

Exercise Induced Anorexia: Effects of Feeding Conditions



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Abstract

Modeling activity-based anorexia, food deprived rats consistently showed that activity increased as weight decreased. My primary objective was to determine whether or not wheel running would produce anorexia as measured by weight loss and food intake during free food and food restriction conditions. The control rats had access to the running wheel for 4 hours per day within 46 continuous days for the whole process alternating between free food and food restriction in an A-B-A-B design. Rats ran with free access to food for the first 14 days as the training and then alternatively with and without food deprivation for the next 32 days. For each value of deprivation, animals were brought to specific weight by adjusting daily food allocation during 32 days. The control rats were run and the amount of exercise was predicted to increase day by day.

Different levels of weight loss and reduction of food intake during free food and food restriction conditions were measured to determine any patterns of anorexia. Twenty five percent of total weight loss is the criteria for anorexia. Results were not overly compelling under the conditional marginal effects of wheel running. Future studies may want to try larger variables suggested by my data.

Exercise Induced Anorexia: Effects of Feeding Conditions

Body image is how people see themselves. Negative body image refers to an illogical perspective of how someone sees their body. Those populations who aim to attain a satisfaction of positive body image are seeking methods to lose weight. Exercise, as one of the most popular and direct solutions for those who want to lose weight could potentially be extremely dangerous if not appropriately applied. It is suggested that inappropriate application could be as bad as no exercise at all according to the BBC news (2014). Individuals should be warned of the hazards and influences of exercise. Those who worry tremendously about food, body image and weight of their own bodies are the populations facing high risks. In the history of human health problems, food deprivation has always been an issue for people who are obsessive with weight loss. Restrictive eating and over exercising are unavoidably leading to patterns of disordered eating and weight obsession that can develop into anorexia, bulimia, orthorexia, compulsive overeating or binge eating disorder. Anorexia nervosa, anorexia for short, is an eating disorder with very possible devastating consequences that can bring to humans. People who suffer from anorexia consume very limited quantities of food, which leads to self-starvation. In the long run, they can become dangerously thin and malnourished -- yet still perceive themselves as overweight. Frequently, people with anorexia become so undernourished that they have to be hospitalized. Even then they deny that anything is wrong with them. (WebMD, 2015) Thus, any attempt to reduce hunger requires a sound understanding. Another problem along with the strong desire to lose weight in human situations is the obesity around the world, and obesity in children

for example is a serious issue in America. “In 2010, The Centers for Disease Control and Prevention (CDC) reported higher numbers once more, counting 35.7% of American adults as obese, and 17% of American Children.” Thus, those populations who desire to lose weight urgently should be more careful.

Those issues I identified justify why I want to design this research. Pierce and Epling (1988) suggested that rats submitted to food deprivation and access to wheel running, suggesting an interesting relationship that the increase in activity could cause self-starvation and weight loss. To humans, hyperactivity, voluntary food restraint and weight loss are the most evident symptoms and physical factors for anorexia nervosa. From the clinical report of the traditional view, activity is a way that the anorectic applies that simply burns off the calories. Even if the interpretation has been widely accepted, it's proven wrong for later research. There are more factors than just calories burning off causing food restraint by excessive activity. While exercising, human body balance influencing health condition causing food refusal, energy balance associated with the delay of the desire for eating or resistance of eating, suppression of hunger, appetite, taste preferences, temperature environment, and energy intake, mental status such as pressure and depression and so forth are more considerations and compounds for food deprivation. Also, the further discussed experiments that have been done on rats in the past have suggested some of the most important and fundamental factors and that it will also apply to human situations.

The researchers found the link between excessive activity and self-starvation from controlled experiment on rats. Excessive physical activity appears central to a lot of cases of human self-starvation. Deprivation and satiation: The interrelations between food and wheel running found by Pierce and Epling (1988) argue that depriving rats of food would increase

wheel running and satiation for wheel running would reduce food consumption. Controlled experiments with animals have shown that physical activity is capable of making an animal quit eating when food is provided relatively adequate. During the experiment, animals were set up to exercise on the wheel, and wheel running increased to excessive level rapidly as continues. An adult rat may run up to 20 km per day at the peak. At the end of 1 week, animals were found to eat very little and a lot less than before. The rat was giving up eating regardless of increasing energy consume through wheel running. If this process continues, the animal will die of starvation suggested by Pierce & Epling. (1992) Furthermore, the type and intensity of dieting and exercise are affecting the reactions of other people to the change in body shape and size.

