

A Narrative Review of the Possible Effects of Inflammatory Properties of Diet on Body Weight Regulation

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Abstract

Fatness is considered a serious problem that many people all over the world are suffering from this trouble. Diet is known as a solution to obesity among people. This study aimed to analyze previous studies about the probable effects of inflammatory properties of Diet on body weight regulation. For this purpose, four articles from online sources have been investigated in detail. The results and conclusions of all reviewed articles have been compared at the end of this Study. The results of the reviewed article showed a direct correlation between the inflammatory properties of a diet and body weight regulation.

Keywords: Inflammatory Properties; Weight Regulation; Diet

Chapter One: Introduction

This chapter first provides background about gas scavenging in active packaging. Next, the statement of the problem, objectives, and significance of the Study will be explained. After these brief explanations, definitions of key terms will be reviewed.

Background of the Study

Gas scavenging in active packaging systems is used to slow or stop microbial, enzymatic, and oxidative degradation to reduce contamination and reduce weight [1]. The increasing occurrence of obesity poses a significant concern for public health. Obesity is a prevalent issue in developed nations and developing nations that impacts millions of adults [2]. The implementation of a low-calorie diet and exercise regimen has been found to yield favorable results in promoting weight loss. However, studies also demonstrate that weight frequently regains after weight loss through traditional lifestyle modification, including a low-calorie diet.

Statement of the Problem

Many studies have reported a correlation between the inflammatory properties of one's diet and the likelihood of developing obesity. It remains uncertain whether this phenomenon extends to the specific scenario of weight alteration that occurs during and following participation in a weight loss program. Moreover, studies showed the relationship between gene variations in inflammation markers and obesity [3]. Despite this fact, there exists a need for more meta-analyses and review articles investigating the impact of inflammation on the regulation of body weight. This article tried to make a detailed review of the previous studies related to the mentioned issues.

Significance of the Study

The outcomes and conclusions reached in the current study could be helpful for future review studies and researchers who want quick and sufficient information related to inflammation and body weight regulation.

Definition of Key Terms

Inflammation

Inflammation is a biological process involving various cell parts, such as immune cells and internal organs. Inflammation is a vital response to the host's protection against pathogens [4].

Weight Regulation

Achieving body-weight management precision that remains (within $\pm 1\%$ over a long time) requires the establishment of a pathway that regulates total fat mass [5].

Diet

Diet represents a foundation for the treatment and prevention of obesity and overweight [6].

Chapter Two: Literature Review

Background

In this chapter, various key terms will be explained in detail. Then some articles related to the context of this Study will be reviewed.

Aspects of Inflammatory Properties

Inflammation consists of four types, and each of these four aspects is explained in the following lines.

- 1) Inflammation is modulated through the interplay between innate and adaptive immune responses to combat infectious agents. This involves the activation of various cell types and the release of mediators that aim to terminate or combat the invading pathogen, ultimately leading to the elimination of foreign material.
- 2) Inhaled agents like diesel exhaust particles, ozone, and endotoxin are identified as the causative agents of inflammation.
- 3) Allergic inflammation is initiated through the cross-linking of specific immunoglobulin E antibodies and mast cells, leading to the immediate release of various inflammatory mediators and activation of inflammatory cells.
- 4) Neurogenic inflammation, mediated by the neural system in which some types of cells sense the presence of a “foreign material”, and are born to delete the perceived hostile intruder.

Diet

To realize the relationship between disease and diet, nutritional epidemiologists have recently studied foods or eating habits to look at food and nutrient combinations. Nutrition is related to disease and health [7]. The different types of diets will be explained in the following lines.

Hypo-Energetic Diet

Energy restriction is a diet-dependent but nonspecific way to reduce low-grade inflammation. Weight loss was associated with decreased rates of circulating inflammatory mediators [8]. The reason for this outcome may be attributed to either weight loss or the specific dietary regimen utilized for the treatment of the condition. In contrast, it appears that the decreased freedom of inflammatory mediators by adipocytes or activated adipose tissue macrophages contributes to weight loss [9]. However, calorie restriction may also act as an anti-inflammatory task. The primary causal agents responsible for this outcome are the sirtuin and Forkhead box family proteins, specifically subtype O (FoxO), which are activated or induced in instances of calorie restriction.

