



Self-Reported Dietary Habits and Intensity of Negative Emotions: From a Population of Moroccan University Students.

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Abstract

Emotional disorders are an ever-increasing problem in our society, accounting for a significant portion of the global burden of disease. A healthy and balanced diet is now one of the promising avenues for the prevention and care of psychiatric disorders. The principal objective of this cross-sectional study was to analyze the relationship between eating habits, frequency of consumption of certain foods, and mental well-being in a sample of students. A food frequency questionnaire was developed to describe participants' eating habits. The DAS21 self-questionnaire was used to assess the intensity of negative emotions associated with depression, anxiety, and stress. The age of the participants, who numbered 620, varied from 18 to 25 years (mean age: 22.32 years). The consumption of the different foods studied was varied, with a low consumption of fruits and vegetables. The prevalence of emotional disorders was high among the students. Skipping breakfast had a negative impact on mental well-being. High frequency of consumption of apples, seafood, kiwi, dried fruits, sardines, olive oil, green leafy vegetables, tomatoes, carrots and apricots was beneficial to the mental health of students. This suggests that healthy eating behaviours based on a balanced diet may be an interesting avenue for preventing and treating psychopathological disorders.



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Introduction

Emotional disorders are an ever-increasing problem in our society, accounting for a significant portion of the global burden of disease. In terms of morbidity costs, mental health disorders are second only to heart disease.¹ In the field of mental health, affective disorders may be referred to as mood disorders or mood swings. Depression and anxiety are the most common mental health conditions worldwide.² In addition to the involvement of our genetic heritage, psychological trauma, early brain lesions or neglect in childhood, and attachment disturbances can be at the origin of emotional disorders.³ It is therefore interesting to note that the interplay between specific environmental challenges occurring during developmental periods seems to play an important role in the onset of emotional difficulties. For example, poor nutrition can have negative health consequences, including mood dysfunction, suggesting a strong interaction between these elements.⁴ In this sense, beyond having effects on physical health, recent research shows that diet would influence mood and mental well-being. Thus, a decrease in the risk of depression by consuming healthy diets has been reported in epidemiological studies.^{5,6,7} Similarly, caloric intake and diet composition are two parameters that have important effects on emotions, especially during critical periods of development.⁴ It thus appears that the diet of individuals would have an influence on their mental health. However, the meaning of the relationship between eating habits and mental health status is still poorly elucidated, and more research to better study this possible reverse causality seems to be a necessity.⁸ In long-term mental illness, maintaining a healthy diet may be impaired by environmental factors or by the effect of medications on appetite.⁹ The study of food's impact on well-being is all the more important when we know that the problem of mental health and that of nutrition constitute two public health issues. Moreover, a poor diet characterized by highly processed foods lacking in polyphenols and antioxidants is common in current society.¹⁰ In addition, the burden of mental disorders and in particular depressive and anxiety disorders is increasing. Therefore, it seems necessary, in the field of public health, to consider food as a preventive strategy as well as a complementary treatment of negative emotions, especially during difficult situations in life. It is important to note

that the university teaching period is one of those difficult times when many mental health disorders begin to manifest themselves.¹¹ The occurrence of negative emotions among university students is associated with several factors namely course work, learning difficulties, exams, graduation thesis, and financial difficulties.^{12,13} We also recall that academic performance is frequently altered by psychological problems in university students.¹⁴ In addition, adaptation to the university climate and social and family interactions are other dimensions negatively influenced by the existence of negative emotions among students.¹¹ Furthermore, the development of students' psychosocial skills is crucial to their academic success.¹⁵ Among the avenues considered to address these problems, it is increasingly admitted that a balanced diet is a promising avenue that has preventive and therapeutic effects on mental health. This dietary track will also have beneficial effects on cognitive functions, which are required in the area of learning and which the student population needs, as has been shown by several researches.¹⁶ On another register, it is necessary to mention that negative emotions can have important repercussions on cognitive processes like memory and attention.¹⁷⁻¹⁹ Although the effects of a healthy diet on the reduction of negative emotions are considered a therapeutic recourse, bad eating habits are still practiced by a large population. Thus, a recent study revealed that the food consumption of Moroccan university students is dominated by animal products, fast food, and processed products that are rich in sugar, salt, and saturated fatty acids.²⁰ We also add that in a recent literature review of students aged 12-33 years from 12 Arab countries, the average prevalence of eating disorders was 31.4% in a sample of 17,679 subjects, with a variation of 9.6% to 74.5%.²¹ This data prompted us to conduct this research with a population of Moroccan students. Two major objectives were targeted, the first is to describe some eating habits in a student population. The second objective is to analyze the links between the frequency of consumption of certain foods and the intensity of negative emotions in these students. We have focused on a number of foods, belonging to the category of antioxidant foods, which have already been the subject of very few studies regarding the impact of nutrition on mental well-being as evidenced implicitly by recent literature reviews such as that of Brennstuhl and collaborators (2021).²² According

to the latter, the most documented antioxidant foods were mainly in the category of vegetables and fruits.

