

NATIONAL SPORTS ACADEMY
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**ANNUAL DYNAMICS IN BODY COMPOSITION IN PEOPLE WITH
DIFFERENT LEVELS OF PHYSICAL ACTIVITY**

AUTOREFERATE
dissertation for the award of the educational and scientific degree "PhD"

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The dissertation is developed in a volume of 134 pages, which include: introduction, six parts, including a bibliography of 114 references and two appendices.

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The defense of the dissertation will take place on 16.01.2024 at 13:00 in Hall A3 of NSA "Vasil Levski" at an open meeting of the scientific jury composed of:

Internal members:

1. Assoc. Prof. Neli Yankova Simova, PhD
2. Assoc. Mariana Alexieva Borukova, PhD

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INTRODUCTION

Measurement of body composition in humans is usually in response to the need to describe the deficiency or excess of a component thought or known to be associated with a health risk. Energy stores in the human body are known to be deposited as body fat, and their deficiency or excess poses potential health risks. Long-term tracking of changes that occur in body mass and body composition under the influence of variations in diet and physical activity behaviours is key to developing effective and safe strategies for the long-term management of obesity. For several decades, the efforts of numerous researchers from different scientific disciplines have been directed towards understanding the causes of the increasing prevalence of overweight and obesity, developing various preventive and therapeutic approaches, including diets, exercise programmes, drug and surgical therapies, but to date, obesity remains a problem for which a lasting solution (cure) has not yet been found. Obesity is currently defined as a chronic condition/disease due to the extremely high relapse rate of weight reduction therapies, which has gained popularity as the 'yo-yo effect'. Weight loss attempts usually result in cyclical fluctuations in body mass, which are common in obese individuals. Until recently, most research was focused on developing effective strategies for faster and greater reduction of excess weight, and experts believed that it would be enough for people to understand what they needed to do to lose weight and they would. It turned out that the problem was much more complex, and the concept of "energy balance," while true, was oversimplified. Today it is known that obesity is an extremely heterogeneous phenomenon, both in terms of causes and phenotype. According to the U.S. National Institutes of Health, "one-third to two-thirds of weight is regained within one year (after loss), and almost all is regained within five years." A wide range of phenotypes have been identified that differ in the amount, size, and distribution of fat depots, the degree of potential health risks, and the type of therapeutic responses to different interventions. Dynamic weight change leads to increased inflammation, which in turn increases the risk of many obesity-related diseases. Cyclical weight gain also contributes to the incidence of hypertension, insulin resistance and dyslipidemia. Research has shown that fluctuations in body mass are associated with poor cardiovascular outcomes and increased risk of mortality. Weight dynamics explain all of the excess mortality associated with obesity in both the Framingham Heart Study and the National Health and Nutrition Examination Survey (NHANES). It has been hypothesized that the relationship between weight and health risk is related to weight cycling rather than obesity itself.

The present study is of a scoping nature. Our aim is to investigate the relationship between objectively measured changes in body mass and body composition in a group of volunteers in their natural environment and their subjective self-assessment of their diet and physical activity levels over the

course of a year. We believe that this will contribute to a better understanding of issues related to obesity prevention and therapy.

AIM, OBJECTIVES, ORGANIZATION AND METHODOLOGY OF THE STUDY

PURPOSE OF THE STUDY

The aim of the present study was to investigate the annual dynamics of changes in body mass and body composition in individuals of both sexes with different body mass index and different level of physical activity.

TASKS OF THE STUDY

1. To analyze the existing literature on the problem under study.
2. To form a group of study participants - individuals of both sexes with different body mass index and different level of physical activity.
3. To design online based surveys to collect the required self-reports of the study participants.
4. Pre-assess participants' goals, motivation, eating habits, physical activity and body mass history.
5. To examine the temporal dynamics of body mass and body fat mass of the subjects over 12 consecutive months.
6. To analyze the relationship between body mass index and the stability of body composition indices over one year.
7. To assess the level of physical activity of the participants over the study period and examine its relationship with the dynamics of body composition indices.
8. To analyse the characteristics of feeding behaviour before and during the study, and to investigate their relationship with the temporal dynamics of body composition indices.

STUDY CONTINGENT

The sample was collected through a call for volunteers for a research project, which was distributed on social networks. A total of 34 volunteers responded, of which 27 participated in the project. Of these, 24 completed their participation by the end of the study and three dropped out due to inability to fulfil their commitments.

The subjects were 12 men and 12 women, aged between 28 and 46 years, with a body mass index between 22.4 kg/m² and 46.3 kg/m². The mean age of the participants was 36.79± 5.6 years.

Inclusion criteria:

- age 20-50 years;

- Participants were not diagnosed with a medical condition at the start of the study and were not taking medication that could affect body composition parameters;
- subjects to declare consent to visit a laboratory every month for one year for standardised measurement of body composition parameters;
- Subjects agree to complete a brief weekly questionnaire to subjectively assess diet, physical activity and certain situational factors that may influence body composition measures.

RESEARCH METHODS

Theoretical analysis and interpretation

A detailed analysis of the available scientific literature related to the dissertation topic was conducted. The main scientific concepts and indicators that were used and studied in the dissertation were defined. For the realization of the aim and objectives of the research, the main views and opinions of different authors who worked on the topic were highlighted.

Incoming questionnaire

A questionnaire was developed and completed by participants prior to the start of the study. It is structured in six parts, each dealing with a different topic:

Part 1 includes five statements that gather information about the subjects' current goals/desires regarding body mass, nutrition, and physical activity. A 5-point Likert-type scale ranging from 1 - "absolutely true for me " to 5 - "absolutely false for me" was used for evaluation. The Likert scale is a popular method for assessing opinions, levels of agreement, or levels of agreement in sociology, psychology, and other fields of research. It is named after the American psychologist Rensis Likert, who developed the method in 1932.

