European Journal of Applied Sciences – Vol. 13, No. 04
Publication Date: August 26, 2025
DOI:10.14738/aivp.1304.19281.
Al Shammari, A. M. N. & El-Mehiry, H. F. (2025). A Comparative Study Between the Cultural Level of Dietary Patterns on the Immune System Among Girls of PAAET at the College of Basic Education in Kuwait and the Faculty of Specific Education, Mansoura University, Egypt. *European Journal of Applied Sciences, Vol - 13(04).* 317-326.

A Comparative Study Between the Cultural Level of Dietary Patterns on the Immune System Among Girls of PAAET at the College of Basic Education in Kuwait and the Faculty of Specific Education, Mansoura University, Egypt

Ali Monahi Nazal Al Shammari
Faculty of Home Economics, the Public
Authority for Applied Education and Training, Kuwait

Hanaa F. El-Mehiry
Department of Home Economics,
Faculty of Specific Education, Mansoura University, Egypt

ABSTRACT

Supporting immune function requires a healthy lifestyle, adequate water intake, and essential minerals like magnesium and zinc, as well as vitamin C, D, and E. The purpose of this study was to examine the impact of dietary patterns on the immune system by assessing whether undergraduate students met the recommended dietary intake. The research focused on students from the College of Basic Education in Kuwait and the Faculty of Specific Education at Mansoura University, Egypt, during the academic year 2024–2025. This cross-sectional study involved 150 undergraduate students from the two universities mentioned above. Students completed a 72-hour dietary recall and a questionnaire at (0, 6, and 12 week). A self-administered questionnaire was used to collect data, which included questions on anthropometric measures and eating habits. Results indicated in students' subjects at (0, 6, and 12 weeks) and demonstrated that the mean intakes of water, total fiber, magnesium, calcium, vitamins (B_6, E, D) folate, and all essential amino acids were lower than dietary reference intake. Moreover, the university population consumed a diet with too many calories, carbohydrates, proteins and fats as compared to dietary reference intake at (0, 6, and 12 weeks). Moreover, the results show that overweight and obesity were common among students, with more than 20% classified as overweight or obese, and the majority having unhealthy eating habits. These results increased the probability of developing dysfunction in the immune system and noncommunicable diseases. Thus, it is necessary to introduce an organized nutrition education program aimed at new students.

Keywords: BMI, overweight, obesity, DRI, Immune system.

INTRODUCTION

The structure of the immune system is extraordinarily complex. It is the mechanism that protects humans from pathogens found in the ecosystem, including microbes, viruses, fungi, and parasites. It is made up of different cells, tissues, and organs. The thymus, bone marrow, and other secondary organs like lymph nodes, the spleen, and gut-associated lymphoid tissues are all part of the immune system (1). Eating a healthy diet is linked to enhancing one's quality of life (2). More significantly, it maintains a healthy immune system capable of defending the body against any disease or infection. An optimal diet provides the body with the maximum quantity of nutrients required to develop, maintain, and improve the immune reaction (3).