Materials and Methodology

Population and Study Site

Our present study was conducted with a sample of 620 students pursuing their studies in different governmental institutions of the Sultan Moulay Slimane University in Beni Mellal city (center of Morocco). The academic level of the participants covers the first degree obtained at the university up to the Bachelor's level. Participation in our study was open to students belonging to different institutions of Sultan Mulay Slimane University. They are excluded from our study all students with eating disorders, chronic diseases and neuro developmental disabilities. All these pathologies are suspected to have a psychological burden in humans. The sampling technique adopted was simple random sampling. The sample size was determined by setting the margin of error at 4% and the confidence interval at 95%.

Tools

In this study, in conjunction with questions on the health status and socio-cultural and family background of the participants, the scale that was administered included two questionnaires. One describes some eating habits and the frequency of consumption of certain foods by the participants. The other assesses the intensity of negative emotions related to depression, anxiety and stress.

Depression, Anxiety, and Stress Scale (DASS-21)

The self-administered questionnaire (DASS-21)²³ is composed of three subscales designed to measure negative emotional states associated with depression, anxiety, and stress. Each subscale is composed of 7 items whose total score allows us to estimate the intensity of the symptoms of each negative emotion in normal, light, moderate, and extremely severe. Interviewees indicate their level of agreement or disagreement on a scale ranging from 0 (Does not apply to me at all) to 3 (Applies to me often or most of the time). The total score for each of the three dimensions of mental health is calculated by multiplying the sum of the seven items in each subscale by two, so that the possible scores will range from 0 to 42. Several reasons motivated us to use the DAS21 in this study. Firstly, this questionnaire had shown excellent

psychometric qualities in several international validation studies.²⁴⁻²⁶ In addition, the convergent and discriminant validity of the French version we used in this study was very satisfactory.²⁰ Finally, it is a simple scale to administer and covers the evaluation of three aspects of mental health. The internal consistency of the three subscales ranges from 0.82 to 0.94.^{24,27}

Questionnaire Describing Eating Habits and Consumption of Certain Foods

In order to describe the frequency of food consumption, we developed a questionnaire covering the main categories of foods with high content of vitamins (C, A and E), trace elements and polyphenols. This questionnaire also includes different items related to some other eating habits such as the total number of meals eaten per day, the main meal and the frequency of skipping one of the main meals. The frequencies of food consumption per week were proposed as follows. No time or less than once a week, 2-4 time/ week, 5-6 time/ week or daily. Additional questions about the consumption of certain seasonal foods were included in our questionnaire (without mentioning the frequency of consumption).

Protocol

The living conditions that were imposed by the Coronavirus Disease 2019 (COVID-19), forced us to put our questionnaire online trying to share it as much as possible on social networks especially on students' Whatsapp groups and Facebook pages of targeted academic institutions. Our survey was conducted from March to the beginning of June 2021. The administration time of the questionnaire used varies from 5 to 10 minutes. Our general approach is to describe in a first time the intensity of the negative emotions and the eating habits of the studied population. The analysis of the links between the consumption frequencies of some food groups and the state of mental well-being will be the object of the second stage of our experimental part.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (Version 19.0, SPSS, Inc). Numerical variables were analyzed using the student t-test. Statistical significance between qualitative variables was examined by the chi-square test Relations between study variables

were evaluated using bivariate analysis with Pearson or Spearman (ρ) coefficient for skewed data with a two-tailed $p < 0.05$ indicating statistical significance.

Compliance with Ethical Standards

Before the beginning of this study, a written authorization was delivered to us, under the number FST/LGB/2020/27, JAN.2020-SEPT.2020, by the responsible services of Sultan Moulay Slimane University. During all the stages of our study, we ensured that its conduct complied with the ethical standards of the institutional research committee and the Declaration of Helsinki of 1964, and its subsequent amendments, for studies involving human subjects. All investigators participated voluntarily and were informed that they could withdraw from the study at any time without any consequences. All participant data were confidential and protected during all stages of our research.