The scale is a statement referring to an opinion, preference or level of agreement to which the respondent is asked to express their attitude. The respondent is presented with a series of responses or statements that are rated on a scale, usually consisting of five or seven levels. These levels may look as follows:

- 1) absolutely true for me;
- 2) rather true for me;
- 3) neither true nor false;
- 4) rather untrue for me;
- 5) absolutely false to me.

The respondent chooses one of these levels that most accurately reflects their opinion or level of agreement with the statement.

Desires and goals are part of a wide range of psychological factors that significantly influence eating and activity behaviour. Working with a sample from the general population implies including people who, at the start of the

study, wish to change their weight (lose or gain body mass) or maintain their current body weight. Some participants were not physically active and were willing to incorporate physical activity into their daily regimen, but were reluctant to change their diet. Another proportion were willing to change their diet but were unwilling to include additional physical activity. Those in the third group said they would change their eating habits and add physical activity to their daily regimen.

Part 2 included a set of aitems to gather information about participants' beliefs about their views of their own performance, and hence their motivation to change their diet and physical activity to achieve or maintain a healthy weight.

Part 3 includes statements that aim to gather information on activity, nutrition and body mass from infancy to the time of the survey. Data were also collected on the participants' history of attempts to follow a diet and exercise.

Part 4 concerns the participants' level of physical activity during the study. It contains 11 items - 2 for activity at work, 2 for activity when moving around and 7 for leisure time activity. Three of the items are straight coded (N) and the remaining 8 are reverse coded (R). A 5-point Likert-type scale ranging from 1 - "absolutely true for me" to 5 - "absolutely false for me" was used for assessment.

Part 5 is composed of 25 items related to participants' eating habits.

Part 6 collects information on participant demographics. - Gender and educational level.

Assessment of eating habits

In order to pre-screen participants' eating habits, one of the most commonly used instruments to assess eating styles, the Three-Factor Eating Questionnaire, TFEQ-18v2 (Karlsson et al., 2000), was included in Part 5 of the survey. It is a shortened version of the original 51-item TFEQ (Stunkard & Messick, 1985). Its English version is a translation of the abbreviated revised version TFEQ-18v2 developed by B. Palatova, author of the adaptation (unpublished research kindly provided by the author).

The questionnaire contains 18 items. A 4-point Likert-type scale was used for scoring. The eighteen items form three subscales measuring three different aspects of eating behaviour (Karlsson et al., 2000):

1. Uncontrolled eating (UE) - measures the tendency to overeat due to a subjective feeling of hunger or under the influence of external stimuli.
2. Cognitive Restraint/Self-Restraint (CR) - measures the conscious restriction of food intake to control body weight and/or promote weight loss.
3. Emotional Eating (EE) - measures the tendency to overeat in response to negative moods, for example when a person feels lonely, anxious or depressed.

A high score on one or more of the above subscales signals the possible presence of some form of eating disorder.

Weekly tracking questionnaire

At the end of each week, survey participants are reminded to complete an online-based short survey. It is designed to collect information about their subjective perceptions regarding their diet and exercise and significant internal and external factors that influence them.

Comparative analysis

The main objective of the comparative research method is to formulate an empirical generalization and test hypotheses, which enables the interpretation and generation of new knowledge. We used comparative analysis in the literature review to identify relevant and appropriate research publications to the research topic, and in our choice of approach for body composition assessment.

Mathematical-statistical methods

For the data processing was used the SPSS 23.0 package of mathematical and statistical processing software - the subroutines for variance analysis (descriptive statistics), non-parametric methods, correlation analysis, one-factor analysis of variance and cross tabulation.

Descriptive statistics (graphical and tabular methods) - includes statistical methods for collecting, tabulating and summarizing data to present information. It uses qualitative variables - relative shares, standard deviations and quantitative variables - means.

Cross tabulations are used in cases where descriptive statistics are needed for two variables simultaneously.

Correlation analysis - a method for processing statistical data used to study dependencies (correlations) between variables. The analysis compares the correlation coefficients between one or more pairs of variables to establish a statistical relationship between them. A confidence level of $\alpha = 0.05$ is assumed. In our study, we used Spearman's correlation coefficients (Ganeva, 2016) because they give significantly more freedom in the analysis of samples with different statistical distributions compared to the Pearson's linear correlation coefficient widely used in the scientific literature (Ganeva, 2016). In addition, the results of the conducted survey are rank-scaled, which does not allow the use of methods for determining correlations between continuous variables.

BODY COMPOSITION ANALYSIS

Measuring the amount of adipose tissue is essential to study the pathophysiological changes associated with obesity and to investigate its relationships with adverse health outcomes. Body composition is usually measured in order to detect possible excess or deficiency of any of its components that carry a health risk. For example, in conditions such as obesity or osteoporosis, levels of body fat and, respectively, bone density allow clinical

diagnosis and the prescription of appropriate treatment. In athletes, determination of body composition is mainly performed to measure (and subsequently track) the absolute and relative amounts of active body/muscle mass and adipose tissue and, based on these measurements, to determine an appropriate training and dietary regimen. These variables are particularly important in sports where good performance depends on moving one's own body through space, such as gymnastics and acrobatics, or in those associated with achieving a particular body image, such as bodybuilding and fitness. There are different ways of determining body composition, some requiring specialised equipment and laboratory settings, others suitable for field conditions.