Due to sedentary lifestyles and increased intake of high-calorie meals brought on by urbanization, the incidence of becoming obese in developing nations has tripled over the last 20 years (4). According to WHO (5), at least 2.8 million adults die each year because of being overweight or obese. Deterioration of health is associated with inadequate nutrition. The term 'nutritional disorders' covers a wide range of conditions that are primarily nutritional or nutrition is an important factor in their etiology (6). These could include dietary excesses or deficiencies, chronic diseases triggered by dietary factors, developmental abnormalities for which diet plays no role in etiology but for which dietary interventions are crucial for managing (e.g., phenylketonuria), interactions between foods and nutrients and medications, and allergies to foods. Although eating disorders have significant metabolic consequences and important nutritional impacts, they are not primarily nutritional disorders (7 8). According to recent research, university students who are overweight or obese have a higher propensity for unhealthy lifestyle choices, including eating a lot of high-fat and high-sugar foods and a lack of exercise (8). Diet is associated with chronic conditions and considered one of the most public health concerns in the Middle East (9). During the Middle East's nutritional transition, foods high in fat and energy-dense, refined carbohydrates were introduced (10). This transition has coincided with a rise in chronic diseases linked to lifestyle choices, like obesity (11). Keep in mind that nutrition is the most significant source of energy for everyday activities. Excessive and imbalanced diets, on the other hand, dysregulate energy homeostasis, resulting in metabolic disorders including obesity. High calorie consumption raises body weight, which raises the risk of obesity (12). High fructose refined carbohydrates may raise the risk of insulin resistance and obesity (13). Consuming sugar-sweetened beverages was positively correlated with obesity; this correlation is mediated by weight gain, which counteracts obesity (14). Obesity is associated with dietary energy density because it increases body weight and energy-dense foods (15).

Both unbalanced diet and physical inactivity are strongly associated with obesity. Along with interconnected cultural, psychological, and economic factors, social and physical environments have a significant impact on dietary and physical activity behavior (16). Furthermore, diet, a lifestyle behavior, was described as an administration domain having very low compliance between the obese (17). Analysis of consumption of food as dietary patterns could offer a thorough method of treating or preventing disease. It may improve conceptual understandings of human food practices and offer recommendations for nutrition education and intervention (18). A healthy diet ought to be sufficient, diverse, moderate, and balanced, because excessive consumption of specific nutrients was shown to impair immunity in humans in some instances (19). However, poor nutrition can also have an adverse effect on the immune system. Unfortunately, obesity and malnutrition are two of the most common dual nutritional issues in many nations.

The purpose of this study was therefore to assess the effect of dietary patterns on the immune system by examining if participants meet the recommended dietary intake among undergraduate students from the College of Basic Education in Kuwait and the Faculty of

Specific Education at Mansoura University, Egypt, in order to determine the most effective methods for combating obesity in this population.

SUBJECTS AND METHODS

Subject of Design

An intervention study will be performed on 150 undergraduate students (70 from the College of Basic Education in Kuwait and 80 from the Faculty of Specific Education, Mansoura University, Egypt, students >= 20 years of age) during the academic year 2024–2025.

Design of Works

Prior to beginning fieldwork, individuals were interviewed using questionnaires intended to gather information on their eating habits, attitudes, and anthropometric measurements. These questionnaires included the following questions:

Daily Dietary Data

The dietary history and 72-hour record were employed; the subjects were asked about all food items, the amount, frequency of consumption, and also asked about food items taken during the last 72 hours in a semi-quantitative method. Every food calculation included the contributions of dietary energy, protein, carbohydrates, fats, and important vitamins and minerals. A comparison was then made between the nutritive content of the diet and the computed total amount of nutrients **(20)** that were suitable for the study participants.

Characteristics and Laboratory Investigations

The tested characteristics are carried out as following:

- **Body Weight:** This has been measured with light clothing and no shoes, utilizing a spring-type scale to the nearest 1.0 kilogram.
- **Body Height:** The vertical measuring rod was used to take height measurements to the closest 0.5 cm. The participants stood on the scale's level floor, their feet parallel to each other, and the backs of their heads, heels, buttocks, and shoulders all touched the upright board. The orbit's lower border was in the same horizontal plane as the head, which had been held comfortably. The arms hung naturally at the sides.
- **Body Mass Index (BMI):** This index has been obtained by calculating weight in kilograms/square height in meters (kg/ m^2), and in the case of the obesity, a BMI was greater than 27 **(21)**. Underweight (less than 18.5 Kg/m^2), normal weight (18.5 to 25 Kg/m^2), and overweight (more than 25 Kg/m^2).

The Questionnaires

Two forms of questionnaires have been utilized: the first one was for through 3-day food records at 0, 6, and 12 wks. The second one focuses on food habits, including food likes and dislikes, details on the meals in question, and potential suggestions for how to improve the meals that are delivered.

