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Health problems associated to nutrition and lifestyle changes in the COVID-19 era

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ABSTRACT

Introduction: In the context of the response to the COVID-19 pandemic, the confinement imposed by the States in the world had a negative impact on people's health and lifestyle-related behaviors, particularly eating behaviors, physical activity level and sleep. These impacted dimensions can negatively affect both immunity and the control of chronic noncommunicable diseases.

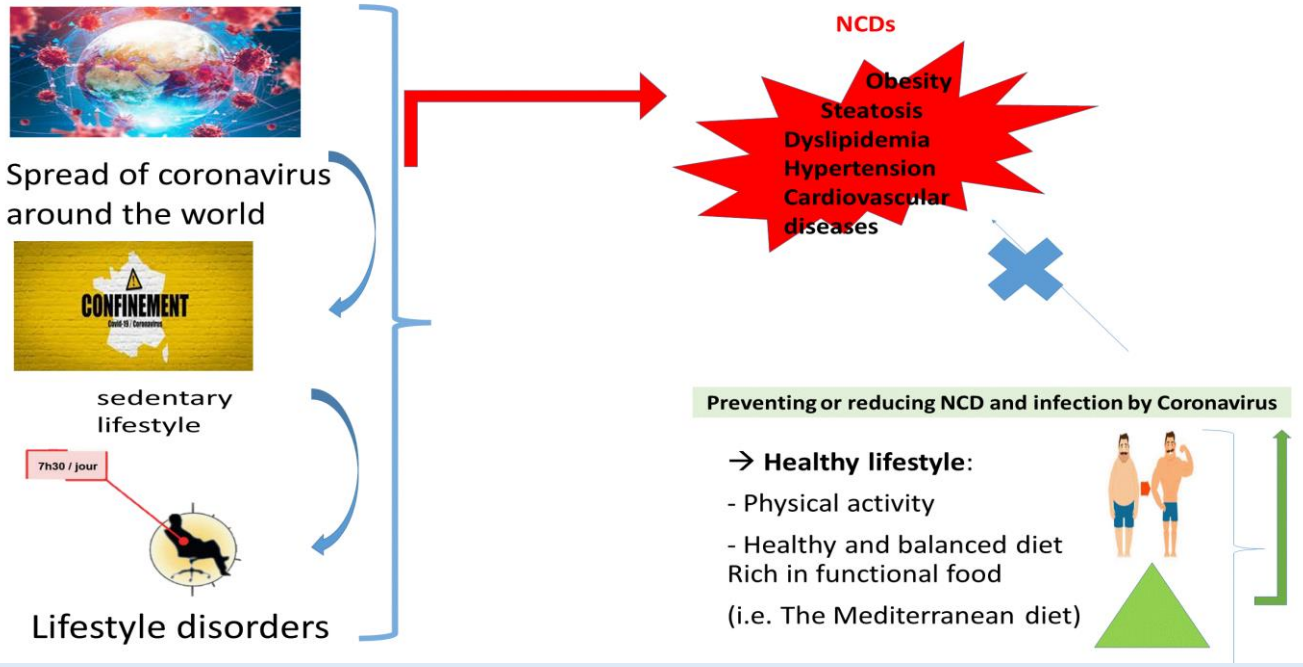
Objectives: This review describes the lifestyle change for people with non-communicable diseases in the era of COVID-19. The review also presents recommendations and advice for the benefit of this vulnerable population in relation to their nutrition.

Methods: The research was conducted by documenting the PubMed, Web of Science and Direct Science databases. Keywords used in the research were non-communicable diseases, containment, COVID-19, lifestyle change.

Results: Containment during the COVID-19 era was associated with increased smoking, physical inactivity, unhealthy eating, and intense fear of the potential impact of the Coronavirus.

Conclusion: Strengthening immunity through the promotion of nutrition has been shown to be useful in preventing the emergence of noncommunicable diseases, which are risk factors linked to increased rates of morbidity and mortality for those infected by COVID-19.

