VILNIUS UNIVERSITY

Rūta Almonaitienė

PERMANENT TEETH EMERGENCE TIME AND GROWTH OF THE FACE AND JAWS OF LITHUANIAN CHILDREN (DATA OF 4–16 YEARS OLD CHILDREN, RESIDENTS OF VILNIUS CITY)

Summary of doctoral dissertation

Biomedical sciences, medicine (06 B)

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Academic supervisor:

Prof. habil. dr. Irena Balčiūnienė (Vilnius University, Biomedical Sciences, Odontology – 07 B)

Academic advisor:

Prof. dr. Janina Tutkuvienė (Vilnius University, Biomedical Sciences, Medicine – 07 B)

The dissertation will be defended at the Research Board for Medicine of the Vilnius University:

Chairman:

Prof. dr. **Algirdas Utkus** (Vilnius University, Biomedical Sciences, Medicine – 06 B)

Members:

Prof. habil. dr. **Ričardas Kubilius** (Lithuanian University of Health Sciences, Biomedical Sciences, Odontology – 07 B)

Prof. dr. **Nomeda Rima Valevičienė** (Vilnius University, Biomedical Sciences, Medicine – 06 B)

Prof. dr. **Neringa Paužienė** (Lithuanian University of Health Sciences, Biomedical Sciences, Biology – 01 B)

Prof. dr. **Eugenijus Lesinskas** (Vilnius University, Biomedical Sciences, Medicine – 06 B)

Opponents:

Prof. habil. dr. **Vytautas Usonis** (Vilnius University, Biomedical Sciences, Medicine – 06 B)

Prof. habil. dr. **Antanas Šidlauskas** (Lithuanian University of Health Sciences, Biomedical Sciences, Odontology – 07B)

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Adress: Ciurlionio 21, Vilnius LT-03101, Lithuania.

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VILNIAUS UNIVERSITETAS

Rūta almonaitienė

LIETUVIŲ VAIKŲ VEIDO, ŽANDIKAULIŲ IR DANTŲ RAIDA (VILNIAUS MIESTO 4–16 METŲ VAIKŲ DUOMENYS)

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Mokslinis vadovas:

prof. habil. dr. **Irena Balčiūnienė** (Vilniaus universitetas, biomedicinos mokslai, odontologija– 07B).

Mokslinis konsultantas:

prof. dr. **Janina Tutkuvienė** (Vilniaus universitetas, biomedicinos mokslai, medicina – 06B).

Disertacija ginama Vilniaus universiteto medicinos mokslo krypties taryboje:

Pirmininkas:

Prof. dr. **Algirdas Utkus** (Vilniaus universitetas, biomedicinos mokslai, medicina – 06 B)

Nariai:

Prof. habil. dr. **Ričardas Kubilius** (Lietuvos sveikatos mokslų universitetas, biomedicinos mokslai, odontologija – 07 B)

Prof. dr. **Neringa Paužienė** (Lietuvos sveikatos mokslų universitetas, biomedicinos mokslai, biologija – 01 B)

Prof. dr. **Nomeda Rima Valevičienė** (Vilniaus universitetas, biomedicinos mokslai, medicina – 06 B)

Prof. dr. **Eugenijus Lesinskas** (Vilniaus universitetas, biomedicinos mokslai, medicina – 06 B)

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Prof. habil. dr. **Vytautas Usonis** (Vilniaus universitetas, biomedicinos mokslai, medicina – 06 B)

Prof. habil. dr. **Antanas Šidlauskas** (Lietuvos sveikatos mokslų universitetas, biomedicinos mokslai, odontologija – 07 B)

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INTRODUCTION

Health of a child as a reflect of social, economic and ecological wellbeing of a society is a concern in everyday practice of many medical specialists. General health and indices of physical status of children are well investigated and documented, including standards of physical indices for monitoring growth and development. In clinical practice, data from morphological studies bear undoubtable value in early diagnosis of disturbed growth or disease and helps to organize both treatment and prophylactic procedures in advance. Undoubtedly, growth of the head and face and eruption of teeth not only reflects child's general health and physical status but also contribute in early diagnosis of impaired development of a child and are especially important in planning treatment for both plastic surgery and orthodontics in children with congenital and acquired facial deformities. As facial proportions change with age, especially during intensive growth, together with the number of erupted permanent teeth they can help to establish child's age when birth records are missing.

Although human face as a special part of the human body has drawn attention of artists, poets and scientists from ancient times and first canons of craniofacial and whole body were established during the Egyptian Dynastic, later developed in Renaissance, most of these so called neoclassical cannons were formulated for adults (Farkas, 1987; Farkas, 1994). Those canons were accepted by modern plastic surgeons and were used in textbooks of plastic reconstructive surgery until recent days (Farkas, Munro, 1994). So the history of the researches of the head and face started from the desire to describe harmony of the human face mathematically.

From the published studies on human head morphology, proportions and growth patterns, it can be concluded that scientists were divided into different groups, separately and sometimes independently from each other investigating regions of the head in which they were interested in. Maybe the fact that human face was attributed more to aesthetic demands rather than to the indices of health and physical status, was the reason why dimensions of human head and especially face during anthropometrical studies were investigated in lesser extent than compared to the dimensions of the whole body. From

anthropometrical perspective, head length, breadth and circumference define general head growth, while face height and width – general size and growth of the face (Balciuniene, Nainys et al., 1991). So in most anthropometric studies dealing with general growth and physical status of children only these few dimensions of the head were investigated and described.

While aesthetics and desire to create or reconstruct ideal facial proportions in a number fields of medicine, including plastic reconstructive surgery, maxillofacial surgery and orthodontics, remained driving force to investigate growing face more deeply, but also separated skeleton of the face from the soft tissues and evaluated growth and shape of these parts separately. Indeed researches on craniofacial growth and development were concentrated in obtaining growth patterns of the bones and most of the knowledge on craniofacial growth, morphology and proportions in vertical and sagittal planes, facial profile changes during growth comes from the longitudinal roentgenologic studies done in the middle of 21st century (Enlow, Hans, 1996; Profit, Fields, 2000).

The growing demand for plastic surgery to treat children with congenital and acquired facial deformities, also to differentiate genetic syndromes based on objective rather than subjective criteria in the head and face, was the main stimulus for developing of clinical facial morphology, standards of minute facial measurements and regional proportion indices. Despite of the long history of anthropometric studies of the head and face, first complete data on the dimensions and proportion indices of head and face covering all growth period appeared in 1991, when Leslie G. Farkas published his research on anthropometric growth study of the head and face (Farkas, Munro 1994). Although the number of subjects in each age group was around 30, this anthropometric study is one of the biggest studies done until recent days, all following researches came shorter either by dimensions studied or age period covered (Zankl et al, 2002; Arboleda et al, 2011, Zhu et al, 2008). Nonetheless, there is a lack of data regarding sexual differences in human face during childhood and not all patterns of craniofacial growth are currently well understood.

In evaluation of face morphology, the assessment of solitary measurements is insufficient, to analyse the relationship between measurements (or

proportion indices) is required. Actually, proportions between different parts of the face are crucial in determining subjective attractiveness of the face, while objective evaluation of proportions are essential for early recognition of developing facial disproportion, disturbances in growth and planning treatment procedures (Farkas et al, 2003; Yamada et al, 2002). The indices are not stable, they change due to disease and syndromes (Farkas 1985, 1989; Yamada et al, 2002), growth (Farkas et al, 2003), race and ethnicity (Farkas et al, 2007) and gender (Buretic – Tomljanovic et al, 2007). There is a lack of anthropometric growth studies, especially regarding preschool and school years, most of them consider only some regions of the face: ears, eyes or lips (Everklioglu et al, 2002; Farkas et al, 2003; Ghanbari, Bayat, 2009; Kalcioglu et al, 2003; Zankl et al, 2002; Zhu et al, 2008).

Along with the recent modern methods for analysis of the human head and face (Ferrario et al, 1999, Ghoddousi et al, 2007), anthropometry has still maintained a great value. The method is non-invasive, comparatively inexpensive, describes quantitative peculiarities of the craniofacial complex, and allows recognize initial signs of disproportion at early childhood (Farkas, 1987; Farkas, Munro 1994, Kolar and Salter, 1996).

In Lithuania, the physical status of children is well examined and documented, but the data on the anthropometry of the head and face is scarce. Main measurements of the head and face of children 7 to 18 years old were investigated several times: 1965-1967 and 1984-1985 (Balciuniene, Nainys, 1991). So there is a need to have measurements and proportions of the head and face as well as their changes during intensive growth periods for both preschool and school children in Lithuania.

Tooth eruption is defined as the movement of a tooth from its site of development within the alveolar process to its functional position in the oral cavity. The whole process is divided into five stages, one of which being mucosal penetration or emergence of any visible part of a tooth into oral cavity. This particular stage of tooth development, sometimes called clinical tooth eruption, had always been of particular interest to various specialists and scientists because knowledge of teeth emergence chronology and sequence is essential in children healthcare planning and numerous fields of clinical dentistry such as preventive and paediatric dentistry, orthodontics

and oral surgery. Also disturbances in permanent teeth emergence time can be the earliest sign of systemic disease or syndrome. They are also supplemental to other maturity indicators in establishing children age in forensic medicine when birth records are unknown or missing.

Timing of teeth emergence differs from population to population and can be affected by genetic (gender, ethnicity, race) and environmental factors (body composition, nutrition, intake of fluorides, socio-economic level, primary teeth caries and its sequels, early loss of predecessor, crowding in dental arch or dental trauma). As timing of permanent teeth emergence can be modified by such a variety of factors, it becomes important to acquire accurate chronological eruption parameters from population in which they are to be used. Little information is available regarding dental parameters in Lithuania. To the best of author's knowledge, data about emergence time of permanent teeth in a Lithuania child population has not been provided. For that reason, dentists working in Lithuania have still been referring to standards available in the textbooks of clinical dentistry.

The aim of the present study was to evaluate measurements, proportions, growth patterns of the face and jaws and to provide the emergence time and sequence of permanent teeth of Lithuanian children 4 to 16 years of age.

Tasks of the study:

1. To investigate general size, form, age dynamics and sexual peculiarities of the head of Lithuanian children 4 to 16 years of age.
2. To investigate general size, form, age dynamics and sexual peculiarities of the face of Lithuanian children 4 to 16 years of age, to establish relationship between measurements of the face and body height.
3. To investigate measurements, age dynamics and sexual peculiarities of the facial regions (orbits, ears, nose and mouth) of Lithuanian children 4 to 16 years of age.
4. To establish proportion indices of the face and jaws and their cut off points for each age group and sex.
5. To evaluate the secular trend of the head measurements of Lithuanian children 7 to 16 years of age in the period of 1965-2011 years.
6. To evaluate the timing, sequence and sexual dimorphism of permanent teeth emergence in Lithuanian children.

The novelty and significance of the study:

This study presents anthropometrical measurements and proportions of the head, face and jaws as well as their age dynamics, sexual dimorphism, secular trend over past 50 years of Lithuanian children 4 to 16 years of age. Also normal variation of the emergence time and sequence, differences between sexes in clinical eruption of permanent teeth, also correlation between number of erupted teeth and facial dimensions and body height are analysed.

Most of the measurements and all proportion indices, the emergence time of permanent teeth and their correlation with body height and facial dimensions in Lithuanian children are presented for the very first time. The study provides modern criteria and gives cut-offs for the evaluation of individual head and face, enhances implementation and evaluation of preventive or curing measures.

The results of the study illustrate variation of the head and face morphology during intensive growth period and gives insight into peculiarities of age dynamics; also, the secular trend in the main dimensions of the head and face of school children during the last 50 years was investigated.

The results are significant and have a great value not only for anthropologists, specialists of human biology or public health, but for the dentists, maxillofacial and plastic-reconstructive surgeons, paediatricians, endocrinologists and all other physicians in their clinical practice evaluating general as well as oral health of the child during the period of growth of the face and jaws and eruption of permanent teeth. Also the results are important to forensic medicine in determining child's age when birth records are missing.

SUMMARY OF THE DISSERTATION

The structure and volume of the thesis. The dissertation is written in Lithuanian. The thesis includes the following chapters: Introduction, Review of the Literature (divided into ten subchapters), Material and Methods, Results, Discussion (divided into five subchapters), Conclusions, References and Annex. The thesis consists of 154 pages of text, 32 tables, 78 figures, 306 references and 213 pages of Annex.

MATERIAL AND METHODS

The data from a cross-sectional study, carried out in 2004 – 2009 and 2010-2011 at Vilnius kindergartens and schools are presented in the thesis. The Lithuanian Bioethics Committee approved the study.

In total, 3617 healthy children 4–16 years old were investigated by the author. The number and age of children are presented in Table 1.

Age group (years)	Boys	Girls	Total
4 (3,5 – 4,4)	100	96	196
5 (4,5 – 5,4)	104	109	213
6 (5,5 – 6,4)	125	109	234
7 (6,5 – 7,4)	143	119	262
8 (7,5 – 8,4)	111	127	238
9 (8,5 – 9,4)	125	138	263
10 (9,5 – 10,4)	128	145	273
11 (10,5 – 11,4)	169	159	328
12 (11,5 –12,4)	190	197	387
13 (12,5 – 13,4)	206	206	412
14 (13,5 – 14,4)	192	189	381
15 (14,5 – 15,4)	101	120	221
16 (15,5 – 16,4)	99	110	209
Total	1793	1824	**3617**

Table 1. The number and age of investigated children.

The standard anthropometric instruments and standard anthropometric methods were used (Farkas, Munro, 1994; Kolar, Salter, 1996; S. Martin & K. Saller, 1957). The possible bias due to interobserver error could be excluded as the measurements were performed by the author. The emergence of all permanent teeth, except wisdom teeth was recorded with a dental mirror under natural light. Tooth was recorded as erupted if any part of the crown was visible.

The anthropometrical programme of the study included the following measured and computed indices:

1. Linear measurements:

1. Body height, auricular height, chin height.
2. Cranial measurements: 2.1 Horizontal: cranial breadth, frontal breadth, cranial base width
   2.2 Sagittal: cranial length
   2.3 Vertical: forehead height, anterior head height, total craniofacial height.
   2.4 Surface: head circumference.
3. Facial measurements: 3.1 Horizontal: face breadth, mandible breadth,
   3.2 Sagittal: middle face depth, upper third face depth, middle third face depth, lower third face depth, mandibular body length.
   3.3 Vertical: physiognomic face height, morphological face height, upper face height, middle face height, lower face height, anterior mandible height, chin height, mandibular ramus height.
4. Orbital measurements: intercanthal distance, biocular width, interpupillary distance.
5. Nasal measurements: length of the nasal bridge, nasal tip protrusion, height of the nose, width of the nose, length of the collumela.
6. Orolabial measurements:
   6.1 Horizontal: labial fissure width, philtrum width.
   6.2 Vertical: upper lip height, philtrum length, upper vermilion height, lower vermilion height, cutaneous lower lip height, lower lip height, lateral lip height.
7. Ear measurements: ear length and width.

2. Relative indices of different head and face parts:

2.1 General proportions of the head:

Total craniofacial height-body height index, cephalic index, cranial breadth-total craniofacial height index, anterior head height- total craniofacial height index, physiognomic face height-total craniofacial height index, morphological face height- total craniofacial height index.

2.2 Areal and interareal proportions of the head:

forehead height-anterior head height index, cranial base breadth-upper face depth index, cranial base breadth-middle face depth index, cranial base breadth-lower face depth, forehead breadth-face breadth index, forehead breadth-cranial breadth index, cranial base breadth-cranial breadth index, forehead breadth-cranial base breadth index, forehead height-middle face height index, forehead height-morphological face height index, anterior head height-morphological face height.

2.3 Areal and interareal proportions of the face:

mandible breadth-face breadth index, middle face height-face width index, anterior mandible height-mandible breadth index, middle face height-morphological face height index, anterior mandible height-middle face height index, anterior mandible height-lower face depth index, middle face height-upper face depth index, morphological face height-physiognomical face height index, facial index, anterior mandible height-lower face height index, mandible breadth-physiognomical face height, lower face height-biocular width index, facial breadth-cranial breadth, facial breadth-cranial base breadth index, lower face height-morphological face height index, middle face depth-lower face depth index, mandible breadth-lower face depth, mandible breadth – morphological face height index.

2.4 Proportions of the facial regions:

2.4.1 Orbital region: intercanthal distance-biocular distance index, intercanthal distance – labial fissure width index, intercanthal distance – nasal width index, intercanthal distance – forehead breadth index, biocular distance – facial breadth index.

2.4.2 Nasal region: nasal tip protrusion – nasal width index, nasal tip protrusion – upper lip height index, height of the nose – morphological face height index, height of the nose – middle face height index, height of the nose – lower face height index, height of the nose – facial breadth index, nasal width – height of the nose index, nasal width – labial fissure width index.

2.4.3 Orolabial region: upper lip vermillion height – upper lip cutaneous height index, labial fissure width – facial breadth index, upper lip vermillion height – lower lip vermillion height index, upper lip height – labial fissure width index, upper lip height – middle face height index, upper lip height – lower face height index, upper lip height – height of the nose index.

2.4.4 Ear region: ear index, ear length – morphological face height index, ear height – craniofacial height index, ear height- lower face height index.

The absolute and relative increments of all measurements and growth rate were computed. The study on parental ethnicity was conducted also (questionnaires were filled in by the parents).

Statistical analysis of the data was performed using the standard statistical programmes SPSS, EXCEL for Windows and MinTab 15. Descriptive statistics for raw data, the main percentiles of the anthropometrical indices were computed. The comparative analysis in groups was performed using Student's t-test, one-way ANOVA, nonparametric Mann – Whitney test, x^2 test (for categorical variables). Correlation analysis of different measurements was performed using Pearson's correlation coefficients. Medians and percentiles of permanent teeth emergence were computed with probit regression analysis.

The recent data of the main indices were compared with the cross-sectional data on school children from Vilnius from the 1965–1967 and 1984–1985 studies.

MAIN RESULTS AND DISCUSSION

The descriptive statistics of the head and face anthropometrical measurements is presented in Table 2 (boys) and Table 3 (girls), measurements of face regions in Table 4 (boys) and Table 5 (girls).

Body height

Height velocity curves in Lithuanian boys and girls had a characteristic pattern of declining and rising, with an acceleration peak at the age of 5, 7 and 14-15 years of age for boys and 7-8, 11-12 years of age for girls. In the present study we recorded body height in order to compare growth velocity peaks of body height with the ones of facial dimensions. Boys were taller than girls in all investigated period except age interval from 10 to 13, although the difference was 0,6-0,8 cm and not significant. Only twelve year old boys were significantly shorter than girls.

Figure 1. Growth velocity curves for body height in Lithuanian children 4 to 16 years of age.