Bioelectrical impedance analysis and anthropological measurements

- **Anthropological measurements.**

We measured the following anthropometric indices using standardized procedures:

1. **Height:** determined to within 1 mm using a portable stadiometer (Sessa Ltd., Hamburg, Germany) with the patient standing and head positioned in the horizontal plane. Each participant was barefoot during the measurement.
2. **Body mass:** determined to the nearest 0.1 kg with a calibrated electronic weighing instrument (TANITABC-420).
3. **Body Mass Index (BMI):** BMI was determined using the standard formula: $BMI = \text{Weight (kg)} / \text{Height}^2 (\text{m}^2)$. The presence of underweight, overweight or obesity is determined on the basis of the WHO criteria for BMI in the population aged 18 years and over. The main problem is that the index does not specifically measure the mass of adipose tissue in the body - no distinction is made between adipose and fat-free tissue. Thus, individuals with a more muscular physique have a relatively high BMI without necessarily having a large percentage of body fat, as their body mass contains a large amount of lean or fat-free tissue. The relationship between BMI and percentage of body fat changes with age. Individuals with the same BMI and sex have a greater percentage of adipose tissue as they age. This is due to the loss of lean body mass. Thus, it has been suggested that other markers of central obesity, such as waist circumference, may be more appropriate for determining adiposity and cardiovascular risk in older adults (Wannamethee, 2007). BMI is also not comparable between sexes, with women having a higher percentage of body fat at the same BMI compared to men. The BMI value also depends on variations in the ratio of lower limb length to total body height and height reduction due to vertebral collapse with age. There may be significant differences between different ethnic groups in the relationships of BMI, waist circumference and waist-hip ratio and the risk of developing type 2 diabetes and cardiovascular disease. BMI has high specificity but

low sensitivity for identifying individuals with high body fat content (Okorodudu et al., 2010).

4. **Body mass composition: bioelectrical impedance analysis.** For the purpose of the present study, a professional grade BIA analyzer from the Japanese company TANITA - TANITABC 420 was used. Body composition measurement was performed based on ESPEN recommendations for method application: measurement was performed after an overnight fasting break and abstinence from coffee intake before the study and without physical exercise. Participants wore underwear and dried bare feet. All subjects with temporary contraindications (e.g., menstruation or febrility) on the day of the study were measured by appointment at a return visit. We followed a standardized protocol of 10 rules for accurate BMI determination set by the analyzer manufacturers:

1. It is best to take measurements on bare feet. If the soles of the feet are callused or if thin nylon stockings are worn, this may affect the accuracy of the measurements. You can place 0.5 ml of water or salt water in the middle of each electrode on the foot.
2. Measure when wearing the same clothes, if possible (best naked or in underwear).
3. Measure under the same conditions and at the same time of day.
4. Measure when the bladder is empty.
5. Do not measure immediately after a large meal or excessive fluid intake.
6. Fluctuations in water balance affect the measurement of body fat percentage.
7. Take enough time to rest after sports or strenuous activity.
8. Do not measure yourself after a sauna, bath or swim.
9. The inside of the buttocks should not be touched while the measurement is being taken, with a towel placed between them if necessary. The same applies to segmental measurement of the arms and upper body.
10. Keep electrodes clean by using disinfectant

Weight and body fat dynamics were tracked using the following variables:

1. Starting weight and starting body fat percentage.
2. Maximum weight and maximum body fat percentage. Depending on the trajectory of weight changes, maximum values may coincide with baseline, be reached after the start of the study or at the end of the period.
3. Minimum weight and minimum body fat percentage - may coincide with starting, ending or any of the intermediate measurements.

Depending on the changes in body mass during the study, the participants were grouped into 4 categories:

1. Deprived - the difference between the final weight and the initial weight, expressed as a percentage of the initial weight, is a negative number with a value greater than 1.5.

2. No change - the difference between the final and initial weights, expressed as a percentage of the initial weight, is less than 1.5.
3. Overweight - the difference between the final and initial weights, expressed as a percentage of the initial weight, is a positive number greater than 1.5.
4. Yo-yo group - the difference between the final and minimum weight is a positive number greater than 1.5.

ORGANIZATION OF THE STUDY

The experimental part of the study was conducted during the pandemic of Covid-19 - 01.10.2020 - 01.10.2021.

The organization of the study was carried out in five main stages.

Stage 1 (December 2018 - September 2019) - a review of the main scientific literature on the topic of the dissertation - physical activity, body composition, research methods, relationship between physical activity, body composition and health.

Phase 2 (November 2019 - March 2020) - online based surveys have been developed and a pilot survey has been conducted.

Stage 3 (October 2020 - October 2021) - the experimental part of the study was conducted.

Stage 4 (January 2022 - April 2022) - statistical processing of the collected data with the statistical software SPSS 23.

Stage 5 (May 2022 - July 2023) - finalisation of the dissertation.

ANALYSIS OF RESULTS THEY

DESCRIPTION OF THE SAMPLE AND RESULTS OF THE SURVEY

The annual dynamics of body weight and body composition in humans depend on complex interactions of an extremely wide range of factors, including sex, age, education, BMI, diet and physical activity, and many others. Our sample includes a total of 24 individuals, 12 men and 12 women aged between 28 and 48 years. The majority of participants, 54.2%, had a master's degree, 29.2% had a bachelor's degree, and 16.7% had a high school education.

According to the body mass index, 3 groups were formed, with participants with a BMI up to 24.9 kg/m falling into the normal weight group, those with a BMI between 25 and 29.9 kg/m² in the overweight group, and those with values above 30 kg/m² classified as obese. The lowest BMI value we measured was 22.10 kg/m², and the highest was 46.3 kg/m².

The body composition analysis performed allows to correct the uncertainties associated with the limitations of BMI as a metric for determining guardedness. To this end, we performed a cross-tabulation on the parameters BMI and body fat percentage, the results of which are presented in **Fig. 1**. It was found that in the group with normal body fat values nearly 43% of the participants had a BMI that corresponded to overweight, whereas in the groups with excess body

fat values nearly ¼ of the subjects had a BMI that underestimated the amount of body fat.