Results

Characteristics of The Population

Our study included 620 participants, 362 of whom were male students, representing 58% of the surveyed population. Participants ranged in age from 18 to 25 years (Mean age = 22.32 years, standard deviation = 3.12 years). The total number of the sample is distributed as follows: 196 first-year

university students (32%), 240 second-year students and 184 bachelor's degree students.

Negative Emotions Intensity Among in the Study Population

For just over half of our sample (51.8%), the depression level was "normal to moderate", 13.5% were severely depressed and an extremely severe depressive state was noted in 24.7% of respondents (Table 1). Regarding anxiety, only 27% of the participants had "normal to mild" symptomatology while 51.8% presented a "severe to very severe" level of intensity in this category of negative emotions (Table 1). The prevalence of stress in the study sample showed that two-thirds of students (68.2%) had "normal to moderate" symptom intensity. Extremely severe intensity was found in 8.4% of the students surveyed (Table 1). The Student's t-test showed that female students had significantly higher levels of negative emotions than male students ($t=2.13$, $p=0.03$; $t=1.53$, $p=0.04$; $t=1.89$, $p=0.03$ for stress, anxiety and depression respectively). The mean scores and standard deviations for stress, anxiety, and depression for females are respectively as follows: $M = 234.12/SD = 6.25$; $M = 17.75/SD = 6.66$; $M=18.09/SD = 8.37$ (for males, these values are respectively: $M=17.53/SD=7.08$; $M=11.96/SD=5.62$; $M=14.13/SD=6.65$).

Table 1: Negative emotion intensity in the study population

Negative emotion intensity	Stress	Anxiety	Depression
Normal to Mild	39%	27%	37.3%
Moderate	29.2%	21.2%	20.5%
Severe	23.5%	14%	17.5%
Extremely severe	8.4%	37.8%	24.7%

Description of Some Eating Habits in the Study Population

Number of Meals Per Day, Main Meal, and Skipping the Main Meal

From the results presented in Table (2), we find that a little over half of the students surveyed (53%) eat three meals a day. A proportion of 34% of the participants declared that they eat four times a day, while 8% mentioned that they eat only two meals per. The data collected showed that the majority

of the students questioned (74%) consider lunch as their main meal, 17% (105 participants) declare that breakfast is their main meal, and only 9% of our study sample give importance to dinner at the expense of the other two meals (Table 2). When asked about skipping one of the three main meals, 539 students (87 % of respondents) did not regularly eat all three meals per day. Among this sub-population who skips meals, 31% does not eat breakfast, 61% does not eat dinner and only 8% omits lunch (Table 2).

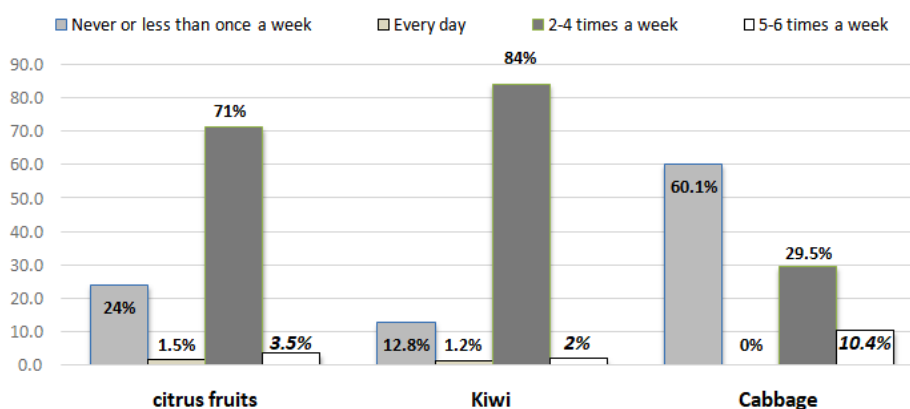
Table 2: Data description related to the number of meals and the main meals.