Keywords: COVID-19, confinement, immunity, chronic noncommunicable diseases, nutrition



INTRODUCTION

The rate of noncommunicable diseases (NCDs) is on the rise worldwide and represents a significant public health issue [1]. Malnutrition is among the several major risk factors determining the increase of NCDs. With the advent of the Covid-19 pandemic, malnutrition that is still persistent in all of its forms has even worsened around the world [2]. Indeed, the last report on The State of Food Security and Nutrition in the World (2021), the 1st one on food security and nutrition after the COVID-19 pandemic in the World, showed that in addition to hunger, food insecurity affected more people and parallelly to the increase of undernourishment prevalence, overweight and obesity and their associated chronic diseases are on the rise in all age categories [3]. On the other hand, several studies reported that food insecurity is associated with an increased risk of chronic diseases including type 2 diabetes [4-5], cardiovascular disease, dyslipidemia [4-6], hyper-tension [4-7] and metabolic fatty liver disease (MAFLD) [8] and obesity [9]. Patterns of being overweight as well as obesity coexist with all these metabolic diseases [7- 10]. In addition, other studies have shown that food insecurity may increase the risk of comp-lications from COVID-19 [4-10-11]. The latter could be consequences of skipped meals, feelings of hunger and exhaustion as well as the physical and psychological diseases that coexist with food insecurity situations. The severity of a COVID-19 infection has also been found to increase food insecurity with an increasing number of metabolic risk factors [12-13]. Accordingly, a report on more than 5,000 New York City patients presented hypertension, obesity and diabetes as the most common comorbidities in relation to COVID -19 infection [13]. These factors are also reported to be linked to increased rates of morbidity and mortality in people infected with COVID-19 [4-14], which could lead to a long-term up-surge in deaths from these diseases [3-15]. Results from a survey conducted by the World Health Organization

(WHO) showed that in Africa, people living with NCDs account for 85% of all deaths from COVID-19 [12]. This highlights the need for increased attention to the prevention and management of NCDs by health systems, including adherence to a healthy lifestyle.

The association of the increase of NCDs, food insecurity and the COVID-19 pandemic together are linked to individuals facing stress, anxiety and fear of being infected with the virus [15-16]. This is manifested by increased risk behaviors such as overeating or undernourishment, physical inactivity and sleep disorders [17]. These behaviors are also associated with unbalanced nutritional profiles [4-18]. The psychological traits are also pathological. Added to this is situations of noncompliance with treatment because of costs or the need to make trade-offs between access to food or medicine [4-19-20]. Furthermore, the cost of medicine is one of the factors in nonadherence, people having adopted financial, health, and food trade-offs to address the challenges of food insecurity and to meet their needs in the era of COVID-19. In addition, the economic crisis caused by the COVID-19 pandemic has oriented the choice towards long-life foods with high energy density [4-19-21]. These shelf-stable foods are generally highly processed, often high in sodium, fat, and sugar contents [22]. Sustained consumption of these foods may partly explain an increased risk of obesity [4-23], diabetes, hypertension and hyperlipidemia [4-13], as well as gastrointestinal involvement, as described by an Amer-ican report [23]. In fact, poor diet is a main risk factor for chronic noncommunicable diseases.

As this situation with several health con-cerning issues existed before the pandemic and worsened with time [3], the fact that people with obesity, diabetes, cardiovascular disease and other diet-related illnesses have been more affected than those without the virus, reveals that their diet is unbalanced, unhealthy and/or is not nutritious enough, with insufficient content in both micronutrients and vitamins [24]. It is likely that the high prevalence of the above-mentioned metabolic diseases of the world, is due to a high dietary energy intake related to consuming diets with large amounts of saturated fat, refined carbohydrates and sugars, and low amounts of fiber, unsaturated fat and antioxidants. This type of diet damages the immune system, leading to chronic inflammation and impaired defenses against infections, including against viruses [25- 26]. The WHO dietary guidelines, especially during the current COVID-19 pandemic, advocate good nutrition, which plays a central role in the dev-elopment and maintenance of the immune system to protect against these diseases, reduce the risk of viral infections and help with patient recovery [27]. Therefore, people with these morbidities require individual nutritional counselling and guide to healthy, balanced diets to strengthen their immune system and prevent infections [28]. In this perspective, this review also highlights key nutritional recommendations that provide health benefits for the population.

The health implications of containment due to COVID-19: The confinement imposed by the States as a method of prevention against COVID-19, has negatively affected people in very different ways and on several levels, both economically, socially and psychologically [29-30]. On the health front, the containment measures have limited access to prevention services, hospital treatment and pres-cription drugs [31]. In addition to travel restrictions, health systems around the world, including that of Morocco, have been oriented towards the response to COVID-19 [7-30]. The global estimates reveal that one in four people suffer from at least one chronic disease, and have faced a major disruption in their prevention, care and treatment services for their disease(s), including NCDs. This is undoubtedly considered a health crisis, as health systems are being destabilized to diagnose and treat these diseases [12-32].