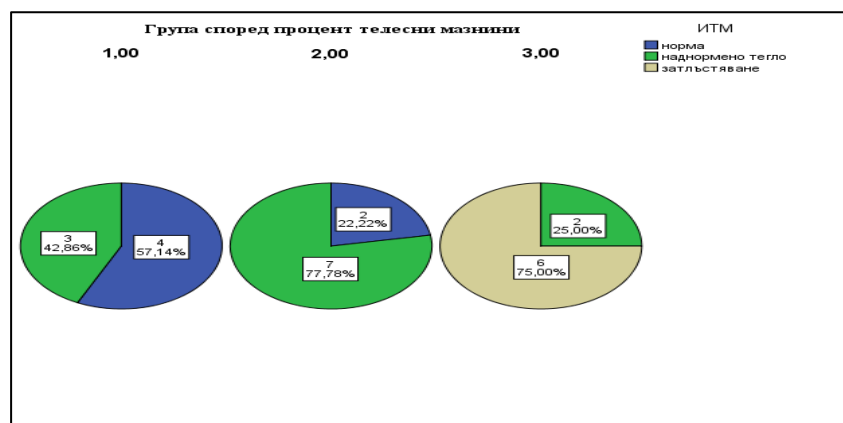


Fig. 1. Cross tabulation of participants according to body fat percentage and BMI group norms.

We found marked differences in the relationship between BMI and body adiposity by sex. In female participants, due to the lighter bone structure, the positive relationship between BMI and amount of body fat was found to be less pronounced. For example, in 66.67% of males with normal adiposity, BMI was elevated, whereas in female subjects, this value was 25%. Similar observations were observed in the other two groups, with all male respondents grouping identically on the two traits, while in the other sex the correlation spanned half of the participants.

PRE-ASSESSMENT OF PARTICIPANTS' GOALS, EATING HABITS AND PHYSICAL ACTIVITY

All study participants completed an intake questionnaire designed to collect preliminary information on personal goals and attitudes, past experiences related to body mass variation, childhood overweight, habitual physical activity levels, and dietary habits. All of these indicators directly or indirectly influence dietary and activity behaviour choices, which are likely to set the stage for weight or body composition change over the study period. Personal goals, for example, are strictly subjective and determined by factors such as perception of norm and aesthetics, values, beliefs, social pressures, etc.

We assumed that during the study year, participants would pursue their goals by striving to adhere to self-selected eating and activity patterns, depending on whether they wanted to change or maintain their current weight. To explore personal goals (part 1 of the input survey) we used the statement "I want to lose weight" with possible responses :

- 6) absolutely true for me;
- 7) rather true for me;
- 8) neither true nor false;

- 9) rather untrue for me;
- 10) absolutely false to me.

The large number of possible answers was chosen to ensure the convenience of the respondents, but when working with small samples, such as ours, this makes the statistical processing of the results difficult. To deal with this problem we chose to convert the responses to a simpler scale with three categories - true, neutral and false. In processing the results, the "somewhat true" and "absolutely true" responses were combined into a single "true" response, and the "absolutely false" and "somewhat false" responses were combined into a single "false" response. 85.7% of survey participants indicated that they wanted to lose weight, 14.3% gave a "neither true nor false" response, and only one (4.2%) indicated that they did not want to lose weight. It is important to note that all those who showed hesitation on this question were overweight and had a high body fat percentage. It is also noteworthy that 6 of the 7 participants whose body fat is in the normal range express a desire to lose weight.

Although these results seem illogical at first glance, the reasons for them are familiar to researchers. The drive for weight loss in individuals whose body fat is within the norm is described in the literature by the term "normative dissatisfaction" and is a direct result of the media's aggressively enforced ideal of the perfect body. It has been found that the closer a person is to such 'perfection', the more likely they are to be highly motivated to make the effort to achieve it. The phenomenon of "normative dissatisfaction" is more common among women. Since all normal-weight participants in our sample were women, the results are not surprising.

To examine the relationship between physical activity at different stages of participants' lives, or specifically the relationship between lifetime physical activity, the year before the study began and during the study, we conducted a univariate analysis of variance. We divided participants into 4 groups - the first group was made up of participants who responded to the statement "I've been arguing all my life" with the response "absolutely not true" or this was 33% of respondents, which is 1 person. The second group responded to the same statement with the answer "rather untrue" and that is 38.46% or 5 people. The third group 20% responded to the statement with the answer "somewhat true" or this 1 person. In the last group 66,67% answer the statement with the answer "absolutely true" or that is 2 people. The potential relationship between childhood and adolescent activity and adult activity suggests that physical activity tracks from childhood through adolescence to adulthood.

We share the view of some authors that building physical activity habits from early childhood can have a positive impact on maintaining healthy physical activity in adulthood, which does not necessarily lead to maintaining a normal weight.

In addition, according to Boreham & Riddoch, 2006, there is a biological carry-over effect into adulthood, in which improved adult health status results

from physical activity in childhood - what better prevention of obesity than building physical literacy from early childhood. A large proportion of overweight and obese people are unable to maintain their weight over the long term, slowly leading to a deterioration in their physical and health status. The role of physical activity (PA) is to curb this trend by performing a preventive health function. According to the World Health Organization, FA is defined as the work of skeletal muscles that require energy expenditure (WHO, 2020). Exercise is an activity that is "planned, structured, repetitive, and designed to improve or maintain one or more components of physical fitness" (Bays, 2021). There are a variety of recommendations regarding the conduct of structured and unstructured physical activity, for aerobic and anaerobic exercise. Of particular importance is the provision of adequate ongoing control of FA so that individuals are comfortably active and able to maintain their physical activity levels long-term.

Current goals and wishes

On **Tab. 1** presents the answers of the subjects to the questions from the first part of the survey, which collected information about the current goals/desires of the subjects regarding body mass, nutrition and physical activity. It is noteworthy that all respondents expressed a desire to develop healthy habits in terms of both nutrition and physical activity. Thus, the expressed consensus of the participants on the need for a healthy lifestyle is not necessarily accompanied by an intention to reduce weight - only 54.2% stated that they would like to lose weight. 4 of the respondents (16.7%) did not link healthy habits to a change in body mass, regardless of their overweight, which we found in the cross-tabulated distribution of responses.

