Dietary Patterns and Depressive Symptoms in Young Guatemalan Women: An Analysis of Specific Correlations

Camila Heredia, M.D. and Lic. María Andrée Neumann
Graduate School
Universidad Francisco Marroquín

This study examines the relationship between inflammatory markers, diet, and depression in young Guatemalan women. Using a quantitative, non-experimental, cross-sectional correlational design, a sample of 30 participants was analyzed through the Beck Depression Inventory, a dietary questionnaire, and blood tests for CRP and ESR. The results revealed significant correlations between dietary patterns and depressive symptoms. A strong negative association was found between fruit consumption and symptoms such as loss of pleasure ($r = -0.49$, $p = 0.006$) and suicidal thoughts ($r = -0.48$, $p = 0.007$). Processed food consumption was positively correlated with symptoms such as pessimism and loss of interest. Although no direct correlations were found between diet and inflammatory markers, the findings suggest a potential protective effect of a fruit-rich diet against depression. The study highlights the importance of considering dietary interventions in the prevention and treatment of depression in young women.

Keywords: Keywords: ESR, CRP, Beck, mood, nutrition

Contextual Framework

The research was conducted on young women in Guatemala City. The decision to collect samples at the Salud UFM clinics and process them at LABOCLIP was based on ease of access and the willingness of these institutions to participate in the study. The Salud UFM clinic, being an institution that collaborates in the collection of samples for its students' research, and LABOCLIP, a laboratory known for its willingness to work with the academic community, provided a conducive environment for carrying out this research.

The study conducted is of significant current relevance given the increasing prevalence of depression globally. Depression is a common illness worldwide, estimated to affect more than 300 million people. On April 7, 2017, in commemoration of World Health Day, the WHO launched an annual campaign titled: "Let's Talk About Depression," highlighting the significant concern this topic generates (Toshi & Eileen, 2022).

Moreover, the results of this research could significantly contribute to the prevention and treatment of comorbidities related to chronic inflammation if a positive association is confirmed. Conversely, if a negative or non-significant association is found, the findings would still be valuable in guiding future research in this area.

Although similar studies have been conducted in various locations, there is a lack of similar research in the Guatemalan population in particular. In general, Guatemala has been a country where research on depression has been less prevalent compared to other regions, which underscores the importance of this study.

Depression is a highly comorbid condition, meaning it often occurs alongside other diseases related to chronic inflammation. Understanding the relationship between inflammation and depression could help improve the management of these comorbid medical conditions. One of the comorbid diseases that can be mentioned is autoimmune disease (Bloch & Rivera, 1983).

Conceptual Framework

Inflammation can be defined as a local response to cellular damage, characterized by increased blood flow, capillary vasodilation, leukocyte infiltration, and the local production of inflammatory mediators by the host. Inflammation is part of the response necessary for returning to homeostasis after damage caused by an infectious agent, physical injury, or metabolic stress (García-Casal & Pons-Garcia, 2014).

This work is presented as part of the Research Methodology I course taught by Professor Regina Fernández Morales during the fourth term of 2023 at UFM. The project presents no conflicts of interest, and the content is original in terms of the literature review, objectives, and methodology proposed.

Communication with the authors should be made through any of the following emails: camilah@ufm.edu or mneumann@ufm.edu

The inflammation process is an adaptive response of the body to indicate that it is in danger and needs attention. The inflammation process can be understood as a highly orchestrated biological response. It involves a series of events at the cellular and molecular levels, including the release of pro-inflammatory cytokines, the activation of immune cells, and the regulation of inflammatory mediators such as prostaglandins and nitric oxide (Stankov, 2012).

Furthermore, inflammation can be classified into two main types: acute inflammation and chronic inflammation. Acute inflammation is a rapid and transient response of the body to injury or infection. This type of inflammation helps eliminate the underlying cause and promotes healing. On the other hand, chronic inflammation is long-lasting and can contribute to the development of chronic diseases such as rheumatoid arthritis, cardiovascular disease, Alzheimer's, cancer, and type 2 diabetes (Osimo et al., 2019).

Nutrition plays a fundamental role in regulating inflammation. Some nutrients, such as antioxidants found in fruits and vegetables, as well as omega-3 fatty acids found in fish, have anti-inflammatory properties. A balanced diet rich in these nutrients can help control inflammation and prevent related diseases.

Similarly, stress is a factor that can influence inflammation. Chronic stress can activate the immune system and trigger an inflammatory response in the body, which can, in turn, have a negative impact on long-term health. Proper stress management can be an effective tool to reduce chronic inflammation if it is the underlying cause.

Among the inflammation processes is pain, which, despite being a negative aspect, it is important to highlight that its presence in our lives is related to survival and well-being. Experiencing pain is a warning sign that something is wrong in the body, prompting us to seek a solution. Pain is an unpleasant sensation that occurs in varying degrees of intensity as a result of injury, disease, or emotional disorder (Farlex, 2023).

The International Association for the Study of Pain (IASP) defines pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" ("Pain Terms", 1979).

There are nutritional factors that can affect or modulate the immune system. These include the total intake of calories. Research suggests that altering or modulating the immune response through diet can be useful in preventing inflammations (García-Casal & Pons-Garcia, 2014).

In recent years, the PINE axis (psychoimmunoneuroendocrinology) has been studied; it shows that all systems of the human body are related and connected to each other. Therefore, the importance of studying the human being integrally. Both physiological and mental aspects are studied (Osimo et al., 2019).

In addition, there has been an accumulation of systematic reviews suggesting a connection between inflammation and depression. Chronic inflammation could play a role in the pathogenesis of depression, and depression could cause further inflammation. The word "depression" is often used to describe many different things. It can define a fleeting mood, perhaps an external physical appearance of sadness, or for others, a diagnosable clinical disorder. Each year, millions of adults suffer from clinically diagnosed depression, a mood disorder that often affects personal, vocational, social, and health functioning (APA, 2014).

