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Preventing and combating obesity among primary school children through volleyball and awareness sessions

ABSTRACT OF DOCTORAL THESIS

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Table of contents

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Introduction

Throughout history and up to the present day, people have reported differently on obesity, with perceptions of it constantly changing. In ancient times, being overweight represented wealth, and was more obvious than expensive clothes or jewellery. (Haslam, 2007). It also represented an advantage for survival in a time of famine, with various epidemics constantly threatening humanity (Eknoyan, 2006). As the years went by and medicine developed, obesity began to raise concern among people, with those affected by this disease often being labelled as people with a disgraceful form and more likely to develop various co-morbidities that seriously threatened the life of the affected (Haslam, 2007).

Currently, the World Health Organization (WHO) (WHO, 2019c), defines obesity as an excess (unnatural) accumulation of adipose tissue that can deteriorate health. In recent decades, according to data published by the WHO, the prevalence of obesity among children in Europe has been steadily increasing, with recent statistics showing that one in three children is overweight or obese (WHO, 2022d). Once established, obesity affects the body directly through physiological changes produced in the body (Tsigos et al., 2008) and indirectly, because of the pressure that high amounts of fat have on the locomotor system, mental health and social life (Chu et al., 2019; Tsigos et al., 2008).

In order to prevent complications of obesity, several criteria are now devised by which to assess weight status: calculation of body mass index (BMI) (Deurenberg, Weststrate, & Seidell, 1991) by measuring waist circumference (Aggarwal & Jain, 2018; Qiao & Nyamdorj, 2010) and waist-to-hip ratio (Qiao & Nyamdorj, 2010) or by analysing body composition (Dolapciu, 2017). Once the diagnosis of obesity has been made, as with any disease, treatment is also applied to this condition, with four main treatment options, each with different financial costs and degrees of complexity: developing a diet, increasing the level of physical activity, pharmacological therapy or bariatric surgery (Uli, Sundararajan, & Cuttler, 2008).

The main causes of obesity include lack of physical activity. According to data published by the WHO, an estimated 81.5% of children and adolescents (11-17 years) worldwide do not meet the minimum recommendations for daily physical activity (WHO, 2022a). For Romania, the percentage of physical inactivity among children and adolescents is 80% (WHO, 2022b). Low levels of physical activity and poor dietary habits lead to imbalances in energy balance. Such behaviour adopted over a

longer period influences the onset and development of obesity through the accumulation of excess adipose tissue, thus changing physical shape. (Bouchard et al., 1990; Levitsky, Obarzanek, Mrdjenovic, & Strupp, 2005; Pasquet & Apfelbaum, 1994). However, in many situations, this developmental dysregulation is not observed and thus unhealthy habits are still retained. Numerous studies show that parents misperceive their children's weight, underestimate their weight and thus do not take action or seek expert help. (Bayles, 2010; Crawford et al., 2004; De La O et al., 2009; Duncan, Hansen, Wang, Yan, & Zhang, 2015; Figueroa, Ip, Gesell, & Barkin, 2008; Glassman, Figueroa, & Irigoyen, 2011; Killion, Hughes, Wendt, Pease, & Nicklas, 2006; Reifsnider et al., 2006; Strava, 2017).

Given the present situation, the present research starts from the premise that a large body of evidence published in the literature shows that a considerable proportion of parents in the samples studied do not perceive their children's body weight correctly. They often underestimate their children's weight status, ignoring the weight problem they face, the consequence of which is a lack of action to combat overweight. In most cases, parents' beliefs are passed on to their children and they end up underestimating their own weight. Therefore, we hypothesize that using volleyball and awareness sessions, improved fitness results can be achieved in overweight or obese children by improving body composition. Positive changes can also occur in the quality of social life and general health.

The aim of this study is to contribute to the development of databases containing information on overweight and obesity by obtaining and publishing topical results. To achieve this aim, the research objectives were as follows:

1) Conduct a survey on the nutritional status of primary school students in Timisoara.

2) Identification of children's lifestyle by parents filling in questionnaires to assess and analyse behavioural factors (food intake, eating habits, sedentary lifestyle, physical activity) and environmental factors (lifestyle promoted by society, entourage, family environment) that may be conducive to the development of obesity.

3) Assess parents' perceptions of children's physical development against known standards for age, height and gender.

4) Promoting a healthy lifestyle by presenting the basics of healthy eating, the negative effects of sedentary lifestyles and the benefits of physical activity.

5) To increase the quality of life of overweight and obese children by designing, implementing and monitoring a training program consisting of introductory, strengthening and improvement activities in volleyball.

Elements of novelty and originality

Following the literature review, we identified that volleyball is insufficiently studied by specialists in terms of how it improves body composition in overweight or obese individuals under 18 years of age (Trajković et al., 2021). Moreover it is not at all studied how a volleyball program, conducted for a minimum of 6 months, acts against overweight or obesity in children under 11 years of age.

In this sense, in this PhD thesis, the novelty/originality element is represented by the use of volleyball, over a period of 6 months, accompanied by awareness/counselling sessions, in the treatment of overweight or obese children aged between 7 and 11 years. The intervention programme was monitored throughout implementation with validated instruments, with three groups of subjects with different research involvement. Final results were compared in such a way that the effects of the intervention programme were highlighted and isolated from other major factors that could influence the accuracy of the data.

Also, another novel element in this PhD thesis is represented by the actual results of a survey conducted on a representative sample of primary school students in Timisoara. Thus, the results obtained will contribute to the development of databases containing information on the prevalence of obesity, certain behavioural factors (physical activity and sedentary habits) or dietary factors (quantity of unhealthy products consumed or various inappropriate eating habits) that are associated with obesity. Last but not least, the data show how parents perceive their children's body weight.

The theoretical content of this thesis, based on the synthesis of a large number of publications, contributes to the updating of the theoretical basis, concentrating in one place current results on the prevalence of obesity and the level of physical activity and sedentary in Romania, on the tools by which obesity can be diagnosed and how certain factors can influence the appearance of obesity, as well as on the management of overweight and obesity.

Summary of Chapter 1: The concept of obesity

Historical evidence shows that the origins of obesity can be traced back to ancient times. One of the key pieces of evidence attesting to the antiquity of obesity is the Venus of Willendorf statue, dating from around 30-20,000 BC. (Haslam, 2007).

