

**Federal State Budgetary Educational Institution higher education  
«North Ossetian State Medical Academy»  
of the Ministry of Health of the Russian Federation**

**DEPARTMENT OF GENERAL HYGIENE  
AND PHYSICAL CULTURE**

**ORGANIZATION OF PHYSICAL EDUCATION  
CLASSES FOR STUDENTS OF SPECIAL  
MEDICAL GROUP WITH MUSCULOSKELETAL  
SYSTEM DISORDER (FLAT-FOOT)**

Methodological recommendations  
on the organization of independent work and study of the  
disciplines "Physical culture and sports" and "Elective course in  
physical culture and sports" of the main professional educational  
program of higher education – specialty program in the specialty  
31.05.03 Dentistry (partially implemented in English)

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Organization of physical education classes for students of a special medical group with a violation of the musculoskeletal system (flatulence); methodological recommendations for the independent work of students of a special medical department. North Ossetian State Medical Academy: Vladikavkaz, 2019. – 15s.

In these methodological recommendations, one of the types of violation of the musculoskeletal system is described in detail – flatulence. The work reveals a complex of physical exercises that prevents the development of this disease. Regular systematic application of general development and strengthening exercises will allow to avoid deformation of feet and formation of flatulence in the early stages.

The methodological recommendations "Organization of physical education classes for students of a special medical group with a violation of the musculoskeletal system (flatulence)" were prepared in the discipline "Physical culture" in accordance with the Federal State educational standard for higher professional education for students of a special medical department.

UDC  
BBK 75.0

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*Approved and recommended for publication by the Central Coordination  
the educational and methodological council of the  
FSBEI HE NOSMA MOH of Russia (Protocol No.6 of July 6, 2020)*

## **1. The concept of violation of the musculoskeletal system.**

*The musculoskeletal system* is the main system with which physical exercises are performed. Well-developed musculature is a reliable support for the skeleton and contributes to the proper operation of internal organ systems. For example, with pathological spinal curvatures, chest deformities (the reason for this is the weakness of the muscles of the back and shoulder girdle), the work of the lungs and heart becomes difficult, the blood supply to the brain worsens, etc. The trained muscles of the back strengthen the vertebral table, unload it, taking part of the load on themselves, prevent the intervertebral discs from falling out, and slip the vertebrae. If the muscles are doomed to long rest, they begin to weaken, become flabby, decrease in volume. Therefore, the study of the musculoskeletal system and its diseases is very relevant for modern humans.

The causes that provoke the occurrence of musculoskeletal disorders are divided into internal and external. Internal include those that affect internal organs and systems, contributing to bone damage. This may be a lack of necessary vitamins and minerals in the body (for example, rickets – a form of avitaminosis that loses bone strength, the reason is a lack of vitamin D). External causes are human-uncontrolled events that affect the integrity of the musculoskeletal system bones, i.e. injuries. The improper position of the body during movement or at rest (posture) and flattening of the sole (flatulence) have a gradual but constant deforming effect on the locomotive system. All injuries resulting in disorders of the musculoskeletal system can lead to the development of serious diseases, if not eliminated in the early stages.

Disorders of the musculoskeletal system can be both innate and acquired.

### **1. The concept of flatulence.**

Flatulence (from lat. *Pes planus* – flat leg) – deformation of the foot, characterized by a persistent decrease in the height of its longitudinal and transverse arches until their complete disappearance.

In a normal foot shape, the leg rests on the outer longitudinal arch, and the inner arch serves as a spring that ensures the elasticity of the gait. If the muscles supporting the arch of the foot weaken, the entire load falls on the ligaments, which, stretching, flatten the foot.

With flatulence, the supporting function of the lower limbs is impaired, their blood supply worsens, which causes pain, and sometimes seizures in the legs.

## **2. Diagnosis of flatulence**

Diagnosis of flatulence is based on clinical examination and data from podometry, radiography, plantography and pedobarography.