The reasons why exercise might cause food deprivation are studied. In the current opinion in clinical nutrition and metabolic care, fields that study exercise and food deprivation (Hoyt & Friedl, 2006) argue that the failure of human body balance during exercise could disrupt the health condition and cause food refusal. When performing exercise along with underfeeding, the human body experiences rapid weight loss, which indicates that initial body fat mass has a significant positive impact on fat oxidation rates per kilogram of fat-free mass. That means the reduction of fat-free mass due to weight loss from exercise could cause underfeeding because the physical health condition is disrupted. Plus, it differs in genders since men and women have different patterns of body fat and lean mass loss while exercising.

However, another study found the relationship of exercise causing anorexia to be not absolute. Other possibilities were considered by more careful observations during the exercise once weight loss started to appear. According to the study, "Exercise-induced Suppression of Appetite: Effects on Food Intake and Implications For Energy Balance", the effects of exercise on short-term energy intake are a brief suppression of hunger, accompanied by a delay to eating,

all of which results in exercise-induced anorexia (King, Burkely & Blundell, 1994). The temporal aspects of exercise-induced anorexia may be best measured by the resistance of eating instead of the amount of food consumed. Subjective feelings of hunger were significantly suppressed during and after intense exercise, but the suppression was temporary. There was no significant influence of exercise on the total amount of food consumed in the test meal but intense exercise delayed the desire for eating. When energy intake was assessed relative to the energy expenditure during exercise, only the prolonged high intensity session created a significant short-term negative energy balance. Furthermore, the journal of “The Female Athlete Triad: A Statement of the Problem” (Smith & Mercer, 2008) explains that there are more factors besides the amount of exercise that attributes to anorexia. Female Athlete Triad (FAT) as a health problem consisting of disordered eating, amenorrhea and osteoporosis is crucial by promoting a higher risk for young women in sports training that ultimately leads to an emphasis of low body weight or thin appearance. It argues that disordered eating along with excessive and continued exercise can eventually manifest itself into an actual eating disorder such as anorexia or bulimia. But abnormal eating habits induced by exercise don’t necessarily mean or immediately cause anorexia. Studies have found that sport-related factors including personality of the athlete, pressure to lose weight to enhance performance, overtraining, injuries, coaching stressors and early onset of sport-specific training could lead to the increase of female athletes’ risk of developing FAT. (?) Another study of “Exercise, Appetite and Appetite-Regulating Hormones: Implications for Food Intake and Weight Control” (Stensel, 2009) was interested in how the knowledge about the relationship between exercise and appetite is important both for athletes wishing to optimize performance and for those interested in remaining a healthy body weight. The author argues that the factors contributing to exercise induced anorexia involve hormones in

appetite regulation with high concentrations of each hormone in the blood suppressing appetite. Exercise does not acutely increase appetite and vigorous exercise may lead to a temporary suppression of appetite. The researchers found that during the immediate (80-min) post-exercise period, food intake is reduced after exercise in a hot environment, whereas food intake is increased after exercise in cold water, suggesting energy intake may have to be increased when performing for prolonged periods in a cold atmosphere.

There are more than one factor psychotically that might be the compound for exercise induced anorexia. The article of Anorexia in Exercise and Sport (Landers, 2014) has indicated some characteristics that are common to compulsive runners and anorectic females and this research is asking for an answer if there are actually any mental issues along with exercise-induced anorexia for people. The author argues that for those who have lost at least 25% of their initial body weight, are high achievers, are uncomfortable with their anger and inhibit the direct expression of emotion. For the findings, the depression that is the characteristic of anorectic women is not found in all runners, although a small portion of middle-aged, obligatory runners are aware of the presence of depression prior to their involvement with running. Endorphin production through exercise creates a sense of wellbeing that might be used as an antidepressant.