Over tens of thousands of years, the perception of obesity has been changing. Thus, in the past, when famine, plague or various epidemics threatened humankind, an individual's ability to store more fat was an advantage for survival at that time. (Eknoyan, 2006). In various cultures, obesity was valued not only from the perspective of survival but also because it represented the idea of wealth, being a means for the rich to stand out. Expensive clothes or shiny jewellery did not show off social status as well as excess body fat did. (Haslam, 2007).

As time goes by, being overweight becomes a cause for concern. Thus, the obese become discriminated, being labelled as people with a disgraceful shape. In addition, with the development of medicine, obesity begins to be associated with morbidity and mortality (Haslam, 2007).

Currently, according to the World Health Organization (WHO) (WHO, 2019c), obesity can be defined as an unnatural accumulation (an excess) of adipose tissue that can deteriorate health. The complications that obesity can cause to the body in adulthood have been known for more than 2000 years. Given the pathogenetic mechanisms, according to the study published by Tsigos et al. (2008) we can classify the complications of obesity into two categories: obesity-associated disorders resulting from physiological changes (Tsigos et al., 2008; Wharton et al., 2020) and conditions caused by the mechanical stress of high body fat (locomotor pathologies, effects on mental health and social life). (Chu et al., 2019; Tsigos et al., 2008).

In order to identify obesity, an assessment of weight status can be carried out to see if there is a growth disorder for children or if there are deviations from the ideal weight standardised for age, height and gender. Thus, following the interpretation of the weight status, it can be divided into the following weight categories: underweight, overweight, obese grade 1, obese grade 2, and obese grade 3 (Ashwell, Mayhew, Richardson, & Rickayzen, 2014; Dixon et al., 2011; Engin, 2017). In order to make this assignment, we need a well-established criterion to guide us. In this respect, weight status classification can be achieved by interpreting the Body Mass Index (BMI) value (Deurenberg et al., 1991)by measuring waist circumference (Aggarwal & Jain, 2018; Qiao & Nyamdorj, 2010) and waist-to-hip ratio (Qiao & Nyamdorj, 2010) or by analysing body composition (Dolapciu, 2017).

In recent decades, the prevalence of childhood obesity in Europe has been steadily increasing. According to the WHO, recent statistics show that one in three children is overweight or obese. Countries such as Greece, Italy, Spain and Malta top the list. (WHO, 2022b).

Despite the fact that obesity is a major health problem, at the national level the amount of research carried out to determine the prevalence of childhood obesity in Romania is limited. However, from the data provided by the WHO, we can observe the same trend of increasing prevalence of obesity similar to that at European level (WHO, 2022b). Thus, the first important data are published in 2012, provided by WHO following Romania's participation in the third phase of the COSI (Childhood Obesity Surveillance Initiative) project. The results show a prevalence of 25.5% of overweight among children aged 8 years in Romania (28% boys; 23% girls). (WHO, 2018). Romania's participation in this project had a positive impact on the development of the theoretical basis in our country on this topic. In this regard, Romania continued to be part of this international collaborative project by participating in phase IV and thus, in 2016, following measurements, it was shown that 28.5% of children aged 8 years were overweight or obese (31% boys, 26% girls). (WHO, 2021). The COSI project continues with the 5th phase, with Romania still included in the monitoring phases (during 2018/2019). Different from the 2 previous phases is that the age range assessed was 7-9 years, with a 26% prevalence of overweight identified among both girls and boys (WHO, 2022a). COSI Phase VI will provide a new overview for Romania, which is due for completion and publication in 2023. In parallel with the monitoring carried out in the COSI project, over the last 20 years various authors have studied the prevalence of obesity. Although the number of participants did not allow conclusions to be drawn at national level but only at local level, the prevalence trend was similar to the European data and to those obtained in the COSI project. Thus, summarising the articles found after consulting the literature, we can see that in the last 20 years there has been a trend of increasing prevalence of overweight and maintaining it around 30%. (Barbu et al., 2015; Chirita-Emandi et al., 2016; Csaba & Jozsef, 2020; De Onis & Blössner, 2000; Lotrean et al., 2021; Miron, Gabriela, Filimon, Gaidamut, & Craiu, 2021; Mocanu, 2013; Olaya et al., 2015; Pop et al., 2021; Radu, Luminita Ciotaru, & Macovei, 2007; Trandafir, Fraseniuc, & Lotrean, 2022; Valean, Tatar, Nanulescu, Leucuta, & Ichim, 2009). This growth trend can be clearly observed by comparing the study conducted by De Onis and Blössner (2000)conducted in 1991 on a sample of 10957 children in Romania (age range 0-4.99) of which only 2.3% were overweight. After 27 years, in the same age range, we find in the study of Miron et al. (2021) a prevalence of overweight of 20.7% (of which 13.5% obese).

Obesity can be classified according to several criteria. Of all, the most practical form of classification is aetiopathogenic. This classification divides this pathology into exogenous obesity also called simple (Balint, 2006) or common (Popa & Brega, 2009) and endogenous obesity (Balint, 2006) also called secondary (Popa & Brega, 2009). Another criterion for classifying obesity is the way body fat is distributed, with android type obesity with body fat significantly distributed in the upper body, predominantly in the abdominal and thoracic area, and gynoid type obesity, characterized by fat deposition around the hips and thighs. (Kopelman, Caterson, & Dietz, 2009). The severity of obesity is another criterion by which this pathology can be classified. Depending on the BMI, obesity can be classified into three grades: grade I obesity (BMI 30 and 34.9 kg/m²), grade II obesity (BMI 35 and 39.9 kg/m²), grade III obesity also called morbid obesity (BMI 40 kg/m² or more) (Kopelman et al., 2009).

Summary of Chapter 2: Causes of overweight

Identifying factors that may contribute to the onset and development of obesity is a growing concern among scientists. Several factors favour the onset of the condition. The main factors are social, psychological, behavioural, metabolic, genetic and cellular (Gafencu et al., 2013), which are often associated with each other due to the social environment and lifestyle. This contributes to the complexity of the aetiology of this condition (Dev, McBride, Fiese, Jones, & Cho, 2013; Isganaitis & Levitsky, 2008).