Although the four identified main risk factors for NCDs are smoking, alcohol, inadequate physical activity and poor eating habits, the literature has shown that containment during the COVID-19 era was associated with increased tobacco consumption, sedentary life-styles, unhealthy diet and intense fear of the potential impact of COVID-19 [17-24]. The physical and psych-ological malaise of people confined at home [34-35-36] could lead to more severe cases of NCDs and may increase the susceptibility of these people to COVID-19 in-fection. In addition, a study in Northern Europe of 2447 respondents which included data on health behaviors and weight changes during confinement, showed that 49.4% of respondents ate more than usual, 45.1% ate more snacks and 62.1% cooked at home more often [37]. The consumption of fast food and commercial pastries has decreased, while the consumption of homemade pastries and fried foods has increased [36]. A decrease in physical activity was reported by 60.6% of the respondents and 31.5% had gained weight [36]. Also, the results of a meta-analysis of 35 cross-sectional studies and one cohort study showed changes in body weight and body mass index (BMI). Body weight was reported to be greater in a significant portion of individuals (11.1-72.4%) [38]. Therefore, nutritional behaviors that are less health-promoting as well as the negative health implications of inactivity and sedentary behavior may increase the risk of NCDs. However, a range of 7.2-51.4% of individuals reported weight loss [38]. Contrary to general trends, one study notably reported a loss of body weight in the elderly (> 60 years) [39]. This suggests an increased risk of losing weight and a potential risk of malnutrition that the elderly may be at risk for in association with confinement [40]. Possibly, older people eat less because of their chronic diseases, because of the absorption of their med-ications or following a mal-absorption of proteins consumed, which are essential to their health.

In Morocco, data obtained during the pandemic has shown that in 30% of households, at least one member has a chronic disease, of whom 48% could not access health services during the confinement period for several reasons [31]. Among the reasons declared by the surveyed population, the fear of contamination by the virus was cited by 39.5%, difficulties in accessing medical practices for 16.1%, hospital reception difficulties for 23.8%, the high cost of the service was mentioned by 16.5%, and for various other reasons by 4.2% [31]. This population being at risk for complications and worsening of pre-existing conditions [12-14-30], no access to health care services is likely to lead to a long-term upsurge in deaths from NCDs [12-13], as these diseases require regular management. In addition, changes in daily routine, fear and anxiety from COVID-19, and isolation have been linked to boredom and could lead to either binge eating, explained by emotional eating [16-17], or a loss of appetite [17-19]. Further, a high prevalence of sleep disorders [16-33] as well as sedentary lifestyles are also reported [16- 41- 42]. A reduction in sun exposure was also reported among 76.5% of the population in studies conducted by the LBBN nutrition and food science research team at Chouaib Doukkali University (El Jadida) in Morocco [43]. The last results have potential impact on this population vitamin D status, and strongly corro-borate with the results of the study conducted at Ibn Sina hospital (Rabat CHU) in Morocco, reporting that 76.6% of patients suffered from vitamin D deficiency [44].

Eating habits have also changed during the pandemic period. Indeed, 60% maintained the same number of meals, 48.4% adopted the consumption of a healthier diet, an increase in snacking was observed in 21.3%, and 8% had recourse to a diet delivered from outside the home [45]. Results from another study carried out by another group in Morocco showed that 10% of the respondents declared having hepatic steatosis, 11.4% diabetes, 13.7% hypertension and 10%

problems of the thyroid. In addition, hyperlipidemia was also found in this study population including hypertriglyceridemia and hypercholesterolemia (Table 1) [45]. Table 1 also shows that respondents with chronic illnesses adhered to the outbreak to varying degrees. The use of the chi-square test revealed that except for hypertension, all the other non-communicable diseases found in this study were significantly associated with the outbreak degree [45].

Table 1: Distribution of the respondents by chronic disease and degree of confinement

Confinement	NAFLD n= 22	Diabetes n=25	HTA n=30	HG n=12	Dyslipidemia n=11	HCHOL n=18	Thyroid problem n=21
Totally	8(36.36)	13(52)	16(53.33)	7(58.34)	6(54.55)	9(50)	**13(61.91)**
Partially	10(45.5)	8 (32)	12(40)	4(33.33)	3(27.27)	5(27.78)	**6(28.57)**
Rarely	4(18.18)	4 (16)	2(6.67)	1 (8.33)	2(18.18)	4(22.22)	**2(9.52)**
Not at all	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	**0(0)**
Chi2 test	32.54	24.5	9.66	13.78	17.16	35.44	**55.22**
p- value	**0.001**	**0.003**	**0.139**	**0.032**	**0.046**	**0**	**0**