State of the Art

The study of the relationship between inflammation, diet, and depression has been of growing interest over the past decade, even though it remains a developing area. The connection between mental and physical health has been a constant concern in medicine and psychology, and more recently, the role of diet and inflammation has emerged as a potential mediator in this relationship.

The inflammatory phenomenon has captured the attention of the scientific community due to its link with various chronic diseases. Although inflammation can originate from multiple causes, such as infections or injuries, recent emphasis has been placed on investigating the impact of diet as a potential pro-inflammatory agent. This concern arises because chronic inflammation can increase the risk of conditions such as insulin resistance, diabetes, metabolic syndrome, and cardiovascular diseases. Therefore, understanding and modulating inflammation through diet may be key to preventing and managing such diseases (Danesh, 2000; Ridker, 2004; Salas-Salvadó et al., 2006).

Some nutrients may have anti-inflammatory properties, while others may be pro-inflammatory. Therefore, it is important to know which nutrients can modulate inflammation and in what quantity they should be administered (Giugliano, 1997).

It is essential to mention that most studies employed multiple linear regression for their analyses and adjusted for factors such as gender, age, socioeconomic status, body mass index (BMI), among others. These findings reinforce the relevance of diet concerning inflammatory and cardiometabolic markers in young populations (Cota et al., 2021).

In a meta-analysis, $1,545$ studies were reviewed, of which 37 met the inclusion criteria to investigate the relationship between inflammation and depression. Of these, it was determined that 27% of the $11,813$ patients with depression analyzed showed low-grade inflammation. Despite the heterogeneity among studies, sensitivity analyses confirmed a similar prevalence. Notably, when comparing patients with

depression to non-depressed controls, those with depression were 1.46 times more likely to present low-grade inflammation. These findings suggest significant relevance of inflammation in a broad segment of patients with depression (Osimo et al., 2019).

According to (Farré et al., 2020), nutrition is essential not only for our survival and growth but also for maintaining the homeostasis of different components of the mucosal barrier. Research has shown that nutrients play crucial roles in: (1) maintaining the intestinal epithelium, promoting cell growth, homeostasis, and functions; (2) regulating the function of the intestinal epithelial barrier; (3) modulating intestinal immunity; and surprisingly, (4) nutritional supplementation could improve mucosal abnormalities present in patients with gastrointestinal disorders.

This overview reinforces the relevance of nutrients in the homeostasis of the mucosal barrier and the maintenance of normal intestinal physiology. More well-designed clinical trials are needed to confirm the possibility of nutritional supplementation as a treatment for patients with mucosal barrier dysfunction, including those with diseases such as celiac disease, non-celiac gluten sensitivity, irritable bowel syndrome, and functional dyspepsia (Farré et al., 2020).

With support from the National Heart, Lung, and Blood Institute (NHLBI), the capacity of inflammatory and lipid markers to predict the risk of cardiovascular events was evaluated in a case-control study of 366 apparently healthy women enrolled in the Women's Health Study. Of the 12 markers evaluated, CRP was the strongest variable for predicting inflammation (Ridker, 2004).

The following are studies that have explored this connection and their conclusions. In a systematic review, the interaction between inflammation and depression was explored in 109 studies, most of which were rated moderate to high in quality (Toenders, Laskaris, et al., 2022).

When examining dimensional measures of depressive symptoms, most studies found no significant correlation between the severity of depression and key inflammatory markers such as $IL-1b$, IL-6, and CRP in healthy young people, suggesting that clinical levels of depression may be necessary to observe inflammatory dysfunction (Toenders, Laskaris, et al., 2022).

From a longitudinal perspective, variability has been observed in inflammatory responses following different therapeutic interventions. For example, a study on cognitive-behavioral therapy (CBT) for insomnia in patients with knee osteoarthritis examined its effects on systemic inflammation (Mun et al., 2024). In the case of breast cancer patients, research evaluated the impact of brief stress management interventions, including CBT, on levels of S100A8/A9 associated with RAGE, a marker related to inflammation and tumor development (Taub et al., 2019). Additionally, in patients with heart failure, the effects of CBT for insomnia on autonomic function and inflammatory markers were analyzed (Redeker et al., 2020). These studies suggest that the effects of psychological interventions on inflammatory markers are not uniform and may vary depending on the condition treated and the specific biomarkers measured. The observed divergences could be attributed to differences in treatment protocols, studied populations, or the complex interactions between the various components of the immune and inflammatory systems.

Problem Statement

The relationship between inflammation and depression, as previously mentioned, has been the subject of multiple investigations globally, with robust evidence linking inflammatory markers and depressive episodes in various populations. However, most of these studies have focused on specific populations, leaving many regions, such as Central America, with a notable lack of data in this area.

Guatemala, despite having a population with unique sociodemographic, genetic, and environmental traits, lacks research addressing the interaction between inflammation and depression. This knowledge gap is exacerbated when considering that not only has the relationship between inflammation and depression not been explored per se, but also how Guatemalan socioeconomic and demographic factors modulate this relationship. In the Guatemalan context, where genetic diversity and variability in environmental and socioeconomic factors are significant, it is imperative to fill this informational gap to offer more contextualized interventions and treatments.

This research seeks to answer the pressing question: How are inflammatory markers related to the severity of depressive symptoms and dietary habits in the population of young Guatemalan women?

Objectives

General Objective

To analyze the relationship between inflammatory markers, the severity of depressive symptoms, and dietary habits in the population of young Guatemalan women.

