DDC-UDC 611.087.1:572.512]-055.62:618.3-008.9-092.9 DOI:10.19221/201927

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DYNAMICS OF THE MASS-GROWTH INDEXES OF RATS, GOT FROM MOTHERS WITH EXPERIMENTAL METABOLIC SYNDROME

Abstract. *According to experts, about 1,5 billion inhabitants of our planet are overweight, and about 300 million are suffering from obesity. But a particular concern is the increase in the prevalence of obesity among children, which is doubling every three decades. Therefore, the purpose of our work is to determine the dynamics of mass-growth rates of rats received from mothers with an experimental metabolic syndrome depending on the dietary ration. For this purpose, 120 white laboratory rats on the 1st, 7th, 14th, 21st, 30th, 60th, 90th and 120th days of postnatal life were examined. It was found that rats receiving high-calorie diet throughout the experiment had a significantly higher body mass compared to control. Taking into account this, conclusions were drawn about the influence of dietary foods on body weight.*

Key words: *rat, metabolic syndrome, body weight, body mass index, Lee index.*

Introduction. Today, there is no doubt that the roots of metabolic disorders are in child's and juvenile age [1,2]. The rapid increase of the distribution of the obesity, especially in developed countries, leads to a substantial increase of amont of children and teenagers that have signs of metabolic violations [3]. Given the data, that specify about the presence of metabolic syndrome (MS) in overweight and obese children [4,5,6,7]. The risk of developing MS with the surplus body weight is about 20%, then at obesity this index exceeds 50%.

23,8 % boys and 22,6% girls have excessive body weight in the developed countries [8]. According to WHO, the number of patients with MS in the world ranges from 14% to 24%, in Europe - approximately 40-60 million person. Therefore, in opinion of WHO experts, MS is a new pandemic of the XXI century, which is becoming a scale of demographic catastrophe for developed countries. Consider, that MC in two times is anymore widespread, than diabetes mellitus [9].

As obesity during pregnancy is the substantial factor of development of metabolic violations for descendants in adult age, this problem acquires a large value. Despite the high significance of the metabolic syndrome, as a pathogenetic basis for the development of a number of diseases, the dynamics of mass-growth rates occurring in the offspring, depending on the conditions of their feeding in the postnatal period, is not sufficiently studied.

Objective: to determine the dynamics of the mass-growth indices of rats obtained from mothers with an experimental metabolic syndrome.

Materials and methods: the object of the study is the offspring of 120 white laboratory rats at the 1st, 7th, 14th, 21th, 30th, 60th, 90th and 120th days of postnatal life. The animals were retained in the conditions of vivarium. During work with animals followed requirements and recommendations of the European Union Directive 2010/10/63 EU on experiments on laboratory animals, the European Convention for the Protection of Vertebrate Animals (Strasbourg, 1961). The rats offspring were divided into 3 groups: I - the experimental group MS_1: rats were obtained from females with a simulated metabolic syndrome, these animals after a birth received a high-calorie diet until the 120th day inclusive. II group - an experimental group of MS_2: rats were obtained from females with a simulated metabolic syndrome, who received a standard diet after birth. III group is a control group of rats - with a standard diet and water regime ad libitum. Since the time from birth to the 21st day of the postnatal life in rats is a period of breastfeeding, therefore the division of the experimental groups MS_1 and MS_2 began from the 30th day of observation.

Morphometric parameters were determined

in rats: mass and body length were measured (naso-anal length). Based on the data obtained, mass-growth rates were calculated, namely: body mass index (BMI) is the ratio of body weight (g) to a square of body length (cm^2) and the Lee Index (the ratio of the cubic root mass in grams to body length in centimeters). The results of the study were statistically processed using Student's test. The compared results considered such, that for certain differ at $p<0,05$.

Results. In the newborn rats of the control group, the body weight was 5365,42 ± 227,54 mg, BMI was 0,45 ± 0,02, and the Lee index was 0,5 ± 0,01, respectively (table 1). The body weight of the offspring of the experimental group on the 1st day of life was statistically significantly higher (6278,84 ± 318,32 mg) compared to the control. As for mass-growth indicators, their values were also higher (BMI 0,55 ± 0,02 and Lee index – 0,55 ± 0,01 respectively).