Table 1
Frequency table of survey results - part 1, analysis of respondents' current objectives

II1. I want to lose weight.		
Answer	Number	Percentage
1	13	54,2
2	7	29,2
3	3	12,5
5	1	4,2
II4. I also want to build healthy eating habits.		
1	24	100,0
II5. I want to maintain healthy physical activity.		
1	24	100,0

Answers: 1. absolutely true; 2. rather true; 3. neither true nor false; 4. rather false; 5. absolutely false

Motivation

Table 2 presents the responses to the questions in the second part of the survey, which analysed participants' motivation to change their diet and physical activity in order to achieve or maintain a healthy weight. Respondents' dissatisfaction with their own body (M2) was clearly evident, and was coupled with a lack of confidence in their own ability to maintain the desired weight (M1). At the same time, two-thirds of respondents were confident in their ability to maintain a healthy diet (M3). Interestingly, this belief was not accompanied by confidence in knowledge of the principles of healthy eating (M5), with the majority of participants not even attaching much importance to them (M4). Nevertheless, the majority of respondents stated that they maintain a strict diet and physical activity regime (M6 and M7). At the same time, there is a tendency to neglect the importance of FA (M8) against a background of doubt in one's own leisure management capabilities in terms of its inclusion in the daily regime (M9 and M10). The analysis of the responses to this part of the survey paints a picture of respondents' dissatisfaction with the appearance of their own bodies, accompanied by a desire for change, which is, however, perceived as unfeasible.

Table 2

Frequency table of survey results - part 2, analysis of participants' motivation to change diet and physical activity to achieve or maintain a healthy weight

M1. I am confident in my ability to achieve/maintain my desired weight		
Answer	Number	Percentage
2	2	8,3
3	2	8,3
4	14	58,3
5	6	25
M2. I like my body.		
2	5	20,8
3	4	16,7
4	10	41,7
5	2	8,3
M3. It is not possible to eat healthy.		
2	3	12,5
3	5	20,8
4	8	33,3
5	8	33,3
M4. For me it is of paramount importance to eat healthy.		
3	5	20,8
4	15	62,5

5	4	16,7
M5. I am well aware of the principles of healthy eating and try to follow them whenever possible.		
2	2	8,3
3	4	16,7
4	12	50
5	6	25
M6. I follow a strict diet/nutritional regime.		
1	6	25
2	8	33,3
3	6	25
4	4	16,7
M7. I train intensively/regularly for more than 6 months.		
1	7	29,2
2	5	20,8
3	3	12,5
4	4	16,7
5	5	20,8
M8. It is of paramount importance for me to achieve/maintain a high enough level of physical activity.		
1	1	4,2
2	2	8,3
3	4	16,7
4	10	41,7
5	7	29,2
M9. It is not possible to include enough physical activity in my daily life.		
1	7	29,2
2	8	33,3
3	3	12,5
4	6	25
M10. I am confident that I can achieve/maintain a healthy level of physical activity.		
2	2	8,3
3	1	4,2
4	15	62,5
5	6	25

Answers: 1. absolutely true; 2. rather true; 3. neither true nor false; 4. rather false; 5. absolutely false

History of weight changes

On **Tab. 3** presents the answers to the questions from the third part of the questionnaire, where the history of changes in body mass, diet and physical activity of the respondents is analyzed. As a consequence of the body mass problems, the majority of the participants declared experimenting with different diets, and the results achieved quickly were easily and quickly lost - the answers to questions I2-I4. These results paint a picture of a classic yo-yo effect of following a body mass reduction diet. It is known that one of the main consequences of this process is a change in body composition in the direction of reduction of active body mass at the expense of adipose tissue. This, in turn, leads to a chronic decrease in energy expenditure and difficulty, if not impossibility, of weight reduction, which is reflected in the answers to question I7. Expectedly, respondents declared sporadic inclusion of some kind of physical activity in the daily regimen, and this was invariably accompanied by difficulties in adherence (I5 and I6).

Table 3

Survey results - Part 3, history of changes in respondents' body mass, diet and physical activity

I1. I have been overweight since childhood.		
Answer	Number	Percentage
1	12	50,0
2	4	16,7
3	4	16,7
4	4	16,7
I2. I have tried all kinds of diets.		
1	7	29,2
2	10	41,7
3	4	16,7
4	3	12,5
I3. I'm losing weight fast, but I can't keep the score.		
1	7	29,2
2	15	62,5
3	2	33,3
I4. It is easy for me to follow a diet.		
1	4	16,7
2	11	45,8
3	8	33,3
4	1	4,2
I5. I've been playing sports my whole life.		
1	3	12,5
2	13	54,2

3	5	20,8
4	3	12,5
II6. I've tried to exercise, but I'm not consistent.		
1	3	12,5
2	10	41,7
3	8	33,3
4	3	12,5
II7. No matter how hard I try, I can't lose weight.		
1	4	16,7
2	15	62,5
3	4	16,7
4	1	4,2

Answers: 1. absolutely true; 2. rather true; 3. neither true nor false; 4. rather false; 5. absolutely false

Physical activity

According to the responses to the first six questions, the majority of respondents' habitual physical activity is relatively low, and attempts are made to compensate for this to some extent at weekends. Respondents' own judgement of their level of FA is relatively unclear - the distribution of responses to questions FA7-FA10 does not suggest any firm conclusions. There was a tendency to adjust exercise parameters to the energy restriction of the diet (FA10).

Eating habits

Table 4 presents a grouping of participants by their dietary habitus based on their responses to the fifth part of the survey. We subsequently use this data in the correlation analysis of the results in **Section III.3**.

