Research Article

Food Production Chain, Changes of Consumers' Behaviors and Lifestyles: COVID-19 Impact

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Abstract

The Objective of the Study is to review and analyze the impact of COVID-19 or coronavirus pandemic on issue-related to food or agri-food production, food supply chain, government's policies, employees and employers assistance programs, individuals' or consumers' behavioural changes.

***Method of the Study :** The data were collected and analyzed from articles that published in journals, websites, news papers, and other social media between 2004 and 2020.*

Results of the Study: *The consumers' food demand varies depending on income level of consumers, consumption, the price of foodstuffs, sociodemographic situation, time constraints, and shopping preferences, in addition to spending money on food in per visit changed and number of visits to food store. Interruption of the daily-routine life by COVID-19 pandemic resulted in boredom with high consumption of carbohydrate, fat, and protein, in addition to quarantine-caused stress that pushed the people to sugary food consumption for feeling positive. Due to ability of carbohydrate-rich foods to encourage serotonin production, they can be used as self-medicating components. These unhealthy eating habits may lead to obesity-associated-COVID-19 serious complications and chronic inflammation. The Logistic Sub-Group of the United Kingdom developed crisis management, shore base logistics and freight management, accommodation and transportation, and safe passage programs to provide safe passage (health issue) and assurance to health personnel and their families, including guidelines and raising awareness to logistic sector. The "green lanes " for vehicles carrying agri-food products for ensuring the fast and free movement on the borders was implemented by the Commission of the European Union (EU), in addition to highlighting the free movement of seasonal workers and agri-foods for easy reaching their workplaces.*

In conclusion*, movement restrictions both national and international contributed to challenges, including consumers' changes in demand. These restrictions caused consumers to prepare cooking at their homes, in addition to preventing them from getting COVID-19 infection at the stores, restaurants, markets, and supermarket.*

Keywords: *COVID-19, SARS-CoV-2, Impact, Food Production, Food Supply Chain*

Abbreviations:

CAP: Common Agricultural Policy
CPS: Cyber Physical System
CREA: The Council for Agricultural Research and Economics of Italy
EU: European Union
SCM: Supply Chain Management
US CDC: United States Centers for Disease Control and Prevention
US FDA: United States Food and Drug Administration
WHO: World Health Organization

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Results of the Study

The results of the study were analyzed and demonstrated below. Food Supply Chain Impacted By COVID-19 Pandemic Five stages of food supply chain include agricultural production, postharvest handling, processing, distribution/retail/service, and consumption **(**1**)**. The two used-food-supply-chain systems include system-based on regulations and laws that use mandatory standards which are under the state agency inspection and voluntary standards which are under the market laws or international associations **(**2**)**. The World Health Organization (WHO) the strategic preparedness and response plan that includes the health measures with eight priority steps and actions:

1) Coordination, planning, and monitoring at the country level,
2) Risk communication and community participation,
3) Surveillance, rapid response teams, and case investigation,
4) Entry points,
5) National laboratories,
6) Prevention and control of infection,
7) Situation management, and
8) Operational support and logistics **(**3**)**.

Due to rapidly spread globally of the COVID-19, it eventually forced countries to apply lockdowns and strict social (physical) distancing measures. Currently, online meeting and flexible work from home have become standard practices **(**4-5**)**. The United States Centers for Disease Control and Prevention (US CDC) developed response plans to provide guidance for continuity of operations in the food processing facilities and manage COVID-19 in the food industry, particularly, meat and poultry processing industries **(**6**)**. COVID-19 pandemic might contribute to a US $ 80 billion loss in tourism sector and US $ 113 billion loss in aviation **(**7, 8**)**. The European Food Safety Authority stated that there is no evidence of association between risk of COVID-19 and food consumption **(**9**)**, whereas the Norwegian officials

stated that there is no association between the transmission of SARS-CoV-2 (COVID-19) via imported food and the origin of the salmon outbreak is still unclear **(**10, 11**)**. Nevertheless, some eating and cooking habits may contribute to the emergence of the coronavirus from animals to humans **(**9**)**. During the COVID-19 pandemic era, four major issues involving the food supply chain and the food industry have been raised,

1) People tend to have follow a healthy diet for protecting their immune system **(**12**)**, therefore , the demand in bioactive-ingredient-containing functional food is increased,

2) Producers, retailers, and consumers has payed more attention on food safety,

3) Due to people on lockdown restrictions, food security concerns have been arisen, and

4) During the COVID-19 pandemic era, the food sustainability problems have emerged **(**13**)**. In Germany and France, some of the markets limited the number of items, such as pork and beef products that a customer can buy and some restaurants stopped serving beef hamburgers. Close-down of the food plants contributed to the ripple effect in the food supply chain **(**14-17**)**.