Body weight change was also affected during the pandemic period, as shown in Table 2, presenting the corpulence status of the respondents, according to their compliance with containment. Body mass index (BMI) was calculated as the ratio of the respondent's weight (W) in kg before (W1) and during confinement (W2) to height (Ht) in meter squared (m^2): ($BMI1 = W1 / Ht^2$, $BMI2 = W2 / Ht^2$). The classification that was adopted is, BMI <18 for underweight, between 18 and 25 for a normal weight, between 25 and 30 for overweight people and greater than or equal to 30 (BMI> = 30) for obese people. Of the respondents, 1.8% were underweight, 31.5% normal weight, 42.9% over-weight and 23.7% were obese. Changes in weight status assessed by calculating the difference between BMI during confinement and BMI before confinement showed that underweight and normal weight people did not change but varied in 2.8% of people with overweight or obesity. Thus, the average change in BMI was 0.35 Kg / m2 ± 1.29. It is also shown (Table 3) that the majority of the respondents (65%) who fully or partially complied with confinement were overweight or obese and that a significant association exists between weight status and levels of adherence to confinement. An under-estimation of weight by the respondents according to their perception was also revealed, making the task of weight management difficult. Indeed, the obesity rate declared by the respondents during the confinement was lower (11.87%) compared to the rate computed based on the calculation of the BMI (23.7%) (Table 3) [45].

Table 2: Distribution of the respondents according to weight status and confinement

	Underweight	Normal weight	Overweight	Obesity	Total n(%)
Totally	2 (1.4%)	51(35.2%)	65(44.8%)	27(18.6%)	145(66.2 %)
Partially	2(3%)	18(26.9%)	29(43.3%)	18(26.9%)	67(30.59%)
Rarely	0(0%)	0(0%)	0(0%)	5(100%)	5(2.28%)
Not at all	0(0%)	0(0%)	0(0%)	2(100%)	2(0.91%)
Total	4(1.8%)	69(31.5%)	94(42.9%)	52(23.7%)	219(100%)

Table 3: Perception of weight status during confinement

Weight status	**Underweight 4(1.8%)**	**Normal weight 69(31.5%)**	**Overweight 94(42.9%)**	**Obesity 52(23.7%)**	**Total 219**	**%**
Weight perception as:						
Normal weight	2(1.6%)	60(49.2%)	50(41.0%)	10(8.2%)	122	55.71%
Underweight	2(8.7%)	6(26.1%)	4(17.4%)	11(47.8%)	23	10.50%
Obesity	0(0%)	0(0%)	12(46.2%)	14(53.8%)	26	11.87%
Abdominal obesity	0(0%)	3(6.3%)	28(58.3%)	17(35.4%)	48	21.92%

The results of the same study also revealed that the majority (80%) of the respondents infected with COVID-19 did not respect containment against only 20% who did. In addition, respecting containment and catching an infection with COVID-19 has also been significantly associated. On the other hand, respondents infected with COVID-19 were mostly obese (83.3%), 16.7% were overweight, 66.7% were diabetic, 66.7% hypertensive, 38.9% had dyslipi-demia, 16.7% hypertriglyceridemia, 61.11% hyper-cholesterolemia, 77.8% had hepatic steatosis and 33.3% had thyroid problems (Table 4) [45].

Table 4: Distribution of respondents by NCDs and COVID-19 infection

Non-communicable diseases	No COVID-19 infection	COVID-19 Infection	Total	Chi2 test
Overweight	91(45.3%)	3(16.7%)	94 (42.9%)	39.01
Obesity	37(18.4%)	15(83.3%)	52 (23.7%)	
Diabetes	13(6.5%)	12(66.7%)	25 (11.4%)	84.39
Hypertension	18(9%)	12(66.7%)	30 (13.7%)	48.04
Dyslipidemia	4(2%)	7(38.9%)	11(5%)	60.43
Hyper triglyceridemia	10(5%)	3(16.7%)	13(5.9%)	31.84
Hyper-cholesterolemia	8(4%)	11(61.11%)	19(8.7%)	76.78
No alcoholic fatty liver	8(4%)	14(77.8%)	22(10%)	102.85
Thyroid Problem	16(8%)	6(33.3%)	22(10%)	62.4