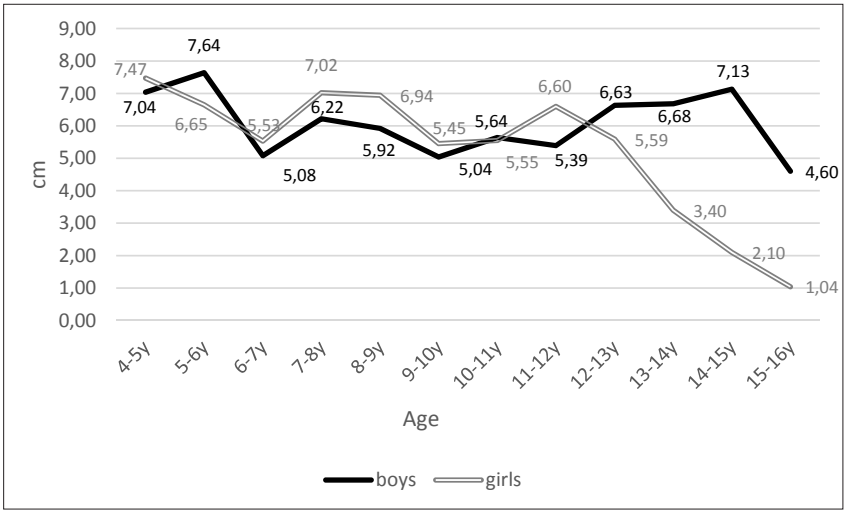


Table 2. Descriptive statistics of the anthropometrical measurements (cm) of head and face in Lithuanian boys 4 to 16 years of age

Measurement	Age	4	5	6	7	8	9	10	11	12	13	14	15	16
body height	X	105,38	112,49	120,16	125,24	131,55	137,46	142,42	148,06	153,46	160,12	166,77	173,89	178,50
	SD	,42	,43	,43	,39	,56	,55	,52	,49	,54	,64	,66	,83	,59
craniofacial height	X	19,89	20,30	20,86	20,71	21,07	21,16	21,72	21,83	22,14	22,57	23,28	23,96	24,00
	SD	,13	,12	,11	,11	,11	,12	,13	,09	,09	,12	,12	,22	,14
head circumference	X	51,12	51,71	52,08	52,78	53,39	53,91	54,15	54,50	54,85	55,21	55,74	56,28	57,08
	SD	,18	,16	,16	,14	,14	,14	,31	,13	,12	,14	,13	,17	,16
anterior head height	X	10,40	10,49	10,82	10,53	10,55	10,49	10,68	10,65	10,78	10,99	11,42	11,76	11,45
	SD	0,13	0,12	0,11	0,11	0,10	0,12	0,12	0,08	0,08	0,11	0,11	0,22	0,14
cranial length	X	17,67	17,91	18,01	18,16	18,28	18,39	18,62	18,58	18,72	18,84	18,97	19,22	19,34
	SD	,07	,06	,05	,05	,06	,06	,06	,05	,05	,05	,05	,07	,06
cranial breadth	X	13,95	13,98	14,25	14,29	14,44	14,47	14,71	14,80	14,82	14,93	14,97	15,12	15,32
	SD	,05	,05	,05	,04	,04	,05	,05	,04	,04	,04	,04	,05	,06
forehead breadth	X	10,00	9,95	10,07	10,24	10,42	10,63	10,68	10,77	10,84	11,06	11,09	11,28	11,56
	SD	,05	,04	,04	,04	,04	,04	,04	,04	,04	,04	,04	,06	,06
cranial base breadth	X	12,46	12,70	13,00	13,07	13,38	13,42	13,74	13,93	14,09	14,28	14,44	14,59	14,86
	SD	,04	,06	,05	,04	,05	,06	,05	,04	,04	,04	,04	,06	,06
physiognomic face height	X	14,96	15,38	15,56	15,97	16,49	16,57	17,09	17,09	17,35	17,55	17,93	18,37	18,67
	SD	,06	,08	,07	,05	,07	,07	,07	,06	,06	,06	,07	,09	,09
morphological face height	X	9,49	9,80	10,04	10,18	10,53	10,67	11,04	11,18	11,35	11,58	11,87	12,20	12,56
	SD	,04	,05	,04	,03	,04	,04	,04	,04	,04	,04	,05	,06	,06
face width	X	11,40	11,48	11,78	11,90	12,21	12,39	12,64	12,82	12,91	13,10	13,20	13,46	13,63
	SD	,04	,04	,05	,04	,04	,05	,05	,04	,03	,04	,04	,05	,05

Table 2 (continuation). Descriptive statistics of the anthropometrical measurements (cm) of head and face in Lithuanian boys 4 to 16 years of age

Measurement	Age	4	5	6	7	8	9	10	11	12	13	14	15	16
middle face height	X	6,06	6,26	6,37	6,47	6,70	6,73	6,93	7,00	7,17	7,33	7,50	7,65	7,82
	SD	,03	,04	,03	,02	,03	,03	,03	,03	,03	,03	,03	,04	,05
lower face height	X	5,49	5,65	5,74	5,83	5,99	6,05	6,27	6,33	6,40	6,50	6,66	6,86	7,14
	SD	,03	,04	,03	,02	,03	,03	,04	,03	,03	,03	,04	,05	,06
chin height	X	2,43	2,49	2,54	2,61	2,69	2,75	2,84	2,86	2,89	2,96	3,01	3,11	3,23
	SD	,03	,03	,02	,02	,03	,03	,03	,02	,02	,02	,02	,03	,03
upper face depth	X	10,59	10,84	11,09	11,21	11,40	11,46	11,68	11,84	11,98	12,16	12,28	12,56	12,70
	SD	,04	,04	,03	,03	,04	,04	,04	,03	,03	,03	,03	,05	,04
middle face depth	X	10,73	11,02	11,32	11,50	11,70	11,79	12,08	12,25	12,45	12,68	12,84	13,19	13,27
	SD	,03	,04	,03	,04	,04	,04	,04	,03	,03	,04	,04	,05	,05
lower face depth	X	11,26	11,60	11,94	12,16	12,45	12,59	12,99	13,11	13,33	13,59	13,88	14,21	14,50
	SD	,04	,05	,05	,04	,05	,05	,05	,04	,04	,05	,05	,07	,06
mandible width	X	7,56	7,70	7,87	8,01	8,30	8,44	8,57	8,90	9,02	9,17	9,33	9,56	9,67
	SD	,05	,05	,04	,04	,04	,05	,05	,04	,04	,04	,04	,06	,05
mandible body length	X	7,48	7,68	7,94	8,11	8,34	8,49	8,76	8,95	9,12	9,31	9,47	9,82	10,13
	SD	,05	,04	,04	,04	,04	,05	,04	,04	,03	,04	,03	,06	,05
anterior mandible height	X	3,85	3,95	4,05	4,12	4,22	4,29	4,44	4,50	4,58	4,65	4,78	4,93	5,14
	SD	,03	,03	,03	,02	,03	,03	,03	,03	,03	,02	,03	,04	,04
mandible ramus height	X	4,87	5,00	5,31	5,40	5,46	5,59	5,74	6,00	6,13	6,24	6,42	6,74	7,01
	SD	,04	,04	,03	,04	,05	,05	,04	,04	,04	,04	,04	,06	,06

Table 3. Descriptive statistics of the anthropometrical measurements (cm) of head and face in Lithuanian girls 4 to 16 years of age

Measurement	Age	4	5	6	7	8	9	10	11	12	13	14	15	16
body height	X	103,98	111,60	118,25	123,87	130,80	137,74	143,13	148,74	155,34	160,93	164,38	166,35	167,47
	SD	,45	,50	,53	,51	,50	,56	,51	,53	,49	,48	,47	,55	,49
craniofacial height	X	19,34	19,92	20,21	20,42	20,49	21,01	21,01	21,22	21,89	22,37	22,44	22,79	22,48
	SD	,12	,12	,13	,10	,14	,12	,10	,09	,10	,12	,11	,15	,13
head circumference	X	50,61	51,28	51,69	52,46	52,70	53,30	53,56	54,00	54,29	55,09	55,31	55,73	55,28
	SD	,18	,14	,18	,14	,13	,15	,14	,14	,14	,12	,13	,17	,17
anterior head height	X	9,89	10,18	10,15	10,19	9,98	10,29	10,10	10,15	10,51	10,77	10,73	10,76	10,46
	SD	,11	,11	,12	,10	,12	,11	,09	,08	,09	,11	,10	,15	,13
cranial length	X	17,31	17,43	17,61	17,74	17,87	18,13	18,10	18,30	18,44	18,55	18,59	18,74	18,60
	SD	,06	,05	,06	,06	,06	,06	,05	,05	,05	,05	,05	,06	,06
cranial breadth	X	13,52	13,68	13,84	13,97	14,07	14,23	14,26	14,47	14,47	14,62	14,63	14,76	14,75
	SD	,05	,05	,05	,05	,05	,04	,04	,05	,04	,03	,04	,05	,05
forehead breadth	X	9,68	9,86	9,87	10,06	10,25	10,46	10,54	10,67	10,74	10,93	10,98	11,09	11,04
	SD	,05	,04	,04	,04	,04	,04	,04	,04	,03	,04	,04	,06	,05
cranial base breadth	X	12,16	12,37	12,54	12,72	12,81	13,18	13,31	13,45	13,61	13,78	13,90	14,03	14,00
	SD	,05	,05	,04	,04	,05	,05	,04	,04	,04	,04	,04	,05	,05
physigomical face height	X	14,61	15,10	15,32	15,73	16,06	16,38	16,58	16,82	17,10	17,21	17,39	17,70	17,62
	SD	,07	,07	,07	,06	,06	,07	,06	,06	,06	,05	,06	,08	,08
morphological face height	X	9,23	9,53	9,81	10,04	10,27	10,50	10,73	10,90	11,20	11,38	11,50	11,75	11,77
	SD	,04	,04	,04	,04	,04	,04	,04	,04	,04	,04	,04	,05	,05
face width	X	11,13	11,37	11,50	11,78	11,95	12,19	12,38	12,54	12,70	12,87	12,99	13,08	13,13
	SD	,04	,04	,04	,04	,04	,05	,03	,04	,03	,03	,03	,05	,04

Table 3 (continuation). Descriptive statistics of the anthropometrical measurements (cm) of head and face in Lithuanian girls 4 to 16 years of age

Measurement	Age	4	5	6	7	8	9	10	11	12	13	14	15	16
middle face height	X	5,88	6,04	6,23	6,37	6,48	6,63	6,78	6,87	7,10	7,19	7,24	7,34	7,35
	SD	,03	,03	,03	,03	,03	,03	,03	,03	,03	,02	,03	,03	,04
lower face height	X	5,37	5,47	5,62	5,72	5,84	5,94	6,05	6,09	6,29	6,34	6,40	6,50	6,58
	SD	,03	,03	,03	,03	,04	,03	,03	,03	,03	,03	,03	,04	,04
chin height	X	2,43	2,48	2,50	2,60	2,64	2,70	2,79	2,76	2,83	2,91	2,89	3,00	2,94
	SD	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,03
upper face depth	X	10,32	10,53	10,72	10,95	11,04	11,31	11,40	11,54	11,73	11,89	11,95	12,11	12,05
	SD	,03	,04	,04	,03	,04	,04	,03	,03	,03	,03	,03	,04	,04
middle face depth	X	10,46	10,71	10,97	11,21	11,31	11,66	11,80	11,91	12,16	12,36	12,43	12,60	12,53
	SD	,03	,04	,04	,04	,04	,04	,03	,03	,03	,03	,03	,04	,04
lower face depth	X	11,00	11,26	11,61	11,90	12,12	12,47	12,64	12,76	12,99	13,25	13,35	13,60	13,56
	SD	,04	,05	,05	,04	,04	,05	,04	,04	,04	,04	,04	,05	,05
mandible width	X	7,35	7,49	7,76	7,85	8,10	8,23	8,36	8,58	8,76	8,88	9,01	9,21	9,26
	SD	,05	,04	,05	,05	,04	,05	,04	,04	,04	,04	,04	,05	,04
mandible body length	X	7,27	7,54	7,76	7,93	8,12	8,42	8,53	8,72	8,93	9,09	9,16	9,43	9,51
	SD	,05	,04	,04	,04	,04	,04	,03	,03	,03	,04	,03	,05	,05
anterior mandible height	X	3,77	3,85	3,95	4,05	4,14	4,21	4,32	4,39	4,50	4,55	4,63	4,72	4,70
	SD	,03	,02	,03	,03	,03	,03	,03	,03	,02	,02	,03	,03	,03
mandible ramus height	X	4,77	4,96	5,16	5,25	5,31	5,50	5,69	5,74	5,96	6,01	6,16	6,40	6,42
	SD	,04	,05	,04	,03	,04	,04	,04	,03	,03	,03	,04	,05	,04

Table 4. Descriptive statistics of the anthropometrical measurements (cm) of face regions in Lithuanian boys 4 to 16 years of age

Measurement	Age	4	5	6	7	8	9	10	11	12	13	14	15	16
intercanthal distance	X	2,78	2,86	2,93	2,94	2,96	3,02	3,04	3,07	3,13	3,12	3,10	3,16	3,15
	SD	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02
biocular width	X	8,40	8,60	8,81	8,84	8,88	8,99	9,05	9,11	9,22	9,38	9,50	9,66	9,74
	SD	,04	,04	,03	,03	,04	,04	,04	,04	,03	,04	,03	,05	,05
interpupilary distance	X	4,70	4,79	5,01	4,99	5,07	5,20	5,22	5,33	5,40	5,47	5,48	5,63	5,65
	SD	,04	,04	,04	,03	,03	,03	,03	,02	,02	,03	,02	,04	,03
nasal width	X	2,73	2,81	2,86	2,90	2,89	2,91	2,94	2,98	3,07	3,14	3,25	3,41	3,44
	SD	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02
height of the nose	X	4,33	4,49	4,62	4,73	4,88	4,96	5,06	5,14	5,27	5,44	5,61	5,73	5,84
	SD	,03	,03	,03	,03	,03	,03	,03	,02	,02	,03	,03	,04	,03
nose bridge length	X	3,97	4,14	4,27	4,34	4,48	4,54	4,68	4,76	4,85	5,04	5,22	5,34	5,45
	SD	,03	,03	,03	,02	,03	,03	,03	,02	,02	,03	,03	,04	,03
nasal tip protrusion	X	1,46	1,56	1,62	1,61	1,68	1,70	1,71	1,77	1,85	1,89	1,95	2,08	2,08
	SD	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,03	,03
collumela length	X	,68	,70	,73	,76	,84	,82	,79	,80	,74	,76	,82	,80	,70
	SD	,02	,01	,01	,01	,02	,02	,02	,02	,02	,02	,02	,03	,03
lower lip vermillion height	X	,68	,71	,70	,75	,83	,85	,83	,88	,87	,87	,90	,93	,96
	SD	,01	,01	,01	,01	,02	,01	,01	,01	,01	,01	,01	,02	,02
labial fissure width	X	3,75	3,85	3,98	4,10	4,11	4,21	4,35	4,39	4,46	4,64	4,79	4,95	5,02
	SD	,03	,02	,02	,03	,03	,03	,03	,03	,02	,03	,03	,04	,04
lower lip height	X	1,52	1,49	1,57	1,64	1,75	1,76	1,85	1,85	1,83	1,89	1,95	1,98	2,10
	SD	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,03	,03

Table 4 (continuation). Descriptive statistics of the anthropometrical measurements (cm) of face regions in Lithuanian boys 4 to 16 years of age

Measurement	Age	4	5	6	7	8	9	10	11	12	13	14	15	16
lateral lip height	X	1,45	1,45	1,44	1,55	1,69	1,74	1,85	1,81	1,85	1,94	1,93	1,93	1,94
	SD	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,03	,03
lower lip cutaneous height	X	,88	,86	,91	,94	1,00	1,00	1,07	1,02	1,01	1,09	1,10	1,15	1,22
	SD	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,03
philtrum width	X	1,03	1,09	1,13	1,15	1,17	1,19	1,22	1,25	1,27	1,34	1,37	1,37	1,40
	SD	,02	,01	,02	,01	,02	,01	,01	,01	,01	,01	,01	,02	,02
upper lip vermillion height	X	,65	,70	,71	,74	,71	,71	,68	,71	,69	,72	,75	,76	,77
	SD	,01	,01	,01	,01	,01	,01	,01	,01	,01	,01	,01	,01	,01
upper lip height	X	1,67	1,75	1,75	1,76	1,81	1,76	1,81	1,83	1,84	1,86	1,87	1,91	1,92
	SD	,02	,02	,01	,01	,02	,02	,02	,01	,01	,01	,02	,02	,02
upper lip cutaneous height	X	1,12	1,20	1,18	1,14	1,18	1,14	1,20	1,18	1,20	1,19	1,21	1,17	1,20
	SD	,02	,02	,01	,01	,01	,01	,01	,02	,01	,01	,01	,02	,02
ear width	X	3,51	3,60	3,68	3,63	3,69	3,63	3,65	3,69	3,70	3,71	3,75	3,68	3,75
	SD	,02	,02	,02	,02	,03	,03	,02	,02	,02	,02	,02	,03	,03
ear length	X	5,20	5,35	5,44	5,55	5,64	5,61	5,71	5,76	5,91	5,96	6,02	5,94	6,09
	SD	,04	,03	,03	,03	,04	,04	,03	,03	,03	,03	,03	,04	,04

Table 5. Descriptive statistics of the anthropometrical measurements (cm) of face regions in Lithuanian girls 4 to 16 years of age

Measurement	Age	4	5	6	7	8	9	10	11	12	13	14	15	16
intercanthal distance	X	2,77	2,83	2,88	2,89	2,94	2,98	2,98	3,02	3,06	3,09	3,06	3,09	3,05
	SD	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02
biocular width	X	8,25	8,47	8,56	8,61	8,64	8,84	8,88	9,03	9,16	9,28	9,37	9,51	9,43
	SD	,04	,04	,04	,03	,04	,03	,03	,03	,03	,03	,03	,04	,04
interpupilary distance	X	4,60	4,75	4,86	4,93	5,00	5,15	5,17	5,250	5,323	5,386	5,418	5,535	5,551
	SD	,03	,03	,03	,03	,03	,03	,03	,026	,023	,023	,028	,030	,031
nasal width	X	2,66	2,73	2,76	2,77	2,84	2,87	2,88	2,94	3,06	3,09	3,14	3,20	3,17
	SD	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,01	,02	,02
height of the nose	X	4,25	4,41	4,55	4,70	4,81	4,92	5,04	5,10	5,29	5,40	5,47	5,53	5,51
	SD	,03	,03	,03	,03	,03	,03	,03	,03	,02	,02	,02	,03	,03
nose bridge length	X	3,89	4,05	4,21	4,27	4,37	4,50	4,65	4,72	4,89	5,03	5,08	5,17	5,15
	SD	,03	,03	,03	,03	,03	,03	,03	,02	,02	,02	,02	,03	,03
nasal tip protrusion	X	1,46	1,54	1,63	1,61	1,63	1,69	1,70	1,76	1,83	1,91	1,95	2,01	2,01
	SD	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,03
collumela length	X	,68	,69	,73	,77	,83	,81	,79	,75	,76	,82	,84	,79	,79
	SD	,01	,01	,01	,02	,02	,01	,02	,02	,02	,02	,02	,03	,03
lower lip vermillion height	X	,67	,69	,68	,71	,82	,85	,82	,86	,87	,89	,92	,88	,94
	SD	,01	,01	,01	,01	,01	,01	,01	,01	,01	,01	,01	,02	,01
labial fissure width	X	3,66	3,80	3,87	3,99	4,07	4,19	4,25	4,37	4,45	4,55	4,64	4,72	4,79
	SD	,03	,03	,03	,03	,03	,03	,03	,03	,02	,02	,03	,03	,03
lower lip height	X	1,45	1,47	1,50	1,57	1,71	1,76	1,78	1,80	1,82	1,85	1,90	1,86	1,86
	SD	,02	,02	,02	,02	,01	,02	,02	,02	,02	,02	,02	,02	,03

Table 5 (continuation). Descriptive statistics of the anthropometrical measurements (cm) of face regions in Lithuanian girls 4 to 16 years of age

Measurement	Age	4	5	6	7	8	9	10	11	12	13	14	15	16
lateral lip height	X	1,38	1,41	1,41	1,53	1,62	1,73	1,75	1,77	1,79	1,85	1,82	1,77	1,76
	SD	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,02	,03	,03
lower lip cutaneous height	X	,84	,86	,87	,96	,99	,99	1,05	,99	1,00	1,05	1,07	1,04	1,04
	SD	,02	,02	,02	,02	,02	,02	,01	,02	,02	,01	,02	,02	,02
philtrum width	X	1,00	1,02	1,02	1,08	1,12	1,18	1,20	1,25	1,26	1,31	1,29	1,28	1,29
	SD	,01	,02	,02	,02	,01	,02	,01	,01	,01	,01	,01	,02	,02
upper lip vermillion height	X	,68	,70	,71	,73	,81	,71	,73	,71	,73	,76	,73	,72	,72
	SD	,01	,01	,01	,01	,06	,01	,01	,01	,01	,01	,01	,01	,01
upper lip height	X	1,60	1,64	1,67	1,67	1,72	1,73	1,71	1,74	1,77	1,78	1,77	1,77	1,79
	SD	,02	,02	,01	,01	,02	,02	,02	,01	,01	,01	,01	,02	,02
upper lip cutaneous height	X	1,08	1,10	1,12	1,09	1,09	1,09	1,10	1,08	1,11	1,09	1,09	1,07	1,11
	SD	,02	,01	,01	,01	,02	,02	,01	,01	,01	,01	,01	,01	,02
ear width	X	3,38	3,45	3,50	3,50	3,44	3,56	3,50	3,54	3,55	3,51	3,54	3,57	3,55
	SD	,02	,02	,03	,02	,03	,03	,02	,02	,02	,02	,02	,03	,02
ear length	X	5,04	5,12	5,22	5,27	5,42	5,51	5,53	5,66	5,65	5,74	5,77	5,86	5,83
	SD	,03	,03	,03	,03	,03	,04	,03	,03	,03	,03	,03	,04	,03

The relative increment of height from 4 to 16 y. was 69,2% for boys and 60,8% for girls, hence boys grew faster than girls. Pubertal growth peak for girls occurred at 11-12 y. and 3 years later for boys. Although prepubertal and pubertal growth peaks were very similar in girls, the pubertal peak in boys was bigger than prepubertal but lesser than childhood midgrowth peak.