At the 7th day of postnatal life of offspring of control animals, body mass index increases compared to the previous observation period and is 8545,48 ± 365,74 mg. In animals, obtained from females with metabolic syndrome, body mass was significantly higher – 11485,23 ± 545,24 mg. Correspondingly, BMI indicators increased (0,65 ± 0,01 in experimental animals and 0,53 ± 0,02 in control animals). The index of Lee index in both study groups did not have significant differences (0,47 ± 0,01 and 0,42 ± 0,01 respectively). The progeny of the control animals at the 14th day of life continues to tend to increase body mass index and mass-growth indices. A similar pattern can be observed in the offspring of animals with a simulated metabolic syndrome, but the above indicators are significantly higher compared to the control group (18785,76 ± 1519,81 mg and 13245,44 ± 1307,45 mg, respectively). BMI in the offspring of experimental animals is statistically significantly higher than in the control group – 0,56 ± 0,02 vs. 0,43 ± 0,01. As for the Lee index, there was no significant difference between the studied groups.

In the offspring of animals in the experimental group, for the 21st day of observation, the body mass is 32348,26 ± 3174,26 mg, while in animals of the control group, the similar indicator is significantly lower - 21856,61 ± 2348,85 mg. BMI growth in both groups was observed, but in the offspring of animals derived from females with metabolic syndrome, BMI rates were significantly higher in comparison with control animals (0,62 ± 0,02 and 0,53 ± 0,01 respectively).

At the end of the first month of life, animals move to self-catering. Therefore, the experimental animals were divided into two groups: the first group (hereinafter MS_1) - animals, starting from the 21st day of life, received a high-calorie diet until the 120th day inclusive. Animals of the second group (hereinafter - MS_2), in the similar terms received a standard diet.

At the 30th day of postnatal life in the offspring of control animals, the body mass index was 29785,64 ± 5324,49 mg, and in animals of the experimental group MS_2 34865,43 ± 5271,32 mg (table 2). The offspring of animals that received a high calorie diet showed a significantly higher body mass index than control ones 44756,73 ± 6028,49 mg. Similar changes are observed in BMI in all studied groups of animals. Regarding changes in the Lee index, there were no significant differences between the values of the control group and the MC_2 group.

At the end of the second month of life in the offspring of control animals, an increase in body

Table 1

Comparative characteristics of mass-growth indices of offspring of rats from the 1st to the 21st day of life, (M ± m); * - the results are considered to be valid at p <0,05.

Day of life	Experiment	Body weight, mg	BMI	Lee Index
1	Control	5365,42 ± 327,54	0,45 ± 0,02	0,5 ± 0,01
	Metabolic syndrome	6278,84 ± 418,32*	0,55 ± 0,02*	0,55 ± 0,01*
7	Control	8545,48 ± 365,74	0,53 ± 0,02	0,42 ± 0,01
	Metabolic syndrome	11485,23 ± 545,24*	0,65 ± 0,01*	0,47 ± 0,01*
14	Control	13245,44 ± 1307,45	0,43 ± 0,01	0,42 ± 0,01
	Metabolic syndrome	18785,76 ± 1519,81*	0,56 ± 0,02*	0,47 ± 0,01*
21	Control	21856,61 ± 2348,85	0,53 ± 0,01	0,44 ± 0,01
	Metabolic syndrome	32348,26 ± 3174,26*	0,62 ± 0,02*	0,49 ± 0,01*

Table 2

Comparative characteristics of mass-growth indices in rats from the 30th to the 120th day of life, (M ± m); * - the results are considered to be valid at p <0,05.