Variable	n	%
Number of meals per day		
1	8	1.2%
2	51	8.22%
3	324	52.25%
4	212	34.19%
5 or more times	25	4.03%
Main meal		
Breakfast	105	17%
Lunch	457	74%
Dinner	58	9%
Skipping the main meal		
Breakfast	192	31%
Lunch	50	8%
Dinner	378	61%

Consumption Frequency of some Foods Rich in Vitamin C

In this category of foods, we are particularly interested in the consumption of citrus fruits, kiwis and cabbage. These foods are known for their high content of vitamin C. Despite the frequency of consumption, the percentage of students who

affirmed that they regularly eat kiwis and citrus fruits was high (84% and 71% respectively). This finding does not apply to cabbage, whose consumption was very low (60% of the population never eat it or eat it less than once a week versus 29% with a frequency of 2 to 4 weeks). (Figure 1).

**Fig. 1: Consumption frequency of certain foods rich in vitamins C**

Consumption Frequency of Some Foods Rich in Vitamins E and A

When we look at the intake of foods rich in vitamins E and A, we noticed that tomatoes and carrots are

the most frequently consumed, followed by green leafy vegetables and red peppers, while dried fruits are the least consumed (Figure 2).

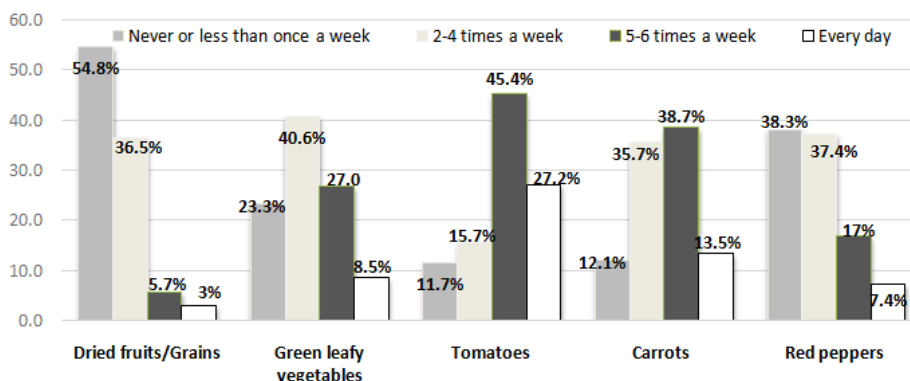


Fig. 2: Consumption frequency of certain foods rich in vitamins A and E

Intake of Foods Rich in Trace Elements and Fatty Acids

Avocado is among the foods whose consumption was the subject of a questionnaire item adopted in this research. The information obtained indicate that almost a quarter of students do not eat this food classified as particularly rich in polyunsaturated fatty acids and trace elements. The frequency

of consumption of some other foods, known for their richness in trace elements and polyunsaturated fatty acids, shows that olive oil is the most consumed daily. Meat and dairy products ranked second, with the proportion of respondents who said they eat sardines and seafood 2 to 4 times a week remaining very low, at 15.7% and 11.7% respectively (Figure 3).

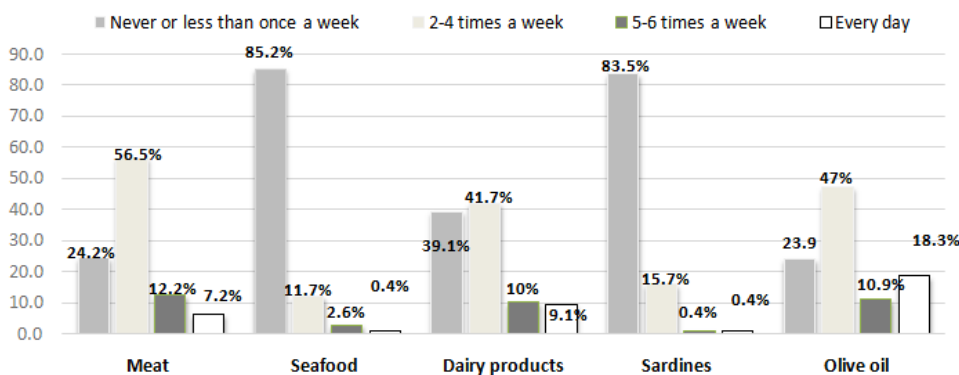


Fig. 3: Consumption frequency of some foods rich in trace elements and polyunsaturated fatty acids

Foods Containing Polyphenols

Responses collected to the question about seasonal consumption of berries and grapes indicate that the majority of subjects consume these two foods (81% and 90% for berries and grapes respectively). The figure below shows the consumption frequency

of some other foods with a high polyphenol composition. We note that tea is the most consumed in our population (24% of the participants consume it every day and a little more than half take it 2 to 4 times a week). The intake frequency of chocolate and apples was very low (Figure 4).