Governments are facing financial pressures because of the economic shrinkage and reallocating their resources focusing on financial incentives and social assistance programs **(**18, 19**)**. Seasonal or temporary employment, particularly for planting, sorting, harvesting, processing, or transporting crops to markets is common in the developing and developed countries that significantly affects the food supply chain as a result of the shortage of local or migrant workers because of travel restrictions imposed by city lockdown or sickness **(**20**)**. The objective of "Pick for Britain" campaign in Britain was to identify 70,000 British to work during the harvest and in the field, whereas a call has been performed to the unemployed individuals to work in fields in France **(**21**)**. In India, tea plants were being lost due to logistical challenges, whereas the British chair of dairy farmers demonstrated that around 5 million liters of milk are at risk in one week **(**22**)**.

Impact of COVID-19 Pandemic on Consumer Behavior

The consumers' food demand varies depending on income level of consumers, consumption, the price of foodstuffs, sociodemographic situation, time constraints, and shopping preferences, in addition to spending money on food in per visit changed and number of visits to food store **(**23, 24**)**. Interruption of the daily-routine life by COVID-19 pandemic resulted in boredom with high consumption of carbohydrate, fat, and protein, in addition to quarantine-caused stress that pushed the people to sugary food consumption for feeling positive **(**25**)**. Due to ability of carbohydrate-rich foods to encourage serotonin production, they can be used as self-medicating components **(**25**)**. These unhealthy eating habits may lead to obesity-associated-COVID-19 serious complications and chronic inflammation **(**25**)**. An unusual demand shift from food service to retail due to the closure of restaurants and limited service

eating places that affected the eating or purchasing habits (23, 26). Using food service and purchasing food from supermarkets had the same ratio as 50 % before the COVID-19 outbreak, nevertheless, it is almost 100 % for supermarkets (23, 26). During the COVID-19 lockdown, consumers experienced decreased availability of certain types of foods (23, 26). The spending money on food was raised per visit, whereas the number of visits to food store was decreased (23, 26). Flour, a staple product was not found on food store shelves because of the more interest in home-baking, as a family activity in European countries (23, 26). Individuals have focused on the products with long shelf life, such as canned or dried foods, milk, milk substitutes, pasta, and frozen foods because of convenience and daily cooking at home (23, 26). Interestingly, the shortage of eggs was not only due to lack of packing for retail but also increased demand (27, 28).

In the United States, sales for eggs rose by 44 % compared to last year (2019), whereas household egg consumption increased 40 % since march 20, 2020 in Argentina (4, 27, 28). During COVID-19 pandemic, the flexibility associated with the packing and labelling of eggs because of the insufficient availability of suitably labelled retail packages to facilitate the egg distribution and fulfill the demand was provided by the United States Food and Drug Administration (US FDA) (4, 27, 28). In the European countries, the demand for frozen vegetables increased by 52 % and fresh bread by 76 % in the week when the COVID-19 pandemic was announced, whereas the demand for alcoholic beverages increased twice, one month after pandemic announcement (29). A study on 18 countries revealed that food buying behavior has changed due to willingness of healthy food consumption without exceeding normal budget. Most customers adopted a basic approach of returning to ingredient-containing beverage products, such as olive oil, whole grains, legumes, fruit, and vegetables and natural food. They are also looking for food products that improve their COVID-19-related mood (25, 30). The behavior of the Italian population on food choices and behavior was assessed under COVID-19 quarantine in a recent poll performed by the Italy's the Council of Agricultural Research and Economics (CREA) among approximately responded 2,900 individuals from all regions of Italy demonstrated that healthy food and beverage consumption increased for 33 % of vegetables, 29 % of fruit, 26.5 % of legumes, and 21.5 % of extra-virgin olive oil. Nevertheless, 44.5 % and 16 % of them consumed more sweet food and drank more wine, respectively, whereas 44 % and 37 % of them reported body weight gain because of low-level physical activity and intake of higher calories and needed weight loss by adjusting their diet, respectively (31).

