



Role of Food and Nutrition in Managing COVID-19 in Low-Middle-Income Countries



Rubina Hakeem

Nutrition Foundation of Pakistan



Role of Food and Nutrition in Managing COVID-19 In Low Middle Income Countries (LMIC)

RUBINA HAKEEM

and

NFP COVID-19 Group



NUTRITION FOUNDATION OF PAKISTAN

www.nutrition.org.pk

e-book, published by Nutrition Foundation of Pakistan (NFP)

Lead Author:

Rubina Hakeem PhD Nutrition; MSc Home Economics

Professor & Principal RLAK College of Home Economics Karachi Pakistan

Copy Right © 2020 by Rubina Hakeem-Chairperson NFP.

First Edition: June 2020.

All rights reserved. No part of this book may be modified or reproduced in any manner whatsoever without written permission.

Contact: info@nutrition.org.pk, nutrition.pakistan@gmail.com

NFP COVID-19 group

1. **Abdul Momin**, PhD Food and Nutrition, UVAS, Lahore, Assistant Professor, The University of Lahore, Islamabad Campus, Pakistan
2. **Atta-e-Rabbi**, M.Sc. Home Economics (Nutrition and Dietetics) RLAK CHE Karachi Pak., Free Lance Nutritionist
3. **Falak Zeb**, PhD Nanjing Medical University, China.
4. **Fatima Zehra**, BS Home Economics (Nutrition and Dietetics), Consultant Dietitian in Ehad diabetes and medical center
5. **Hafsa Javed Vapiwala**, BS Home Economics (Nutrition and Dietetics) RLAK CHE Karachi Pak., Ex Clinical Dietitian at OMI Hospital Karachi
6. **Iqra Akram**, MSc Scholar Public Health at University of Debrecen, Hungary.
7. **Kanwal Ali**, BS Home Economics (Nutrition and Dietetics) RLAK CHE Karachi Pak., Free Lance Nutritionist
8. **Latifullah Khattak**, BSc hons. MD. MSc Public Nutrition (in progress)., Public Health Consultant, Alelaj hospital, Wah Cantt
9. **Madiha Ajaz**, BS Home Economics (Nutrition and Dietetics) RLAK CHE Karachi Pak., MPH (in progress) DUHS.
10. **Marwa Nazakat**, DDNS (Lahore Pak.)
11. **Mehreen Amer**, M.Sc. Home Economics (Nutrition and Dietetics), Lecturer at Dow university of Health Sciences
12. **Memoona Manzoor**, M.Phil. Nutritional Sciences, PITB, Manager Food Services, Bahawalpur
13. **Muhammad Barkaat Azam**, DDNS (Doctor of Diet and Nutritional Sciences), The University of Lahore (in progress).
14. **Rabia Imtiaz**, BS Home Economics (Nutrition and Dietetics) RLAK CHE Karachi Pak., Clinical dietitian, BIDE Karachi
15. **Rubina Sabir**, M.Sc. Home Economics (Nutrition and Dietetics) RLAK CHE Karachi Pak PGDPHN (AUS) RDN (PAK), Lecturer, UAE university, Alain, United Arab Emirates (*Co-author chapter 9*)
16. **Sidra Raza**, BS Home Economics (Nutrition and Dietetics) RLAK CHE Karachi Pak., Clinical Nutritionist DUHS
17. **Syeda Aaisha Sohail**, BS Food Science & Technology, Free Lance Nutritionist
18. **Syeda Anchel Zahra**, M.Sc. (Hons) Human Nutrition and Dietetics, University of Agriculture, Faisalabad
19. **Zarghuna Bukhari**, BS Home Economics (Nutrition and Dietetics) RLAK CHE Karachi Pak., Clinical Dietitian, AKUH Karachi

Contributions of NFP COVID-19 group

Lead Author:

Dr. Rubina Hakeem wrote Preface, Executive Summary & Chapter 5, guided the writing of all the chapters, assisted in writing all the chapters and did final additions, deletions and corrections in all the chapters.

Contributions of other team members

Chapter 1 : Latifullah Khattak did the main writing, Mehreen Amer & Syeda Anchel Zahra assisted in writing

Chapter 2 : Madiha Ajaz did the main writing, Hafsa Javed Vapiwala & Latifullah Khattak assisted in writing , and Fatima Zehra conducted literature search

Chapter 3 : Abdul Momin did the main writing, Muhammad Barkaat Azam assisted in writing , and Atta-e-Rabbi conducted literature search

Chapter 4 : Mehreen Amer did the main writing, Rubina Hakeem & Falak Zeb assisted in writing .

Chapter 5 : Rubina Hakeem did the main writing & Mehreen Amer assisted in writing .

Chapter 6 : Abdul Momin did the main writing, Rabia Imtiaz assisted in writing , and Memoona Manzoor conducted literature search

Chapter 7 : Sidra Raza did the main writing, Madiha Ajaz assisted in writing , and Marwa Nazakat conducted literature search

Chapter 8 : Kanwal Ali did the main writing, Zarghuna Bukhari & Aisha Sohail assisted in writing

Chapter 9 : Zarghuna Bukhari did the main writing, Iqra Akram, & Rubina Sabir assisted in writing and Madiha Aijaz conducted literature search

Acknowledgment

I am truly obliged to all my honorable national and international colleagues named below, for sparing their valuable time in reviewing the manuscript and sharing their useful comments. I feel truly honored by the kind voluntary support provided by our revered senior colleague Sylvia Scott-Stump by her meticulous editing of the final manuscript.

Hajra Ahmad PhD

Professor Allama Iqbal Open University Islamabad Pakistan

Marianella Herrera-Cuenca PhD

Associate Professor & Researcher Center for development Studies (CENDES) Central University of Venezuela (UCV)

Philip C. Calder, PhD

Professor of Nutritional Immunology, Head Human Development & Health, Faculty of Medicine, University of Southampton,

Rezzan Khan PhD

Consultant Nutritional, and Head of Food & Nutrition Department, Shifa International Hospital, Sector H-8, Islamabad Pakistan

Sue L. T. McGregor PhD

Professor Emerita, Faculty of Education at Mount Saint Vincent University, Halifax, Nova Scotia, Canada

Susan Yake, RDN, CD, CDCES, CLT, FAND

Senior dietitian, Naval Hospital. Bremerton

Sylvia Escott-Stump MA, RD, LDN, FAND

Faculty Associate, University of Wisconsin-Madison, Winterville, North Carolina
Past President, Academy of Nutrition and Dietetics
Author for 5 editions of Krause's Food and the Nutrition Care Process

I would also like to thank my talented ex-student Ms. Tanzila Kulsoom for benefiting me from her publication experience and giving useful suggestions re publication of e-book and last but not least I am truly impressed by the NFP COVID-19 team who worked with passion and perseverance to make this publication possible.

Reviewers' comments

"A Nice to see a very timely, need based joint effort by the nutritionists under your vibrant leadership. A good collection of latest available evidence-based information on COVID-19 from different sources"

Hajra Ahmad PhD

Professor Allama Iqbal Open University Islamabad Pakistan

"This report represents the true efforts of experts for a call on evidence based actions in the middle of a global catastrophe. When the world, and particularly low and middle income countries are at risk and are immerse within food insecurity, adequate nutrition, prevention of acute malnutrition and protection of the population is key, so guidance is needed and this excellent tool provides it."

Marianella Herrera-Cuenca PhD

Associate Professor & Researcher Center for development Studies (CENDES) Central University of Venezuela (UCV)

"This report provides a robust evidence-based appraisal of the potential for food to contribute to coronavirus infection and for various foods and their component nutrients to influence the ability of the host to deal with becoming infected with coronavirus"

Philip C. Calder, Professor of Nutritional Immunology, Head Human Development & Health, Faculty of Medicine, University of Southampton,

"Very well researched and presented in such a good timely manner, developing countries will benefit a lot from this."

Rezzan Khan PhD

Consultant Nutritional, and Head of Food & Nutrition Department, Shifa International Hospital, Sector H-8, Islamabad Pakistan

"I see that much work has gone into this document. It looks to be well researched and cover the most critical information needed for prevention of spreading COVID-19 and best treatment practices for those who are infected by the virus."

Susan Yake, RDN, CD, CDCES, CLT, FAND

Senior dietitian, Naval Hospital. Bremerton

"At a time when the world is reeling from the impact of COVID-19, I commend you for the vision of pulling together concerned colleagues who were able to set aside their own angst and concerns to focus on what others need to pull themselves through this global health crisis. This is the true heart of home economics and nutrition specialists."

Sue L. T. McGregor PhD

Professor Emerita, Faculty of Education at Mount Saint Vincent University, Halifax, Nova Scotia, Canada

"This manuscript is an excellent resource for individuals who are serving clients with COVID-19 symptoms or disease. Food and nutrition are essential components of a healthy immune system, and they are even more important during a medical crisis. Individuals who are unable to acquire safe, adequate and nutritious food are highly vulnerable. Thus, health professionals will benefit greatly from using this timely, important tool as they assess and plan for their communities."

Sylvia Escott-Stump MA, RD, LDN, FAND

Faculty Associate, University of Wisconsin-Madison, Winterville, North Carolina

Past President, Academy of Nutrition and Dietetics

Author for 5 editions of Krause's Food and the Nutrition Care Processes

Table of Contents

Preface	1
Executive Summary	2
Part 1: Position Statements	5
Chapter 1 Food in Local Markets as Source of Transmitting COVID-19	6
Chapter 2 Transmission of COVID-19 Infection Through Food Handling by the Consumer	8
Chapter 3 Role of Food and Nutrition in Influencing Replication of Viruses	11
Chapter 4 Role of Nutrition in Influencing the progression of COVID-19?	15
Chapter 5 Role of Fulfillment of COVID-19 Induced Nutritional Needs?	18
Chapter 6 Role of Food and Nutrition security in managing the COVID-19 induced personal stress, and socioeconomic challenges	22
Part 2: Guidelines and Recommendations	26
Chapter 7 Guidelines for provision and selection of safe food?	27
Chapter 8 Guidelines for safe food management by consumers	29
Chapter 9 Guidelines for Combating COVID-19 Infection Through Food and Nutrition	31
References	36

Preface

Food provides us nutrition and well-being. For meeting the short and long term challenges posed by COVID-19 pandemic, optimal nutrition care is an essential tool for all but more so for low middle income countries (LMIC). This monograph is an attempt to review the primary evidence about COVID-19, identify its implications for LMIC, and to develop simple locally applicable guidelines for developing countries like Pakistan.

