

IMPACT OF A LIFESTYLE ON WELLNESS AND PROSPERITY  
CHAPTER XXIV

---

AKTON Zielona Góra

MIROSLAW MROZKOWIAK

*Description of differences in the length and width  
of the left and right foot burdened with its weight  
on the basis of males and females at the age from 4 to 18  
in the light of projection moiré*

---

In the course of development the human's foot adapted to carrying body on various surfaces, hard and soft, slippery and uneven. In such conditions the muscular system adapted to the functional requirements and to the external environment. Because of the fact that feet support the weight of the whole body, they sometimes become subject to their specific pathologies which, in turn, serve as a basis of deformations and joint ailments at a higher level, i.e. in knee, hip and spinal joints. Feet deformations may be inborn and requiring already in childhood such interventions as orthopaedic shoe inserts or orthopaedic shoes, and sometimes even operative treatment. Their consequence are deformations of the whole lower limb resulting in asymmetric positioning of pelvis and spine.

In various periods of a child's life the forming of lower limbs and feet is a little different. In newborns a developmental regularity is a varus positioning of knees and bending positioning of hip and knee joints resulting from the advantage of the tension of flexors over extensors. This is an after-affect of intrauterine positioning. The physiological „short legs” occurring in the first years of life and disappearing in the 7th year are considerably decreasing. The state of varus deformity preserves up to the about 3rd year of life, and afterwards it turns into a physiological valgity – in the about 4-5th year of life. Straight limbs occur in children in the 7th year of life. The appearance of knee valgity in the puberal period may be of a durable character. At a later school age the development of lower limbs becomes more similar to the proportions of adults. This creates better balance conditions, and at the same time weakens the muscular system [1].

Asymmetry is a feature of every organism. It is characterised by irregularity in structure in relation to the axis of symmetry. In the case of humans this feature is a consequence of two-legged locomotion, physical activeness, environment. It covers three areas: morphological, dynamic and functional. The asymmetry of human body should be regarded as a physiological phenomenon in the course of phylogenesis; however, the determination of an acceptable range of this asymmetry is problematic since the changes which it generates

within the region of the locomotor system cannot precisely be specified. The research carried out by Nadolska [8] shows that the phenomenon of asymmetry is the most prominently reflected in the width of a heel, ankle and circumference of foot through toes. It is the most weakly reflected in the length of foot. The research carried out by Kingm [4] shows that more advanced static or dynamic asymmetry is a basis for overload changes.

The arrangement of azygous internal organs is quite important for body posture. Asymmetric location of liver facilitates moving the centroid to the right, which in combination with functional domination of one of the upper limbs lead to insignificant asymmetries of the silhouette. The morphological symptoms of these asymmetries are regarded as natural and typical of humans. If they intensify, they may cause uneven loading of the locomotor system and become a reason for overload changes and pain [3].

Posture defects occur the most frequently in the 7th, 8th and 9th year of life [7]. Also, in this period progressive quantitative changes in the frequency of occurrence of the disorders of the body statics take place. Furthermore, qualitative changes intensify, which consists in transforming subtle disorders of body posture into fixed defects. A reliable assessment of the degree of advancement of the changes in a child's posture, their interpretation against the background of its somatic development can provide a basis for creating an effective reparation programme. The deformation of foot very often initiates the whole chain of unfavourable asymmetries in the course of postural development.

The research aims at the determination of the course of differences in the measurements of the width and length of feet in the population of males and females at the age from 4 to 18

## SUBJECTS AND RESEARCH METHODOLOGY

The research covered the population of 9804 females and 8699 males at the age from 4 to 18 from randomly selected nursery and other schools in the Warmińsko-Mazurski region, table 1. The statistical analysis covered only these research results where the doctor had not diagnosed any considerable posture defects.

The research methodology covered the measurement of the differences in the length and width between homonymous feet: (R.d.lwK) the difference in the foot lengths when the left one is longer in females (M – in males, (R.d.pw) the difference in the foot lengths when the right one is longer, (R.sz.lw) the difference in the foot widths when the left one is wider, (R.sz.pw) the difference in the foot widths when the right one is wider.

