The Effects of Intermittent Fasting on Quality of Life and Happiness: A Randomized Control Trial

by

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ABSTRACT

Background: College students face a particularly high prevalence of body dissatisfaction and weight instability increasing the risk of being unhappy and having a poor quality of life. Time-restricted feeding, a type of intermittent fasting, has gained popularity recently for sustainable weight loss without the characteristic dietary restrictions of most fad diets. A limited number of randomized control trials have looked at the effects of time-restricted feeding in humans, but none have looked at how this dietary regimen impacts happiness and quality of life.

Objective: The goal was to examine the effects of an 18-hour daily fasting regimen compared to an 8-hour daily fasting regimen on happiness and quality of life in college students in Arizona.

Methods: Participants included 29 healthy, non-smoking, non-vaping students attending college in Arizona between October 2020 to March 2021. Of the 16 participants allocated to the time-restricted feeding intervention, 8 completed the trial. Of the 13 participants allocated to the control group, 10 completed the trial. The eating window began within one hour of waking up with a 6-hour eating window for the intervention group and 16-hour window for the control group. They could do one cheat day per week. No dietary restrictions were enforced. Participants completed the Oxford Happiness Questionnaire and the WHOQOL-BREF quality of life questionnaire at baseline, week 4, and week 8. Week 8 data were not reported due to data collection changes and cancellations related to the new safety protocols for the COVID-19 pandemic.

Results: Quality of life related to social relationships improved significantly in the intervention group ($p=0.026$). There was a trend favoring the intervention group as well

showing a possible improvement in happiness related to perceived energy levels (p=0.088). No other significant data were reported.

Conclusion: Adherence to an 18-hour time-restricted feeding regimen for 8 weeks may improve quality of life related to social relationships in college students in Arizona. The results of this trial do not suggest a significant impact on overall quality of life or happiness in this population.

DEDICATION

This master's thesis is dedicated the two strongest pillars in my support system; my parents, Ricardo and Teresa De León. As the first in my family to get a master's degree, my heart is bursting at the seams with the love and encouragement I have received from them. Even though my parents only ever saw me working on my computer late at night and never actually saw me conducting research or collecting data, they never once failed to hug me and tell me they were incredibly proud of me day after day. They gave me everything they have unconditionally my whole life, I owe them my entire world. I am so honored to have the privilege of such truly remarkable parents who have shown me that anything is possible when you have love and courage. Para mis más grandes ejemplos a seguir, mamá y papá, los quiero con todo mi corazón.

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CHAPTER 1

INTRODUCTION

About one in every four college students who think they are overweight are more likely to suffer from frequent mental distress and engage in fad dieting than those who view their weight as normal[1]. Due to the popularity of fad dieting, young adults are experiencing instability in weight management, a condition known to impact mental health in this vulnerable population[2–6]. Research has shown that fluctuating between different fad diets that limit foods is not sustainable and contributes to feelings of defeat and poor mental health[5]. Maintaining weight loss is shown to improve quality of life, mental health, and the ability to manage healthy eating habits independently[5]. The diets that actually work sustainably do not limit or demonize foods; they simply encourage dietary lifestyle changes and increasing nutrient-dense food intake[2].

Intermittent fasting is one of the latest diet fads circulating on social media and fitness blogs for effective weight loss; however, it has a long history particularly in religious practices[2,7,8]. As opposed to most diets, it does not limit what a person can eat only what time of day they can eat[2,3,7,9,10]. The recent rise in its popularity can be attributed to online blogging and health coaching via social media[2]. Time-restricted feeding (TRF) is a variation of intermittent fasting that may prove to be beneficial and realistic to implement[2,11,12].

Currently, the research on intermittent fasting is limited, with few reports on TRF specifically, but no studies have looked at the mental health effects of those who practice TRF[13,14]. Even within the published studies that are available on intermittent fasting, most are in animal models and few human trials have been reported[15]. A recent human trial

demonstrated that TRF decreased appetite during fasting periods and burned more fat compared to non-fasting controls[16]. Although intermittent fasting trials reported reductions in body weight and body fat were due to the associated energy restriction, the data are simply too scarce to derive similar conclusions for TRF, let alone its effects on mental health status[9].

The importance of conducting more trials is undeniable with the recent rise in popularity of intermittent fasting[2]. It is pertinent for healthcare providers to provide peer-reviewed, evidence-based recommendations to clients and patients who seek nutrition advice. As college students face a high risk for a perceived low quality of life and unhappiness often related to weight and health status, this population would benefit tremendously from a study looking at this relationship[1,4]. It is possible that engaging in TRF could align with a college student's lifestyle leading to sustainable weight loss, an improved quality of life, happiness, and a better overall health status[1,5,6,9,16,17].

PURPOSE OF STUDY

The purpose of this study is to assess the effects of engaging in a daily 18-hour fasting regimen on quality of life and happiness in college students in Arizona. Participants were randomized to an 18-hour daily fasting regimen or to an 8-hour daily fasting regimen for eight weeks with one cheat day per week where they could veer away from the intervention.

RESEARCH AIM AND HYPOTHESIS

The research aim is to examine whether there is a positive or negative effect on happiness and quality of life due to engaging in a time-restricted feeding regimen.

- Primary Hypothesis: Adherence to an 18-hour daily fasting regimen for eight weeks compared to an 8-hour daily fasting regimen will improve happiness and quality of life in college students in Arizona.

DEFINITION OF TERMS

- Caloric restriction: reducing the amount of calories one eats normally or below their energy requirements
- Fad dieting: a diet plan or regimen that gains popularity for a period of time and promises rapid or effective weight loss often without sufficient scientific evidence of its effects; they tend to be trendy and gain popularity among bloggers and social media influencers
- Happiness: although definitions vary based on the individual, it generally entails feelings of satisfaction and well-being with oneself and/or their life (measured using the Oxford Happiness Questionnaire)[18]
- Intermittent fasting: an umbrella term that covers various types of diet regimens where one alternates between fasting and eating for established periods of time
- Nutrient dense foods: foods that have high nutrients (vitamins/minerals) and relatively low calories; opposite of energy dense (high calories, low nutrients)
- Quality of life: how a person perceives their achievements, goals, priorities, concerns, and position in life based on their cultures and values they live by (measured using the World Health Organization Quality of Life assessment)[19]

- Time-restricted feeding: fasting for over 14 hours per day and eating all daily calories earlier in the day to align with circadian rhythms[16]
- Weight management: maintaining a healthy body weight long term due to healthy dietary and physical activity habits
- Young adults: people about 18 to 25 years old

DELIMITATIONS AND LIMITATIONS

- Delimitations:
    - Not generalizable for:
        - Non-college students
        - People who regularly fast
        - People who regularly diet, are actively trying to lose weight, or saw a change in weight of >5lbs
        - Elite athletes or those training for sports events
        - Smokers
        - Unhealthy adults
        - Severely underweight adults
        - Pregnant or lactating women
        - Women with irregular menstrual cycles
        - People who work night shifts
        - Those unwilling to participate in the study
- Limitations:
    - Participant compliance to following the fasting regimen assigned to them

- Honesty on happiness and quality of life questionnaire
- Trial period runs through a holiday season generally associated with increased levels of happiness
- Inability to control for college-related stressors for students
- Variability between different investigators taking measurements
- Being in a good or bad mood due to life events (e.g. car accident, death in the family, winning the lottery, passing a test, getting in an argument, hormones, etc.)
- Pessimistic or optimistic attitudes that affect their perception while filling out the quality of life and happiness surveys

CHAPTER 2

REVIEW OF LITERATURE

INTERMITTENT FASTING

INTERMITTENT FASTING AND THE METABOLIC SWITCH

Intermittent fasting is an encompassing term to describe various diet regimens that entail fasting[9,11]. Alternate day fasting, as implied, is a regimen of alternating a day of fasting and a day of normal consumption without restriction[11]. Alternate-day modified fasting is similar, but it allows for less than 25 percent of energy needs to be consumed on fasting days[11]. The 5:2 Diet is where five days per week are without fasting or dietary restriction and two days per week are dedicated to fasting or calorie restriction[3,20]. Considering that intermittent fasting is flexible and can accommodate lifestyles and dietary needs, there are many versions of intermittent fasting practices that could be considered in future research[2,11]. The problem is the frequent use of the term "intermittent fasting" to categorize all of these diverse regimens.

A popular intermittent fasting protocol is time restricted feeding where fasting periods are between 12 to 21 hours with an "eating window" situated during the daytime[2]. Traditionally, this method does not ask for a restriction of calories consumed but rather a timespan to consume all daily energy. The mechanism that this diet aims to use for weight loss is called the metabolic switch[11,21]. When a meal is consumed, the excess energy is stored as glycogen[11,21]. During the first 12 hours of postprandial fasting, the body will use these glycogen stores as energy[11,21]. The metabolic switch occurs when liver glycogen stores are depleted after 12 hours of fasting and the body switches to fat oxidation for energy[10,11]. This switches the body from glycolysis, an anaerobic pathway,

to lipolysis, an aerobic pathway, producing ketones for energy in the process[11,21,22]. While traditional, longer-term energy restriction is more prone to burning muscle mass, time restricted feeding is thought to prevent muscle oxidation via this metabolic switch[11,21].

RELIGIOUS FASTING PRACTICES

Intermittent fasting has recent relevance as it is currently a popular diet fad, but there is actually a long history of religious fasting, that goes back centuries[23]. Persynaki et al. analyzed these traditions to determine the possible health benefits from religious intermittent fasting[23]. They selected religious fasting practices that provided relatively long fasting periods of time with consistent requirements and characteristics[23]. They reported that Ramadan, Orthodox Christian fasting, Buddhist fasting, and 21-day Daniel fasting were the most commonly practiced fasting regimens with long durations[23]. For example, Ramadan requires fasting for about a month during daylight hours, which equates to vast differences in the length of the fast depending on the part of the world and hours of daylight[23,24]. Other fasts simply change the foods that can be consumed and drastically reduce caloric intake during these times[23].

Trepanowski et al. found that most of these religious fasting practices reduced overall calorie consumption and tended to increase healthier food consumption thus improving overall health[24]. For example, during Greek Orthodox Christian fasts, fiber intake increased while cholesterol and total fat consumption decreased[24]. This could be due to dietary restrictions during the fasts that limit the consumption of meats and animal products that may be an individual's main source of fat or protein[24]. These limitations likely increase consumption of other fiber-rich, plant-based foods usually substituted for meat or animal products during fasting days[24]. While these results are interesting, it

would be beneficial to see the long-term effects of annual intermittent fasting in adults who have practiced religious fasting their entire lives.

There are other aspects of an individual's health that may be affected by time-restricted feeding, or intermittent fasting, such as mood and quality of life. Hsouna et al. studied this in physically active men who practice Ramadan fasting[8]. They ran various tests on twelve men that were around 22 years old and looked for changes before, during, and after Ramadan to see if there was an effect from the fasting period[8]. They determined that there were no significant changes in mood and alertness, however there were significant decreases in sleep quality while fasting which improved after the fasting regimen ended[8]. Since this was done on a relatively small, specific group that followed this intermittent fasting diet for religious purposes, it would be prudent to repeat this study outside of a religious setting on a larger group that includes women.

