Measurements taken in the standing position						
1 – Mass	17	22.6	**21.8**	18.8	29.6	3.3
2 – Body height	17	119.6	**118.1**	110.0	132.5	5.9
5 – Elbow height / V_ elbow	17	70.7	**69.8**	64.5	80.5	4.1
Measurements of a sitting child						
14 – Eye line height in sitting position / Eye-line_height_sitting	16	52.0	**51.7**	46.4	56.1	2.3
17 – Elbow height in sitting position / Elbow_Height_sitting	16	15.2	**14.7**	12.2	18.4	1.9
22 – Width over elbows (width of elbows) / Elbow_width_sitting	16	42.1	**42.8**	28.5	61.1	9.8
23 – Seat width / Width_sitting	16	25.3	**25.6**	20.7	29.0	2.3
24 – Height of popliteal / Popliteal_height_sitting	16	30.5	**30.5**	27.0	35.0	2.0
Functional dimensions						
45 – The forward reach toward the grip / Reach_grip	16	52.0	**52.0**	45.5	61.7	3.5
46 – Length elbow – grip / Elbow_grip	16	24.3	**24.6**	20.9	26.2	1.7
49 – Length of popliteal in sitting position / Popliteal_length_sitting	16	31.8	**32.1**	27.7	34.9	2.0

The measurements have been taken by the Department of Anthropology of the Faculty of Natural Sciences, Masaryk University, under the leadership of Mgr. Martin Čuta, Ph.D.

The measured values (see: Tabs. III–VI) in frames of individual age groups divided as per the classification for school attendance purposes give the number of children that were subjected to measurement (**N**). The leading author of the paper focuses primarily on junior school age (age span 7–11 year = first level of elementary school) as well as on senior school age (age span 11–15 years = second level of elementary school or first 4 grades at an eight-grade grammar school).

The percentile distribution of body height in these two major age groups is visualised at Fig. 6 and Fig. 7.

Tab. VII presents the body height differences measured in 1975 and current anthropometric measurement up to 2013 at junior and senior school age. Children demonstrate an increase in body height.

Based on the ongoing measurements, requirements, i.e. dimensional requirements, are stipulated for school furniture. As regards the

IV: *Junior school age 7–11 years (source: Zach)*

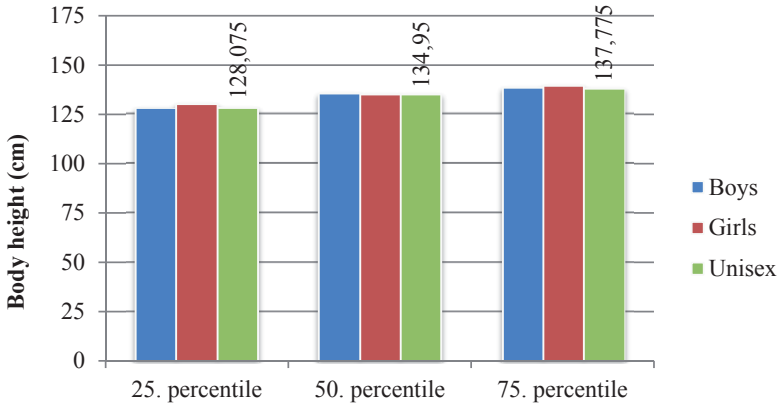
Summary Statistics All children 7–11 years	N	Average	Median	Minimum	Maximum	SD
Measurements taken in the standing position						
1 – Mass	38	30.1	**28.4**	20.6	49.6	7.6
2 – Body height	38	134.2	**135.0**	120.8	149.4	7.7
5 – Elbow height / V_ elbow	36	80.7	**81.4**	70.2	93.4	5.5
Measurements of a sitting child						
14 – Eye line height in sitting position / Eye-line_height_sitting	38	59.2	**59.7**	51.7	66.9	4.2
17 – Elbow height in sitting position / Elbow_Height_sitting	36	17.1	**17.2**	11.2	22.3	2.3
22 – Width over elbows (width of elbows) / Elbow_width_sitting	35	49.5	**48.2**	27.7	73.3	11.2
23 – Seat width / Width_sitting	38	27.7	**26.6**	22.5	40.3	3.8
24 – Height of popliteal / Popliteal_height_sitting	38	33.4	**33.7**	28.0	38.0	2.1
Functional dimensions						
45 – The forward reach toward the grip / Reach_grip	38	57.7	**58.0**	48.1	66.4	4.0
46 – Length elbow – grip / Elbow_grip	38	26.9	**26.9**	22.5	32.2	2.1
49 – Length of popliteal in sitting position / Popliteal_length_sitting	38	37.1	**37.2**	31.2	44.0	3.0