During COVID-19 pandemic in the United States, a survey of 630 consumers in May 2020 revealed that 70 % of consumers decreased the frequency of food shopping and preferred online shopping, 56 % of them were worried about not finding particular foods they would like to buy in the store orforgetting to buy something, 70 % of them consumed more food while staying at home, 43 % of them consumed more

fruits, 42 % of them consumed more vegetables, 30 % of them consumed more protein-containing foods (fish, chicken, or meat), 39 % of them made their breakfast more balanced, 47 % of them consumed more sweet foods, 24 % of them consumed less vegetables, 21 % of them consumed less fruits, and 19 % of them consumed less protein-containing foods **(**32**)**.

A survey on 1,005 over-18-year-old-male and -female French people demonstrated that during the 8-week quarantine, they changed their views on the ecological, economic, and social value of food production **(**33**)**. They would only buy "essential" foods, spend more time cooking, and pay more attention to food spending when they return to "normal" after COVID-19 pandemic measures have been relieved **(**33**)**. Approximately, one-third of them wasted less food, 29 % of them bought more local food, and 20 % of them went online shopping **(**33**)**. Another survey in France conducted on April 6th and 7th, 2020 among 1,000 above-18-year-old adults revealed that 82 % of them believed in safety of foods they bought, 7 % of them believed in unsafety of foods they bought, 42 % of them preferred the packaged foods more than normal, 42 % of them stated that the COVID-19 pandemic did not change their attitudes towards packaged foods, 77 % of them believed in enough food production to meet the consumers' needs, and 16 % of them did not believed in enough food production **(**34**)**.

Impact of COVID-19 Pandemic on Global Food Trade

Before COVID-19 crisis, the vulnerability of food systems to problems-associated with diseases and climate has been confronted long, including the SARS and Ebola outbreaks, the oil crisis in the 1970s, and the food crisis in 2006-2008 **(**35**)**. Due to current COVID-19 crisis, some governments changed the food trade policies by moving towards facilitating imports and restricting exports for ensuring the maintenance of the number of products in the domestic markets. The export restriction has some negative effects as the following : 1) Countries will lose their competitive advantage by losing their place in international markets, 2) Dropping domestic prices that will decrease crop production and incentives in the industry, and 3) Undermining exporters' reputation and decreasing importers' confidence in the international markets that contribute to destroying future business opportunities and trust for exporters **(**36, 37**)**. Due to COVID-19 pandemic, a total of 19 countries have taken to export restrictions for27 food products. Currently, a total of 8 countries are going on their measures on 11 food products. For considering the assessment of the effects of the import restrictions in term of kilocalorie unit, Tajikistan, Uzbekistan, Afghanistan, and Azerbaijan were negatively affected by 79 %, 70 %, 61 %, and 54 %, respectively **(**38**)**. The world prices of stable food commodities, such as rice, wheat, and maize were pushed up by export-restricted policies and contributed to decreasing the quantity and quality of food products **(**39**)**. Due to export restrictive policies and negatively effects of the capacity utilization of food-manufacturing plants to respond demand, foods that are not locally grown but needed for processing

were not available, including inability of local sellers to find buyers that resulted in excess supply and waste accompanying economic losses and transportation challenges for air and sea cargo **(**40-43**)**.

Minimizing The Impact of COVID-19 Pandemic

COVID-19 disruptions may contribute to hunger, malnutrition, and increasing number of individuals facing extreme hunger to 265 million in 2020 **(**44, 45**)**. Among children who are younger than 5 years old, COVID-19 pandemic contributed to 14.3 % increase in prevalence of malnutrition wasting or health and social-protection interruption in low- and middle-income countries **(**46**)**.

Food Supply Chain Strategies

At the household level, COVID-19 pandemic resulted in 12 % of increase in food waste **(**47**)**. Approximately, one-third of all food productions was wasted across the food supply chain stages (production, postharvest handling, processing, distribution, and consumption). Some bioactive compounds can be gained from food wastes to re-utilize them in food chain, such as carotenoids, essential oils, flavonoids, glucosinolates, isothiocyanates, phenols, and whey protein by conventional or innovative techniques (extraction, fractionation, and isolation stages) **(**13, 48, 49**)**. Robot systems assist individuals to serve the foods to consumers in food-serving industry, in addition to monitoring the unsafe or low-quality food products in food supply chain by the Cyber Physical System (CPS) **(**50, 51**)**. Approximately, 25 % increase of productivity by automation to complete the work more efficiently than humans, indicating an important role by making data-driven autonomous decision in production in the fourth industrial revolution **(**50, 51**)**. The COVID-19 pandemic resulted in challenges that include adopting new workplace policies, actions to decrease human contact, and change of working conditions **(**52**)**.