BENEFITS AND PERCEIVED BENEFITS

As with any popular diet, there are benefits commonly perceived by the general public, such as weight loss and increased satiety; however, these benefits are often not supported in controlled clinical trials. Tinsley et al. reviewed fasting trials to evaluate the various effects of these diets on the body and overall health[9]. They found that alternate day fasting and whole day fasting did reduce body weight and body fat, but the data are too scarce to derive similar conclusions on time restricted feeding[9]. Although time restricted feeding benefits cannot be determined with as much certainty, this fasting regimen may appeal to those with history of dieting for its effects on weight loss and perceived self-improvement[9]. Future studies should focus on the benefits and effects of time restricted feeding specifically to broaden the current data.

There are other benefits to intermittent fasting beyond body weight and fat reduction. Mattson et al. looked at the effects of fasting on heart and brain health to determine if there were any consistent findings across studies[10]. The researchers determined that most intermittent fasting regimens were paired with caloric restriction which is known to improve health in individuals with obesity and overweight[10]. However, Mattson et al. also noted that some intermittent fasting trials in mice reported health benefits without caloric restriction, which might mean that the frequency of meal timing is also effective at improving these aspects of health[10]. This suggests that further intermittent fasting research should be done on humans without caloric restriction to determine the physiological effects of intermittent fasting alone without the influence of other diet practices[10].

Persynaki et al. assessed the relationship between fasting practices and heart or brain health benefits[23]. These researchers looked at animal fasting and found both cognitive and metabolic benefits for animals fasted for over 24 hours[23]. Mice that underwent intermittent fasting showed improved insulin sensitivity via a glucose tolerance test and improved heart disease risk factors including a reduced heart rate and blood pressure[23]. Brandhorst et al. reported better cognitive performance in mice from improved growth of nervous tissue in the brain while fasting[25]. This can be protective against brain and nervous system degeneration[25]. From a survival aspect, this could be perceived as beneficial since food is not always readily available and animals must be prepared to defend against predators[10,23,25].

Studies looking at specific effects of intermittent fasting are scarce possibly because intermittent fasting as a method of dieting has only recently become popular. Johnstone et al. noted that, historically, people used to fast for cultural, religious, or sacrificial reasons[2]. Presently, it appears that most people do intermittent fasting for self-improvement to lose weight, feel more aesthetically pleasant, increase quality of life, and improve overall health and wellness[2]. This suggests that motivation for intermittent fasting may be similar to most fad diets, but there is not yet enough research to determine if intermittent fasting may be more sustainable than the traditional fad diets[2].

With the rapid growth of media influencing dietary behaviors and health coaching via social media encouraging fad dieting, it is no surprise that intermittent fasting has gained popularity. Moro et al. analyzed that what has made intermittent fasting so appealing to many people is that it does not change what and how much can be consumed but rather the timing and frequency of meals[26]. Although the diet is not restrictive, the researchers did see significant weight loss and health improvement[26]. This opens the door for a research study looking at the subjective reasoning for intermittent fasting and what motivates individuals to try this diet over others. It would be interesting to see if these motivational factors are related to weight loss during fasting periods.

Although intermittent fasting studies are limited, Ravussin et al. acknowledged that fasting might reduce body weight but wanted to understand mechanisms[27]. They looked at eleven adults who practiced early time restricted feeding to see whether weight loss during intermittent fasting was linked to either reduced caloric intake, increased energy expenditure, or decreased appetite[27]. The researchers found that this dietary

strategy was linked to weight loss due to lower appetite not higher energy expenditure[27]. Therefore, since no correlation was found with energy expenditure, the researchers inferred that there may not be a change in metabolism during intermittent fasting[27]. This study provides additional reasoning and understanding for early time restricted feeding in the hopes of losing weight and reducing appetite instead of increasing energy expenditure[27]. Further research should look at the sustainability of these changes in appetite after a fasting period to see whether it helps suppress cravings or increase binging behaviors post-fasting.

LIMITATIONS OF EXISTING INTERMITTENT FASTING RESEARCH

Controlled intermittent fasting studies are limited but several studies have evaluated various fasting practices that are categorized under this term. Templeman et al. reviewed these trials and urged researchers to clearly specify fasting methods and thoroughly ensure fidelity[3]. Some of the common issues with these trials include poor adherence to fasting regimens and the difficulty for researchers to monitor participants during these interventions[3]. Many of the trials are also single-arm trials with no comparative control groups which makes it difficult to draw conclusions about intervention effects[3,28]. Some of the common delimitations that make generalizability difficult are that most of the few intermittent trials are conducted in populations with obesity, overweight, or other chronic conditions such as diabetes[3,14,20,28–31]. Since a large majority of these studies are aimed to see an effect on weight loss, there remains a largely unexplored area of study to establish the effects of intermittent fasting on other aspects of physical and mental health[2,3,28–30].

Many of the current trials on intermittent fasting have similar limitations and few have even looked at time restricted feeding specifically. Anton et al. looked at time restricted feeding in 2019 to assess whether this would be an effective diet strategy for weight loss and health improvement in elderly, overweight individuals[30]. They found that it may be feasible for weight loss and noted small improvements in physical ability and health-related quality of life[30]. The issue with generalizing these data is that they did not have a control group so the results on quality of life and physical ability may have been affected by external factors[30]. They do not believe that the significance in weight loss may have been affected by external factors but they do admit to not having measured diet quality, intake, or the composition of the weight loss[30]. The sample size only included 10 participants, as well, with a short duration of 4 weeks of fasting for 16 hours per day[30]. The study methods should be repeated with a control group, a larger sample size, longer study duration, and observance of dietary intake and body composition measurements in older individuals with obesity or overweight[30].

Harvie et al. avoided many of these gaps in the literature by looking at body composition in a larger group of individuals for a longer period of time than the previous article[30,32]. The study compared an energy-carbohydrate restriction intervention with a traditional energy restriction control group in 115 overweight women 20 to 69 years old with a history of breast cancer in their family[32]. They believe that this diet would be effective to improve insulin resistance and promote fat loss in this population[32]. Although this study was longer than others, three months is still too short to generalize this regimen as a long-term solution[32]. It would be beneficial to conduct further research and long term follow up data collections in any replication of this study to strengthen these results[32].

Carter et al. compared the effects of the 5:2 type of intermittent fasting and traditional daily energy restriction[20]. Participants in the intermittent fasting group were asked to restrict calories twice a week to about 400 to 600 calories on each of the two non-consecutive, fasting days[3,20]. The other group was asked to reduce their daily consumption to about 1200 to 1550 calories per day[3,20]. After 12 weeks of intervention, the resulting effects were decreased glycated hemoglobin A1c levels, a biomarker that reflects glucose levels during the last 3 months, and decreased body weight in both groups, but no significant difference was noted between both intervention groups[20,33]. Since only 51 participants completed the study, and all participants had obesity and type 2 diabetes, there is evidently a need for larger, more generalizable trials[20].

St-Onge et al. reviewed the literature to examine relationships between meal timing or intermittent fasting-style diets and heart disease[13]. They reported that the research was extremely limited and compiled of mainly animal studies with few human interventions, and the human studies were underpowered due to small sample sizes, or examined isolated topics that have not been widely supported by other studies yet[13]. These factors limit the ability to derive evidence-based conclusions or recommendations regarding fasting[13]. It does, however, open the door for many future studies on a variety of topics and relationships with intermittent fasting since the literature is scanty[13].

IMPLICATIONS FOR FUTURE RESEARCH

The limitations in the current research conducted on humans appear to be consistent in intermittent fasting trials and provide very limited generalizability[3,9,11–14,20,28–32]. The review conducted by Tinsley et al. identified only a few randomized control trials on intermittent fasting and almost none repeated by the same lab[9]. It would

be helpful to conduct repeat measures and secondary studies to support findings and control for variations in methodology, requirements, or definitions of the type of fasting[9]. Moreover, most studies report on physiological and metabolic outcomes with psychological effects as secondary outcomes[2,3,9–11,13,23,26,27]. No studies thus far have primarily looked at psychological effects of intermittent fasting.

Foley et al. conducted a pilot study on eleven 18-21 year old college students to see if time-restricted feeding would have an effect on mood states[22]. The intervention group was allowed an 8-hour window for eating with 16 hours of fasting while the control group was not restricted to any time frame[22]. The researchers found that mood states improved in the intervention group after 4 weeks following this regimen[22]. Although this unpublished trial suggests that mood is improved after a few weeks of intermittent fasting, it would be interesting to measure mood changes at the beginning and end of each daily fasting window to see if there are any changes in daily mood while experiencing fasting and hunger[22].

QUALITY OF LIFE

OVERVIEW AND DEFINITION

Quality of life is an extremely personal, individualized concept that depends on how each person finds their individual sense of fulfillment. Lin et al. studied over 200 college students in health sciences programs to assess their dietary behaviors and quality of life status[34]. Quality of life could be characterized into groups that encompass the criteria that most people use to define their quality of life, including self-identification, interactions with social networks, and overall psychological health[34]. The researchers explained that these areas are affected by food intake[34]. With this nutrition focus, they

surveyed the participants and found that females and those in certain programs of study such as nursing had significantly increased quality of life, but finances and BMI did not make significant differences in overall scores[34]. Interestingly, social factors including roommates, friends to provide emotional support, and high levels of daily social interactions provided the highest quality of life scores[34]. They noted that people with good quality of life scores were more physically active and had better dietary habits than those with lower quality of life scores[34]. It is not known whether intermittent fasting impacts quality of life.

The World Health Organization (WHO) developed a questionnaire that is highly validated to determine quality of life by asking questions about subjective perception of quality of life and satisfaction with health status[17]. This organization defines quality of life by how people perceive their life, their role in it, how it lines up with their cultures, moral values, achievement of goals and goal setting, expectations, and personal priorities[17]. Costa et al. used this questionnaire to assess how eating attitudes and disorders relate to overall quality of life in health care students in Brazil[17]. They noted that lower quality of life scores correlated with low-income status amongst all students and a high risk of eating disorders in nutrition students leading to the conclusion that disordered eating attitudes negatively affected quality of life[17]. This shows that quality of life and diet are strongly related and must be acknowledged in diet studies, including studies of intermittent fasting[17].

FAD DIETS

Quality of life can be closely interrelated with the motivational factors behind dieting[2,35–38]. Fad dieting, for example, entails fluctuating between popular diets that

promote rapid weight loss and periods of dietary disregard or binging[2,36]. This is often promoted via social media and fades out of the spotlight after a few years when the next trend arises[2]. Passos et al. believes that people obsess over fad diets for aesthetics but claim it is for health benefits via weight loss[35]. Their research found that the top words associated with the word "diet" on Google were all popular fad diets such as "paleo diet" or "ketogenic diet"[35]. They also noted that famous people and social media influencers made a large impact on popularizing these trending diets encouraging people to strive for an idealized body type by following a specific diet and exercise regimen[35]. Whether the motives are for health, aesthetics, or to follow the latest trend, these dieting fads can play a detrimental role in society and lead to disordered eating, poor self-esteem, and a poor quality of life[1,35].

Intermittent fasting gained a lot of popularity in the diet community on social media since it is not restrictive on dietary intake like other diets are, however many consider it another one of these fad diets[2]. The long term consequences of intermittent fasting, and many other fad diets at first, are not clear yet as there is a gap in the literature[2]. In the short term, intermittent fasting seems to produce weight loss by unintended caloric deficits due to the difficulty of consuming enough energy for the day in a small window of time[2,10,27,37]. While a large focus has been put on the increased risk of micronutrient deficiencies due to low energy intake, there has been minimal focus on the way intermittent fasting may affect the psychological and social determinants of quality of life[38].