Numerous publications have been identified in the literature that have focused on these factors, with the following themes: genetic factors, physical activity level as a predictor of overweight, the importance of nutrition in preventing overweight, perception of weight as a factor favouring the onset of obesity, breastfeeding and the link with obesity and the relationship between obesity and sleep duration.

Summary of Chapter 3: Management of overweight and obesity - types of treatment

Overweight and obesity management plays a vital role in treating obesity. Early and well-organised intervention, using specific means, can prevent various complications arising from nutritional health disorders, both in childhood and adulthood.

Reviewing the literature, we identify four main directions of approach in treating obesity, each with different costs and degrees of complexity in implementation: developing a balanced diet, increasing physical activity levels, using pharmacological therapy and bariatric surgery (Uli et al., 2008).

In designing a treatment scheme, in the first two stages, the specialist's approach is oriented towards correcting the caloric intake and changing the lifestyle by increasing the level of physical activity, initially avoiding the use of drug or surgical treatment. The changes proposed through the application of treatment must be child-centred, personalised and adapted according to the child's possibilities and, for greater effectiveness, the child's entourage (family, friends, colleagues, teachers) must also be involved. In implementing treatment, account must also be taken of other health problems that the child may have. If efforts at this stage do not result in weight loss, pharmacological or bariatric surgical therapy is also used in the treatment. (Thenappan & Nadler, 2019; Wickham III & DeBoer, 2015). The order of use of these treatments is valid for obesity caused by natural factors, without hormonal or genetic disorders.

Summary of Chapter 4: Playing volleyball - a means of combating obesity

One of the best ways to increase the physical activity levels of children and adolescents is to involve them as actively as possible in physical education classes or after-school sports activities. This prevents or combats excess adipose tissue and also relieves mental fatigue accumulated during the day. (Johnston, Delva, & O'Malley, 2007). There are many different ways of practising sport, whether individual or team sports. Sports that require object handling, such as ball handling, require a well-developed motor skill set to achieve efficiency with minimal effort. As well as skill, thinking is also stimulated by finding the best tactical solutions, reacting and overcoming the opponent.

One such sport that involves the above is the game of volleyball (Tsunawake et al., 2003). It is considered as one of the most popular games worldwide (Gabbett et al., 2006), with all technical procedures being largely performed by hand by hitting or rebounding. The dynamics of the game are also given by the fact that there is a balance between high and low intensity moments of play. Intense moments of the game are represented by jumps materialised by attacking shots or blocks, sprints, changes of direction and dives to retrieve the ball. (Kutáč, Zahradnik, Krajcigr, & Bunc, 2020). All

these actions are performed at increased intensities amounting to 6 METs thus, the game of volleyball can be considered an intense physical activity that can consume up to 7 kcal/min. (Scribbans, Berg, Narazaki, Janssen, & Gurd, 2015). This makes volleyball players consume 50% more energy than a person with a normal daily activity, with daily energy consumption in the range of 2400-4200 kcal (Papadopoulou, 2015).

The effort parameters of volleyball can provide the necessary conditions for the sport to be a useful tool in developed programmes to combat obesity. However, how volleyball influences body composition improvement in overweight people is insufficiently studied by specialists (Trajković et al., 2021).

PART II -

Summary of Chapter 5: Preliminary study on combating overweight in 7-11 year olds through volleyball and awareness sessions

5.1 Introduction

Obesity has become a major global health problem, causing serious conditions such as diabetes, cardiovascular disease, several types of cancer and damage to the musculoskeletal system (Dixon, 2010). Given its negative effects on the body, obesity has now been included in the top five causes of death (Safaei, Sundararajan, Driss, Boulila, & Shapi'i, 2021) being defined, according to the WHO, as an excessive accumulation of adipose tissue that can affect the health of the body.

Although the diagnosis of obesity is not very difficult to make, a large number of studies indicate that the majority of parents in the samples surveyed do not perceive their children's weight correctly, in that the body image chosen from the questionnaire does not correspond to the actual BMI, with the majority of children weighing more than their parents chose. As a result of parents' misperception of their children's weight, and the lack of a culture in this area, many parents do not seek specialist treatment because they do not consider their child's weight to be a problem (Bayles, 2010; Crawford et al., 2004; De La O et al., 2009; Duncan et al., 2015; Figueroa et al., 2008; Glassman et al., 2011; Killion et al., 2006; Reifsnider et al., 2006; Strava, 2017).

Considering the complications of overweight and obesity and the alarming statistical data, the research aim of this preliminary study is to develop a comprehensive program that will attempt to combat overweight in children through volleyball and obesity awareness sessions. Thus, by implementing it, we can verify, based on the results obtained, whether the methods used are useful in order to achieve the objectives proposed in this paper, namely, to support/help develop the theoretical and practical basis in the prevention and treatment of obesity.

Hypothesis: In this research, we assume that through the means of volleyball and awareness sessions we can improve fitness and positively change body composition, exercise capacity, quality of social life and general health to combat and prevent obesity and its complications.

The objectives of the preliminary study were:

1) Conducting a survey on the nutritional status of a group of children in Timisoara enrolled in primary school.

2) Identification of the lifestyle by filling in questionnaires by parents to assess and analyse behavioural (food intake, eating habits, sedentary lifestyle, physical activity) and environmental (lifestyle promoted by society, entourage, family environment) factors that may be conducive to the development of obesity.

3) Assessment of parents' perception of children's physical development compared to known standards for age, height and gender.

4) Promoting a healthy lifestyle by presenting the basics of nutrition, the negative effects of sedentary lifestyles and the benefits of physical activity.

5) To increase the quality of life of overweight or obese children by designing, implementing and monitoring a training program consisting of volleyball initiation and consolidation. Thus, the aim will be to find the most effective and accepted ways for the subjects to prevent or combat obesity.

6) Through this preliminary research, it will be verified how the tools used can be used in the large study of this PhD thesis.

5.2 Material and methods

5.2.1. Place, subjects and stages of research

The present research was conducted in Timisoara, in two stages with different research tasks, with a group of 30 girls (mean age 9.5 ± 1.40 years) and their parents (mean age 41.16 ± 4 years) at the beginning of the study.