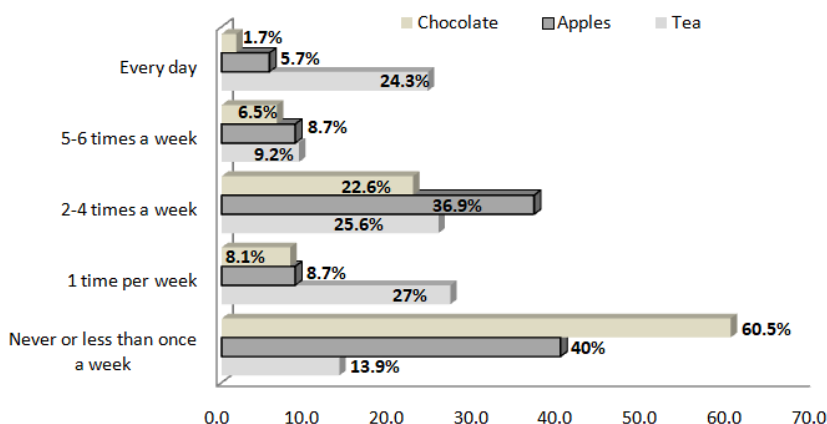


Fig. 4: Frequency distribution of consumption of foods rich in polyphenols.

Table 2: Correlations between certain eating habits, sleep problems and negative emotions.

	Gender	NMD	Main meal	Meal skipping	Skipped meal	Sleep problems	Stress	Anxiety	Depression
Gender	—	0.046	0.07	-0.17**	0.127	-0.123	-0.253**	-0.251**	-0.148*
NMD		—	-0.58	-0.124	-0.05	-0.204**	0.035	0.014	-0.078
Main meal			—	-0.131*	-0.198**	0.027	-0.020	-0.058	-0.009
Meal skipping				—	0.116	0.090	0.066	-0.026	0.005
breakfast skip					—	0.081	0.001	-0.131*	0.091
Sleep problems						—	0.374**	0.312**	0.338**

NMD: Number of meals eaten per day (1 to 2 meals/day, 3 or 4 meals/day, 5 or more meals/day) Main meal: Breakfast, Lunch, Dinner; Meal skipping: Yes, No; Skipped meal: Breakfast, Lunch, Dinner; Sleep problems: Yes, No; Stress, Anxiety, Depression: normal, light, moderate, and extremely severe (Intensity of symptoms according to the DAS21 scale);**: Correlation is significant at the 0.01 level; *: Correlation is significant at the 0.05 level.

Eating Habits, Sleep Problems and Mental Well-Being

Given the close and bidirectional links that can develop between certain eating habits, sleep disturbances, and emotional well-being, we examine in this section the correlations between the data from the three parameters. Statistical analysis showed no significant associations between total scores reflecting mental well-being status (scores reflecting

symptoms of stress, anxiety and depression), the total number of meals taken per day and the meal chosen as the main meal (Table 2). However, the Spearman test showed that skipping breakfast appeared to be significantly associated with the intensity of anxiety symptomatology ($r = -0.13$; $p < 0.05$). This suggests that the population of students who do not eat breakfast is more anxious than their peers who eat breakfast regularly

(Table 2). It should be noted that according to the Student's t-test for independent samples, average age of the subjects who skip breakfast ($M=20,42$ ans ; $SD=1,45$ ans) is significantly lower than that of the subjects who eat this meal ($M=21,55$; $SD=1,08$ ans . $t=2.09$, $p=0.03$). Comparison by Student's t-test for independent samples also revealed that the mean number of meals eaten per day was significantly lower in participants without sleep problems ($t=2.90$, $p=0.04$). who ate an average of 3.34; $SD= 0.56$ meals/day versus 4.12; $SD =0.45$ reaps/day in their peers with sleep difficulties. Highly relevant positive correlations were found between sleep problems and negative emotion scores. This means that symptoms related to stress, anxiety and depression are much more frequent in students who reported that they suffer from sleep problems (Table 2). It should be noted that the direction of this relationship between the two variables remains to be elucidated. Examining some of the gender data by Pearson correlation, we found that female students skip one of the main meals more than male students ($r=-0.177$, $p=0.007$).