To respond to these challenges, organizations should establish some measures as the following:
1) Monitoring COVID-19 symptoms of the workers, suppliers, contractors, and visitors before entering the facilities, monitoring all staff to wear face protection equipment and gloves, and performing body temperature screening of all staff at the entrance of the facilities;
2) Should consider employees' work rotation, working hour reduction, dividing number of workers in each work shift into 3 or 4 groups, and adjusting their break time to avoid overcrowding; and
3) Should redesign warehouses and processing to allow social (physical) distancing, build barriers or dividers that cover the upper part of the body of the workers to maintain social distance, and use diagonal arrangement in case of using two side engagement in food processing **(**53**)**. All countries should maintain the balance between workers' safety and food product quantity **(**54**)**.

Decentralization of the food manufacture provides reduction of the transportation and storage costs, minimizing the environmental impacts, shortening the food supply chain, reduction of the emission and energy consumption during storage and transportation, flexibility in food supply chain, and simplifying the administrative procedures (55-57). During COVID-19 pandemic, changes in food demands should be determined by using simulations, statistical models and forecasts, particularly, the daily-life products, such as food items and sanitizers to propose optimal decision for demand disruptions and tackling supply by the manufacturers (58).

Storage centers should be invested by the government or private centers. Web-based-food-distribution system should be established to strengthen the relationship between buyer and seller (20, 54, 59-60). Digital commerce services, an important role in interaction and trading activities among the actors of the food supply chain allow small farmers to reach more consumers in a direct effective way and collaboration between the largest e-commerce companies and government to encourage rural markets to be part of e-commerce economy and offer mostly organic fertilizers at a reasonable cost (61), in addition to " Supply Chain Management (SCM) Data Science " (62).

Agricultural production collection centers with high capacity storage at the location comfortably reached by small-scale farmers should be built by countries (63). Maintaining the activities of small- and medium-size agricultural enterprises requiring additional capital injection by using the capital injections from donor or government through improved technologies or modern facilities that entail higher production costs (64). Contractual agricultural arrangement can be made by the horizontal and vertical coordination mechanisms between food banks and farmer associations as the following : 1) Assist farmers to create new markets (65), 2) Countries can deploy warehouse receipt systems that allow small-scale food producers to easily access to financial loans and receive the best price for their agricultural products (66), 3) Countries should develop e-commerce for small shareholders to commercialize agricultural products to wider scale of consumers (67), and 4) Small-scale agricultural producers should have easy access to credit for involving the financial problems (63). Additionally, confidence in financial organizations can be promoted by the temporary liquidity guarantee program (TIGP) that allows a limited term guarantee for newly issued debt of financial companies and affiliates and non-interest bearing transaction accounts (54, 68-70).

Recommendations for Government

To focus on the impact of COVID-19 pandemic on agricultural products and food supply cuts by observation of the progress and recommended actions without waiting too long for the implementation of certain interventional strategies, a COVID-19 crisis committee should be appointed during food value chain in collaboration with the private sectors **(**20**)**. An Agriculture Response Program was designed by the government of Canada for 50-70 % funding assistance without paying back regarding health protocol, strategic projects, product distribution, product movement, marketing, development, and abattoir efficiency **(**71**)**. The government of Canada also implemented a US $ 50 million financial aid program for small farmers who hired temporary foreign employees through the COVID-19 outbreak by allowing employers to get US $ 1,500 per foreign worker with 14-day-self-isolation upon entry into Canada **(**72**)**. Additionally, The government of Canada and Belgium allowed postponing the recruitment or offer long-term contracts for employers **(**73**)**. The Logistic Sub-Group of the United Kingdom developed crisis management, shore base logistics and freight management, accommodation and transportation, and safe passage programs to provide safe passage (health issue) and assurance to health personnel and their families, including guidelines and raising awareness to logistic sector **(**74**)**. The "green lanes" for vehicles carrying agri-food products for ensuring the fast and free movement on the borders was implemented by the Commission of the European Union (EU), in addition to highlighting the free movement of seasonal workers and agri-foods for easy reaching their workplaces. Common Agricultural Policy (CAP) payments and temporary framework for state aid measures were also introduced by the Commission of the EU to extend the farmers' application deadline to get income support and supported farmers and agri-food business for ensuring liquidity **(**75**)**. To facilitate connections between the local residents and agriculture sectors, online platforms should be implemented **(**68**)**. The best way to solve the labor shortage over the medium to longer term during COVID-19 pandemic is " labor-replacing mechanization policy " **(**76**)**. Additionally, the employed agricultural-production individuals were importantly considered as " critical infrastructure workers " by the United States government **(**77, 78**)**. To take the recommendations and measures in food and agriculture during the COVID-19 pandemic, the COVID-19 Commission that consisted of two members of from the Ministry of Agriculture and Forestry and seven academicians in Turkey was established **(**79**)**.