In the first phase, a survey was conducted on the nutritional status and lifestyle of the subjects enrolled in the study as well as an assessment of parents' perception of their children's weight. The inclusion criterion for children in the first phase of the study was that they were aged 7-11 years.

In the second stage, 15 girls were selected from the initial group and after assessments were diagnosed as overweight or obese and included in the intervention programme. The criteria for participation in the intervention programme were as follows:

- subjects to be aged 7-11 years, who at the time of study initiation are overweight or obese, selected from the initial group;
- are willing to complete a workout program 3 times a week and attend 3 obesity awareness sessions

- ❖ have no medical conditions that contraindicate physical exertion (based on a medical certificate drawn up by the family doctor).

5.2.2. Description of the evaluation protocol

The survey carried out in the first phase of the study consisted of the following assessment protocol: anthropometric measurements, body composition assessment, identification of eating habits, family activity and determination of physical activity level, assessment of parents' perception of their children's weight. In the second phase, the above-mentioned assessments were repeated both at the beginning and at the end of the study. In addition, fitness status was assessed using the EUROFIT (Eurofit, 1993).

Intervention programme

The intervention program consisted of subjects in this study participating in volleyball training and awareness sessions promoting a healthy lifestyle. The period of the intervention program spanned 4 calendar months. The trainings took place in a private volleyball club in Timisoara, and the girls in the study were part of a newly formed group at the initiation stage. Three volleyball training sessions were held each week during the 4 months. A training session lasted one hour and thirty minutes, respecting the three parts of a training lesson: preparatory, fundamental and concluding.

For the newly formed group in the intervention programme, in terms of technical training, the following objectives have been set:

- ❖ Learning and consolidation of the technical process passes from the top with two hands forward off the ground.
- ❖ Learning and consolidation of the two-handed lower grip technique.
- ❖ Learning the service from below.
- ❖ Performing technical-tactical complexes with emphasis on the 3-stroke rule using the learned procedures.

In order to achieve these objectives, the exercises proposed for training were designed based on the principle of accessibility, namely: to move from easy to hard, from simple to complex, from known to unknown (Dragnea et al., 2006).

Physical training was geared towards developing endurance speed using frontal motor games, such as "the trap", "frozen wolf", "crabs and shrimps", etc. It also aimed to develop general strength

by working with one's own body weight using four physical exercises: squats, trunk flexion on the thighs from supine with knees bent and soles on the ground, trunk extensions from face-lying with hands on the back of the head, from standing apart, trunk bending and transition to floating position-returning to the starting position

5.3 Results

The data obtained in the first stage of this study were processed and analysed using the statistical software Graph Pad Prism 6, interpreted and published in part in the article by Strava, Oravitan, and Monea (2019). Following the measurements applied to the sample of the first stage of this study, we can observe that the evaluated subjects belong to all the weight categories as follows: in the underweight category, represented with a percentage of 10% (3 cases), normal weight in a percentage of 40% (12 cases), overweight with an incidence of 30% (9 cases) and finally, the obese category with a percentage of 20% (6 cases). We therefore observe that for the group studied the prevalence of overweight is 30% and that of obesity 20%. In other words, in the group in this study, one out of two children is overweight or obese with an average percentage of fat tissue (of the two weight categories mentioned above) of 35.25%, with a minimum value of 28.1% and a maximum value of 44.9%.

The actual situation regarding the distribution of subjects in the four weight categories is statistically different ($\chi 2 = 8.084$; DF = 3, $p = 0.04$) from the body images that parents chose as similar to the physical shape of their children. Thus, the percentage of parents who chose from the CBIS scale (Truby & Paxton, 2002) body images corresponding to the overweight and obese category is only 26.67%, compared to the actual situation represented by 50% of all those measured. Therefore, 46.67% of parents whose children are overweight or obese and who completed the questionnaire on their children's weight perception underestimated their children's weight by choosing a body image from a lower weight category on the CBIS scale.

A similar situation is found when comparing the actual weight classification situation and the answers given by parents to the question "How do you rate your child according to body weight?" where the answers were in text form.

The significant difference between the two variables ($\chi 2 = 9.085$; 3; DF = 3, $p=0.02$) shows that again, almost half (40%) of the parents surveyed whose children are overweight or obese failed

to choose a correct answer that reflects the true weight status of their children, underestimating their body weight.

Errors of perception of the weight of their own children were also identified in the underweight category, for both versions of the questionnaires (CBIS and text), in which case, out of three children in this category none was correctly identified, their parents tending to consider them as belonging to a higher weight category.

In terms of the ideal body image chosen by parents for their children, 90% of parents chose an ideal body image that falls into the normal weight category. We can therefore see that although there are errors of perception, nine out of ten parents opt for an ideal CBIS figure that is part of the healthy weight category. This may suggest that parents in this study can identify a figure belonging to the normal weight category, but when they have to relate to their own children, they are no longer as objective, and so the perception errors come into play.

In the first phase of the study, in addition to investigating the nutritional status of the subjects included in the study, as well as parents' perceptions of their children's weight, an attempt was made to identify some of the factors related to dietary style that may influence the onset and development of obesity. We can therefore see from the results of the last questionnaire applied that there is no statistically significant difference between the normal, overweight and obese categories in terms of physical activity and sedentary lifestyle.

From the same questionnaire, several links were identified between the questionnaire results and body composition data. Of note is a first result showing that there is a weak, inverse correlation between children's age and body fat percentage. Thus, as age increases, there is a decrease in the percentage of body fat ($r = -0.28$; $p = 0.007$), and BMI ($r = -0.24$; $p = 0.01$). In addition to these, a reasonable, positive correlation was found between the age of the subjects and the percentage of skeletal muscle mass ($r = 0.36$; $p = 0.0004$). It is interesting to note that although the percentage of body fat decreases with increasing age, we observe another weak correlation showing that the level of participation in various leisure activities also decreases, including exercise, with increasing age ($r = -0.38$, $p = 0.0004$). Therefore, we can assume that this decrease in body fat with increasing age, but also with decreasing physical activity, is due to positive changes in eating habits. Thus, with increasing age, the child's habit of eating standing up decreases ($r = -0.3$; $p = 0.003$), as does the habit of eating in the bedroom ($r = -0.30$; $p = 0.004$).