Mediterranean Diet

The Mediterranean diet is typical of many areas of southern Spain, southern Italy, Greece, and other parts of the world. Other places in the Mediterranean area. The traditional Mediterranean diet is high in vegetables, fruits, fish, Nuts, low-fat dairy products, legumes, olive oil, whole grains, and moderate alcohol consumption [10]. Adherence to the Mediterranean diet was assessed by scores associated with the consumption of these foods [11].

Vegetarian Diet

Several articles have studied the relationship between vegetarian or non-vegetarian diets in healthy subjects with inflammatory markers. A diet rich in vegetables decreased endothelial function and concentrations of markers of inflammation [12]. In one study, C-reactive protein (CRP) concentrations were reduced in thirty Taoist adults after 5–55 years (average 22 years) of vegetarianism [12]. In a study, it was observed that the average concentration of CRP was notably lower among individuals who followed a vegetarian diet (0.77 mg/l) in comparison to those who did not adhere to this dietary pattern (1.30 mg/l).

Body Weight Regulation

The lack of balance between the energy consumed and energy intake surely caused obesity [13], Various factors, including individual metabolism, dietary macronutrient composition, energy consumption distribution [14], and the energy balance equation, have been identified as potential contributors to body weight and composition regulation. Based on these findings, it is possible to postulate that this regulation is influenced by three primary factors: (1) body fat storage, (2) food intake, and (3) nutrient metabolism and thermogenesis. These three components are explained in the following lines, and the relation between body weight regulation and these components is presented in Figure 1.

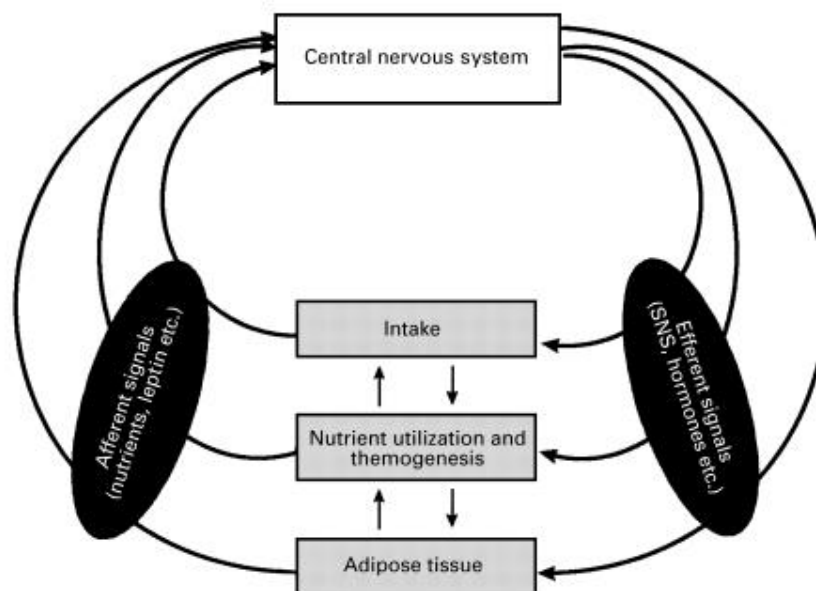


Figure 1: The relation between body weight regulation and inter-related components [15]

Food Intake

The act of consuming food can trigger various sensory inputs such as nutrient signals, gastrointestinal signals, and circadian rhythms, all of which play a role in modulating appetite through specific mechanisms involving neurotransmitters [16], such as neuropeptides, monoamines, and amino acids. Additionally, the metabolic response to food intake involves several circulating hormones and the autonomic nervous system [17]. The inputs derived from the consumption of food result in humoral and neural outputs that serve to properly regulate nutrient metabolism, nutrient intake, and energy [18].

Nutrient Turnover and Thermogenesis

The regulation of fat oxidation after food intake is less strict compared to carbohydrate, or protein oxidation [19]. The thermogenic response of brown adipose tissue (BAT) is attributed to a balance between the effects of the sympathetic innervation of BAT and its central nervous system origin [20]. This balance has direct implications for both food intake and fat deposition [17].

