USING RED LIGHT THERAPY FOR FAT LOSS – AN EVIDENCE-BASED GUIDE

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INTRODUCTION

Red light therapy is a non-invasive procedure that uses red light and near-infrared light for pain relief, wound healing, and the reduction of inflammation (3,7,9). The purpose of this article is to provide personal trainers, nutritionists, and clients on how to create a program which uses red light therapy to aid in weight loss and weight management while also providing information on the mechanisms of red light therapy.

HISTORY AND OVERVIEW OF RED LIGHT THERAPY

Red light therapy, which is also called photobiomodulation (PBM), was first used as a treatment option by Endre Mester in 1967, who used it first on mice and then on human patients; subsequent studies done by other individuals also used red light therapy to study its effects on both animals and humans (15). Red light therapy uses different wavelengths of the electromagnetic spectrum that fall in red and near-infrared wavelengths, which range from 600 – 1,070 nm; the wavelengths that range from 600 – 700 nm are used to treat superficial tissue, while the wavelengths that range from 780 – 950 nm are used to penetrate the tissue further to reach deeper tissues (9,37). Red light therapy has also been used as a method for weight loss (2,6,9,10,31,32,34). Although there have been studies on the effect of red light therapy on weight loss, there have not been many programs created that use both red light therapy and nutritional therapy to help weight loss and management, hence the purpose of this article.

CELLULAR MECHANISM OF RED LIGHT THERAPY

Throughout the body, mitochondria are found within cells powering their function. For example, in skeletal muscle, mitochondria produces energy for contractions and in the gastrointestinal tract, mitochondria is needed to convert chemical energy for the surrounding cells. More functions of mitochondria include oxidative phosphorylation (energy harnessed by complex proteins to create adenosine triphosphate [ATP]), homeostasis, metabolic pathways (cellular chemical reactions), appointed cell deaths (apoptosis), and help with cellular metabolism consumption (5). These functions, with the course of time, are related to aging and the development of diseases (5). Biological aging is characterized by buildup of intercellular debris which creates a cycle of chronic inflammation and progressive cell deterioration, and a large part of that decline can be due to a lack of ATP production (4,26,28,29). Highly desirable options that mitigate age-related destruction in mitochondria and the organelles that the energy produced by the mitochondria powers involve quality control and repair (4,28). Red light therapy can be useful in monitoring and restoring the checkpoint markers that mitochondria have in their DNA that signal cellular degradation (17,28).

In mitochondrial DNA, there are progressive mutations occurring that reduce ATP production significantly as humans age (17). Studies conducted on old mice show that infrared light exposure increases ATP production and reduces inflammation (11). An experiment was conducted on fruit flies following the promising evidence of mitochondrial effects in mice. Even with a low wavelength of exposure (670 nm), the fruit flies had reduced inflammation, increased ATP levels, and an increase in their life span by 75% (3). In humans, there has been signs of reduced inflammation and increased ATP levels with red light therapy (15).

In a seemingly never-ending cycle, weight gain drives inflammation, and inflammation makes it harder to lose weight (1). Development of deterioration in the mitochondria leads to metabolic changes and obesity, (21). With restoration of mitochondrial functions by red light therapy, there can be a significant decrease in onset obesity (1,5). A gene named the mechanistic target of rapamycin kinase (mTOR) functionally regulates protein synthesis in cells, that when activated, has been linked to shortening the human lifespan and producing chronic health issues. When ATP production is decreased significantly by an impaired mitochondrion, this leads to the activation of mTOR. Consequently, this gives aid to glucose intolerance, inflammation of the cells, and disrupts fatty acid metabolism in the mitochondria (21). This organelle is a key component of fat loss, as fatty acids are transported to the mitochondria to undergo oxidation (4). If there was an increase of ATP production, the gene expression of mutation would have a significant likelihood of not deteriorating mitochondrial functions if coupled with red light therapy sessions; however, more studies are needed to observe a consistent effect on human subjects.

TARGETING OF ADIPOSE CELLS

As previously mentioned, red light and infrared light therapy can penetrate to the cellular level. Everybody has adipocytes, cells that store fat. Whether a person has a high or low body fat percentage does not matter because everyone has some amount of stored fat. Red light therapy may help to lose body fat over time by the light being able to penetrate through the adipocytes, making them release triglycerides (1,14). Triglycerides store fat like adipocytes; however, they also release energy when used. Thus, light therapy may help to decrese body fat percentage as well as increase energy levels due to the function of the triglycerides (1).

In a study published in the *Lasers in Medical Science Journal*, red light therapy was used to test its effects on adipose tissue through a mitochondrial pathway in obese individuals (39). In this study, cytochrome C oxidase, a mitochondrial molecule, is activated into an excited state which leads to increased levels of cyclic adenosine monophosphate (cAMP) in adipose tissue, a molecule which is responsible for regulating the metabolism of

a mitochondria and cell cycle progression (28,39). Following this excitation, the process of oxidative stress in the mitochondria is initiated, causing an increase of dynamin-related protein 1 (Drp1), a protein that triggers apoptosis (39). In turn, mitochondrial dysfunction, breakdown, and apoptosis occur as shown by the apoptotic markers (39). These results show that red light therapy acts through the mitochondria, and subsequently leads to cellular events that allow for lipolysis and apoptosis in superficial adipose tissue, allowing for fat loss (39). Further studies are needed with a randomized population to explore further results (39).

To further support these results, the person must be at an optimal distance from the light panels. This is because the further away from the panels an individual is during treatment, the less penetration the red and infrared light will produce. In essence, the closer they are to the panels, the deeper the light will likely be able to reach, and those adipocytes, in turn, have more potential to react to expend more energy. The longer the intervals in which one does this red light therapy, the longer this cycle of adipocyte breakdown will occur; as well as the frequency in which the person is doing these sessions (1,6,39). As with exercise, consistency is key with this form of wellness application. The author recommends a treatment protocol of five times a week for 10 min of red and infrared light treatment.