V: *Senior school age 11–15 years (source: Zach)*

Summary Statistics All children 11–15 years	N	Average	Median	Minimum	Maximum	SD
Measurements taken in the standing position						
1 – Mass	54	49.2	**44.7**	25.6	96.1	16.2
2 – Body height	54	158.3	**158.8**	129.3	187.6	12.4
5 – Elbow height / V_ elbow	53	97.6	**97.5**	77.8	117.1	8.6
Measurements of a sitting child						
14 – Eye line height in sitting position / Eye-line_height_sitting	54	69.7	**69.2**	51.3	82.6	6.9
17 – Elbow height in sitting position / Elbow_Height_sitting	53	19.9	**19.5**	12.0	27.8	3.7
22 – Width over elbows (width of elbows) / Elbow_width_sitting	52	63.3	**63.2**	39.6	85.7	9.4
23 – Seat width / Width_sitting	53	33.5	**33.1**	25.3	47.3	5.2
24 – Height of popliteal / Popliteal_height_sitting	53	39.2	**38.8**	34.0	64.0	4.3
Functional dimensions						
45 – The forward reach toward the grip / Reach_grip	54	67.3	**66.6**	54.2	81.7	5.8
46 – Length elbow – grip / Elbow_grip	54	31.8	**32.0**	24.8	37.2	2.8
49 – Length of popliteal in sitting position / Popliteal_length_sitting	52	44.2	**43.8**	36.7	53.0	3.6

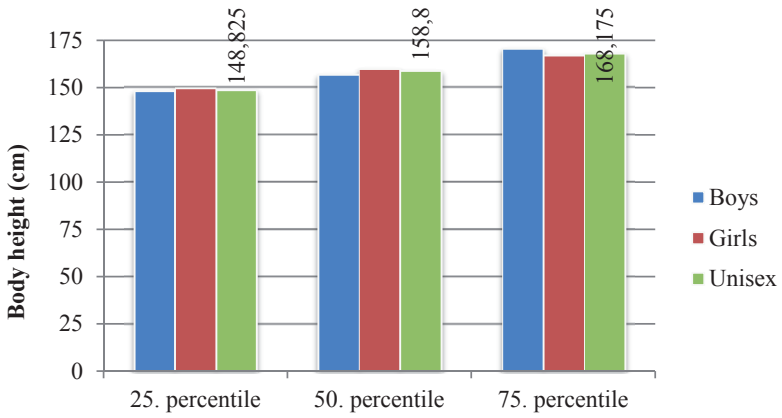
VI: *Adolescenns 15–18 years (source: Zach)*

Summary Statistics All children 15–18 years	N	Average	Median	Minimum	Maximum	SD
Measurements taken in the standing position						
1 – Mass	62	57.5	**55.6**	36.6	87.8	11.7
2 – Body height	62	169.3	**168.6**	153.8	198.5	9.2
5 – Elbow height / V_ elbow	60	104.5	**104.7**	92.9	129.6	6.5
Measurements of a sitting child						
14 – Eye line height in sitting position / Eye-line_height_sitting	61	76.5	**75.9**	67.4	87.6	4.5
17 – Elbow height in sitting position / Elbow_Height_sitting	60	23.4	**23.1**	14.3	31.2	2.7
22 – Width over elbows (width of elbows) / Elbow_width_sitting	53	66.5	**67.9**	41.3	104.9	11.2
23 – Seat width / Width_sitting	61	37.1	**36.6**	30.0	47.4	4.0
24 – Height of popliteal / Popliteal_height_sitting	61	40.8	**41.2**	34.0	50.0	2.9
Functional dimensions						
45 – The forward reach toward the grip / Reach_grip	61	71.6	**70.8**	61.7	81.0	4.1
46 – Length elbow – grip / Elbow_grip	61	33.9	**33.8**	28.5	39.9	2.3
49 – Length of popliteal in sitting position / Popliteal_length_sitting	61	47.8	**47.2**	42.3	54.2	2.7



Percentile distribution of body height of junior school age

6: *Visualisation of percentile distribution of body height of junior school age (source: Zach)*