Specific Objectives

1. Identify and quantify the main inflammatory markers present in young Guatemalan women.
2. Identify depressive symptoms using the Beck Depression Inventory.
3. Determine or characterize the dietary habits of young Guatemalan women through a questionnaire.

4. Establish the degree of correlation between the presence of certain inflammatory markers and dietary habits.

5. Describe the distribution of depressive symptoms in the population of young Guatemalan women based on their level of inflammation.

Materials and Methods

Research Design

The design of this research was quantitative, non-experimental, and cross-sectional correlational. This approach was carefully chosen to objectively study the correlation between diet and mood in the sample, focusing on specific inflammatory markers.

Approach

In this study, the quantitative approach was employed to measure and analyze the variables in a numerical and statistical manner. The primary interest was in measuring how variations in inflammatory markers were described by the independent variable(s), i.e., how diet and mood could influence the levels of inflammatory markers such as C-reactive protein and erythrocyte sedimentation rate. This quantitative approach allowed for an objective and precise evaluation (particularly in the R^2 coefficient) of the relationships between these variables, facilitating data-based conclusions.

Scope

The scope of this research was correlational. The aim was to understand how diet and inflammation in the body were related to mood. By analyzing these correlations, it was hoped to discover whether statistically significant associations existed that could suggest (though not prove) a causal relationship or influence between the factors.

Techniques

To obtain reliable and accurate data, a combination of techniques was employed. Blood sampling was conducted on young women in Guatemala City. Through this sampling, the mentioned inflammatory markers were measured: C-reactive protein and erythrocyte sedimentation rate. Additionally, the Beck Depression Inventory, a validated and reliable instrument for measuring mood, was used.

Dietary Questionnaire

Complementarily, to gather detailed information about the participants' diets, a questionnaire specifically designed for this study was applied. This combined techniques approach allowed for a holistic and systematic analysis of the relationships between inflammation, mood, and diet.

Instruments

A combination of meticulously selected instruments was used to accurately assess the interrelationships between diet, mood, and inflammatory markers in young women in Guatemala City.

Dietary Habits Questionnaire

This questionnaire was designed to obtain detailed and relevant information about the participants' food consumption and dietary patterns. This questionnaire, following best practices in questionnaire design, included carefully formulated questions to ensure the accuracy and relevance of the selected data.

Beck Depression Inventory

This validated and widely recognized and used instrument was applied to measure the severity of the participants' depressive symptoms. This scale facilitated a quantitative and comparative evaluation of mood states, allowing for the correlation of these data with dietary habits and inflammatory markers. This questionnaire consists of 21 groups of statements.

The total score was obtained by summing each of the items, with 0 being the minimum score and 63 the maximum. The scoring norms in the Mexican population are as follows: from 0 to 5 points, minimal anxiety; from 6 to 15, mild anxiety; from 16 to 30 points, moderate anxiety, and from 31 to 63, severe anxiety (Beck & Alford, 2009).

Laboratory Tests for Inflammatory Markers

As part of the sampling process, clinical tests were performed to identify and quantify the inflammatory markers mentioned earlier: C-reactive protein and erythrocyte sedimentation rate. These tests generated an objective base of clinical data that was used in conjunction with the other instruments to allow for a comprehensive analysis of the interactions between the different variables.

Sample and Population

The population of this research consisted of a homogeneous sample of 30 young women residing in Guatemala City. Thirty women were chosen because it was assumed that this sample would achieve normality (Hernández Sampieri et al., 2018). The participants were selected to provide a

representative perspective on the interactions between diet, mood, and inflammatory markers.

The study considered the following inclusion criteria:

1. Women
2. Aged 25 to 30 years
3. Residing in Guatemala City
4. Willingness to participate in the study

Additionally, the following exclusion criteria were identified: a) Women with inflammatory diseases b) Women with autoimmune diseases c) Pregnant women, to avoid any influence of these conditions on inflammatory markers. Clarifying these exclusions, participants were warned that if they did not meet the exclusions, the researchers would not be held responsible, as they signed and read the informed consent. This sample and population selection methodology ensured that the research was accurate, relevant, and replicable.

Selection and Definition of Variables

In this study, variables encompassing biochemical, psychological, and nutritional aspects were selected. Thus integrating both quantitative and qualitative measures to achieve a comprehensive and thorough analysis.

Beck Depression Inventory

This is an ordinal measure that evaluated the severity of depressive symptoms. The scale is a validated and recommended psychometric tool, and its inclusion allowed for the quantification of the participants' mood in a standardized and reliable manner.

Dietary Questionnaire

This is a categorical variable designed to assess the dietary habits of the participants as well as their quality. This questionnaire helped capture detailed information about food consumption and dietary patterns, which was crucial for investigating the relationship between diet and inflammatory markers.

Hypothesis

There is a significant bidirectional relationship between diet and depression, which influences the levels of inflammatory markers in the body.

Based on a comprehensive review of the literature and understanding of the interactions between diet, mood, and inflammatory responses, the following hypothesis is proposed: "There is a statistically significant bidirectional relationship between diet and depression, which influences the levels of inflammatory markers in the body." This hypothesis is based on the premise that dietary patterns do indeed contribute to mood disturbances and, in turn, influence the body's inflammatory processes, being bidirectional, the reverse is also true. The confirmation or refutation of this hypothesis will provide valuable information on how these factors interact and influence each other.

Data Collection Procedure

After the topic and methodology for this research were approved, it was necessary to conduct a detailed literature review to validate the importance of the research. It was ensured that the background information was up-to-date and highly reliable.

It was ensured that the matrix instrument was reliable for selecting the searched articles. For this, it was necessary to specify the different inclusion and exclusion criteria. The criteria for article selection were of utmost importance to ensure specificity and clarity. Additionally, research involving young Guatemalan women with inflammation, investigating diet and mood, and finding specific instruments such as scales to measure mood were necessary.