COVID-19 is an infectious disease caused by a novel coronavirus named SARS-CoV2. Coronaviruses like all other viruses are non-living chemical units that are only "active" within host cells which they need to reproduce. Viruses are complicated organization of molecules, including proteins, nucleic acids, lipids, and carbohydrates, that can do nothing until they enter a living cell and multiply.

Coronaviruses are classified together on the basis of the crown or halo-like appearance of the envelope glycoproteins, and on characteristic features of chemistry and replication. Coronaviruses cause acute, mild upper respiratory infections (common cold). Transmission is usually via airborne droplets to the nasal mucosa. The virus enters the host cell, and where genomic information is utilized for replication of the new virus cells by budding from host cell membranes. The appearance of antibody in serum is followed by resolution of the infection (He and Zheng 2020).

Six coronaviruses were previously known to cause disease in humans, SARS-CoV2 is the seventh member of the coronavirus family that infects human beings. It was reported in late December 2019, as a case of unidentified pneumonia in Wuhan, Hubei Province, People's Republic of China (PRC). WHO officially named the disease COVID-19 (Kaul 2020;KaviyarasiRenu et al. 2020).

This virus most probably originated from bats and transmits from humans to humans. Virus containing fluids from an infected person can be transmitted to others by air, surfaces, handshake or oral-fecal route (Yang et al. 2020). Due to high transmissibility of the virus, in spite of global aggressive measures the pandemic is estimated to continue and have several peaks (Oberemok et al. 2020).

COVID-19 pandemic has already shown its impact on all levels, ranging from quality of life of individuals to global economies. Low middle income countries appear to be more severely influenced and less prepared to bear the impact of pandemic. Financial, administrative and political limitations make transmission control more difficult for LMIC that are less likely to have adequate treatment and rehabilitation facilities (Coleman 2020;Ma et al. 2020;Mesa et al. 2020).

Food insecurity, malnutrition, low nutrition literacy and lack of appreciation for the role of nutrition in nations' prosperity are other preexisting conditions that may escalate the devastating impact of this pandemic (Perez-Escamilla et al. 2020;The Lancet 2020). At present, appreciation of the role of food and nutrition is the most crucial need for LMIC for various reasons. While it can definitely help these populations in improving quality of diets and nutritional status, it is very likely to reduce the severity of symptoms and deterioration of health among the infected ones. Better nutritional status can reduce the need for critical care resources and better preserve health and functionality of survivors. Multilevel actions are needed to achieve this aim (Naja and Hamadeh 2020).

This monograph is an attempt to review the primary evidence and explore its implications for LMIC; and to develop simple locally applicable guidelines for the Pakistani population

Executive Summary

Introduction:

COVID-19 pandemic is culmination of hazards posed by outbreaks of viral infections. Global variations in morbidity and mortality and other impacts of pandemic are already very obvious and are often attributed to variation in the control measures. Variation in status of food security and nutrition adds to the differences in measures required to assure optimum well-being of people during and after the pandemic. Evidence suggests that diet and nutrition status is not only one of the determinants of viral infection risk but also a potential factor in determining the outcomes of viral infections.

Objective:

This project aims to explore the implications of available evidence for identifying the role of food and nutrition in managing COVID-19 pandemic in Low Middle Income Countries like Pakistan. We aim to identify the potential of food and nutrition in transmission and impact of COVID-19 in developing countries like Pakistan, and to develop guidelines and recommendation to utilize that potential.

Methods:

To identify the potential of food and nutrition in combating COVID-19 in Pakistan we reviewed the following:

- (1) high quality evidences and systematic reviews about the role of nutrition in controlling infections in general and coronaviruses in particular.
- (2) Research articles and reposts about mechanism of transmission and infection of Novel coronavirus
- (3) Observations and experts view about potential of nutrition in combatting COVID-19
- (4) Food and nutrition related situations in Pakistan

After reviewing the literature answer to the following questions were sought:

What is the role of food available in markets and consumers' food handling techniques in transmission of COVID-19?

What is the role of nutrition in influencing the outcome of COVID-19: (1) by limiting the replication of virus; (2) by limiting progression of the disease; (3) by fulfilling disease induced biochemical needs (4) by enhancing wellbeing and ability to cope.

On the basis of position statements, and guidelines developed by international agencies public messages and recommendations were developed for Pakistan. The recommendations were aimed at: (1) limiting possibilities of food serving as a carrier of SARS-COV2 (2) assuring best possible nutrition care for people before, during and after the infection.

Workgroup:

Project outline was developed by Dr. Rubina Hakeem as Chairperson of "Nutrition Foundation of Pakistan" (NFP). It was shared with all the nutrition related professionals of Pakistan with an invitation to participate in the project. Brief invitation was sent through WhatsApp groups where almost all the professionals are included and open to public Facebook pages. The invitation included like to a survey that had details of the projects and where respondents could share their qualification, expertise and interest.

More than 90% of Human Nutrition Professionals (HNPs) were thus reached. About 35 professionals responded to the invitation to participate. Roles were assigned by project in-charge in accordance with interest and expertise. Group communicated through email, WhatsApp and Zoom meetings. A

few could not continue due to personal reasons and a total of 19 volunteers formed the “NFP COVID-19 group” and made contributions in developing this document.

RESULTS

In relation to various research questions the position of workgroup is as follows:

- 1. Due to lack of regulations, and any other alternate quality control measures, in Low Middle income countries both packages and unpacked food in local markets may serve as a vehicle for transmitting COVID-19 infection. Appreciation of this potential, and taking measures to minimize chance of transmission of COVID -19 through food in local markets can help in supporting efforts to the spread of the infection.*
- 2. Food and its packaging like other surfaces can be exposed to SARS-COV2 before or after procurement by the customer. Virus if already present on any surfaces, can be rendered inactive by storage, disinfection and preparation techniques. Uninfected food and packaging may get the virus on its surface by infected persons within the customers’ homes. Eventual risk from these foods is modulated by food handling by the customer. Professionals and the public in developing countries need to be informed about technique of controlling the risk of transmitting of COVID-19 via food.*
- 3. Evidence suggests that once infected, along with other factors, the food and/or nutrient intake or nutritional status of a person has the potential to influence the rate of replication of viruses and is very likely to impact the replication of SARS-COV2. There may not be enough research evidence to show exclusive significant impact of nutritional interventions on the replication of SARS-COV2 but in view of relevant evidence, all attempts must be made to correct all nutritional deficiencies and replenish the body stores of nutrients. This measure would better assure steady physiologic supply of nutrients to support the immune system.*
- 4. At present there is insufficient evidence to claim that any particular food or nutrient would be universally beneficial in controlling the progression or severity of COVID-19 at all stages of the disease. However, evidence does indicate a role of good nutritional status and optimum nutrition care in giving support to other treatment regimes. People having nutritional deficiencies would safely benefit from correction of deficiencies by diets or supplements. Hydration may relieve some symptoms and repletion of nutrition can better prepare the bodies to restrict the progression COVID-19. The public may be guided to keep themselves hydrated and consume a healthy diet, while clear disclaimers must be issued that no diet or nutrients can entirely assure prevention or cure of COVID-19. Use of self-prescribed, non-evidence based herbal treatments, may increase the risk of severity and mortality.*
- 5. Individualized, aggressive nutrition care can contribute to moderating the clinical course of infections. Identification of, and prudent response to emergent nutritional needs of COVID-19 patients can support other treatment modalities in decreasing the severity and mortality of COVID-19. Non critical patients could benefit from nutrition care by qualified dietitians, who can assess their emergent nutritional needs and design interventions for responding to those needs. Among critically ill patients, pharmacological doses of required nutrients can be given after weighing potential benefits and risk by the health care team.*

6. *Appropriate food and Nutrition can support individual's as well as a nation's efforts to survive the physiological, psychologic and economic impact of COVID-19 Pandemic, by building morale, enhancing vitality and optimize productivity. Individuals, family and governments in the developing countries must prioritize optimal nutrition in order to have best possible quality of life during and after the pandemic. This can be done only by exploiting technical knowledge and skills to make best use of available resources.*

The public messages developed by the workgroup in accordance with the position statement focused on enhancing consumer's ability:

- (1) To Identify foods having high or low risk of exposure to COVID-19 infection and buying food having low risk of exposure to SARS-COV2
- (2) To use appropriate techniques for buying, handling, storing, preparing and serving foods
- (3) To support best possible nutrition care for all high risk groups and for confirmed COVID-19 patients

Recommendations for relevant sectors focused on:

- (1) Minimizing exposure of food or its packaging to infection by developing evidence based and culturally appropriate good manufacturing practices for Pakistan.
 - (2) Assuring access to and availability of affordable foods to facilitate the consumption of healthy diet.
 - (3) Integrating food and nutrition messages in public communications about combatting COVID-19.
 - (4) Assuring provision of competent individualized nutrition care to all COVID-19 confirmed cases with moderate or severe disease.
-

Part 1: Position Statements

Chapter 1

Food in Local Markets as Source of Transmitting COVID-19

POSITION STATEMENT:

Due to lack of regulations, and any other alternate quality control measures, in Low Middle income countries both packages and unpacked food in local markets may serve as a vehicle for transmitting COVID-19 infection. Appreciation of this potential, and taking measures to minimize chance of transmission of COVID -19 through food in local markets can help in supporting efforts to the spread of the infection

Introduction

COVID-19 emerged from wet-food markets in China thus concern about its transmission through foods are not unjustified (Hamid et al. 2020). While guidelines developed in the context of developed countries state that “Currently there is no evidence to support transmission of COVID-19 associated with food” the evidence could be interpreted differently for developing countries. In spite of lack of evidence of transmission through foods, a number of precautionary measures are suggested by international agencies to prevent food-related transmissions. Almost all the guidelines recommend precautions in consuming foods of animal origin (Centers for Disease Control and Prevention 2020;EUROPEAN COMMISSION 2020;Food Standards Agency 2020;The Food and Drug Administration USA 2020;WHO 2020). We conducted this review to explore the possibilities of locally available food serving as source of transmission of COVID-19 infection.