MENTAL HEALTH

Another contributing factor to quality of life is mental health[39]. Mental health is very similar to quality of life as they are affected by many of the same lifestyle factors, such as environment or social networks, as well as affecting each other[40]. Bremner et al. suggested that dietary intake high in saturated fats is associated with poor mental health including depression and anxiety[39]. College students have a much higher rate of mental health disorders that are influenced by socioeconomic status, limited access to healthy foods, and stress[40]. These conditions may be related to a deficiency in one of the neurotransmitters that are attributed to happiness, serotonin[22,40,41]. Serotonin, which is largely produced in the intestines by gut microbes, is dependent on the consumption of the essential amino acid tryptophan[41,42]. In cases of nutrient deficiency due to food insecurity or poor diet quality, serotonin levels may become insufficient if tryptophan-containing foods do not meet needs via the diet or supplements[40,41].

Mental health in relation to quality of life is very connected with stress levels[39,41,43]. Andre et al. looked at the four domains of quality of life to determine how each are affected in students enrolled in dental school[43]. They found that psychological and social health were affected negatively while enrolled in this program, and those further into the program were more severely affected[43]. The researchers also noted that those further into the program have higher expectations and challenges resulting in higher anxiety levels[43]. Although dieting and mental health has been well-explored, there remains a gap in whether intermittent fasting contributes to poor mental health by producing additional stress for college students attempting to lose weight by following this regimen.

Engaging in periodic dieting is known to correlate with poor mental health status and disordered eating patterns[44,45]. Haynos et al. looked at classifying dieting behavior types by how dedicated an individual is in following the dietary guidelines and the mindset of the person in regards to the diet[45]. Those who had a flexible mindset, dieted for health, and were dedicated to the rules of the diet achieved weight loss and sustained it more often than those with excessive fixation, perfectionism, and aesthetic desires to lose weight[45]. Those who excessively fixated on the diet and engaged in the regimen suffered many mental health consequences included poorer self-esteem and disordered eating tendencies[45]. Chithambo et al. used these classifications to assess the effects and motivations of dieting on body image and disordered eating behaviors[44]. They saw poor mental health outcomes and body dissatisfaction in those who wanted to diet for the sake of looking thinner[44]. Further investigations on mental health and dieting, particularly fad dieting, should look at the reasoning behind why people engage in these behaviors and healthcare professionals encourage a health mindset rather than an aesthetic body image mindset[44,45].

DIETING FOR WEIGHT LOSS

Quality of life is not just related to dietary intake but also other perceptions of health, appearance, and weight[17,34,46,47]. Vieira et al. studied the effects of weight loss and maintenance on quality of life to see if there were relationships among women who have lost weight intentionally, not tried to lose weight at all, or have maintained intentional weight loss after interventions[5]. In this trial, women completed a survey to assess their health and weight-related quality of life across the three groups[5]. The survey covered many aspects such as physical functioning and limitations, pain, and general wellness[5].

They found that those currently in weight loss programs showed the highest scores on these tests followed by those who have maintained the weight loss and lastly by those who have not made any attempts to lose weight[5]. This could be due to the support and guidance to lose weight when actively in a weight loss program versus those who maintain the weight loss on their own[5]. They also noted that intrinsic motivation was significantly higher in those who achieved weight loss on their own versus those who were not trying or in a program[5]. This suggests that weight loss is subjective to motivation which is affected by quality of life, something that in itself is psychologically subjective and varies from person to person. An analysis focusing primarily on quality of life while intermittent fasting or engaging in other diets should be conducted to determine if there is a direct correlation present[5].

College students and young adults face many issues with weight overestimation, and this phenomenon is more common in women than men[1]. While dieting for weight loss is not necessarily negative behavior, it can contribute to a poor quality of life when it is rooted in a misperception of body weight[1]. Southerland et al. believes that the potential consequences of this body dysmorphia can directly relate to depression, poor self-esteem, disordered eating, excessive exercising for weight loss, and greatly impact mental health overall[1]. This was not exclusive to those who struggle with obesity and overweight status but equally impacted those in the normal weight BMI class[1]. Although quality of life is strongly related to psychological health, a majority of studies such as this one look at the psychological impact of dieting rather than the larger impact on quality of life[1]. There is a need for more research into how body image, motivation for dieting, and weight misperceptions affect all aspects of quality of life beyond just the psychological domain.

SOCIAL NETWORK AND RELATIONSHIPS

In assessing overall determinants of quality of life, many have found that social networks are significant predictors[17,46,47]. For instance, Ferreira et al. conducted a research study on how older adults represent their quality of life socially and what aspects of such are most prevalent in their population[47]. They saw that quality of life for those older than 60 years of age is a complex subject with many aspects contributing to their overall satisfaction[47]. It was notable that they seemed to seek out a lot of social interaction and viewed loneliness as extremely negative on their overall well-being[47]. In fact, many who participated in the study did so as a way to interact socially and escape their loneliness, an important tactic for mental health in elderly populations[47]. They noted how this relates to the dangers of depression, especially in older individuals, and how social networks can help improve quality of life and lower the risk of depressive episodes[47]. This suggests that strong social networks are directly related to quality of life[47].

While socializing with others is part of the foundation for a high quality of life, emotional support from that social network is key to maintain that sense of satisfaction[46]. Fu et al. conducted a cross-sectional study on 294 nurses in Taiwan to assess their social support and effects on quality of life at work[46]. These researchers noted that nurses undergo great amounts of burnout and stress that affects their mental health and quality of life[46]. They administered a questionnaire only to find that their social support system was very effective in reducing the mental health stress associated with this profession and possibly other professions of a similar intensity[46]. Stronger social networks and support systems provided major protection against facing the emotional difficulties of life and

work, specifically systems consisting of family and friends more so than coworkers had stronger influences[46]. They also noted stronger resilience as professional experience increases which suggests a need for more experienced nurses to provide support and understanding for younger nurses[46]. This suggests that the effect of social support on quality of life is more impactful than previously thought[46].

ENVIRONMENTAL INFLUENCES ON QUALITY OF LIFE

Elderly individuals are at an increased risk of suffering from issues in their community or neighborhoods[48]. Mõttus et al. explored the connection between mental health, quality of life, and neighborhood deprivation[48]. Elderly individuals who reported they were unhappy with their neighborhoods also had low quality of life scores[48]. They noted that deprived communities are considered more dysfunctional and can contribute to a low quality of life for older populations who may need assistance in their physical, social, or psychological aspects of daily living, such as getting a ride to a doctor's office or having meals delivered[48]. Mõttus et al. also pointed out that there is a possibility that the risk of emotional disorders goes up as the quality of the neighborhood goes down[48].

Accordingly, individuals and families with high social status, financial stability, and healthy marriages are more likely to have a high quality of life[49]. This could be very prevalent in large cities where wealth and social status varies drastically within the same neighborhoods[49]. Fassio et al. looked at the effects of an environment's population density on quality of life to see if the connection exists[49]. They found that high income, physical health, marriage, being female, and low population increased the perception of a high quality of life[49]. Population density most affected quality of life in regards to psychological, environmental, and socioeconomic health status[49]. This contributes to the

notion that the environment has strong ties to perceived quality of life and certain zip codes may put individuals at higher risk[48–50].

WHOQOL-BREF QUESTIONNAIRE

The World Health Organization Quality of Life Questionnaire (WHOQOL) is one of the most reliable tools for measuring quality of life in research and clinical settings[19]. There are many variations of this survey since the original consists of 236 questions[19]. The WHOQOL-100 was developed to be more universally applicable across cultures and other languages[19]. The abbreviated, 26-question WHOQOL-BREF Questionnaire was created to be more practical and quick[19]. This uses the most impactful questions from each of the four domains to measure happiness[19]. This version consists of 7 questions asking about physical health, 6 for psychological health, 3 for social relationships, 8 for environmental health, and 2 questions about overall quality of life[19]. When compared to the original WHOQOL Questionnaire and the other variations, the WHOQOL-BREF provided similar data results with no significant difference between surveys[19]. Although the WHOQOL or the WHOQOL-100 are slightly more accurate due to the higher number of questions, the WHOQOL-BREF is an appropriate survey to use when quality of life is not the primary outcome being measured[19].

HAPPINESS

OVERVIEW AND DEFINITION

To define happiness would result in varying answers across various cultures, individuals, and ages in different environments and stages of life. Hart et al. vaguely defines happiness as the satisfaction someone gets from their own life[50]. Happiness is often defined as having positive feelings about life that bring pleasure, not having

negative feelings about life that bring distress or difficulty, and feeling satisfied in general[51,52]. There are many complexities that contribute to a feeling of happiness, such as how well someone reaches their goals, personality type, confidence, social networks and human interaction, job and financial status, mental and physical health, and an sense of purpose or meaning in life overall[50]. The weight that each of these domains carries is different from person to person. Some might view their job as their primary source of fulfillment while others simply see it as a way to support their family and it plays a much smaller role in their happiness.

Happiness is not just a measure of satisfaction, it directly contributes to an individual who is better prepared to handle the difficulties of life[53]. Vatankhah et al. sought to teach various life skills to children and measure their happiness and self-esteem[54]. These data suggest that individuals who have strong life skills are generally happier[54]. Assertiveness was also found to be closely interrelated to happiness and entails strong communication skills and emotional maturity[53]. Hojjat et al. noted that those who are happy are better at making decisions, have more positive personal relationships, feel safer, and have better control over their emotions[53]. This relationship works the other way too. Small lifestyle changes contribute to improved happiness which is related to an improved longevity and decreased disease prevalence[55].

SOCIOECONOMIC DETERMINANTS

Although happiness is deeply dependent on internal factors and personality traits, achieving happiness can be directly influenced by external stimuli as well[50]. It is safe to say that living in a safe neighborhood with good weather would be more likely to contribute to improved levels of happiness than living a city riddled with crime and

devastating natural disasters[50]. Hart et al. studied the effects of these environments in thousands of neighborhoods across Europe[50]. They found that those who thought their neighborhoods were safe, functional, visually appealing, and had an active social life were much happier than those in less accessible regions[50]. This may be attributed to reduced levels of stress, more emotional support, and aesthetic pleasure, all of which contribute to achieving happiness[50,56].

Brereton et al. sought to determine which aspects and amenities of the geographic environment contribute to happiness[56]. They used Geographic Information Systems software to compare data visually according to the geographic location[56]. Extreme weather such as high or low temperatures affect the perceived happiness of individuals living in those conditions[56]. Access to transportation was also influential but it depended on the type of transportation site in the area[56]. Loud roads with high levels of traffic decreased happiness while access to an airport within a short driving distance increased happiness[56]. What they concluded is that climate, landfill and transportation sites, and natural amenities are just as important to happiness levels as non-geographic factors such as marital status or job satisfaction[56]. It would be interesting to use this software in future research to investigate the impact of proximity to grocery stores to happiness levels in the area.

Within any living environment, there must be a social community to provide stress relief and emotional support in the company of other individuals[50]. Those who report high levels of happiness often live in communities where the social network interacts frequently and there is mutual trust amongst neighbors[50,57]. This provides a sense of social safety and support while reducing negative emotions that hinder

happiness[50,57]. Rohrer et al. analyzed whether the intentions behind the pursuit of happiness affect the end result[57]. Participants who aimed to increase happiness via social interaction and spending more time with loved ones were significantly happier a year later[57]. Those who aimed to improve happiness by job satisfaction, financial gains, or other non-social achievements did not increase happiness after one year[57]. The researchers believe this is culturally dependent and may be impacted by the values of the social community[57]. Those in parts of Asia and Europe find happiness in social interaction and strive to model their lives to allow for more social engagement, while those in the United States often pursue happiness by way of non-social achievements such as employment or living conditions[57,58]. This suggests that happiness is not just subjective to the desires of an individual but also to socioeconomic and cultural standards[50,56–58].