Many countries like Saudi Arabia, United Arab Emirates, Bahrain, Egypt and Sudan did not begin easing restrictions until the end of June 2020, whereas Yemen declared easing lockdown restrictions in Mid-July 2020 **(**80**)**. The lockdown restrictions included closure of the borders, closure of non-essential businesses, local movement and travel restrictions, nightly travel curfew,

cancelling prayers to avoid mass gathering events, and facilitating remote working and online learning (80). Numerous financial plans were implemented by many countries to cope with the COVID-19 curfew. The Ministry of Finance of Saudi Arabia has supported the private sectors and individuals who lost their income by funding during COVID-19 crisis (81) as well as Canada and some countries (82, 83). A recent study in Saudi Arabia revealed that approximately 52 % of employed study participants who might usually not have adequate free time to cook demonstrated changes in their eating habits due to having more time to cook (84). Nevertheless, increased prevalence of food insecurity due to COVID-19 pandemic lockdown among negatively affected individuals was demonstrated despite this efforts (85). The health organizations in Saudi Arabia should focus on the importance of promoting positive eating habits, avoiding overconsumption of foods, and increasing physical activity during curfew for maintaining health and preventing body weight gain (84).

ALMughamis et al conducted a recent study in Kuwait and demonstrated that 41.6 % of the valid respondents reported that their body weight would increase, 63.8 % of them felt anxious sometimes during day, 25.5 % of them always felt anxious, and 10.7 % of them never felt anxious (86). More than 69 % of them revealed that their physical activity had decreased than before and the mean number of hours spent being sedentary at home were 9.56 (86). When using the logistic regression model for predictors of body weight increase among the Kuwaitis in this study, the study revealed that those respondents who reported eating unhealthy diets were 4.5 times (95 % Confidential Interval = 2.45 to 8.23) more likely to report an increase in body weight, compared with the respondents with diet changes (86). Those respondents demonstrating having anxiety throughout the day were 2.45 times more likely to have an increase in body weight than those who never confronting it (86). There was also association of 3.27 times higher odds of increase in body weight among respondents who consumed snacks excessively (> 3 times per day) than those who did not consume it, whereas consuming moderate amounts of snacks (1-3 times per day) did not differ than the respondents who never consumed snacks throughout the day (86). Considering Post-COVID-19 era in Kuwait, an increase in body weight gain and unhealthy eating habits will be a challenge that the Kuwait government's policies strengthen health systems to tackle it (86). Kuwait National Program for Healthy Living (2013-2017) had previously been developed, therefore, the authorities can develop a strategic plan to fight against harmful effects of this pandemic on health originated from unhealthy eating behaviors, psychological issues, and sedentary lifestyle (86).