Objective

To investigate the possibility of food as available in markets as a primary source of transmitting COVID -19 infection

Method:

In order to explore the possibility of transmission of COVID-19 through food in local markets, we reviewed (1) available evidence about mechanism of replication and transmission of coronavirus in general and that of SARS-COV2 in particular, and (2) food production and distribution situation in Pakistan. Databases reviewed included PubMed, and Google Scholar.

Results:

Mechanism of replication of SARS-COV2: Coronaviruses cannot multiply in plants. They need an animal or human host to multiply (He & Zheng 2020). After the death of the animal exactly for how long viruses are able to replicate and transmit the infection is not known. As cells of the body do not die instantly after death the possibility of transmission cannot be completely excluded remains. Possibility of transmission of COVID -19 from the dead body of an infected person is reported from Thailand (Sriwijitalai and Wiwanitkit 2020).

Mode of transmission of COVID-19: The main way the COVID-19 virus spreads from person-to-person is through contact with sneeze or cough droplets of an infected person. Air can carry the droplets for

a certain period of time and eventually the droplets settle on any available surfaces. The virus cannot replicate on those surfaces but remain replicable if it reaches a host within a reasonable period of time and that time varies according to type of surface (Atzrodt et al. 2020;Feng et al. 2020;Shi et al. 2020). Duration of stability of SARS-CoV2 on surfaces differ according to material of the surface as well as on environmental conditions (van et al. 2020). Thus potentially outermost surfaces of any food or its packaging that has been exposed to risky environment and acquired by consumer within a specific time span can be a source of transmission of COVID-19. However, the degree of risk depends on the environment in which the food is grown, processed, packed, transported, displayed, stored, bought and taken home.

In Pakistan a large proportion of food reaches the customers without any monitoring for the implementation of food safety procedures (Akhtar 2015). Both opportunities for and readiness for COVID-19 testing of people with mild symptoms is limited. Thus there are fair possibilities of exposure of food and its packaging to the virus. In small towns and rural areas time duration between food production and consumptions often much shorter than in any areas of the developed countries. So possibilities of survival of virus, till it reaches the customer are also much greater than in the developed urban world.

Conclusions drawn in developed countries are based on food industry dynamics and norms in those countries and may not apply similarly to developing countries.

Conclusion:

Based on current knowledge about survival of SARS-CVO2, in developing countries like Pakistan food as available in markets can be a source of transmitting COVID-19

Food related businesses, other stakeholders and public must be warned against food and its packaging as a potential source of transmitting COVID-19. Population specific rules should be made and implemented to minimize the exposure of food and its packaging to the virus. Risk of exposure of various type of foods in various setting should be done. Consumers should be educated about level of risk from various sources of getting foods and treatment of food to decrease the risk of transmission.

Chapter 2

Transmission of COVID-19 Infection Through Food Handling by the Consumer

Position Statement:

Food and its packaging like other surfaces can be exposed to SARS-Cov2 before or after procurement by the customer. Virus if already present on any surfaces, may be rendered inactive by storage, disinfection and preparation techniques. Uninfected food and packaging may get the virus on its surface by infected persons within the customers' homes. Eventual risk from these foods is modulated by food handling by the customer. Professionals and public in developing countries need to be warned against possible transmission of COVID-19 via uncooked food, semi-cooked food, food packaging and sharing of food and utensils.

Introduction:

While consumers need to choose the food having least possibilities of exposure to infection, buying guaranteed safe food may not be always possible. Food handling and treatment done by the consumer may increase or decrease the risk of transmission of COVID-19 through food or its packaging.

Though there is no current evidence to confirm the transmission of SARS-COV2 from food to human or food packaging to human, mode of transmission of the virus indicates that it is not impossible. Just like any other surfaces, food and its packaging may serve as a carrier of droplets from infected persons and may transmit the virus to the consumer. In developing countries this risk is much higher due to lower level of administrative controls on food safety (Grace 2015; Grace et al. 2019) and people's lacks knowledge about safe food handling practices (Naeem et al. 2018; Odeyemi et al. 2019). In these situations, appropriate handling of bought food by the consumer becomes more important.

Objective

This review aims at identifying the scientific advice that can guide the consumers in controlling food related transmission of SARS-COV2.

Method:

In order to explore the possibilities of controlling transmission of COVID-19 by handling of food by consumers, we reviewed (1) available evidence about mechanism of replication and transmission of coronavirus in general and that of SARS-COV2 in particular, and (2) food buying, storing and preparation practices of people in Pakistan. Databases reviewed included PubMed, and Google Scholar.

Results

Coronaviruses cannot replicate in food excluding the cases where live animals are eaten as food (Pressman et al. 2020). Any transmission through food is feasible only by uninfected person's contact with the food that has been exposed to virus containing human fluids or excretions. Risk of getting sick from consumption of virus exposed food depends on the survivability of virus on the surfaces of food or its packaging. Food management practice could decrease or escalate the risk of. knowledge

about survivability of the virus can guide the food management strategies needed to decrease the risk of transmission of virus through food consumption

No information is yet available about the duration of survival of COVID-19 on surfaces of foods. Report about the Infectivity of bovine coronaviruses shows that it could survive on the surface of romaine lettuce under household refrigeration conditions for at least 14 days (Mullis et al. 2012). Information about survival of SARS-COV 2 and other coronaviruses on various surfaces can guide about potential of transmission through food management practices. A recent study found that the COVID-19 coronavirus can survive up to four hours on copper, up to 24 hours on cardboard, and up to two to three days on plastic and stainless steel (van, Bushmaker, Morris, Holbrook, Gamble, Williamson, Tamin, Harcourt, Thornburg, Gerber, Lloyd-Smith, de, & Munster 2020; Yeo et al. 2020). Another study observed that coronaviruses can survive on glass up to 7 days. Coronaviruses are observed to survive longer on non-absorbent surfaces as compared to absorbent surfaces and survive for a longer period of time in colder environment as compared to warmer environment. Many common coronaviruses may well survive or persist on surfaces for up to one month (Ren et al. 2020). While the presence of the COVID-19 virus in untreated drinking-water is possible, it has not been detected in drinking-water supplies. The virus that causes COVID-19 has also been detected in the stool of certain people. Digestive tract is reported as a possible route of transmission of COVID-19 (Adhikari et al. 2020). It is suggested that fecal–oral transmission of SARS-CoV-2 is likely possible, especially in areas with poor sanitation (Yeo, Kaushal, & Yeo 2020). So we food exposed to droplets from infected person would serve as a carrier of SARS-Cov2.

Coronavirus are inactivated by exposure to temperature above 56 degrees centigrade and at alkaline pH (Pressman, Naidu, & Clemens 2020).

Discussion:

The review of evidence suggests that food management practices can serve as a gatekeeper for controlling the risk of transmission of virus through food. In developed countries where industrial and public level food hygiene practices are good, the risk may be low but in developing countries it needs to be assessed on the basis of knowledge about survivability of the virus and local consumers' food related practices. Food management practices that can control the transmission of virus needs to be identified and translated into guidelines and public messages.

In localities where rate of COVID-19 infection is high, food items displayed in open shelves or carts and buyers and sellers not wearing any masks will increase the risk of exposure to the virus. Example of a local scenario is given here.

As many of the consumers check food by touching and picking up the food with hands, contaminating by direct touching is also possible. Food bought is usually cooked on the same day or refrigerated without washing for later use. In either case, persons handling the food during preparation may be exposed to the virus. In case of cooked food risk is decreased for people who would eat the food but it remains high for the ones preparing the food. Most of these risks could be minimized by thorough washing of food surfaces before cooking or storing. Another option is leaving the acceptable food items untouched, at room temperature, for 2-3 days before use. Need for thorough washing of hands before and after washing the food and avoid touching face in between, needs to be stressed.

Depending on the type of packaging, wrapped food may be wiped with disinfectant, stored after removing outermost layer of packaging or left untouched for 2-3 days.

Food and its packaging are a potential carrier of SARS-COV2 and maybe exposed to virus even during the food handling in households. Even within households, using masks while handling food especially

if the food is to be eaten raw or the person handling the food may have cough or cold needs to be stressed.

Knowledge of survivability of virus on surfaces can be used to develop guidance for handling of food utensils and food preparation and consumption at local eateries.

Conclusion

Despite the fact that transmission of SARS-COV2 through food or food packaging is not yet reported, it is a potential source of transmitting COVID-19. Handling of bought food by the consumer is the eventual determinant of the risk from food or its packaging. Knowledge about survival of food on various surfaces and under different conditions can be utilized to explore culturally acceptable and effective methods of minimizing the risk at household level.

Further research needs to be done to estimate survival of the virus on food surface and packaging in local conditions. Based on available information culturally-specific guidelines should be developed for the consumers to minimize the risk of COVID-19 through food management practices.

Chapter 3

Role of Food and Nutrition in Influencing Replication of Viruses

Position statement:

Evidence suggests that once infected, along with other factors, the food and/or nutrient intake or nutritional status of a person has the potential to influence the rate of replication of viruses and is very likely to impact the replication of SARS-COV2. There may not be enough research evidence to show exclusive significant impact of nutritional interventions on the replication of SARS-COV2 but in view of relevant evidence, all attempts must be made to correct the nutritional deficiencies and replenish the body stores of nutrients. This would better assure steady physiologic supply of nutrients to support the immune system.