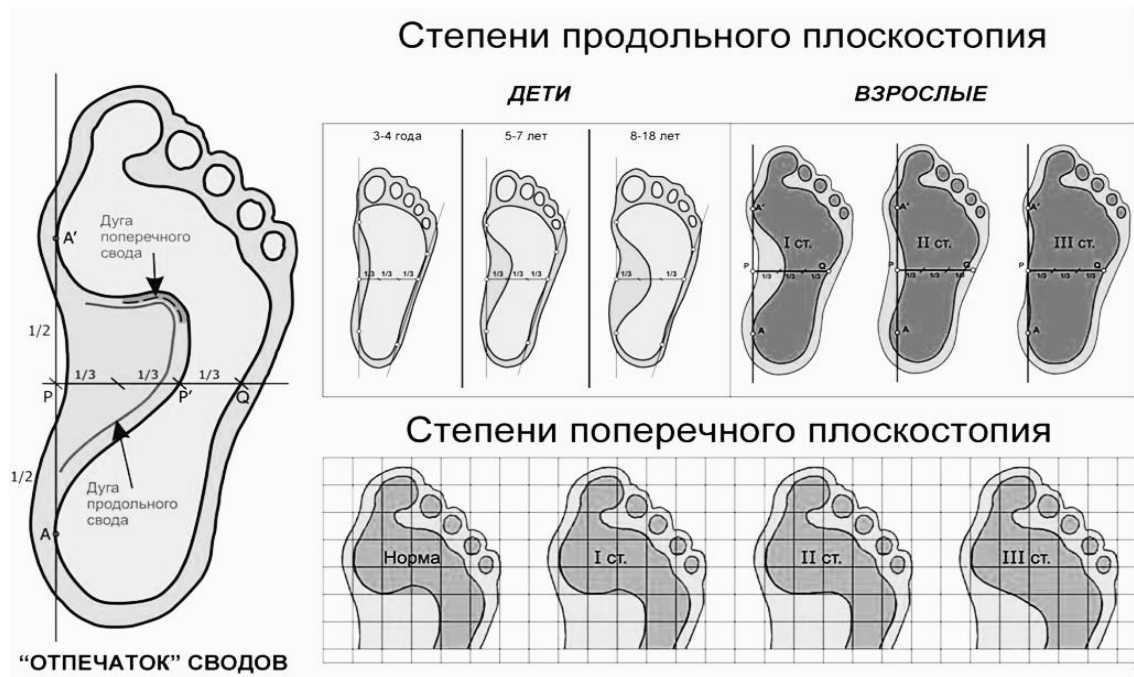
By means of podometry, the height of the bony arch of the foot (distance from the plane of support to the lower edge of the tuberosity of the palm bone) and the length of the foot (from the tip of the most protruding finger to the posterior half-circle of the heel) are determined using a compass and a ruler.

Plantography (obtaining an imprint of the plantar surface of the foot) allows you to evaluate the size of its supporting surface. On the plantogram from the center of the heel imprint, a straight line is drawn through the III intervertebral gap (it cuts off the cargo vault from the spring). With the help of special plantogram processing methods, it is possible to reliably evaluate the retraction or retraction of the forefoot, the valgus or varus position of the heel and other features of the mutual position of individual parts of the foot.

Pedography and pedobarography make it possible to study the distribution of load on the plantar surface using modern technologies both at the moment of standing (statically) and when walking (dynamically). An example of computer functional diagnostic systems for measuring pressure on foot soles are Diazhd complexes (Russian Federation), Parotec (Germany, Kramer), Emed (Germany), Foot-o-Graph platform.

During clinical examination complaints of patients are clarified, shape of foot, type of deformation and degree of its fixation are determined, features of patient's statics and walking are examined. The main complaints are:

- 1) rapid leg fatigue;
- 2) pain in the feet and muscles of the lower leg;
- 3) deformation of feet;
- 4) periodic convulsive muscle contractions;
- 5) pastosity and swelling of feet.