Statistical Analysis

Version 14 of the Statistical Package for the Social Sciences (SPSS) was used to analyze the data. Results are presented as mean ±SD. ANOVA was used to test the difference between groups, and the averages of groups were analyzed with a significance level of 0.05 (22).

RESULTS

Nutritional Status

Mean and Standard Deviation of Nutrient at (0, 6 and 12 weeks) Compared with Dietary Reference Intake (DRI):

It is clear that the daily intake of water by students subjects at (0, 6 and 12 weeks) were less than recommended food (DRI) allowances with (29.87%, 36.01% and 48.85% of DRI, respectively) (Table 1). In addition, it is noticed that total fiber for students groups at (0, 6 and 12 weeks) were lower than of recommended intake (29.78%, 31.53% and 34.10% respectively of DRI). On the other hand, the calorie intake were high for students groups at (0, 6 and 12 weeks) which recorded (113.69%, 115.91% and 119.11% respectively) of recommended allowance (DRI). In addition, protein intake was more than recommended food allowance (DRI) which reached to (119.32%, 146.04% and 116.50% respectively of DRI). As for total fat and carbohydrate that students groups at (0, 6 and 12 weeks) consumed fat and carbohydrate more than the recommended daily allowance which recorded (110.8, 108.5, 109.10% for total fat and 104.01, 108.89, 112.28% for carbohydrate respectively).

Table (1): Mean and standard deviation of nutrients at (0, 6 and 12 weeks) compared with dietary reference intake (DRI):

Nutrients	Groups (0 w)	Groups (6 w)	Groups (12 w)	DRI
Water (g)	406.59±217.44	472.04±225.78	318.99 ±146.10	1500
Energy (kcal)	1573.87±422.54	1618.39±385.17	1682.20±492.45	2500
Protein (g)	54.89 ±19.66	67.18±24.16	53.59±25.31	46
Total fat (g)	60.94±24.54	59.68±23.35	60.01±25.26	35
Carbohydrate (g)	201.44±83.71	203.12±85.29	231.93±98.34	130
Fiber, total (g)	8.78±6.11	9.46±3.56	10.22±5.88	21

Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat and Protein (23) and Dietary Reference Intakes for Water (24), each value represent the mean± SD Significant with control group *$p < 0.05$

Mean and Standard Deviation of Minerals at (0, 6 and 12 weeks) Compared with Dietary Reference Intake (DRI):

It is noticed that the daily intake of calcium by students groups at (0, 6 and 12 weeks) were less than recommended food (DRI) allowances (39.59%, 47.21% and 40.33% respectively of DRI) (Table 2). The percentage of magnesium intake for students groups was lower than the recommended allowance (DRI) which recorded (52.19%, 61.32% and 46.95% of DRI). With respect to levels of minerals in subjects groups which represent in Table (2), it can seen that the daily consumption of iron, phosphorus, sodium, zinc, manganese and selenium were higher than the recommended level of DRI. Whilst, daily intake of potassium and copper were very lower than recommended food allowance (DRI) which recorded (37.23, 39.14, 39.20, 90, 86.66 and 70 % respectively of DRI).

Table (2): Mean and standard deviation of minerals at (0, 6 and 12 weeks) compared with dietary reference intake (DRI).