Introduction

It is believed that the nutritional status of the host can reduce the infectivity and replication of alpha-viruses and it should be considered as one of the crucial factors during the times of outbreaks (Weger-Lucarelli et al. 2019).

Objective:

To explore evidence about Role of Food and Nutrition in Influencing Replication of Viruses among low resource populations

Methods

We searched scientific databases mainly PubMed and google scholar using the search term “Coronavirus Replication”, “Replication of Coronavirus” and “Replication Mechanism of Viruses”, limiting the publication period from 2016 to 2020. After reviewing titles and abstracts, we retrieved 13 articles that could provide scientific basis for role of food and nutrition in influencing replication of viruses.

Results:

Our main research question was that is there any role of nutrition with regards to replication of viruses in general and that of SARS-CVO2 in particular. Based on our review, it was concluded that definitely, nutrition can impact the replication of viruses as considerable evidence has supported this. On the basis of our review, we can state that a huge probability exists that nutrition can affect the replication of viruses and this particular phenomenon could be exploited while managing a coronavirus patient.

Vitamin A

Another name for Vitamin A is “anti-infective” vitamin which is because several defense mechanisms of body depend on an adequate supply of Vitamin A. It has been reported by various research studies that supplementation of Vitamin A could reduce both morbidity as well as mortality in case of different infections such as Human Immunodeficiency Viruses (Zhang and Liu 2020). According to a recent research, when calves were given a diet low in Vitamin A, they were found to be more vulnerable to

the development of Bovine coronaviruses. Vitamin A could therefore be one of the potential nutrition interventions while managing Coronavirus patients (Zhang & Liu 2020).

Vitamin B Complex

B complex vitamins mainly act as coenzymes in various biochemical reactions occurring inside a living organism. Researchers have reported that Riboflavin along with UV light was effective in decreasing the titer of MERS-CoV in human plasma products. Similarly, Niacin has been found to be considerably effective as anti-inflammatory nutrient for lung patients on the ventilator (Zhang & Liu 2020). Moreover, Vitamin B6 plays a very important role in the overall immune system functioning of an individual (Mikkelsen and Apostolopoulos 2019). Since deficiency of Vitamin B complex renders the individual's immune system weak, therefore supplementation of Vitamin B complex to coronavirus patients could optimize their immunity (Zhang & Liu 2020).

Vitamin C

Vitamin C regulates immunity by enhancing differentiation and proliferation of B- and T-cells, and it is beneficial in preventing and treating respiratory and systemic infections. Vitamin C potentially protects against infection caused by Coronaviruses due to its benefits on immune function. High doses of vitamin C were recommended for prevention of SARS-CoV-2 infections by the Chinese Center for Disease Control and Prevention and Chinese Nutrition Society. Currently, Vitamin C is under investigation in a clinical trial for its benefit in patients with severe SARS-CoV-2 infection (Chen et al. 2020).

Vitamin C levels in white blood cells are tens of times higher than in plasma, which may indicate functional roles of the vitamin in these immune system cells (Chen, Hu, Hood, Zhang, Zhang, Kan, & Du 2020). Vitamin C has been shown to affect the functions of phagocytes, production of interferon, replication of viruses, and maturation of T-lymphocytes, etc. in laboratory studies (Hemila 2017).

In another study, red ginseng and vitamin C synergistically showed anti-viral effects by enhancing the activation of immune cells such as T cells and NK cells. Furthermore, red ginseng and vitamin C suppressed viral replication and reduced lung inflammation and pro-inflammatory cytokine production in influenza virus-infected Gulo mice (Kim et al. 2016).

Vitamin D

Vitamin D, a natural immune-regulator has been demonstrated to enhance antimicrobial activity against several pathogens including respiratory viruses: syncytial virus, influenza, pneumonia, coronaviruses and other non-respiratory viruses, such as human immunodeficiency virus, Hepatitis C virus and dengue virus. Classically, the mechanisms reported to support these antiviral effects are based on the ability of vitamin D to upregulate antimicrobial peptides and induce antiviral cytokines to interfere the viral replicative cycle. So, it may be postulated that Vitamin D might attenuate SARS-CoV-2 infection by impairing viral attachment to target cells (Arboleda and Urcuqui-Inc 2020).

The relevant actions of vitamin D include maintenance of tight cell junctions when viruses try to disturb junction integrity (Grant et al. 2020b). Therefore, Vitamin D should be considered as an important factor in the prevention of Coronavirus disease as the decreased levels of vitamin D in 20 European countries especially the aging population of the most vulnerable countries of Spain, Italy and Switzerland was found associated with the higher number of cases and rate of mortality (Ilie et al. 2020).

Zinc

Zinc is known to modulate antiviral immunity and regulate inflammatory response and this can be beneficial in reducing the burden of COVID-19 (Razzaque 2020).

The presently available data suggests that modulation of zinc status may be beneficial in COVID-19 as it possesses antiviral activity through inhibition of SARS-CoV RNA polymerase. Zn^{2+} may also decrease the activity of angiotensin-converting enzyme 2 (ACE2), known to be the receptor for SARS-CoV2. Improved antiviral immunity by zinc may also occur through up-regulation of interferon α production and increasing its antiviral activity (Skalny et al. 2020).

Omega 3 Polyunsaturated Fatty Acids (PUFAs)

The protectin D1, the omega-3 PUFA-derived lipid mediator, could markedly attenuate influenza virus replication via RNA export machinery. In addition, treatment of 'protectin D1' with 'peramivir' could completely rescue mice from flu mortality. Liu *et al.* had found that several PUFAs also had anti-hepatitis C virus (HCV) activities. Therefore, Omega-3 including protectin D1, which served as a novel antiviral drug, could be considered for one of the potential interventions of this novel virus, COVID-19 (Zhang & Liu 2020).

The effect of extracellular vesicles on replication of HCV was assessed in 'coculture' models. Functional analyses were performed to assess the impact of Omega-3 & Omega-6 PUFAs on EV-mediated antiviral immunity. It was found that macrophages secreted various cytokines shortly after stimulation with type I and II IFN, which orchestrated a fast but short-lasting antiviral state. This rapid innate immune answer was followed by the production of macrophage-derived EVs, which induced a late, but long-lasting inhibitory effect on HCV replication (Cai et al. 2018).

Gut Microbiota and dietary fiber

The gut microbiota plays a role in proper functioning of the immune system. Disturbance in gut microbiota is a feature of many infectious diseases. Dietary fiber is fermented by the gut microbiota into short-chain fatty acids (SCFA). SCFA, has been shown to produce anti-inflammatory effects.

In addition to SCFA, dietary fiber has also been reported to influence variety of gut microbiota and increase proportion of health promoting bacteria. Some varieties of dietary fiber provide substrate for the growth of healthy bacteria and are termed prebiotics. Food items like cultured yogurt providing healthy bacteria to gut and serve as probiotics. Dietary approaches, exploiting probiotic and prebiotic properties of food can help in achieving a healthy microbiota can also benefit the immune system (Akour 2020;Iddir et al. 2020).

Bioactive Compounds

The food bio-actives found in traditional Chinese medicine (e.g., plant-derived phenolic compounds, flavonoids from litchi seeds, quercetin, and kaempferol) have been reported to inhibit the enzymatic activity of SARS 3-chymotrypsin-like protease. This enzyme is vital for the replication of SARS-CoV2 and thus could be suggested as a supportive care agent for patients with COVID-19. However, the potential preventive effect of these formulas should be confirmed with rigorous and prospective clinical studies (Galanakis 2020).

Over nutrition

Both undernutrition and over nutrition could promote severity of disease. Obesity inhibits both virus-specific CD8+ T cell responses and antibody responses to the seasonal influenza vaccine. Obesity is associated with higher risk of severe COVID-19 (Korakas et al. 2020;Scheen 2020).

Discussion

A wide variety of nutrients have varied roles in the support of immune system and restricting the replication of infections including viral infections. Available evidence provides strong support that nutritional status and diet can influence the replication of SARS-COV2. Review by several other

experts also highlight the potential of nutrition in controlling COVID-19 (Calder 2020;Calder et al. 2020;Iddir, Brito, Dingo, Fernandez Del Campo, Samouda, La Frano, & Bohn 2020).

Conclusion

Although there is still insufficient data to suggest that food and nutrition directly affect the replication of SARS-COV2, yet recent reviews have suggested that several nutrients could play a potential role in controlling COVID-19. Based on our review, it can be stated that there is a high probability that food and nutrition can impact the replication of Coronavirus. It is therefore recommended that keeping in view the poor overall nutritional status of Pakistani population, focused efforts should be made towards consuming a healthy and well-balanced diet. This might reduce the replication of Novel Coronavirus, eventually improving the health of the infected patients as well as those who have not been yet infected with the Novel Coronavirus.

Chapter 4

Role of Nutrition in Influencing the progression of COVID-19?

Position Statement

At present there is insufficient evidence to claim that any particular food or nutrient would be universally beneficial in controlling the progression or severity of COVID-19 at all stages of the disease. However, evidence does indicate a role of good nutritional status and optimum nutrition care in giving support to other treatment regimes. People having nutritional deficiencies would safely benefit from correction of deficiencies by diets or supplements. Hydration may relieve symptoms and repletion of nutrition can better prepare the bodies to restrict the progression COVID-19. Public may be guided to keep themselves hydrated and consume a healthy diet, while clear disclaimers must be issues that no diet or nutrients can entirely assure prevention or cure of COVID-19

Introduction

Diet has traditionally been associated with causation, control and treatment of several diseases. It is natural for people to be interested in finding out role of diet in prevention and progression of COVID-19. Non evidence-based speculations about role of diet may give false hopes. One of the very widely circulated myths about COVID-19 is that certain techniques of hydrating the mucous membranes can prevent the infection from progressing to lungs. The purpose of this review is to find out the role of diet in progression of COVID-19

Method

We searched PubMed for relevant evidence by using search terms [COVID-19 OR coronavirus] AND “clinical course” AND [Nutrition Or hydration].