THE NEUROSCIENCE BEHIND HAPPINESS

Feeling a sense of satisfaction with life is key to achieving happiness. This does not mean that everything has to be perfect in life, instead a happy individual would feel emotionally satisfied and grateful with what is present in their life. Pleasure and a sense of satisfaction are the acute responses to internal and external stimuli, while happiness is more of a chronic emotion based on these stimuli and emotional responses[59,60].The neurotransmitters that can be attributed to feeling generally happy in life include dopamine, serotonin, norepinephrine, and endorphins[60].

Endorphins and dopamine are both famously known as the neurotransmitters that produce a sense of euphoria from exercise[59–62]. However, endorphins are also released from the stimuli that are associated with intense emotion such as laughter, music, feeling

anger, fear, love, orgasms, eating chocolate or other foods that bring pleasure, physical activity, creating art, watching a movie, as well as many other actions and stimuli[60]. During these moments, endorphins are released promoting relaxation and tranquility in the brain which provide a sense of satisfaction and happiness[63]. Dopamine provides more of a higher energy type of happiness that increases risk-taking behavior[59]. Rutledge et al. looked at the effects of administering dopamine to healthy young adults to see how it would affect their feelings of happiness and decision making skills[59]. They found that the increased dopamine levels were related to being more willing to take risks[59]. The sense of reward from positive outcomes of those risky decisions were associated with increased happiness compared to those with lower dopamine levels[59]. They concluded that dopamine is related to increased momentary happiness[59,60]. Ashby et al. also suggests that dopamine is associated with increased happiness but that it does not directly cause it[64]. This is related to the idea that happiness is a chronic emotion that cannot be singularly caused by one neurotransmitter alone or a single moment of pleasure[59,60,64].

Serotonin, as previously discussed, is responsible for optimistic tendencies and being more easily satisfied by stimuli[42,60]. Similarly, norepinephrine can be attributed to happiness by both processing and demonstrating emotions via facial expressions[60,61]. Prescription medications, called reuptake inhibitors, are used to increase these neurotransmitters in the brain to treat depression, a clinical condition of low mood state where serotonin, norepinephrine, and other neurotransmitters are low[60,61]. Harmer et al. attempted to find the mechanism behind norepinephrine and happiness by putting one of these medications to the test[61]. Participants consisted of healthy adults who were given a dose of a norepinephrine reuptake inhibitor and asked to view and identify the emotions

portrayed by actors doing different facial expressions[61]. They found that the way stimuli and facial expressions are perceived by individuals with lower norepinephrine levels is skewed[61]. These tendencies result in negative thoughts and difficulty with decision making in those who are depressed[61]. However, the processing was significantly better in the intervention group where norepinephrine levels were increased and participants were able to identify emotions accurately[61]. Harmer et al. conducted another study using serotonin reuptake inhibitors using the same methods and found similar results to the norepinephrine trial[61,62]. This suggests that those who have adequate levels of serotonin as well as norepinephrine are more likely to achieve happiness in life[61,62].

DIET QUALITY

Current research has indicated that dietary intake can have a major effect on mental state including happiness and a sense of well-being[65]. One study by Jyväkorpi et al. looked at the effects of diet quality on happiness in elderly men between 82-97 years old[65]. They found that those who consumed more fruits and vegetables and met their caloric needs had increased levels of happiness[65]. In contrast, those who skipped meals, had unintended weight loss, and did not meet their energy needs were more likely to have a lower sense of perceived well-being[65]. This effect is supported in findings by Mujcic et al. where over 12,000 individuals ages 15 to 93 living in Australia were assessed for the effect of fruit and vegetable intake on happiness[66]. Not only did increased consumption of plant foods correlate with increased happiness after 2 years, these effects were more immediate than the benefits of increased diet quality on physical health[66]. Impressively, these effects were equally significant at increasing happiness as getting a job after being unemployed[66]. Mujcic et al. maintain that this research has rarely been used as a primary

goal for nutrition education since most programs aim at improving diet quality by promoting physical health benefits[66]. Future research should investigate the effects of promoting increased happiness as a benefit of improved plant food intake and see whether this is a more effective philosophy in motivating the public.

The mechanism behind plant foods improving happiness levels can be referenced back to the neuroscience of happiness[41,42]. Inflammatory cytokines activate the enzymes that limit tryptophan availability thus limiting serotonin availability[67]. This inflammation and low tryptophan levels are present in those who experience depression[67]. This implies that happiness levels may increase in the absence of inflammation and presence of adequate tryptophan levels. Bremner et al. believes that high intakes of saturated fat affect mood in this way by increasing inflammation and interfering with these neurotransmitters[39]. This sort of poor diet quality can affect the gut microbiome by contributing to leaky intestinal walls and decrease the production of serotonin and other neurotransmitters associated with positive psychological states[39,41,42]. Diets that include high intakes of fish, unsaturated fats, fruits, vegetables, nuts, and moderate portion sizes, such as the Mediterranean diet, are associated with higher levels of happiness and decreased prevalence of depression[39,68]. The Mediterranean diet is known to decrease inflammatory biomarkers due to the high intake of polyphenols found in olive oil and wine as well as many fruits, vegetables, and grains[68]. This low inflammatory state allows for more efficient use of neurotransmitters that support satisfaction, pleasure, and overall happiness[39,41,42,68].

HAPPINESS WHILE FASTING

A few studies have looked at the mental health effects of religious fasting[69,70]. Nasiri et al. administered a survey before and after Ramadan to see if there was a change in mental health status related to Ramadan[71]. They found that mental health was significantly improved in those who participated in Ramadan fasting[71]. They attributed much of the change in mental state to the community aspect of religion as well as the social and cultural support[71]. Whether this affects happiness directly is left to be determined, but it can be inferred that it may be a positive relationship due to the ties between mental health and perceived well-being[71].

Some intermittent fasting trials have noticed improvements to mental health during Ramadan fasting, but there is some speculation on how the fasting itself affects neurotransmitters as opposed to diet quality[69]. Michalsen et al. set out to identify how to mood states can be improved by engaging in periods of fasting[72]. They found that fasting improved tryptophan and serotonin availability in the brain thus leading to a more positive mental state[72]. BDNF, brain-derived neurotrophic factor, helps grow nerve cells in the brain and manage energy balance[73]. Low BDNF levels are associated with depression and other neurological conditions relating to negative psychological states[73]. Intermittent fasting may counteract these effects as BDNF levels increase during periods of fasting[14,72,73]. However, elevated BDNF and serotonin in fasting periods may not be sufficient to significantly increase happiness alone. Future fasting studies should address the multifactorial influences on happiness rather than attempt to narrow it down to one neurotransmitter.

CHALLENGES OF COLLEGE STUDENTS

Higher education has proven to be a particular experience in life that provides its own unique challenges and major life changes in a short period of time. During their studies, college students deal with a great amount of psychological and emotional stress, something that plays a major role in influencing happiness[74]. Short et al. looked at two different surveys measuring happiness to see if they were good predictors of resiliency in college students[74]. They found that although the surveys provided varying levels of measured happiness, they both displayed linear correlations to resilience[74]. They believe that resilience is foundational in achieving academic success and vital to perceived well-being in college[74].

An aspect of resiliency and happiness that college students tend to struggle with is having a positive body image and perceived well-being[74,75]. Wang et al. analyzed these characteristics in 425 college students in China to find a relationship to disordered eating[75]. They found that women who were unhappy with their physical appearance had lower self-esteem and were less happy overall[75]. Both men and women were shown to engage in fad dieting and excess exercising in the pursuit of weight loss for aesthetic purposes[75]. It would be interesting to see the data on students who are not satisfied with their body image who engage in intermittent fasting during college.

OXFORD HAPPINESS QUESTIONNAIRE

Happiness can be seen as the ultimate goal in life for many people and what drives motivation and desire. The Oxford Happiness Instrument (OHI) is a survey developed for psychology research at The University of Oxford in 1989[76]. Although it only consisted of 29 questions at the time, it has since been adapted into the Oxford

Happiness Questionnaire (OHQ) in the hopes that an abbreviated version would be more easily applicable for use in other areas of research where happiness is not the primary outcome[76]. When the OHQ was compared to the OHI for significant difference between the two groups, the surveys were significantly related and could be substituted for eachother[76]. This survey is widely used today across many areas of research for its accuracy, practicality, and accessibility[18,51,53,54,74,76–78].

CHAPTER 3

METHODOLOGY

PARTICIPATION AND STUDY DESIGN

Participants qualified if they were healthy, free of acute or chronic illnesses, non-smoking, non-vaping college students at least 18 years old attending university in Arizona. In addition, participants needed to be normal to underactive engaging in less than 420 minutes of physical activity per week and not training or competing in any sporting events. Participants needed to have a waist circumference ≥ 80 centimeters for women or ≥ 94 centimeters for men. Female participants were required to have regular menstrual cycles. Participants were not excluded for race, ethnicity, or socioeconomic status.

Participants did not qualify if they were fasting regularly for more than 12 hours per day or participating in other types of fasting such as Ramadan in the prior six months. Applicants were also excluded if they tried to lose weight or had a change in weight (≥ 5 pounds) in the last six months, including recent or current pregnancy, lactating, or history of weight cycling. They did not qualify if they worked night shifts or could not adhere to the fasting regimen or data collection visits. Female participants who were not on prescription contraceptives were excluded if they reported irregular periods.

Sample size was determined by examining other studies that looked at quality of life using the WHOQOL-BREF questionnaire before and after an intervention (see Appendix G)[79–83]. A minimum of 42 participants were needed to determine that there would be a treatment effect in WHOQOL-BREF scores with 80% power and a two-sided significance level of 0.05[79–83].

One doctoral student, three MS students, and three undergraduate students recruited participants. Participants were recruited by handing out flyers to students outside of classrooms and walking around the downtown Phoenix and Tempe campuses at Arizona State University (ASU) and neighboring universities, sending emails asking ASU professors to send the flyer to their students, posting flyers on bulletin boards and bathroom stalls, and speaking in front of ASU students in their classes.

The Institutional Review Board at Arizona State University approved this study to be conducted from October 4, 2019 to October 3, 2020 (see Appendix A). Participants provided official written consent before any other data was collected at the initial visit and a copy of the consent form is given to the participants.

The study was a parallel-arm, randomized control trial consisting of two groups: the intervention group that was instructed to fast 18 hours per day and a control group that fasted for 8 hours per day. Researchers and participants were not blinded to the fasting regimens but participants were not aware of a control group or the study hypothesis. Dr. Carol Johnston, the principal investigator who did not interact with participants, stratified de-identified participants by age, gender, BMI and METS, and randomly assigned them to either the intervention or control group. Participants were measured at baseline and week 4, and at the end of the study (week 8). Measurements were completed while fasted (no food or beverage for ≥ 8 hours) at the same time of day, the same day of the week, and (for women) the first week of the menstrual cycle The visits were administered by the same researchers who were cross-trained to keep measurements consistent.

