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The impact of diet on the digestive, cardiovascular and immune systems

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ABSTRACT

INTRODUCTION AND AIM OF WORK

One of the key factors shaping human health is diet. It serves as the foundation for the functioning of cells, organs, and the entire body. Properly chosen food has an impact, among other things, on the functioning of the immune, digestive, and cardiovascular systems.

MATERIALS AND METHODS

The objective of this study is to analyze the changes in the functioning of the cardiovascular, digestive, and immune systems through the application of different dietary approaches. For this purpose, an original questionnaire was developed. The questionnaire was distributed via social media (Telegram platform) in August 2023 among the population of Ukraine.

RESULTS

We collected a total of 94 surveys, with an average participant age of 26 years. A similar number of participants indicated consuming meals 3 times, 4 times, or 5 times a day. These were 23 individuals (24.47%), 25 individuals (26.6%), and 21 individuals (22.3%) respectively. The analysis of correlations revealed a negative correlation between the frequency of meal consumption and the frequency of infections ($r = -0.21$, $p = 0.035$). A significant relationship was also observed between body weight and the frequency of meal consumption ($r = 0.34$, $p < 0.001$). However, no significant relationship was found between following a special diet and body weight ($p > 0.05$).

CONCLUSIONS

The collected results suggest a connection between dietary habits and the frequency of infections as well as body weight. Interestingly, this relationship was related specifically to the frequency of meal consumption and was not linked to the intake of specific food groups. The obtained results highlight the significance of regular meal consumption in maintaining a healthy body weight and reducing the frequency of infections.

KEY WORDS: diet, digestive system, immune system, cardiovascular system, obesity, malnutrition, infection

Introduction

A normal diet provides the proper supply of protein, carbohydrates, fats, minerals, and vitamins, protecting against deficiencies or excesses. It supplies around 2000-3500 calories, with at least half of the fat coming from plant sources. Special diets are used for various medical conditions, covering the requirement for the main components. These diets differ in the proportion of protein, fats, and carbohydrates, salt content, cholesterol, and fiber due to the exclusion of certain products. Therapeutic diets include Carrel's diet, Jarocki's diet, fruit diet, low-sodium diet, dry diet, and low-fat diet, among others. Proper nutrition is correlated with good health (1). Evidence suggests that reducing calorie intake has a significant impact on increasing lifespan and delaying the onset of diseases (1,2). Two-thirds of adults in the United States are classified as overweight, with one-third being obese (3).

Immune system

It has been proven that a low level of protein increases the risk of infection, partly due to reduced antibody production (4). Optimal nutrition plays a significant role in the proper functioning of the immune system during oxidative stress and inflammation (5). Nutrients such as omega-3 fatty acids, vitamin A, vitamin C, various phytochemicals, polyphenols, and carotenoids of plant origin have anti-inflammatory and antioxidant properties (6, 7, 8, 9). Fiber also exhibits anti-inflammatory properties. Through fermentation by gut microbiota, short-chain fatty acids and other metabolic compounds are formed (10). Such anti-inflammatory compounds may be important in maintaining homeostasis in the context of inflammation and oxidative stress. Scientific reports indicate that vitamin D, in interaction with cell receptors, inhibits viral particles from entering cells (11). It has been demonstrated that oxidative stress during infection involves the release of free radicals, which can protect against microbial invasion (12). Among the minerals supporting the immune system are zinc and selenium. Better immunity, optimal nutrient utilization, and improved metabolism are also ensured by regular nutrition. A balanced and diverse diet that provides essential micro and macroelements is fundamental for the proper functioning of the immune system (13).