Relationship Between Food Consumption Frequency and Scores Reflecting the Intensity of Negative Emotions

Overall, high frequency of consumption of twelve foods/food categories is significantly related to a reduced level of stress, anxiety and depression scores. These include sardines, seafood, olive oil, kiwi, green leafy vegetables, tomatoes, carrots, apricots, eggplant and dairy products (Table 3). These foods are known for their high content of trace elements and polyunsaturated fatty acids. In the category of foods rich in polyphenols, high consumption of apples was associated with very low levels of symptoms related to emotional difficulties (Table 3). High consumption of dried fruit/grain was also correlated with lower levels of negative emotions in the surveyed student population (Table 3). Although the total scores reflecting the state of negative emotions decreased by consuming certain foods rich in polyphenols such as tea and chocolate, the relationship between the two variables was not statistically significant (Table 3).

Table 3: Correlations between food consumption and intensity of negative emotions

Key nutrients & Foods		Negative emotions		
Key nutrients with an antioxidant effect	Food/ Food Category	Stress scores	Anxiety scores	Depression scores
Trace elements and Polyunsaturated fatty acids	Meat	0 .097	-0.054	-0.09
	Seafood	-0.194*	-0.124	-0.110
	Dairy products	-0.183**	-0.238**	-0.183**
	Sardines	-0.209**	-0.208**	-0.161**
	Olive oil	-0.149*	-0.085*	-0.101
	Avocado	-0.061	-0.046	-0.078
Vitamin C	Citrus	0.042	0,002	0.062
	Kiwi	-0.138*	-0.017	-0.013
	Cabbage	0.088	0.103	0.109
	Cauliflower	0.07	0.109	0.100
Vitamins E and A	Dried fruits/Grains	-0.170*	-0.092*	-0.0128
	Green leafy vegetables	-0.081*	-0.025	-0.065
	Tomatoes	-0.082	-0.094*	-0.062
	Carrots	-0.029	-0.092*	-0.002
	Red peppers	0.037	-0.005	-0.010
Polyphenols	Berries	0.001	0.096	0.107
	Raisins	-0.031	0.013	0.012
	Tea	-0.096	-0.014	-0.028
	Apples	-0.151*	-0.183**	-0.173**

Vitamins A and C	Chocolate	-0.016	-0.050	-0.022
	Apricots	-0.097*	-0.007	0.065
	Mango	0.038	-0.011	-0.015
	Papaya	-0.166	0.053	0.062
	Garlic	0.070	0.109	0.100
	Eggplant	-0.097*	-0.005	-0.010
	Pumpkin	0.067	0.101	0.096

** : Correlation is significant at the 0.01 level; * : Correlation is significant at the 0.05 level.

Discussion

It should be remembered that the aims of our research were to investigate the frequency of consumption of certain foods, negative emotions, and to analyze the link between these two subjects in a population of university students. Starting with the description of negative emotions, we found that almost one third (27%) of students had "severe to very severe" stress intensity and 68% had "normal to moderate" symptomatology in this same emotion. For anxiety, our study revealed that almost half (48.2%) of the subjects had normal to moderate symptomatology. Similarly, the presence of depression in our study sample indicates that "severe to very severe" intensity was recorded in 38% of respondents. These results are very similar to those obtained in a recent study focusing on physical activity and negative emotions in a population of students studying at the same university as our sample.²⁷ According to this latest study, 48% of the participants had a normal to moderate level of anxiety. The same study also showed that the prevalence of severe to very severe stress and depression was 32% and 34% respectively. These very similar results of the two studies, conducted with two independent samples of students belonging to the same university, reinforce each other and prompt officials to take urgent action for the mental well-being of Moroccan students. We can also compare these results to a study carried out on medical students, which highlighted that the age group between 21 and 23 years is more exposed to anxiety and depression problems.²⁸ The psychological distress found among students can be attributed to several factors. We can cite the difficulties in adapting to the university environment and to the course process, especially for new students. The challenge of validating exams and training courses, which students face, can cause a huge negative emotional impact on them. The worries of finding internships, whether for senior

projects or for recruiting and hiring, appear to be sources of stress and distress for students. In our context, the high prevalence of negative emotions in our student population makes sense when one knows that Moroccan universities do not provide medical structures for psychological care of students. In the general context, the changes in eating habits, especially among young people, which are induced by the revolution and technological advances in the food industry, have a negative impact on mental health.²⁹ The opening of psychological support cells and accompaniment structures for students, both during their training and after graduation, is therefore one of the urgent measures to be integrated into the higher education cycle in Morocco.