For the purpose of the assessment of their values, the attitude towards a computer assessment of posture, with the application of projection moiré technique- Posturemeter M, was used. The methodology and technique of research were in agreement with the generally adopted and described rules [6]. The measuring position consisted of a computer, graphic card, program, monitor and printer, projection and receiving device with a camera for measuring feet. Procuring a spatial image was possible only thanks to projecting a line with precisely specified parameters on a child's feet. The lines falling on feet became subject to distortions depending on the surface configuration. Thanks to the application of object glass, the image of a person subject to research could be received through a special optical system with a camera, and then transmitted to the computer monitor. The distortions of the line image were entered in the computer memory, and then they were processed by a numerical algorithm into a layered map of the researched surface [9].

The obtained image of the foot surface enables the interpretation of body posture in many respects. The accuracy of measurement and the analysis of the registered spatial parameters account for the possibility that the drawn conclusions may differ from the ones which have been published so far. The most significant factor in this method is the simultaneity of measurement of all real values of the spatial positioning of particular foot segments.

The achieved research results were prepared statistically, determining the average value, standard deviation, variation coefficient, minimum and maximum value. The distribution of variables was normal.

### ACHIEVED RESULTS

The research results have been presented graphically. Diagram 1 presents the course of changes in average differences in the length and width between the left and right foot of females, diagram 3 refers to males. Diagram 2 presents average values of the differences in the length and width of feet of both sexes.

#### Females

The curve of length differences in feet when the right foot is longer (R.dł.pw) is diversified. It starts from the value of 2.75 mm, and it increases to 4.36 mm in the 13th year of life, and it reaches its maximum in the 18th year, i.e. 5.85 mm, after the decrease of the difference to 3.38 mm in the 17th year of life. In the period from the 4th to 13th year of life it shows a constant growing tendency, and then the difference value falls to the 17th year of life, and it increases up to the 18th year, the greatest difference occurs in the 13th and 18th year of life.

The curve of length differences in feet when the left foot is longer (R.dł.lw) is less diversified. It starts from the value of 0.51 mm, taking lower and lower values up to the 13th year of life (0.09 mm), and then they increase up to the 17th year of life (0.8 mm), and next they drop to 0 in the 18th year of life.

The greatest difference in the foot lengths occurs in the 6th and 17th year.

The curve of width differences in feet when the right one is wider (R.sz.pw) is diversified. It starts from the value of 0.9 mm, and it reaches its maximum in the 12th year of life, i.e. 3.83 mm, and it finishes with the difference of 3.57 mm. In the period from the 4th to 6th year of life the width difference in feet increases, up to the 8th year of life it decreases to grow gradually to the 12th year, and next it falls up to the 14th year of life, and it grows to the 16th year, and finally it takes the value of 3.57 mm in the 18th year of life. The greatest difference occurs in the 12th year.

The curve of the width differences in feet when the left one is wider (R.sz.lw) is also diversified. It starts from the value of 2.09 mm, and it reaches its minimum in the 12th year of life, i.e. 1.1 mm, and it finishes with the difference of 1.57 mm. In the period from the 4th to 6th year of life the width difference in feet decreases, up to the 8th year of life it increases to reach its lowest value in the 12th year, and next it rises to the 14th year, and it

drops to the 16th year, and finally it takes the value of 1.84 mm in the 18th year of life. The greatest difference occurs in the 8th and 14th year.

The curves of differences in the length and width of feet in the population of both sexes have a similar course to the changes occurring within one of the sexes.

The curve of length differences in feet when the right foot is longer (R.dł.pw) is diversified. It starts from the value of 2.55 mm, and it reaches a high value in the 12th year of life, i.e. 4.48 mm, then it falls to 3.36 mm in the 17th year, and finishes with the difference of 4.65 mm. In the period from the 4th to 12th year of life it shows a constant growing tendency, and then the difference value falls in the 15th and 17th year of life, and it increases in the 16th year, and it finishes with the maximum value of 4.46 mm in the 18th year of life.

The curve of length differences in feet when the left foot is longer (R.dł.lw) is less diversified. It starts from the value of 0.6 mm, taking lower and lower values up to the 13th year of life (0.16 mm), and then they increase up to the 17th year of life (0.83 mm), and next they drop to 0 in the 18th year of life.

The curve of width differences in feet when the right one is wider (R.sz.pw) is diversified. It starts from the value of 1.2 mm, and it reaches its maximum in the 16th year of life, i.e. 3.84 mm, and it finishes with the difference of 2.57 mm. In the period from the 4th to 5th year of life the width difference in feet increases, up to the 8th year of life it decreases to grow gradually to the 12th year, and next it falls up to the 14th year, and it grows to the 16th year, and finally it takes the value of 2.57 mm in the 18th year of life.