Cardiovascular system

Cardiovascular diseases remain the leading cause of death and disability in developed countries (14). Proper nutrition and diet are among the key factors in preventing and treating cardiovascular diseases (15). The Japanese diet, rich in fish, seaweed, vegetables, soy products, and green tea, has been associated with lower blood pressure values, as recent scientific reports have shown (16). Furthermore, it has been observed that the traditional Japanese way of eating is linked to a reduced risk of mortality from cardiovascular diseases (17). The Nordic diet includes vegetables, fruits, fatty fish, whole grains, and berries. It has been found to have a positive impact on blood pressure, blood lipids, inflammation, insulin sensitivity, and body weight (18, 19). However, recent cohort studies did not show a significant relationship between adherence to the Nordic diet and a reduced risk of cardiovascular diseases (20). The connection between a vegetarian diet and lower blood pressure values has been known for many years. A meta-analysis has demonstrated that a vegetarian diet significantly reduces blood cholesterol levels, LDL-C, and HDL-C, without affecting triglycerides (21).

Digestive system

Red meat, especially processed meat, is associated with a higher risk of developing gastrointestinal cancer (22, 23). Mechanisms such as oxidative stress and inflammation influence the development of tumors (24). Furthermore, oxidative stress can damage DNA in cells, increasing the risk of cancer if the DNA is not repaired (25). Plant bioactive compounds are beneficial in the fight against cancer. These include substances like fiber, sulfur compounds, carotenoids, and polyphenols (26). Dietary fiber shortens the transit time through the intestines and increases anaerobic fermentation, reducing exposure to carcinogens for the mucous membrane of the large intestine (27).

Consuming up to 45% of total daily calories from carbohydrates is considered a low-carb diet. Normal carbohydrate consumption falls within the range of 45-65% of total daily calories (28). Additional calorie restriction leads to weight loss and beneficial metabolic changes (29, 30).

Materials and methods

To assess the issue, we created a survey that evaluated age, dietary habits, and the frequency of infections. In total, the survey consisted of 10 questions. The questionnaire was created using Microsoft Forms and was shared through Telegram groups between August 13th and August 21st, 2023. We received 94 responses from participants. All participants were provided with clear participation guidelines and informed of their ability to withdraw from the study at any time.

In addition to the age question, the survey consisted of single-choice questions regarding: meal frequency, current body weight status (underweight, malnourished, normal weight, overweight, obesity), the frequency of infections within a year, the presence of autoimmune diseases, adherence to a vegetarian diet, any diet regimen, attempts at weight loss in the past year, the frequency of consuming fruits and vegetables, and the frequency of consuming sweet snacks.

Statistical Analysis

The data were analyzed using LibreOffice software, and the obtained statistical values were calculated using Statistica. Normality of the age distribution was determined using the Shapiro-Wilk test and histograms. The other factors were translated into corresponding numerical values. Their relationships were assessed using the rho-Spearman non-parametric correlation test. Results are expressed using the correlation coefficient 'r'. To compare two groups, the Mann-Whitney U test was employed, and when dealing with more than two groups, the Kruskal-Wallis test was used. All tests were conducted with a two-tailed hypothesis. A statistically significant result was defined as a p-value below 0.05. Due to the limited number of comparisons, no continuity correction was applied to mitigate the risk of false negatives.

Results

A total of 96 surveys were collected. Two surveys were excluded due to respondents not answering all the questions. For further analysis, 94 surveys were used. The average age of the respondents was 26 years (SD = 5.14). The youngest participant was 20 years old, and the oldest was 33 years old.

Details of responses regarding the frequency of meal consumption, body weight, and the frequency of viral infections are presented in Figures 1, 2, and 3, respectively.