We note that poor eating habits can be associated with a high percentage of fat tissue. This idea may be supported by other results obtained in this study. Children with a higher fat mass developed a habit of eating directly from the pot/bowl/pan ($r = 0.30$; $p = 0.003$) or while watching TV or reading ($r = 0.21$; $p = 0.04$). In addition to these aspects, the meal taken in the living room is associated, in a weak correlation, with increased fat mass ($r = 0.37$; $p = 0.0003$).

Continuing the study of factors that may influence the onset of obesity, we observe that the higher the fat mass, the higher the age of the parents ($r = 0.24$; $p = 0.02$). This phenomenon can be explained by a high positive correlation between the age of the parents and their tolerance for inappropriate food consumption (chips and/or sweets) ($r = 0.65$; $p = < 0.0001$).

In the second phase of the study, for the 15 girls who met the conditions for participation in the intervention programme, positive results were obtained both on the fitness tests and on the body composition part.

In the balance test, there were on average 2.1 fewer imbalances, the number of right-handed plate touches increased by an average of 2.85, and 2.92 for the left hand. In terms of the long jump from the seat, a longer jump was obtained by an average of 2.78 cm more than in the initial test. Also, the number of repetitions of the trunk thigh flexion increased by an average of 2.33 repetitions, with a better time on the "shuttle" run, finishing an average of 2.21 seconds faster.

In addition to improvements in EUROFIT tests, improvements in body composition were also observed. For the girls in the intervention programme, we identify a significant decrease in the percentage of adipose tissue by 4.48% between baseline and final testing, with a statistical significance of $p = 0.0005$. Although there is a significant decrease in the percentage of adipose tissue from baseline to final testing, the mean body mass index does not differ significantly between the two tests. This phenomenon can be explained by the fact that the percentage of skeletal muscle mass increased by 2.75% during the 4 months of intervention, with a statistically significant difference ($p= 0.0002$).

5.4 Conclusions

In the present research, the prevalence of overweight is 50%. In other words, one in two children assessed is overweight or obese. However, there is a significant difference between the body mass index classification of the children assessed and the parents' perception of their children's body

weight. Nearly half of the parents who completed the questionnaire underestimated their children's body weight, opting for a lower weight category, different from the actual one.

The increased prevalence of overweight in this study can also be attributed to these misperceptions that affect how parents report their children's body weight and thus do not take action or seek expert help.

The correlations between various body composition parameters and the responses from the FEAHQ questionnaire, as well as the results from the second part of the study show that the child's entourage (family, teachers, etc.) should encourage the child to develop good habits, a healthy lifestyle, including eating a proper diet and participating regularly in at least 3 sport sessions or an exercise programme per week.

For the subjects included in the second part of the study, an improvement in body composition was noted by decreasing the percentage of adipose tissue and increasing the percentage of skeletal muscle mass. There was also an improvement in fitness following participation in the three training sessions per week and the awareness/counselling sessions.

PART III-A

Summary of Chapter 6: Preventing and combating obesity among primary school children through volleyball and awareness sessions

6.1 Introduction

Obesity is a health disorder characterized by an amount of body fat above the normal range, often caused by poor diet and low physical activity levels (Foreyt, Goodrick, & Gotto, 1981). The prevalence of obesity worldwide has tripled in the last three decades and is now considered a global epidemic, starting at an early age (WHO, 2019). Such an alarming increase is also found in Romania, including among children. Comparing two studies conducted in Romania, 27 years apart, we observe that in the study of De Onis and Blössner (2000) conducted in 1991 on a sample of 10957 children in Romania (age range 0-4.99), the prevalence of overweight was 2.3%. In the second study, 27 years later, in the same age group, the prevalence of overweight was 20.7% (of which 13.5 obese) (Miron et al., 2021). Increased levels of obesity at an early age put enormous pressures on the health system, in that an obese child will often maintain this weight status into adulthood, thus developing more medical conditions (Kumar & Kelly, 2017). In order to avoid such complications, like any disease, obesity must be treated. The development of a treatment scheme depends on the causes that led to the development of this condition. Studying the causes of obesity is proving to be a real challenge for specialists in the field because of the complexity of this condition (Dev et al., 2013). A number of factors contribute to the onset and development of this disease, often interacting with each other. These factors are social, psychological, behavioural, metabolic, genetic or cellular in nature. (Gafencu et al., 2013). One of the common factors is a misperception of body weight. A consistent series of studies prove that parents have a wrong perception of their children's weight, underestimating their weight and thus, do not take action or do not ask for expert help (Bayles, 2010; Crawford et al., 2004; De La O et al., 2009; Duncan et al., 2015; Figueroa et al., 2008; Glassman et al., 2011; Killion et al., 2006; Reifsnider et al., 2006; Strava, 2017).

The premise of this research is that a large number of studies show that the majority of parents in the samples surveyed do not perceive their children's weight correctly, underestimating their body weight and thus not opting to treat this condition. As parents are role models for their children in terms of both behaviour and beliefs, children end up picking up these misperceptions. Based on this, we

hypothesize that through the means of volleyball and awareness sessions, the physical shape of overweight or obese children can be improved, body composition, effort capacity, quality of social life and general health can be positively modified.

The aim of this study is to contribute to the development of databases containing information on overweight and obesity by conducting a local survey to determine the prevalence of overweight and obesity among school children in the city of Timisoara enrolled in primary school, assessing the eating and activity habits in the family of the subjects mentioned above, identifying parents' perception of their children's weight and finally, implementing a volleyball training program, associated with awareness sessions to prevent and combat obesity.

In order to achieve the proposed purpose, the research objectives of this study were as follows:

1) Conduct a survey on the nutritional status of primary school students in Timisoara.

2) Identification of lifestyle by parents filling in questionnaires to assess and analyse behavioural factors (food intake, eating habits, sedentary lifestyle, physical activity) and environmental factors (lifestyle promoted by society, entourage, family environment) that may be conducive to the development of obesity.

3) Assess parents' perceptions of children's physical development against known standards for age, height and gender.

4) Promote a healthy lifestyle by presenting the basics of nutrition, the negative effects of sedentary lifestyles and the beneficial effects of physical activity.

5) To increase the quality of life of overweight or obese children by designing, implementing and monitoring a training program consisting of introductory, strengthening and improvement activities in volleyball.