The results of the articles deemed pertinent and necessary for the research were used. Two investigators responsible for this research reviewed the data to minimize bias and extract the most accurate data.

The research data were grouped based on diet and mood scale. A scale was used to measure mood and an interview to analyze the diet of each research participant, using them based on the inflammation produced as a result of the previously mentioned analysis.

Statistical Analysis and Data Processing

Statistical analysis and data processing formed the backbone of this research; because by providing the necessary quantitative foundation, it was possible to evaluate the hypothesis and conclude. Below is a detailed account of the methodological approach and the various statistical techniques used to explore and understand the interrelationships between the study variables. Through a rigorous and systematic process, it was proposed to discover statistically significant patterns, trends, and correlations that shed light on the complex dynamics between diet, mood, and inflammatory markers.

Description and Justification of Methods and Analysis Techniques

The selection of statistical methods and analysis techniques for this study was guided by statistical principles and based on a deep understanding of the nature of the variables involved. Since the goal was to examine possible correlations between variables: dietary habits, mood states, and inflammatory markers, correlation and regression techniques were employed to investigate the relationships between the

variables. Correlation allowed us to determine the strength and direction of the relationship between two variables, while regression analysis helped to understand how the variation in the dependent variable was described by the independent variables.

Additionally, considering the nature of the data collected, which included continuous measures (inflammatory markers) and ordinal measures (Beck scale), methods that fit these characteristics were used. Among them were normality tests to evaluate the distribution of the sample; a crucial step in selecting the most appropriate statistical tests. Furthermore, analysis of variance was used when relevant to compare means between different groups and better understand variations in the variables of interest.

This approach not only allowed for establishing the existence of correlations but also exploring the nature and significance of these relationships, providing a solid basis for subsequent interpretations and conclusions.

Statistical Procedures

Application and Analysis of the Beck Depression Inventory

After applying the scale to the sample, participants were categorized based on their scores: minimal or no depression, mild depression, moderate, and severe depression. This classification was the central focus for the following analyses.

Normality Tests

Before proceeding with comparative analyses, as part of the statistical processes, a crucial step was to analyze the normality of the sample. The *Shapiro-Wilk* test implemented in *'SciPy'* was used to check the data distribution. If the sample was normal, the following statistical tests could be performed.

Variance Comparisons (ANOVA)

An analysis of variance was used to compare levels of inflammatory markers and dietary patterns among the different depression groups. If significant differences were identified, post-hoc tests were performed to determine where these differences resided.

Correlation and Regression Analysis

The relationship between the severity of depressive symptoms, dietary habits, and levels of inflammatory markers was explored using Pearson's correlation coefficient and regression analysis. This allowed for a better understanding of the nature and strength of these relationships.

Data Visualization and Presentation

With the support of the *'Python'* programming language and *'Jupyter Notebook'* for statistical analysis and Tableau for visualization, the data was presented in a way that highlighted key relationships and important findings, facilitating interpretation.

Contextualized Interpretation of Results

All results were interpreted considering reliability and statistical significance. The conclusions were discussed in the context of existing literature and practical implications for the general scientific context and specifically for the Guatemalan population.

Inclusion of Key Aspects in the Analysis

In this research, the integrity and accuracy of statistical analysis were fundamental. Therefore, several key aspects were incorporated to ensure the quality and reliability of the results and conclusions.

Verification of Data Normality

At each stage of the analysis, normality tests were conducted, such as the Shapiro-Wilk test to assess the distribution of the data where required. This verification was crucial to determine the suitability of selecting statistical tests given the normality of the sample and thus ensure the validity of the proposed interpretations.

Evaluation of the Reliability of Measurement Tools

It was essential and fundamental to validate the reliability of the tools used, such as the Beck Depression Inventory and the Dietary Questionnaire. This was done by calculating Cronbach's alpha coefficient, as high reliability ensured that the collected data was consistent and representative.

Descriptive Statistics of the Sample

Descriptive statistics of the sample, including means, medians, modes, ranges, and standard deviations, were provided. These statistics offered a clear and understandable view of the data to establish analyses based on a solid foundation for subsequent statistical tests.

Contextualized Interpretation of Results

All results were interpreted in light of contextualized hermeneutics based on respective reliability and statistical significance. Clear thresholds for statistical significance were also established, and the findings were discussed in relation to these criteria. This allowed for evaluating the strength and relevance of both the results and the presented conclusions.

Additionally, the results were presented based on existing literature and relevant theories in the field. This provided relevant conclusions for the Latin American population, especially Guatemalans.

Ethical Considerations

Informed Consent

Informed consent was obtained from all participants. To achieve this, they were provided with detailed information about the study's objectives, procedures, possible risks, and benefits. Additionally, it was ensured that they understood that their participation was entirely voluntary and that they had the right to withdraw from the study at any time without consequences.

Confidentiality and Privacy

Confidentiality and privacy of all collected information were maintained. Participants' personal data were anonymized and kept confidential, ensuring their privacy and protection.

Approval by an Ethics Committee

The research protocol was submitted for review and approval by an ethics committee, ensuring that it met ethical standards and current regulations.

Impact and Benefit for Participants and the Community

The potential impact and benefits of the research for both the participants and the involved community were evaluated and described. Additionally, emphasis was placed on maximizing benefits and minimizing any potential risks.

Budget

Item	Cost (Q)
Band-Aids	30
Needles	150
Cotton	20
Alcohol	20
Gasoline	200
Electricity and Internet	100
Total	520

Table 1

Budget for the study

The budget will be covered by the principal investigators.