A recent study in United Arab Emirates (UAE) revealed that during COVID-19 pandemic, the participants reported lost body weight 20.9 %, gained body weight 31.0 %, maintained body weight 40.1 %, and they did not know their body weight change 7.9 % **(**87**)**. The study participants perceived health state during COVID-19 pandemic as the following : 21.4 % excellent, 39.7 % very good, 28.1 % good, 10.1 % fair, and 0.7 % poor **(**87**)**. The most common source of information for health and nutrition updates that the participants relied on were 69.1 % and 67.8 %, respectively **(**86**)**. The second source of information for health information and nutrition updates were 65.4 % and 48.7 %, respectively **(**87**)**. The study results demonstrated a significant increase in the percentage of participants consuming mostly homemade meals during COVID-1 pandemic and a significant decrease in those consuming fast-food ($p < 0.001$) **(**87**)**. Additionally, the percentage of participants consuming five or more meals per day increased from 2.1 % before the COVID-19 pandemic to 7 % during the COVID-19 pandemic ($p < 0.001$), whereas the percentage of participants consuming breakfast increased from 66 % to 74.2 % ($p < 0.001$) **(**87**)**. The percentage of those skipping meals reduced from 64.5 % (mainly due to lack of time before the COVID-19 pandemic (62.3 %), 36 % of participants was lack of appetite) to 46.2 % during the COVID-19 pandemic ($p < 0.001$) **(**87**)**. The percentage of participants intaking water increased from 24.1 % (consuming eight or more cups per day) before the COVID-19 pandemic to 27.8 % during the COVID-19 pandemic ($p = 0.003$) **(**87**)**. More than half (51.2 %) of the study participants did not consume fruits daily, 46.2 % of the participants did not consume milk and dairy products daily, 37 % of the participants did not consume vegetables daily, 46.1 % of the participants consumed sweets and desserts at least once daily, 37.1 % of the participants consumed salty snacks (nuts, crackers, and chips) daily, 86.5 % of the participants never consumed energy drinks during COVID-19 pandemic, 69.2 % of the participants consumed tea or coffee at least once daily, and 44.2 % of the participants never consumed tea or coffee **(**87**)**. When considering the physical activity, 32.1 % of the participants did not engage in any physical activity before the COVID-19 pandemic, the percentage increased to 38.5 % during the pandemic ($p < 0.001$) **(**87**)**. Interestingly, there was significant association between the reported change in body weight and the frequency of performing physical activity among the participants during COVID-19 pandemic ($p < 0.001$) **(**87**)**.

There was notification of a significant higher percentage (47.6 %) of study participants spent more than five hours per day on the computer for work or study compared to before the pandemic (32 %) ($p < 0.001$), and spent more than five hours on screens for fun increased from 12.9 % of the participants before the city lockdown to 36.2 % of the participants during the lockdown ($p < 0.001$) **(**87**)**. The study results also demonstrated a significant increase in the percentage of the participants of the all four stress parameters (physical exhaustion, emotional

exhaustion, irritability, and tension) " all the time " during the COVID-19 pandemic compared to before the pandemic : 13.3 % versus 7.7 % for physical exhaustion; 14.1 % versus 6.3 % for emotional exhaustion; 13.5 % versus 6.9 % for irritability; and 17.8 % versus 6.3 % for tension (all $p < 0.001$) **(**87**)**. When considering the poor sleep quality during the COVID-19 pandemic and before the pandemic, the results demonstrated a significant decrease in the sleeping hour that was less than seven hours per night from 51.7 % of the participants to 39 % of the participants during COVID-19 pandemic ($p < 0.001$), 28.1 % of the participants increase in poor sleep quality compared to 17.3 % of the participants before the pandemic, 60.8 % of the participants demonstrated sleep disturbance compared to 52.9 % of the participants before the pandemic, and 30.9 % of them felt lazy and less energized during the COVID-19 pandemic, compared to 4.7 % of the participants before the pandemic ($p < 0.001$) **(**87**)**. More male reported significantly reduced engagement in physical activity (50 % versus 39.3 %; $p = 0.013$) and increased screen time (54.5 % versus 51 %; $p = 0.002$) **(**87**)**. Female participants demonstrated significantly higher sleep disturbances ($p = 0.011$) **(**87**)**. Weight gain and an increase in the number of meals consumed daily were reported ($p = 0.042$ and $p = 0.024$, respectively) **(**87**)**. Participants aged 18-35 were mostly affected in sleep duration and quality ($p < 0.001$) **(**87**)**. Association between lifestyle changes and difference of the education levels was not demonstrated **(**87**)**. The realized Mediterranean diet is benefit as an anti-inflammatory dietary pattern that emphasizes on low consumption of red meat and dairy, moderate consumption of monounsaturated fat source such as olive oil, and high consumption of plant foods that associate with increased immunity, and lower risk of inflammation and chronic diseases **(**88-91**)**, in addition to having a lower environmental impact than the characteristic Western diet and a favorable effect on chronically inflammatory diseases, such as type 2 diabetes mellitus, metabolic syndrome, and visceral obesity **(**92-97**)**. Several previous studies indicated a transformation of the diet in Eastern Mediterranean countries from a traditional Mediterranean diet to a more Westernized diet that is low in fruits, vegetables, fiber, and polyunsaturated fat and high in refined carbohydrate, salt, cholesterol, saturated fat, and energy **(**98-101**)**. Thus, current UAE dietary behaviors may be ineffective against the SARS-CoV-2 (COVID-19), whereas it was questionable that these dietary patterns were due to city lockdown following the COVID-19 pandemic **(**102, 103**)**. By considering an adequate supply of macro- and micro-nutrients are necessary for optimal immune function and response can be detrimental implications **(**102, 103**)**. For delivering mental health service, the use of telehealth has been demonstrated to be useful in providing support to the patients **(**104**)**. An increased compliance with the Mediterranean diet can be associated with better sleep, higher scoring for self-perceived health status, and lesser mental distress **(**105-107**)**, in addition to having a protective effect on the risk of cardiovascular diseases and some types of malignancies **(**96, 108**)**.