Percentile distribution of body height of senior school age

7: *Visualisation of percentile distribution of body height of senior school age (source: Zach)*

VII: *Body height of individual age groups of children in the Czech Republic in years and difference between them (cm) (source: Zach)*

Body height (cm)	**x̄ Arithmetic mean**		
Junior school age	1975	**2012**	difference
Boys	132.8	**133.5**	0.7
Girls	132.5	**135.3**	+ 2.8
Unisex	132.7	**134.2**	+ 1.5
Senior school age	1975	**2012**	difference
Boys	154.9	**158.4**	3.5
Girls	156.1	**158.1**	2.0
Unisex	155.5	**158.3**	2.8

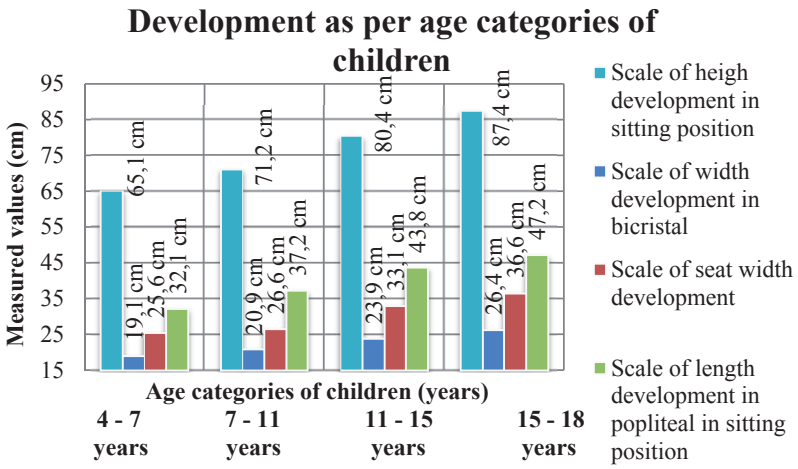
priorities, these concern sitting and table furniture, i.e. school (work) furniture. The somatic dimensions development at individual age groups of Czech children can be viewed in the diagram Fig. 8 and Fig. 9 below.

On the basis of measured values the model examples of a pupil sitting by a school desk have been processed = simulated. Fig. 10 shows a simulation of a healthy pupil in a sitting position as well as a pupil with mobility restrictions (on a wheelchair).

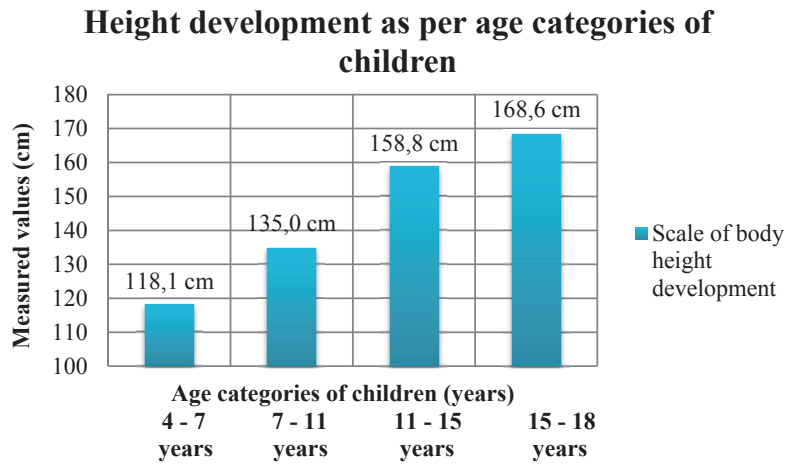
Thanks to the conducted measurement – research requirements and criteria have been defined that are subject to the school furniture assessment methodology. The suggested methodology of school furniture requirements assessment forms a primary objective of the final work of one of the paper's authors. Publication of an electronic professional monograph constitues the pillar of the final work processing (Zach, 2013).

Requirements are divided into three levels that are interconnected. The first level follows a user (a pupil with mobility restrictions). The second level directly focuses on furniture as such and the third level assesses a long-term sustainability and cost-effectiveness.