The study also revealed that during confinement, 66.7% of the respondents decreased their level of physical activity (PA) (4:05 h/ d ±2.42) compared to only 10% who increased it (5 h / d ± 3.34), while 23.3% kept the same number of PA hours. The results also showed an increase of sleep duration (+2:05 h ± 0.28) in about 43% and a disturbed sleep patterns in ~35% of respondents. The tobacco use has increased to 24.1% while alcoholic beverage consumption decreased in 33.3% of the study participants. Dietary habits during the confinement revealed a raise of food consumption frequencies to: 2 times per day for meats in around 16% of the respondents, in 15.52% for cheeses, for other dairy products in 18.26%, for eggs in 10.50%, for fish in 9%, for vegetables in 30.70% and for fruits in 30.59% of the respondents. The frequency increased to 2 times per day for the consumption of pastries, for sugary snacks for salty snacks, in 5.9%, 12.8% and in 16.89% of the respondents resp-ectively. However, the frequency of bread con-sumption remained unchanged during confin-ement with a rate of more than three times per day in 28.77% of the respondents. On the other hand, some respondents also reported consuming foods ordered from outside their home during confin-ement, these foods were mostly ice cream by 43.48% followed by bread in 21.74% [45].

DISCUSSION

The COVID-19 pandemic is currently a major public health problem in the world, including in Morocco. It is a pandemic with multidimensional implications, particularly with psychological and physiological health impacts, as well as socioeconomic aspects [16- 17- 31]. The Moroccan studies included in this review the examination of the effect of home confinement due to the COVID-19 pandemic, based on lifestyle. These studies reveal information regarding eating habits, physical activity (PA) levels, smoking, sleep and stress as well as food insecurity**.** The results described the negative effect of confinement on lifestyle indicators, namely the decreased level of physical activity, increased duration and rhythm of sleep and the increased number of cigarettes smoked, as well as the number of meals. The consumption of sweet and savory snacks was high averaging a frequency of twice a day. Analysis of these information shows that the study's results are unanimous with the literature reporting that food intake was increased during confinement associated with dietary imbalances and nutritional disorders [1- 2-12- 13-46]. This is an alarming situation as all these components are involved as risk factors for overweight, obesity and their associated comorbidities. Dietary imbalances could also further dramatize the state of obesity and its comorbidities including NAFLD [16- 47]. Irregular food intake disrupts the gut microbial composition, [19-36] inducing dysbiosis that in turn leads to obesity This is an important contributing factor to NAFLD, its progression to non-alcoholic steatohepatitis (NASH) and the risk of COVID-19 infection [47]. Another nutritional disorder revealed in most of the COVID-19 patients of three studies, is the development of anorexia leading to drastic reductions in food intake and malnutrition [17- 40- 46]. Only one study showed an increased risk of weight loss and a potential risk of undernutrition in older adults at the time of confinement [39]. More and more elderly people eat less because of their chronic illnesses, the absorption of their medications or following a malabsorption of the proteins consumed, which is essential to their health. COVID-19 infection was also reported to be associated with age, place of residence, level of education, family situation, occupation, and degree of compliance with confinement by respondents [31- 45]. Indeed, large proportion of people infected with COVID-19 did not respect the confinement and those residing in urban areas had a risk of infection with COVID-19 of 1.5 times that of those from rural areas**.** In addition,

a significant association was found between NCDs and the degree of confinement. Furthermore, among people infected with COVID-19: the majority (83.3%) were obese, 16.7% were overweight, 66.7% had diabetes, 38.9% dyslipidemia, 16.7% hyper-triglyceridemia, 61.1% hypercholesterolemia, 77.8% hepatic steatosis and 33.3% had thyroid problems. All the data is consistent with reports from several studies that say that comorbidities such as hypertension, diabetes and coronary heart disease, chronic liver disease and chronic kidney disease have been common in COVID-19 patients and that older patients have a higher risk of progression to infection severity [17-18-19-21]. Similarly, a study of COVID-19 deaths in Italy found that 98.8% of patients who died had at least one chronic disease and 48.6% had at least three comorbidities, the most common being hypertensive in 73.8% of cases, diabetic in 33.9% and chronic disease in 3.7% of patients [21]. All these metabolic diseases are largely preventable. Balancing intake versus energy expenditure, and paying attention to nutrition, appears to be a beneficial factor against COVID-19 [46]. Therefore, the implications of COVID-19 underscore the value of nutritional recommendations to improve the immune system and reduce the risk of NAFLD and related diseases [16-48].