The curve of width differences in feet when the left one is wider (R.sz.lw) is also diversified. It starts from the value of 2.09 mm, and it reaches its minimum in the 12th year of life, i.e. 0.98 mm, and it finishes with the difference of 1.57 mm. In the period from the 4th to 6th year of life the width difference in feet decreases, up to the 8th year of life it increases to reach its lowest value in the 12th year. Next it grows to the 14th year of life, decreases up to the 16th year, and it finally reaches the value of 1.57 mm in the 18th year.

#### Males

The curve of length differences in feet when the right foot is longer (R.dł.pw) is diversified. It starts from the value of 2.35 mm, and it reaches its maximum in the 12th year of life, i.e. 4.87 mm, and it finishes with the difference of 4 mm. In the period from the 4th to 12th year of life it shows a constant growing tendency, and then the difference value falls to the 15th year, and it increases up to the 16th year, drops to the 17th year and it increases again in the 18th year of life.

The curve of length differences in feet when the left foot is longer (R.dł.lw) is less diversified. It starts from the value of 0.69 mm, taking lower and lower values up to the 12th year of life (0.27 mm), and then they increase up to the 17th year (0.8 mm), and next they drop to 0 in the 18th year of life.

The curve of width differences in feet when the right one is wider (R.sz.pw) is diversified. It starts from the value of 1.4 mm, and it reaches its maximum in the 12th year of life, i.e. 3.6 mm, and it finishes with the difference of 2.23 mm. In the period from the 4th to 5th year of life the width difference in feet increases, up to the 7th year it decreases to grow gradually to the 12th year. Next it drops to the 14th year of life, increases up to the 16th year, and it finally reaches the value of 2.23 mm in the 18th year.

The curve of width differences in feet when the left one is wider (R.sz.lw) is also diversified. It starts from the value of 2.15 mm, and it reaches its minimum in the 12th year of life (0.91 mm), and it finishes with the difference of 1.84 mm. In the period from the 4th to

5th year of life the width difference in feet decreases, up to the 7th year it increases to reach its lowest value in the 12th year. Next it grows to the 14th year of life, decreases up to the 16th year, and it finally reaches the value of 1.84 mm in the 18th year.

## DISCUSSION

### Females

The research carried out by Nadolska [8] shows that the measurements of the left foot are greater than in the case of the right foot. She notices that in the group of 7-, 8-, 16-year-old girls average differences in the right and the left foot are small and statistically insignificant. In older groups the differences intensify and they are statistically significant to a large and very large degree. The differences in the measurements of the foot width in females are statistically significant, except for the group of 5-year-old girls. On average the widths of the left foot are greater than in the case of the right foot. Similarly, Mollison's coefficient shows the left-sidedness of the measurements of this feature. Starting with the group of 12-year-old girls, it increases to the oldest groups. An exception is the group of 16-year-old girls. The shown differences are statistically extremely significant. The research carried out by Demczuk-Włodarczyk [2] shows that the morphological symmetry of feet points to a relation between the direction of domination and age of subjects as well as researched feature. The left-side domination concerns the width of foot. The diversification of this feature value is statistically significant in every year of life for girls. Prominently indicated domination of the length of the left foot, which is noted in the period between the 3rd and 5th year of life, decreases and changes its direction. Between the 8th and 20th year of life the length of the right foot dominates. The diversification of the foot length increases in the following years and becomes statistically significant between the 17th and 20th year of life.

### Males

The research carried out by Nadolska-Ćwikła [8] shows that the measurements of the left foot length are greater than in the case of the right foot. An exception is the group of 10-year-old boys whose measurement of the left foot length is smaller than in the case of the right foot. The difference is not statistically significant. From the 3rd to 19th year of life no statistically significant differences are noted as regards the measurement of the length of the right and left foot. An exception are the groups of 4- and 11-year-old boys. The measurements of the left foot width are greater than in the case of the right one, starting with the 3rd up to the 18th year of life. The differences between the right and the left foot are significant except for the groups of 5-, 8- and 13-year-olds. Mollison's coefficient specifying the degree of asymmetry reaches its highest value in the group of 11-year-old boys.

