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Effects and Implementation Pathway of a High-Protein Diet Combined with Exercise Intervention in Adolescent Obesity

Jiayu Qiu*, Yiyun Zhang

College of Physical Education, Shanghai Normal University, Shanghai, China
**Corresponding Author. Email: 1000552303@smail.shnu.edu.cn*

Abstract. With the continuous improvement in people's living standards, the incidence of adolescent obesity has shown an increasing trend. Adolescent obesity not only affects growth, development, and mental health but also increases the risk of future chronic diseases. Existing intervention methods primarily include exercise, dietary modification, and pharmacotherapy, each of which has inherent limitations. Research indicates that a combined exercise and nutritional strategy can effectively improve body composition and overcome the negative effects of single-modality interventions. Therefore, this paper aims to explore the mechanisms and implementation pathways of a high-protein diet combined with exercise intervention in adolescent obesity, to enhance adolescents' exercise capacity and mental health, and to provide a reference for theoretical development and clinical practice in related fields.

Keywords: adolescent obesity, high-protein diet, exercise intervention

1. Introduction

1.1. Current status of adolescent obesity

Teen obesity has turned into a big global public health challenge. Based on the MSD Manuals 2024 Global Report on the number of children and adolescents who are overweight or obese, about onefifth of young people around the world are overweight or obese. Numbers from 2022 also tell us that in China, more and more kids and teens are becoming obese [1]. Obesity harms mental health, movement skills, and how they fit in with others; it also raises the chance of getting metabolic diseases like type 2 diabetes, high blood pressure, and fatty liver disease not caused by alcohol when they become adults. Compared with grownups, teenagers are in a key growing stage, and they need energy and nutrients in a special way [2]. So, any plan to treat obesity in this group has to bring body fat down while still making sure they grow normally, develop sexually, and have healthy brain development.

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1.2. Limitations of existing intervention models

1.2.1. Dietary intervention alone

If only diet is used, a simple lowcalorie balanced diet can give shortterm weight loss, but it is often followed by a big loss of lean body mass. Lean body mass is what mainly decides how many calories the body burns at rest; when it goes down, the body burns less energy while resting, and that makes weight regain more likely. This forms a bad circle of "weight loss → metabolic decline → weight regain." Besides, if teenagers take in very few calories, they might not get enough nutrients, which can hurt their growth and development; and a diet that people don't enjoy is hard to stick with for a long time, raising the risk of gaining the weight back.

1.2.2. Exercise intervention alone

When people exercise but don't adjust what they eat, the energy shortage created is easily covered by eating more, [3] so fat loss becomes very small; what's more, if the exercise plan is mostly aerobic activities without any resistance training, it's hard to push the body to make new muscle protein under a negative energy balance. The muscle mass that gets lost, along with a slower metabolic rate, is also bad for keeping weight off over a long time.

1.2.3. Value of combined intervention

Because of these problems, a highprotein diet put together with exercise, especially when resistance training is included, works well for teen obesity. Taking in enough protein supplies the building blocks for muscle repair and growth after exercise, and it makes a person feel full, so they are more likely to stick to the diet; regular exercise, mainly resistance training, directly tells muscles to grow and raises the amount of energy the body uses [4]. This combination changes the goal from just "weight loss" to "making body composition better," which means cutting down fat while keeping or even adding lean mass; this brings better metabolic health. This study is set to review in a systematic way the ways and real effects of a highprotein diet with exercise on adolescent obesity, and to build a scientific pathway to put it into action, giving a reference for both theory and clinical practice in related areas.

2. Definition of core concepts

2.1. Adolescent obesity

Teen obesity means a longlasting metabolic state in individuals aged 10–19, where too much body fat builds up and harms either current or expected health. Doctors mainly diagnose it by using the Chinese standard "Screening for Overweight and Obesity in SchoolAge Children and Adolescents," which looks at BMI percentiles based on age and sex; obesity is usually defined as having a BMI at or above the 95th percentile for that age and sex [5]. Waist size and the waisttoheight ratio are also suggested to help check for belly fat and the metabolic risks tied to it.

2.2. Highprotein diet

A highprotein diet is a way of eating where the share of energy coming from protein is raised to 20%–30% (while a normal balanced diet gives about 10%–15%), or protein intake reaches 1.5–2.0

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grams for each kilogram of body weight every day, usually figured from ideal body weight or fatfree mass; [6] total energy intake is kept right and the diet stays balanced overall [7]. The central idea is to pick highquality protein sources that are low in fat, like lean meat, poultry, fish, eggs, lowfat or skim dairy products, and soy foods; these should be part of a whole healthy eating pattern, not just a simple rise in protein.