### 3. Flatbed views.

There are 2 classifications of flatulence:

1. According to the reasons why the foot flattens, the flatulence is divided into five main species:

**a) Static** (from lat. *Pes planus staticus*) – flatulence due to chronic overload of the feet (for example, in overweight persons). When static flatulence causes long-term loads associated with human professional activity, it is a professional flatulence. It is also possible to distinguish reflex-spastic flatulence – static flatulence, accompanied by painful reflex spasm of the foot muscles during its overload. Static flatulence is characterized by pain in the following areas: on the sole, in the center of the arch of the foot and at the inner edge of the heel; on the rear of the foot, in its central part, between the palm and ram bones; under the inner and outer ankles; between the heads of the pre-salivary bones; in the muscles of the tibia due to their overload; in the knee and hip joints; in the hip due to muscle overstrain; in the lower back on the basis of compensatory-enhanced lordosis (deflection). Pain intensifies by evening, weakens after rest, sometimes the ankle has swelling.

**b) Traumatic** (from lat. *Pes planus traumaticus*) – flatulence caused by fracture of the outer ankle, other bones of the foot or damage to its muscles. As the name implies, this disease occurs as a result of injury, most often fractures of the ankles, heel bone, preplusna and metatarsal bones. The heel in combination with

the palm and cuboid bones, as well as tubular metatarsal bones, resembles an arched vault.

**c) Congenital** (from lat. *Pes planus genuinus*) – flatulence, the cause of which is an anomaly in the development of structural elements of the foot in the utero. As a rule, such children find other violations of the skeletal structure. Treatment of this type of flatulence should be started as early as possible. In complex cases, they resort to surgery.

**d) Rachitic** (from lat. *Pes planus rachiticus*) – flatulence in children with rickets, characterized by flattening the foot in the state of rapid restoration of the arches after relieving the load. Rachitic flatulence – not congenital, but acquired, is formed as a result of improper skeletal development, caused by vitamin D deficiency in the body and as a result of insufficient calcium absorption. From static flatbed rachytic differs in that it can be prevented by preventing rickets (sun, fresh air, gymnastics, fish oil).

**d) Paralytic** (from lat. *Pes planus paralyticus*) – flatulence due to paralysis of the muscles supporting the arches of the foot. Paralytic flat foot – the result of paralysis of the muscles of the lower extremities and most often the consequence of lethargic (or peripheral) paralysis of the muscles of the foot and lower leg caused by polio or other neuroinfection. Often a person does not realize that he has flatulence. It happens that at the beginning already with a pronounced illness, he does not experience pain, but only complains of feeling tired in his legs or problems when choosing shoes. But later, the pain of walking becomes increasingly palpable, they give to the hips and lower back; calf muscles are stressed, areas of skin rejuvenation, bone-scar sprawls at the base of the thumb, deformation of other toes of the foot appear.

2. **According to the deformation** of the foot, there are two types of flatulence:

**1) Longitudinal** (from lat. *Pes planus longitudinalis*) – flatulence, in which the height of the longitudinal arch of the foot is reduced.

Three degrees of longitudinal flatulence are distinguished:

**I degree** – weakly expressed longitudinal flatulence. Patients are worried about fatigue in the lower limbs and pain in the feet during loads. Lowering of longitudinal arch occurs mainly at load. The foot is not externally deformed, the gait can lose resilience. There are no difficulties in selecting shoes. On the planthogram, the painted part extends to 1/3 of the subsoil space. On the profile

radiograph of the feet produced by standing, the inclination angle of the heel bone is 11–15 °, and the ram angle increases to 100 °.

***II degree*** – moderately pronounced longitudinal flatulence, pain is more intense and more constant, they are noted not only in the feet, but also in the tibia. The lowering of the longitudinal vault is determined already without load, but while standing it is more pronounced. Gait loses elasticity and smoothness. The selection of shoes is somewhat difficult. On the planthogram, the shaded part applies to 2/3 sub-water space. On the profile radiograph of the foot, the inclination angle of the heel bone decreases to 6–10 °, the ram angle increases to 110 °.