Results

Nutrition traditionally has been associated with infections. During 1918 Influenza pandemic, among the host factors associated with variations in influenza morbidity and mortality, age, cellular and humoral immune responses, genetics and nutrition played a role. Malnutrition and famine were associated with high disease severity and were related to mortality also in the younger population (Short et al. 2018). Undernutrition remains a problem for viral pandemics of the twenty-first century and beyond. Indeed, chronic malnutrition was thought to have contributed to the high morbidity and mortality seen in Guatemalan children during the 2009 influenza pandemic (Reyes et al. 2010) .

Vitamin D deficiency is found more often among COVID-19 patients in ICU as compared to those who did not need ICU admissions. At present there is yet not enough evidence to claim a definite role of any dietary or nutrition factor in the progression of COVID-19 but in view of evidence from other similar conditions intake of vitamin D, vitamin C, Omega-3 fats, vitamin A and Probiotics is considered to have a potential to influence the progression of disease or severity of the symptoms (Calder, Carr, Gombart, & Eggersdorfer 2020; Grant et al. 2020a; Zhang & Liu 2020).

Regarding hydration, evidence from other similar conditions indicate role of hydration in relieving symptoms of cold and influenza but there is no evidence that it can check the progression of infection from upper to lower respiratory tract. Though patients often feel that steam inhalation relieves the symptoms of cold (Braun et al. 2000) research evidence does not show any impact on symptoms (Singh et al. 2017). Two nasal inhalation treatments with steam had no effect on viral shedding in volunteers with experimental Rhino Virus (RV) colds (Hendley et al. 1994). Hot drinks are felt to improve air flow by people having a cold, though objectively measured airflow was not found to be increased (Sanu and Eccles 2008).

Obesity and concomitant low grade inflammation and metabolic derangements are also indicated as determinants of progression of COVID-19 and the severity of symptoms (Korakas, Ikonomidis, Kousathana, Balampanis, Kountouri, Raptis, Palaiodimou, Kokkinos, & Lambadiari 2020;Scheen 2020;Simonnet et al. 2020). While aggressive weight loss attempts cannot be recommended, to reduce the obesity related risks, dietary and nutritional interventions that can decrease low grade inflammation and metabolic derangements could be recommended.

Discussion

Though there is insufficient evidence to recommend any particular nutrient as a mandatory treatment for COVID-19, evidence is sufficient to support the role of optimum nutrition in giving support to other treatment regimes. Evidence strongly supports the view that people having nutritional deficiencies would safely benefit from correction of deficiencies by diets or supplements. Hydration may relieve symptoms and repletion of nutrition can better prepare their bodies to restrict the progression COVID-19. Public may be guided to keep them hydrated and consume a healthy diet with clear disclaimers that diet or any nutrients cannot assure prevention or cure of COVID-19

No data are available either about intake or biochemical status of water soluble vitamins like Thiamine and Ascorbic acid. However, in view of reported food expenditure patterns and observed food preparation practices, a large proportion of Pakistani population is expected to have sub-optimal levels of several water soluble vitamins.

Guidelines developed by experts from various developed countries do include the recommendation to correct nutritional deficiencies but apparent need for implementation of these are much less there than in developing countries. ESPEN's guidelines for nutritional management of COVID-19 states: *"Subjects with malnutrition should ensure sufficient supplementation with vitamins and minerals."* In low resource populations with low nutrition literacy this would mean a vast majority of the population.

Food consumption patterns exhibited by Household Income and Expenditure Survey (HIES) indicate that diet of most of Pakistanis even among food secure groups is estimated to be deficient in several micronutrients. According to HIES average per capita consumption of fruit and vegetables in Pakistan in 161 and 23 grams respectively (Pakistan Bureau of Statistics 2020;Pakistan Bureau of Statistics. 2020). The vegetables here include potatoes that is otherwise grouped among starchy foods by nutritionists. More than 95% percent of these vegetables are eaten after extended cooking and significant proportion of vitamin C and thiamine would have been lost.

Information about intake of micronutrient is rare and so are the reports about biochemical or clinical assessment of micronutrient status of Pakistani adults. Vitamin D is the only frequently explored vitamin among adults and deficiency in Pakistan is estimated to be high (Akhtar 2016;Iqbal et al. 2019;Jadoon et al. 2018;Riaz et al. 2016).

In relation to omega-3 fats, because of high consumption of saturated fats, trans fats, and omega-6 rich oils, and low consumption of fatty fish, physiological availability of omega-3 fatty acids is expected to be low.

This quick Estimation of micronutrient status of Pakistanis indicted grave need for optimizing the intake of micronutrient and omega-3 fats,

Conclusion:

Nutritional status and nutrition care can contribute to other disease management regimes in controlling the progression of disease, by providing nutrients required to support the immune function as well as by limiting infection induced physiological damages.

As people of low middle income countries are very likely to have multiple micronutrient deficiencies, timely nutrition care can play an important role in influencing the progression of COVID-19.

Chapter 5

Role of Fulfillment of COVID-19 Induced Nutritional Needs?

Position Statement:

Individualized, aggressive nutrition care can contribute to moderating the clinical course of infections. Identification of, and prudent response to emergent nutritional needs of COVID-19 patients can support other treatment modalities in decreasing the severity and mortality of COVID-19. Non critical patients could benefit from nutrition care by qualified dietitians, who can assess their emergent nutritional needs and design interventions for responding to those needs. Among critically ill patients, pharmacological doses of required nutrients can be given after weighing potential benefits and risk by the health care team.

Introduction

Physiologic and health variations exert influence on food and nutrition needs. Estimation of these emergent needs, predicting relative benefit of fulfillment of those needs and finding feasible modalities for fulfilling those needs could exert significant influence on the outcomes (Reckefuss 2020;Rhodes and Kirkpatrick 2018). Evidence-based guidelines are prepared by experts for nutrition care during various physiologic and health conditions (Academy of Nutrition and Dietetics 2020;Dietitians of Canada 2020). Based on available evidence similar guidelines have been prepared for nutrition care of potential and actual cases of COVID-19 (Arkin et al. 2020;ASPEN 2020;Barazzoni et al. 2020).

Objective

The purpose of this appraisal is to review the evidence to estimate nutrition care needs of COVID-19 patients in developing countries and feasibility of fulfilment of those needs.

Methods

In order to explore the nutrition needs during COVID-19 infection, we explored articles that could give information about (1) clinical course of COVID-19 pathophysiology seen in COVID-19, (2) nutritional needs during similar pathophysiology seen in other diseases and (3) nutrition care situation in developing countries. Google Scholar search engine was used to search the articles.

Results:

The symptoms of pathophysiology accruing during COVID-19 range from no or minimal symptoms to severe respiratory failure with multiple organ failure. Though all the symptoms do neither present in all the patients nor in the same sequences, reports have described symptom according to severity of disease.

1. **Mild** Symptoms of acute upper respiratory tract infection (fever, fatigue, myalgia, cough, sore throat, runny nose, sneezing) or digestive symptoms (nausea, vomiting, abdominal pain, diarrhea)

2. **Moderate** Pneumonia (frequent fever, cough) with no obvious hypoxemia, chest CT with lesions.
3. **Severe** Pneumonia with hypoxemia (SpO₂ < 92%)
4. **Critical** Acute respiratory distress syndrome (ARDS), may have shock, encephalopathy, myocardial injury, heart failure, coagulation dysfunction and acute kidney injury.

This review has explored relevance of nutrition to variable clinical course and severity of COVID-19.

Neuro-muscular manifestation of COVID-19 pathogenesis includes fatigue, generalized weakness, headache, malaise, muscle pain, cold extremities. Deficiencies of several vitamins and minerals have well established association with these symptoms. Nutrition interventions are observed to reduce these symptoms in other health conditions (Azzolino et al. 2020; Bjorklund et al. 2018; Damanti et al. 2019) and are rationally expected to do the same in case of COVID-19. They are unlikely to have any negative impact if given within the safe upper limits in all. Patients exhibiting clinical deficiencies can be given therapeutic doses recommended for correcting deficiencies.

Upper respiratory tract exhibitions of COVID-19 infection include cough, nasal congestion, sore throat, sputum production and hyposmia/macrosomia/anosmia. Intake of various food and nutrients e.g. Vitamin C, Flavonoids and Vitamin D have shown to mitigate symptoms of upper respiratory tract infections (Ginde et al. 2009; Raposo et al. 2017; Vorilhon et al. 2019; Zakaryan et al. 2017)

Fever is reported in a large proportion of COVID-19 patients. Fevers increase REE by approximately 7% for each degree of increase in body temperature more than 98.6° F or 13% for each degree more than 37° C. Studies in hospitalized patients have demonstrated increases in energy expenditure during fever as well as during cooling. Fever also increases needs for hydration and sodium. (Mahan and Raymond 2016a). Due to apparent increase in metabolic needs, for febrile patients who are not critically ill, a high energy-high protein diet is recommended.

Neurologic ramifications of COVID-19 include dizziness and altered mentation. Presence of these complications in non-hospitalized isolated patients may make self-care including nutrition care difficult. Though there are no COVID-19 specific observations, but established associations between nutrition status and mental functions indicate a rationale for assuring adequate intake or therapeutic doses of vitamin and minerals (LaChance and Ramsey 2018; Pourhassan et al. 2019; Sevim et al. 2017).

Gastrointestinal problems like Vomiting and diarrhea are also reported among COVID-19 patients (Suresh Kumar et al. 2020). A soft diet tailored to patients needs can help in provision of required energy and nutrients and replenish the losses (Mahan and Raymond 2016b).

Mild and moderate pneumonia is indicated by symptoms like: dyspnea, hypoxemia, shortness of breath, tachycardia, are few of the most common manifestations of advanced cases of COVID-19. Nutritional factors like serum albumin and cholesterol have also been found to be associated with the severity of pneumonia (Akuzawa and Naito 2015).