Nutrients	Groups (0 w)	Groups (6 w)	Groups (12 w)	DRI
Ca (mg)	475.13±278.50	566.52±207.23	484.03±255.51	1200
Fe (mg)	9.41±3.84	9.88±3.48	10.76±4.42	8
Mg (mg)	167.01±76.04	196.23±62.19	150.26±107.63	320

P (mg)	773.59±303.54	911.98±269.07	855.47±304.23	700
K (mg)	1749.92±923.68	1839.88±800.14	1842.46±1053.86	4700
Na (mg)	1578.88±953.53	1436.88±780.90	1505.25±828.21	1300
Zn (mg)	9.19±6.15	10.78±5.96	11.24±7.22	8
Cu (mg)	0.81±0.39	0.98±0.60	0.93±0.58	0.9
Mn (mg)	3.36±4.54	5.36±3.54	5.00±2.22	1.8
Se (µg)	77.74±33.00	88.68±26.59	79.69±30.44	55

Dietary Reference Intakes for minerals (**25**), each value represent the mean± SD. Significant with control group *p< 0.05

Mean and Standard Deviation of Vitamins at (0, 6 and 12 weeks) Compared with Dietary Reference Intake (DRI):

It is clear that the daily intake of vitamin C and thiamin were lower for students subjects groups (Table 3). Daily intake of vitamin B-6, folate, vitamin E and vitamin D were lower than the recommended allowance (DRI) for students groups (0 w) which recorded 57.33, 59.57, 24.80 and 3.77% respectively , for (6 w group) which recorded (66, 57.86, 23.73 and 5.89% and finally for (12 w group) which recorded (55.33, 59, 27.6 and 6.80% respectively). Whilst the daily intake of riboflavin, niacin, vitamin B-12 and vitamin A were higher than standard RDA for tested subjects.

Table (3): Mean and standard deviation of vitamins at (0, 6 and 12 weeks) compared with dietary reference intake (DRI)

Nutrients	Groups (0 w)	Groups (6 w)	Groups (12 w)	DRI
V. C (mg)	52.25±47.36	52.97±25.85	36.15±16.59	75
Thiamin (mg)	0.94±0.36	0.934±0.503	0.95±0.45	1.1
Riboflavin (mg)	1.34±0.59	1.39±0.57	1.26±0.61	1.3
Niacin (mg)	14.48±7.21	16.70±7.65	14.69±8.98	14
B_6 (mg)	0.86±0.45	0.99±0.47	0.83±0.46	1.5
Folate, total (mcg)	238.30±153.27	231.46±125.41	236.00±155.15	400
B_{12} (mcg)	2.93±4.18	3.09±1.38	4.45±2.87	2.4
Vitamin A, IU	2321.26±3424.76	2237.24±1477.92	1797.05±310.39	1166.66
Vitamin E (mg)	3.72±3.91	3.56±2.04	4.14±2.66	15
Vitamin D (IU)	22.65±54.21	35.34±16.00	40.84±14.94	600

Dietary Reference Intakes for vitamins (**26**), each value represent the mean± SD Significant with control group *p< 0.05

Mean and Standard Deviation of Essential Amino Acids for Subjects at (0, 6 and 12 weeks) Compared with Dietary Reference Intake (DRI):

With respect to daily rates of essential amino acids consumption of students subjects groups which represent in table (4), it can be seen that the daily intake of all essential amino acids for (0 w group) was lower than the levels of dietary reference intake (DRI) which recorded (7, 5.98, 5.43, 6.14, 7.92, 3.96, 2.72, 4.02 and 6.9%) for (tryptophan, leucine, lysine, threonine, isoleucine, methionine, cystine, phenyalanine and valine respectively). As, that the daily intake of all essential amino acids for (6 w group) was lower than the levels of dietary reference intake (DRI) which recorded (9.28, 7.56, 7.19, 7.85, 10.32, 5.48, 3.24, 5.25 and 8.72%) for (tryptophan, leucine, lysine, threonine, isoleucine, methionine, cystine, phenyalanine and valine respectively). In addition, the daily intake of all essential amino acids for (12 w group) was lower than the levels of dietary reference intake (DRI) which recorded (5.57, 5.94, 5.17, 5.92, 7.96, 3.88, 2.68, 4.13 and 6.78%) for (tryptophan, leucine, lysine, threonine, isoleucine, methionine, cystine, phenylalanine and valine respectively).