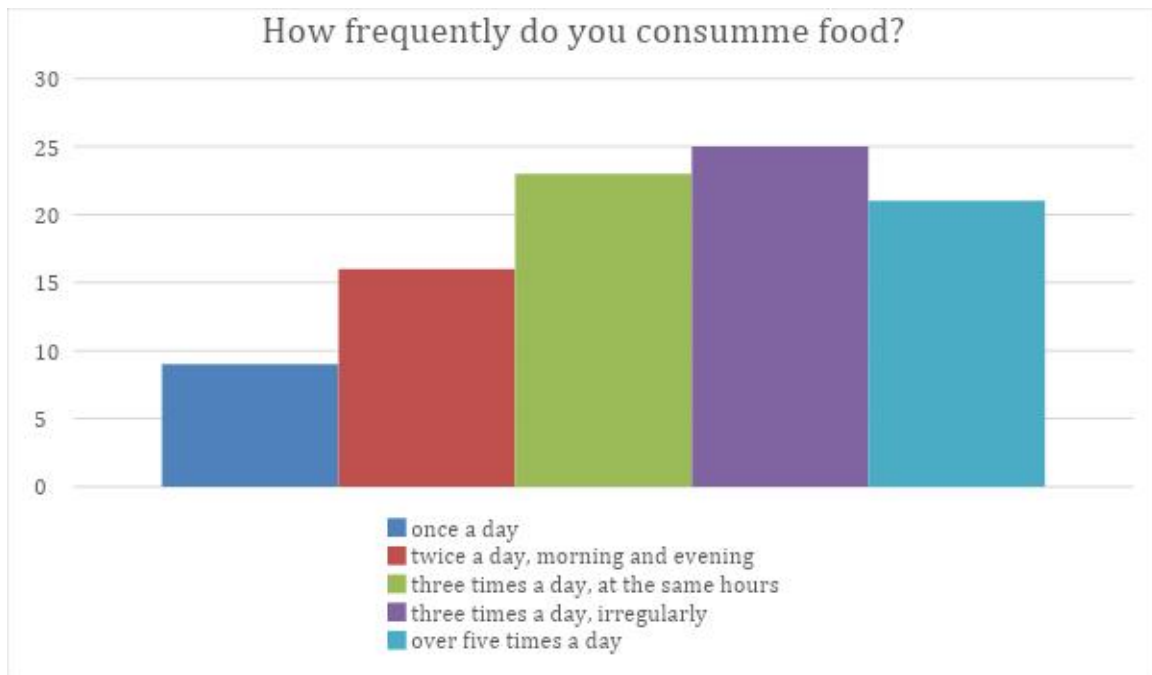


Figure 1.

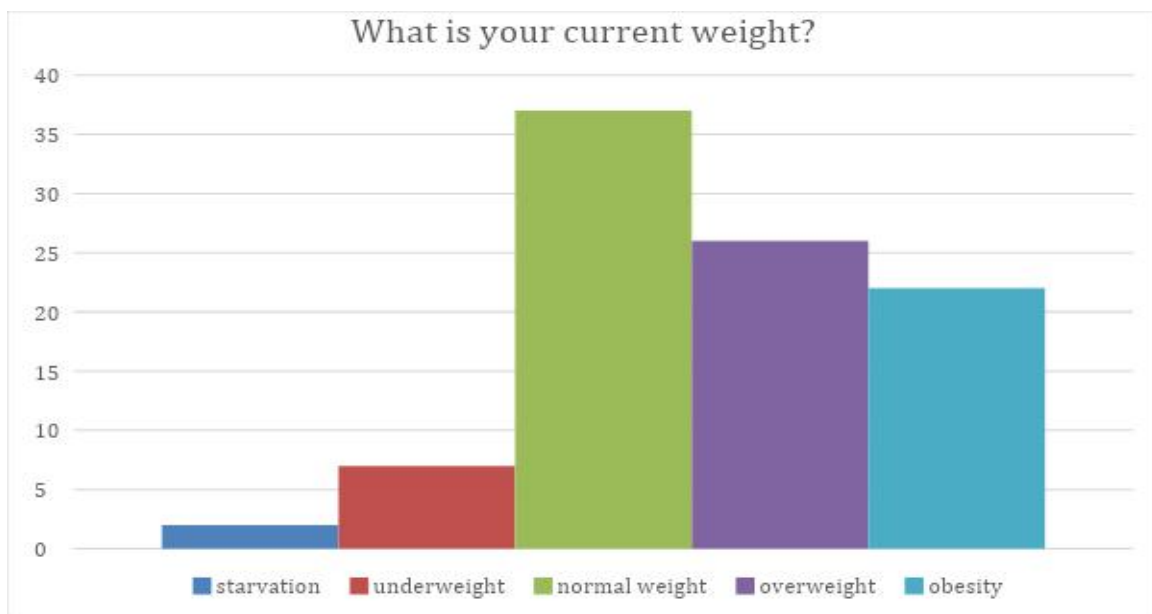


Figure 2.