Critical illness due to COVID-19 lead to ARDS, organ failure

ALI and ARDS are characterized by a pro-inflammatory response associated with hyper catabolism that could lead to significant nutrition deficits. Nutrition support is necessary to prevent cumulative caloric deficits, malnutrition, loss of lean body mass, and deterioration of respiratory muscle strength. Furthermore, early delivery of enteral nutrition has been associated with the modulation of stress and the systemic immune response as well as the attenuation of disease severity (Krzak et al. 2011).

Lung injury Microvascular permeability as a result of the endothelial injury can facilitate viral invasion. Antioxidants in the serum such as vitamins A, C and E, and β -carotene, in addition to other red blood cell components provide antioxidant protection of the luminal pulmonary endothelial membrane from the effects of blood-derived oxidants (Pacht et al. 2003;Voelkel and Rounds 2009).

Oxidative stress

Several comorbidities seen during COVID-19 severe illness are being linked with oxidative stress as well as depletion of vitamin C among other factors (Delgado-Roche and Mesta 2020;Polonikov 2020). Vitamin C is a known antioxidant and a clinical trial is underway for estimating efficacy of its clinical doses (Carr 2020). Prophylactic intake of vitamin C within safe limits to prevent or manage COVID-19 are suggested by several nutrition experts (Calder, Carr, Gombart, & Eggersdorfer 2020;Hemila and Chalker 2020;Kim and Yeom 2020).

Cytokine storm

Inflammation usually solves at the end of the immune response, due to initiation of a particular negative-feedback mechanisms. But in certain cases this negative feedback system may not be efficient. Cytokine storm, is a derangement of immune response where the body starts to attack its own cells and tissues rather than just fighting off the virus. Like several other infections, cytokine storm is also identified in COVID-19 and is considered to be a possible cause of organ damage and death. Several nutrient related mechanisms can lower viral replication rates and reduce the concentrations of pro-inflammatory cytokines, as well as increase the concentrations of anti-inflammatory cytokines. Vitamin D is identified as potential moderator of cytokine storm (Grant, Lahore, McDonnell, Baggerly, French, Aliano, & Bhattoa 2020b).

Zinc possesses anti-inflammatory activity by inhibiting signaling and modulation of regulatory T-cell functions that may limit the cytokine storm in COVID-19. Improved Zn status may also reduce the risk of bacterial co-infection by improving mucociliary clearance and barrier function of the respiratory epithelium, as well as direct antibacterial effects against *S. pneumonia* (Skalny, Rink, Ajsuvakova, Aschner, Gritsenko, Alekseenko, Svistunov, Petrakis, Spandidos, & Aaseth 2020).

The omega-3 fatty acids present at the site of inflammation, along with others mechanisms, contribute to resolve the inflammation and to support healing.

Nutritional deficiencies may be responsible delayed or suboptimal resolution of inflammation and timely nutrition support has a potential to prevent these damages.

Discussion

The review of evidence provides strong possibilities for the role of individualized aggressive nutrition care in influencing the clinical course of infections. Responding to emergent nutritional needs of COVID-19 patients can support other treatment modalities in decreasing severity and mortality of COVID-19. Due to similarities in basic pathophysiology of immune response, inflammation and organ injuries observations made by researchers about role of nutrition could be applicable to COVID-19 also. Using nutrient in pharmaceutical doses requires approval for drug regulatory authorities while prescribing doses within upper safe limits in order to correct or prevent deficiencies does not. Dietary recommendations and Nutrition supplements providing nutrients with the upper limit of RDI does not even need a prescription.

Non critical patients could benefit from nutrition care by qualified dietitian, who can assess their emergent nutritional needs and design intervention for responding to those needs. Among critically

ill patients higher pharmacological doses of required nutrients can be given after weighing potential benefits and risk by the health care team. Ignoring emergent nutrition care needs could be seen as a harm-inflicting negligence.

Conclusion:

In Pakistan and other developing countries, majority of people are likely to be deficient in several nutrients. With existing deficiencies or depleted stores, their need for nutrition support is much more critical than in developed countries. Aggressive nutrition support has promising potential to decrease the severity of COVID-19 and mortality.

Recommendation

In developing countries like Pakistan, relative focus on nutrition support as a measure of controlling the negative impact of Pandemic is much greater than in developed countries. Robust nutrition care must be assured for all high risk groups including frontline and key workers, aggressive mass education is needed to guide public behavior and socioeconomic interventions are needed to assure access to and availability of needed foods.

Chapter 6

Role of Food and Nutrition security in managing the COVID-19 induced personal stress, and socioeconomic challenges

Position statement:

Appropriate food and nutrition can support an individual's as well as a nation's efforts to survive the physiological, psychologic and economic impact of COVID-19 pandemic, by building morale, enhancing vitality and optimizing productivity. Individuals, family and governments in the developing countries must prioritize optimal nutrition in order to have the best possible quality of life during and after the pandemic. This can only be done by exploiting technical knowledge and skills to make the best use of available resources.

Introduction

Association between diet and physical and mental health are well established (Briguglio et al., 2020). Any disruption in supply of nutrients and quality of diet can influence peoples' wellness and productivity. COVID-19 pandemic has already had a great impact on people's life and exposed them to various kind of stresses) (de Quervain et al., 2020; Xiang et al., 2020). Physical, mental and economic stresses are inter-related and can impact each other. Pre-existing food insecurity could make the outcome of infection and the pandemic more devastating.

Objective:

This review aimed at collating evidence about potential role of food security and various dietary components in preventing catastrophic impact of COVID-19 pandemic on human lives and wellness.

Results

Impact of diet on physical and mental health is an established fact. Recent research evidence also supports the role of pre-existing nutritional status and nutrition interventions in maintaining or restoring physical and mental health. A few of the established associations between dietary components and physical and mental health are given below.

Water Soluble Vitamins.

Thiamine.

Lack of thiamin leads to lethargy (Wildman 2018), low morale and depression (Pourhassan, Angersbach, Lueg, Klimek, & Wirth 2019). Large proportion of Thiamine is lost during cooking (Liu et al. 2019). Pakistanis mainly eat cooked foods so they are likely to be deficient and can benefit greatly by correction of deficiency by diet or supplements where needed. Public awareness about eating fresh foods and sensible cooking are needed to assure good thiamin status of Pakistanis.

Riboflavin.

Riboflavin is an antioxidant which may prevent lipid peroxidation and reperfusion oxidative injury. It may also exert a neuroprotective effect in some neurological disorders through its role in some pathways that are hypothesized to be impaired in neurological disorders (Saedisomeolia and Ashoori 2018). Ultraviolet light is known to destroy riboflavin. (Korus 2020).

Niacin.

Niacin deficiency leads to Pellagra which is characterized by triad of dermatitis, diarrhea and dementia. Central nervous system involvement symptoms include confusion, disorientation and neuritis (Mahan & Raymond 2016).

Vitamin B6.

Inadequate levels of PLP (Pyridoxal phosphate), the active form of vitamin B6 in the brain cause neurologic dysfunction, particularly epilepsy (Mahan & Raymond 2016a). Deficiency of this vitamin causes Dermatitis, Glossitis and Convulsions (Wildman 2018). Canning vegetables may destroy more than half of the vitamin due to the heating process. Freezing vegetables may destroy up to 1/3rd of it (Kondjoyan et al. 2018). Therefore, it is best to store them at room temperature and Keep them in light-resistant containers Preferably without freezing.

Folate

Deficiency can lead to megaloblastic anemia. Diarrhea and Fatigue are the major problems caused by deficiency of folate (Mann and Truswell 2017). Deficiency of folate can also cause Depression and confusion (Wildman 2018). Folate can be easily destroyed by heat (Moll and Davis 2017). Therefore, fruits and vegetables should not be overcooked.

Vitamin B12

Deficiency of Vitamin B12 can cause Megaloblastic anemia (Mahan & Raymond 2016a), Impaired mentation and depression. If prolonged, cause permanent nerve damage (Mahan & Raymond 2016a). Vitamin B-12 is stable and does not breakdown even at the boiling point of water for several hours (Moll & Davis, 2017).

Vitamin C

Vitamin C is essential for the biosynthesis of collagen, catecholamines, L-carnitine, cholesterol, amino acids, and some peptide hormones. Its deficiency causes blood vessel fragility and connective tissue damage. In addition, vitamin C affects the nervous system. (Mann & Truswell, 2017). Its deficiency may also cause anxiety (Braun & Chadwick, 2019). Vitamin C is sensitive to light, heat, and air and can be destroyed during food preparation, cooking, or storage (Armstrong, Jamieson, & Porter, 2019).

Fat Soluble Vitamins.**Vitamin A**

Vitamin A has essential roles in vision and various systemic functions, including normal cell differentiation and cell surface function. It is stored in the body and very high levels can cause toxicity. Acute vitamin A deficiency is treated with large oral doses of vitamin A. When the deficiency is part of concomitant PEM, the malnutrition must be treated for the patient to benefit from vitamin A treatment (Mahan & Raymond, 2016).

Vitamin D

Vitamin D besides supporting bone health, may also help in maintaining immunity, vascular function, and cardio myocyte health and reduces inflammation and insulin resistance (Mahan & Raymond, 2016). It could also improve the symptoms of patients with Psychiatric problems (Jamilian et al., 2019). Excessive intake of vitamin D can produce intoxication (Mahan & Raymond, 2016).

Vitamin E

Vitamin E protects the body from the damaging effects of reactive oxygen species. Its deficiency causes Muscle weakness, visual disturbance, loss of deep tendon reflexes, impaired vibratory and position sensation, changes in balance and coordination (Mahan & Raymond, 2016). It is destroyed by rancidity of the fats (Mahan & Raymond, 2016).

Vitamin K

It plays a role in blood clotting, bone formation, and regulation of multiple enzyme systems. Impaired blood clotting is a sign of vitamin K Deficiency (Wildman, 2018). Vitamin K also regulates enzymes involved in sphingolipid metabolism in the brain, as well as other enzyme systems. Freezing foods may destroy vitamin K, but heating does not affect it. It is not destroyed by cooking, but light can cause some loss of its effects (Wildman, 2018).