Table (4): Mean and standard deviation of essential amino acids at (0, 6 and 12 weeks) compared with dietary reference intake (DRI).

Nutrients	Groups (0 w)	Groups (6 w)	Groups (12 w)	DRI
Tryptophan (mg)	0.49±0.21	0.65±0.32	0.39±0.24	7
Leucine (mg)	3.29±1.60	4.16±2.16	3.27±1.90	55
Lysine (mg)	2.77±1.69	3.67±1.43	2.64±1.84	51
Threonine (mg)	1.66±0.83	2.12±1.17	1.60±0.98	27
Isoleucine (mg)	1.98±1.01	2.58±1.41	1.99±1.18	25
Methionine (mg)	0.99±0.52	1.37±0.73	0.97±0.59	25
Cystine (mg)	0.68±0.32	0.81±0.35	0.67±0.36	25
Phenylalanine (mg)	1.89±0.87	2.47±1.16	1.94±1.12	47
Valine (mg)	2.21±1.06	2.79±1.45	2.17±1.23	32

Dietary Reference Intakes for Amino Acids **(23)**, each value represent the mean± SD Significant with control group *p< 0.05

Some Anthropometric Measurement of the Subjects

Data presented in Table (5) displayed some anthropometric measurement of subjects. It could be noticed that the mean of students subjects height was 1166.72 ± 6.56 cm, the weight mean of the subjects was 83.50 ± 7.55 kg. Otherwise, the mean percentage of BMI were 14.67 and 16% for overweight and obese subjects and the mean of subjects age was 20.22± 3,87.

Table (5): Anthropometric characteristics of the study subjects

Variables		Mean ±SD
Height (Cm)		166.72 ± 6.56
Weight (kg)		69.50 ± 16.55
BMI *(Kg/m2)*	**Underweight < 18.5 n (%)**	23 (15.3%)
	Normal 18.5–24.9 n (%)	81 (54%)
	Overweight 25–29.9 n (%)	22 (14.67%)
	Obese ≥ 30.0 n (%)	24 (16%)
Age		20.22 ±3.87
F		1.672

BMI: Body Mass Index; n=150, each value represent the mean± SD Significant with control group *p< 0.05

DISCUSSION

Enough energy is needed for immunological cells, and both macro- and micronutrients have a role in the development, expression, and upkeep of the immunological response. Foods high in protein promote the synthesis of immunoglobulins and have antiviral properties (27). As a result, individuals ought to include whole grains, legumes, nuts, vegetables, and animal products in their normal diet. Likewise, eating a plant-based, low-fat diet may help to boost the immune system (28). Additionally, fiber can support the maintenance of a healthy BMI, which is associated with improved immunity (29). Carotenoids, flavonoids, and vitamins A, C, and E, for example, are abundant in the diet and function as antioxidants, scavenging oxidative free radicals (30). It was discovered that taking vitamin D supplements was safe for preventing influenza and upper respiratory infections (31).

Dietary diversity and quality may be linked with unhealthy meal patterns, and it has been demonstrated that a lower dietary diversity score raises the risk of metabolic syndrome (32). Adolescent girls who score low on dietary diversity may be more susceptible to nutrient deficiencies, including iron deficiency anemia (33). In some cases, nutrient insufficiency is seen as a significant risk factor for infection because of immune response impairment if not treated. Additionally, dietary pattern preference may be influenced by age group; for example, adults tend to follow a western diet, which may raise their risk of obesity, metabolic syndrome, and other complications (34). According to a 2011 World Health Organization report, a BMI of 30 or higher is considered obese. A person's body fat composition changes and increases on body overweight (31). It is a well-known fact that central or abdominal fat is far more likely to be linked with chronic metabolic disorders rather than the overall excess weight reflected by BMI. Moreover, Nuttall (21) reported that BMI as one of best effective anthropometric indices for women to identify the obesity case. Furthermore, Bastien et al. (35) indicated that, body mass index (BMI) as the most commonly marker which are firmly associated with the probability and riskiness of the obesity. In addition, Wang et al. (36) stated that obesity as a basic independent and modifiable risk factor and previous epidemiological studies suggested a progressive rise in the prevalence of obesity. In this study conducted among 150 students from the college of Basic Education in Kuwait and the Faculty of Specific Education, at Mansoura University, Egypt, It is fact that Abdominal obesity appeared in females than males (37), and related the difference to the different body fat distribution between females and males as the numbers and size of fat cells consider a possible determinants of rats of adiponectin production (37). The study's findings are similar to those from Pharos University, where 11.8% of students were obese (38). And slightly comparable to Saudi students, whose 15.7% were obese (39).