2.3. Exercise intervention

In this paper, exercise intervention is taken to mean a planned, organized physical activity program based on exercise science, aimed at making body composition and metabolic health better in obese teenagers. It is mainly split into two kinds: aerobic exercise and resistance training. A complete and useful exercise program usually puts both types together and clearly states how often, how hard, how long, and what kind; for teen obesity, the program has to carefully think about the physical features of their growing stage, and also things like their own interest and how engaged they are [8].

3. Mechanisms of intervention

3.1. Effects on body composition

The combined plan helps fat loss while muscle is kept or even increased. When someone only cuts calories, lean body mass is often lost too, which makes the basal metabolic rate go down and raises the risk of putting weight back on. In the combined method, regular exercise puts mechanical loading on the body, and this directly turns on the pathways that build muscle protein, giving a physical base for muscles to stay or grow; at the same time, enough highquality protein intake gives the amino acid building blocks needed, which strongly fights against muscle breakdown under a negative energy balance. This sets up an efficient cycle of "stimulation + supply," letting the body use fat for energy while holding on to as much calorieburning muscle tissue as possible; the result is a lower body fat percentage and more fatfree mass, and the bad circle of "weight loss → metabolic decline → weight regain" is broken.

3.2. Improvement of metabolic profile

Once body composition gets better, the combined approach fixes obesityrelated metabolic problems through several paths. Keeping or growing muscle mass makes the body much more sensitive to insulin and helps control blood sugar well; bringing down body fat, especially the fat around organs, directly lowers the levels of inflammatory substances that fat tissue releases in a wrong way, makes the blood fat picture better, and brings down triglycerides and lowdensity lipoprotein cholesterol. A highprotein diet can also adjust the hormones that control appetite; it raises the hormones that bring fullness and lowers the hunger hormone levels. This appetiteregulating effect, together with the extra energy burned from exercise, helps form a stable energy balance that can be kept up.

3.3. Effects on exercise performance and physiological metabolism

The combined intervention builds a positive cycle that makes exercise ability and physiological metabolism stronger. Enough protein supports muscle energy metabolism during exercise and repairs muscle fibers in time afterwards; this helps delay tiredness, raises muscle strength and endurance, and makes recovery after training faster. Losing weight and having better muscle function lighten the load on the heart and blood vessels during daily activities and exercise, take

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stress off the joints, and make physical activity feel easier. Aerobic exercise directly makes the heart and lungs fitter. All these bodylevel improvements act as positive feedback, which further pushes teenagers to keep following the intervention program [9].

3.4. Psychological and behavioral effects

The benefits clearly reach the mental and behavioral side as well. When real changes in body shape, physical fitness, and health numbers are reached through their own effort, it can greatly raise obese teenagers' belief in themselves, how they see their body, and their confidence; this helps lighten negative feelings like anxiety and low selfworth caused by obesity. When a scientific diet and regular exercise together give positive personal experiences, such as feeling more energetic and lighter, this healthy behavior pattern is more likely to be turned from an outside rule into a personal habit. Better overall body and mind health, plus the feeling of being in control of weight management, builds up the inner drive for longterm healthy actions, which is a key point for making obesity intervention effects last.

4. Existing controversies regarding combined intervention

Even though a highprotein diet with exercise shows promise for teen obesity, its longterm safety and possible risks—especially the effect of a highprotein diet on teenagers in a special growing stage—are still points of debate among researchers. These arguments mainly focus on the metabolic load on organs, whether the diet structure stays balanced, and the possibility of messing with growth and development.

4.1. Organ burden

A main worry is that a highprotein diet puts more metabolic work on the liver and kidneys in teenagers. When protein is broken down, wastes such as urea and uric acid are made, and these are mostly taken out by the kidneys. For teenagers whose kidney function is not yet fully grown, or who have hidden risks, eating far more protein than recommended for a long time could, in theory, raise the filtering load of the kidneys. While shortterm studies mostly say that a moderate highprotein intake does not hurt kidney function in healthy individuals, there isn't enough proof about what too much protein does over many years, especially in obese teenagers who may already have some hidden metabolic problems. What's more, handling a lot of protein might also add to the conversion work the liver has to do. So, when putting such an intervention into practice, it is very important to check the kidney function of each person at the start, keep watching it regularly, and make sure they drink enough water [10].