Our data corresponds well with other scientists' works on Lithuanian children and shows that Lithuanian children are among tallest children in Europe (Jakimaviciene, 2008; Tutkuviene, 1990).

General size of the head

Changes of general size of the head can be evaluated from the changes of total craniofacial height – body height index during growth period. The index undergone the biggest relative change from 4 to 16 years of age among all indices we investigated. Relative change for boys (28,75%) was a little bit bigger than compared to girls (27,8%). Although at the 4 y. of age the head of girls makes significantly smaller relative part of the body height than compared to boys, but at the end of studied period the proportion between sexes did not differ significantly. This shows that overall human head size to body height ratio is strictly genetically determined and sex independent. The decreasing value of the index also shows that despite intensive growth of the face and head vertically during the studied period, body height grows about 3 times faster and more than the head and face. Although to compare our results with other scientists' studies is not possible due to the lack of data in the literature, the values of the index at the 16 years of age are similar to the ones, given on French-Canadian children sample (Farkas, 1989).

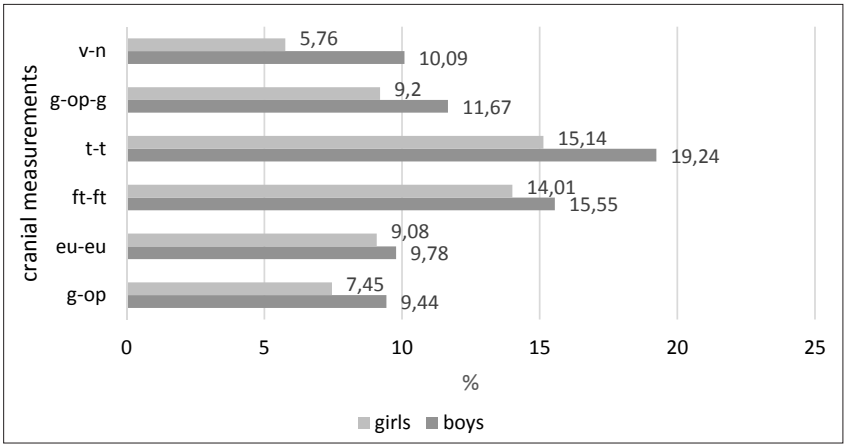
Total craniofacial height (v-gn) was bigger in boys in all age groups, but the measurement did not differ significantly between genders at the age of 4, 9, 12 and 13y. due to more rapid growth in girls during period of 9 to 10 years. Actually, total craniofacial height peaked before pubertal growth spurt at the age of 9-10 years in girls reaching growth velocity of 0,9 cm/year during that moment. Although the dimension peaked later in boys and the peak of growth velocity curve corresponded with pubertal growth spurt in body height, relative and absolute values of growth increments were more pronounced in boys than in girls, recorded relative change from 4 years was 20% and 15,4% accordingly.

Cranial measurements and proportions, age dynamics, differences between sexes

All measured cranial dimensions were bigger in boys and the difference between genders was within the limit of 0,3-0,4 cm at the age of 4. Minimal differences between sexes appeared at the age of 9 to 10 y. and this can be attributed to the earlier onset of intensive growth in girls, while most evident differences started to appear at the end of puberty, when the estimated differences were up to 0,9 cm in some measurements. At the age of 4 boys and girls did not differ significantly in head circumference and anterior head height, while largest absolute differences at the age of 16 were noted for head circumference and cranial base width. Such results are along with data, published in scientific literature (Farkas, 1992; Grabowskiej, 1998).

Analysis of relative growth increment during studied period revealed that cranial base width and forehead width show largest increments from the age of 4, while head length – the smallest ones in both sexes (Figure 2). Also it can be seen that boys exhibit more intense growth in all recorded dimensions of the head. Head width grew relatively more than head length, especially in girls, and it means that head form becomes slightly rounder from the age of 4.

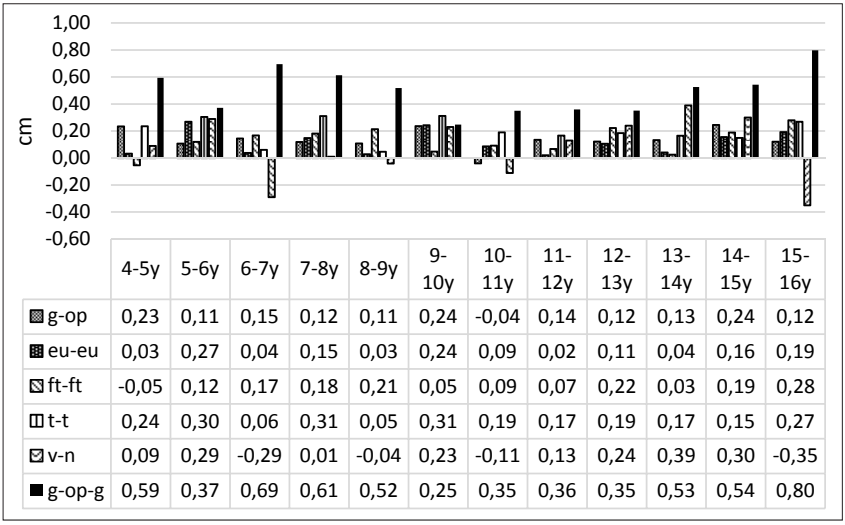
Figure 2. Relative increments of cranial measurements in Lithuanian children 4 to 16 years of age



v-n anterior head height, g-op-g head circumference, t-t cranial base width, ft-ft forehead width, eu-eu head width, g-op head length.

Absolute growth increments of the head dimensions are not only larger for boys, but also more variable and last longer than for girls (Figure 3 and 4). The largest absolute increments during 4 to 16 years was noted for cranial base width and forehead width, smallest – for anterior head height. Such findings correspond with data from other studies only in part, as scientists have found that anterior head height grows more than head width and length, and most intensive growth occur from the age of 5, with the peak at the age of 11-12 (Farkas, 1992). While our data suggest that anterior head height although has a peak at the same time in girls and 2 years later in boys, but it's relative and absolute increments are very similar to the increments of head width and length in boys, but are lesser in girls. Smaller relative increment of anterior head height in the present study could be explained by the fact that we did not cover all growth period, especially in boys or maybe rapid growth of that particular dimension starts earlier in studied Lithuanian children as the absolute values in present study are bigger than in published data on French-Canadian children (Farkas, Munro; 1994).

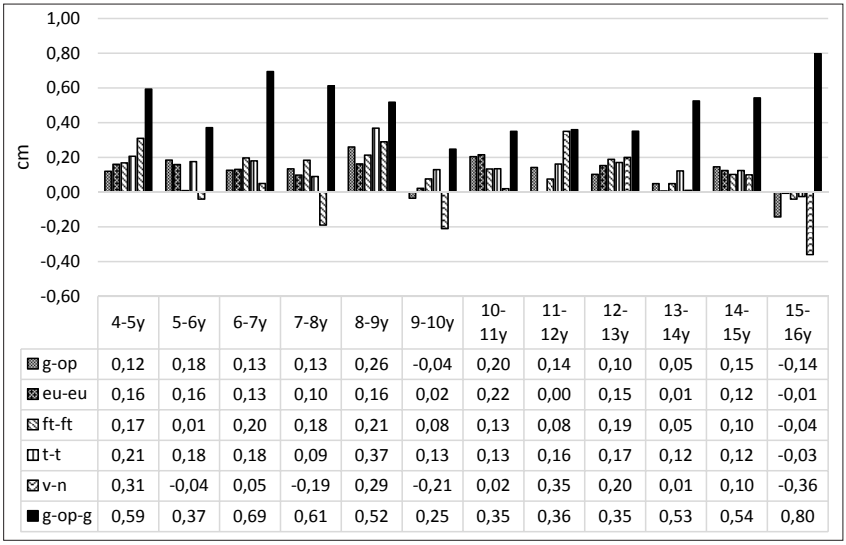
Figure 3. Absolute growth increments and growth velocity of the head measurements of Lithuanian boys 4 to 16 years of age



	4-5y	5-6y	6-7y	7-8y	8-9y	9-10y	10-11y	11-12y	12-13y	13-14y	14-15y	15-16y
g-op	0,23	0,11	0,15	0,12	0,11	0,24	-0,04	0,14	0,12	0,13	0,24	0,12
eu-eu	0,03	0,27	0,04	0,15	0,03	0,24	0,09	0,02	0,11	0,04	0,16	0,19
ft-ft	-0,05	0,12	0,17	0,18	0,21	0,05	0,09	0,07	0,22	0,03	0,19	0,28
t-t	0,24	0,30	0,06	0,31	0,05	0,31	0,19	0,17	0,19	0,17	0,15	0,27
v-n	0,09	0,29	-0,29	0,01	-0,04	0,23	-0,11	0,13	0,24	0,39	0,30	-0,35
g-op-g	0,59	0,37	0,69	0,61	0,52	0,25	0,35	0,36	0,35	0,53	0,54	0,80

v-n anterior head height, g-op-g head circumference, t-t cranial base width, ft-ft forehead width, eu-eu head width, g-op head length.

Figure 4. Absolute growth increments and growth velocity of the head measurements of Lithuanian girls 4 to 16 years of age



	4-5y	5-6y	6-7y	7-8y	8-9y	9-10y	10-11y	11-12y	12-13y	13-14y	14-15y	15-16y
g-op	0,12	0,18	0,13	0,13	0,26	-0,04	0,20	0,14	0,10	0,05	0,15	-0,14
eu-eu	0,16	0,16	0,13	0,10	0,16	0,02	0,22	0,00	0,15	0,01	0,12	-0,01
ft-ft	0,17	0,01	0,20	0,18	0,21	0,08	0,13	0,08	0,19	0,05	0,10	-0,04
t-t	0,21	0,18	0,18	0,09	0,37	0,13	0,13	0,16	0,17	0,12	0,12	-0,03
v-n	0,31	-0,04	0,05	-0,19	0,29	-0,21	0,02	0,35	0,20	0,01	0,10	-0,36
g-op-g	0,59	0,37	0,69	0,61	0,52	0,25	0,35	0,36	0,35	0,53	0,54	0,80

v-n anterior head height, g-op-g head circumference, t-t cranial base width, ft-ft forehead width, eu-eu head width, g-op head length.

Absolute increments and time of peaks of head length and head width in examined Lithuanian girls corresponds with the data in scientific literature, while Lithuanian boys tend to have peaks about 1-2 years later than their counterparts from other countries (Arboleda, 2011, Gazi-Coklica et al, 1997; Grabowskiej, 1998). According to the results of our study, rapid growth of the head circumference appear at the ages 4-5 and 6-7 for both sexes, slowdowns during later ages but remains significant until the age of 9 in girls and 10 y. in boys when it reaches 95% of future value, and exhibit another peak of growth velocity during puberty.

All examined dimensions of the head exhibit cyclic acceleration and deceleration of growth curve, although some of them (head length, head width, anterior head height) have more concentrated periods of acceleration

while others (forehead width, head circumference, cranial base width) show larger variation. Our results show that the most intensive growth of head measurements for girls appear to happen until the age of 9 and stabilizes during 15-16 years period while the most intensive growth of the head measurements in boys is until 10 years of age and peak again during pubertal growth peak of body height with no tendency for stabilization of growth after puberty. These data correspond with other scientists' observation that growth in the head stabilizes in girls after 16 years of age while boys tend to grow longer (Farkas, 1992; Grabowskiej, 1998).

The proportion indices of the head had a tendency to change throughout all investigated period (Table 5). From the age of 4, most changes in proportions occur in the vertical plane: total craniofacial height decreases by one third to body height, but increases by one tenth to anterior head height in both sexes and to head width in boys. Total craniofacial height-head width index increases more in boys than in girls and for this reason at the age of 16, head of the girls resemble form of square while head of the boys – rectangle. In the horizontal plane, most of the changes occur in forehead width, cranial base width and head width relationship. Forehead and especially cranial base in four year olds are relatively narrow than compared to head width: they comprise 72 and 89 % of head width accordingly. During growth, forehead and cranial base widths increase relatively more than head width and the head of sixteen year olds look more harmonious. Our data revealed that in boys' head forehead width and especially cranial base width comprises bigger part of head width than in girls', but other scientists stated that mentioned proportions do not differ between sexes (Farkas, Munro; 1987). Proportion indices concerning cranial base width are poorly documented in literature, but from available sources can be seen that Lithuanian sixteen year olds have relatively narrow forehead but wider cranial base compared to the head width than the counterparts from Canada (Farkas, Munro; 1987).

Table 5. The proportion indices of head measurements in Lithuanian children 4 to 16 years of age

Sex	Index	Value of the index at the age of 4	Value of the index at the age of 16	Absolute change of the index from 4 to 16 years	Relative change of index from 4 to 16 years of age
Boys	total craniofacial height-body height index	18,88	13,45	-5,43*	-28,75
	head width-head length index	79,07	79,26	0,19*	0,24
	head width-total craniofacial height index	70,42	64,02	-6,40*	-9,09
	forehead width-head width index	71,73	75,50	3,77*	5,26
	cranial base width-head width index	89,38	97,07	7,69*	8,60
	forehead width-cranial base width index	80,31	77,81	-2,50*	-3,11
	forehead height-anterior head height index	43,28	43,51	0,22	0,51
	anterior head height-total craniofacial height index	56,38	50,37	-6,01*	-10,65
Girls	total craniofacial height-body height index	18,61	13,43	-5,18*	-27,85
	head width-head length index	78,27	79,39	1,12*	1,43
	head width-total craniofacial height index	70,16	65,82	-4,34*	-6,19
	forehead width-head width index	71,64	74,89	3,25*	4,53
	cranial base width-head width index	89,92	94,94	5,02*	5,58
	forehead width-cranial base width index	79,75	78,94	-0,81*	-1,02
	forehead height-anterior head height index	42,98	42,04	-0,94*	-2,18
	anterior head height-total craniofacial height index	56,11	50,62	-5,49*	-9,78

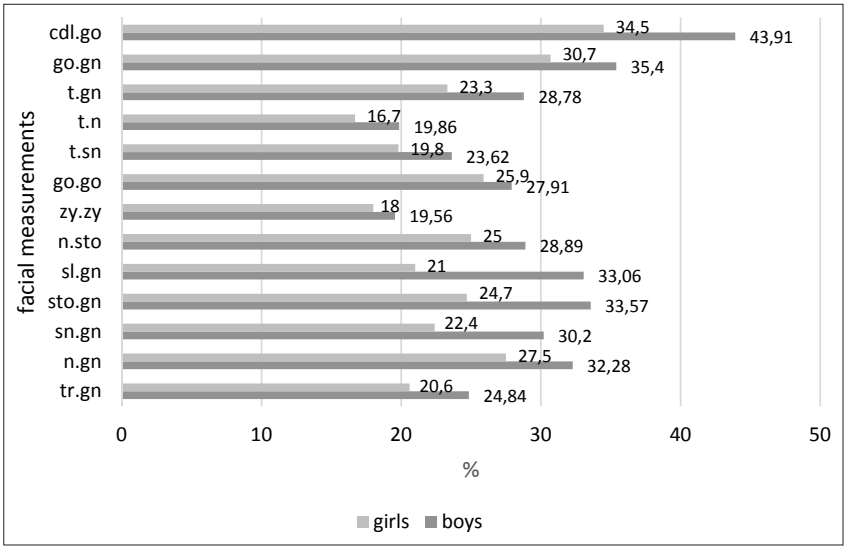
Yellow – major change (over 10 %), purple – moderate (5–9,9 %), blue – mild (1–5 %), green – neglible (less than 1 %) according to Farkas LG. Anthropometric facial proportions in medicine, 1987.

* statistically significant p<0,05

Facial measurements and proportions, age dynamics, differences between sexes

General size and form of the face is best described by the height of the face and face width and relationship between them. Both physiognomic and morphological face height increased relatively more (Figure 5) than face width from the age of 4 and face becomes elongated and narrow at the age of 16 and resembles rectangle more than at the age of 4. The vertical growth in boys is more pronounced than in girls, but rapid growth occurs later and that's why their face form changes to adult one later also. At the age of 4 boys still have euryprosopic face, during 5-12 years – mesoprosopic and becomes leptoprosopic thereafter. Contrary, girls have adult face form (leptoprosopic) from the age of 6.

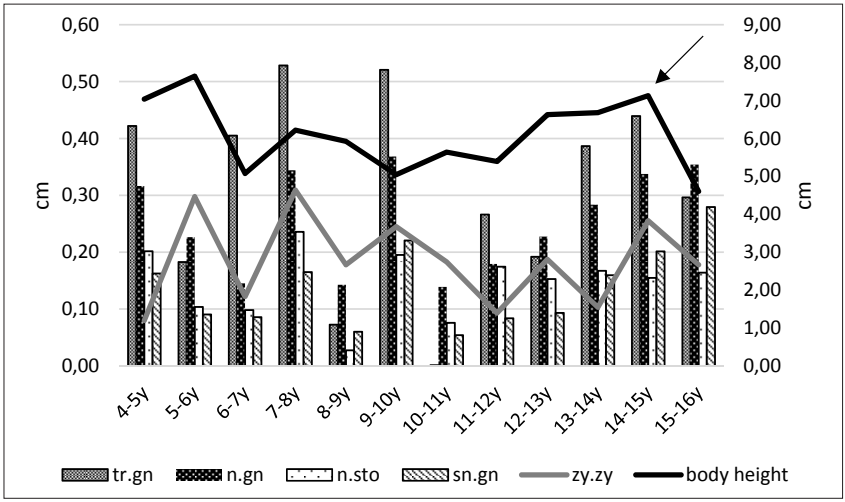
Figure 5. Relative increments of facialy measurements of Lithuanian children 4 to 16 years old



cdl.go-the height of mandible ramus, go.gn mandible body length, t.gn lower face depth, t.n upper face depth, t.sn middle face depth, go.go mandible width, zy.zy face width, n.sto middle face height, sl.gn chin height, sto.gn anterior mandible height, sn.gn lower face height, n.gn morphologic face height, tr.gn physiognomic face height.

Intensive growth of vertical dimensions, especially of morphological face height, state most of anthropometrical and cephalometrical studies (Arboleda et al, 2011; Farkas et al, 1992; Lux et al, 2004; Schuler, 2007; Thilander et al, 2005, Thordarson et al, 2006). Indeed, due to rapid growth of the face vertically some researches recommend to use proportions of the face height and other facial measurements to establish biological age of a child during preschool years (Schuler, 2007). All vertical dimensions, especially concerning lower face height, increased relatively more than sagittal and horizontal dimensions of the face (Figure 5). The growth velocity curves of all measured vertical dimensions, except physiognomic face height and chin height, exhibited rising and declining pattern throughout all period 4 to 16 years old, with peaks during puberty corresponding that of body height peak, in both gender (Figure 6 and 7). In girls, actually, the growth of vertical dimensions slows down after puberty, but show another peak in growth at the age of 14-15. This is an interesting finding and is along with some studies (Thilander et al, 2005), as there is an opinion that vertical growth in girls slows down until neglible

Figure 6. Growth velocity of vertical and horizontal facial measurements and body height of Lithuanian boys 4 to 16 years of age

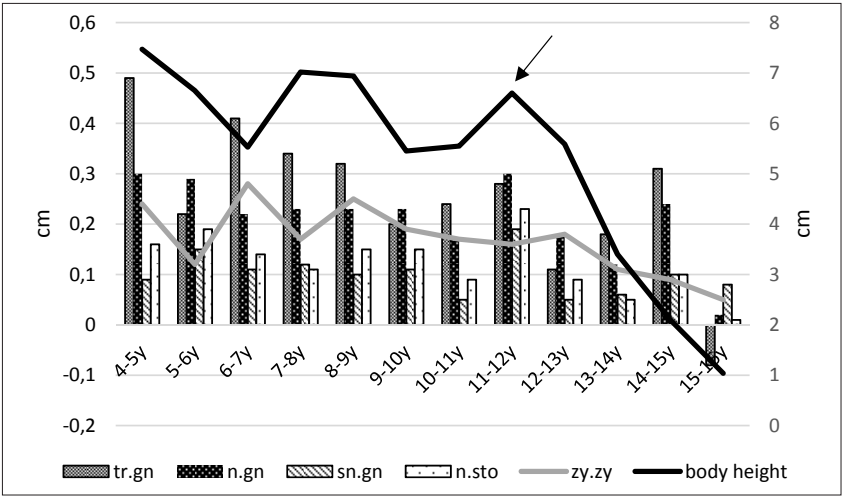


tr.gn physiognomic face height, n.gn morphological face height, n.sto middle face height, sn.gn lower face height, zy.zy face with

Arrow shows pubertal growth spurt of body height

changes after the age of 10 (Arboleda et al, 2011). This pattern in our study, was found only for physiognomic face height in girls. Data from our study revealed that growth velocity of physiognomic face height and morphological face height differ not only between themselves but also between sexes. Increments of both measurements in boys varies more than compared to girls, the same tendency was noted by other researches (Arboleda et al, 2011). Another difference have been noted between sexes in the growth of vertical dimensions in face: in girls middle face height and mandible height increases equally about 25% and relatively more than lower face height (22%), in boys mandible height shows the most relative growth (34%) compared to middle face height and lower face height, which grow equally. This is the reason for different vertical proportion ratios in the faces of sixteen year olds: although in both sexes middle face height makes equal part in the face, but its relation to lower face height increases for girls, but decreases for boys. It means that middle face height dominates relatively more in the girls' faces, while boys' faces have pronounced lower face height and especially anterior mandible height.