INDEPENDENT VARIABLE

This study examined whether the independent variable, an 18-hour fasting intervention or an 8-hour fasting control, would have an effect on the dependent variables, quality of life and happiness, after 8 weeks. Participants were not instructed to change their diet in any way other than the window of time they can eat. The feeding window began one hour after waking and continued for 6 hours in the intervention group and for 16 hours in the control group. Participants were allowed one 'free' day per week (e.g., they did not need to adhere to the assigned fasting regimen); the 'free' day was the same day of the week each week.

PROTOCOL PROCEDURES AND DEPENDENT VARIABLES

The flyer used in recruitment (see Appendix B) included a QR code with a link to a survey to check if applicants qualify to participate in the study. If they qualified, they were emailed and asked to complete a 7-day food diary. This diary was used as a fidelity check to test if they would be able to manage fasting for the study; it was also used as a screening tool to check their bedtime, total calories consumed, and see if they currently fast. If they completed the diary successfully, consumed sufficient daily calories for their estimated requirements, did not fast, and had regular sleep times, they were entered into the study.

For females, the initial visit was scheduled on or several days after the first day of their period. Upon arrival, participants were instructed to sign in and meet the researcher in the lobby of the Arizona Biomedical Collaborative building 1 in Phoenix, Arizona. Participants were then escorted to the consent room. The lead researcher discussed the consent form (see Appendix C) and, after signing the consent, answered questions.

Participants were given a copy of the consent form and recruitment flyer to keep for their records. They then read, filled out, and signed the Research Results Acknowledgement Statement form (see Appendix D) to receive their results from the study. To measure blood pressure, participants remained seated quietly for 10 minutes and completed a health questionnaire, the WHOQOL-BREF survey to determine their perceived quality of life (see Appendix F), and the Oxford Happiness Questionnaire to evaluate their perceived levels of happiness (see Appendix E). Following the blood pressure measurement, the researcher administered a diet recall questionnaire using plastic foods to help visualize portion sizes. Participants were given paper calendars to keep track of study visits and fasting days. All participants were instructed to complete a 4-day food log record at weeks 4 and 8.

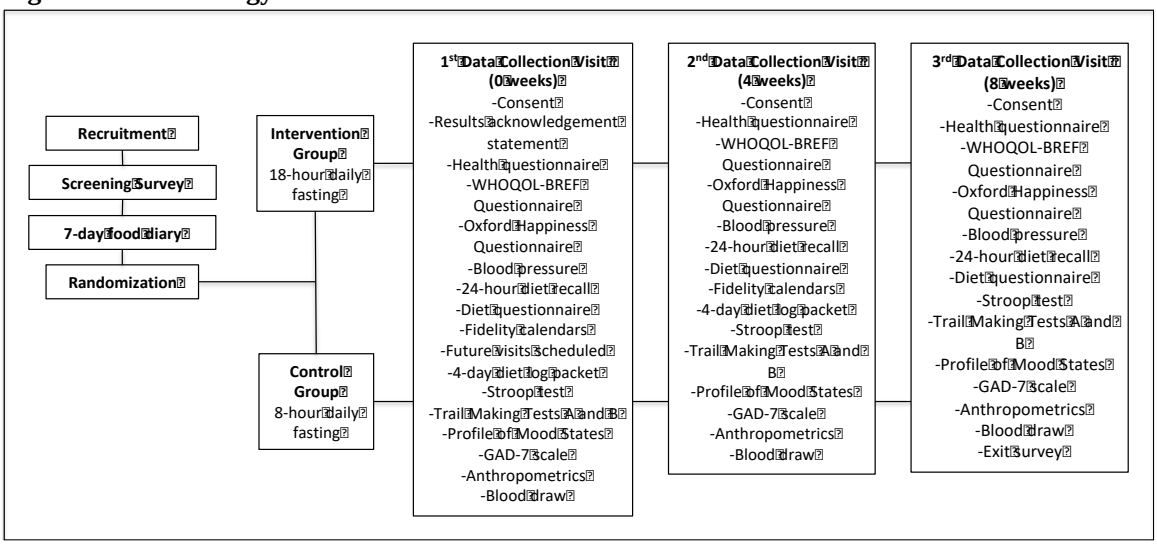
Participants then moved to the next station to complete cognition testing. Researchers administered the Stroop Test using a video on a laptop. Participants watched a video with names of colors in different colored fonts and said the color of the font while the researcher kept track on a piece of paper whether they got it right or wrong. They then completed two Trail Making Tests. The first test had them connect numbers in numerical order without raising their writing utensil while the researcher kept track of the time. The second trail making test followed the same protocol but added letters between each number in alphabetical order connecting 1 to A to 2 to B and so on.

Following the cognition tests, participants completed the Profile of Mood States and Generalized Anxiety Disorder 7-item scale to evaluate moods and anxiety levels. Next, anthropometric measurements were completed. Participants were asked to remove their shoes and any bulky layers of clothing such as a sweater or coat. Their height was

measured in centimeters using a stadiometer (Cat. No. 2131821009, SECA 213, Birmingham, UK). Weight and body composition were recorded by bioelectrical impedance (Cat. No. TBF-300, Tanita, Arlington Heights, IL). Participants were asked to step onto the scale with toes and heels touching the metal pads. Waist circumference measurement was taken twice using a Gluck tape measure (Jamar Tape Measure with Weight, Rolyn Prest #081546209, Japan), and a third measurement may have been taken if the first two were not within 0.5 centimeters of each other. The same standard procedure was repeated for hip circumference. Participants were asked to take a seat while the trained phlebotomist drew 12 milliliters of blood from the median cubital vein on their arm of choice.

Participants began their fasting regimen for eight consecutive weeks after the first visit, and two additional visits took place on weeks four and eight repeating the same procedures as visit one. The last visit also included an exit survey about their experience in the study, and participants were given a $25 gift card once they completed all requirements.

Figure 1. Methodology Flow Chart



The present study only focused on the results from the WHOQOL-BREF survey to determine their perceived quality of life and the Oxford Happiness Questionnaire to evaluate their perceived levels of happiness.

LABORATORY ANALYSES

The WHOQOL-BREF questionnaire was developed as an abbreviated version of the WHOQOL-100 questionnaire[19]. Dr. John Orley led the project development with the help of researchers and health practitioners from 15 different countries around the world. The measure covers four domains: physical health, psychological health, social relationships, and environment[19]. Only domains 2 and 3 were used for this study, which comprised of questions 5-7, 11, 19-22, and 26.[19]

Psychologists Dr. Michael Argyle and Peter Hills developed the Oxford Happiness Questionnaire at Oxford University in 2002[76]. It consists of 29 questions that are answered on a 6-point scale from "strongly disagree" to "strongly agree"[76].

These questionnaires were self-administered and took less than 5 minutes to complete both. The data from both questionnaires were graded by two different people and entered as total scores into an Excel spreadsheet. The values for questions 15, 21, 25, and 28 from the Oxford Happiness Questionnaire were also entered into the spreadsheet. Microsoft Excel for Mac 2011 Version 14.5.2 (150604) was used to record the data.

STATISTICAL ANALYSES

Data from both questionnaires were presented as mean scores with standard deviations within each randomized group. Both questionnaires had numerical scores associated with the answer participants chose[19,76]. The WHOQOL-BREF asked for answers on a scale from 1 to 5 while the Oxford Happiness Questionnaire asked for

answers on a scale from “strongly disagree” to “strongly agree”[19,76]. Some of the answers on both questionnaires were scored in reverse[19,76]. For example, if there were six possible answers and a participant selected “strongly agree”, which was equivalent to 6 points, for “I laugh a lot”, then they got 6 points; if they selected “strongly agree” again for “I don’t have fun with other people”, this was scored in reverse as it is a negative statement and they got 1 point[76].

The software IBM SPSS Statistics Version 25 64-bit edition was used to test the data for normality. The Shapiro-Wilk significance score was used if the sample size was <50; the Kolmogorov-Smirnov significance score was used for a larger sample. If the data were normal, an unpaired t-test would have been used to analyze the change data for any treatment effects (week 8 minus baseline). If the data were not normal, a log transformation would have been used to normalize the data. If they remained not normally distributed, a Mann-Whitney test would have been used. With at least 42 participants, there was an 80% power and a two-sided significance level, or p-value, of 0.05 suggesting that if any significant effect were detected, it was likely not due to chance.

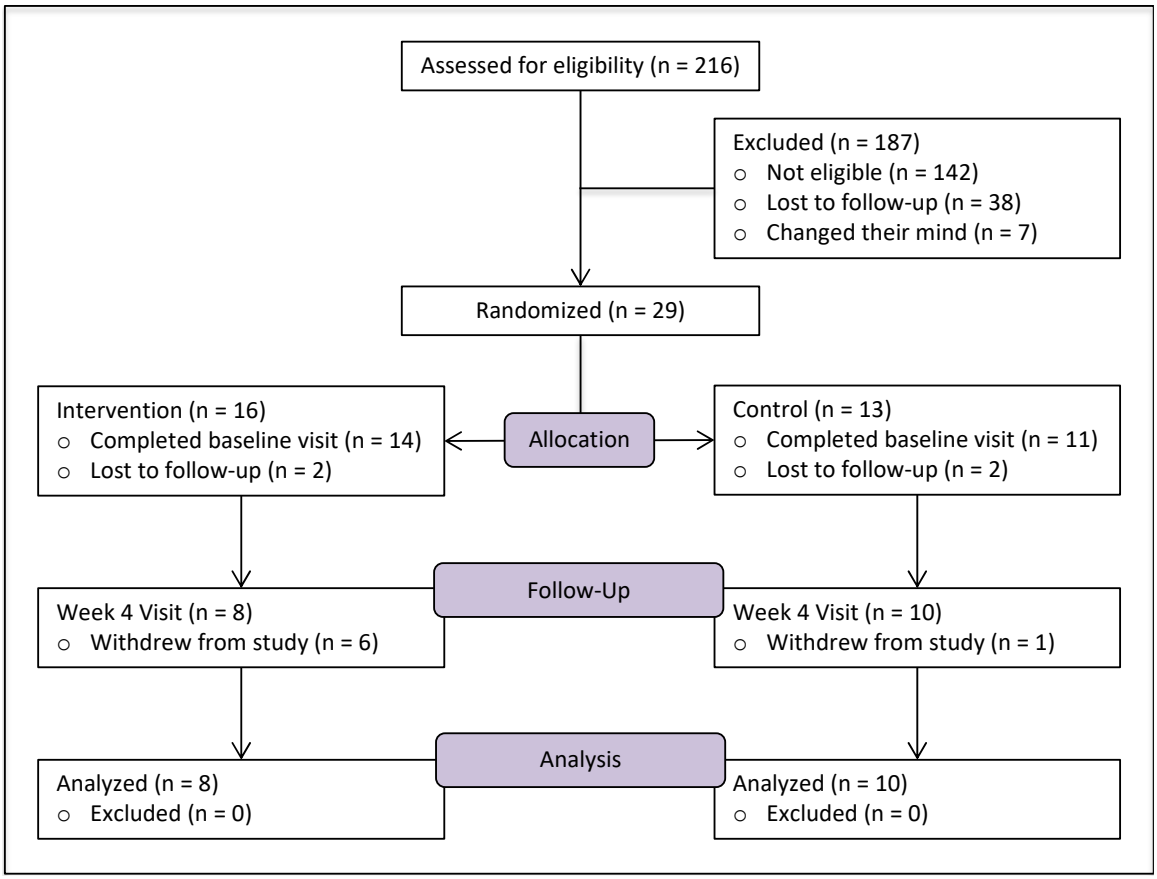
CHAPTER 4

RESULTS

DESCRIPTIVE STATISTICS

There were 74 participants who met the inclusion criteria out of 216 that were initially assessed for eligibility. Only 29 of these participants were randomized into the trial because the other 45 participants either never responded or changed their mind about participating in the study. Once randomized, 16 participants were allocated to the intervention group (INV) and 13 to the control group (CON). A total of 18 participants, 8 in the intervention group and 10 in the control group, completed the study and were used in the statistical analysis (Figure 2).