Taste preference is another factor causing food deprivation after exercise. Food choice is involved in determining whether or not it would lead to anorexia according to American Physiological Society. (2004) In the article, the author argues that there is a reduction in glycogen content in the liver and skeletal muscles after exercise. Fluid replacement is also important to avoid severe dehydration, and factors like taste and flavor have been shown to be keys for successful rehydration. (It has been shown that athletes consumed more amounts of fluids that they prefer than fluids that they don't like.) It is known that tastes, which stimulate

voluntary fluid intake along with exercise, include saltiness and sweetness. Sweetness actually decreases after exercise but preferred before exercise. Thus, this factor could also be an easily avoided and addressed along with the risk of the exercise. Food deprivation and anorexia could perhaps be lessened.

The studied and suggested possible factors from the previous researches are involved in causing food deprivation by excessive exercise. Through excessive exercise, burning the calories would simply and directly leads to food restraint is absolutely not correct. Physical and psychological factors are both important and should be acknowledged by all people.

The goal for my study is to find out whether or not exercise as the reinforcement would cause anorexia as body weight and food consumption changes, and come up with exercise and anoxia associated problems and social potential reasons for anorexia populations for the discussion. Then reference possible treatments. The experiment was done on animal models-rats. Similar experiment has been done in the past by Pierce and Epling as written in the former text, also application of ABAB design by Martain and Pear's as to seeking the interrelations between free food access and food limitations during wheel running. My experiment was systematic repeat but different manipulation.

The hypothesis is that excessive exercise could cause less food intake and excessive exercise more severely could cause anorexia and other eating disorders.

Method

Subject

Five Sprague- dawley experimentally naïve, 3 males and 2 females adolescent rats, obtained from the Neuroscience Department lab in Allegheny College, approximately 4 weeks period of age upon arrival, housed individually in animal vivarium of 12 hours light-dark cycle with temperature-controlled room. Male rats were born on 8/6/15 and the females were born on 8/12/15. Water was freely available in the home cages with free food and food restriction reverse. Rats were checked daily for the health conditions, and no severe health issue anticipated, the cages were cleaned every other day by the experimenter. The rats were marked with colors on the tails in order to distinguish. All rats for the test were stored in pairs in cages in the basement of Psychology Department. 5 rats were used to be appropriate amount for seeking behavioral changes during the experiment.

Apparatus

Five Wehmann, Baltimore, MD metal running wheels were used to measure the rotations of exercise, they are all standard rodent running wheel with side holding cages, counting a single rotation, and sliding doors. Wheel rotations are measured by the numbers of revolution, which shows on the apparatus on the counter as numbers. One wheel revolution is recorded when rats make a completion of revolution on either side. Take the finished rotation numbers to subtract the begin numbers and get the rotations they run. Then average the numbers across the rats and compare that day to day. There is a retractable lever underneath that contains the waste from the rats cleaned after the test. The equipment was located in a separate room with no disturbance anticipated during the test. There were 5 individually prepared wheels for rats to run. During the test, the light was provided in the room.

Procedure

Before the experiment, there was Animal Subjects Approval Form and Animal Care and Use Committee Protocol from the Psychology Department to be filled and submitted to the animal department for approval. The whole process took up to 1-2 weeks period. Once approved, there were trainings for Animal Neglect Policy and other associated animal care policy to be educated and informed. Signed before assigned the rats. After the training, check rats and start taking care daily for health conditions, food and water and cleaning. There were forms to fill out each day after checking and taking care of. The 5 rats were administered to have access to the running wheel for 4 hours daily with reverse of free food and food restriction (1-hour exposure) during the process. Rats were also weighted before and after access to wheel running. Food amount was limited to 10g of food restriction and weighted of food consumption for each day. The food amount should be abundant for survival. Before running, there was a 1-week pilot study prior to the experiment testing on adult rats of how many revolutions were run in relations to any levels of weight loss. The adult rats didn't seem to run much and the revolutions ranged from 11-119. After the pilot study, the running started. The running was without forcing. The exercise was approximately the same time every single day. If noticing life threatening signals, they were given antibiotics or stopped from the experiment if needed to avoid life-threatening issues. There were 14 days of wheel running with free food and water access for the training. 32 days reverse and replication of free food and food limitation to 10g each as ABAB. During the 32 days, the reversal-replication research design was applied 8 days each with free food as "A" for baseline, food restriction as "B" for treatment, and free food reversal as "A" and then another food restriction treatment as "B" to end. Total numbers of rotations were counted at the end of each day running. The

subsequent food amount was enough to maintain normal body weight. Rats and food consumption were also weighted before and after the access to wheel running. By continuing the process, the notes were collected for further analyses.