Figure 7. Growth velocity of vertical and horizontal facial measurements and body height of Lithuanian girls 4 to 16 years of age



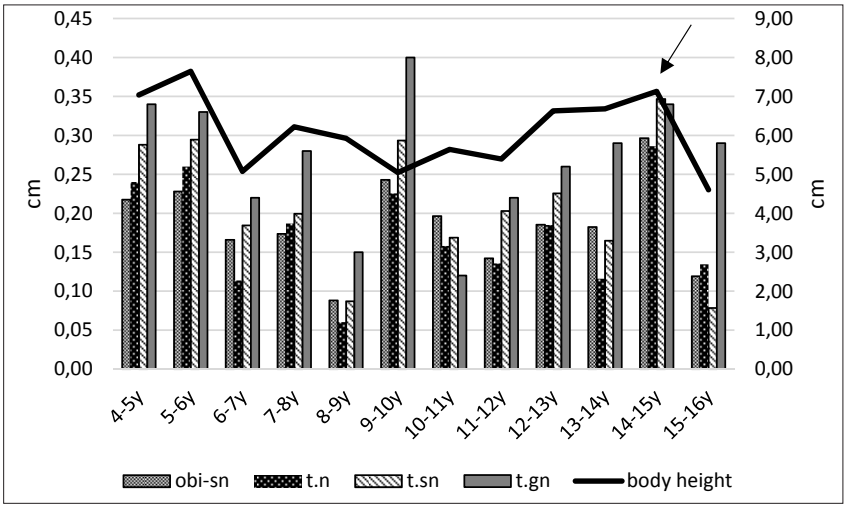
tr.gn physiognomic face height, n.gn morphological face height, n.sto middle face height, sn.gn lower face height, zy.zy face with

Arrow shows pubertal growth spurt of body height

Horizontal dimensions of the face: face width increased relatively more in boys, but growth velocity was almost the same in both sexes. In general, more intensive growth with peaks occurred until the age of 10, and decreased thereafter with small peaks during puberty.

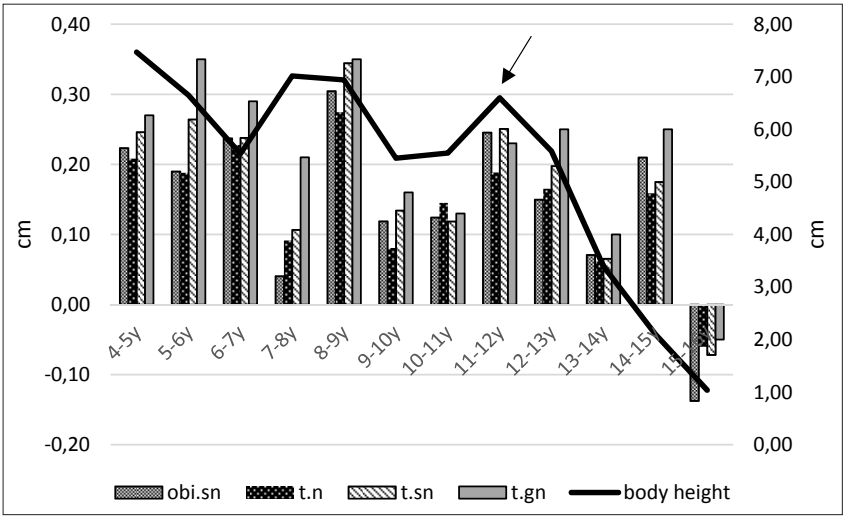
Sagittal face dimensions: relative increments were more pronounced for lower face depth (23,3% for girls, 28,8% for boys) than compared to middle face depth (19,8% for girls, 23,6% for boys) and results are along with data from cephalometric and anthropometrical studies, stating that the prognathism of maxilla increases in lesser extent than that of mandible (Farkas et al, 1992; Lux et al, 2004; Thilander et al, 2005, Thordarson et al, 2006). Although sagittal measurements do show acceleration of growth during pubertal spurt in body height, the largest increments in dimensions occur before puberty in both gender: until 9 years of age in girls and 10 years in boys. It has to be mentioned that all sagittal indices and lower face depth in particular, have acceleration peak after puberty in girls (at the age of 15) and its value is nearly equal to that occurring during pubertal growth spurt (Figure 8 and 9).

Figure 8. Growth velocity of sagittal facial measurements and body height of Lithuanian boys 4 to 16 years of age



obi-sn middle face depth, t.n upper face depth, t.sn middle face (or maxillary) depth, t.gn lower face depth
Arrow shows pubertal growth spurt of body height

Figure 9. Growth velocity of sagittal facial measurements and body height of Lithuanian girls 4 to 16 years of age



obi-sn middle face depth, t.n upper face depth, t.sn middle face (or maxillary) depth, t.gn lower face depth

Arrow shows pubertal growth spurt of body height

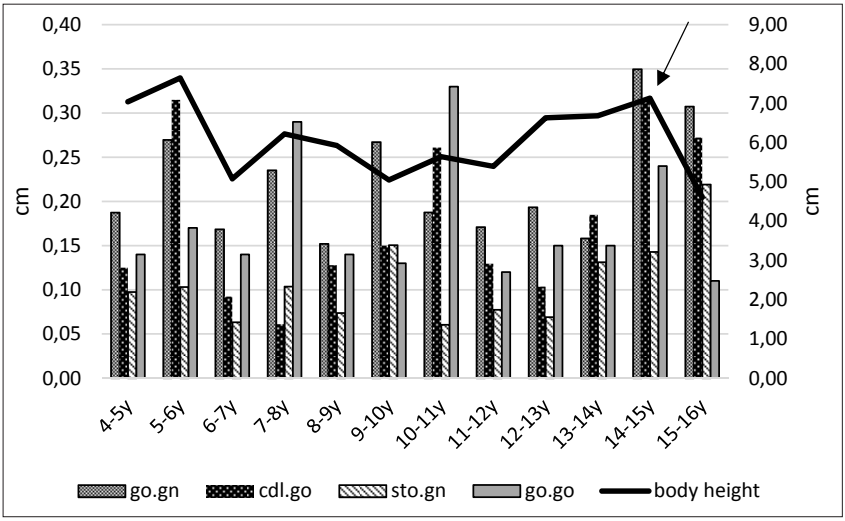
The studied measurements of **mandible** tended to have the most incremental growth of all investigated facial measurements. Most of all increased height of mandible ramus (by 34,5% for girls, 43,9 % for boys) and mandible body length (by 30,7% for girls and 35,4% for boys) while increments of mandible height and width were smaller (Figure 5). Data are in agreement with researches, stating that during school years mandible grows more in vertical and sagittal directions than compared to horizontal ones (Lux et al, 2004; Savara, Tracy, 1967). Documented relatively smaller increments of growth in mandibular width than compared to its height are explained by the fact that at the age of 5, mandibular width has already reached bigger values of future adult size than its height, but rapid growth is still to be occur during school years for both dimensions (Farkas, 1992). Although our data show that proportion between height of the mandible and its width increases from the age of 4 y. by 4,4% in boys but remains

nearly constant in girls (decreases by 1%) and it means that vertical growth of mandible is more pronounced in boys, while girls tend to have more harmonious growth between mandibular height and width. Boys and girls in present study differed in mandible width-lower face depth index, too. Boys tended to have the mentioned proportion unchanged from the age of 4 y., while index increased by 2% in girls and it means that the width of mandible is relatively wider than compared to its depth in girls' faces and it is why their faces look relatively shorter and rounder than compared to boys. The expression of rounder and shorter face in adolescent girls is intensified by the fact that mandibular width comprises relatively larger part of both physiognomic and morphological face height than in boys' faces.

Growth velocity and amplitude of mandibular dimensions are very important in planning treatment time and tactics in children with skeletal malocclusions. There is still ongoing debate in scientific literature how to estimate the onset, duration and end of intensive growth of the mandible. The evidence show that results in treating Class II malocclusion are more stable and better if correction is done during circumpubertal period (Baccetti et al, 2005; Cozza et al, 2006) while it is best to correct Class III malocclusion and plan dental implants after intensive growth period has stopped. As it is clear that chronological age of a child not always corresponds with biological and skeletal age, some authors advice to use pubertal growth spurt of body height as the index to establish skeletal maturity and growth potential of mandible (Bjork, 1963; Mellion et al, 2013). Class II malocclusion is prevalent in Lithuania, according to one study, done on Lithuanian children, 39,9% of 10-11 year olds and 35,3% of 14-15 year olds have this type of malocclusion (Baubiniene, 2010). Results of present study show that although the largest increments in mandibular width were registered before puberty in both sexes, but the growth accelerates again during pubertal growth spurt and after it in girls and corresponds with pubertal growth spurt of body height in boys. Mandibular body length in girls tended to increase rapidly before puberty (7-9 y.) and after pubertal growth spurt (14-15y.),

Mandibular height peaked at the same time as body height (11-12), while mandibular ramus height reached largest increment 2-3 years later than peak in body height. In boys, both mandibular body length and ramus height peaked at the same time as body height, but increments of anterior mandible height started to increase from the age of 13 and were still increasing at the age of 16. As correction of Class II malocclusion involves mandibular ramus height and mandibular body length mostly, we agree that most appropriate time for treatment is circumpubertal: for girls – 11-15, boys – 13-16 years of age.

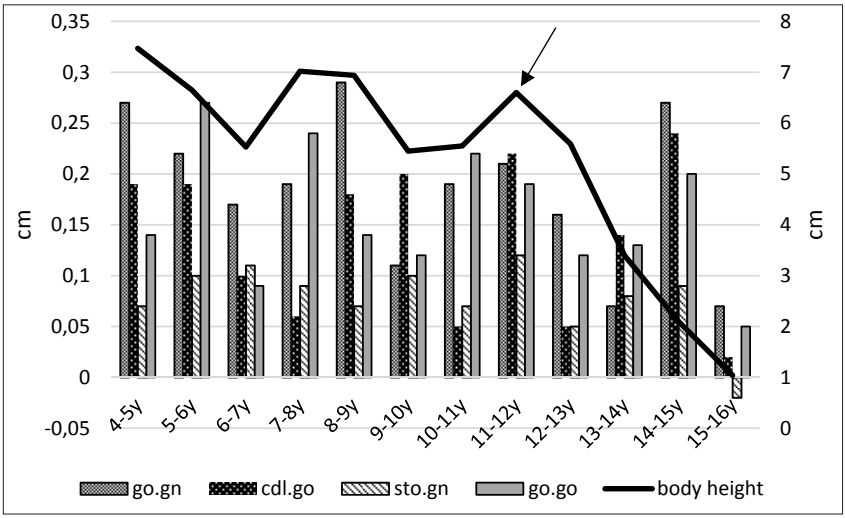
Figure 10. Growth velocity of mandibular measurements and body height of Lithuanian boys 4 to 16 years of age



go.gn mandible body length, cdl.go mandible ramus height, sto.gn anterior mandible height, go.go mandible width

Arrow denotes pubertal growth spurt of body height

Figure 11. Growth velocity of mandibular measurements and body height of Lithuanian girls 4 to 16 years of age



go.gn mandible body length, cdl.go mandible ramus height, sto.gn anterior mandible height, go.go mandible width
Arrow shows pubertal growth spurt of body height

All examined facial measurements were significantly bigger in boys, except face width in 5y., mandible width in 6-7y., anterior mandible height in 7-8y., physiognomic face height, lower face depth, mandibular body length in 9y., middle face height in 12 y. and mandible ramus height in 4-5 and 9-10 year olds. Chin height was the only one dimension that started to differ significantly between sexes at the end of puberty.

Considering the proportionality of the face vertically (Figure 12 and 13), our data shows that from the age of 4, morphological face height- total craniofacial height index undergoes most dramatic change in both sexes. However, least changes have been found for chin height – total craniofacial height index.

Figure 12. Vertical face proportions of Lithuanian boys 4 to 16 years of age

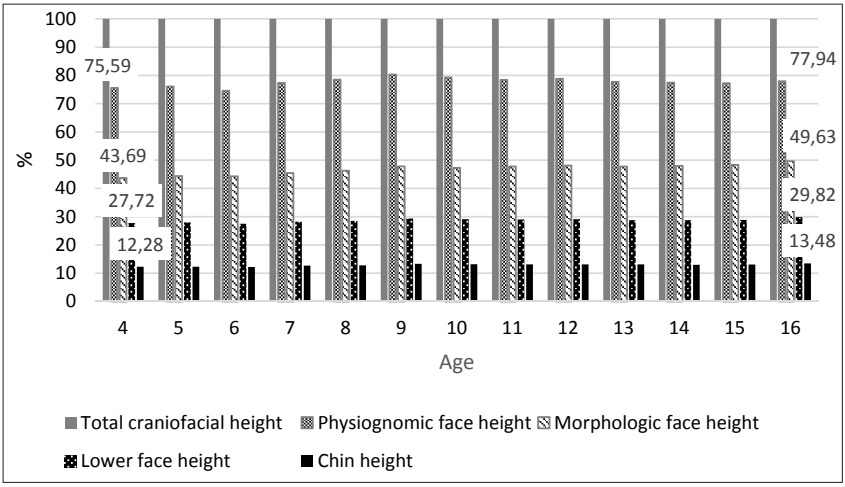
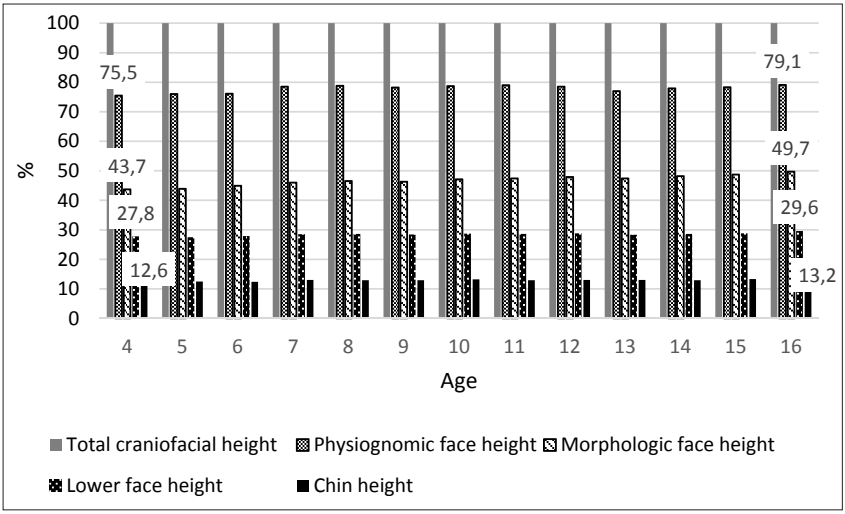


Figure 13. Vertical face proportions of Lithuanian girls 4 to 16 years of age



From the examined facial proportions, 9 indices increased and 7 decreased during period 4 to 16 years of age. Major (for boys) and moderate (for girls) positive changes were for facial index and lower face height-biocular width index (Table 6), negative – for middle face depth-lower face depth index (Table

7). In general, all examined indices show that face grows more vertically than in horizontal and sagittal directions, lower jaw becomes more prominent in both horizontal and vertical directions of the face, morphological face height is the most growing dimension compared to other vertical components of the face, lower face depth becomes more prominent in relation to middle face depth and changes for most of indices are bigger in boys than in girls.

Table 6. Increasing facial indices of Lithuanian children 4 to 16 years old

Index	Sex	Value of the index at the age of 4	Value of the index at the age of 16	Absolute change of the index from 4 to 16 years	Relative change of index from 4 to 16 years of age
lower face height-biocular width index	boys	65,4	73,4	8,0**	12,2
	girls	65,2	69,9	4,7**	7,2
facial index	boys	83,3	92,2	8,9**	10,6
	girls	83,0	89,7	6,7**	8,1
middle face height – upper face depth index	boys	57,3	61,6	4,3**	7,5
	girls	57,0	61,0	4,0**	7,0
mandible width-face width	boys	66,3	71,0	4,7**	7,0
	girls	66,0	70,6	4,5**	6,8
middle face height-face width	boys	53,2	57,4	4,1**	7,8
	girls	52,9	56,1	3,1**	5,9
morphological face height-physiognomic face height index	boys	63,5	67,3	3,8**	6,0
	girls	63,2	66,9	3,6**	5,7
physiognomic face height-total cranio-facial height	boys	75,4	77,9	2,5**	3,3
	girls	75,8	78,5	2,8**	3,7
mandible width-physiognomic face height index	boys	50,6	51,9	1,3	2,6
	girls	50,4	52,7	2,3**	4,5
anterior mandible height-lower face height index	boys	70,3	72,0	1,8**	2,6
	girls	70,2	71,6	1,4*	1,9
anterior mandible height-middle face height index	boys	63,7	65,9	2,2	3,5
	girls	64,1	64,1	0,0	0,0

Yellow – major change (over 10 %), purple – moderate (5–9,9 %), blue – mild (1–5 %), green – neglible (less than 1 %) according to Farkas LG. Anthropometric facial proportions in medicine, 1987.

* denotes significant change $p<0,05$ ** denotes significant change $p<0,01$

Table 7. Decreasing facial indices of Lithuanian children 4 to 16 years old

Index	Sex	Value of the index at the age of 4	Value of the index at the age of 16	Absolute change of the index from 4 to 16 years	Relative change of index from 4 to 16 years of age
middle face depth-lower face depth index	boys	95,4	91,6	-3,8**	-4,0
	girls	95,2	92,5	-2,7**	-2,9
mandible width-morphological face height index	boys	79,7	77,2	-2,5	-3,2
	girls	79,7	78,8	-0,9	-1,1
lower face height-morphological face height index	boys	57,8	56,9	-1,0	-1,7
	girls	58,2	55,9	-2,3**	-4,0
middle face height-morphological face height index	boys	63,9	62,3	-1,6**	-2,5
	girls	63,8	62,5	-1,3**	-2,1
mandible width-lower face depth index	boys	67,2	66,8	-0,4	-0,7
	girls	66,9	68,4	1,5	2,3
middle face height-lower face height index	boys	110,7	109,8	-0,9	-0,8
	girls	109,8	112,1	2,3	2,1
anterior mandible heigh-mandible width index	boys	51,1	53,3	2,2*	4,4
	girls	51,5	50,9	-0,6	-1,1

Yellow – major change (over 10 %), purple – moderate (5–9,9 %), blue – mild (1–5 %), green – neglible (less than 1 %) according to Farkas LG. Anthropometric facial proportions in medicine, 1987.
* denotes significant change p<0,05 ** denotes significant change p<0,01

Proportions between facial and cranial dimensions. Most examined proportions were decreasing from the age of 4y. Major negative changes were established for indices, showing intensive growth of morphological face height and middle face height relative to forehead height and anterior head height in both gender (Table 8). Although not significantly, middle face height for girls tended to increase more in relation to forehead height than in boys. In general, growth of the face vertically in relation to cranial measurements is more than twice bigger than in horizontal or sagittal directions, although face width considerably increases in relation to head width, forehead width and cranial base width.