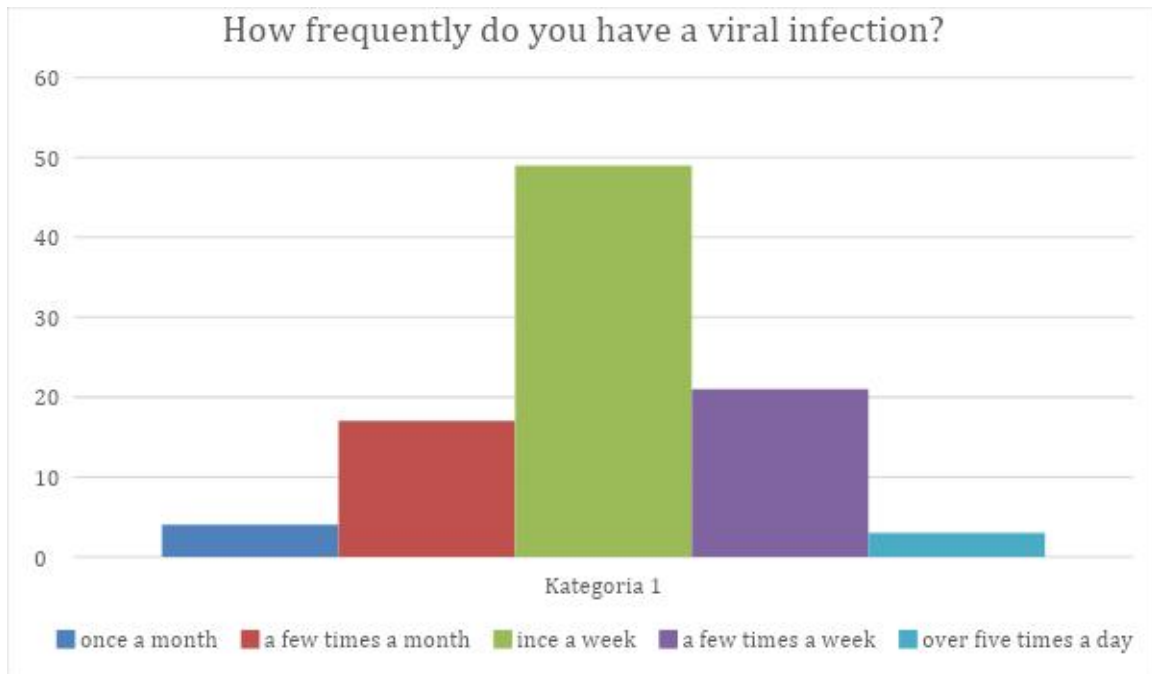


Figure 3.

In the question regarding autoimmune diseases, 92 individuals denied having such a condition (97.82%), while only 2 people (2.12%) confirmed its presence.

Nine respondents (9.58%) indicated that they follow a vegetarian diet, while 85 individuals (90.42%) do not.

Over the past few months, 30 people (31.91%) attempted to lose weight, while 64 individuals (68.09%) did not make such attempts.

Regarding the question about the frequency of following any diet, only 1 person (1.06%) stated "never," 14 respondents (14.89%) mentioned "once in a lifetime," 33 individuals (35.11%) selected "several times in life," 29 respondents (30.85%) indicated "several times a year," and 17 people (18.09%) stated "all the time" or "continuously with minimal breaks."

In response to the question about the consumption of fruits and vegetables, 4 participants (4.26%) indicated consuming them once a month, 17 participants

(18.09%) a few times a month, 49 participants (52.13%) once a week, 21 participants (22.34%) a few times a week, and 3 participants (3.19%) every day.

Regarding snacking on sweet treats, 3 respondents (3.19%) reported indulging in sweet snacks less often than once a month, 8 respondents (8.51%) once a month, 18 respondents (19.15%) a few times a month, 32 respondents (34.04%) a few times a week, and 33 respondents (35.11%) every day.