COMPARISON OF RED LIGHT THERAPY TO LIPOSUCTION: A NONINVASIVE VS. AN INVASIVE PROCEDURE

To achieve weight loss, some individuals prefer surgical enhancements, believing it is safe and the most efficient way of having less fat in their body composition. Liposuction is the most common cosmetic procedure according to the Aesthetic Society (8). However, the risks of such an invasive procedure at times outweigh the immediate benefits. Some common risks include damage to nerves, blood vessels, and abdominal organs; intense bruising; buildup of fluid; and excessive swelling (8,20). Although some of these risks heal within a few months, there are other complications that might never recover: nerve damage, blood vessel damage, irregular asymmetry, irregular pigmentation, and loss of sensation in the skin (8,20). The only advantage liposuction has over red light therapy is the immediate results. With red light therapy, there is no need for recovery time and the results are more maintainable because it becomes a lifestyle, not a one-time surgery.

NUTRITIONAL INTERVENTION AND INTERACTIONS

Red light therapy has been used in conjunction with traditional weight loss therapies to aid in the reduction of localized fat. Utilizing both these methods together has a greater effect on many anthropometrics parameters such as body mass and total visceral fat (2,9,31,32). Red light therapy may improve the body's metabolic functions, which enhances the ability to reduce total and visceral fat. Nutritional interventions are used to educate participants on basic nutrition topics, such as adequate caloric intake, and to assess their food habits through daily food records (2). The *Journal of Obesity and Weight Loss Therapy* performed a study that compared just an exercise and nutrition intervention program to an exercise, nutrition, and red light therapy intervention on a single subject. They conducted two eight-week trials testing the two methods and the results nearly doubled (2). Weight loss in the first trial with just exercise and nutrition intervention caused an average loss of 4.8 kg while the second trial that used red light therapy along with the exercise and nutrition therapy caused an average of 8.8 kg after the eight-week trial (2). Fat loss results were about the same as the amount of weight reduced, 4.3 kg and 8.2 kg, respectively.

Red light therapy has also been shown to improve lipid profiles due to greater metabolic demand, glucose levels, and insulin status (11,14,24,32,33). Dyslipidemia is characterized by increased triglycerides levels, low levels of high-density lipoprotein levels (HDL), and high levels of low-density lipoproteins (LDL). Type 2 diabetes is characterized as a lack of or resistance to insulin causing the body to not be able to regulate blood sugar levels properly. High levels of HDL, LDL, cholesterol, and triglycerides is linked to causing an increased risk of diseases such as diabetes and dyslipidemia. Individuals struggling with these diseases may also be able to benefit from red light therapy. A study in the *Journal of Population Therapeutics and Clinical Microbiology* used red light therapy in combination with standard medical treatment of diabetes and dyslipidemia (12). The trials showed significant decreases in blood sugar in the diabetic patients, increases in HDL, and decreases in LDL and triglycerides (12). Since the findings are new, more research would be needed to support these results due to fluctuations in the data (12,14,25,32).

FREQUENCY, DURATION, AND OPTIMAL STANDING DISTANCE OF RED LIGHT THERAPY

Table 1 shows a sample program in which red light therapy (15 min) is being used before exercise to help with weight loss. This program can be used on a day-to-day basis over a long period of time. Currently, resistance training frequency ranges from 2 – 5 days per week, depending on what the subjects' training status is at the time (30). Red light therapy can be used in conjunction with resistance training, with the best results found when being used before beginning resistance training (15,39). As the person begins training, they can use red light therapy not only for weight loss, but also for muscle recovery. Red light therapy should be done at an optimal dose, with the penetration depth of near infrared light being at around 810 nm (16). This can be done every day as long as the wavelength is at an optimal range (15,18). One study notes some potential side effects when evaluating the effects of lasers include possible scarring, hypertrichosis, and hypopigmentation (23). Most LED redlight panels on the market today are Class II medical devices, which have been approved by the Food and Drug Administration (FDA) and provide minimal side effects, if any. Two possible side effects could be a slight headache or nausea, but they are transient in duration.

One other thing to consider when doing red light therapy is the duration of the session and the optimal standing distance from the device. One study showed that optimal effects for wound healing

TABLE 1. SAMPLE PROGRAM WITH EXERCISE TRAINING AND RED LIGHT THERAPY

ACTIVITY	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Red Light Therapy	Rest	15 min	15 min	Rest	15 min	15 min	15 min
Muscle Group Trained	Rest	Lower body	Upper body	Rest	Lower body	Upper body	Upper/lower body
Distance from Red Light Panel	Rest	6 in.	6 in.	Rest	6 in.	6 in.	6 in.

were seen at 10 min at 8 mW once per day; however, additional studies are needed to determine the optimal duration of a session for weight loss as different studies used different durations (2,6,24). Although not much research has been done to find an optimal distance, the irradiance decreases with distance from the center of the beam (9). The closer to the source of light a person stands, the higher the dosage.

CONCLUSION

Personal trainers and nutritionists now have a contemporary science-based application that can be used with their clients to improve their overall wellness and weight loss programs. Red light therapy may encourage weight loss by targeting adipose cells. Red light therapy may have the capability to replace invasive procedures such as liposuction as it is less costly and risky. Red light therapy can be coupled with nutritional interventions to help reduce fat in the body. The optimal wavelength, distance of light exposure, and frequency of red light therapy is subject to more testing and research. However, this novel approach to weight and fat loss gives personal trainers and nutritionist an alternative for their clients to consider in their wellness programs.

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