Body Fat Stores

Maintaining lipid balance is much less noticeable because daily calorie imbalance significantly affects on body fat stores. The hormone leptin plays a crucial role in regulating the body's energy balance by activating a lipo stat, which acts as a regulatory system. This lipo stat provides information to the central controller regarding the current fat stores in the body [21]. The system regulates fat deposition by activating neuronal and endocrine signals that act as mediated by β_3 -adrenergic receptors [22] and certain peptides or hormones that directly affect lipid turnovers, including insulin, growth hormone, insulin, adrenal steroids, and growth factor-1 [18]. This study investigates the function of recently identified molecules and genes in the process of adipocyte differentiation and fat deposition, with a specific focus on peroxisome proliferative activating receptors, CCAAT enhancer binding protein, binding protein fatty acids, etc. [22].

Empirical Previous Studies

The aim of this study was to investigate the impact of dietary habits and variations in inflammatory genes on weight fluctuations in individuals with obesity. The study had four specific objectives, including: (1) This study aims to assess the correlation between inflammatory components of dietary intake and the likelihood of experiencing weight regain following participation in a weight loss program. Furthermore, this investigation seeks to determine the level of risk for obesity associated with these dietary factors; (2) A low-calorie diet with Low Inflammatory Properties, which can aid in weight reduction. Additionally, the study will investigate the correlation between dietary inflammatory characteristics and the likelihood of weight regain; (3) investigate the impact of variations in genes associated with inflammation on the relationship between obesity and inflammation; and (4) examine the relationship between alterations in genes associated with inflammation, dietary composition, and their effects on weight regain after a weight reduction program. The results indicated that dietary inflammation was associated with inflammation in adipose tissue, as evidenced by increased levels of leptin. Furthermore, it was found that dietary inflammation partially accounted for changes in weight regain after a weight loss program. The study concluded that modifying a standard low-calorie diet (LCD) to reduce its inflammatory traits (i.e.; LCID) resulted in decreased hs-CRP levels compared to an LCD but did not affect modifications in weight, IL6, or TNF- α variables [23].

One study investigated inflammatory markers, body compounds, and dietary total antioxidant capacity (dietary TAC) in obese and overweight women. They found that eating more antioxidant-rich foods can reduce visceral fat area (VFA), visceral fat level (VFL), fat-free mass (FFM), fat-free body mass index (FFMI), and waist circumference (WC), therefore, the risk of central obesity. The researchers infer that there is a positive correlation between various anthropometric measurements and the consumption of a diet high in dietary total antioxidant capacity (DTAC) [24]. This relationship is likely influenced by the elevation of serum levels of PAI-1 and IL-1 β . In light of these findings, it may be beneficial to incorporate antioxidant-rich foods into one's diet as a prophylactic measure against chronic illnesses, including cardiovascular disease [25].

A study to investigate the correlation between obesity indices and diet quality in working-age adults residing in Inner Mongolia. The findings indicated that the traditional diet only had a positive impact on obesity and overweight in men from Jiangsu province, China [26]. On the other hand, one study analyzed the relationship between endothelial activation and markers of inflammation and dietary habits 5089 non diabetic subjects from the Multiethnic Atherosclerosis Study. The study utilized factor analysis and identified four dietary patterns, of which the fish and vegetable model (cruciferous vegetables, yellow fish and foods, and other vegetables) was inversely related to IL-6 levels. While the fruit pattern and whole grain (green leafy vegetables, fruits, nuts, and whole grains) showed an inverse association with CRP, sICAM-1, and IL-6 concentrations. However, refined grains, tomatoes, and legumes (high-fat dairy products, refined grains, tomatoes, and beans) were positively associated with sICAM-1 levels. Similarly, fat and processed meat patterns (salty snacks, chips, processed meats, desserts, oils, and fats) were directly associated with CRP and IL-6 levels. It is worth noting that few studies have examined this topic using data outside of Europe or the United States [27].

Chapter Three: Methodology

The method used in this study was a narrative review. According to Egger and Davey Smith (1997), the review is a research process that synthesizes or systematically combines the results of single, independent studies using statistical methods to calculate an overall or "absolute" impact.