Whereas Kurniewicz-Witczak [4] does not note any statistically significant differences between the measurements of the right and left foot in the groups from the 3rd to 18th year

of life. The phenomenon of the left-sided asymmetry is dominant in groups after the period of sexual maturation in the case of males.

The research carried out by Demczuk-Włodarczyk [2] concerning the development of morphological features of foot on the basis of the comparative analysis of the average value shows that the dynamics of their development is diversified in both static and dynamic conditions, both in the right and in the left foot.

### CONCLUSIONS

1. The differences of average values in the length and width of feet in the male population at the age from 4 to 18 have an antagonistic course. This means that if in the case of a greater value of the width or length of the left foot, the value of the difference grows, the value of the difference falls in the case of the right foot.
2. The differences in the foot lengths in the case of the right foot which is longer are significantly greater than the differences when the left foot is longer. However, the greatest difference occurs in the 12th, and the smallest in the 4th year of life.
3. The length of feet is always different, the width is even in the about 5th, 7th, 9th, 13th, 15th year of life.

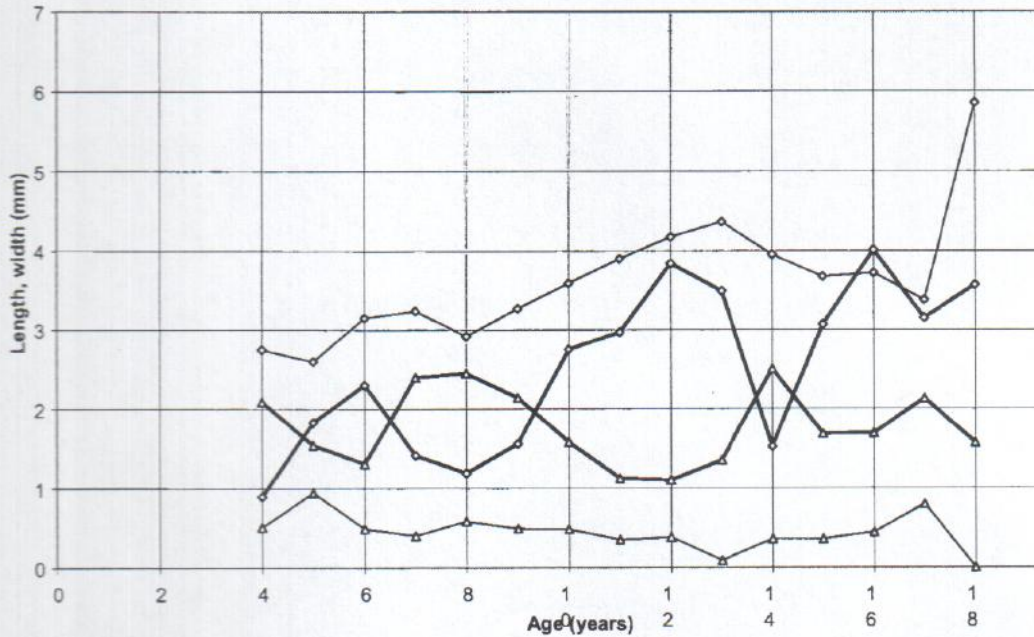
### BIBLIOGRAPHY

1. Bąk S., 1965, *Postawa ciała, jej wady i leczenie*, PZWL, Warszawa.
1. Demczuk-Włodarczyk, 2003, *Budowa stopy w okresie rozwoju progresywnego człowieka*, *Studia i Monografie AWF Wrocław*, nr 66
2. Dziak A., *Bóle i dysfunkcje kręgosłupa*, *Medicina Sportiva*, Kraków, 2007.
3. Kingm I. i wsp., 1998, *Asymmetric low back loading in asymmetric lifting movements is not prevented by pelvic twist*. *Journal of Biomechanics*, 31, 6, s. 527-534.
4. Kurniewicz-Witczakowa R., 1966, *Kształtowanie się stopy na tle analizy metod jej badania u dzieci i młodzieży warszawskiej*. *Prace i Materiały Naukowe Instytutu Matki*
5. Mrozkowiak M., 2008, *Uwarunkowania wybranych parametrów postawy ciała dzieci i młodzieży oraz ich zmienność w świetle mory projekcyjnej*, *Wydział Zamiejscowy Kultury Fizycznej AWF Poznań, Gorzów Wlkp.*
6. Mrozkowiak M., 2007, *Zróżnicowanie wiekowe występowania postaw ciała prawidłowych, wadliwych i skolioz u dzieci i młodzieży w wieku od 4 do 19 lat w wybranych województwach Polski*, *Uniwersytet Marii Curie-Skłodowskiej, Akademia Medyczna, Lublin, Suppl. XVIII, nr 7, s. 189-192*
7. Nadolska-Ćwikła I., 1990, *Budowa stopy mieszkańców Gorzowa Wlkp. w wieku 3 – 65 lat*, *Monografie, Podręczniki, Skrypty AWF Poznań*, nr 266.
8. Świerc A., 2006, *Komputerowa diagnostyka postawy ciała – instrukcja obsługi*, *Czarnica Wroclawska*.