***Degree III*** – pronounced longitudinal flatulence, there are complaints of constant pain in the feet, ankles, as well as in the lower back, significantly increasing after the load. Clinically, the longitudinal vault of the foot is not defined. The heel is rounded, the contours of the Achilles (heel) tendon are smoothed. Walking is difficult. Tightness in the joints of the feet and ankle joints gradually increases. The appearance of swelling of the feet and the ankle joint area is possible. The selection of shoes is difficult, and sometimes impossible. On the planthogram, the shaded part extends to the entire subsoil space. On the profile radiograph, the inclination angle of the heel bone is from 5 to 0 °. The ram angle reaches 125 °.

The deformation of the feet at any degree of longitudinal flatulence may not be fixed if passive correction is possible, and fixed if it is not possible. In addition, longitudinal flatulence can be combined with valgus deflection of the posterior part or the whole foot, with bringing or retracting the anterior part of it. Lowering of the longitudinal arch can occur not only due to the middle part of the so-called underwater space, but also due mainly to the front, rear or both parts of the foot.

**2) Transverse** (from lat. *Pes planus transversoplanus*) – flatulence, in which the height of the transverse arch of the foot is reduced.

Three degrees of transverse flatulence are distinguished:

***I degree*** – weakly expressed transverse flatulence. Increased fatigue of the lower limbs after prolonged walking or standing is noted. Periodic pain in the anterior foot is possible. The anterior part of the feet is spread due to the deviation of the I metatarsal bone medially or V metatarsal bone laterally or fan-shaped divergence of all metatarsal bones. The skin under the heads of II, III, IV metatarsal bones is coarse. Some enlargement of the medial edge of the head of the metatarsal bone, cucumber and frequent inflammation of the skin in this area are

noted. Tendons of finger extensors are contoured on the back surface of the anterior foot. Deflection of I finger from outside to  $29^{\circ}$  is determined on the planthogram and X-ray of the feet produced in the facial projection.

**Grade II** – moderately pronounced transverse flatulence. When loaded, pain appears under the heads of the middle metatarsal bones, a sense of burning, as well as pain in the area of the head of the I metatarsal bone along its medial edge, in a standing position, especially in shoes. Transverse flattness becomes significant either due to fan-shaped divergence of all metatarsal bones, or deviation of medially I metatarsal bone or laterally V metatarsal bone. There are also variants of transverse flatulence, in which metatarsal bones are normally located, and the heads of the middle metatarsal bones are lowered to the plantar side. In this case, under the heads of II, III, IV metatarsal bones, skin rejuvenation is determined. The head of the metatarsal bone I is enlarged due to bone-cartilaginous outgrowths along its medial edge, skin rejuvenation is noted, and inflammation of subcutaneous synovial bags (bursitis) is possible. The tendons of the extensors of the fingers on the rear of the foot are strained. Hammer-like deformation of the II, III, IV fingers with skin rejuvenation on the interphalangeal joints often develops, the deformation is passively eliminated. Deflection of I finger outside to  $39^{\circ}$  is determined on plantogram and radiograph.

**III degree** sharply pronounced flatulence. When loading, severe and constant pain is noted under the heads of metatarsal bones, pain in the area of deformed heads of the first and possibly fifth metatarsal bones in the standing position. The flattness of the front foot section is sharply expressed. Significant stumps are formed under the heads of the middle metatarsal bones. The head of the I metatarsal bone is deformed and protrudes medially, the I finger is significantly deflected outward, sometimes it is in the dislocation position (in the metatarsal joint). Bursitis often recur in the head area of the first metatarsal bones. The tendons of the extensors of the fingers, as in the II degree of flatulence, are strongly strained, II, III, IV fingers are hammerlike deformed, but the deformation is no longer passively eliminated. Finger dislocations are formed. Usually, painful calluses and bursitis on interphalangeal joints are also observed. On the radiograph and plantogram, the first fingers are deflected outward by more than  $40^{\circ}$ .

#### **4. Peculiarities of physical education in flatulence.**

Exercises include pre-warm-up of the ankle joint and fingers, performed at a slow pace. After that, the exercises themselves are performed, for example, with a massage ball – rolling with the plantar surface – from the heel to the sock, alternately with the right/left feet, very gently touching the surface of the ball.