This may be the consequence of the global nutrition transition, as fast food has replaced traditional cultural foods in many countries (4). Fast food is a common dietary pattern that is high in simple carbohydrates, trans fats, and saturated fats, but low in fiber and complex carbohydrates. It is often referred to as a high-calorie diet that is poor in nutrients such as vitamins and minerals. Fast food intake is linked to the high rates of obesity and chronic illnesses, including Type 2 diabetes. Therefore, increased inflammatory markers are indirectly caused by this food pattern. Research suggests that fast food, combined with physical inactivity, is a risk factor for 'metaflammation,' that is, a metabolism-induced inflammation. However, it is hypothesized that the increased absorption of lipopolysaccharide (LPS), a component of gram-negative bacteria's cellular membranes, from the intestinal microbiota results in excessive gut leakage, which is detected by innate immune system cells through toll-like receptor 4 (TL4) and activates the inflammatory response. This permits the infection to enter the bloodstream from the gut. Because fast food is poor in fiber and rich in sugar and salt, which trigger inflammation and increase the risk of cancer and other immune-related disorders, it can result in a less diverse variety of gut microbes (40).

The current study's observed disparity in the percentages and distribution of overweight and obesity may be the result of complex multifactorial influences relating to various student behavioral and genetic factors. Physical inactivity and poor eating habits could account for some of the current study's higher prevalence of overweight and obesity.

CONCLUSION

Consuming an optimum diet has been linked to improved human life quality and the preservation of a robust immune system capable of protecting against infection and disease. An optimal diet enhances the immune system and provides the body with an abundance of essential nutrients. According to the results, more than 20% of students are obese or overweight, and they have unhealthy dietary and lifestyle habits. Moreover, the subjects are not taking their recommended dietary intake from some vitamins and minerals that boost the immune system. Therefore, an organized nutrition educational program ought to be implemented for newly enrolled university students. Additionally, universities ought to promote healthy food stores and reduce the number of fast-food joints on university.

ACKNOWLEDGMENT

Thank you to Dr. Madiha Mohamed Abdel-Hay, Department of Home Economics, Faculty of Specific Education, Mansoura University, for providing the necessary for the successful completion of this project.