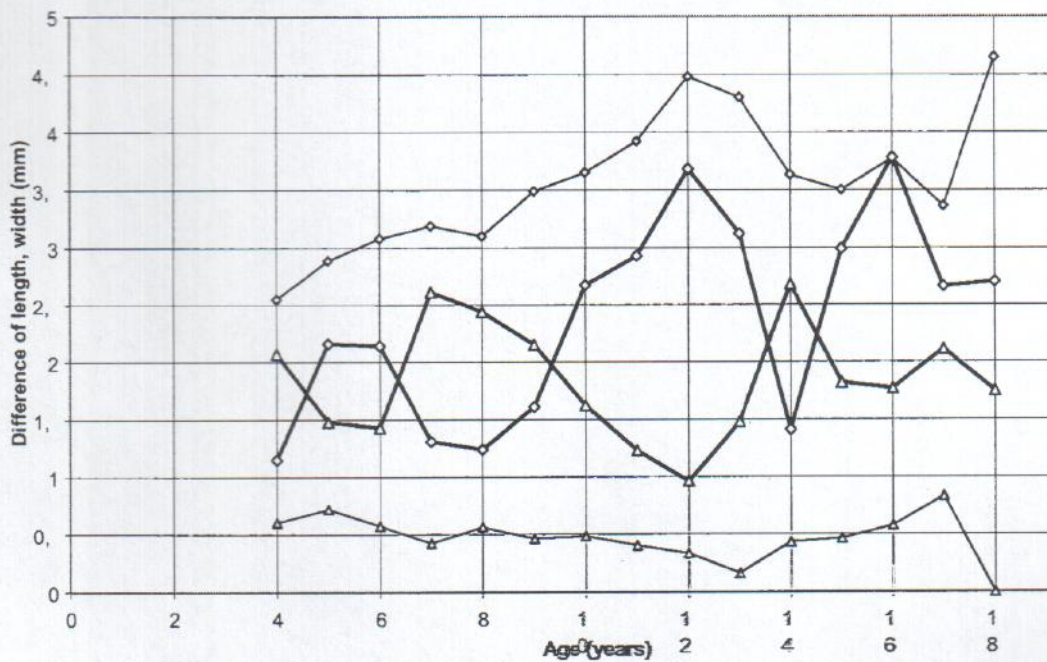
*Mirosław Mrozkowski*

Description of differences in the length and width of the left and right foot burdened with its weight on the basis of males and females at the age from 4 to 18 in the light of projection moiré

Diag. 1 Course of changes in average differences of the length and width between the left and right female population at the age from 4 to 18 (n) 9804



Diag. 2 Course of changes in average differences of the length and width between the left and right foot the population of both sexes at the age from 4 to 18 (n) 18503



Diag. 3 Course of changes in average differences of the length and width between the left and right male population at the age from 4 to 18 (n) 8699