Moreover, strong pressure on the support, it must be remembered that this is not useful. The exercise can also be performed on a massage mat or with a massage roller. Exercises are performed in the initial positions of lying, sitting, standing and walking, which makes it possible to regulate the load on certain muscles of the lower leg and foot. First, you must limit yourself to performing exercises in the initial lying and sitting positions. Exercises should be performed with alternating contraction and relaxation of the muscles. It is recommended that you include static load exercises later.

### **Complex of physical exercises in initial position lying on the back.**

1) Imitation of foot movements, as when riding a bicycle, with simultaneous pulling of socks and turning of foot inside. Perform 6–8 rotations, free breathing. Record attention on correct position of stops.

2) Sliding alternate foot movements along the shin of the other leg from the ankle joint to the knee joint and back. Perform 8–10 movements with each leg. Then the plantar surface of the foot try to cover the shin.

3) Alternating movements of straight legs up–down (as when swimming with a rabbit on the back). The socks are pulled, the feet are turned inward. Perform 2–3 series with rest between series, in each series 4–6 cycles.

So, the exercises are performed in the initial position lying on the back as follows:

4) In turn and at the same time pull off the LE flaps with their simultaneous supination.

5) Bend your legs, rest your feet in half. Spread your heels and reduce. After a series of movements – relaxation.

6) Alternating and simultaneous lifting of heels from the support.

7) The legs are bent in the knees and divorced, the feet contact each other with the plantar surface. Retraction and actuation of heels with emphasis on toes of feet.

8) Put the leg bent in the knee on the knee of the other, semi–bent, leg. The circular movements of the foot in one direction and the other. The same, changing the position of the legs.

9) Sliding movements of the foot of one leg along the lower leg of the other, "embracing" the lower leg. Same with the other leg.

### **A complex of physical exercises in the initial position sitting on a chair.**

- 1) Swing the leg forward–backward by movement in the knee joints. The socks are pulled, the feet are turned inward. Perform 10–16 movements.
- 2) Bringing and taking the legs. The foot position is the same as in the previous exercise. Perform 10–14 movements.
- 3) Circular rotations of stops inward and outward. Perform 15–20 rotations in each direction.
- 4) Knock out a ball suspended on a cord with the outer edge of the rear surface of the foot–1–2 minutes.
- 5) Rolling with the feet of a stick or mace.
- 6) Gripping and lifting with the feet of a medical ball or ball.
- 7) Tightening the fabric mat with fingers.
- 8) Selection of small objects with toes.

### **Complex of physical exercises in initial standing position**

Performing exercises in the initial standing position makes it possible to strengthen the muscles of the arch of the foot and lower limbs, develop the right posture, the right position of the body and limbs when standing and walking, and perform movements to improve the sense of balance.

When performing exercises at first, you can stick to the gymnastic wall.

- 1) The feet are parallel, at a distance of the width of the foot, hands on the belt. Rise on socks simultaneously and alternately. Lift toes of feet with support on heels simultaneously and alternately. Rolled from heel to sock and back.
- 2) Half–sits and squats on the socks, hands to the sides, up, forward.
- 3) Feet are parallel. Skewed to and from the outer edges of the foot.
- 4) Socks together, heels apart. Half–sits and squats in combination with hand movements.
- 5) The feet are parallel, hands on the belt. Alternately raising heels.
- 6) Standing on a gymnastic stick, the feet are parallel. Half–sits and squats combined with hand movements.

7) The same, but, standing on the rack of the gymnastic wall, grabbing hands at the level of the chest.

8) Standing on the rack of the gymnastic wall. Lift on socks and return to and. o.

9) Standing on a padded ball. Squats combined with hand movements.

### **A complex of exercise in walking.**

To strengthen the muscles of the arch of the foot, walking along a semicircular or triangular pole is recommended. When walking, put the socks inside. To develop muscle strength and strengthen the vault of the feet, climbing the rope and pole, walking barefoot on a path with a coating of gravel is recommended. In the warm season, it is recommended to walk barefoot on the sand, on the beveled grass. It is necessary to combine such special walking with hardening procedures.