References

1. Marshall JS, Warrington R, Watson W, Kim HL. An introduction to immunology and immunopathology. Allergy Asthma Clin Immunol. 2018;14(Suppl 2):49. doi:10.1186/s13223-018-0278-1
2. Milte CM, Thorpe MG, Crawford D, Ball K, McNaughton SA. Associations of diet quality with health-related quality of life in older Australian men and women. Exp Gerontol. 2015;64:8-16. doi:10.1016/j.exger.2015.01.047.
3. Martinez-Lacoba R, Pardo-Garcia I, Amo-Saus E, Escribano-Sotos F. Mediterranean diet and health outcomes: a systematic meta-review. Eur J Public Health. 2018;28(5):955-961. doi:10.1093/eurpub/cky113.
4. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. Nutr Rev. 2012; 70(1):3-21. doi:10.1111/j.1753-4887.2011.00456.x.
5. World Health Organization (WHO). Obesity and overweight factsheet from the WHO.2011
6. El-Mehiry HF, Shelbaya LA. Immunotoxicity effect of lavender (Lavendula Spica) flowers powder and oil on azathioprine induced toxicity in experimental rats. J Specific Edu Stud Res, Zag Univ. 2017; 2(1): 202-221.
7. Ayling RM. Nutritional disorders and their management. In: Marshall WJ, Lapsley M, Day A, et al., editors. Clinical Biochemistry Metabolic and Clinical Aspects. Edinburgh: Elsevier; 2014. 200-213.
8. Al Sabbah H. Prevalence of overweight/obesity, anaemia and their associations among female university students in Dubai, United Arab Emirates: a cross-sectional study. J Nutr Sci. 2020;9:e26. doi:10.1017/jns.2020.23.
9. Musaiger AO. Overweight and Obesity in the Eastern Mediterranean Region: Can we control it? East Mediterr Health J. 2004; 10:789-793.
10. Musaiger AO, Al-Hazzaa HM. Prevalence and risk factors associated with nutrition-related noncommunicable diseases in the Eastern Mediterranean region. Int J Gen Med. 2012;5:199-217. doi:10.2147/IJGM.S29663.
11. Amuna P, Zotor FB. Epidemiological and nutrition transition in developing countries: impact on human health and development. Proc Nutr Soc. 2008; 67(1):82-90. doi:10.1017/S0029665108006058
12. Kahn SE, Hull RL, Utzschneider KM. Mechanisms linking obesity to insulin resistance and type 2 diabetes. Nature. 2006; 444(7121):840-846. doi:10.1038/nature05482

13. Gross LS, Li L, Ford ES, Liu S. Increased consumption of refined carbohydrates and the epidemic of type 2 diabetes in the United States: an ecologic assessment. Am J Clin Nutr. 2004;79(5):774-779. doi:10.1093/ajcn/79.5.774

14. Hu FB, Malik VS. Sugar-sweetened beverages and risk of obesity and type 2 diabetes: epidemiologic evidence. Physiol Behav. 2010;100(1):47-54. doi:10.1016/j.physbeh.2010.01.036

15. Mendoza JA, Drewnowski A, Christakis DA. Dietary energy density is associated with obesity and the metabolic syndrome in U.S. adults. Diabetes Care. 2007; 30(4):974-979. doi:10.2337/dc06-2188

16. Roberts K, Cavill N, Hancock C, Harry, R. Social and economic inequalities in diet and physical activity. Oxford: Public Health England Obesity Knowledge and Intelligence. 2013: 55-71

17. Committee DGA. Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture and the Secretary of Health and Human Services. Washington, DC: U.S. Department of Agriculture, Agricultural Research Service; 2020.

18. Gwamaka M, Kurtis JD, Sorensen BE, et al. Iron deficiency protects against severe Plasmodium falciparum malaria and death in young children. Clin Infect Dis. 2012;54(8):1137-1144. doi:10.1093/cid/cis010

19. 27 Institute of Medicine. Dietary Reference Intakes: A Risk Assessment Model for Establishing Upper Intake Levels for Nutrients. 1998, Washington, DC: The National Academies Press. https://doi.org/10.17226/6432.

20. Nuttall FQ. Body Mass Index: Obesity, BMI, and Health: A Critical Review. Nutr Today. 2015;50(3):117-128. doi:10.1097/NT.0000000000000092

21. 29 SPSS Inc. Released 2008. SPSS Statistics for Windows, Version 17.0. Chicago: SPSS Inc.

22. Institute of Medicine. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients). 2005. National Academic Press.DOI:10.17226/10490

23. Institute of Medicine, Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate. 2005. National Academic Press. DOI: 10.17226/10925

24. Ross AC, Manson JE, Abrams SA, et al. The 2011 report on dietary reference intakes for calcium and vitamin D from the Institute of Medicine: what clinicians need to know. J Clin Endocrinol Metab. 2011; 96(1):53-58. doi:10.1210/jc.2010-2704.