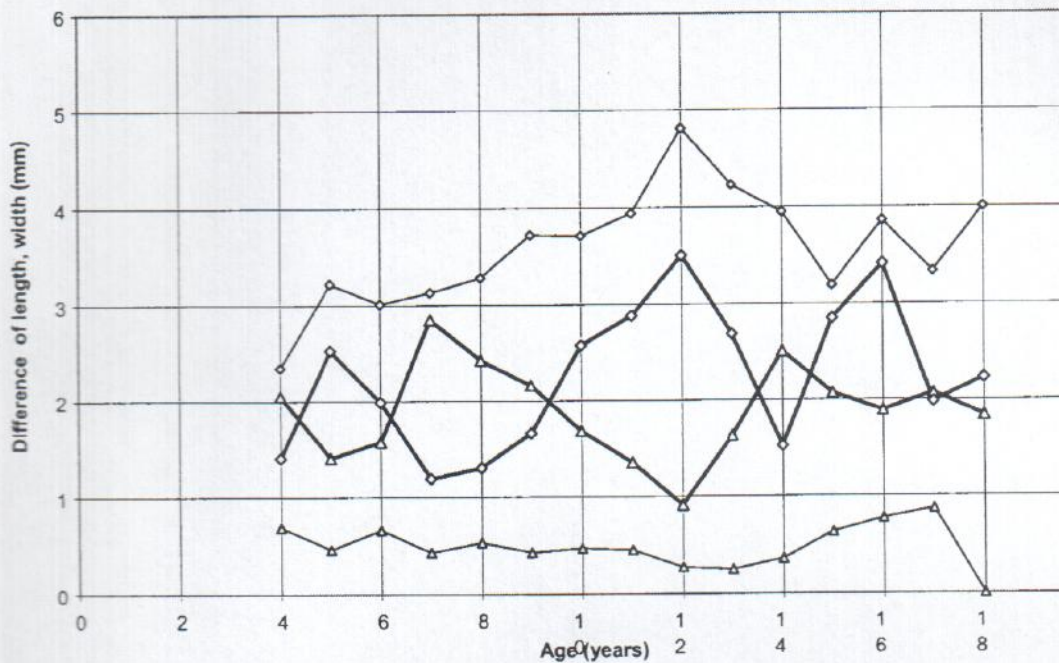


Table 1 Human material, age, body weight and height

Age	F			M		
	Quantity	B.W.	B.H.	Quantity	B.W.	B.H.
4	95	19.1	111.0	104	19.5	109.5
5	196	21.0	113.8	206	20.1	113.0
6	269	22.5	117.3	263	21.7	118.4
7	610	26.42	121.0	597	23.21	127.93
8	1341	26.42	128.28	1255	28.0	130.23
9	1839	30.14	132.87	1677	31.34	134.47
10	1752	35.11	138.26	1542	35.11	139.84
11	1047	41.95	145.0	901	42.48	145.37
12	670	44.77	151.84	549	43.61	151.7
13	569	46.47	157.2	462	48.45	157.52
14	582	52.56	162.24	436	54.25	165.42
15	424	55.25	165.18	355	59.82	169.81
16	108	55.4	162.4	83	58.8	167.7
17	134	57.0	164.7	123	64.0	171.0
18	168	61.3	166.7	146	70.0	175.4
Total	9804			8699		

Source: own research: Legend: B.W. – average value of body weight B.H. – average value of body height F – females M – males



*Mirosław Mrozkowiak*

Description of differences in the length and width of the left and right foot burdened with its weight on the basis of males and females at the age from 4 to 18 in the light of projection moiré

---

### ABSTRACT

Asymmetry is a feature of every organism. It is characterised by irregularity in structure in relation to the axis of symmetry. In the case of humans this feature is a consequence of two-legged locomotion, physical activeness, environment. It covers three areas: morphological, dynamic and functional. The asymmetry of human body should be regarded as a physiological phenomenon in the course of phylogenesis. However, determination of an acceptable range of this asymmetry is problematic since the changes which it generates within the region of the locomotor system cannot precisely be specified. Determination of the course of changes in differences in the measurements of the width and length of feet in the population of males and females at the age from 4 to 18. The research covered the population of 9804 females and 8699 males at the age from 4 to 18 from randomly selected nursery and other schools in the Warmińsko-Mazurski region. The research methodology covered the measurement of the differences in the length and width between homonymous feet. For the purpose of the assessment, the attitude towards a computer assessment of posture, with the application of projection moiré technique- Posturemeter M, was used. The research results have been presented graphically. Diagram 1 presents the course of changes in average differences in the length and width between the left and right foot of females, diagram 3 refers to males. Diagram 2 presents average values of the differences in the length and width of feet of both sexes. 1. The differences in average values of the length and width of feet in the male population at the age from 4 to 18 have an antagonistic course. This means that if in the case of a greater value of the width or length of the left foot, the value of the difference grows, the value of the difference falls in the case of the right foot. 2. The differences in the foot lengths in the case of the right foot which is longer are significantly greater than the differences when the left foot is longer. However, the greatest difference occurs in the 12th, and the smallest in the 18th year of life. 3. The length of feet is always different, the width is even in the about 5th, 7th, 9th, 13th, 15th and 17th year of life.