Table 8. Proportions between facial and cranial dimensions in Lithuanians 4 to 16 years of age

Index	Sex	Value of the index at the age of 4	Value of the index at the age of 16	Absolute change of the index from 4 to 16 years	Relative change of index from 4 to 16 years of age
forehead height-morphologic face height index	boys	52,09	42,67	-9,41**	-18,07
	girls	51,40	41,55	-9,85**	-19,16
anterior head height-morphological face height index	boys	118,67	96,81	-21,86**	-18,42
	girls	118,15	97,26	-20,90**	-17,69
forehead height-middle face height index	boys	81,69	68,66	-13,03**	-15,95
	girls	80,66	66,45	-14,22**	-17,62
cranial base width-lower face depth index	boys	110,78	102,58	-8,20**	-7,40
	girls	110,70	103,35	-7,35**	-6,64
cranial base width-middle face depth index	boys	116,16	112,07	-4,09**	-3,52
	girls	116,30	111,81	-4,49**	-3,86
forehead width-face width index	boys	87,73	84,80	-2,93**	-3,34
	girls	87,09	84,15	-2,94**	-3,38
cranial base width-upper face depth index	boys	117,71	117,08	-0,63	-0,53
	girls	117,86	116,22	-1,63	-1,39
face with-cranial base width index	boys	91,53	91,77	0,24	0,27
	girls	91,56	93,84	2,28**	2,49
face width-head width index	boys	81,77	89,05	7,28**	8,91
	girls	82,29	89,05	6,76**	8,21

Yellow – major change (over 10 %), purple – moderate (5–9,9 %), blue – mild (1–5 %), green – neglible (less than 1 %) according to Farkas LG. Anthropometric facial proportions in medicine, 1987.

* denotes significant change p<0,05 ** denotes significant change p<0,01

Correlations between facial measurements and body height were moderate to low but significant (p<0,01). The largest correlation in present study have been found between sagittal (upper face depth, middle face depth, lower face depth, mandible body height) and vertical dimensions

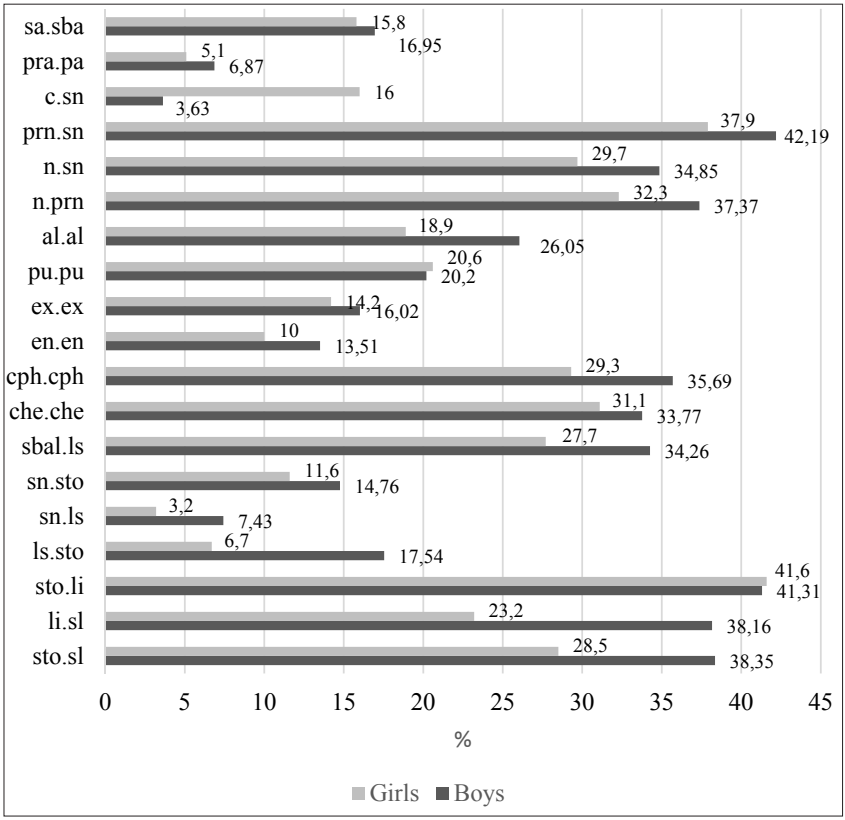
(morphological face height, physiognomic face height, mandible ramus height, middle face height) of the face. The least and not significant correlation was between parameters of the lips. Due to the lack of references we could not to compare our results with other works.

Regional measurements and proportions of the face, age dynamics and differences between sexes

Dimensions of the nose and mouth, especially lower lip parameters, in present study were the most changing dimensions in the face of boys and girls during period 4 to 16 years of age (Figure 14). In the faces of children from the age of 4y. nose dimensions, with special attention to nasal tip protrusion and nose height are revealed as well as widening of the mouth, increased expression of lateral upper lip height and both lower lip height and lower vermillion height is evident.

The orbits, situated between the cranial vault and face, are a dominant aesthetic element in the craniofacial complex (Farkas, Kolar, 1987) that greatly influence visual judgments of healthy persons as well as those with facial deformities. According to literature, both intercanthal and biocular widths are developed almost equally at the end of first year (Farkas et al, 1992) but due to the more rapid growth of intercanthal width than compared to biocular width until the age of 5y., in older children the latter dimension increases relatively more. Our data also show the same tendency: intercanthal width increases by 10-13,5% and biocular width – 14,2-16% from the age of 4y. The largest increments in growth of orbital measurements were established during preschool years in both sexes (Figures 15-16) and this finding agrees with the references (Farkas et al, 1992). Although some researches find significant differences between sexes in linear measurements of the orbits (Sforza et al, 2009, Ferrario et al, 2001), our data suggest that boys and girls are similar in some age periods regarding interpupillary and intercanthal distances and differ mostly in biocular width. Concerning areal and interareal proportions of the orbits, the results of present study show that horizontal dimensions of the face (mouth width, nose width, face width and forehead width) increased relatively more than biocular and intercanthal width, in particular (Table 9).

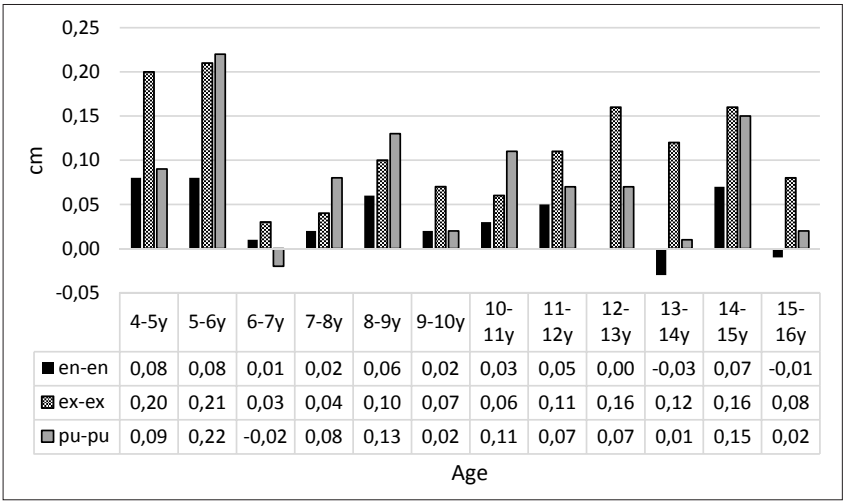
Figure 14. Relative increments of regional measurements of the face in Lithuanian children 4 to 16 years of age



sa.sba ear length, pra.pa ear width, c.sn collumela height, prn.sn nasal tip protrusion, n.sn nose height, n.prn nasal bridge length, al.al nose width, pu.pu interpupillary distance, en.en intercanthal distance, ex.ex biocular width, cph.cph philtrum width, che.che labial fissure width, sbal.ls lateral upper lip height, sn.sto upper lip height, sn.ls philtrum length, ls.sto upper vermillion height, sto.li lower vermillion height, li.sl lower cutaneous lip height, sto.sl lower lip height.

So the orbits in the faces of adolescents make smaller part and are relatively closer than compared to the faces of 4 year olds. Between sexes, the most difference was noted in intercanthal width-nose width index: girls have more harmonious relation between the dimensions while boys tended to have relatively wider nose than compared to intercanthal width.

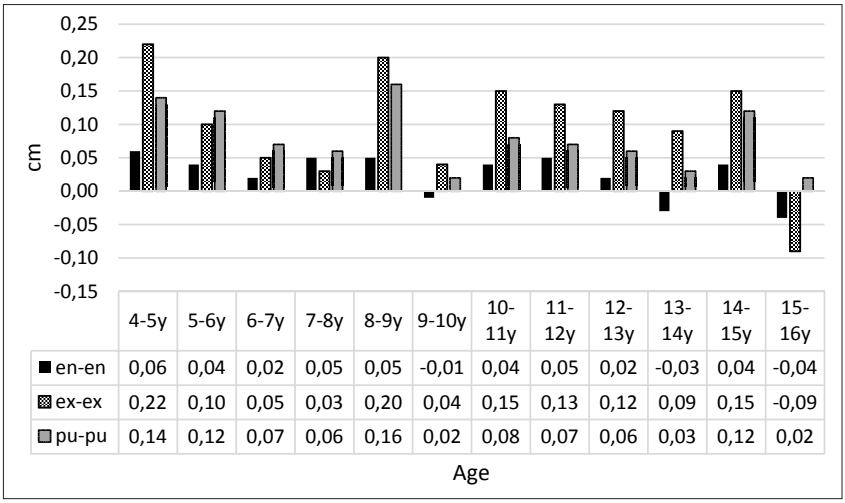
Figure 15. Growth velocity of orbital measurements of Lithuanian boys 4 to 16 years of age



	4-5y	5-6y	6-7y	7-8y	8-9y	9-10y	10-11y	11-12y	12-13y	13-14y	14-15y	15-16y
en-en	0,08	0,08	0,01	0,02	0,06	0,02	0,03	0,05	0,00	-0,03	0,07	-0,01
ex-ex	0,20	0,21	0,03	0,04	0,10	0,07	0,06	0,11	0,16	0,12	0,16	0,08
pu-pu	0,09	0,22	-0,02	0,08	0,13	0,02	0,11	0,07	0,07	0,01	0,15	0,02

en-en intercanthal distance, ex-ex biocular width, pu-pu interpupillary distance

Figure 16. Growth velocity of orbital measurements of Lithuanian girls 4 to 16 years of age



	4-5y	5-6y	6-7y	7-8y	8-9y	9-10y	10-11y	11-12y	12-13y	13-14y	14-15y	15-16y
en-en	0,06	0,04	0,02	0,05	0,05	-0,01	0,04	0,05	0,02	-0,03	0,04	-0,04
ex-ex	0,22	0,10	0,05	0,03	0,20	0,04	0,15	0,13	0,12	0,09	0,15	-0,09
pu-pu	0,14	0,12	0,07	0,06	0,16	0,02	0,08	0,07	0,06	0,03	0,12	0,02

en-en intercanthal distance, ex-ex biocular width, pu-pu interpupillary distance

Table 9. Areal and interareal proportions of orbital measurements in Lithuanian children 4 to 16 years of age

Index	Sex	Value of the index at the age of 4	Value of the index at the age of 16	Absolute change of the index from 4 to 16 years	Relative change of index from 4 to 16 years of age
intercanthal width-mouth width index	boys	74,54	63,09	-11,45**	-15,36
	girls	76,28	63,93	-12,35**	-16,19
intercanthal width-nose width index	boys	101,87	91,87	-10,00**	-9,82
	girls	104,76	96,78	-7,98**	-7,62
intercanthal width biocular width index	boys	33,05	32,33	-0,72	-2,18
	girls	33,66	32,38	-1,28**	-3,80
biocular width – face width index	boys	73,70	71,51	-2,19**	-2,97
	girls	74,15	71,84	-2,31**	-3,12
intercanthal width – forehead width index	boys	27,78	27,28	-0,50	-1,80
	girls	28,68	27,69	-0,99*	-3,45

Yellow – major change (over 10 %), purple – moderate (5–9,9 %), blue – mild (1–5 %), green – neglible (less than 1 %) according to Farkas LG. Anthropometric facial proportions in medicine, 1987.

* denotes significant change p<0,05 ** denotes significant change p<0,01

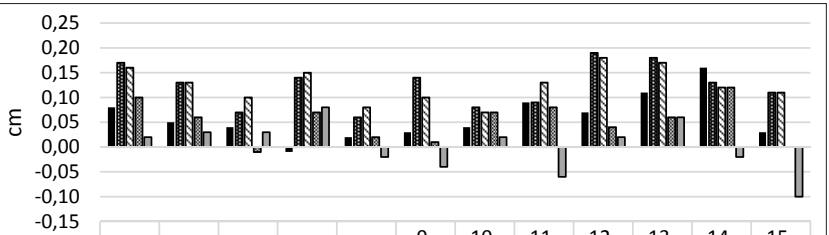
In both gender, most correlation has been found between orbital measurements and face width (r=0,34 - 0,31 for intercanthal distance, r=0,48 - 0,46 biocular width and r=0,38 - 0,36 for interpupillary distance) and upper face depth (r=0,52 for intercanthal distance, r=0,35 - 0,37 for biocular width and r=0,36 - 0,40 for interpupillary distance).

In the **nose** region, nasal tip protrusion was the most developing dimension while nose width and *collumela* height showed least increments from the age of 4y in both sexes (Figure 14). All examined dimensions exhibited largest increments in growth during 4 to 6 years in both gender, 11-13 in girls and 12-15 years in boys. It has to be noted, that in contrary to other facial measurements, increments of growth in nose region during older ages were larger than during preschool years. Although some studies state significant differences between sexes in linear measurements of the nose (Sforza et al, 2011), we have found significant differences only for nasal

width until the age of 8y., no significant difference have been found during period 8 to 13 y. in either examined dimension of the nose, from the age of 13y. nose width and from the age of 14y. nose height and nose bridge length were significantly bigger in boys than compared to girls. We have not found significant differences between sexes in nasal tip protrusion and collumela height during all studied period.

Analysed proportions of the nose revealed that nose height increases dramatically in comparison to nasal width and facial dimensions (face width, lower face height, middle face height, morphological face height) (Table 10). The most change occurred in nasal tip protrusion – nose width index and the increase was bigger in girls than in boys. Hence, the nose of the boys resembles equilateral triangle while girls' nose resemble isosceles triangle if viewed from the nostril side.

Figure 17. Growth velocity of nasal measurements of Lithuanian boys 4 to 16 years of age

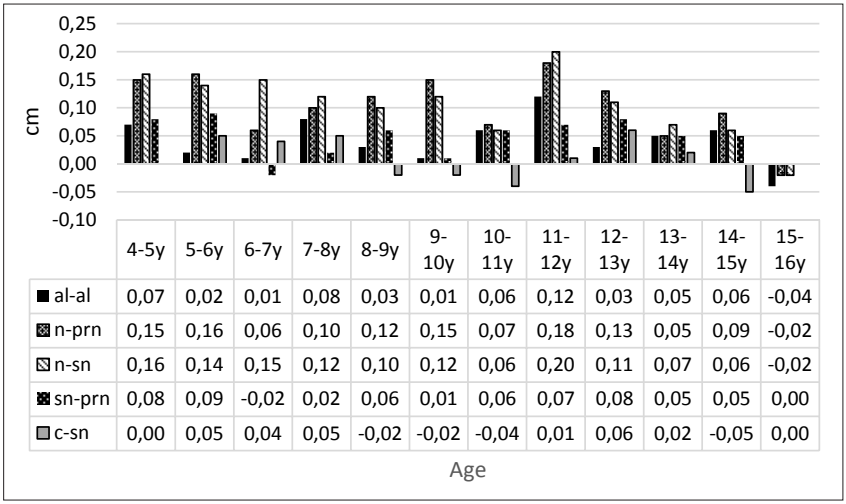


	4-5y	5-6y	6-7y	7-8y	8-9y	9-10y	10-11y	11-12y	12-13y	13-14y	14-15y	15-16y
al-al	0,08	0,05	0,04	-0,01	0,02	0,03	0,04	0,09	0,07	0,11	0,16	0,03
n-prn	0,17	0,13	0,07	0,14	0,06	0,14	0,08	0,09	0,19	0,18	0,13	0,11
n-sn	0,16	0,13	0,10	0,15	0,08	0,10	0,07	0,13	0,18	0,17	0,12	0,11
sn-prn	0,10	0,06	-0,01	0,07	0,02	0,01	0,07	0,08	0,04	0,06	0,12	0,00
c-sn	0,02	0,03	0,03	0,08	-0,02	-0,04	0,02	-0,06	0,02	0,06	-0,02	-0,10

Age

al-al nose width, n-prn nasal bridge length, n-sn nose height, sn-prn nasal tip protrusion, c-sn collumela height

Figure 18. Growth velocity of nasal measurements of Lithuanian girls 4 to 16 years of age



	4-5y	5-6y	6-7y	7-8y	8-9y	9-10y	10-11y	11-12y	12-13y	13-14y	14-15y	15-16y
al-al	0,07	0,02	0,01	0,08	0,03	0,01	0,06	0,12	0,03	0,05	0,06	-0,04
n-prn	0,15	0,16	0,06	0,10	0,12	0,15	0,07	0,18	0,13	0,05	0,09	-0,02
n-sn	0,16	0,14	0,15	0,12	0,10	0,12	0,06	0,20	0,11	0,07	0,06	-0,02
sn-prn	0,08	0,09	-0,02	0,02	0,06	0,01	0,06	0,07	0,08	0,05	0,05	0,00
c-sn	0,00	0,05	0,04	0,05	-0,02	-0,02	-0,04	0,01	0,06	0,02	-0,05	0,00

Age

al-al nose width, n-prn nasal bridge length, n-sn nose height, sn-prn nasal tip protrusion, c-sn collumela height

Nasal width and other dimensions of the face correlate weakly, in boys the largest correlation have been found with mouth width (r=0,32), middle face depth (r=0,31), in girls – with biocular width (r=0,32) and middle face depth (r=0,28). Nasal bridge length and nose height in both sexes correlated mostly between each other (r=0,78–0,79), and with middle face height (r=0,65 and 0,67), morphological face height (r=0,53), middle face depth (nose height r=0,36–0,38, nose bridge length in girls r=0,33, boys– 0,37).

Orolabial measurements tended to increase more in boys than in girls and the increments in all dimensions, except upper lip parameters exceeded one third of initial value at the age of 4y, while in girls only mouth width and lower vermillion height showed the same amount of increments. The dimensions of upper lip undergone only minor changes, lateral lip height was the most growing dimension in both sexes. The same difference between the growths of upper lip than compared to lower lip was noted in other works (Ferrario et al, 2000). All examined orolabial parameters exhibited rapid growth during preschool years and only few of them (lower

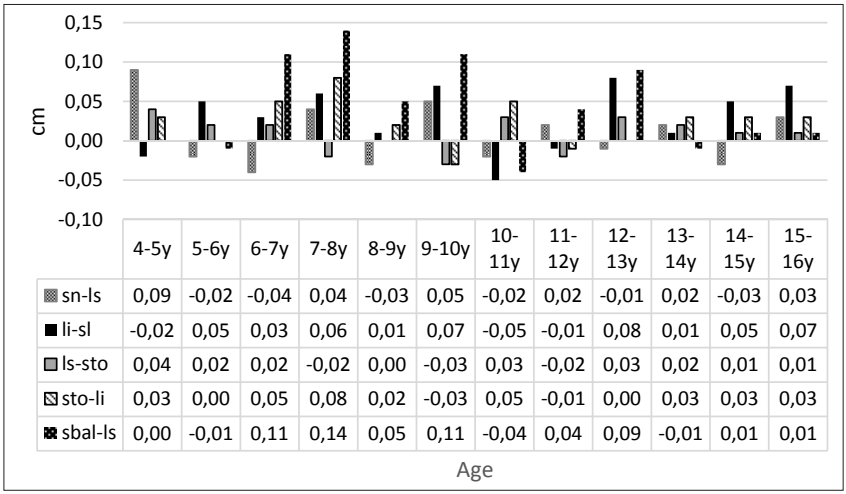
Table 10. Areal and interareal proportions of nose measurements in Lithuanian children 4 to 16 years of age

Index	Sex	Value of the index at the age of 4	Value of the index at the age of 16	Absolute change of the index from 4 to 16 years	Relative change of index from 4 to 16 years of age
nasal tip protrusion-nose width index	boys	53,62	60,60	6,98**	13,02
	girls	54,93	63,94	9,01**	16,40
nose height – face width index	boys	38,04	42,90	4,86**	12,78
	girls	38,23	42,02	3,79**	9,91
nose height – lower face height index	boys	79,18	82,32	3,14**	3,97
	girls	79,34	84,11	4,77**	6,01
nose height – upper face height index	boys	71,53	74,92	3,39**	4,74
	girls	72,26	75,04	2,78**	3,85
nose height-morpho-logic face height index	boys	45,67	46,60	0,93	2,04
	girls	46,11	46,87	0,76	1,65
nose width-labial fissure width index	boys	73,34	68,88	-4,46**	-6,08
	girls	73,12	66,23	-6,89**	-9,42
nose width-nose height index	boys	63,24	59,07	-4,17**	-6,59
	girls	62,77	57,62	-5,15**	-8,20

Yellow – major change (over 10 %), purple – moderate (5–9,9 %), blue – mild (1–5 %), green – neglible (less than 1 %) according to Farkas LG. Anthropometric facial proportions in medicine, 1987.
* denotes significant change p<0,05 ** denotes significant change p<0,01

lip height, mouth width, lower vermillion height, philtrum height) showed acceleration in growth during puberty, which was more pronounced in boys than in girls (Figures 19-22). Boys and girls are similar in orolabial parameters throughout childhood, only upper lip height is significantly larger in boys from the age of 5y. Mostly, significant differences in all other parameters start to appear from the age of 15, except mouth width and lower lip height that are significantly different from the age of 12 y. Lower vermillion height did not differ between sexes in all investigated period. Such results contradict data from other research, suggesting inter-gender differences in orolabial parameters from the age of 8y. (Ferrario et al, 2000) or even in all age groups (Sforza et al, 2010).