Table 4

Survey results - part 5, grouping respondents by type of eating habits

X1.Uncontrolled eating		
Answer	Number	Percentage
1	9	37,5
2	9	37,5
3	6	25,0
X2.Cognitive nutrition		
1	6	25,0
2	14	58,3
3	4	16,7
X3.Emotional eating		

1	9	37,5
2	7	29,2
3	8	33,3

CORRELATIONS BETWEEN BODY MASS AND BODY COMPOSITION AND THE RESULTS OF THE SURVEY

Table 5 shows the correlations between body mass and composition and the responses to the survey on the participants' goals. With the exception of the correlation coefficient between C5 and BMI, we do not find statistically significant values for any of the analysed relationships. For this reason, we will assume that there is no relationship between participants' stated goals and their body mass and composition.

Table 5

Correlations (Spearman correlation coefficient) between body composition and survey results on participants' goals

		ITM	PTM
Q1	Correlation coefficient	0,069	-0,388
	Credibility	0,749	0,061
Q4	Correlation coefficient	0,098	0,159
	Credibility	0,649	0,459
Q5	Correlation coefficient	0,408*	0,245
	Credibility	0,048	0,249

Legend: body mass index (BMI); body fat percentage (BF); questions 1 to 5 of part 1 "What are your current goals?"

The majority of the correlation coefficients between body composition and the results of the analysis of respondents' motivation did not meet the requirement for statistical significance ($p \leq 0.05$). Of interest are the statistically significant correlations (responses to questions M4, M7, M9 and M10). The conclusion that emerges is that participants declaring high motivation to change body mass and composition have a high percentage of adipose tissue. It is possible that it is this fact that motivates them to change.

Table 6 shows the correlations between the respondents' reported history of body mass change and body mass and composition. A clear trend for a positive association between BMI and the amount of adipose tissue and overweight at a young age and subsequent attempts at weight reduction with different regimens

emerges. We believe that this effect is due to unfolding yo-yo effects, especially in light of the highly reliable positive correlation between I7 ("No matter how hard I try, I can't lose weight").

Table 6

Correlations (Spearman's correlation coefficient) between body composition and survey results on respondents' history of changes in body mass, diet and physical activity

		ITM	PTM
И1	Correlation coefficient	0,473*	0,236
	Credibility	0,020	0,267
И2	Correlation coefficient	0,631**	0,580**
	Credibility	0,001	0,003
И3	Correlation coefficient	0,111	0,073
	Credibility	0,604	0,736
И4	Correlation coefficient	-0,071	-0,084
	Credibility	0,741	0,696
И5	Correlation coefficient	-0,018	-0,065
	Credibility	0,933	0,763
И6	Correlation coefficient	0,230	0,446
	Credibility	0,279	0,029
И7	Correlation coefficient	0,152	0,490*
	Credibility	0,478	0,015

Legend: BMI- body mass index; BMI- body fat percentage; И1 to И7- questions 1 to 7 of Part 3 "History" of the General Questionnaire

As expected, statistically significant correlations were found between many of the responses to the survey questions and the physical activity indicators. Of interest is the fact that no such correlations were recorded for BMI. Considering the positive correlation between physical activity level and normal body mass, it is possible that this finding represents a striking demonstration of the subjectivity of respondents' own assessment of physical activity. On the other hand, it is known that establishing physical activity habits from early childhood can have a positive influence on maintaining healthy physical activity in adulthood, which does not necessarily lead to maintaining a normal weight.

Tables 6 and 7 present the correlations (in the form of a correlation matrix) between body mass and composition and the results of the survey on the dietary habits of the participants.

Table 6

Correlation matrix (Spearman's correlation coefficient) between body mass index and the results of the questionnaire on participants' eating habits

		ITM	NH	KH	EX
ITM	Correlation coefficient	1	0,258	-0,312	0,437*
	Credibility	.	0,223	0,137	0,033
NH	Correlation coefficient	0,258	1	-0,014	0,378
	Credibility	0,223	.	0,949	0,069
KH	Correlation coefficient	-0,312	-0,014	1	-0,243
	Credibility	0,137	0,949	.	0,253
EX	Correlation coefficient	0,437*	0,378	-0,243	1
	Credibility	0,033	0,069	0,253	.

Legend: BMI, body mass index; NH, unstructured eating; CH, cognitive eating; EX, emotional eating;

Table 7

Correlation matrix (Spearman's correlation coefficient) between the amount of body fat and the results of the questionnaire on the participants' eating habits

		PTM	NH	KH	EX
PTM	Correlation coefficient	1	0,308	0,028	0,437*
	Credibility	.	0,143	0,898	0,033
NH	Correlation coefficient	0,308	1	-0,014	0,378
	Credibility	0,143	.	0,949	0,069
KH	Correlation coefficient	0,028	-0,014	1	-0,243
	Credibility	0,898	0,949	.	0,253
EX	Correlation coefficient	0,437*	0,378	-0,243	1
	Credibility	0,033	0,069	0,253	.

Legend: BMI, body fat percentage; NH, non-nutritive eating; CH, cognitive eating; EX, emotional eating

In **Table 8**, we present the correlation matrix of the studied body mass and body composition indices and the participants' daily dietary and physical activity parameters. A high degree of correlation was found between BMI and body fat

percentage, which is largely the expected result - overweight is associated with increased body adiposity in non-exercisers.

Table 8

Correlation matrix (Spearman correlation coefficients) between mass and body composition parameters of the participants' daily regimen

		Age	ITM	PTM	NFA	NH
Body mass index (BMI)	Correlation coefficient	0,172				
	Credibility	0,423				
Body fat percentage (BFP)	Correlation coefficient	0,665**	0,851			
	Credibility	0,000	0,000			
Physical activity level (PAAL)	Correlation coefficient	-0,067	-0,120	-0,465*		
	Credibility	0,758	0,576	0,022		
Uncontrolled feeding (UF)	Correlation coefficient	0,189	0,258	0,308	-0,498*	
	Credibility	0,377	0,223	0,143	0,013	

TEMPORAL DYNAMICS OF "BODY MASS" AND "BODY FAT MASS" AND CORRELATIONS WITH PHYSICAL ACTIVITY AND DIETARY HABITS

Figure 2 shows the dynamics of body mass and its relationship with the physical activity level of the study participants over a one-year period. It is important to emphasize that the present study was an observational study - only body mass and composition parameters were measured, and no attempts were made to influence the choice behavior of the participants in any way.