Minerals.

Calcium

Calcium in addition to its crucial role in building bones and teeth, also has numerous critical metabolic roles in cells in all other tissues. Calcium is required for nerve transmission and regulation of heart muscle function. In addition, calcium ions play a critical role in smooth muscle contractility. Its deficiency may lead to weakness of bones and Tetany (Mahan & Raymond, 2016). Phytic acid and oxalic acid, found naturally in some plants, bind to calcium and can inhibit its absorption (Sirohi & Pundhira Ghosh, 2018). Therefore, foods with high levels of oxalic acid include spinach, collard greens, sweet potatoes, rhubarb, and beans; they should not be taken at the same time as calcium rich foods.

Phosphorus

Phosphorus participates in numerous essential functions of the body. Since it is found in many foods, its deficiency is rare. However, if it occurs due to use of phosphate binders or very poor intake, effects of phosphorus deficiency can be widespread, and ultimately may have muscular, skeletal, hematologic and renal abnormalities, leading to fatal consequences. Neurological abnormalities may also occur due to deficiency of phosphorus (Mahan & Raymond 2016a).

Iron

Deficiency of iron can lead to anemia, fatigue, decreased resistance to infection, (Mahan & Raymond, 2016). Lack of concentration and focus, and impaired cognitive functions may also occur (Pivina et al. 2019). Absorption Inhibiting factors are plant components in some vegetables, tea and coffee (e.g., polyphenols, phytates), and calcium (Ahmad Fuzi et al. 2017). Absorption enhancing factors are ascorbic acid and meat, fish and poultry (Ahmad Fuzi, Koller, Bruggraber, Pereira, Dainty, & Mushtaq 2017).

Magnesium

Magnesium is a cofactor for more than 300 enzymes involved in the metabolism of food, synthesis of fatty acids and proteins and several other mechanisms. Magnesium plays a role in neuromuscular transmission and activity. (Mahan & Raymond 2016a).

Macronutrients.

Carbohydrates

Deficiency of carbohydrates can cause lethargy as this is the major fuel of the body (Mahan & Raymond 2016a). Its deficiency can also cause poor memory and impaired brain function (Fioramonti and Pénicaud 2019).

Fats

As the most energy dense macronutrients, fat provides protection to vital body organs and insulate the body (Mahan & Raymond 2016). Studies have concluded both in favor and against the association between fat consumption and brain functions (Chianese et al. 2018) .

Protein

Protein is essential for normal growth and development and also required for optimized immunity. Low levels could lead to depression as Dopamine and Serotonin (neurotransmitters) will not be produced in enough quantities (Oh et al. 2020).

Discussion

Building morale and assuring optimum quality of life during the difficult times is essential for prosperity of individual, community, nation, and the world. Thus, role of assuring adequate consumption of wholesome and nutritious food needs to be highlighted and facilitated at all levels.

During the pandemic all would benefit from a better mental health and higher morale but those infected are more in need a high morale to combat the infection. Depression has been observed to enhance infection associated risks; it needs to be prevented amidst this pandemic by all possible actions. Nutritious diet can surely support these efforts. Due to additional risks, crucial need for maintenance of health and morale during pandemic is also evident. In countries like Pakistan where food insecurity is high (State Bank of Pakistan 2019) and quality of diet is generally poor, nutrition interventions that can improve the quality of diet can play an important role in prevention associated with further deterioration of psychological well-being.

Pandemic itself can expose people to food insecurity. Poverty and malnutrition are known to be synergistic. Developing nations may enter into a downward spiral of food insecurity, loss of productivity and poverty. Robust and aggressive intervention to optimize food and nutrient intake can have short and long term positive impact at individual as well as national level. For improving the nation's health access to health care, as well as a strong focus on the core elements of prevention, including nutrition are needed (Blankenship et al. 2019).

Threat of increase in food insecurity (The Lancet 2020) combined with expected long tenure of the pandemic highlights the need of urgent measures to preserve and enhance people's nutritional status. Else, for LMICs this pandemic can trigger a steep downward spiral of malnutrition, infection, poverty and food insecurity. Investing in nutrition is the critical control point that can containing the hazardous impact of COVID-19 on LMIC's economy and people's well-being.

Investment in food security has potential to mitigate the course of the pandemic however this potential is yet to be appreciated. In relation to mitigating the course of the pandemic it has been noted that "Government communication strategies to keep the public informed of how best to avoid infection are vital, as is extra support to manage the economic downturn" (The Lancet 2020). Realization of an urgent need to optimize food and nutrition security can help in mitigating the hazards of infection as well in curtailing the economic downturn.

Conclusion

Among people who have not been consuming adequate diets, improvement of diets amidst this pandemic can be very useful in enhancing quality of life. The role of adequate consumption of wholesome and nutritious food needs to be highlighted and facilitated at all levels. In a developing country such as Pakistan, focus on dietary choices and nutritional status of individuals will definitely bring a positive impact on physical and mental health of people amidst and after COVID-19 Pandemic .

Part 2: Guidelines and Recommendations

Chapter 7

Guidelines for provision and selection of safe food?

Introduction:

Food and related items that have been exposed to human fluids or excretions, like other surfaces, may be a source of transmission of SARS-COV2. Availability of low risk foods in the market and consumers' awareness about importance and techniques of selecting safe foods can support other efforts being made to reduce COVID-19 related morbidity and mortality. This review aims at exploring available evidence and general observations to devise population specific guidelines and public messages for use in Pakistan.

Objective

To develop evidence based guidelines for provision and selection of safe food amidst situations like COVID-19 Pandemic

Methods:

Based on conclusion drawn in article one and two, and further review of guidelines developed by international agencies, we enlisted the basic scientific fact about mode of transmission of SARS-COV2. we and developed overarching guidelines and public messages for use in developing countries. Food production, transportation and selection related situation in developing countries like Pakistan was kept in mind while developing the guidelines.

Result:

SARS-COV2 can be transmitted through food and related items only if the same have been exposed to fluids or excretions from the infected person. Exposure to virus is feasible if the infected person coughs or sneezes near food or touched the hands that have remnants of infected persons' excretions. Transmission of virus through these exposed foods to consumers is feasible only if it reaches the consumer within a short period of time. Infectivity of the corona viruses on food and related substances depends on type of surfaces, temperature and humidity of the environment and time elapsed between exposure to virus and handling by the consumer. Higher absorbency of the surfaces, higher temperature and humidity, longer duration of transit time, and treatment with acids, rubbing alcohol or strong alkalis decrease or diminish the infectivity of the virus (Islam et al. 2020;Ren, Wang, Hao, Zhang, Wang, Chen, & Gao 2020;van, Bushmaker, Morris, Holbrook, Gamble, Williamson, Tamin, Harcourt, Thornburg, Gerber, Lloyd-Smith, de, & Munster 2020).

Food production and distribution practices vary widely in various areas of Pakistan. A large proportion of food items are produced and distributed without any formal quality control measures. Thus making accurate estimates of the risk of exposure of food to virus and surviving of virus at the time when it reaches the retailer or consumer is not easy. Virus on exposed foods may lose its infectivity due to high and humid environments but may again get laden with virus due to exposure at the retailers' outlets.

Food items produced by large companies are expected to follow good manufacturing practices, require a longer time to reach the consumer and are packaged before distribution. These factors decrease the chances of exposure of food to the virus and increase the chances of inactivation of the virus before it reaches the consumer. However, risk of exposure of unpackaged food and outermost layer of packaging's in case of packed food depends on the conditions of the retailer's outlets. Due to widespread denial of the risks from COVID-19, presence of infected person in the markets is high. Social distancing and safety precautions are not taken even in most of the food outlets where the food produced by large companies is sold, thus exposure at retailers' outlets are great.

Recommendations

Based on the above mentioned situations following actions by the food producers and retailers can decrease the risk of COVID-19 from food and related substance

1. Any person coming within six feet of the food being produced and distributed must be free from any kind of cough, cold or flu and use face masks during their period of close proximity to foods
2. Any person coming within six feet of the food being sold in large or small market, shops or kiosks must be free from any kind of cough, cold or flu and use face masks during their period of close proximity to foods.
3. Consumers should be given a limited time to stay near the foods and unnecessary touching of foods should be discouraged.

Based on the above mentioned situations following actions by the restaurants and consumers can decrease the risk of getting food that have been exposed to COVID-19 virus

1. No non-living food item is to be avoided due to fear of COVID-19 infection. All food including meats can be bought and eaten during this pandemic
2. Persons going to buy food should disinfect their hands and use face masks.
3. Buy from places that are less crowded, where workers use face masks and the retailer practice and support social distancing and use of face masks.
4. Be more careful in case of foods that are to eaten raw, cannot be exposed to high temperatures or can't be treated with any disinfectant.
5. Cooked food bought soon after cooking has least chance of having infective viruses
6. Cold foods and salads prepared by workers who maybe a carrier of virus have chance of having infective SARS-COV2
7. Virus on plastic packaging will remain live for a longer period of time than paper packaging. Packages having outermost layer of paper are safer than the packing having outer most layer of plastic.

Dine in and Delivery of Food

- We discourage or prohibit dining in congregate settings. We also recommend discontinuing salad bars and buffets.
- Discard packaging of delivered cooked food and transfer into plate and wash hands thoroughly with soap and water.
- This virus is killed during cooking. Therefore, it is advised to eat cooked foods and avoid salads or raw foods that have no cooking process involved as we are not sure how the food was handled and whether hand washing practice was properly done.

Drinking Water and COVID-19

- COVID-19 has not been detected in drinking water. CV is not present in ground water or transmitted through contaminated drinking water (Organization, 2020)

Chapter 8

Guidelines for safe food management by consumers

Introduction:

The current literature is based on identification of the risks and critical points involved in the transmission of COVID-19 through food handling process in developing countries like Pakistan. Although no food borne outbreak of COVID-19 has been reported in the U.S. and other developed countries, neither any evidence has been developed regarding multiplication of COVID-19 virus within food during food handling processes.