Item	Detail
Start Date	February 2024
End Date	June 2024
Duration	5 months

Table 2

Study Dates and Duration

Timeline

Results

Sociodemographic Data

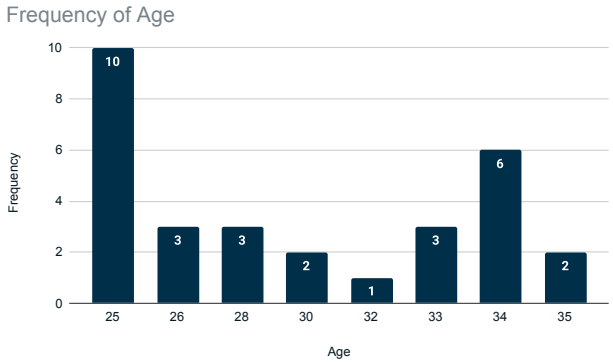


Figure 1

Age Frequency

Statistic	Total Beck	Total Diet	ESR	CRP
N	30.00	30.00	30.00	30.00
Mean	19.00	4.77	10.27	2.56
Median	17.00	6.00	9.00	1.45
Standard Deviation	9.28	9.58	6.58	2.52
Minimum	7.00	-17.00	1.00	0.00
Maximum	42.00	21.00	26.00	7.60
Skewness	0.97	-0.22	0.81	0.79
Kurtosis	0.14	-0.60	0.36	-0.89
Shapiro-Wilk W	0.90	0.97	0.93	0.83
Shapiro-Wilk p-value	0.01	0.63	0.06	0.00

Table 3

Descriptive statistics of the variables

Total Beck Scale

The score on the Beck scale shows a non-normal distribution with a right skew. This suggests that there are more individuals with lower depression scores, but with a wide variability. The high standard deviation indicates significant differences between individual scores.

Total Diet Questionnaire

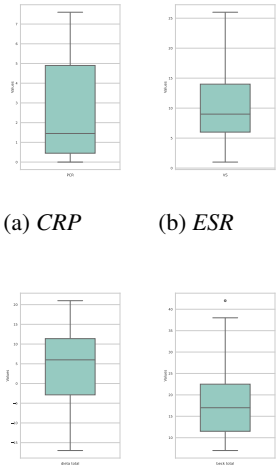
The distribution of diet scores is normal and has negative values, which are allowed by the questionnaire. The median is higher than the mean, indicating a slight tendency towards higher values.

Erythrocyte Sedimentation Rate

The ESR score shows a slight right skew, indicating that most observations are below the mean, but there are some significantly high scores.

C-Reactive Protein

The CRP scores are also right-skewed and do not follow a normal distribution. The median significantly lower than the mean suggests that most observations have low CRP values, but there are some observations with much higher values, indicating possible cases of acute inflammation in some individuals.



(a) *CRP* (b) *ESR*

(c) *Total Diet* (d) *Beck Total*

Figure 2

Box and Whisker Plots of Variables

The table 4 shows the correlations between various consumption variables and different emotional or psychological symptoms, along with the associated p-values indicating the statistical significance of these correlations.

There is a significant negative correlation between fruit consumption and loss of pleasure, suggesting that higher fruit consumption is associated with a lower loss of pleasure. There is also a significant negative correlation between fruit consumption and suicidal thoughts, indicating that higher fruit consumption is associated with a lower frequency of suicidal thoughts.

	Variable #1	Variable #2	Correlation	P_Value
3	beck_loss_of_pleasure	diet_fruit	-0.489	0.006
7	beck_suicidal_thoughts	diet_fruit	-0.480	0.007
1	beck_pessimism	diet_sugar	0.432	0.017
21	beck_pessimism	age	-0.424	0.019
13	beck_loss_of_interest	diet_soft_drinks	0.418	0.021
24	diet_red_meat	blood_pressure	-0.415	0.022
20	beck_difficulty_concentrating	diet_flour	0.414	0.023
0	beck_pessimism	diet_red_meat	0.407	0.026
10	beck_agitation	diet_ginger	-0.404	0.027
2	beck_failure	diet_olive_oil	0.404	0.027
4	beck_punishment	diet_fruit	-0.398	0.030
8	beck_crying	diet_vegetables	0.396	0.030
6	beck_dissatisfaction	diet_fruit	-0.391	0.033
15	beck_irritability	diet_red_meat	0.388	0.034
16	beck_irritability	diet_sugar	0.378	0.039
12	beck_loss_of_interest	diet_flour	0.378	0.040
19	beck_difficulty_concentrating	diet_nuts	0.376	0.040
17	beck_irritability	total_diet	-0.372	0.043
14	beck_indecision	diet_soft_drinks	0.372	0.043
25	diet_flour	age	-0.367	0.046
9	beck_agitation	diet_alcohol	0.366	0.047
11	beck_loss_of_interest	diet_fruit	-0.365	0.047
23	beck_self_disesteem	age	-0.360	0.050
18	beck_appetite_changes	diet_soft_drinks	0.354	0.055
22	beck_indecision	CRP (C-reactive protein)	0.351	0.057
5	beck_punishment	total_diet	-0.351	0.057

Table 4

Correlation Table

Other observed correlations include a positive correlation between sugar consumption and pessimism, suggesting that higher sugar consumption is associated with higher levels of pessimism. A positive correlation between soda consumption and loss of interest indicates that higher soda consumption is associated with greater loss of interest.

Additionally, there is a positive correlation between flour consumption and difficulty concentrating, suggesting that higher flour consumption is associated with greater difficulty concentrating. There is also a positive correlation between red meat consumption and pessimism, indicating that higher red meat consumption is associated with higher levels of pessimism.

There is a significant negative correlation between fruit consumption and feelings of punishment, indicating that higher fruit consumption is associated with lower feelings of punishment. There is also a negative correlation between fruit consumption and dissatisfaction, suggesting that higher fruit consumption is associated with lower levels of dissatisfaction.