So, exercises are performed when walking (in motion) as follows:

- 1) Walking on socks.
- 2) Walking on the outer edges of the feet.
- 3) Walking in the position of the sock inside, heels outside.
- 4) Walking in the position of the sock inside, heels outside, with alternating lifting on the socks.
- 5) Walking on the socks of semi-bent legs.
- 6) Walking on socks with high knee lifting.
- 7) Sliding steps with simultaneous bending of fingers.
- 8) Walking on a ribbed board.
- 9) Walking down, on an inclined plane.
- 10) Walking on socks up and down the inclined plane.

Regular, systematic application of the above exercises together with general development and strengthening will allow avoiding deformation of the feet in the early stages of flat foot formation. In advanced cases, the complex of the listed

measures used simultaneously with wearing comfortable shoes with supinators will stabilize the deformation process, eliminate pain in the muscles and joints of the lower extremities, increase the functionality of the entire musculoskeletal system.

## CONTROL AND TRAINING TESTS

### 1. Define **flatulence**:

- a) deformation of the foot, characterized by a persistent decrease in the height of its longitudinal and transverse arches until their complete disappearance;
- b) deformation of the foot, characterized by a persistent decrease in the height of its transverse arch up to their complete disappearance;
- c) deformation of the foot, characterized by an increase in the height of its longitudinal and transverse arches up to their complete disappearance;
- d) deformation of the foot, characterized by a persistent increase in the height of its transverse arch until their complete disappearance.

### 2. **The static** flatbed is:

- a) flatulence caused by paralysis of the muscles supporting the arches of the foot;
- b) flatulence caused by chronic overload of the feet;
- c) flatulence caused by an abnormality in the development of structural elements of the foot in the utero;
- d) flatulence in children with rickets, characterized by flattening of the foot in the state of rapid restoration of the arches after relieving the load;
- e) flatulence caused by fracture of the outer ankle, other bones of the foot or damage to its muscles.

### 3. **The rachitic** flatbed is:

- a) flatulence caused by paralysis of the muscles supporting the arches of the foot;
- b) flatulence caused by chronic overload of the feet;
- c) flatulence caused by an abnormality in the development of structural elements of the foot in the utero;
- d) flatulence in children with rickets, characterized by flattening of the foot in the state of rapid restoration of the arches after relieving the load;
- e) flatulence caused by fracture of the outer ankle, other bones of the foot or damage to its muscles.

### 4. **The traumatic** flatulence is:

- a) flatulence caused by paralysis of the muscles supporting the arches of the foot;
- b) flatulence caused by chronic overload of the feet;

- c) flatulence caused by an abnormality in the development of structural elements of the foot in the utero;
- d) flatulence in children with rickets, characterized by flattening of the foot in the state of rapid restoration of the arches after relieving the load;
- e) flatulence caused by fracture of the outer ankle, other bones of the foot or damage to its muscles.

5. **The congenital** flatulence is:

- a) flatulence caused by paralysis of the muscles supporting the arches of the foot;
- b) flatulence caused by chronic overload of the feet;
- c) flatulence caused by an abnormality in the development of structural elements of the foot in the utero;
- d) flatulence in children with rickets, characterized by flattening of the foot in the state of rapid restoration of the arches after relieving the load;
- e) flatulence caused by fracture of the outer ankle, other bones of the foot or damage to its muscles.

6. **The paralytic** flatbed is:

- a) flatulence caused by paralysis of the muscles supporting the arches of the foot;
- b) flatulence caused by chronic overload of the feet;
- c) flatulence caused by an abnormality in the development of structural elements of the foot in the utero;
- d) flatulence in children with rickets, characterized by flattening of the foot in the state of rapid restoration of the arches after relieving the load;
- e) flatulence caused by fracture of the outer ankle, other bones of the foot or damage to its muscles.