Search Strategy And Study Selection

We conducted a review to evaluate Effects of the Inflammatory Properties of Diet on Body Weight Regulation. The search encompassed all relevant studies available in databases from their inception until 15th July 2022 in four databases in English (PubMed, Web of Science (WOS), and Scopus). The data was extracted very carefully using specific keywords: ("Inflammations" OR "Innate Inflammatory Response" OR "Inflammatory Response, Innate" OR "Innate Inflammatory Responses") AND ("Diet" OR "Body Weights" OR "Weight, Body" OR "Weights, Body" OR "Obesity" OR "Weight Loss" OR "Weight Regulation"), which can be used combined with "OR" and/or "AND" or alone to identify additional studies. In order to guarantee precision, our search was limited to studies involving only human subjects. To prevent any possible replication, a pair of autonomous researchers conducted an evaluation of both main titles and abstracts. In instances where we were unable to obtain access to certain articles, we contacted the relevant author(s) via email.

Chapter Four: Findings

Background

In this chapter, the results of each Study mentioned in the literature review (chapter 2) will be provided in detail. Then all the results from the reviewed article will be compared and analyzed.

Data and Results

Results of Harry Freitag' (2021) Article

The influence of dietary variations and inflammatory genes on inflammatory properties and body weight variation in obesity was investigated (see review of literature in chapter 2). The absorption of IID components in the Indonesian population was compared to the global mean [25]. The study participants had elevated intakes of anti-inflammatory substances such as carbohydrates, total energy, vitamin B12, and iron while having reduced consumption of anti-inflammatory ingredients such as vitamin E, vitamin D, vitamin A, niacin, ω -6 fatty acids, and ω -3 fatty acids. The average daily energy intake for men was 11,285 kJ/day, consistent with Indonesian dietary recommendations for adult men [28]. Women's average energy is 10,277 kJ/day, which is low. They also found that DII scores did not correlate with lipid profiles, such as HDL-C and triglycerides. One study conducted a study involving a large cohort of French adults ($n = 3726$), The study revealed a positive correlation between DII scores and triglyceride levels at baseline, while no such correlation was found with HDL-C levels. However, after a 13-year follow-up period, the study indicated a significant association between DII scores and lower HDL-C levels, along with higher triglyceride levels. The relationship between lipid profile and DII score was also confirmed. who conducted a smaller study involving 90 participants in Colombia. Based on the DII scoring, participants with high anti-inflammatory diets demonstrated considerably reduced HDL levels, as per the findings of this study.

The results of a study involving 447 U.S. police officers indicate that an elevated DII score does not appear to be linked with a heightened risk for low HDL cholesterol or raised triglyceride concentration. Dyslipidemia has traditionally been regarded as an early biomarker of cardiovascular diseases, with cholesterol and triglyceride levels being key indicators. However, recent research

suggests that inflammation may be a more significant biomarker of cardiovascular diseases. This shift in focus is important as it may influence dietary approaches to prevent cardiovascular disease. Rather than solely targeting the reduction of triglycerides and cholesterol, alternative strategies may need to be considered, lowering the Diet's inflammatory properties might be more beneficial in preventing cardiovascular diseases [23].

Results of Radkhah et al.'s (2022) Article

In the second article mentioned in chapter 2 (Literature Review), conducted a study on overweight and obese women to investigate the relationship between body composition, inflammatory markers, and dietary total antioxidant capacity (DTAC) [24]. Findings showed that participants with higher scores on DTAC had high-density lipoprotein (HDL) and lower fasting blood sugar (FBS). Also identified was the beneficial impact of dietary antioxidants on both liver dysfunction and systemic inflammation, however, no significant alterations in FBS or HDL levels were detected. Additionally, they found that a high antioxidant diet led to a reduction in plasma concentrations of high-sensitivity C-reactive protein, gamma-glutamyl transferase activities, alkaline phosphatase, and alanine transaminase. Similarly, we did not find any significant association between DTAC tertiles and FBS or HDL levels. However, researchers reported an inverse relationship between lipid profile and DTAC in healthy Brazilian teens, indicating that an antioxidant-rich diet may reduce the risk of central obesity by decreasing visceral fat level, fat-free mass, and waist circumference [24].