The analysis of associations between meal frequency and other factors revealed two significant relationships. The first was a negative, weak correlation between the frequency of meal consumption and the frequency of infections ($r = -0.21$, $p = 0.035$). Individuals who consumed meals more frequently were less likely to experience infections. There was also a significant relationship between body weight and the frequency of meal consumption ($r = 0.34$, $p < 0.001$). Individuals with a higher body weight significantly consumed meals more often.

Analysis of other relationships did not reveal statistically significant associations. We did not find a link between following a special diet and body weight ($p > 0.05$). Similarly, individuals who attempted to lose weight did not significantly differ in body weight from those who did not attempt to lose weight ($p > 0.05$). Body weight was not influenced by the frequency of diet adherence, as well as a vegan or vegetarian diet.

Due to the limited number of respondents who reported autoimmune diseases (2 respondents), it was not possible to compare the two groups due to inadequate statistical power.

Discussion

The obtained results confirm an association between dietary habits, the frequency of infections, and body weight. Interestingly, this association was related to meal frequency itself and was not linked to the consumption of specific food groups or adherence to a particular diet (including vegan/vegetarian diets).

Dietary Relationship

In our study, we established a relationship between infection frequency and the frequency of meal consumption. However, we did not find other relationships related to diet and the frequency of infections. The available literature is often contradictory in this regard. Soares and colleagues, for instance, noted a lack of clear evidence linking COVID-19 infection with diet (34). However, other authors suggest that such a connection may exist (35, 36). Importantly, these connections often relate to specific diets (e.g., vegetarian) rather than meal frequency. These studies primarily focus on the COVID-19 coronavirus and stem from the recent pandemic outbreak.

Results regarding a vegetarian diet do not align with those in the literature, as there have been reports of the benefits of such a diet on metabolic profiles (31, 32) and body weight (33).

Obesity Relationship

In our study, we found an increased frequency of obesity with an increased frequency of meal consumption. The literature is relatively consistent on this topic, as obesity pathophysiology is closely associated with excessive calorie intake, which encompasses both the quantity and frequency of meals (37, 38, 39, 40).

The study had several limitations. The survey was distributed via social media, meaning it was taken voluntarily by individuals who chose to participate rather than through random selection. Therefore, any identified relationships may result from self-selection bias and the non-random composition of the sample. The survey was anonymous, and respondents completed it independently, with no opportunity to seek clarifications on survey questions if needed. Respondents were limited to selecting predefined options for the frequency of specific occurrences (e.g., once a week, once a month) in nine questions. The only question

where respondents could provide their own response was about age. Furthermore, the question about autoimmune diseases could not be used for statistical analysis, as only two respondents selected that option, leading to an imbalance in group sizes (2 individuals vs. 92 individuals).

On the positive side, the study had a relatively large group of participants. The study population was relatively homogeneous as it focused on individuals of Ukrainian nationality, mainly young people (ranging from 20 to 33 years old). The survey was distributed in groups that were intended to represent a broad cross-section of the young population, rather than specific subsets like people with higher education, residents of a particular city, or fans of a particular music band. The survey was short and consisted of straightforward questions, which encouraged most participants to complete it in its entirety. However, the brevity of the survey limits the depth of examination of specific topics, allowing for responses to only a limited number of questions.

Conclusions

Our study conducted on a group of 94 individuals confirms the association between meal frequency and increased body weight, as well as an inverse relationship with the frequency of infections. However, further research is needed to confirm these relationships.

Authors' contribution

Conceptualization, Martyna Kępczyk, methodology, Michał Urbaś.; software, Mateusz Kobierecki; check, Miłosz Ojdana, Yehor Demianenko; formal analysis, Oliwia Kwasniewska.; investigation, Dawid Kosciolek; resources, Aleksandra Kościółek; data curation, Oliwia Czekał, writing - rough preparation, Aleksandra Kosciolek and Dawid Kościółek; writing - review and editing, Miłosz Ojdana and Jakub Misiak; visualization, Jakub Misiak; supervision, Oliwia Kwasniewska; project administration, Martyna Kępczyk; receiving funding - no specific funding.

All authors have read and agreed with the published version of the manuscript.

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Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

Not applicable.

Conflict of interest

The authors deny any conflict of interest

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