7. How many degrees of longitudinal flatulence are distinguished:

- a) 2;
- b) 3;
- c) 4;
- d) 5.

8. Describe **the I degree** of transverse flatulence:

- a) weakly expressed transverse flatulence; note increased lower limb fatigue after prolonged walking or standing; periodic pain in the forefoot is possible;
- b) moderately pronounced transverse flatulence; when loaded, pain appears under the heads of the middle metatarsal bones, a feeling of burning, as well as pain in the area of the head of the I metatarsal bone along its medial edge, in a standing position, especially in shoes;
- c) pronounced flatulence; severe and constant pain under the heads of metatarsal bones, pain in the area of deformed heads of the first and possibly fifth metatarsal bones in standing position.

9. Describe **the II degree** of transverse flatulence:

- a) weakly expressed transverse flatulence; note increased lower limb fatigue after prolonged walking or standing; periodic pain in the forefoot is possible;
- b) moderately pronounced transverse flatulence; when loaded, pain appears under the heads of the middle metatarsal bones, a feeling of burning, as well as pain in the area of the head of the I metatarsal bone along its medial edge, in a standing position, especially in shoes;
- c) pronounced flatulence; severe and constant pain under the heads of metatarsal bones, pain in the area of deformed heads of the first and possibly fifth metatarsal bones in standing position.

10. Describe **the III degree** of transverse flatulence:

- a) weakly expressed transverse flatulence; note increased lower limb fatigue after prolonged walking or standing; periodic pain in the forefoot is possible;
- b) moderately pronounced transverse flatulence; when loaded, pain appears under the heads of the middle metatarsal bones, a feeling of burning, as well as pain in the area of the head of the I metatarsal bone along its medial edge, in a standing position, especially in shoes;
- c) pronounced flatulence; severe and constant pain under the heads of metatarsal bones, pain in the area of deformed heads of the first and possibly fifth metatarsal bones in standing position.

11. Describe **the I degree** of longitudinal flatulence:

- a) weakly expressed longitudinal flatulence; patients are worried about fatigue in the lower limbs and pain in the feet during loads; lowering of the longitudinal arch occurs mainly at load;
- b) moderately pronounced longitudinal flatulence, pain is more intense and more constant, they are noted not only in the feet, but also in the tibia; the lowering of the longitudinal vault is determined already without load, but while standing it is more pronounced;
- c) pronounced longitudinal flatulence, there are complaints of constant pain in the feet, tibia, as well as in the lower back, significantly increasing after loading; walking is difficult and tightness in the joints of the feet and ankle joints gradually increases; the appearance of swelling of the feet and the ankle joint area is possible.

12. Describe **the II degree** of longitudinal flatulence:

- a) weakly expressed longitudinal flatulence; patients are worried about fatigue in the lower limbs and pain in the feet during loads; lowering of the longitudinal arch occurs mainly at load;
- b) moderately pronounced longitudinal flatulence, pain is more intense and more constant, they are noted not only in the feet, but also in the tibia; the lowering of the longitudinal vault is determined already without load, but while standing it is more pronounced;

- c) pronounced longitudinal flatulence, there are complaints of constant pain in the feet, tibia, as well as in the lower back, significantly increasing after loading; walking is difficult and tightness in the joints of the feet and ankle joints gradually increases; the appearance of swelling of the feet and the ankle joint area is possible.

13. Describe **the III degree** of longitudinal flatulence:

- a) weakly expressed longitudinal flatulence; patients are worried about fatigue in the lower limbs and pain in the feet during loads; lowering of the longitudinal arch occurs mainly at load;
- b) moderately pronounced longitudinal flatulence, pain is more intense and more constant, they are noted not only in the feet, but also in the tibia; the lowering of the longitudinal vault is determined already without load, but while standing it is more pronounced;
- c) pronounced longitudinal flatulence, there are complaints of constant pain in the feet, tibia, as well as in the lower back, significantly increasing after loading; walking is difficult and tightness in the joints of the feet and ankle joints gradually increases; the appearance of swelling of the feet and the ankle joint area is possible.

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