In Zimbabwe, there were crucial policy implications for the national government centred around the need to stop the COVID-19 spread using city lockdowns, in addition to the glaring need to deal with negative impacts of such policy decisions on food security and livelihood that were greatly affected due to mobility restrictions (109). Naja and Hamadeh provided the recommendations the government of Zimbabwe on how to provide nutrition demands during COVID-19 pandemic by using a multilevel framework for action adapted from the ecological model of health behavior (110). The government of Zimbabwe was also encouraged to produce evidence and informed decisions for ensuring responsible lockdown exit strategies (109). A previous study in Zimbabwe demonstrated that there was decrease in immunizations and growth monitoring (37.8 %), access to medical doctors (58.6 %), and access to drugs (59.9 %) during the COVID-19-city-lockdown period, (109), in addition to disruptions in drug- and vaccine- supply chains-associated with defaulters on immunization schedules among children (111).

A recent study in Poland during COVID-19 pandemic with city lockdown demonstrated that 43 % of participants ate more, 52 % of the participants ate snack more, more than 18 % experienced body weight gain, 18 % of the participants confronted body weight loss, whereas older (aged 36-45 and > 45), obese, and overweight participants tended to gain body weight more frequently (112). Those participants with underweight tended to lose their body weight further (112). Participants with increased body mass index (BMI) frequently consumed less vegetables, fruits, and legumes with higher adherence to higher adherence to fast-foods, dairy, and meat during quarantine (112). Additionally, 14.6 % of the participants demonstrated an increase in alcohol consumption, particularly in participants addicted to alcohol, and more than 45 % of the participants with cigarette smoking revealed an increase in smoking frequency during quarantine (112). City lockdown during COVID-19 pandemic in Poland may affect dietary habits and eating behaviors and advocates for organized nutritional support during future disease-epidemic-related quarantines, especially for the most vulnerable people (112). Proactive development of strategies must be stressed to mitigate the increase in alcohol consumption among alcohol-addicted Poles during COVID-19 pandemic or during future disease-epidemic-related quarantines or city lockdowns (112). Another recent study among the Poles revealed that 34 % of the participants revealed an increase in food consumption, 43 % of them demonstrated a decrease in physical activity (PA), and 49 % of them revealed an increase in screen time (113). Before the COVID-19 pandemic in Poland, a low percentage of the Polish people met the WHO's recommendations for PA, and lower percentage of people were actively engaged in sports than those in other European Union countries (114). Adult Poles over 40 years old, those living with unemployed, children, those not consuming homemade meals, and those living in a region with a higher Gross Domestic