Figure 2. Consort Flow Chart



Descriptive data was collected at baseline and assessed for significant differences between treatment groups (Table 1). There was statistical significance between the INV and CON groups for age with a p-value of 0.009 (INV 29.1 ± 9.7 y; CON 21.8 ± 3.8 y). None of the other five descriptive characteristics showed significance between groups. The p-values for waist circumference (0.068) and weight (0.083) were close to the significance marker of $p < 0.05$, which may suggest a possible statistical trend toward significance (INV 69.5 ± 4.8 cm; CON 75.7 ± 7.0 cm). Average weight for INV and CON was 59.5 ± 6.4 kg and 67.6 ± 10.6 kg respectively. Hip circumference (p=0.101) was 95.8 ± 6.6 cm and 101.2 ± 7.0 cm for INV and CON respectively. The average BMI for the INV and CON groups were 22.3 ± 2.2 and 24.4 ± 2.4 kg/m^2, respectively (p=0.146). Height showed a p-value of 0.573, the furthest from the significance marker: 163.5 ± 5.8 cm and 166.1 ± 7.4 cm for INV and CON respectively.

Table 1. Descriptive Statistics at Baseline by Treatment Group

	CON (n = 10)	INV (n = 8)	p-value
Age (years)	21.8 ± 3.8	29.1 ± 9.7	0.009
Height (cm)	166.1 ± 7.4	163.5 ± 5.8	0.573
Weight (kg)	67.6 ± 10.6	59.5 ± 6.4	0.083
BMI (kg/m^2)	24.4 ± 2.4	22.3 ± 2.2	0.146
Waist Circumference (cm)	75.7 ± 7.0	69.5 ± 4.8	0.068
Hip Circumference (cm)	101.2 ± 7.0	95.8 ± 6.6	0.101

Table 1: INV represents the group receiving the time-restricted feeding intervention, and CON represents the control group. Data was tested for significance using a Mann-Whitney Nonparametric Independent T-test. Values were recorded as the mean ± standard deviation for each characteristic by treatment group. Statistical significance was noted for any p-value < 0.05.

DATA ANALYSIS

The data from the Oxford Happiness Questionnaire and WHOQOL-BREF questionnaire were analyzed for significance and reported in Table 2. The COVID-19

global pandemic interrupted data collection in March 2020 prior to data collections for week 8 visits. The safety protocols required participants to complete their final visits via Zoom and questionnaires to be sent by email. Due to these changes and the potential impact on quality of life and happiness from the pandemic, only the data from baseline and week 4 were analyzed (Table 2). Week 8 data was not used in the final report.

The WHOQOL-BREF Questionnaire showed significance favoring fasting for Domain 3 which covered social relationships ($p=0.026$). From baseline to week 4, the CON group mean scores decreased from 12.4 ± 1.9 to 11.8 ± 2.4, a change of -0.6 ± 0.5; the INV group increased from 11.0 ± 1.3 to 11.5 ± 1.6, a change of 0.5 ± 0.3. Domain 2 of this questionnaire did not show significant change ($p=0.290$).

There were no statistically significant data reported from the Oxford Happiness Questionnaire in the first four weeks of treatment. However, there was a slight trend in favor of the intervention for question 25 stating "I feel I have a great deal of energy" ($p=0.088$). The CON group went from a 4.2 ± 0.8 to 3.6 ± 0.8 points for this question, a decrease of 0.6 ± 0.0 after 4 weeks. The INV group saw an increase of 0.6 ± 1.0 points after 4 weeks from 4.3 ± 1.6 at baseline to 4.9 ± 0.6 points at follow-up. The total happiness score and the other questions did not show a trend toward significance.

Table 2. Quality of Life (QOL) and Happiness indicators at Baseline and at Week 4

		CON (n = 10)	INV (n = 8)	p value
WHOQOL-BREF Questionnaire				
Domain 2	Baseline	23.0 ± 2.8	23.8 ± 4.5	0.290
psychological health	Week 4	23.7 ± 3.6	23.5 ± 2.8	
Domain 3	Baseline	12.4 ± 1.9	11.0 ± 1.3	0.026
social relationships	Week 4	11.8 ± 2.4	11.5 ± 1.6	
Oxford Happiness Questionnaire				
Happiness	Baseline	135.9 ± 17.5	137.8 ± 22.3	0.690
(Total Score)	Week 4	132.0 ± 19.2	135.9 ± 28.0	
Question 15	Baseline	5.1 ± 1.0	4.9 ± 1.6	0.584
"I am very happy"	Week 4	4.8 ± 0.9	4.8 ± 1.2	
Question 21	Baseline	4.3 ± 1.3	5.1 ± 0.6	0.555
"I feel…mentally alert"	Week 4	4.2 ± 0.9	4.8 ± 1.0	
Question 25	Baseline	4.2 ± 0.8	4.3 ± 1.6	0.088
"I feel…great deal of energy"	Week 4	3.6 ± 0.8	4.9 ± 0.6	
Question 28	Baseline	4.6 ± 1.4	5.4 ± 0.7	0.342
"I don't feel…particularly healthy"	Week 4	4.1 ± 1.4	5.4 ± 0.7	

Table 2: INV represents the group receiving the time-restricted feeding intervention, and CON represents the control group. Data was tested for significance using a repeated measures ANOVA test. Data is reported as the mean ± standard deviation for each variable by treatment group. Those with average scores for the Oxford Happiness Questionnaire between 29-58 are not happy, 59-87 are somewhat happy, 88-115 are neither happy nor unhappy, 116 are somewhat happy, 117-145 are happy, 146-173 are very happy, and 174 are too happy[18,76]. The WHOQOL-BREF questionnaire does not have a comparable interpretation of values. Any p-value < 0.05 is statistically significant.

CHAPTER 5

DISCUSSION

This study attempted to determine whether engaging in a daily 18-hour fasting regimen would impact quality of life and happiness in university students in Arizona after 8 weeks. Much of the research done on intermittent fasting is on animals, and even within the few human trials and the animal trials, none have looked at the effects of these regimens on quality of life nor happiness[22,69,70,72]. The most similar trials have looked at how Ramadan and religious fasting affects mental health[8,23,69–71]. One unpublished pilot trial found that mood states improved after 4 weeks of daily 16-hour fasting, however the population sample was small[22]. This suggested that time-restricted feeding may impact moods which contributes to mental health status and is closely related to happiness and quality of life[5,22,39,40,43,44,69–71]. The hypothesis was that adherence to an 18-hour daily fasting regimen for eight weeks compared to an 8-hour daily fasting regimen will improve happiness and quality of life in college students in Arizona.

Two questionnaires were used to determine quality of life and happiness: the Oxford Happiness Questionnaire and the WHOQOL-BREF Questionnaire. Certain statements were picked out of the Oxford Happiness Questionnaire to be further analyzed against overall happiness scores. The intent was to see if a statement such as "I am very happy," would provide significance against the total happiness score. None of the selected questions provided this anticipated significance though. Furthermore, only two of the four domains of the WHOQOL-BREF Questionnaire were used. The domains on physical health and environment were not expected to be affected after 8 weeks of this diet regimen. The domain on psychological health did not show significance either, but

the domain on social relationships displayed significant improvement. Although there was some significant improvement in quality of life, there was none for happiness, therefore the hypothesis is rejected.

The significant improvement in social relationships is particularly interesting because the most common complaint amongst those who dropped out of the study was that they were having a hard time maintaining social relationships with such a restrictive eating window. These participants struggled to not eat during evening social gatherings and stated that their families were complaining about not being able to eat meals together. This complaint was also mentioned in the pilot study by the participants as the main difficulty throughout the entire trial[22]. Participants also stated they were overwhelmed with feelings of hunger, struggling to eat enough food within 6 hours, and feeling fatigued. The inconsistency with the data and the reported comments may reflect the small sample size and/or the bias created by participant attrition; that is, the participants who did complete the study were not having these issues or they had strong relationships and interactions with family and friends. It is possible that the screening process inadvertently excluded those who frequently socialize at meal times such as in ethnic cultures where food is the center of social gatherings[84].

This may also have been similar in the results found by Lin et al. where 83% of their population sample were female[34]. They saw a significant improvement in quality of life in females when compared to males[34]. Another similarity to this trial is that their participants consisted of college students in health-related areas of study[34]. Although the present study did not collect data on this, much of the participants stated they were in health-related studies and the recruitment was primarily done in these classes. This raises

the need for further research into how quality of life is affected by gender and the area of study in college students.

Lin et al. also mentioned an improved nutrition-related quality of life in those with high social and interpersonal relationship scores[34]. This is similar to the significance found in the present study and suggests a possible nutrition-related impact beyond fasting alone. Albeit possible, it is not likely that the improvements in social life in the present study were related to an improved diet quality due to the findings from the primary study[85]. The primary study by Mayra et al. examined how time-restricted feeding affects diet quality, weight, and cardiometabolic measures[85]. Although they did find that weight significantly decreased in the time-restricted feeding group, they did not see an improvement in diet quality nor cardiometabolic measures[85]. This is the only study to date to look at changes in diet quality during a time-restricted feeding regimen [85].

There was also a trend towards significance in the Oxford Happiness Questionnaire statement "I feel a great deal of energy". This is also interesting considering another common complaint from participants who dropped out was low levels of energy and feeling fatigued throughout the day. Similar to the social relationships data, this may be due to the small sample size or that the participants that did complete the trial were able to consume enough calories in their eating window to sustain energy levels throughout the day.

Participants were also asked to start their eating window within one hour of waking up. This made it particularly difficult for participants who, for example, wake up at 6 AM and attend class for the next few hours. Trying to eat during class or between classes and following the study protocol may have put additional stress on participants

that was not accounted for by the committee approving the main study. This was not required for the present study, however, this study was a part of a larger trial with a different set of requirements set by that committee for approval. The intent with starting the eating window so soon in the morning was to align circadian rhythms to dietary intake. Human metabolism has evolved to use circadian rhythms as a way of signaling the start and end of the day[28]. This provides the body increased efficiency and disturbing this rhythm, such as in those who work night shifts, can put individuals at increased risk of chronic disease including negative psychological states[28]. The committee did not want this disturbance to play a role in the intervention so they set this requirement as a way to control for this possible influence on the data. However, this restriction seemed to make it harder for participants to complete the study with 43% (6 participants) of the intervention group dropping out of the study and only 9% (1 participant) dropping out of the control group. This difficulty with timing of meals may have been alleviated by allowing participants to choose when their 6-hour eating window commenced, possibly improving the ability to eat during social gatherings and eat around their own schedule.