A positive correlation was observed between red meat consumption and irritability, indicating that higher red meat consumption is associated with greater irritability.

Most of the negative correlations involve fruit consumption, which could suggest a protective effect of fruit consumption against certain negative psychological symptoms. The positive correlations between sugar and soda consumption with negative symptoms such as pessimism and loss of interest could indicate the need to moderate the consumption of these products to improve emotional well-being.

All mentioned correlations are significant with a p-value < 0.05, which supports the robustness of these associations. These insights can be used to recommend dietary adjustments as part of a holistic approach to improving emotional and

mental well-being.

Cronbach's α is a measure of the internal consistency of a scale. Values between 0.7 and 0.8 are generally considered acceptable, suggesting that the scale has adequate reliability. In this case, a value of 0.741 indicates that the items in the diet questionnaire are reasonably correlated and measure the same underlying construct.

McDonald's ω is another measure of internal consistency and is often considered a more accurate estimate than Cronbach's α. A value above 0.9 is considered excellent, indicating high reliability of the scale. In this case, a value of 0.904 suggests that the questionnaire is very reliable and that the items are consistent in measuring the construct.

Both values indicate good internal consistency, although McDonald's ω is notably higher than Cronbach's α. This can occur when the items have different factor loadings, and McDonald's ω, which takes these differences into account, provides a more accurate estimate of reliability. The diet questionnaire we developed is reliable for use in research and practical applications, as both reliability metrics exceed the generally accepted thresholds.

Beck Depressive Symptoms

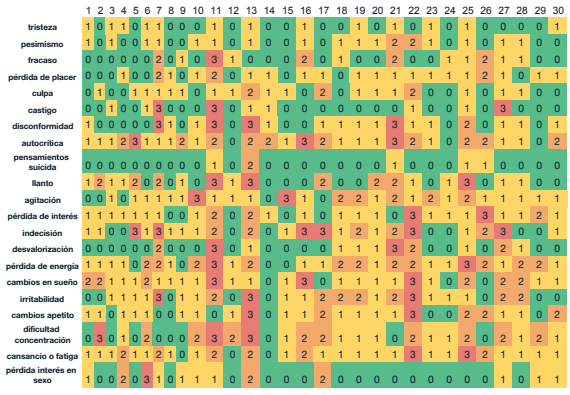


Figure 3

Heat Map: Depressive Symptoms

Dietary Habits of Young Guatemalan Women

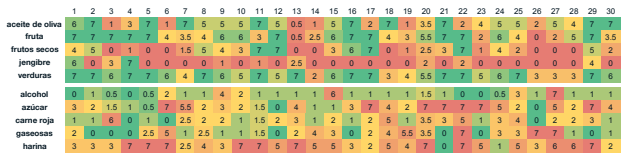


Figure 4

Heat Map: Dietary Questionnaire

Discussion of Results

This study aimed to analyze the relationship between inflammatory markers, the severity of depressive symptoms, and dietary habits in young Guatemalan women. The results provide significant evidence of these interactions and offer valuable insights into understanding the relationship between diet, inflammation, and depression in this specific population.

Summary of Main Findings

Our study revealed significant correlations between certain dietary patterns and specific depressive symptoms. In particular, a strong negative association was found between fruit consumption and various depressive symptoms, including loss of pleasure ($r = -0.49$, $p = 0.006$) and suicidal thoughts ($r = -0.48$, $p = 0.007$). On the other hand, positive correlations were observed between the consumption of processed foods (such as sugars, sodas, and flours) and symptoms such as pessimism, loss of interest, and difficulty concentrating.

Regarding inflammatory markers, although no significant direct correlations were found between diet and the levels of CRP and ESR, a trend was observed suggesting a possible relationship between these factors that warrants further investigation.

Interpretation of Results

Protective Effect of Fruit Consumption

The negative correlation between fruit consumption and depressive symptoms suggests a possible protective effect of a fruit-rich diet against depression. This could be attributed to the nutrients and antioxidants present in fruits, which may have a positive impact on mental health. The particularly strong association with the reduction of suicidal thoughts is a notable finding that warrants further investigation.

This relationship could be explained by several mechanisms:

1. Antioxidants present in fruits may reduce oxidative stress, which has been associated with depression.

2. Fruits are rich in essential vitamins and minerals for optimal neurological functioning.

3. The dietary fiber in fruits may positively influence the gut microbiota, which in turn affects the gut-brain axis.

Negative Impact of Processed Foods

The positive correlations between the consumption of processed foods and depressive symptoms support the hypothesis that a diet high in refined sugars and saturated fats may contribute to the development or exacerbation of depressive symptoms. This could be related to the inflammatory effects of these foods, although our study did not find significant direct correlations between diet and the inflammatory markers measured (CRP and ESR).

Possible mechanisms for this relationship include:

1. Processed foods can cause blood glucose spikes, which can affect mood.
2. These foods often lack essential nutrients for mental health.
3. Excessive consumption of processed foods can lead to obesity, which has been associated with a higher risk of depression.

Comparison with Existing Literature

Our findings on the protective effect of fruits are consistent with previous studies that have found associations between fruit and vegetable consumption and a reduced risk of depression. For example, a meta-analysis conducted by (Liu et al., 2016) found that higher fruit and vegetable consumption was associated with a lower risk of depression. However, our study provides specific evidence of the relationship between fruit consumption and specific depressive symptoms in a little-studied population: young Guatemalan women.