6.2 Material and methods

6.2.1. Place, subjects and stages investigated

The present research was carried out in Timisoara from December 2021 to August 2022 and was organised in two phases. Each phase had both common and different tasks and objectives.

Stage I

The first stage of the study was conducted over a period of 3 months (December 2021-February 2022), with a representative sample (95% confidence interval; margin of error ±5) of 385 children enrolled in primary school (6-11 years; 184 girls with mean age 8.56±1.42 years; 201 boys with mean age 8.43±1.58 years) and their parents (334 mothers with mean age 38.88±4.57 years; 51 fathers with mean age 41.47±4.88 years).

The first stage research protocol consisted of anthropometric measurements, assessment of parents' perception of their children's weight, identification of dietary and activity habits in the family and determination of physical activity levels.

Stage II

The second stage of the study was conducted over a period of 6 months (March 2022-August 2022) and involved 30 overweight and 30 obese girls, divided into three groups.

Group 1 consisted of 20 subjects (9.2±1.19 years) (10 overweight girls, mean age 9.4±0.96 years; 10 obese girls, mean age 9±1.41 years), selected from the sample participating in the first stage. As selection mode, the first 10 overweight and obese girls were chosen, after being arranged in alphabetical order. Inclusion criteria for group 1 in this phase were as follows:

- Subjects should be aged 7-11 years, female and, based on body mass index interpretation, belong to the overweight or obese category.
- Have no metabolic, cardiac or respiratory conditions that interfere with the ability to perform physical activities.
- Not be part of other obesity prevention or control intervention programmes.
- Be available to conduct a volleyball training program 3 times a week.
- Be available to attend three awareness/counselling sessions on the topic of obesity and the factors that contribute to its onset and development.

Group 2 consisted of 20 subjects (mean age 8.8±1.19 years) (10 overweight girls with mean age 9.1±1.19; 10 obese girls with mean age 8.5±1.17), selected from the sample participating in the first stage. Inclusion criteria for group 2 were as follows:

- Subjects must be aged 7-11 years, female and, based on the interpretation of the body mass index, belong to the overweight or obese category.
- Have no metabolic, cardiac or respiratory conditions that interfere with the ability to perform physical activities.

- ❖ Not be part of other obesity prevention or control intervention programmes.
- ❖ Be available to conduct a volleyball training program 3 times a week.
- ❖ Not be part of nutritional counselling programmes.

Group 3 consisted of 20 subjects (mean age 9.05±1.46 years) (10 overweight girls with mean age 9.8±1.31; 10 obese girls with mean age 8.3±1.2), who were co-opted into the study based on a new invitation to the parent groups via teachers. Inclusion criteria for group 3 were as follows:

- ❖ Subjects must be aged 7-11 years, female and, based on the interpretation of the body mass index, belong to the overweight or obese category.
- ❖ Have no metabolic, cardiac or respiratory conditions that interfere with the ability to perform physical activities.
- ❖ Not be part of other obesity prevention or control intervention programmes
- ❖ Show no interest in participating in a volleyball training program or similar activities both at the time of the start of this study and in the near future.

The evaluation protocol for the three groups mentioned above consisted of both common and different research tasks. The common ones were carried out at the beginning and end of the study and are listed below:

- anthropometric measurements and body composition analysis;

- questionnaire-based survey to identify dietary habits, family activity habits and physical activity levels;

- fitness assessment.

Intervention programme

The intervention programme that groups 1 and 2 took part in consisted of their participation in volleyball training. In addition to group 2, group 1 also participated in 3 counselling sessions promoting a healthy lifestyle. The programme lasted for 6 months, with training taking place in a private volleyball club in Timisoara. The girls in groups 1 and 2 had never participated in volleyball training before, thus forming two new groups at the initiation stage, with the training planning being taught identically for both groups. Each training session lasted one hour and thirty minutes and was structured in the three parts of a training lesson: preparatory, fundamental and concluding.

The objectives of the six-month intervention programme were: to improve body composition, improve fitness through the development of overall strength and speed, and to learn, consolidate and

perfect basic mini volleyball skills. Specifically, in terms of technical training, the following objectives were set:

- learning, consolidating and perfecting the technical process of the two-handed forward pass from the ground;
- learning and consolidating the technical process of two-handed lower grip;
- learning and consolidating the service downstairs;
- learning and consolidating the attack shot;
- to perform technical-tactical complexes with an emphasis on the three-stroke rule using the procedures learned;

In order to achieve these objectives, the exercises proposed for training were designed based on the principle of accessibility, namely: to go from easy to hard, from simple to complex, from known to unknown (Dragnea et al., 2006).

Physical training was geared towards developing endurance speed using frontal motor games, such as "the trap", "frozen wolf", "crabs and shrimps", etc. It also aimed to develop general strength by working with one's own body weight using four physical exercises: squats, trunk flexion on the thighs from supine with knees bent and soles on the ground, trunk extensions from face lying with hands on the back of the head, from standing apart, trunk bending and transition to floating position-returning to the starting position.

In parallel to the volleyball training, subjects in group 1 and their parents attended 3 counselling sessions organised at the beginning, middle and end of the intervention programme. The main topic of discussion during these sessions was the importance of adopting a healthy lifestyle through a balanced diet and a physically active lifestyle.

6.3 Results

The data recorded from the tests applied in phase I and II were centralized in tables and statistically interpreted using Graph Pad Prism 6 software. From stage I, partial results were published in the article Strava, Oravitan, Avram, and Monea (2023). Table 24 shows the prevalence of obesity of the sample studied in stage I. This was determined by classifying the BMIs obtained from the measurements into weight categories.

Table 1. Classification of first stage subjects into weight categories based on BMI

Weight category	Children			Parents		
	Girls	*Boys*	*Total*	*Mothers*	*Fathers*	*Total*
Underweight	22 (11.95%)	19 (9.45%)	41 (10.64%)	19 (5.68%)	0 (0%)	19 (4.93%)
Normal weight	120 (65.21%)	104 (51.74%)	224 (58.18%)	202 (60.47%)	15 (29.41%)	217 (56.36%)
Overweight	20 (10.86%)	38 (18.9%)	58 (15.06%)	77 (23.05%)	23 (45.09%)	100 (25.97%)
Obese	22 (11.95%)	40 (19.9%)	62 (16.1%)	36 (10.77%)	13 (25.49%)	49 (12.72%)

From the table above we can see that more than 31% of the children studied are overweight, with 15.06% overweight and 16.1% obese.