LIMITATIONS

Since this was part of another study, the exclusion criteria were much more specific than would have been necessary for the present study. This made recruitment difficult with 87% of applicants not qualifying to participate in the trial. Furthermore, participants may have been discouraged by the need for three blood draws, whether the gift card incentive was worth their commitment, the difficulty of the regimen, the upcoming holiday season, medical conditions, or other personal concerns. Happiness and quality of life could have been influenced by the holidays as participants started in

November 2019 through January 2020. Participants may have been in a poor financial state, stressed by the holidays, spending the holidays alone, may have done poorly on final exams, or been affected by the COVID-19 pandemic, all of which worsened their happiness and quality of life; or conversely, they may have been surrounded by loved ones, traveling, receiving gifts, or celebrating the end of the fall semester thus improving their happiness and quality of life.

Other limitations in the sample include that only one of the 18 participants to complete the trial was male. There was a significant difference between age for both groups with the average age in the control group being 7 years greater than the intervention group. The compliance to the regimens were self-reported in logs and subject to the honesty of the participants. The participants also had one day per week where they could veer away from the diet regimen but it had to be the same day of the week. During the holidays, it was permitted to change to another day such as Christmas or Thanksgiving to prevent stress, discouragement, or dropping out. Those who started in January did not get this adjustment privilege at any point. Also, participation was originally exclusive to Arizona State University college students but then liberalized to other college students halfway through the study in the hopes of increasing the sample size.

Additionally, the COVID-19 pandemic provided extreme difficulty with concluding the study. The trial was interrupted when only a few participants were left that needed to finish their week 8 visit. As such, only the data up to week 4 was used in analysis which was not the initial intention. Future studies should use the full 8 week trial period but attempt to narrow the window of possible start dates to control for the external

factors that may affect happiness and quality of life. A larger sample size, more even distribution of age and gender, more liberal exclusion criteria, and closer monitoring of compliance would be beneficial when conducting any further investigations on intermittent fasting, quality of life, and happiness.

GENERALIZABILITY

The data from the present study can be generalized to healthy, non-athlete female college students who are non-smokers, not pregnant or breastfeeding, and don't work night shifts. The present study had a high attrition rate, only one male participant and he was in the control group, a small sample size recruited mostly from health-related schools within the universities, and other practical difficulties during data collection such as different research assistants administering surveys and entering data.

The lack of studies looking at the effects of intermittent fasting on mental health, happiness, or quality of life and the increased likelihood of engaging in fad diets in college indicates a need for more generalizable data for this population. For one, the feeding window for the intervention group may need to be expanded from 6 hours to 8 hours or more as was in the pilot study. In addition to extending the feeding window, allowing participants to choose the time of day to start eating could reduce the difficulty with social relationships and family meals. Although the COVID-19 pandemic could not have been anticipated, further research should attempt to complete and analyze the full 8 week trial. It would be beneficial to include computer-generated surveys as well to eliminate the possible variations between different researchers methodology and reduce data entry errors. Recruiting participants from other degree majors and areas of college campuses to get a variety of students may help balance out the gender disparities seen in

the present study. Future studies would benefit from controlling for these limitations to generalizability seen in the present study and increase the practicality of the diet regimen.

CHAPTER 6

CONCLUSION

The primary hypothesis that adherence to an 18-hour daily fasting regimen for eight weeks compared to an 8-hour daily fasting regimen would improve happiness and quality of life in college students was not fully supported by the data from this study. Quality of life improved in the time-restricted feeding group by way of improved social relationships, however, there were no significant data to support happiness would also improve. Future studies should include a larger sample size with a wider variety of participants to increase validity and generalizability. As happiness and quality of life have such a significant impact on academic performance, well-being, and mental health, universities should support future investigations on whether time-restricted feeding impacts quality of life and happiness in their students.

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APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL FORM

APPROVAL: EXPEDITED REVIEW

Carol Johnston
CHS: Health Solutions, College of
602/496-2539
CAROL.JOHNSTON@asu.edu

Dear Carol Johnston:

On 10/4/2019 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Mealtime Matters: An 8-wk Randomized-Controlled Trial to Examine the Effects of a Daily Time-Restricted Feeding Protocol on Diet Quality
Investigator:	Carol Johnston
IRB ID:	STUDY00010810
Category of review:	(2)(a) Blood samples from healthy, non-pregnant adults, (4) Noninvasive procedures, (7)(b) Social science methods, (7)(a) Behavioral research
Funding:	Name: Graduate College
Grant Title:	
Grant ID:	
Documents Reviewed:	• REAPS, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • 24-h diet recall, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Data release form, Category: Technical materials/diagrams; • survey monkey screener, Category: Screening forms; • POMS, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • trail making test, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);

	• calendar, Category: Participant materials (specific directions for them); • email for food diary, Category: Screening forms; • consent, Category: Consent Form; • generalized anxiety disorder measure, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • quality of life questionnaire, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • oxford happiness questionnaire, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • protocol, Category: IRB Protocol; • health questionnaire, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • exit survey, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • verbal script and ad, Category: Recruitment Materials;

The IRB approved the protocol from 10/4/2019 to 10/3/2020 inclusive. Three weeks before 10/3/2020 you are to submit a completed Continuing Review application and required attachments to request continuing approval or closure.

If continuing review approval is not granted before the expiration date of 10/3/2020 approval of this protocol expires on that date. When consent is appropriate, you must use final, watermarked versions available under the "Documents" tab in ERA-IRB.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc:

Kelly Chondropoulos
Selicia Mayra
Natalie Kopplin
Anateresa De Leon

APPENDIX B

RECRUITMENT FLYER

ASU STUDY SEEKS PARTICIPANTS:

FASTING AND HEALTH

THE ASU NUTRITION PROGRAM IS RECRUITING

HEALTHY COLLEGE STUDENTS

TO EXAMINE THE EFFECTS OF FASTING ON HEALTH

Participation is voluntary – **three study** visits are required, and you will be asked to fast either 18 hours/day or 8 hours/day for 8 weeks

Participation Includes:

- Three 60-minute visits to the Nutrition Research Facility (ABC1) at the downtown ASU campus (near 5th Street and Van Buren)
- At each study visit you will complete diet recalls and health questionnaires, body composition assessments, a single blood draw, and blood pressure testing
- Fasting is defined as no beverage or food with the exception of water and non-caloric beverages such as tea or coffee; however, there will be one 'cheat' day per week allowed each week of the study

You will receive a **$25** *Amazon card for your participation and study results*

INTERESTED?? Please visit our recruitment site:

https://www.surveymonkey.com/r/FastForHealth

APPENDIX C

PARTICIPANT CONSENT FORM

Informed Consent

Fasting and Health in College Students

INTRODUCTION
The purposes of this form are (1) to provide you with information that may affect your decision as to whether or not to participate in this research study, and (2) to record your consent if you choose to be involved in this study.

RESEARCHERS
Dr. Carol Johnston (ASU Nutrition professor) and Selicia Mayra (registered dietitian and ASU doctoral student in nutrition), have requested your participation in a research study.

STUDY PURPOSE
The purpose of this study is to investigate the effects of fasting on health including common blood biomarkers, disposition, and anthropometrics in college students.

DESCRIPTION OF RESEARCH STUDY
You have indicated to us that you are a non-smoker and □years of age and healthy. You have not recently dieted for weight loss, regularly fast □hours per day, followed fasting regimens (i.e., alternate day fasting, Ramadan-style fasting, 5:2 fasting), and if female, you are not currently pregnant or planning a pregnancy, and you either have a regular cycle or are currently on hormonal contraceptives (i.e., birth control pills, IUDs, or patches). Also, you are not currently ill or taking prescription medications for a medical condition, and you do not work the night shift. You will be randomly assigned to a fasting arm of the study: the 18-hour fast or the 8-hour fast. You are asked to follow the fasting protocol 6 days a week for 8 weeks. You will select one day of the week (e.g., Friday or Saturday) as 'cheat day' for the entire study and on this day you do not need to 'fast'. You may eat the foods of your choice during the study, and we ask that you maintain your normal physical activities and not initiate a new exercise protocol.

This research entails three study visits to our test facilities on ASU's Downtown Phoenix campus for up to 60 minutes per session. You will be asked to complete diet recalls and mood/cognitive questionnaires and your height, body weight, blood pressure, and waist and hip circumference will be measured, and a small amount of blood (<2 tablespoons) will be collected from an arm vein during these three visits. No food or beverage aside from water is to be consumed for the 8 hours prior to this blood draw. Blood will be used to measure biomarkers related to cardiovascular health such as cholesterol and ketones.

You will receive a $25 e-gift card to Amazon once you have completed your final visit to our test facilities.

RISKS
You may feel hungry and unfocused during the fasting periods; you are allowed to consume unsweetened and non-caloric beverages such as water, coffee and tea during this period. The blood draw will be performed by trained staff (either a registered nurse or a registered radiology technician) under sterile conditions. You may feel lightheaded or nauseous when your blood is drawn and you may bruise; our staff are trained to handle such situations. You may feel discomfort when blood pressure is recorded due to the cuff constriction.

BENEFITS
You may not benefit from this study, but once the study is complete you will be provided with your data, if desired. You will need to complete a study release form to receive your test results.

NEW INFORMATION
If the researchers find new information during the study that would reasonably change your decision about participating, then they will provide this information to you.

CONFIDENTIALITY
All information obtained in this study is strictly confidential unless disclosure is required by law. The results of this research study may be used in reports, presentations, and publications, but your name or

identity will not be revealed. In order to maintain confidentiality of your records, Dr. Johnston will use subject codes on all data collected, maintain a master list separate and secure from all data collected, and limit access to all confidential information to the study investigators.

WITHDRAWAL PRIVILEGE

You may withdraw from the study at any time for any reason without penalty or prejudice toward you. Your decision will not affect you any manner. We ask that you notify us in a timely manner if you decide to withdraw from the study, and we will ask you to complete the exit survey at that time.

COSTS AND PAYMENTS

You will receive a $25 Amazon e-gift card for participation in this trial. There are no payments required for this study; however, you may need to pay for curbside parking at the test site (rate: $1.50/hour).

COMPENSATION FOR ILLNESS AND INJURY

If you agree to participate in the study, then your consent does not waive any of your legal rights. However, in the event of harm, injury, or illness arising from this study, neither Arizona State University nor the researchers are able to give you any money, insurance coverage, free medical care, or any compensation for such injury. Major injury is not likely but if necessary, a call to 911 will be placed.

VOLUNTARY CONSENT

Any questions you have concerning the research study or your participation in the study, before or after your consent, will be answered by Dr. Carol Johnston, 550 N. 3rd St., Phoenix, AZ 85004. [602-496-2539]

If you have questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Research Compliance Office, at 480-965 6788.

This form explains the nature, demands, benefits and any risk of the project. By signing this form you agree knowingly to assume any risks involved. Remember, your participation is voluntary. You may choose not to participate or to withdraw your consent and discontinue participation at any time without penalty or loss of benefit. In signing this consent form, you are not waiving any legal claims, rights, or remedies. A copy of this consent form will be given to you.

Your signature below indicates that you consent to participate in the above study.

_____	_____	_____
Subject's Signature	Printed Name	Date

_____	_____
Contact phone number	Email

INVESTIGATOR'S STATEMENT

"I certify that I have explained to the above individual the nature and purpose, the potential benefits, and possible risks associated with participation in this research study, have answered any questions that have been raised, and have witnessed the above signature. These elements of Informed Consent conform to the Assurance given by Arizona State University to the Office for Human Research Protections to protect the rights of human subjects. I have provided the subject/participant a copy of this signed consent document."