The positive association between processed foods and depressive symptoms also aligns with previous research linking Western diets (high in processed foods) with a higher risk of depression. For example, (Lane et al., 2022) found that a diet characterized by processed foods was associated with a higher likelihood of depression and anxiety in women. Nonetheless, our study provides a more detailed view by examining correlations with specific symptoms. Additionally, several other studies have been published evaluating the relationship between ultra-processed food consumption and depression, as well as other mental disorders. Our study included a total of 17 observational studies (n = 385,541); 15 cross-sectional and 2 prospective. Higher consumption of ultra-processed foods was cross-sectionally associated with greater odds of depressive and anxiety symptoms, both when these outcomes were evaluated together (odds ratio of common mental disorder symptoms: 1.53, 95% CI 1.43 to 1.63) and separately (odds ratio of depressive symptoms: 1.44, 95% CI 1.14 to 1.82; and, odds ratio of anxiety symptoms: 1.48, 95% CI 1.37 to 1.59). Additionally, a meta-analysis of prospective studies showed that greater intake of ultra-processed foods was associated with an increased risk of subsequent depression (hazard ratio: 1.22, 95% CI 1.16 to 1.28). Although we found evidence of associations between ultra-processed food consumption and adverse mental health, rigorously designed prospective and experimental studies are needed to better understand the causal pathways.

Implications

These results have important implications for both clinical practice and public health:

1. Dietary interventions: The findings suggest that dietary interventions, particularly increasing fruit consumption and reducing processed foods, could be effective strategies for the prevention and management of depression in young women.
2. Public health policies: These results could inform public health policies aimed at improving mental health through the promotion of healthy diets. For example, nutritional education programs focused on increasing fruit consumption and reducing the intake of processed foods could be implemented.
3. Integrated approach: The association between diet and depressive symptoms reinforces the importance of an integrated approach to depression treatment that considers both psychological and nutritional factors. Mental health professionals might consider including dietary recommendations as part of their treatment plans.
4. Prevention: Since our study focused on young women, the results suggest that early dietary interventions could play an important role in preventing depression in this population.

Limitations

It is important to acknowledge the limitations of this study:

1. Sample size: With 30 participants, the sample size is relatively small, which may limit the generalizability of the results. Future studies should consider larger samples to increase statistical power.
2. Cross-sectional design: The cross-sectional design of the study does not allow for establishing causal relationships between diet and depressive symptoms. Longitudinal studies are needed to determine the direction of causality.
3. Specific population: The study focused on young Guatemalan women, which may limit the applicability of the results to other populations. Studies in different demographic groups are needed to confirm whether these findings are generalizable.

4. Inflammation measures: Although CRP and ESR were measured, no significant correlations were found with diet or depressive symptoms, which could be due to the need for more sensitive or specific inflammation measures.

5. Definition of dietary patterns: As observed in the literature, the lack of a standardized definition of "healthy diet" can make comparison between studies difficult. In our case, we focused on specific foods rather than general dietary patterns, which may limit comparability with other studies.

6. Variability in depression measurement: Although we used the Beck scale, which is widely validated, the literature notes that variability in depression measures across studies can make it difficult to compare results.

7. Confounding factors: Although several demographic and lifestyle factors were controlled for, there may be other unmeasured confounding factors that could influence the relationship between diet and depression.

Recommendations for Future Research

Based on our findings and limitations, we recommend:

1. Conduct longitudinal studies to establish causal relationships between dietary patterns and depressive symptoms.

2. Investigate the biological mechanisms underlying the relationship between fruit consumption and the reduction of depressive symptoms.

3. Explore the effectiveness of specific dietary interventions in the prevention and treatment of depression.

4. Expand the study to more diverse and larger populations.

5. Include broader and more sensitive inflammation measures to better understand the relationship between diet, inflammation, and depression.

6. Standardize the definition and measurement of dietary patterns to facilitate comparison between studies.

7. Use multiple measures of depression, including structured clinical interviews, to obtain a more comprehensive assessment of depressive symptoms.

8. Investigate the interaction between diet and other lifestyle factors, such as exercise and sleep, in relation to depression.

Conclusion

This study provides important evidence on the relationship between dietary patterns and depressive symptoms in young Guatemalan women. The findings underscore the potential protective role of a fruit-rich diet and the possible negative effects of processed foods on mental health. Although more research is needed, these results suggest that dietary interventions could be a valuable component in prevention and treatment strategies for depression.

The complexity of the relationship between diet, inflammation, and depression evidenced in this study underscores the need for a multidisciplinary approach to depression research and treatment. As we advance in understanding these interactions, it is crucial that mental health professionals, nutritionists, and public health policymakers work together to develop comprehensive strategies that address both the nutritional and psychological aspects of mental health.

References

APA, A. P. A. .-. (2014). *Manual diagnóstico y estadístico de los trastornos mentales DSM-5* (5a. ed.). Editorial Médica Panamericana.

Beck, A. T., & Alford, B. A. (2009). *Depression: Causes and treatment* (2nd ed). University of Pennsylvania Press.
OCLC: ocn229036125.

Bloch, M., & Rivera, H. (1983). Enfermedades autoinmunes. Patogenia. Patologia. *Rev. Inst. Invest. Méd*, 248–259.

Cota, B. C., Suhett, L. G., Leite, N. N., Pereira, P. F., Ribeiro, S. A. V., & Franceschini, S. D. C. C. (2021). Cardiometabolic risk and health behaviours in adolescents with normal-weight obesity: A systematic review. *Public Health Nutrition*, *24*(5), 870–881. https://doi.org/10.1017/S1368980020004863

Danesh, J. (2000). Low grade inflammation and coronary heart disease: Prospective study and updated meta-analyses. *BMJ*, *321*(7255), 199–204. https://doi.org/10.1136/bmj.321.7255.199

Farlex. (2023). Dictionary. https://www.thefreedictionary.com/dictionary

Farré, R., Fiorani, M., Abdu Rahiman, S., & Matteoli, G. (2020). Intestinal permeability, inflammation and the role of nutrients. *Nutrients*, *12*(4), 1185. https://doi.org/10.3390/nu12041185

García-Casal, M. N., & Pons-Garcia, H. E. (2014). Dieta e inflamación. *Anales Venezolanos de Nutrición*, *27*(1), 47–56.