Following the application of the CBIS scale, it was identified that there was a significant difference (x^2 =81.16; d=3; p<0.0001) between the actual BMI classification status of each child and the body images chosen by the parents from the CBIS scale. Thus, out of 120 cases of overweight or obese, only 25 cases were correctly perceived. In this situation, we can state that only 20.83% of parents whose children are overweight chose a body image appropriate for the child's actual weight status. The other 79.17% of parents underestimated their weight and chose a slimmer figure. Perception errors are also observed in the underweight category where 7.79% more cases of underweight are perceived than actually exist. Thus, we identify the same underestimation of real body weight.

Significant differences in perception (x^2 =63.49; d=3; p< 0.0001) were also found when comparing actual BMI with text responses chosen by parents. When asked „how do you rate your child in terms of weight?", out of 120 overweight and obese children, only 64 (53.33%) parents correctly chose the weight category they considered their child to belong to.

Lack of objectivity on the part of parents or simply ignoring their children's body weight can be one of the factors that can lead to obesity and its development. In this study, this can be seen statistically through the relationship between child BMI and parental perception. We therefore observe a reasonable, positive correlation (r = 0.55, p < 0.0001) between the child's BMI and the deviation of perception from the true value. This result shows us that when parents' perception deviates from reality and the child's BMI is higher.

The second major objective of the first phase of this study was to examine certain dietary and family activity habits that may be associated with obesity. From the results obtained, we can see that the overweight have an average number of hours spent per week in front of the TV or computer 3.27

hours less than those in the obese category (p=0.008). Also, the average number of hours spent in different physical activities is 1.47 hours more of those in the overweight category compared to those in the obese category (p=0.04). In terms of the amount and varieties of snacks, sweets, cakes, ice cream or candy on a stick found in the home of each subject analysed as well as how accessible these products are for children, it was observed that there are more types of cakes in the homes of those in the obese category than those in the overweight category (p=0.01). Also, those in the obese category had 0.32 more ice cream or candy bars per stick on average than those in the normal weight category (p=0.04). Also listed as a statistically significant difference was the frequency with which children buy such products themselves, with those in the obese category having, on average, 0.51 more frequency in buying unhealthy snacks themselves compared to those in the normal weight category (p=0.0005). This trend was also identified by a weak, positive correlation between children's BMI and the frequency with which they buy sweets for themselves (r=0.2; p<0.0001). Thus, as the frequency with which children buy sweets for themselves increases, so does their BMI. Within these differences we observe that subjects in the obese category have 0.26, on average, higher frequency of eating standing up (p=0.01), 0.33, on average, of eating while reading, working or watching TV (p=0.02) and 0.37, on average, of eating out of boredom than those in the normal weight category (p=0.001).

Further, from the present results, it can be seen that those in the obese category have an average 0.41 higher frequency of eating on a nervous background (p=0.0001) than those in the overweight category, materializing in erratic eating in the afternoon (average score 0.44 higher than the overweight category, p=0.0008) or late in the evening or at night (average score 0.33 higher, p=0.01).

In many families, mealtimes are not limited to the kitchen as the place for this activity, but extend to several locations in the household. Such trends are also observed in the results obtained from the FEAHQ questionnaire. Subjects in the obese category are more likely to dine in the bedroom (mean score 0.34 higher than the normal weight category, p=0.01) or in the office (mean score 0.33 higher than the normal weight category, p=0.009).

Pace of eating/snacking is another habit that is more inappropriate in those in the obese category, with them having a 0.29 higher pace of eating/snacking on average than those in the normal weight category (p=0.0008). This causes the habit to increase by 0.34, on average, to ask for a second portion of food (p=0.002) compared to the normal weight category.

After the Phase II study, statistically significant decreases in mean BMI percentiles were observed at 6 months. The mean value of group 1 decreased by 6.99% (p<0.0001), group 2 by 4.1%

($p<0.0001$) and group 3 by 0.9% ($p=0.0001$). These decreases can be attributed to improvements in body composition, with statistically significantly improved results in groups 1 and 2. In group 3, the group that continued its routine as before the initial measurements, without taking part in any organised sporting activity, no improvement in body composition was identified, on the contrary, an increase in the percentage of adipose tissue by 0.78% ($p = 0.0007$) and a decrease in the percentage of muscle mass by 0.27% ($p = 0.02$) was observed. Thus, the decrease in the mean BMI percentile value of group 3 can be attributed to the fact that the height of those in the group increased, on average, by 2.5 cm. Comparing the final BMI percentile values of each group, there is a significant difference between group 1 and 3 ($p=0.01$) and between group 2 and 3 ($p=0.04$). There is no statistically significant difference in BMI percentile values between group 1 and 2 at the end of the study.

After participating in the intervention activities, group 1 showed a decrease in fat percentage by 4.8% ($p < 0.0001$) and an increase in muscle mass percentage by 3% ($p < 0.0001$). In group 2, fat percentage decreased by 2.07% ($p < 0.0001$) and muscle mass percentage increased by 1.87% ($p < 0.0001$) compared to baseline. Comparing the body composition results of group 1 and 2, obtained at the end of the study, we observe that there are no significant differences between the final values of fat and muscle mass percentages ($p=0.9$).

From the results presented above, we can see that the intervention programme positively influenced groups 1 and 2. However, for group 3 there were no positive changes, except for the decrease in BMI percentile following the increase in average height. The lack of changes in group 3 can be explained by the fact that no intervention was applied to group 3, as they continued their daily routine before stage II.

Analysing the final results reached by groups 1 and 2, and the comparisons made between them, we see that there are no statistically significant differences between them. However, the intervention programme was more effective for group 1 which achieved a 2.88% greater decrease in mean BMI percentile than the decrease recorded by group 2 ($p=0.004$). Also, group 1's mean percent body fat decreased by 2.73% more than group 2 ($p<0.0001$). We also identify a higher percentage achieved in muscle mass gain, group 1's mean percent muscle mass increased by 1.13% more than group 2 ($p<0.0001$).

In parallel with the improvements in anthropometric and body composition parameters, there was an improvement in fitness, as evidenced by better results in the battery of tests applied.