Subjects in the first group reduced their weight, with 33.33% of them having a high level of physical activity, 33.33% - medium and 33.33% - low. No change in body mass was recorded in the second group of subjects. 75% of the participants had high level of FA and 25% had medium level. It is important to note that not only physical activity, but also eating habits, energy balance and various individual factors can also have an influence in the process of body mass reduction.

Participants in the third group increased their body mass, with 50% declaring a low level of FA and 50% declaring a medium level. In the last (fourth) group were subjects who started to lose weight but subsequently regained their

initial body mass (the so-called yo-yo effect). In 37.5% of them physical activity was high, in 37.5% it was average and 25% reported low FA.

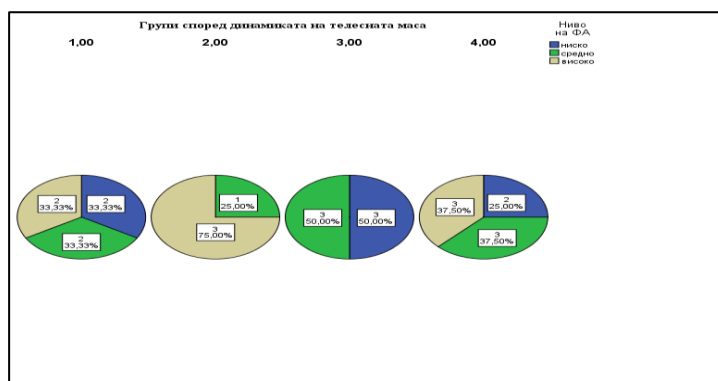


Fig. 2. Cross-sectional distribution of body mass dynamics according to physical activity level.

Legend: 1. Weakened; 2 No change; 3. 4. Yo-yo effect

Fig. 3 shows the dynamics of body mass in the different cohorts of subjects. 25% of the participants lost weight, 16.67% showed no change in weight, 25% gained weight, and 33.33% showed a yo-yo effect.

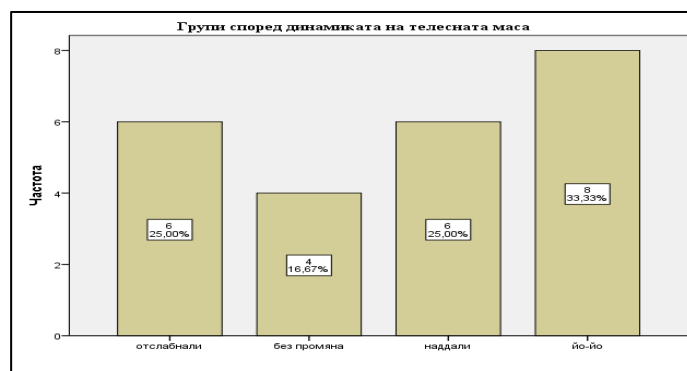


Fig. 3. Frequency distribution of study participants according to change in body mass

Fig. 4 shows the histogram of the distribution of percentage changes in body mass of the participants over the study period. The mean of the recorded results was negative (-1.39%). Despite the fact that at first glance the data are located centrally around the zero value, a significantly higher number of subjects who reduced their weight is recorded, with some of them having losses of more than 5%. These data demonstrate a clear trend among the subjects to strive (in most cases successfully) to reduce body mass. As the experiment was entirely observational, we believe that the reason for the asymmetric statistical distribution of weight changes is the very inclusion of the subjects in it - the presence of observation (and presumed control) over daily diet and physical activity provokes attempts to adopt a healthier lifestyle.

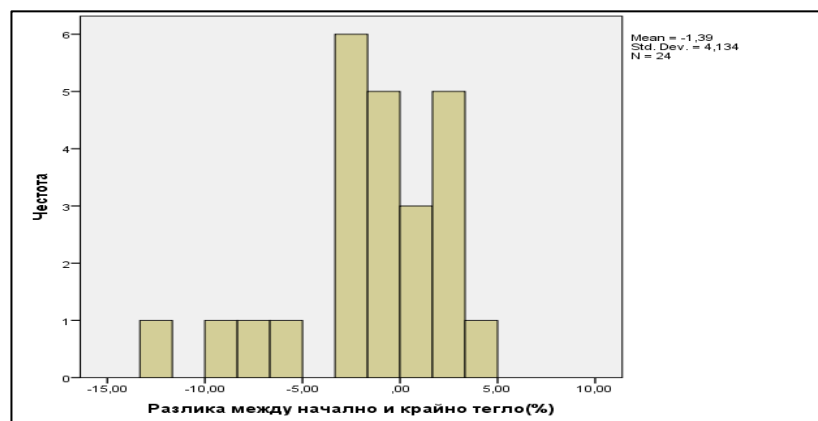


Fig. 4. Histogram of the difference between participants' final to initial weights in percentage.

Figure 5 shows the relationship between body mass dynamics and uncontrolled eating. In 50% of the examined persons in the group with reduction of their body mass, an average level of uncontrolled eating (UU) was found, in 33.33% - a low level of UU and in 16.67% - a high level. 75% of the participants with no weight change had a low level of HH and the remaining 25% had a medium level.

50% of the participants in the group that showed an increase in body mass had a high level of NQ, 33.33 - medium NQ and 16.67% - low. The level of HA was high in 25% of the subjects of the yo-yo group, in 37.5% of them it was medium and in 37.5 - low.