Giugliano, D. (1997). Metabolic and Cardiovascular Effects of Carvedilol and Atenolol in Non-Insulin-Dependent Diabetes Mellitus and Hypertension: A Randomized, Controlled Trial. *Annals of Internal Medicine*, *126*(12), 955. https://doi.org/10.7326/0003-4819-126-12-199706150-00004

Hernández Sampieri, R., Fernández Collado, C., & Baptista Lucio, P. (2018). *Metodología de la investigación* (4th ed.). McGraw-Hill Interamericana.

Lane, M. M., Gamage, E., Travica, N., Dissanayaka, T., Ashtree, D. N., Gauci, S., Lotfaliany, M., O'Neil, A., Jacka, F. N., & Marx, W. (2022). Ultra-Processed Food Consumption and Mental Health: A Systematic Review and Meta-Analysis of Observational Studies. *Nutrients*, *14*(13), 2568. https://doi.org/10.3390/nu14132568

Liu, X., Yan, Y., Li, F., & Zhang, D. (2016). Fruit and vegetable consumption and the risk of depression: A meta-analysis. *Nutrition*, *32*(3), 296–302. https://doi.org/10.1016/j.nut.2015.09.009

Mun, C. J., Speed, T. J., Finan, P. H., Wideman, T. H., Quartana, P. J., & Smith, M. T. (2024). A Preliminary Examination of the Effects and Mechanisms of Cognitive Behavioral Therapy for Insomnia on Systemic Inflammation Among Patients with Knee Osteoarthritis. *International Journal of Behavioral Medicine*, *31*(2), 305–314. https://doi.org/10.1007/s12529-023-10184-z

Osimo, E. F., Baxter, L. J., Lewis, G., Jones, P. B., & Khandaker, G. M. (2019). Prevalence of low-grade inflammation in depression: A systematic review and meta-analysis of CRP levels. *Psychological medicine*, *49*(12), 1958–1970. https://doi.org/10.1017/S0033291719001454

Pain terms: A list with definitions and notes on usage. Recommended by the IASP Subcommittee on Taxonomy. (1979). *Pain*, *6*(3), 249.

Pullen, A. B., Jadapalli, J. K., Rhourri-Frih, B., & Halade, G. V. (2020). Re-evaluating the causes and consequences of non-resolving inflammation in chronic cardiovascular disease. *Heart failure reviews*, *25*(2), 381–391. https://doi.org/10.1007/s10741-019-09817-x

Redeker, N. S., Conley, S., Anderson, G., Cline, J., Andrews, L., Mohsenin, V., Jacoby, D., & Jeon, S. (2020). Effects of Cognitive Behavioral Therapy for Insomnia on Sleep, Symptoms, Stress, and Autonomic Function Among Patients With Heart Failure. *Behavioral Sleep Medicine*, *18*(2), 190–202. https://doi.org/10.1080/15402002.2018.1546709

Ridker, P. M. (2004). High-sensitivity C-reactive protein, inflammation, and cardiovascular risk: From concept to clinical practice to clinical benefit. *American Heart Journal*, *148*(1), S19–S26. https://doi.org/10.1016/j.ahj.2004.04.028

Salas-Salvadó, J., Márquez-Sandoval, F., & Bulló, M. (2006). Conjugated Linoleic Acid Intake In Humans: A Systematic Review Focusing on Its Effect on Body Composition, Glucose, and Lipid Metabolism. *Critical Reviews in Food Science and Nutrition*, *46*(6), 479–488. https://doi.org/10.1080/10408390600723953

Stankov, V. S. (2012). Definition of inflammation, causes of inflammation and possible anti-inflammatory strategies. *The Open Inflammation Journal*, *5*(1), 1–9. https://doi.org/10.2174/1875041901205010001

Taub, C. J., Lippman, M. E., Hudson, B. I., Blomberg, B. B., Diaz, A., Fisher, H. M., Nahin, E. R., Lechner, S. C., Kwak, T., Hwang, G. H., & Antoni, M. H. (2019). The effects of a randomized trial of brief forms of stress management on RAGE-associated S100A8/A9 in patients with breast cancer undergoing primary treatment. *Cancer*, *125*(10), 1717–1725. https://doi.org/10.1002/cncr.31965

Toenders, Y. J., Laskaris, L., Davey, C. G., Berk, M., Milaneschi, Y., Lamers, F., Penninx, B. W. J. H., & Schmaal, L. (2022). Inflammation and depression in young people: A systematic review and proposed inflammatory pathways. *Molecular psychiatry*, *27*(1), 315–327. https://doi.org/10.1038/s41380-021-01306-8

Toenders, Y. J., Kottaram, A., Dinga, R., Davey, C. G., Banaschewski, T., Bokde, A. L., Quinlan, E. B., Desrivières, S., Flor, H., Grigis, A., Garavan, H., Gowland, P., Heinz, A., Brühl, R., Martinot, J.-L., Paillère Martinot, M.-L., Nees, F., Orfanos, D. P., Lemaitre, H., … Schumann, G. (2022). Predicting Depression Onset in Young People Based on Clinical, Cognitive, Environmental, and Neurobiological Data. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, *7*(4), 376–384. https://doi.org/10.1016/j.bpsc.2021.03.005

Toshi, L. R., & Eileen, V. H. (2022). Depresión: Situación actual. *Revista De La Facultad De Medicina Humana*, *17*(3).

Yıldırım, S. (2012). Dental pulp stem cells. *SpringerBriefs in Stem Cells*. https://api.semanticscholar.org/CorpusID:860011