product (GDP) could be more exposed to unhealth behaviors (113). In maintaining health by giving the importance of PA, its promotion during COVID-19 pandemic should take a new meaning (113). The issue of PA in Poland was little publicized although there were appeals for PA at home on the websites of the National Health Fund and the Ministry of Health, and fitness instructors also posted the videos with exercises for the duration of the COVID-19 pandemic on several websites (113). Thus, working on special programs of gymnastics education and enhancing the message " to be active " in the situations of the mandatory home isolation or quarantine is essential (113). It is critical to create effective, targeted recommendations and tools to maintain health and to prevent chronic diseases that exist among the Polish population (113). A recent Italian survey demonstrated that 17.7 % of the participants had less appetite, 34.4 % of the participants had more appetite, 33.9 % of the participants felt hungry before the main meals, 22.8 % felt hungry in between the main meals, 11.2 % of the participants felt hungry after dinner (115). The study revealed that after-dinner hungry was associated with the habit of having a break before bedtime (OR= 4.067, $p < 0.001$) (115). During the COVID-19-city lockdown in Italy, 37.4 % of the participants ate more healthy food (vegetables, fruit, legumes, and nuts), and 35.8 % of the participants ate less healthy food (115). Age and BMI were positively and inversely associated with the increased appetite and night snacks, respectively (OR = 1.073, $p < 0.001$; OR = 0.972, $p < 0.001$) (115). North and Center Italy were both inversely associated with appetite increase, compared to the South and Islands (OR = 0.527, $p < 0.001$; OR = 0.582, $p < 0.001$), whereas living in Southern and Islands and Center Italy was associated with the after dinner snack in comparison to the Northern Italy (OR = 1.843, $p = 0.009$; OR = 2.128, $p = 0.002$) (115). The participants with training during the COVID-19-city lockdown and the participants from Northern and Center Italy had a minor perception of body weight gain, compared to those from the Southern and Islands (OR = 0.660, $p < 0.001$; OR = 0.786, $p = 0.024$; OR = 0.747, $p < 0.001$) (115). Lower age, higher BMI, enhanced appetite, and after dinner hunger were associated with an increase of junk food consumption (sweet beverages, dressing sauces, savory snacks, and packaged sweets and baked products) (For higher BMI : OR = 1.025, $p = 0.005$; For lower age : OR = 0.979, $p < 0.001$; For enhanced appetite : OR = 4.044, $p < 0.001$; For after dinner hunger : OR = 1.558, $p < 0.001$) (115). Participants with having suspended their usual job or started smart working had a greater perception of having increased their body weight in comparison to the participants not changing their routine job (OR = 1.250, $p = 0.037$) (115). The majority of the participants purchased food at the supermarket (75.8 %), 26.0 % of them purchased at the grocery shops, 14.8 % of them purchased at farmers, organic or local markets or using " Solidal Purchasing Groups ", and 9.0 % used online delivery (115). Nevertheless, 11.8 % of the participants declared not to purchase food and to delegate shopping to the third parties and 54.0 % of

them used the leftover food more than 30 % of times (115). Using " Solidal Purchasing Groups " or shopping at farmers, organic markets, or local markets was associated with the habit of recycling the leftover food (OR = 1.468, p < 0.001) that the participants from the North and Center of Italy appeared to be more prone to this behavior in comparison to Southern and islands participants (OR = 2.109, p < 0.001; OR = 1.735, p < 0.001) (115). In consideration of the physical activity during COVID-19-city lockdown, there was no significant difference between the percentage of participants who did not train before (37.7 %) nor during (37.4 %) the COVID-19-city lockdown (p = 0.430) (115). Conversely, a higher frequency of training during the emergency was identified in comparison to the previous period (McNemar value = 259.529, p < 0.001) (115). In consideration of the highest adherence to the Mediterranean diet (MD), 93.7 % of the participants consumed vegetables, 80.9 % of them consumed legumes, 75.9 % of them consumed nuts, 63.3 % of them consumed fish, and 58.7 % of them consumed fruit (115). MD could be one of the best nutritional models to construct innate and adaptive immunity during COVID-19 pandemic and might be a supplemental therapeutics of the COVID-19 (115). Decreasing the consumption of junk food to reduce " obesogenic environment " that contributes to body weight gain and susceptibility to COVID-19 was strongly recommended (116, 117). Consumption of junk and ultra-processed food in the postprandial period contributes to a greater susceptibility significantly to the development of inflammation, oxidative stress or damage, and chronic diseases, while the consumption of foods rich in antioxidants and seasonal foods is highly protective (118).

Review of personnel occupational health and safety practices, human resource planning in the face of absenteeism or increasing demand, travel limitations, business continuity planning, progressive investment and resource plans of the next 3 years, alternative input source channels, establishing COVID-19 positive-reporting system, and promoting understanding COVID-19 transmission are important to change the business models of the agricultural firms (119, 120). More organized by using the COVID-19 crisis as a driving force are needed by the small companies (121). COVID-19 pandemic, panic buying, food- supply-chain disruptions, and city-lockdown restrictions caused a significant risen-food price (122), whereas some consumers will pay more attention to decrease food waste for improving food security (123). Movement restrictions both national and international contributed to challenges, including consumers' changes in demand. These restrictions caused consumers prepared cooking at their home, in addition to preventing them from getting COVID-19 infection at the stores, restaurants, markets, and supermarkets (44).

Conclusion

Movement restrictions both national and international contributed to challenges, including consumers' changes in demand. These restrictions caused consumers prepared cooking at their home, in addition to preventing them from getting COVID-19 infection at the stores, restaurants, markets, and supermarkets.

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Volume 2 Issue 3 March 2021