Nutritional Recommendations: The nutritional rec-ommendations for healthy diet are to be adapted to the Mediterranean context, consisting in following the pyramid guide of Mediterranean diet. It is about reducing consumption of refined sugars, with 50 to 55% of total energy intake (TEI) from carbohydrates of which 60-65% as complex carbohydrates. The share of simples added carbohydrates must be less than 10% of (TEI). A good quality protein intake of less than or equal to 0.8 kg of body weight / day and an intake of lipid representing less than 30% of the total energy intake with monounsaturated fatty acids and polyunsaturated fatty acids mainly from plants as well as high fat fish are also recommended. In addition, the recommendation includes an intake of raw foods rich in fiber with a satietogenic properties and a minimum recom-mended intake of 25g and an optimum of 30g including 15g of soluble fiber, as the fiber intake regulates blood sugar and reduces cholesterol absorption. The main source of fiber are plants [48] which also maintain adequate intake of micro-nutrients such as vitamins, minerals and trace elements that are essential for metabolic processes [23]. Many micronutrients are also essential for immune-competence, including vitamin A, C, D, E, B, iron, selenium and zinc [23]. On the other hand, rehydration should be done by drinking water at will, and not replacing it with sugary drinks [4]. In summary, macronutrients and micronutrients in the diet generally promote healthy immune responses against all infections, including COVID-19 [48]. They provide antioxidants and anti-inflammatory nut-rients and maintain the energy balance provided by a balanced diet [49].

The Balanced Diet: The food balance is not achieved on a single meal but from one meal to another and over several days by a combination of foods with nutritional value. Food equivalence is the replace-ment of a food by another food having the same nutritional qualities. The “substitute” food may be in the same food group or in a different group than the food being replaced. The advantage of using certain food equivalents is to eat a variety of foods, while providing various and complementary elements essential to the body. Thus, the compensation of transient imbalances will have no influence on health. Only the usual imbalances repeated from one meal to another and over long periods are harmful. It is not consistent to remove all sources of fatty acids because their functions in cells and the nervous system are essential for the maintenance of good health.

Thus, the literature is unanimous in adopting the Mediterranean diet as one of the best nutritional approaches. The dietary pattern, common to Mediter-ranean regions, exists in several variants but is generally characterized by a high consumption of fruits and vegetables that are sources of bioactive comp-onents, complex carbohydrates, moderate consumption of fish, low to moderate consumption of red wine during meals, depending on the culture, and olive oil as the main source of fat [48].

CONCLUSION

The COVID-19 pandemic has led to the adoption of measures unprecedented in the world. Among these measures, the lockdown was imposed by the governments of each country in order to control the spread of the pandemic. This measure was acc-ompanied by the unfavorable change of lifestyle, including changes in the level of physical activity, eating habits, fear, anxiety and the duration and rhythm of sleep as well as the adoption of unhealthy eating and bulimia or anorexia behaviors. Lifestyle change characterized by decreased level of physical activity may be a negative factor worsening the condition of patients with NCDs. Also, dietary changes may have adversely affected both immunity and chronic noncommunicable disease control, making of these diet-related NCDs a major public health challenge. Changes in eating habits during the lockdown period have a major impact on the health system by dramatizing NCDs in addition to COVID-19. Therefore, strengthening immunity through nutrition promotion is proven useful in preventing the emergence of NCDs, which are risk factors related to increased morbidity and mortality rates among people infected with COVID-19. A balanced diet, regular physical activity and hygiene are necessary to improve the effectiveness of public health approaches against the COVID-19 pandemic. Thus, a diet based on the Mediterranean diet, characterized by the abundance of plant foods and cereals, such as green and yellow vegetables, salads, legumes, bread, pasta, fruits and nuts as well as olive oil rich in antioxidants and moderate consumption of fish, poultry, dairy products and eggs. The protective effect of Mediterranean diet is attributed to the high concentration of phenols, flavonoids and antioxidants that are considered essential bioactive compounds of health benefits.

As the COVID-19 pandemic is underway, this review opens up new research perspectives to confirm these aspects on vulnerable population groups at higher risk in a such urgent situations.

List of abbreviations: BMI: Body mass index, Height: Ht, HTA: Hypertension, HG: Hypertriglyceridemia, HCHOL: Hypercholesterolemia, MAFLD: Metabolic fatty liver disease, NAFLD**:** Nonalcoholic fatty liver disease, NASH: Non-alcoholic steatohepatitis, NCDs: Non communicable diseases, PA: Physical activity, TEI: Total energy intake, W: Weight

Conflicts of Interest: No competing interests.

Authors' contributions: All Authors contributed to the design, data collection, analysis and editing of the manuscript.

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