25. Ross AC, Manson JE, Abrams SA, et al. The 2011 report on dietary reference intakes for calcium and vitamin D from the Institute of Medicine: what clinicians need to know. J Clin Endocrinol Metab. 2011;96(1):53-58. doi:10.1210/jc.2010-2704

26. Schuetz P, Fehr R, Baechli V, et al. Individualised nutritional support in medical inpatients at nutritional risk: a randomised clinical trial. Lancet. 2019;393(10188):2312-2321. doi:10.1016/S0140-6736(18)32776-4

27. Mishra S, Patel M. Role of nutrition on immune system during Covid-19 pandemic. J Food Nutr Health. 2020;3(2):1–6

28. Rinninella E, Cintoni M, Raoul P, et al. Food components and dietary habits: Keys for a healthy gut microbiota composition. Nutrients. 2019;11(10):2393. doi:10.3390/nu11102393

29. Waheed Janabi AH, Kamboh AA, Saeed M, et al. Flavonoid-rich foods (FRF): A promising nutraceutical approach against lifespan-shortening diseases. Iran J Basic Med Sci. 2020;23(2):140-153. doi:10.22038/IJBMS.2019.35125.8353

30. Grant WB, Lahore H, McDonnell SL, et al. Evidence that Vitamin D Supplementation Could Reduce Risk of Influenza and COVID-19 Infections and Deaths. Nutrients. 2020;12(4):988. doi:10.3390/nu12040988

31. Michels KB, Schulze MB. Can dietary patterns help us detect diet-disease associations?. Nutr Res Rev. 2005;18(2):241-248. doi:10.1079/NRR2005107

32. Gholizadeh F, Moludi J, Lotfi Yagin N, et al. The relation of Dietary diversity score and food insecurity to metabolic syndrome features and glucose level among pre-diabetes subjects. Prim Care Diabetes. 2018;12(4):338-344. doi:10.1016/j.pcd.2018.03.003

33. Sun J, Buys NJ, Hills AP. Dietary pattern and its association with the prevalence of obesity, hypertension and other cardiovascular risk factors among Chinese older adults. Int J Environ Res Public Health. 2014;11(4):3956-3971. doi:10.3390/ijerph110403956

34. Mahadevan S, Ali I. Is body mass index a good indicator of obesity?. Int J Diabetes Dev Ctries. 2016; 36:140–142

35. Bastien M, Poirier P, Lemieux I, Després JP. Overview of epidemiology and contribution of obesity to cardiovascular disease. Prog Cardiovasc Dis. 2014;56(4):369-381. doi:10.1016/j.pcad.2013.10.016

36. Wang Y, Beydoun MA, Min J, Xue H, Kaminsky LA, Cheskin LJ. Has the prevalence of overweight, obesity and central obesity levelled off in the United States? Trends, patterns, disparities, and future projections for the obesity epidemic. Int J Epidemiol. 2020;49(3):810-823. doi:10.1093/ije/dyz273

37. Gierach M, Gierach J, Junik R. Insulin resistance and thyroid disorders. Endokrynol Pol. 2014;65(1):70-76. doi:10.5603/EP.2014.0010

38. Yahia N, Achkar A, Abdallah A, Rizk S. Eating habits and obesity among Lebanese university students. Nutr J. 2008; 7:32. doi:10.1186/1475-2891-7-32

39. Al-Rethaiaa AS, Fahmy AE, Al-Shwaiyat NM. Obesity and eating habits among college students in Saudi Arabia: a cross sectional study. Nutr J. 2010;9:39. doi:10.1186/1475-2891-9-39

40. Makki K, Deehan EC, Walter J, Bäckhed F. The Impact of dietary fiber on gut microbiota in host health and disease. Cell Host Microbe. 2018;23(6):705-715. doi:10.1016/j.chom.2018.05.012