Figure 19. Growth velocity of cutaneous and vermillion heights of the lips in Lithuanian boys 4 to 16 years of age

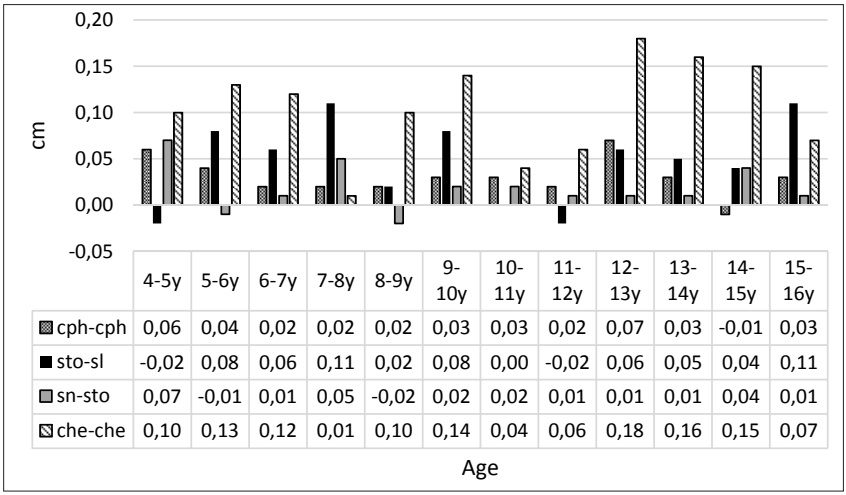


	4-5y	5-6y	6-7y	7-8y	8-9y	9-10y	10-11y	11-12y	12-13y	13-14y	14-15y	15-16y
sn-ls	0,09	-0,02	-0,04	0,04	-0,03	0,05	-0,02	0,02	-0,01	0,02	-0,03	0,03
li-sl	-0,02	0,05	0,03	0,06	0,01	0,07	-0,05	-0,01	0,08	0,01	0,05	0,07
ls-sto	0,04	0,02	0,02	-0,02	0,00	-0,03	0,03	-0,02	0,03	0,02	0,01	0,01
sto-li	0,03	0,00	0,05	0,08	0,02	-0,03	0,05	-0,01	0,00	0,03	0,03	0,03
sbal-ls	0,00	-0,01	0,11	0,14	0,05	0,11	-0,04	0,04	0,09	-0,01	0,01	0,01

Age

sn-ls philtrum length, li-sl lower lip cutaneous height, ls-sto upper vermillion height, sto-li lower vermillion height, sbal-ls lateral lip height

Figure 20. Growth velocity of labial fissure width, *philtrum* width and heights of the lips in Lithuanian boys 4 to 16 years of age

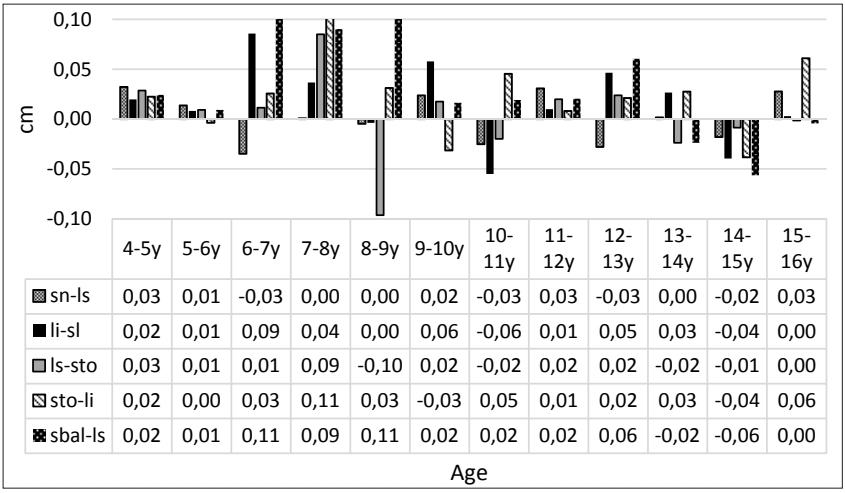


	4-5y	5-6y	6-7y	7-8y	8-9y	9-10y	10-11y	11-12y	12-13y	13-14y	14-15y	15-16y
cph-cph	0,06	0,04	0,02	0,02	0,02	0,03	0,03	0,02	0,07	0,03	-0,01	0,03
sto-sl	-0,02	0,08	0,06	0,11	0,02	0,08	0,00	-0,02	0,06	0,05	0,04	0,11
sn-sto	0,07	-0,01	0,01	0,05	-0,02	0,02	0,02	0,01	0,01	0,01	0,04	0,01
che-che	0,10	0,13	0,12	0,01	0,10	0,14	0,04	0,06	0,18	0,16	0,15	0,07

Age

cph-cph *philtrum* width, sto-sl lower lip height, sn-sto upper lip height, che-che labial fissure height

Figure 21. Growth velocity of cutaneous and vermillion heights of the lips in Lithuanian girls 4 to 16 years of age

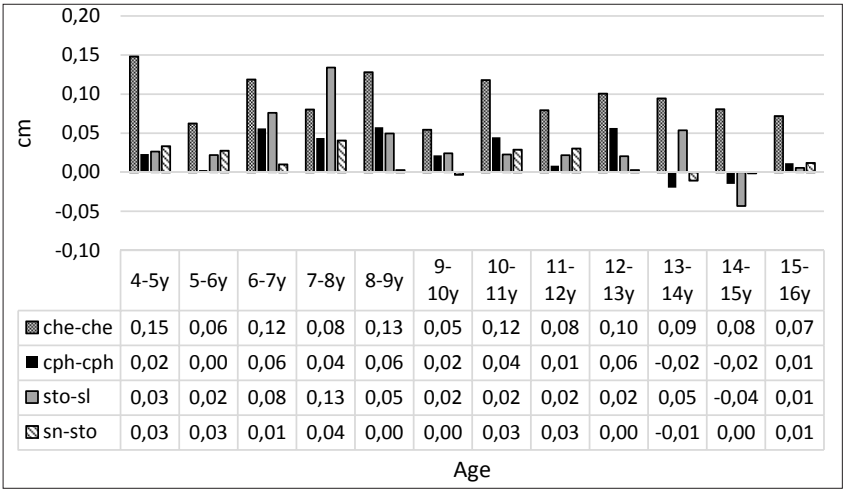


	4-5y	5-6y	6-7y	7-8y	8-9y	9-10y	10-11y	11-12y	12-13y	13-14y	14-15y	15-16y
sn-ls	0,03	0,01	-0,03	0,00	0,00	0,02	-0,03	0,03	-0,03	0,00	-0,02	0,03
li-sl	0,02	0,01	0,09	0,04	0,00	0,06	-0,06	0,01	0,05	0,03	-0,04	0,00
ls-sto	0,03	0,01	0,01	0,09	-0,10	0,02	-0,02	0,02	0,02	-0,02	-0,01	0,00
sto-li	0,02	0,00	0,03	0,11	0,03	-0,03	0,05	0,01	0,02	0,03	-0,04	0,06
sbal-ls	0,02	0,01	0,11	0,09	0,11	0,02	0,02	0,02	0,06	-0,02	-0,06	0,00

Age

sn-ls *philtrum* length, li-sl lower lip cutaneous height, ls-sto upper vermillion height, sto-li lower vermillion height, sbal-ls lateral lip height

Figure 22. Growth velocity of labial fissure width, *philtrum* width and heights of the lips in Lithuanian girls 4 to 16 years of age



	4-5y	5-6y	6-7y	7-8y	8-9y	9-10y	10-11y	11-12y	12-13y	13-14y	14-15y	15-16y
che-che	0,15	0,06	0,12	0,08	0,13	0,05	0,12	0,08	0,10	0,09	0,08	0,07
cph-cph	0,02	0,00	0,06	0,04	0,06	0,02	0,04	0,01	0,06	-0,02	-0,02	0,01
sto-sl	0,03	0,02	0,08	0,13	0,05	0,02	0,02	0,02	0,02	0,05	-0,04	0,01
sn-sto	0,03	0,03	0,01	0,04	0,00	0,00	0,03	0,03	0,00	-0,01	0,00	0,01

Age

cph-cph *philtrum* width, sto-sl lower lip height, sn-sto upper lip height, che-che labial fissure height

According to proportional change in orolabial region from the age of 4y., we conclude that in the growing face mouth width and vermillion heights of the lips become more prominent in relation to other facial dimensions (Table 11 and 12).

Table 11. Increasing areal and interareal proportions of orolabial measurements in Lithuanian children 4 to 16 years of age

Index	Sex	Value of the index at the age of 4	Value of the index at the age of 16	Absolute change of the index from 4 to 16 years	Relative change of index from 4 to 16 years of age
nasal tip protrusion-upper lip height index	boys	87,42	110,24	22,82**	26,10
	girls	91,84	114,37	22,53**	24,53
labial fissure width-face width index	boys	32,92	36,84	3,92**	11,91
	girls	32,86	36,53	3,67**	11,17
upper vermillion height-philtrum height index	boys	60,39	65,78	5,39	8,93
	girls	64,48	67,09	2,61	4,05

Table 12. Decreasing areal and interareal proportions of orbital measurements in Lithuanian children 4 to 16 years of age

Index	Sex	Value of the index at the age of 4	Value of the index at the age of 16	Absolute change of the index from 4 to 16 years	Relative change of index from 4 to 16 years of age
upper lip vermillion height-lower lip vermillion height index	boys	99,41	82,19	-17,22**	-17,32
	girls	103,83	78,09	-25,74**	-24,79
upper lip height-labial fissure width index	boys	45,10	38,41	-6,69**	-14,83
	girls	44,07	37,54	-6,53**	-14,82
upper lip height-nose height index	boys	38,89	32,87	-6,02**	-15,48
	girls	37,86	32,61	-5,25**	-13,87
upper lip height-middle face height index	boys	27,75	24,54	-3,21**	-11,57
	girls	27,25	24,37	-2,88**	-10,57
upper lip height-lower face height index	boys	30,63	26,83	-3,80**	-12,41
	girls	29,89	27,20	-2,69**	-9,00

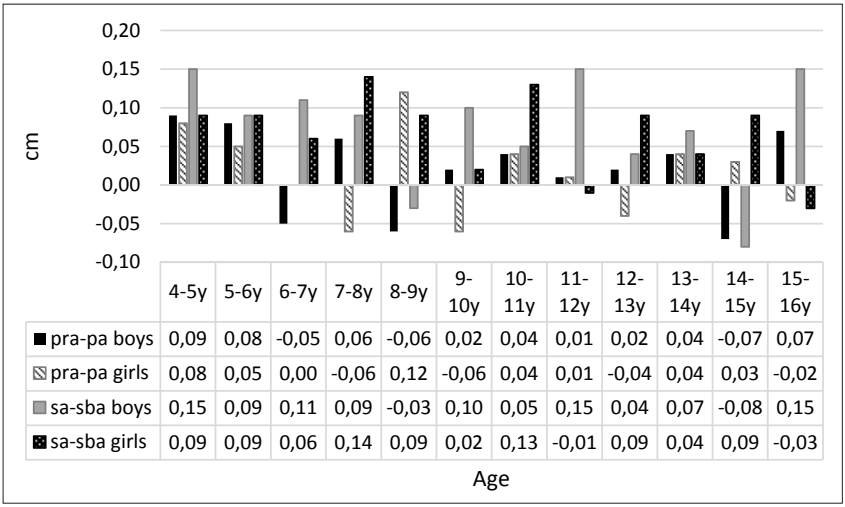
Yellow – major change (over 10 %), purple – moderate (5–9,9 %), blue – mild (1–5 %), green – neglible (less than 1 %) according to Farkas LG. Anthropometric facial proportions in medicine, 1987.

* denotes significant change p<0,05 ** denotes significant change p<0,01

Most of all, labial measurements correlated with vertical facial dimensions, largest correlation have been found between lower lip height and morphological face height (girls' r=0,47, boys' r=0,45), physiognomic face height (r=0,39 and 0,36 accordingly), lower face height (r=0,5 and 0,49 accordingly), anterior height of the mandible (r =0,49 and 0,48 accordingly), middle face height (only for girls r=0,36).

Ear width was among those dimensions that showed least change during period 4 to 16 years of age in both sexes and it is not surprising as ear width reaches its maturity according to references very early, about at 5-6 y. of age (Farkas, 1992, Kalcioglu et al, 2003). While there is evidence in literature, that ear length has a tendency to increase throughout all life (Kalcioglu et al, 2003, Sforza et al, 2009), our results show a relative stabilization of the dimension in sixteen year old girls. Most rapid growth of ear width occurred until 9 years of age and that of ear length until 12 years in both sexes, although growth velocity of the latter tended to increase in boys during 15-16 year old period (Figure 23). Both dimensions of the ear were significantly larger in boys during all period from 4 to 16, except for ear length measurement in 9 and 15y. olds.

Figure 23. Growth velocity of ear width (pra-pa) and ear length (sa-sba) in Lithuanian children 4 to 16 years of age



	4-5y	5-6y	6-7y	7-8y	8-9y	9-10y	10-11y	11-12y	12-13y	13-14y	14-15y	15-16y
pra-pa boys	0,09	0,08	-0,05	0,06	-0,06	0,02	0,04	0,01	0,02	0,04	-0,07	0,07
pra-pa girls	0,08	0,05	0,00	-0,06	0,12	-0,06	0,04	0,01	-0,04	0,04	0,03	-0,02
sa-sba boys	0,15	0,09	0,11	0,09	-0,03	0,10	0,05	0,15	0,04	0,07	-0,08	0,15
sa-sba girls	0,09	0,09	0,06	0,14	0,09	0,02	0,13	-0,01	0,09	0,04	0,09	-0,03

Although ear length increased more than three times more than ear width, its relative increase compared to other facial dimensions was smaller and this tendency is reflected in the proportion indices (Table 13).

Table 13. Areal and interareal indices of ear region in Lithuanian children 4 to 16 years of age

Index	Sex	Value of the index at the age of 4	Value of the index at the age of 16	Absolute change of the index from 4 to 16 years	Relative change of index from 4 to 16 years of age
ear width-ear length index	boys	67,74	61,79	-5,95**	-8,78
	girls	67,21	61,03	-6,18**	-9,20
ear length-morphological face height index	boys	54,90	48,53	-6,37**	-11,60
	girls	54,67	49,64	-5,03**	-9,20
ear length-lower face height index	boys	95,06	85,61	-9,45**	-9,94
	girls	94,04	89,00	-5,04**	-5,36
ear length-total craniofacial height index	boys	26,25	25,42	-0,83	-3,16
	girls	26,11	26,01	-0,10	-0,38

Yellow – major change (over 10 %), purple – moderate (5–9,9 %), blue – mild (1–5 %), green – neglible (less than 1 %) according to Farkas LG. Anthropometric facial proportions in medicine, 1987.
* denotes significant change p<0,05 ** denotes significant change p<0,01

Ear measurements with other facial dimension correlated weakly and insignificantly.

Secular changes in head and face measurements

In order to evaluate secular trend in head and face measurements, we compared data of the present study with the ones done on Lithuanian children 7 to 16 years of age in 1965-1967 and 1984-1985. Recent data revealed that although head circumference is larger in today children until the age of 10, the circumference of the head in older children did not change significantly over period of 20 years (Figure 24). This finding is along with earlier done study on Lithuanian children showing that head circumference is stable over time although acceleration in body height and face height have

been taken place (Balciuniene, Nainys et al, 1991). The tendency to have larger head circumference during earlier ages have been noted in recently done study on Lithuanian preschool children (Jakimaviciene, 2008) and we can conclude that maybe now day's children grow rapidly during preschool years and reach final size in head circumference earlier.

Figure 24. Secular change in head circumference of Lithuanian children 7 to 16 years of age

Head width increased a little but significantly over last 20 years, the difference varied between 0,24 and 0,93 cm (Table 14) . The head width in boys is wider in all age groups, the biggest difference has been noted in 10-12y. and 15-16y. olds. Head length also increased over the same period, but the relative increase was smaller than compared to head width (Table 15). Cephalic index increased by 1,87 points in sixteen year old boys and by 0,56 point in girls (Table 16). Hence, our result suggest ongoing head brachycephalisation although in European countries debrachycephalisation have been noted since 1944.

Table 14. Secular changes in head width (cm) of Lithuanian children 7 to 16 years of age

Age in (years)	Boys				Girls			
	1984–1985 years	2009–2011 years	Absoliute difference (cm)	Relative difference (%)	1984–1985 years	2009–2011 years	Absolute difference (cm)	Relative difference (%)
7	14,05	14,29	0,24	1,68	13,66	13,97	0,31	2,27
8	13,87	14,44	0,57	3,95	13,55	14,07	0,52	3,84
9	14,07	14,47	0,4	2,76	13,76	14,23	0,47	3,42
10	13,78	14,71	0,93	6,32	13,53	14,25	0,72	5,32
11	13,93	14,79	0,86	5,81	13,73	14,47	0,74	5,39
12	14,11	14,82	0,71	4,79	13,85	14,47	0,62	4,48
13	14,34	14,93	0,59	3,95	14,24	14,63	0,39	2,74
14	14,47	14,97	0,5	3,34	14,22	14,63	0,41	2,88
15	14,38	15,12	0,74	4,89	14,07	14,76	0,69	4,90
16	14,54	15,32	0,78	5,09	14,26	14,75	0,49	3,44

Table 15. Secular changes in head length (cm) of Lithuanian children 7 to 16 years of age

Age (years)	Boys				Girls			
	1984–1985 years	2009–2011 years	Absolute difference (cm)	Relative difference (%)	1984–1985 years	2009–2011 years	Absolute difference (cm)	Relative difference (%)
7	17,81	18,16	0,35	1,97	17,33	17,74	0,41	2,37
8	17,82	18,28	0,46	2,58	17,46	17,87	0,41	2,35
9	17,96	18,38	0,42	2,34	17,46	18,13	0,67	3,84
10	17,79	18,62	0,83	4,67	17,59	18,09	0,5	2,84
11	17,9	18,58	0,68	3,80	17,59	18,3	0,71	4,04
12	17,98	18,72	0,74	4,12	17,58	18,44	0,86	4,89
13	18,18	18,84	0,66	3,63	17,88	18,54	0,66	3,69
14	18,3	18,97	0,67	3,66	18	18,59	0,59	3,28
15	18,46	19,22	0,76	4,12	18	18,74	0,74	4,11
16	18,8	19,34	0,54	2,87	18,1	18,59	0,49	2,71

Table 16. Secular changes in cephalic index of Lithuanian children 7 to 16 years of age

Age (years)	Boys			Girls		
	1984–1985 years	2009–2011 years	Difference	1984–1985 years	2009–2011 years	Difference
7	78,89	78,69	-0,20	78,82	78,75	-0,07
8	77,83	78,99	1,16	77,61	78,74	1,13
9	78,34	78,73	0,39	78,81	78,49	-0,32
10	77,46	79,00	1,54	76,92	78,77	1,85
11	77,82	79,60	1,78	78,06	79,07	1,02
12	78,48	79,17	0,69	78,78	78,47	-0,31
13	78,88	79,25	0,37	79,64	78,91	-0,73
14	79,07	78,91	-0,16	79,00	78,70	-0,30
15	77,90	78,67	0,77	78,17	78,76	0,60
16	77,34	79,21	**1,87**	78,78	79,34	**0,56**

Face height although increased since 1965-1967 and 1984-1985 but not as dramatically as face width and it is a surprising finding. Our data show that face height increased in all age groups than compared to children 45 years ago and almost in all age groups than compared to children from the 1984-1985 study sample (Figures 25-28). It should be pointed out that positive trend in face height during the last 20 years is not as big as it was from 1965-1967 until 1984-1985 years. Hence, today face of school children are longer than their peers 40 years ago, but the process acceleration is stabilizing during the last decades. If growth velocity of the face height over time is to be analysed, the results of present study suggest that the growth velocity of present children varies less but is larger in amplitude during early school years and has a peak in acceleration during pubertal growth spurt. While elongation of the face in secular aspect is well documented in most anthropometric studies (Buretic-Tomljanovic et al, 2004; Gyenis, 1994; Hossain et al, 2005, Hossain et al, 2011; Jantz and Meadows, 2000; Kondo et al, 1999; Little et al, 2006; Zellner et al, 1999), face widening over time is a new finding, although one study from Italy also reported wider face in today's children (Sanna and Soro, 2000). Maybe our finding could be explained by the change in direction of growth acceleration from vertical dimensions to horizontal ones.