Day of life	Experiment	Body weight, mg	BMI	Lee Index
30	Control	29785,64 ± 5324,49	0,44 ± 0,01	0,38 ± 0,01
	Metabolic syndrome, group 1	44756,73 ± 6028,49*	0,6 ± 0,01*	0,41 ± 0,01*
	Metabolic syndrome, group 2	34865,43 ± 5271,32	0,52 ± 0,01*	0,39 ± 0,01
60	Control	65385,64 ± 7465,26	0,58 ± 0,01	0,38 ± 0,01
	Metabolic syndrome, group 1	87915,43 ± 9468,64*	0,8 ± 0,02*	0,42 ± 0,01*
	Metabolic syndrome, group 2	72164,41 ± 8665,23	0,65 ± 0,01*	0,39 ± 0,01
90	Control	104586,23 ± 14346,34	0,64 ± 0,01	0,37 ± 0,01
	Metabolic syndrome, group 1	129865,52 ± 12648,37*	0,82 ± 0,02*	0,4 ± 0,01*
	Metabolic syndrome, group 2	108465,26 ± 9796,65	0,67 ± 0,01	0,38 ± 0,01
120	Control	157625,48 ± 20486,15	0,74 ± 0,01	0,37 ± 0,01
	Metabolic syndrome, group 1	185563,48 ± 21456,96*	0,87 ± 0,02*	0,4 ± 0,01*
	Metabolic syndrome, group 2	160456,35 ± 15018,73	0,75 ± 0,01	0,37 ± 0,01

mass index is observed to 65385,64 ± 7465,26 mg, respectively. In the group of experimental animals with a standard diet, the body weight reached 72164,41 ± 8665,23 mg. Animals of the MS_1 group exhibited a statistically significantly higher body weight than control animals (87915,43 ± 9468,64 respectively).

During the third and fourth months of life in the control animals, the tendency to increase body weight with an increase in the observation period persists. At the 120th day of life, the weight of the body of control animals is 157625,48 ± 20486,15 mg, the mass-growth rates also increase (BMI is 0,74 ± 0,01, Lee index – 0,37 ± 0,01). Regarding the dynamics of body mass of animals receiving high-calorie diet, the changes of the above indicators are more pronounced (185563,48 ± 21456,96 mg, 0,87 ± 0,02 and 0,4 ± 0,01 respectively). In the offspring of experimental animals of the MS_2 group, at the end of the observation period, the mass-growth indices are leveled and not significantly different from the values of the control group.

Discussion of the results. So, from the moment of birth up to the 120th day, including in the offspring of animals of all the studied groups, there was a gradual increase in body weight with an increase in the observation period. However, in the offspring of experimental animals that received a high calorie diet from the 21st day of life, significantly higher body mass indexes were observed until the end of the observation period compared to control animals (185563,48 ± 21456,96 and 157625,48 ± 20486,15 in accordance). A similar trend can be traced in the dynamics of mass-growth indicators. The revealed changes are confirmed by clinical data on cases of fetal macrosomia and organomegaly born from women with gestational diabetes and obesity. Gestational diabetes is also a risk factor for the development of kidney abnormalities [10,11].

In the offspring of animals that received a standard diet from the 21st day of life, there was also a gradual, statistically significant increase in body weight from birth during four months of life compared to control posterity. However, at the end of the observation period, body mass index and mass-growth indices are offset and almost do not differ from the control group.

The determination of obesity throughout the experiment was carried out using the Lee index for each rat [12]. BMI was used as an integral indicator for monitoring the reproduction of alimentary obesity. In experimental groups, both indicators were significantly higher in the period from the 30th to the 120th day of life compared with the control group. However, while comparing the BMI of the Lee index between the two experimental groups, the changes were more pronounced in the rats receiving a high-calorie diet.

Conclusions. 1. In the offspring of rats from the 1st to 21st day of observation, there was a significant increase in body weight compared to the control group (MS: 32348,26 ± 3174,26 and

control group: 21856,61 ± 2348,85).

2. Starting from the 30th day of life until the 120th day, in the offspring of experimental animals receiving a high calorie diet, a statistically significant increase in body mass index was observed (MS_1: 185563,48 ± 21456,96 and control group: 157625,48 ± 20486,15).

3. In animals that received a standard diet from the 21st day of life, body weight was significantly higher than the control, but at the end of the observation period, the mass-growth rates in animals in this group are leveled.

4. Taking into account the dynamics of BMI and Lee index throughout the experiment, when comparing experimental and control rats, it can be argued that the diet has a significant effect on the dynamics of these mass-growth rates.

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