Design

The reversal-replication (ABAB) research design as a cause-effect relationship design was used in my experiment after the training. Both original baseline and the original treatment effects were replicated to seek for any behavioral change during the procedures. (Pear, 2003) The research design was so named because it is a reversal design starting from baseline conditioned and followed by replication of the treatment conditions. The baseline for the study is decided by the experimenters according to the applied research project, thus one can shorten or lengthen the baseline. Controlled rats were assigned to access the running wheel by the order of the marked tail color, female red, blue went first and male green, black and strip black went right after. Time was recorded once everyone was in and doors closed and time out at the same time for each one. There could be up to 10 seconds difference from each for the start of running time. 40 seconds difference as the largest time difference for total running was unavoidable. This operant procedure was within subjects, repeated measures design. The independent variables are the time of food restriction, food restriction amount and hours of exercise. The dependent variables are the rotations of running, weight and food consume.

Results

During the whole process, rat black (male) and red (female) didn't seem to have significant change in rotations. But for the rest, the rotations all seemed consistent with rapidly increasing rotations in B phases, then back to consistent gradually to A and then increasing again

in B. The second B session didn't seem as rapid as the first B but was still increasing rapidly. The weight loss didn't reach 25% to display anorexia activity. In A replication phases, there was rapid increase of food intake and weight gain found after the past 8 days of food restriction with weight loss. B replication phase had slight weight drop but definitely not as many as the first B phase.

Discussion

This research wasn't overly compelling. It is very hard to define if a rat is anorexic. Even if we tested the parameter of body weight, exercise amount and food consumption based on human studies, there is no direct application to human in this case. Body Mass Index is what we look at on humans to diagnose anorexia, (Here give more info from the source) but it is unknown if that also apply on rats in diagnosing anorexia. The most direct way was through the body weight percentage that was lost. 25% as the criteria and basic judgement was what as the closest we could get in diagnosing anorexia in rats. When we looked at the weight loss on rats, we can't translate that into Body Mass Index. Furthermore, humans have verbal behaviors that can help describe reflection and body language. Rats don't have the role govern behavior, thus no listeners and speakers. For example, humans could communicate their weight concern suggesting a weight problem by say 'Oh I shouldn't eat this much'. What they say might not modify weight with humans but this can never be seen on rats because they don't talk. Thus, there are definitely social factors involved that couldn't be tested or governed on animal models.

This research didn't have the results of anorexia. Nobody's weight drop reached 25%. Longer run time and fewer amount of food gave during food restriction may need for future successful studies. The previous research had more time on wheel running access for rats.

During the experiment, there were disrupted eating patterns and constant reduce of weight and food consumption appearing that might suggest eating disorders. But it could also be resistance of eating or delay desire to eating due to the environment condition, or failure to adjust to diet change from free food to food restriction. Thus, these could be short term negative energy balance that is not enough leading to anorexia since their body weight increased during the second treatment of the same amount food restriction. It was also hard to predict the mental status of rats because we couldn't observe their emotions. But some status such as pressure could be predicted. For example, their body color turning pink could be a cause of stress and other negative factors along with less healthy condition. Stressors could come from diet change, fatigue, environment, water or even my interactions with them while conducting the research. These could lead to unwillingness of food intake and exercise.

There are a few appropriate treatments and solutions according to resources from the research and clinical experience. There are many reasons as to why one wants to lose weight or can't control him or her losing weight. Families can play an important role in treating the anorectic, according to clinicians using a treatment-Maudsley approach. The treatment is a family therapy that helps parents in getting their kids to eat again. In the beginning of the treatment, the family is invited to share a picnic meal. That could give them a sense of family meal patterns and also allows them to suggest ways parents can help the child to eat more. In weekly sessions, the parents then describe what they've fed their kid and what's improving and working well. Clinicians also help the family learn how to assist the child deal with the challenges of adolescence. One study found that 70% of patients regained normal weight without having to go to the hospitals. Most showed big enhance in psychological functioning. (In the end of the research, there will be suggested therapies for humans for exercise-induced anorexia as

relations found on rats. Also, I would include taste preferences for extensions I read from past articles in the discussion part, for suggesting ideas of what could be adjusted and considered for the future testing.)

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