Signature of Investigator_____ Date_____

APPENDIX D

RESEARCH RESULTS ACKNOWLEDGEMENT STATEMENT

ASU College of Health Solutions

Nutrition Program

Research Results Acknowledgement Statement

This letter is to communicate your lab results from the ASU study: Fasting and Health in College Students

The result ranges given reflect acceptable general ranges and do not serve as definitive indicators of health or disease as the results of any test need to be evaluated in the context of other factors by a physician or clinician. Therefore, these results do not serve as a diagnosis of any kind for any medical condition and need to be interpreted by a physician or qualified health care provider. By signing below, you agree to share this information with your primary care physician to learn about how these results are relevant to your health and/or disease risk and discuss next steps.

If all your results are within the normal range please share these results with your physician or health care provider at your next routine checkup visit.

If you have results outside of the normal range we recommend you share and discuss these results with your primary care physician or qualified healthcare provider within 5 days. ASU Student Health Services is also an option for you to consider for access to care if you do not currently have a primary care provider.

ASU Health Services contact information:
• Phone 480-965-3349
• Online scheduling https://eoss.asu.edu/health
• For locations and other information https://eoss.asu.edu/health/contact

Sincerely,

Selicia Mayra and Dr. Carol Johnston

_____

Read and initial each statement below and sign to request your research results

_____ understand that test results obtained during research studies are not used for diagnostic purposes.

_____ understand that it is my responsibility to discuss any results and follow up with my primary care physician or qualified health professional and that neither the study investigators or research staff will provide interpretation or care recommendations on the basis of any of the research results provided to me.

My signature below confirms the above statements and receipt of my results from participation in the research study entitled: ASU Study: Fasting and Health in College Students

_____ _____
Signature /Printed Name Date

_____ _____
Researcher collecting signature /Printed name Date

Results will be sent by U.S. mail.
Address to send results: _____

_____

APPENDIX E

RECRUITMENT EMAIL TEMPLATE

Hi _____,

My name is Anateresa De Leon and I'm a graduate student in the College of Health Solutions working with Dr. Carol Johnston. I am currently recruiting participants for our study that I believe some of your students might be interested in. I am writing to ask if you could post the recruitment flyer for my IRB approved research study on your ____ Canvas platform, please?

Please let me know if there are any questions.

Warmest regards.

Anateresa De León
Research Assistant, College of Health Solutions
Nutrition Graduate Student, MSDI Program

Arizona State University

ASU STUDY SEEKS PARTICIPANTS

FASTING AND HEALTH

THE ASU NUTRITION PROGRAM IS RECRUITING HEALTHY COLLEGE STUDENTS TO EXAMINE THE EFFECTS OF FASTING ON HEALTH

Participation is voluntary – **three study** visits are required, and you will be asked to fast either 18 hours/day or 8 hours/day for 8 weeks

Participation Includes:

- Three 60-minute visits to the Nutrition Research Facility (ABC1) at the downtown ASU campus (near 5th Street and Van Buren)
- At each study visit you will complete diet recalls and health questionnaires, body composition assessments, a single blood draw, and blood pressure testing
- Fasting is defined as no beverage or food with the exception of water and non-caloric beverages such as tea or coffee; however, there will be one 'cheat' day per week allowed each week of the study

You will receive a **$25** Amazon card for your participation
INTERESTED?? Please visit our recruitment site:
https://www.surveymonkey.com/r/FastForHealth

APPENDIX F

OXFORD HAPPINESS QUESTIONNAIRE

ID# _____ Date _____

Questionnaire – check the appropriate answer for the recent past	Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Moderately agree	Strongly agree
I don't feel particularly pleased with the way I am						
I am intensely interested in other people						
I feel that life is very rewarding						
I have every warm feelings towards almost everyone						
I rarely wake up feeling rested						
I am not particularly optimistic about the future						
I find most things amusing						
I am always committed and involved						
Life is good						
I do not think that the world is a good place						
I laugh a lot						
I am well satisfied about everything in my life						
I don't think I look attractive						
There is a gap between what I would like to do and what I have done						
I am very happy						
I find beauty in some things						
I always have a cheerful effect on others						
I can fit in (find time for) everything I want to						
I feel that I am not especially in control of my life						
I feel able to take anything on						
I feel fully mentally alert						
I often experience joy and elation						
I don't' find it easy to make decisions						
I don't have a particular sense of meaning and purpose in my life						
I feel I have a great deal of energy						
I usually have a good influence on events						
I don't have fun with other people						
I don't feel particularly healthy						
I don't have particularly happy memories of the past						

APPENDIX G

WHOQOL-BREF SURVEY TO MEASURE QUALITY OF LIFE

WHOQOL-BREF

The following questions ask how you feel about your quality of life, health, or other areas of your life. I will read out each question to you, along with the response options. **Please choose the answer that appears most appropriate.** If you are unsure about which response to give to a question, the first response you think of is often the best one.

The following questions ask about **how much** you have experienced certain things in the last four weeks.

	Not at all	A little	A moderate amount	Very much	An extreme amount
How much do you enjoy life?	1	2	3	4	5
To what extent do you feel your life to be meaningful?	1	2	3	4	5

	Not at all	A little	A moderate amount	Very much	Extremely
How well are you able to concentrate?	1	2	3	4	5

The following questions ask about how completely you experience or were able to do certain things in the last four weeks.

	Not at all	A little	Moderately	Mostly	Completely
Are you able to accept your bodily appearance?	1	2	3	4	5

	Very dissatisfied	Dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very satisfied
How satisfied are you with yourself?	1	2	3	4	5
How satisfied are you with your personal relationships?	1	2	3	4	5
How satisfied are you with your sex life?	1	2	3	4	5
How satisfied are you with the support you get from your friends?	1	2	3	4	5

The following question refers to how often you have felt or experienced certain things in the last four weeks.

	Never	Seldom	Quite often	Very often	Always
How often do you have negative feelings such as blue mood, despair, anxiety, depression?	1	2	3	4	5

APPENDIX H

SAMPLE SIZE CALCULATION TABLES[79–83]

	Author	Year	Change	n per group	calculated n per group	age range	subject state	test
1	Pan et al	2010	-0.7 ± 1.7	38	188	20 to 65	obese (BMI >27 kg/m2) with >1 risk factor for metabolic syndrome	WHOQOL-BREF (Taiwanese version) Domain 1 changes from body weight loss
1	Pan et al	2010	-0.9 ± 1.7	38	114	20 to 65	obese (BMI >27 kg/m2) with >1 risk factor for metabolic syndrome	WHOQOL-BREF (Taiwanese version) Domain 2 changes from body weight loss
1	Pan et al	2010	-0.7 ± 1.4	38	128	20 to 65	obese (BMI >27 kg/m2) with >1 risk factor for metabolic syndrome	WHOQOL-BREF (Taiwanese version) Domain 3 changes from body weight loss
1	Pan et al	2010	-0.5 ± 1.2	38	184	20 to 65	obese (BMI >27 kg/m2) with >1 risk factor for metabolic syndrome	WHOQOL-BREF (Taiwanese version) Domain 4 changes from body weight loss
2	Tai et al	2016	1.14 ± 0.45	14	8	>65	Alzheimers patients in outpatient clinic, upper limb mobility, free of other neurological/muscular conditions	WHOQOL-BREF (Chinese version) Domain 1 changes from Tai Chi, calligraphy, and drawing training in alzheimers patients
2	Tai et al	2016	0.24 ± 0.09	14	8	>65	Alzheimers patients in outpatient clinic, upper limb mobility, free of other neurological/muscular conditions	WHOQOL-BREF (Chinese version) Domain 2 changes from Tai Chi, calligraphy, and drawing training in alzheimers patients
2	Tai et al	2016	-0.07 ± 0.02	14	6	>65	Alzheimers patients in outpatient clinic, upper limb mobility, free of other neurological/muscular conditions	WHOQOL-BREF (Chinese version) Domain 3 changes from Tai Chi, calligraphy, and drawing training in alzheimers patients
2	Tai et al	2016	0.16 ± 0.05	14	6	>65	Alzheimers patients in outpatient clinic, upper limb mobility, free of other neurological/muscular conditions	WHOQOL-BREF (Chinese version) Domain 4 changes from Tai Chi, calligraphy, and drawing training in alzheimers patients
3	Chan et al	2017	8.46 ± 1.27	50	4	>65	frail elderly over 65 years old who can sit up and understand instructions/consent	WHOQOL-BREF (Chinese version) Domain 1 changes from acupressure on frail elderly
3	Chan et al	2017	3.94 ± 0.92	50	6	>65	frail elderly over 65 years old who can sit up and understand instructions/consent	WHOQOL-BREF (Chinese version) Domain 2 changes from acupressure on frail elderly
3	Chan et al	2017	4.61 ± 0.84	50	6	>65	frail elderly over 65 years old who can sit up and understand instructions/consent	WHOQOL-BREF (Chinese version) Domain 3 changes from acupressure on frail elderly
3	Chan et al	2017	4.3 ± 0.92	50	6	>65	frail elderly over 65 years old who can sit up and understand instructions/consent	WHOQOL-BREF (Chinese version) Domain 4 changes from acupressure on frail elderly

4	Lüdtke et al	2018	1.36 ± 0.44	35	6	18 to 65	18 to 65 year olds who have depressive symptoms, an iPhone, and aren't a danger to themselves	WHOQOL-BREF (German version) overall changes from self-help phone app in people with depression symptoms
5	Marufe et al	2013	23.33 ± 2.48	45	4	18 to 65	18 to 65 year olds who are physically able who also have uncontrolled high blood pressure despite medication use	WHOQOL-BREF (German version) Domain 1 changes from aerobic exercise in people with high blood pressure
5	Marufe et al	2013	18.17 ± 4.19	45	6	19 to 65	19 to 65 year olds who are physically able who also have uncontrolled high blood pressure despite medication use	WHOQOL-BREF (German version) Domain 2 changes from aerobic exercise in people with high blood pressure
5	Marufe et al	2013	14.51 ± 6.25	45	10	20 to 65	20 to 65 year olds who are physically able who also have uncontrolled high blood pressure despite medication use	WHOQOL-BREF (German version) Domain 3 changes from aerobic exercise in people with high blood pressure
5	Marufe et al	2013	11.51 ± 5.83	45	12	21 to 65	21 to 65 year olds who are physically able who also have uncontrolled high blood pressure despite medication use	WHOQOL-BREF (German version) Domain 4 changes from aerobic exercise in people with high blood pressure

	Author	Year	Change	n per group	calculated n per group	age range	subject state	test
1	Hojjat et al	2015	7.89 ± 1.27	28	4	12 to 15	female, unmarried, 12 to 15, rural areas, both parents addicted to opium, no recent death in family, no mental health issues	OHQ score changes and other effects of assertiveness skill training on middle school girls with parents with drug addiction
2	Rezvan et al	2006	8.33 ± 0.55	30	4	19 to 22	female students, between 19 to 22 years old, attending Esfahan University on a form of academic probation	OHQ score and academic changes of metacognition training on college women with academic probation
3	Vatankhah et al	2014	11.028 ± 1.058	15	4	14 to 18	female students, between 14 to 18 years old, attending Shahed High School in Tonekabon	OHQ score and self-esteem changes of teaching life skills to high school girls
4	Anees et al	2017	37.91 ± 3.4	35	4	13 to 15	boys and girls, between 13 to 15 years old	OHQ score changes and other effects of teaching intrapersonal life skills to adolescents
5	Kim et al	2019	18.733 ± 0.278	15	4	mean 21	men and women, fine arts undergraduate and graduate students at University of South Dakota	OHQ score changes and other effects of being shown positive images/stimuli to college students