Figure 25. Secular changes of morphological face height (n-gn) in Lithuanian boys 7 to 16 years of age

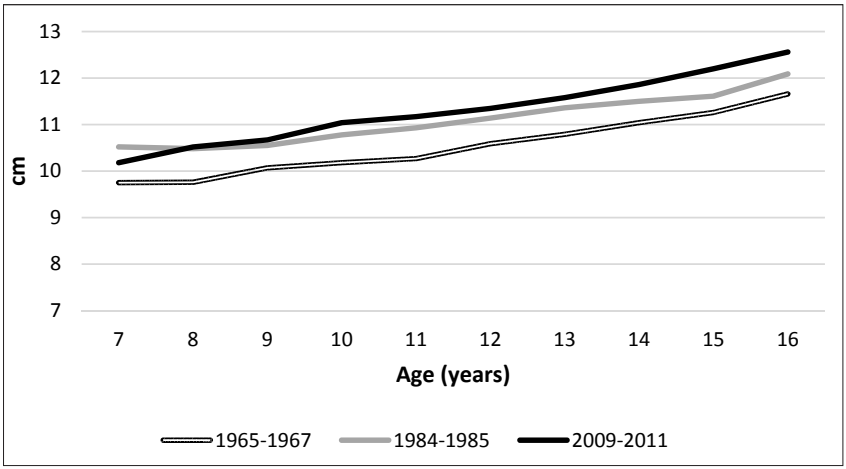


Figure 26. Secular changes of morphological face height (n-gn) in Lithuanian girls 7 to 16 years of age

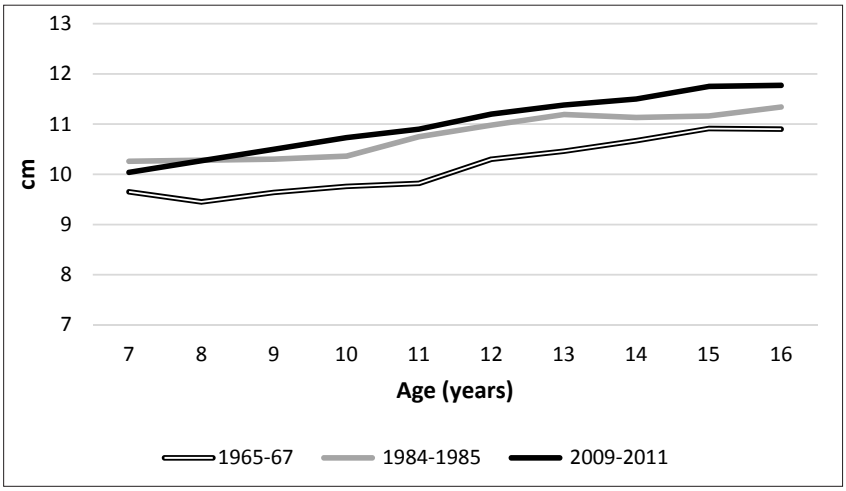


Figure 27. Secular changes of face width (zy-zy) in Lithuanian boys 7 to 16 years of age

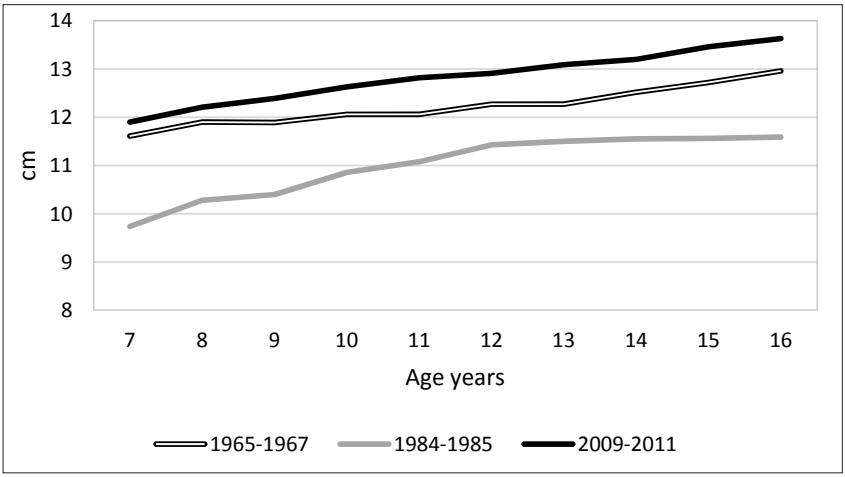
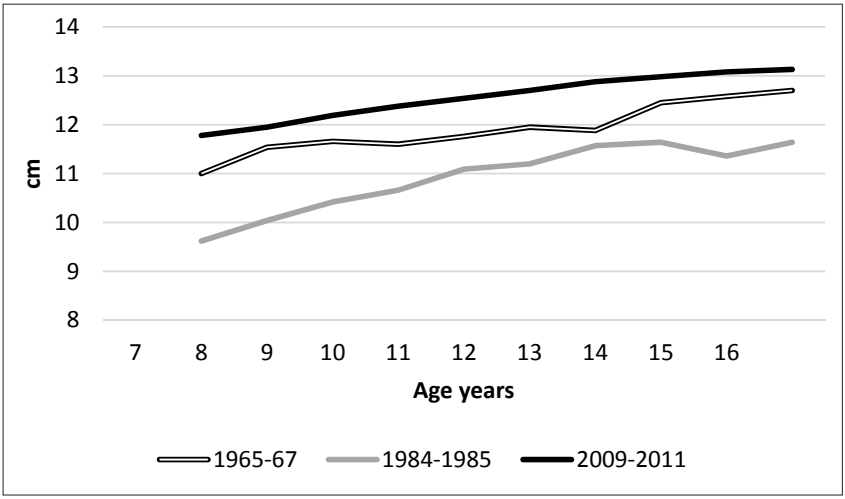


Figure 28. Secular changes of face width (zy-zy) in Lithuanian girls 7 to 16 years of age



Time and sequence of emergence of permanent teeth

The median ages of emergence of all the permanent teeth, excluding third molars, in boys and in girls for upper jaw are provided in Table 17 and for lower jaw - in Table 18. In addition, the 5^{th} and 95^{th} percentiles are presented, indicating the range within which 90 per cent of values within the sample fell. Data are given for both right and left sides, although no significant differences in timing of teeth emergence between them has been found.

The earliest permanent teeth to emerge just before the 5 years of age were lower central incisor for girls and mandibular first molar for boys. If a median eruption age is taken into consideration, then the first transitional period of mixed dentition starts with the eruption of lower central incisors in both genders, although the difference in time of emergence between central incisors and first molars is minimal in boys but is significant in girls. The last tooth to erupt in both genders is maxillary second molar at the age of twelve.

Our findings revealed that the permanent teeth emerged at similar times on the right and left sides, which are consistent with the results of previous studies in different populations (Diamanti et al, 2003; Elmes et al, 2010; Eskeli et al, 1999; Leroy et al, 2003). The fact that permanent teeth in the lower jaw precede corresponding maxillary teeth is also in agreement with other works (Diamanti et al, 2003, Eskeli et al, 1999; Hernandez et al, 2008). All mandibular teeth, except premolars and first molars (with the exception for the first right molar in girls) in both genders showed statistically significant earlier eruption with the range between one and 9 months. The same significant differences were noted in one recently done study (Shaweesh, 2012), while other works just reported the existing difference without testing significance. The order of permanent teeth emergence in both jaws was generally consistent with other studies (Eskeli et al, 1999; Shaweesh, 2012, Leroy et al, 2008) and the first teeth to erupt were central incisors in mandible and first molar in maxilla, the same as reported in other European countries (Eskeli et al, 1999; Hernandez et al, 2008; Leroy et al, 2008; Nystrom et al, 2001).

Table 17. Median eruption times (years) for maxillary permanent teeth in Lithuanian children (including 5th and 95th percentiles)

Tooth	No of tooth (FDI)	Right side			No of tooth (FDI)	Left side	
		Emergence time	Females	Males		Females	Males
Central incisor	11	**Median** *(confidence interval)*	**6.75** *(6.64–6.87)*	**6.89** *(6.78–7.0)*	21	**6.74** *(6.62–6.85)*	**6.84** *(6.73–6.95)*
		5th -95th percentiles	5.61 – 7.9	5.74 – 8.04		5.69 – 7.98	5.77 – 8.10
Lateral incisor	12	**Median** *(confidence interval)*	**7.55** *(7.43–7.66)*	**7.96** *(7.83–8.08)*	22	**7.51** *(7.37–7.63)*	**7.97** *(7.86–8.08)*
		5th -95th percentiles	6.36 – 8.96	6.70 – 9.44		6.20 – 9.08	6.83 – 9.10
Canine	13	**Median** *(confidence interval)*	**10.51** *(10.38–10.64)*	**11.09** *(10.96–11.22)*	23	**10.48** *(10.35–10.60)*	**11.02** *(10.89–11.15)*
		5th -95th percentiles	8.54 – 12.48	9.12 – 13.06		8.76 – 12.53	9.22 – 13.18
First premolar	14	**Median** *(confidence interval)*	**9.51** *(9.37–9.65)*	**9.91** *(9.76–10.05)*	24	**9.55** *(9.41–9.69)*	**9.87** *(9.73–10.02)*
		5th -95th percentiles	7.36 – 11.67	7.75 – 12.06		7.36 – 11.73	7.69 – 12.06
Second premolar	15	**Median** (confidence interval)	**10.63** *(10.49– 10.77)*	**10.82** *(10.68–10.97)*	25	**10.61** *(10.46–10.75)*	**10.98** *(10.84–11.12)*
		5th -95th percentiles	8.29 – 13.27	8.48 – 13.17		8.20 – 13.02	8.57 – 13.39
First molar	16	**Median** (confidence interval)	**6.26** *(6.15–6.38)*	**6.41** *(6.30–6.52)*	26	**6.20** *(6.09–6.30)*	**6.45** *(6.34–6.55)*
		5th -95th percentiles	5.13 – 7.40	5.27 – 7.55		5.32 – 7.07	5.48 – 7.59
Second molar	17	**Median** (confidence interval)	**12.08** *(11.96–12.20)*	**12.32** *(12.19–12.44)*	27	**12.04** *(11.92–12.16)*	**12.26** *(12.14–12.38)*
		5th -95th percentiles	10.10 – 14.07	10.33 – 14.30		10.12 – 13.96	10.34 – 14.19

Table 18. Median eruption times (years) for mandibular permanent teeth in Lithuanian children (including 5th and 95th percentiles)

Tooth	No of tooth (FDI)	Right side			No of tooth (FDI)	Left side	
		Emergence time	Females	Males		Females	Males
Central incisor	41	**Median** *(confidence interval)*	**5,82** *(5,71–5,93)*	**6,07** *(5,97–6,18)*	31	**5,87** *(5,75–5,98)*	**6,13** *(6,02–6,23)*
		5th -95th percentiles	4,75 – 6,89	5,00 – 7,15		4,75 – 6,99	5,02 – 7,42
Lateral incisor	42	**Median** *(confidence interval)*	**6,83** *(6,70–6,95)*	**7,22** *(7,10–7,34)*	32	**6,86** *(6,73–7,0)*	**7,20** *(7,09–7,31)*
		5th -95th percentiles	5,72 – 8,15	6,06 – 8,59		5,39 – 8,33	6,04 – 8,37
Canine	43	**Median** *(confidence interval)*	**9,51** *(9,38–9,63)*	**10,35** *(10,23–10,48)*	33	**9,58** *(9,45–9,71)*	**10,37** *(10,25–10,50)*
		5th -95th percentiles	7,72 – 11,29	8,57 – 12,14		7,78 – 11,38	8,57 – 12,17
First premolar	44	**Median** *(confidence interval)*	**9,60** *(9,47–9,73)*	**10,11** (9,97–10,25)	34	**9,65** *(9,51–9,79)*	**10,12** *(9,99–10,26)*
		5th -95th percentiles	7,86 – 11,73	8,31 – 12,30		7,63 – 11,67	8,11 – 12,14
Second premolar	45	**Median** *(confidence interval)*	**10,60** *(10,46– 10,74)*	**11,07** *(10,93–11,20)*	35	**10,56** *(10,41–10,70)*	**11,06** *(10,92–11,20)*
		5th -95th percentiles	8,30 – 12,91	8,76 – 13,37		8,15 – 12,96	8,65 – 13,46
First molar	46	**Median** *(confidence interval)*	**6,09** *(5,98–6,20)*	**6,29** *(6,17–6,41)*	36	**5,99** *(5,89–6,10)*	**6,21** *(6,09–6,33)*
		5th -95th percentiles	5,06 – 7,12	4,95 – 7,63		5,10 – 7,05	4,87 – 7,55
Second molar	47	**Median** *(confidence interval)*	**11,26** *(11,14–11,38)*	**11,64** *(11,52–11,76)*	37	**11,28** *(11,16–11,41)*	**11,69** *(11,57–11,81)*
		5th -95th percentiles	9,36 – 13,16	9,74 – 13,54		9,28 – 13,29	9,68 – 13,70

The inter-gender differences were also noted: girls precede boys in timing of emergence of all teeth, especially in canine eruption time, and only few of them do not differ in terms of statistical significance (Table 19) and are along with all studies done on permanent teeth eruption (Diamanti et al, 2003; Elmes et al, 2010; Eskeli et al, 1999; Leroy et al, 2003). If we consider clinical significance, it is interesting to note that although both first molars and maxillary second molars emerge more or less on the same time in both genders, mandibular second molars erupt at about 5 months later in boys compared to girls. This fact must be taken into consideration in planning prophylactic dental procedures for children.

Table 19. Gender difference (months) in the median ages of permanent teeth emergence

Tooth No (FDI)	Difference	Tooth No (FDI)	Difference
21	1.2	**47***	4.56
11	1.68	**42***	4.68
16	1.8	**14***	4.8
46	2.4	**12***	4.92
15	2.4	**37***	4.92
27	2.64	**22***	5.52
36	2.76	**45***	5.52
17	2.76	**34***	5.64
41*	3.0	**35***	6.0
31*	3.12	**44***	6.12
26*	3.12	**23***	6.48
24*	3.84	**13***	6.96
32*	4.08	**33***	9.48
25*	4.44	**43***	10.08

* Indicates significant difference ($p<0.05$)

First transitional period of mixed dentition starts at the median age of 5 years and 10 months and ends at 7 years and 6 months in girls. Second transitional period begins with clinical eruption of first premolar in the upper jaw at the age of 9.5 years and continues until the emergence of the upper second molar at the age of twelve. Although both transitional periods start and end later in males (at the age of 6 years and 1 month until 8 years and 9 years 10 months and 12 years 4 months accordingly), their duration

is more or less the same in both genders, actually the second transitional period is even shorter by two months in males (2 years and 7 months for girls and 2 years and 5 months for boys).

Differences between males and females have been observed in permanent teeth emergence sequence in both jaws too. Boys had the most unfavourable teeth emergence sequence in terms of possible dental crowding of in the maxillary arch. They showed a trend towards canine eruption after the first and second premolars and this predisposes the shortage of space in dental arch for canines. In mandible the order of teeth eruption in boys is as follows: central incisors, first molars, lateral incisors, firs premolars, canines, second premolars and second molars. For girls canines emerge ahead of first premolar, otherwise the order is the same as in boys. Maxillary teeth have the following emergence sequence in male sample: first molar, central incisor, lateral incisor, first premolar, second premolar, and canine, second molar. For girls the difference exists in canine eruption, it appears in the oral cavity after the first premolar and so the order of permanent teeth emergence is as follows: first molar, central incisor, lateral incisor, first premolar, and canine, second premolar, second molar. But it should be pointed out that the difference in the median age of emergence between mandibular central incisors and first molar in boys as well as the difference between mandibular first premolar and canine in both genders is minimal and not statistically significant. This means that earlier mentioned teeth can change positions with each other in the sequence row. The same is to be applied for maxillary second premolar and canine in both sexes.

If we consider dynamics or period of eruption, which refers to the time needed for particular tooth to erupt completely and can be established from the interval between 5th and 95th percentile, it can be clearly seen that the permanent teeth of the first transitional period have shorter period of eruption than compared to the teeth of second transitional period. The average value for any tooth eruption period in the first stage of mixed dentition is 2 years and 4 months, while the average duration of eruption of any tooth in the second stage is 4 years 2 months. The values are almost the same for males and females. The shortest time, 1.75 years, is found for maxillary left first molar in girls and the longest one – 4.98 years for the right

second premolar in girls too. On average first permanent molars and lower central incisors were found to have the shortest periods while the second premolars had the longest ones.

Our results show that the number of erupted permanent teeth correlate positively with body height and vertical dimensions of the face during preschool years. During school years, the number of erupted permanent teeth correlate not only with above mentioned dimensions but with linear mandibular dimensions and sagittal measurements of the face as well. The comparison between the number of erupted permanent teeth and body height could have been detected in the available references for the author only. In general, our results agree with the data from other studies, revealing slight but significant correlation between body height and the number of erupted permanent teeth (Garn et al, 1965; Kaur, Singh, 1992).

There are some limitations in this type of cross-sectional study of tooth emergence. The first one was that no radiographs were done to confirm tooth agenesis or impaction. Therefore it is possible that some teeth may have been incorrectly recorded as unerupted rather than missing. Likewise, teeth recorded as congenitally missing might have been still unerupted or extracted or avulsed. Nevertheless, these sorts of recoding errors are unlikely to have biased the results of the study, given the relative large size of the sample. Given the fact that agenesis of lower second premolars and maxillary lateral incisors are the most frequent, hence the median ages of emergence of lateral maxillary incisors and mandibular second premolars were most likely to be increased slightly by lack of radiographic documentation.

The second limitation was that the effect of both premature loss and caries experience in primary teeth could not be evaluated in this cross-sectional study. In order to investigate such a relationship between predecessor and permanent dentitions, either longitudinal design of study should be employed or retrospective data on dental history should be available. Retrospective data on dental history were not available because national health system dealing with dental issues in Lithuania is scattered over both public and private practice and therefore there were no central database of dental records. Longitudinal study approach would be ideal in evaluating developing permanent dentition but such study design also has

a number of limitations as it is elaborate, expensive to run, require long period to complete, sample size is relatively small and participants may quit study at any time. Besides, several works confirmed that data from cross-sectional studies, which are simpler to carry out and can cover large sample of subjects with less expenses and efforts, are reliable and can be used while studying time of tooth emergence (Parner et al, 2001). However, only median time instead of mean time of emergence through probit either logit regression models could be calculated in a cross-sectional study approach. The more recent studies have used this statistical approach to investigate teeth emergence time (Eskeli et al, Shaweesh, 2012; Friedrich et al, 2006).

Figures 29 and 30 depict a comparison of the median emergence ages of Lithuanian children with those of other populations. It can be seen that the median emergence ages of Lithuanian children resemble the medians of German and Finnish children more closely than the others. Overall permanent teeth emergence seems to be earlier in Lithuanians than in other populations and this finding contradict to the classical anthropological literature, saying that dental age is closely related to child's biological age, because Lithuanian children do show later pubertal maturation compared to peers from other coutries but earlier permanent teeth eruption. Special attention must be paid to earlier eruption of premolars, which in Lithuanians emerge up to one year earlier and this difference can be associated with high incidence of caries in primary teeth in Lithuania (Milciuviene et al, 2006).

To the best of the author's knowledge, this study is the first of its kind to provide chronological standards of permanent tooth emergence in the Lithuanian children. Although the study was carried out on the residents of Vilnius city, the study sample size represented about 5% of Lithuanian children 4 to 16 years of age living in that area. Vilnius is a capital of Lithuania and therefore majority of its population can be considered as a mix of Lithuanian people which migrated from different parts of Lithuania to Vilnius. For this reason the presented emergence time of permanent teeth in this paper, maybe with some caution, can be applied to all Lithuanian children.