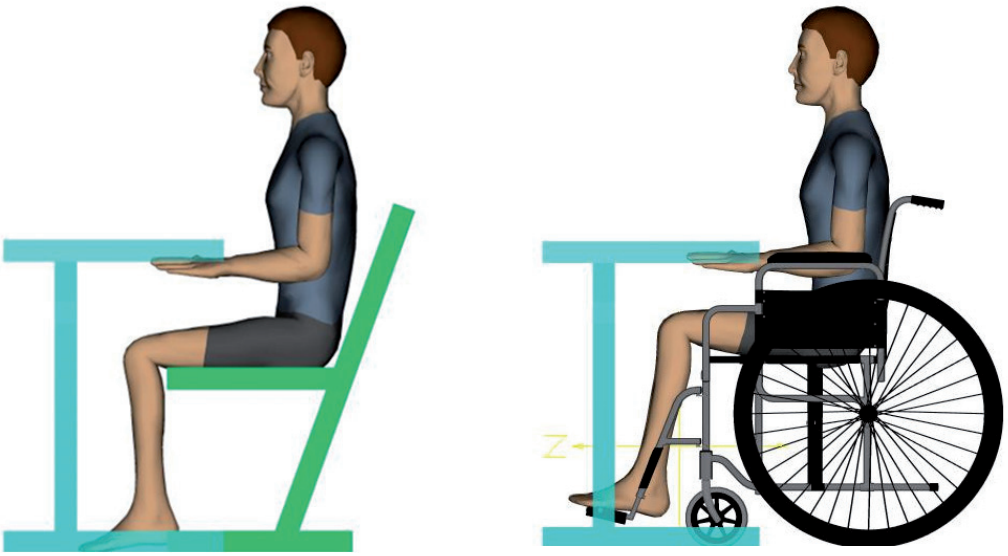
The school furniture assessment methodology for Czech children with mobility restrictions can be forwarded for all educational institutions in the Czech Republic where pupils form the target group. It may be applied when a pupil with mobility restrictions enrols at the given school, i.e. during



8: *Development of somatic dimensions as per age categories of children (source: Zach)*



9: *Height development as per age categories of children (source: Zach)*



10: *Visualisation of a child in a wheelchair – sitting position by a pupil's desk – size group No. 5 – flat table board – a boy of senior school age (source: Zach)*

the selection, purchase and set-up of dimensional parameters of school furniture so that the conditions of pupil's integration into the educational process are well prepared.

The outcome of the assessment is an opinion for each assessed product. On the basis of comparison and assessment the selected school furniture item will be recommended for purchase. The methodology can also be applied to pupils without mobility restrictions.

CONCLUSION AND SUMMARY

The selected issue discussed by the paper is in accord with Oliver Speck (1991 in Horňáková, 1999, p. 30) who states that *everyone lives in a real environment as its integral part*. The quote corresponds to the new theories of treatment and education (a term coined by Dannemann, Schober and Schulze, 1911), it is based on anthropology, namely its subject of study, which has been and is in accordance with the research carried out and described by the authors of the text in the previous chapters. Generally, the issue of treatment and education form a part of the current attempts at integrating its defining area of expertise into Czech special education domain, for which the knowledge obtained by the former become an added value in terms of building a higher-quality environment for individuals and the society with varying degrees of disability – mobility restriction. The facts described form a part of a broader discussion which is related to integration and, ideally, inclusive reception of such excluded individuals (pupils and students) in full-fledged social life (including the school environment). The discipline referred to above mainly focuses on the pupils' ecological and health factors, where it points to the importance of dealing with the variables, in this case the furniture parameters in relation to children anthropometry, where their true knowledge is an indisputable factor in the healthy development (growth) of individuals and forms conditions for the successful implementation of the said societal processes, which is supported by the National Action Plan for Inclusive Education of 15 March 2010, which is compatible with the document Health 21 – The long-term programme to improve the health status of the population of the Czech Republic – Health for everyone in the 21st century (Resolution of the Government of the Czech Republic No. 1046; Government of the Czech Republic, discussed on 30 October 2002).

The results include suggestions and application of the methodology where the assessment requirements are divided into three interconnected levels. The measured characteristics and their values form input data for the definition of requirements and criteria for school furniture, in other words for dimensional characteristics. Apart from defined requirements, model examples of a pupil sitting by a school desk are simulated. Further simulations are carried out for a pupil with mobility restrictions (on a wheelchair) as well.

The importance of the methodology lies in the prevention of faulty body posture in sitting position which is one of the factor of children's health status deterioration. The methodology can be applied

as recommended practices for the management of educational institutions when inviting tenders for a project, public procurements and eventually during the selection procedure, purchase and set-up of dimensional parameters of school furniture.

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