4.2. Nutritional imbalance

Paying too much attention to high protein can accidentally cause the overall diet to be out of balance and other nutrients to be lacking. If teenagers and their families put too much focus on "high protein," vegetables, fruits, and whole grains rich in dietary fiber, vitamins, and minerals might be pushed aside, leading to not enough intake of these musthave nutrients; for example, not eating enough fiber can hurt gut health and the feeling of fullness, and getting too little calcium, potassium, or magnesium can be bad for bone health and blood pressure control. Even more concerning, if protein comes from poor sources—like a lot of red meat and processed meats—that could also mean taking in too much saturated fat and cholesterol, which is not good for heart and metabolic health.

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So, "high protein" has to be understood inside a balanced diet frame; the key is to make protein quality and amount better, not to overstress one single nutrient.

4.3. Interference with growth, development, and endocrine function

Since teenagers are in a key period of fast growth and development, a highprotein diet carries a theoretical risk of messing with normal hormone axes and developmental steps. It has been suggested that eating a lowcarb, highprotein diet for a long time could affect the brainhormone axis that controls puberty, perhaps delaying or changing its normal start and progress [11]. Even though studies on normal balanced highprotein diets haven't proven this, extreme cases push us to be careful with highprotein interventions. Also, taking in too much protein may come with a lot of phosphate; if calcium intake is not enough, the calciumphosphorus balance could be upset, which in theory might pose a longterm risk to building peak bone mass. Making sure enough calcium and vitamin D are taken in during the intervention, and staying away from extreme lowcarb diets, are key to lowering these risks.

5. Implementation pathway

5.1. Individualized assessment

Body check: This takes in measuring height, weight, BMI, waist size, body composition, and doing needed blood tests to rule out secondary obesity, see metabolic risks, and set safety baselines.

Diet check: Diet recalls or food records are used to find out how much energy is taken in each day, the amounts of major nutrients (especially current protein intake and where it comes from), and fiber intake, so as to spot bad eating patterns.

Exercise ability check: Physical fitness tests or questionnaires are used to see current activity levels, what exercises they like, their skills, and how much time they spend sitting.

Mental check: This looks at their reasons for losing weight, belief in themselves, any emotional eating that may be there, and the family support setting.

5.2. Multidimensional support system

A support system that takes in family, school, and society is built. The family is a key part; parents should be given education to understand the ideas behind the intervention, help make the family meals better, and give the emotional encouragement teenagers need. The school is an important place; resistance training can be put into PE classes, nutrition and health education should stress knowledge about protein and exercise, and professional dietitians can give trusted information, answer questions, and adjust plans as needed. Digital tools like apps for food recording and exercise checkins can also be wisely used for reminders and process tracking; peer support groups can be formed to make the intervention more fun, interactive, and easier to keep going.

5.3. Longterm monitoring and dynamic feedback

Teen obesity intervention is a process that keeps changing; a longterm checking and feedback system must be set up so that plans can be made better and effects locked in. What is checked should center on core signs: body composition, size changes, and blood indicators are regularly reassessed, and diet and exercise logs are looked at to see how well they are following the plan [12]. The feedback part stresses twoway talking; on one side, professionals go through the checking data with

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the teenagers and their families, turning good changes into positive push to make their confidence stronger; on the other side, they must listen to the real problems met during the process. Based on what the checking gives, the starting plan can be changed little by little, like finetuning the protein level, changing the kind or intensity of exercise, or setting new small goals for behavior. This closedloop way of "assess → carry out → monitor → adjust" makes sure that intervention steps stay in line with teenagers' growth changes and reallife situations, reaching the final goal of moving health management from outside control to a habit they keep up inside themselves, and bringing longterm health gains.

6. Conclusion

This study put its focus on the ways and scientific implementation paths of a highprotein diet with exercise for teen obesity. The findings tell us that this combined strategy works well to make body composition better—cutting fat while keeping or adding lean mass—and fixes metabolic problems like insulin resistance and bad blood fat levels, while also making exercise ability and mental health better. Still, the intervention has to pay attention to the possible risks that taking in high protein for a long time could bring to kidney function and nutrient balance in teenagers. In the future, research should keep pushing for longterm followups and personal checks, build a workingtogether system that joins family, school, and community, and make sure the combined plan is safe, works, and can be kept going, so as to help solve the problem of adolescent obesity.

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