As anticipated, the mediation analyses conducted for PAI-1 and IL-1 β yielded results that aligned with our expectations. Our findings suggest that these two factors can be regarded as mediating markers in the relationship between DTAC, W.C, VFA, and FFM. Despite the lack of clarity regarding the molecular mechanisms involved, it has been observed that antioxidant-rich diets, caloric restriction, or weight loss can reduce the oxidative stress associated with obesity and its complications, which may alter the production of inflammatory markers and overall antioxidant capacity. The anti-inflammatory properties of several vitamins and other potentially antioxidant bioactive compounds are attributed to their ability to modify the DNA-binding action of NF- κ B. The activation of NF- κ B is primarily heightened by oxidative stress. This leads to an increase in the expression of cell adhesion molecules (CAMs) in CRP production as well as the induction of IL-6 and TNF- α in the liver, which impacts the vascular endothelium through cytokine stimulation. Since the antioxidant vitamins and the effective flavonoids are both able to block the DNA-binding activity of NF- κ B in vitro, they can be considered. Antioxidants exhibit anti-inflammatory effects based on their redox potential rather than their molecular structure. Studies have demonstrated an inverse association between obesity-related properties and DTAC, supporting the hypothesis that oxidative stress induces obesity. Reactive oxygen species (ROS) exposure stimulates adipocyte differentiation (Sen, S., and Simmons, R.A.), leading to increased ROS production in adipose tissue and exacerbating obesity-related features. The pathogenic mechanism of this cycle can be interrupted by dietary antioxidants, which impact various metabolic pathways related to obesity. In addition to preventing intestinal fat absorption and improving catabolism in adipose tissue, dietary antioxidants can inhibit angiogenesis, differentiation, and proliferation in preadipocytes while inducing apoptosis in mature adipocytes. Certain antioxidants have the potential to modulate the thermogenesis and metabolism of brown adipose tissue. Furthermore, they can reduce the expression of leptin and adiponectin genes in adipocytes [24].

Results of Jia et al. (2020) Article

Jia et al. analyzed 1739 subjects (53.8 men, n = 935). They used Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to classify eating habits, and SEM and multivariable logistic regression to explore the relationship between dietary habits and overweight and obesity. Their findings showed the prevalence of overweight and obesity near 49.1% with any differences between men (51.2%) and women (47.2%); $P = 0.090$). maturity was positively associated with obesity and overweight in Jiangsu province, China, the grain alcohol diet (traditionally consumed by men), and the traditional diet (consisting of egg products, eggs, pickled vegetables, and whole grains) by multivariable logistic regression and SEM (OR = 1,954; 95% CI: 1.258 ~ 3.036; $\beta = 0.121$, $P < 0.05$, respectively).

Increasing the residual correlations and the modified indices obtained the final SEM model. The final model's goodness-of-fit indices showed an acceptable fit (male model: RMSEA = 0.052, GFI = 0.937, CFI = 0.745, ACFI = 0.919, PGFI = 0.730). Traditional diets have a positive effect on obesity and overweight ($\beta = 0.121$, $P < 0.05$).

Their conceptual SEM model of the association between sociology, diet, and lifestyle with overweight and obesity is shown in Figure 2.

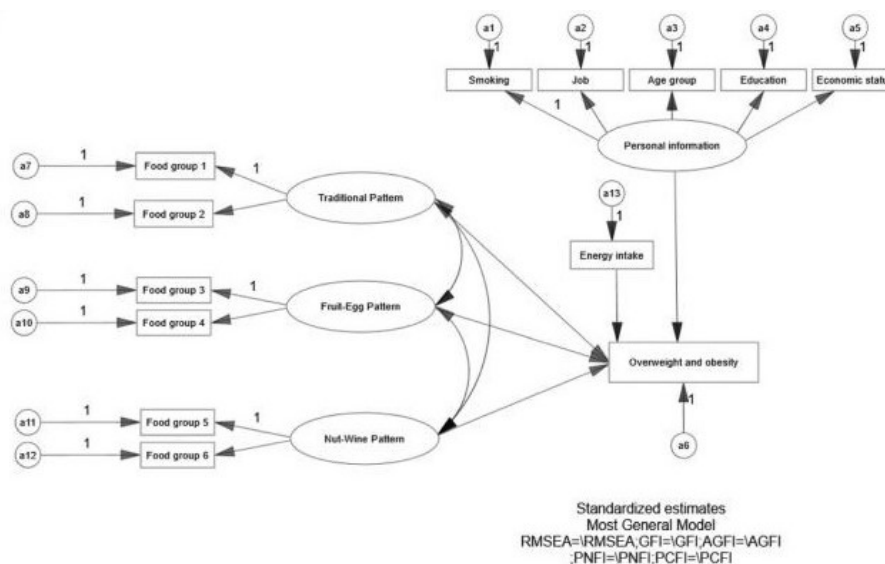


Figure 2: Conceptual SEM Model for the Association of Lifestyle, Dietary pattern, and Socio-demographic with Obesity and Overweight [29]