Concerning the axis dedicated to food consumption and its potential links with the intensity of psychological disorders, we underline first of all that our present work falls within the framework of the dynamics stimulated by the research of healthy ways of life being able to improve the mental wellbeing of the individuals. From such a dynamic, triggered by the concern to face public health problems, emerge new therapeutic ways in the management of psychiatric disorders. Nutrition and healthy eating habits represent one of the most sought-after means of solving problems related to mood changes and disorders. Indeed, it is now increasingly accepted that eating habits have beneficial psychological impacts that affect multiple dimensions of mental health.^{30,31} "Nutritional psychiatry" has therefore been coined to encourage the development of solid evidence to seriously change thinking about the role of diet in mental well-being.³² In this sense, our study would contribute to an evidence base aimed at orienting mentalities towards healthy lifestyle programs in favor of public health. Such a theme is appreciated, especially when we know that applied psychotherapy and psychopharmacology do not

consistently achieve the expected results in treating mental disorders.²⁹ However, depressive and anxiety disorders are becoming a global epidemic.³³ These are satisfying and compelling reasons for the increasing attention given to the search for alternative therapeutic approaches to the prevention and management of psychiatric disorders. Among these avenues, studies focusing on the effects of nutrition on mental well-being have multiplied in recent years.

In the following section we will give a description of the intake frequency of certain foods and then discuss the links between nutrition and emotional disorders. Given that university students constitute our study population, we emphasize the need to discuss the impact of nutrition on cognition and the bidirectional links that the latter (cognition) may have with psycho-emotional difficulties. Overall, the responses collected through the dietary habits questionnaire indicated that our survey population consumed only a low frequency of foods known to be beneficial to health such as fruits and vegetables. This is in accordance with the results of prior research that describes diets of youth as dominated by fast food and processed foods in today's society.^{10,20} When analyzing the eating behavior of the interviewees, one-third of the students reported that they do not eat breakfast regularly. In addition, in our study sample, the correlational analysis showed that subjects who skip breakfast are significantly more anxious than subjects who start their day with this meal. These findings deserve special attention when we know the role that this meal represents in healthy eating patterns. Indeed, the findings of numerous types of research on the impact of breakfast on mental health (anxiety, stress, depression, mood, cognitive performance) have shown beneficial effects.^{29,31,34,35} Thus, in a few studies exploring the association between breakfast consumption and psychological disorders, in an adult population, participants who ate breakfast daily had a lower risk of depression and other psychopathological disorders.^{31,36} Similarly, anxiety symptoms were inversely associated with frequent breakfast consumption.³¹ Findings from other research, conducted among adults who did not have depressive symptoms or mental disorders, revealed that a frequency of breakfast consumption ≤ 1 time/week was associated with a higher rate of depressive symptoms compared with a daily intake of this meal.³⁴ The conclusions of the latter

study showed that the risk of depressive symptoms tended to increase with a decrease in the frequency of breakfast consumption. In the same sense, a recent review of the literature, around "diet and happiness" listing articles in English for the period 2015-2020, showed that the frequency of breakfast is one of the eating habits positively linked to well-being, which participates in happiness.²² The benefits of breakfast on mood are established through the decrease in the level of cortisol, a steroid hormone that is released in response to stress,³⁷ and the regulation of the hepatic circadian clock.³⁸ It should be noted that, in our study, the average age of the participants who occasionally skipped breakfast was significantly lower than that of the subjects who consumed this meal on a daily basis ($t=2.49$, $p=0.03$). These findings incite educational managers at Moroccan universities to take measures to raise awareness among students of good eating habits in general and the benefits of breakfast in particular.

When we focus on the association between the intake frequency of certain foods and the intensity of negative emotions, we note that a group of foods and/or food categories were significantly related to mental well-being. These include apples, sardines, dairy products, dried fruits/cereals and green leafy vegetables, olive oil. In a second order, seafood, kiwi, tomatoes, carrots, apricots and eggplant were also inversely associated with the symptoms of negative emotions studied. This means that regular consumption of these foods was correlated with low symptoms of depression, anxiety, and stress in the students surveyed. Although our study did not focus on food consumption patterns, we believe that the findings are consistent with previous research defining some food behaviors as having beneficial effects on happiness and emotional well-being. For example, recent surveys examining the relationship between fruit and vegetable consumption and happiness have highlighted the positive influence of these food categories on mental health.^{38,40} Moreover, the Mediterranean diet, marked by an important consumption of fruits, vegetables, and nuts associated with moderate consumption of poultry and occasional consumption of red meat, is linked to a reduced risk of psychopathological disorders.^{5,41} In addition to their beneficial effects on mental well-being, high adherence to dietary patterns rich in fruits and vegetables is scientifically

validated as positively correlated with happiness^{40,42} and life satisfaction.^{40,41} On the opposite side, a diet characterized by a high content of simple sugars, and fat and dominated by fast-food and a high consumption of French fries is associated with altered mood and affects mental and emotional stability.^{40,43,44,45}