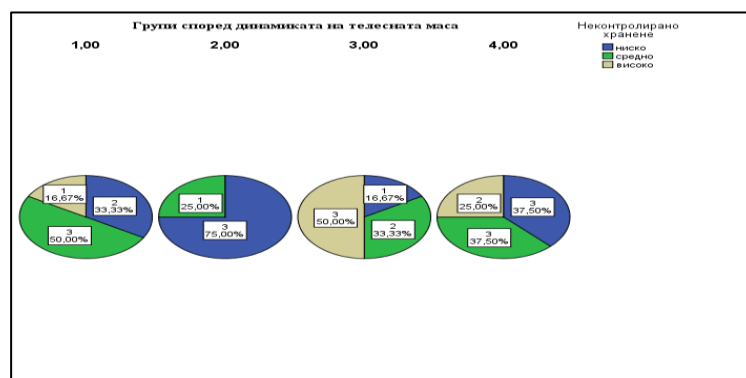


Fig. 5. Cross-sectional distribution of body mass dynamics according to the level of uncontrolled feeding

Legend: 1. Weakened; 2 No change; 3. 4. Yo-yo

Fig. 6 shows the relationship between the dynamics of body mass and the level of emotional eating (EI). 33.33% of the subjects in the weight loss group had a high level of EI, 33.33% had a medium level and 33.33% had a low level. In participants with no weight change, 25% had high level of EX, 50% had medium and 25% had low. In the subjects who increased their body mass the distribution

of EX level was even - 33.33% fell into each level. In the yo-yo group, 37.5% had a high level of emotional eating, 12.5% a medium and 50% a low.

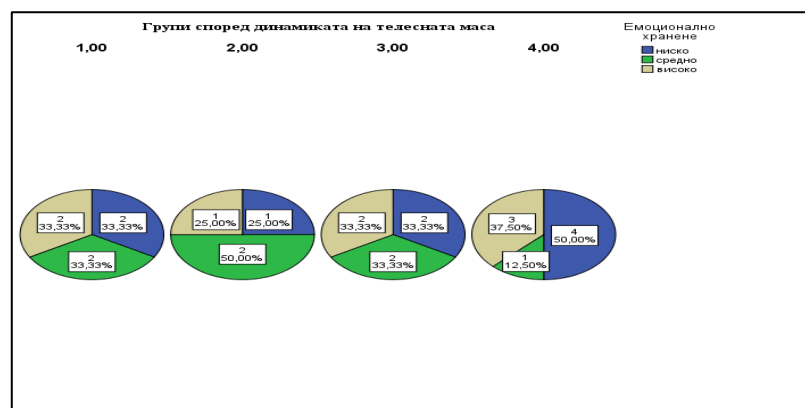


Fig. 6. Cross-sectional distribution of body mass dynamics according to the level of emotional eating.

Legend: 1. Weakened; 2 No change; 3. 4. Yo-yo

CONCLUSIONS AND RECOMMENDATIONS

FINDINGS

1. The use of BMI as a universal measure for assessing guarding should take into account intersex differences in the relative amount of adipose tissue.
2. The distribution of the data on the dynamics of body mass indexes and composition necessitates the conclusion that participation in a study to track them is itself a factor in achieving health effects, despite the absence of a direct intervention.
3. The model of the "ideal" body imposed by the mass media in recent decades often causes an unjustified drive for weight reduction, which can be the cause of unpleasant detrimental effects on the mental state.
4. A high relative amount of adipose tissue represents a motivating factor for switching to a body mass reduction regimen.
5. Regular physical activity from an early age is a factor in the maintenance of normal body mass and body composition in adulthood and the prevention of overweight and obesity.
6. Regular physical activity is negatively correlated with uncontrolled eating and influences the control of eating habits when trying to achieve a healthy diet.
7. Emotional type of nutrition represents a major factor in the increase in mass and adiposity of the body.
8. Uncontrolled eating is a major contributor to the increase in body mass and the amount of adipose tissue in the long term. There may also be psychological effects with the end result being a pronounced yo-yo effect.

RECOMMENDATIONS

1. We believe that adopting an observational approach to body mass and adiposity reduction would be effective in individuals who are unable to participate in organized and supervised therapies. The introduction of remote or online tracking programs of dietary and physical activity parameters could be effective in combating overweight and obesity.
2. Sport educators could use the natural aspiration of adolescents to achieve an aesthetic, athletic and harmoniously developed body to promote regular physical activity in children and adolescents. Such an approach has the potential to build lasting healthy habits in young people that can be maintained into adulthood. However, it is important to stress that the extremes of such a strategy can become a factor in triggering eating disorders. For this reason, children should be taught that body size is not a behaviour, therefore only partially amenable to volitional control.
3. Regular physical activity should be an indispensable element of weight loss therapies. Despite the widespread belief that it has a limited effect on weight reduction, its impact on diet control and body adiposity is undeniable. These findings represent only a portion of the numerous and undeniable beneficial health effects of physical activity in both the short and long term.

CONTRIBUTIONS OF THE DISSERTATION (according to the author)

1. This is the first time in our country that long-term monitoring of changes in body mass and composition of free-living individuals has been carried out. The natural trends in the variation of these indices depending on the type of habitat diet and the level of physical activity were found.
2. The impact of regular physical activity in childhood and adolescence on adult fitness has been established. Specific recommendations are made regarding strategies to regulate body mass and composition.
3. A quantitative correlation was found between the important parameters affecting body mass and composition - diet type and physical activity level. The importance of regular sports activities in maintaining a healthy weight and amount of adipose tissue has been demonstrated.

PUBLICATIONS RELATED TO THE THESIS

1. Palatova, B. & Atanasov, P. (2021). A personalized unstructured approach to long-term obesity care - a case report, NSA Yearbook, Vol. 1 204 pp
2. Atanasov, P. (2020). Physical (in)activity during a pandemic lockdown. Postmodernism Problems 2020-12-15