Three diets were achieved with EFAs and CFAs, in both women and men in this study: the grain alcohol diet, the fruit-egg diet, and the traditional diet. Traditional diets were only positively associated with obesity or overweight in men. A fruit diet with grain alcohol and eggs is not associated with obesity and overweight in men or women [26].

Results of Nettleton et al. (2007) Article

A study conducted on 5089 subjects without diabetes in the Multiethnic Atherosclerosis Study to investigate the relationship between dietary habits and markers of endothelial activation and inflammation. Factor analysis was used to draw four dietary patterns. The pattern characterized by high fat and processed meat consumption, including desserts, salty snacks, chips, processed meat, oil, and fat, was found to have a positive association with homocysteine (P for 0.002), IL-6 (P for 0.001), and CRP (P for trend 0.001). The pattern of refined grains, tomatoes, and beans (high-fat dairy products, refined grains, tomatoes, and beans) was positively associated with sICAM-1 (P for trend 0.007). In contrast, the pattern of fruits and whole grain (green leafy vegetables, nuts, fruits, and whole grain) exhibited a negative correlation with sICAM-1 (P for trend 0.034), homocysteine, IL-6, and CRP (P for trend 0.001), and fish and vegetable models. The relationship between homocysteine, IL-6, and CRP in processed meats and fats, fruit, and whole grains models is independent of demographic and lifestyle factors and is not altered by color or ethnicity. The relationship between homocysteine and CRP was independent of waist circumference. Data analysis for several variables including homocysteine, IL-6, and CRP, showed a positive correlation with the processed meat and fat sample and a negative association with the sample of fruit and whole grains. sICAM-1 exhibited a negative correlation with the fruit and whole grain models but was positively associated with the refined grain, tomato, and pea models. fish and vegetable models exhibited a negative correlation with IL-6 but no other markers. None of the eating patterns were significantly associated with the cell adhesion molecule, SE selection [27]. There is a significant relationship between homocysteine and CRP with fruit, whole grain, fat, and processed meat models, and between refined grain, tomato, and bean models, independent of waist circumference and other risk factors for CVD through food. Obesity is associated with elevated levels of inflammatory markers [30] and is thought to be a causal pathway between inflammation and diet. Their results suggest that the total food components represented by these models, such as low-fat

dairy products, vegetables, fruits, and whole grains, have anti-inflammatory biological qualities. The significance of inflammatory and anti-inflammatory dietary habits persists, irrespective of the individual's physical build. Moreover, our findings indicate that the association between these dietary patterns and inflammation is not attributed to conventional CVD risk factors.

Chapter Five: Conclusion

According to the accumulated consequences of reviewed articles, it may be perceived that during nearly all of them, the high-quality impact of inflammatory residences on Diet and weight problems changed. So, to reply to the query of whether the inflammatory residences in a unique weight loss plan have any impact on weight regulation, it may be proper to mention that there may be a directional relation between inflammatory residences and weight gain. The results indicated that dietary inflammation was associated with inflammation in adipose tissue, as evidenced by increased levels of leptin. Furthermore, it was found that dietary inflammation partially accounted for changes in weight regain after a weight loss program. This, in turn, will help stem the obesity epidemic and ultimately improve quality of life while reducing the economic burden of obesity.

Declarations

Ethical Approval and Consent to participate

Not applicable

Consent for Publication

We allow the publisher to publish the author's work.

Availability of Data and Materials

Available

Competing interests

Not applicable

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Authors' contributions

Zeinab Gholami: The role of the author of the article in designing the research study, collecting the article data, and analyzing and interpreting the article data. The active role of the author in writing the article and approving the final version of the article. Taking on the general and common responsibilities of the article about the research and the article

Professor Zamzam Paknahad: Preparing a draft of the article, revising it carefully

Sheno Karimi: review

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