Figure 29. Comparison of the median age of permanent teeth emergence for boys

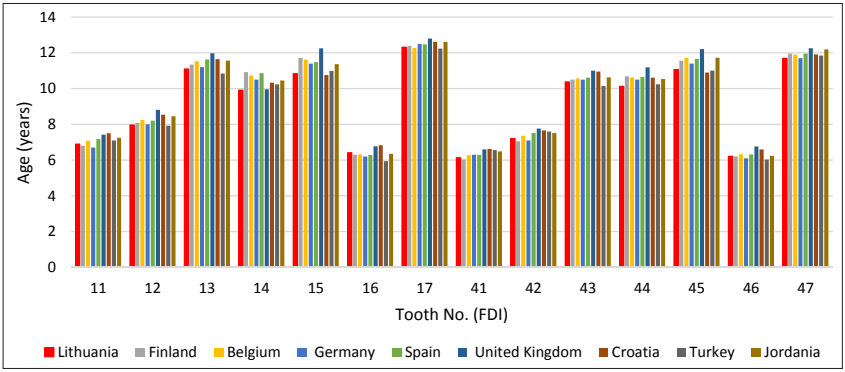
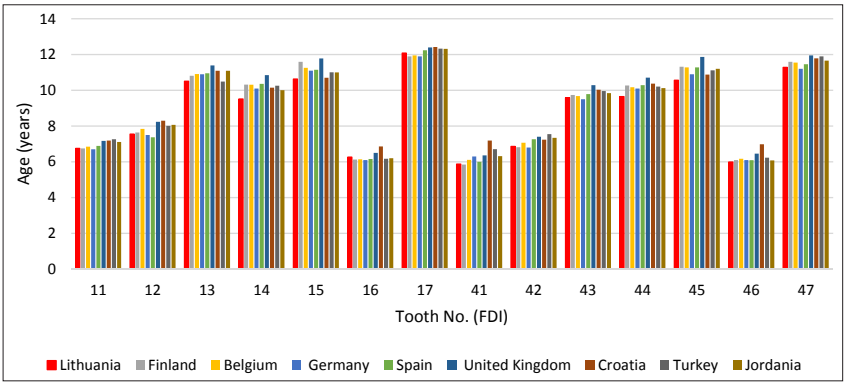


Figure 30. Comparison of the median age of permanent teeth emergence for girls



CONCLUSIONS

1. Mesocephalic head form is characteristic to 4 to16 year old Lithuanian children. The general tendency of growth dynamics of the head measurements do not differ between sexes, although head length, head width and cranial base width are significantly larger in boys during all period 4 to 16 years.
2. 4 year old boys have euryprosopic face form, 5-12 years – mesoprosopic, 13 year and older – leptoprosopic face form. 4 and 5 year old girls have mesoprosopic, older – leptoprosopic face form.

   During the period 4 to16 year old, vertical facial dimensions exhibit largest increments in growth, sagittal dimensions show smaller increments and horizontal – the least increments of growth. The peak in growth of facial width is at the age of 6-7 years.

   The faces of boys and girls are similar during the age of nine years, although facial measurements of boys have larger increments of growth, varies more and grows longer than compared to girls. All examined facial measurements differed significantly from the age of 14 years. All facial dimensions, except measurements of mandible, stabilise at the age of 15 to16 years in girls, while boys show steady incremental growth in facial dimensions until the age of 16 years. The measurements of the face with body height correlates moderately and significantly.
3. The nasal and orolabial measurements exhibit the most intensive incremental growth and the dimensions of the ear – the least during the period of 4 to16 year old. Nose height, nasal tip protrusion and lower lip parameters: height of the lower lip, cutaneous lower lip height and vermillion height show the most pronounced increase in both sexes. The measurements of the regions of the face are similar between boys and girls during growth, significant differences have been noted from the age of 15 to 16 year old.
4. Inter-gender differences in the proportion indices of head, face and regions of the face are minimal. Significant differences for most proportions start to appear from the age of 15 -16 years, due to longer growth period of facial measurements in boys, although the proportions of face width,

upper lip height and ear length with adjacent facial dimensions, also indices between cranial base width and the sagittal measurements of the face differ significantly among sexes during the age of 10 to 13 years due to heterodynamy in the growth of the face measurements.

5. The length and width of the head increased slightly but significantly in 7 to16 year old Lithuanian children since 1984–1985 years. The faces of examined Lithuanian children 7 to 16 year old are longer and wider than compared to Lithuanian children from the 1965–1967 and 1984–1985 year sample.
6. No significant asymmetry in permanent teeth emergence time has been found in either jaw. Lithuanian girls are clearly advanced in permanent teeth emergence than compared to boys. Lower permanent teeth, except premolars, show earlier clinical eruption than corresponding upper teeth in both sexes.

   The correlation between the number of erupted permanent teeth and the measurements of the face is slight but significant. The largest coefficients of correlation are during the ages 7 to 8 and 12 to 13 years in both sexes but the number of facial measurements that correlate with the number of erupted permanent teeth is larger in boys compared to girls.

   Lithuanian children resemble Finish and German children most of all in the emergence time of permanent teeth.

SANTRAUKA

Vaiko sveikata, kaip visuomenės socialinės, ekonominės ir ekologinės padėties atspindys, yra daugelio medicinos sričių specialistų kasdienio darbo rūpestis. Bendra vaikų fizinė būklė ir ją apibūdinantys rodikliai yra gerai ištirti, nustatyti augimo standartai ir dėsningumas, sudarytos bendrų kūno matmenų amžinės lentelės. Visi šie duomenys klinikinėje praktikoje padeda lengviau nustatyti vaiko raidos nukrypimus nuo normos, anksti ir laiku diagnozuoti ligą. Galvos ir veido matmenų augimas, dantų dygimas neabejotinai yra vaiko sveikatos ir bendros fizinės būklės rodikliai, kurie yra neabejotinai vertingi ir reikalingi siekiant ne tik suprasti procesus, vykstančius intensyviai augant veidui, bet ir pagal kuriuos galima anksti įtarti vaiko raidos sutrikimus ar ligą, planuoti veido plastines operacijas, esant įgimtoms ir įgytoms veido deformacijoms, parinkti tinkamiausią laiką sąkandžio korekcijai pagal augimo tempus ir pobūdį, prognozuoti šių gydymo procedūrų ilgalaikius rezultatus ir planuoti profilaktinę odontologinę vaikų priežiūrą, Be to, vaikų veido matmenų ir proporcijų lentelės yra svarbios nustatant vaiko amžių, jei gimimo data nežinoma.

Veido morfologijos vertinimui svarbūs ne tik pavieniai matmenys, bet ir jų tarpusavio santykis (proporcijos). Būtent veido regionų tarpusavio proporcijos lemia subjektyvų veido patrauklumo suvokimą, o kiekybinis (objektyvus) proporcijų vertinimas gali padėti anksti nustatyti besiformuojančią veido disproporciją, augimo sutrikimus ir planuoti gydymą. Tyrimais nustatyta, kad pakitusios veido proporcijos yra būdingos tam tikroms ligoms ir sindromams. Veido proporcijos keičiasi augimo metu, taip pat nustatyti rasiniai, etniniai ir lytiniai veido proporcijų skirtumai.

Galbūt tai, kad veido matmenys priskiriami daugiau estetiniams, o ne sveikatos ir fizinio išsivystymo rodikliams ir buvo tas veiksnys, dėl kurio vėlesnių antropometrinių studijų metu galvos ir ypač veido sritis buvo tiriamos mažai, palyginti su bendrais kūno matmenimis. Antropometriniu požiūriu, galvos smegeninės dalies augimą atspindi galvos apimtis, plotis ir ilgis, veido – veido aukštis ir plotis. Taigi daugumoje fizinę būklę tyrusių ir augimo standartus sudariusių populiacinių tyrimų buvo matuojami tik

šie pagrindiniai matmenys ir iš jų sprendžiama apie bendrą galvos ir veido formą, augimą, taip pat rasinius ir etninius skirtumus.

Žinoma, per pastarąjį dešimtmetį ne tik padaugėjo žmogaus veido morfologijos tyrimų, bet šalia standartinės antropometrijos pradėti naudoti ir kiti tyrimo metodai, tokie kaip fotogrametrija (veido matmenų matavimas standartinėse nuotraukose), stereofotogrametrija ir veido skenavimas lazeriu, kai tolesnė gautų duomenų analizė atliekama kompiuteriu. Tačiau nors šie metodai palengvina tikslių veido morfologijos matmenų atkūrimą iš skaitmeninio vaizdo ir jų naudojimą vertinant pokyčius gydymo ar augimo metu, juos pritaikant medicininės fotografijos poskyryje, tačiau juos naudoti populiaciniams tyrimams, ypač vykstantiems skirtingose įstaigose, yra sudėtinga ir dėl įrangos vežiojimo, montavimo, standartinių tyrimo sąlygų sukūrimo, dėl finansinių išlaidų ir etinių sumetimų. Taigi tiesioginė antropometrija, nepaisant ilgesnio ištyrimo laiko, išlieka vienu tiksliausių, paprasčiausių, neinvazinių ir pigiausių populiacinių tyrimų metodų, veido morfologijos bei augimo standartams sudaryti.

Lietuvoje vaikų galvos ir veido matmenų ir jų proporcijų pokyčiai augimo metu, nuolatinių dantų dygimas detaliai nagrinėtas nebuvo. Pagrindiniai lietuvių vaikų nuo 7 iki 18 metų amžiaus galvos ir veido matmenys ištirti 1965–1967 metais, pakartoti 1984–1985 metais. Šiuo metu trūksta išsamių duomenų apie ikimokyklinio ir mokyklinio amžiaus vaikų veido matmenų ir jų proporcijų pokyčius. Duomenų apie nuolatinių dantų prasikalimo laiką ir eiliškumą nėra, todėl iki šiol gydytojai vadovaujasi vadovėliuose pateiktomis nuolatinių dantų dygimo lentelėmis, kurios sudarytos pagal užsienio šalių vaikų dantų dygimo duomenis.

Taigi mūsų darbo tikslas – kompleksiškai ištirti 4–16 metų vaikų veido ir žandikaulių matmenis, proporcijas, jų ribines vertes, augimo tempus bei išaiškinti nuolatinių dantų prasikalimo laiką ir eiliškumą.

Tyrimas atliktas Vilniaus miesto ikimokyklinėse ir mokyklinėse įstaigose 2004-2009 ir 2010-2011 metais.

Pagal standartinę antropometrinę metodika kompleksiškai ištirti 3843 vaikai: išmatuotas ūgis, daugiau nei 40 galvos ir veido matmenų, išskaičiuoti 59 proporcingumo indeksai, įvertinti išdygę nuolatiniai dantys. Vertėtų pabrėžti, kad autorė visus vaikus ištyrė pati, o tai leido iki minimumo

sumažinti tyrimo paklaidos dėl tyrėjo subjektyvumo tikimybe. Darbe naudoti šiuolaikiniai daugiamatės statistikos metodai.

Darbe pateikiama Lietuvos ikimokyklinio ir mokyklinio amžiaus vaikų galvos ir veido rodiklių ir proporcijų analizė, nušviečiami jų amžiniai ir lytiniai ypatumai, atskleidžiama pagrindinių galvos ir veido rodiklių epochinė tendencija per pastaruosius 50 metų. Lietuvių vaikų galvos ir veido proporcijos, nuolatinių dantų prasikalimo laikas ir dauguma galvos ir veido rodiklių ištirti pirmą kartą. Darbe pateikiami pirmą kartą surinkti ir apibendrinti Vilniaus miesto lietuvių vaikų veido ir žandikaulių antropometriniai duomenys, proporcijos ir nuolatinių dantų prasikalimo laikas, jų ribinės vertės, kurios palengvina veido, žandikaulių ir nuolatinių dantų raidos sutrikimų ankstyvąją diagnostiką, padeda numatyti gydymo ir profilaktikos priemones. Darbe pirmą kartą pateikiami apibendrinti naujausi Lietuvos 4-16 metų vaikų galvos ir veido matmenų ir proporcijų vidurkiai, procentiliai, jų įvairovės ribos, atskleista epochinė tendencija. Taip pat pirmą kartą pateikiama nuolatinių dantų prasikalimo laikas ir eiliškumas, jų ribinės vertės, skirtumai tarp lyčių ir koreliacijos su veido matmenimis ir ūgiu.

Tyrime nustatyta, kad mergaitėms ūgio pubertetinis augimo šuolis 11-12 metais įvyksta 3 metais anksčiau nei berniukams (14-15 metais). Iš visų išskaičiuotų proporcijų, 4-16 metų laikotarpiu daugiausiai keičiasi galvos aukščio ir ūgio proporcija, 27,85% mergaitėms ir 28,75% berniukams. Berniukams minėta proporcija keičiasi daugiau, todėl periodo pradžioje esantys reikšmingi indekso skirtumai tarp lyčių vėlesniais amžiaus periodais išnyksta. Šešioliktais metais indeksas tarp lyčių nesiskiria.

Mūsų rezultatai rodo, kad galvos smegeninės dalies matmenys didėjo visą 4-16 metų periodą su nedideliais pagreitėjimo periodais. Didžiausi metiniai prieaugiai mergaitėms nustatyti iki 9 metų amžiaus, berniukams iki 10 metų. Galvos ilgio metinis prieaugis abiem lytims padidėjo pubertetinio augimo periodu. 15-16 metų periodu mergaitėms nustatyti neigiami metiniai prieaugiai rodo rodiklių augimo stabilizaciją nuo 15 metų.

Nustatėme, kad bendrą veido dydį nusakantys rodikliai: fizionominis veido aukštis, morfologinis veido aukštis ir veido plotis sparčiau augo iki 8 metų mergaitėms ir 10 metų berniukams, abiejų veido aukščių augimas

pagreitėjo pubertetiniu augimo periodu, o veido pločio augimas po truputį lėtėjo abiem lytims nuo 10 metų. Kitų vertikalių veido matmenų (veido vidurinio aukšto, veido apatinio aukšto ir smakro aukščiai) augimo tendencija yra panaši, nors didžiausi metiniai prieaugiai nustatyti ikimokyklinio amžiaus periodais mergaitėms ir ankstyvuoju mokyklinio amžiaus periodu berniukams, šių matmenų augimas paspartėja brendimo periodu. Pažymėtina, kad veido apatinio aukšto aukštis yra vienas iš nedaugelių veido rodiklių, kuriems nenustatytas neigiamas prieaugis 15-16 metų merginoms. Tai rodo, kad veido vertikalus augimas tęsiasi ir po ūgio pubertetinio augimo šuolio.

Remiantis mūsų duomenimis, strėliniai veido matmenys intensyviausiai auga 8-9 metais mergaitėms ir metais vėliau berniukams, o apatinio žandikaulio matmenys, ypač apatinio žandikaulio aukštis ir apatinio žandikaulio šakos aukštis, abiem lytims intensyviau auga brendimo laikotarpiu.

Nustatėme, kad berniukų veido matmenų augimo pikai su ūgio pubertetinio augimo šuoliu sutampa labiau nei mergaičių, tačiau ne visų jų didžiausi metiniai prieaugiai yra pubertetinio augimo šuolio metu, ypač veido pločio. Mergaitėms visų veido matmenų, išskyrus veido plotį, augimas pagreitėja po ūgio pubertetinio augimo šuolio praėjus 2-3 metams.

Duomenų analizė atskleidė, kad 4-16 metų periodu dėl intensyvaus vertikalių rodiklių augimo keičiasi galvos ir veido proporcijos, didžiausi pokyčiai nustatyti indeksams, kurių viena sudėtinių dalių yra morfologinis veido aukštis. Galvos forma nuo 4 metų reikšmingai nesikeičia, tuo tarpu veido forma keičiasi tiek berniukams, tiek mergaitėms. Dėl ne vienodo santykinio prieaugio, veidas nuo 4 metų santykinai ilgėja ir siaurėja, išryškėja nosies išsikišimas, apatinės lūpos raudonis ir aukštis. Akių ir ausų sritys auga santykinai mažiau nei nosies ir burnos sritys.

Mūsų tyrimo rezultatai rodo, kad ketverių metų mergaitės ir berniukai reikšmingai skiriasi tik 4 proporcijomis: galvos aukščio/ūgio, nosies gylio/viršutinės lūpos aukščio, vidinio tarpuakio/išorinio tarpuakio ir vidinio tarpuakio/nosies pločio indeksais. Daugiausiai tirti indeksai reikšmingai skyrėsi tarp lyčių 10 -13 metų periodu, o nuo 15 metų reikšmingi skirtumai nustatyti 20 indeksų. Merginų veidas yra apvalesnis, jame daugiau išreikštas

veido vidurinis aukštas, o apatinio žandikaulio plotis santykinai daugiau išreikštas veido apatinio aukšto ir veido aukščio atžvilgiu.

Paaiškėjo, kad nuolatiniai dantys tirtiems vaikams pradeda kaltis šeštaisiais gyvenimo metais, mergaitėms anksčiau nei berniukams. Pirmieji burnoje pasirodo nuolatiniai apatinio žandikaulio centriniai kandžiai mergaitėms, o berniukams pirmieji gali prasikalti ir centriniai kandžiai, ir pirmi krūminiai dantys apatiniame žandikaulyje. Pirmasis mišraus sąkandžio periodas mergaitėms trunka trumpiau nei berniukams, jis baigiasi išdygus viršutinio žandikaulio šoniniams kandžiams – 7,5 metų mergaitėms ir 8 metų berniukams. Antrasis mišraus sąkandžio periodas prasideda pradėjus dygti pirmiems kapliams arba apatinio žandikaulio iltims, mergaitėms apie 9,5 metus, o berniukams pusmečiu vėliau. Antrasis mišraus sąkandžio periodas baigiasi apie 12 metus, prasikalus viršutiniams antriems krūminiams dantims.

Nustatėme, kad mergaitėms nuolatiniai dantys, išskyrus viršutinius centrinius kandžius, apatinius pirmus krūminius dantis, viršutinius antrus krūminius dantis, dešinės pusės viršutinio žandikaulio pirmą kaplį ir pirmą krūminį dantį, kalasi reikšmingai anksčiau nei berniukams. Dešinės ir kairės pusių nuolatinių dantų prasikalimo laikas reikšmingai nesiskiria. Tirtiems lietuvių vaikams nustatytas ankstyvesnis nuolatinių dantų prasikalimo laikas, lyginant su kitų šalių bendraamžiais. Ypač skiriasi pirmų kaplių prasikalimo laikas.

Remiantis mūsų tyrimo rezultatais, nuolatinių dantų skaičius ir veido matmenys koreliuoja nedaug, bet reikšmingai. Didžiausias koreliacinis koeficientas nustatytas tarp nuolatinių dantų skaičiaus ir veido bendrą dydį nusakančiais matmenimis: veido aukščiu, veido viršutinio, vidurinio ir apatinio aukšto gyliais, veido vidurinio, apatinio aukšto aukščiu, veido pločiu, taip pat su apatinio žandikaulio matmenimis: apatinio žandikaulio ilgiu ir aukščiu. Taip pat reikšminga koreliacija nustatyta tarp nuolatinių dantų skaičiaus ir ūgio, išskyrus šešiamečius berniukus ir devynmetes mergaites.

Epochinė galvos ir veido matmenų analizė rodo, kad veidas ir galva ir ilgėja ir platėja. Ypač per pastaruosius 25 metus pasikeitė veido plotis, o galvos apimtis praktiškai nekito.

Tyrimo rezultatai reikšmingi ir vertingi antropologams, odontologams, burnos ir veido chirurgams, plastinės chirurgijos specialistams, pediatrams, endokrinologams, genetikams ir visuomenės sveikatos specialistams, vertinant tiek vaiko bendrą, tiek ir burnos sveikatą pagal veido, žandikaulių ir nuolatinių dantų raidą augimo laikotarpiu. Taip pat apibendrinti veido ir žandikaulių antropometriniai duomenys yra vertingi teismo medicinoje nustatant vaiko amžių, kai gimimo data nėra žinoma.

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ABOUT RŪTA ALMONAITIENĖ

R. Almonaitienė was born in 1978 in Jonava. In 1996 she entered the Institute of Odontology at the Faculty of Medicine at Vilnius University where she obtained the qualification of dentist (in 2002) and orthodontist (in 2005). Since 2005 R. Almonaitienė works at the Vilnius University hospital Zalgiris Clinic as an orthodontist. Since 2006 she is a doctoral student of the the Institute of Odontology at the Faculty of Medicine at Vilnius University. The field of her research is anthropology of the head and face and eruption of teeth with interests in the growth of face and jaws of preschool and school children. R. Almonaitienė has participated in seven Lithuanian and six international conferences with posters and oral presentations. She is a member of the Lithuanian Orthodontist Society. R. Almonaitienė is married and has two daughters.