In our present study, another category of foods that seemed to have close links with good mood was represented essentially by sardines, seafood, and olive oil. This category of food is known for its richness in polyunsaturated fatty acids, especially omega-3 and omega-6. These findings are coherent with previous works that have proven that one of the major roles that polyunsaturated fatty acids play in brain physiology is the regulation of neurobiological processes involved in cognition and mood.^{46,47} In the same context, other studies have revealed abnormal levels of omega-3 PUFAs in peripheral tissues in the brains of patients with mood disorders or cognitive decline.^{46,48} Recently, a literature review hypothesized that low intake of omega-3 polyunsaturated fatty acids contributes to depression through its effects on endocannabinoid pathways causing memory loss due to synaptic phagocytosis by microglia in the hippocampus.⁴⁹

In our context, given that our study population was composed of students, it seems logical to assume that the impact of diet on mental well-being could be direct or by affecting, in the first instance, cognitive performance which in turn negatively impacts the mental health of students. This is a very reasonable interpretation when we know that learning difficulties, which can be generated by the alteration of cognitive skills, are involved in the development of negative emotions in university students.^{10,11,12,13} We recall that dietary patterns characterized by high consumption of vegetables, fruits, raw vegetables, olive oil, starchy foods, poultry, rice and high water content combined with low consumption of meat, cheese, milk, commercial fruit juices and tea were positively correlated with cognitive performance involved in learning.³⁵ In addition, research has shown that cognitive impairment can be caused by short-term consumption of an unhealthy diet high in saturated fat and/or sugar by triggering neuroinflammatory processes.^{50,51} This is also consistent with a recent study finding that dietary patterns high in fat,

sweets, and marked by low frequency of breakfast consumption negatively influence cognitive function in academic learning.³⁵ Healthy dietary behaviors are therefore one of the promising avenues for the prevention and management of mood disorders and also for improving cognitive performance in student populations.

It should be noted that exploration of the links between diet and negative emotions should focus on the effects of eating behaviors and patterns and not be limited to the impact of specific types of foods. Although individuals' diets do influence their mental health, the evidence has yet to be substantiated. In addition, the nature of the relationship, diet-mental well-being is still unclear and complicated by the possibility of reverse causation.⁸ Indeed, the choices of foods to consume can depend on our psychological state, we cite as an example the case of changes in appetite due to stress as human experiences affecting food intake.⁹ Similarly, regardless of their origin, some emotional disorders, such as anxiety, depression or sadness, may motivate people to consume specific types or amounts of foods.^{52,53} It is also essential to emphasize the need for more research to fully elucidate the mechanisms of the diet-mood links. For example, in our current study, students with sleep problems eat significantly fewer meals per day than their peers without sleep problems. These problems are significantly related to scores reflecting the negative emotions of stress, anxiety, and depression. Although the meaning of all these links is not well established, we can assume that difficulties related to emotional well-being may be generated by sleep disorders, a potential cause of which was diet. Finally, it remains to be pointed out that the links between diet and mental well-being may be explained by the microbiota, which is involved in gut-brain interactions.²² The activation of certain parts of the brain, involved in emotions, by the microbiota was the subject of some research that showed correlations between microbiota disorders and the presence of psychiatric disorders.⁵⁴

Conclusion

By underlining the positive influence of food on the improvement of mental well-being, the results of this research are an additional argument for the integration of this dimension in the prevention and care of psychiatric disorders. The integration of food in the field of health is part of an innovative

multidisciplinary concept whose goal is the well-being of individuals. Although food is not the only dimension to be taken into account to guarantee a good mood, this dimension is important and represents an interesting lever to exploit. Indeed, the adherence to healthy eating behaviors, based on the intake of fruits and vegetables as well as on the regular consumption of breakfast, may be one of the promising tracks to face the worrying increase of the prevalence of psychopathological disorders.

Authors contribution

§These authors have contributed equally to this work and share first authorship

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Conflict of Interest

The authors declare that they have no Conflict of interest.

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