To be able to highlight the impact of the intervention programme, the physical activity level of each group was analysed at the beginning and at the end of the study. At the end of the study, both group 1 and group 2 improved their time spent in physical activity but the average increase for both groups did not differ between groups, this increase largely representing time spent in volleyball training for both groups in addition to the baseline test. Therefore, it can be said that these increases did not unequally influence the effectiveness of the intervention programme on the groups. On the other hand, one change produced that may have influenced the effectiveness of the intervention program for each group, and which was more evident in group 1, was the reduction in the variety and amount of sugary snacks or snacks found in the homes of those studied ($p< 0.0001$). Group 1 also statistically significantly improved ($p< 0.0001$) some of their eating habits associated with obesity. We attribute these changes to the fact that group 1 attended counselling/awareness sessions where these unhealthy habits were discussed.

6.4 Conclusions

The data obtained in the first stage of the research of this study shows that after the nutritional survey among primary school students in Timisoara, more than 31% of the children studied are overweight, with 15.06% overweight and 16.1% obese. If we analyse the data by gender, boys have a higher prevalence of obesity and overweight (38.8%) than girls (22.81%). In other words, in Timisoara, one in three children enrolled in primary school is overweight or obese. As regards the prevalence of overweight among parents, the data show that 25.97% are overweight and 12.72% obese.

A high percentage of overweight pupils is accompanied by a high percentage of parents who do not correctly perceive their children's body weight ($x^2 =81.16$; $d=3$; $p< 0.0001$). Out of 120 cases of overweight or obese, only 25 cases were correctly perceived. Therefore, it can be stated that only 20.83% of parents whose children are overweight chose a body image appropriate to the child's actual weight status. The other 79.17% of parents underestimated their weight by choosing a slimmer figure from the CBIS scale.

Perception errors were also found when comparing the actual BMI with the text responses chosen by parents ($x^2 =63.49$; $d=3$; $p< 0.0001$). When asked „How do you rate your child, based on their weight?”, out of 120 overweight and obese children, only 64 (53.33%) of parents correctly chose the weight category to which they considered their child belonged.

Following the application of the FEAHQ questionnaire to the children surveyed in the first phase of the study, it was observed that those in the overweight category have an average number of hours spent per week in front of the TV or computer that is 3.27 hours less than those in the obese category ($p=0.008$). Also, the average number of hours spent in various physical activities is 1.47 hours more for those in the overweight category compared to those in the obese category ($p=0.04$). From the results obtained from the same questionnaire administered, we observe that those in the overweight category have a smaller amount and variety of snacks, sweets, cakes, ice cream or candy on a stick in the house than those in the obese category. In addition, those in the overweight category have more restricted access to these throughout the week.

In subjects in the obese category there was a higher frequency compared to those in the normal weight category of eating in the bedroom ($p=0.01$) or in the office ($p=0.009$), eating standing up ($p=0.01$), reading, working, watching TV ($p=0.02$) or out of boredom ($p=0.001$). The habit of eating in a nervous state or as a result of a negative mood is more common in the obese category ($p=0.0001$), as is the habit of eating food erratically in the afternoon ($p=0.0008$) or late at night ($p=0.01$). Last but not least, the obese have a higher rate of chewing/eating compared to those in the normal weight category ($p=0.0008$), thus increasing their habit of asking for a second portion of food more often ($p=0.002$).

After the Phase II study, at 6 months, there were statistically significant decreases in the mean BMI percentiles of all groups in the study. The mean value of group 1 decreased by 6.99% ($p<0.0001$), group 2 by 4.1% ($p<0.0001$) and group 3 by 0.9% ($p=0.0001$). These decreases resulted for group 1 in a shift of 7 subjects from obese to overweight and 10 subjects from overweight to normal weight. For group 2, 8 subjects moved from obese to overweight and 7 from overweight to normal weight. For group 3, the only change is the shift of 3 subjects from obese to overweight.

The changes mentioned above are due to improvements in body composition, the exception being group 3, which did not show any positive changes. The effects of the intervention programme on group 1 resulted in a decrease in the percentage of fat tissue by 4.8% ($p < 0.0001$) and an increase in the percentage of muscle mass by 3% ($p < 0.0001$). In group 2, the percentage of fat decreased by 2.07% ($p < 0.0001$) and the percentage of muscle mass increased by 1.87% ($p < 0.0001$).

Improved results were also recorded in the fitness tests, with all groups recording higher values ($p < 0.0001$), except group 3 which stagnated in the balance test. Of the 3 groups, group 1 showed the greatest progress.

To validate the impact of the intervention programme, other major factors contributing to changes in body composition or fitness were checked for. Thus, at the beginning and end of phase II, physical activity levels and a series of dietary habits were assessed by questionnaire. The results show that between the two tests, group 1 increased their average physical activity time by an additional 4.65 hours per week ($p< 0.0001$), while group 2 increased their average physical activity time by 4.47 hours ($p< 0.0001$). This increase is largely due to their participation in the three volleyball training sessions per week, thus increasing their average physical activity time by at least 4.5 hours. There is no statistically significant difference ($p=0.5$) between the final results of time spent in physical activities on average per week by children in groups 1 and 2. Thus, at the end of the study, both groups had a nearly similar level of physical activity suggesting that there is no possibility that one group was more active than the other and thus, this may influence or reduce the effectiveness of the intervention programme. As for group 3, for them there was a decrease in time spent in various physical activities by 0.35 hours ($p=0.01$).

While the level of physical activity was similar between groups 1 and 2 throughout the study, the results were statistically different between the two groups ($p < 0.0001$) in terms of the quantity and types of sugary snacks found in the homes of those studied and the accessibility of these products to children. Thus, those in group 1 at the final test reported a much lower number of such products than those in group 2 or 3. Also, at the end of the study, group 1 improved a number of their eating habits and was the only one ($p=0.001$).

As a final conclusion regarding the intervention programme, it was more effective for group 1, which in addition to volleyball training also took part in 3 awareness/counselling sessions. According to these results, we believe that volleyball can be used in future programs to prevent or combat obesity and to improve general fitness. The inclusion of awareness sessions in this type of activities is an advantage in achieving increased benefits in preventing and combating obesity.

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