However, developing countries like Pakistan has different food handling practices as compared to developed countries throughout food chain and needed to be considered as risk for transmission of COVID-19 and must adopt safe food handling practices.

Objective

To develop evidence based guidelines for safe food management by consumers amidst situations like COVID-19 Pandemic

Method:

Based on conclusion drawn in article one and two and further review of guidelines developed by international agencies, we enlisted the basic scientific fact about mode of transmission of SARS-COV2 and developed overarching guidelines for food management by consumers in developing countries. Food handling and preparation related situation in households of developing countries like Pakistan was kept in mind while developing the guidelines.

Results:

The researched articles described that there exist chances of survival of the virus on surfaces for up to 72hrs. This indicates that equipment, cooking utensils, packaging material and most importantly food handlers could be potential risk factors for transmission of COVID-19. In food handling process, considering the temperature, type and time of exposure of the surface with actually or possibly infected person can help in risk assessment. To reduce the overall risk, it has been advised by scientific reports to follow safe food handling practices at both household and industrial levels.

In Pakistan, there exists considerable chances of transmission of COVID-19 during food handling operations due to poor food handling practices in majority of the households and food industries.

Most of the foods available in local markets of developing countries have fair probability of having been exposed to human fluids or excretions. Amidst the current state of COVID-19 pandemic when neither vaccine nor treatments are available, any possible measures that can reduce the risk of transmission need to be taken. Risk of food related transmission of SARS-COV2 can be reduced by adoption of appropriate food management practices by the consumers. Knowledge about survivability of coronaviruses can guide in identifying the actions that can be taken by the consumer. Risks can be reduced by discarding outer most layer of packaging, washing and scrubbing hard surfaced foods, avoiding contact with food or packaging during the period of infectivity of the virus, and thorough cooking of food. Hand washing before and after contacting any food or food related item e.g. utensils,

and avoiding household level exposure of food and related items to the virus do remain the most important elements of safe food management practices.

Following best possible safety guidelines and providing sufficient awareness to the public about safe food handling practices can ensure exclusion, reduction and minimization of the spread of COVID-19 from food chain and food handling process in Pakistan.

Recommendations:

Based on scientific knowledge about survivability and inactivation of SARS-COV2 following actions could be taken by the consumer during food handling to minimize the risk of transmitting the virus from food related surfaces to humans.

1. When you come home from shopping, you should place the shopping bags on the floor and first wash your hands.
 2. Wash your hands again after food has been stored.
 3. If the shopping bag touched the counter or a surface, clean the surface with a sanitizing wipe or solution.
 4. Wash hands thoroughly before starting any food related activities
 5. Wear mask during food handling, washing and storing food or utensils
 6. Washing utensils with soap and warm water can remove any virus from its surface
 7. Counter tops and other surfaces can be cleaned with appropriate disinfectant
 8. Provide sufficient heat to meat so that it is well done.
 9. People having any symptom of COVID-19 or suffering from any other disease/infection should avoid entering the kitchen
 10. Avoid unnecessary movement in kitchen and practice social distancing
 11. Prevent contamination of animal based food with other food material by keeping them separate and covered
 12. Wash fruits and vegetables thoroughly with clean water especially if you eat them raw and they are not going to be cooked.
 13. If there is a firm surface, such as on apples or carrots, the surface can be scrubbed with a brush under running water without using soap.
 14. Do not use soap, sanitizers, disinfectants, acids, any other chemical or a bleach solution on food.
 15. Detergents and bleach solutions are approved for surface application and are not meant to be consumed or used on food. Also it can cause health hazards. Washing your fresh produce in these solutions can make you sick.
 16. It is not advisable to try to clean and sanitize food packages before opening due to the risk of leaving chemical residues in the food.
 17. It is best to wash your hands frequently, especially before and after handling food and after removing packaging materials.
 18. Before eating, wash your hands with clean water and soap for a minimum of 20 seconds.
 19. During eating, cover your mouth and nose when coughing and sneezing
 20. If someone shows any symptoms of respiratory illness such as coughing and sneezing, separate their utensils and serve them separately
-

Chapter 9

Guidelines for Combating COVID-19 Infection Through Food and Nutrition

Introduction:

The COVID virus presents us with many uncertainties. Since there is no cure currently available cure for this infection, it has drawn the attention of the world to build up immune systems. As we know, good immunity protects us from catching infections. And no specific diet or super food can prevent it. Therefore, it is important to follow a healthy diet and maintain overall health is important in protecting health and immunity.

The emerging evidence on COVID-19 highlights the relevance of nutrition in determining health outcomes, we do not know exactly what dietary factors can contribute in preventing infections like COVID-19, but we do know that a healthy diet and other factors can keep immune functions strong. A healthy diet consists of a diet rich in fruits, vegetables, whole grains, proteins, fibers. Exercise, adequate sleep patterns, stress management and no smoking also can contribute to functioning the immune system properly.

Objective

To develop Guidelines for low income countries like Pakistan for combating COVID-19 infection through Food and Nutrition

Method:

Based on conclusion drawn in article no 3 to 6 and further review of guidelines developed by international agencies we developed overarching guidelines and public messages about “food and nutrient intake during COVID-19”, for use in developing countries. Nutritional status and food habit of people in Pakistan and similar developing countries was kept in mind while developing these public messages.

Results

Nutrition is a key determinant of health. More importantly, nutrition is part of the treatment regimen for acute and chronic diseases and applies particularly to ailments for which an etiologic treatment has not yet been discovered and validated like COVID-19. Therefore, verification of the nutritional status of COVID-19 infected patients before, during and after the administration of general treatment and providing appropriate nutrition and dietetics interventions is important (ASPEN 2020; Barazzoni, Bischoff, Breda, Wickramasinghe, Krznaric, Nitzan, Pirlich, & Singer 2020). The use of a normal modified diet as the base for any nutrition management is encouraged.

While proper nutrition and hydration improve health and immunity, they are not magic bullets. People living with chronic illnesses who have suspected or confirmed COVID-19 may need support with their diet to ensure they keep in good health.

All the identified articles were read thoroughly to find scientific information that could answer our research questions. No particular food was found anywhere during the search that could prevent or treat the infection from COVID-19. No alternative medicine or other herbal supplement is yet found

to protect the human body from invasion of COVID-19 virus or from severity of the disease. Use of self-prescribed, non-evidence based herbal treatments, may increase the risk of severity and mortality (NIH-NCCIH 2020).

We found that nutrition is the part of the treatment during illness and healthy diets can help one from fighting infections by building immune systems strong. Therefore, it is indicated by scientists that keeping up health with balanced healthy eating which includes nutrients from all food groups, along with other lifestyle factors like physical activity, cessation of smoking, and limitation of alcohol, managing stress and good sleep can help one fight the disease (Laviano et al. 2020)

While no particular component of diet alone has yet found to cure the disease, in general, people who are malnourished and deficient in nutrients are observed to face more severe symptoms and greater risk of mortality. Observations regarding COVID-19 also have indicated some role of nutritional status and nutrition interventions in better management of disease.

Almost all guidelines for nutrition during COVID-19 include assessment of nutritional status and supplementation to correct nutritional deficiencies. Many nutrition experts have suggested higher than usual intake of vitamin D, vitamin C and omega-3 fats for combatting COVID-19 (Calder, Carr, Gombart, & Eggersdorfer 2020).

In view of quality of diets in Pakistan, vast majority of population would benefit from a more adequate diet. Among the infected ones, correction of nutrition deficiencies can be a crucial factor in determining clinical course of the infection.

COVID-19 like other diseases influences the nutritional needs that differ according to severity of symptoms. Fulfillment of these disease induced needs is crucial for supporting medical management of the disease.

In view of the above we believe that in Pakistan there is crucial need for improving diets and assuring best possible nutrition care of hospitalized patients for supporting the efforts to combat the pandemic. Recommendation and guidelines that we consider to be useful in various situation are as follows:

Recommendations:

For Government

Government must ensure food security at national level by keeping the food prices low and provision of food rations on a regular basis to those who can't afford to buy.

Government must protect ongoing nutrition related projects on malnutrition and micronutrient deficiencies and provide special considerations to areas affected with COVID-19 and experiencing lock down.

Government should promote the consumption of natural foods by lowering the prices of fruits and vegetables which is usually unaffordable for the underprivileged.

For Hospitals:

Nutrition screening and assessment should be a policy for patients diagnosed with COVID-19.

Hospitals should ensure provision of adequate nutrition to all patients diagnosed with COVID-19.

Appropriate mode of nutrition should be provided depending on the condition of patients under care of dietitians.

Micronutrient deficiencies should be addressed during treatment to prevent further health deterioration.

Education for home and rehabilitation plans should be given to patients and family especially with co-morbidities and those at risk.

Public messages

- **FOR EVERYONE:**

1. We must practice social distancing and proper food safety and personal hygiene for keeping the virus away as no food or nutrient can alone prevent or cure COVID-19
2. Eating a healthy diet can help in making you physically and mentally strong and support your system in combatting the virus if it enters your body.
3. Variety is the most important characteristic of a healthy diet.
4. Try to include some uncooked plant foods like salads and fruit in your diet every day and if possible at each meal. Fruit need not be expensive ones, guava, 'amla', 'berries', all count as very nutritious fruits.
5. Try to include some dark n leafy vegetable in your diet every day. Wash the vegetables before chopping because washing after chopping incurs loss of water soluble vitamins. Do not cook these vegetables for a long time and try to eat it freshly cooked so that you don't have to reheat. Each time you heat it some of the vitamins are lost.
6. Try to include 1-2 servings of milk or its products like yogurt in your daily diet. If you can't take this amount each day, try to eat smaller amount each day instead of large amounts on one day and nothing on other days.
7. Try to include lentils, egg or meat at most meals of a day. Try to eat smaller amount of dal, egg or meat at each meal instead of large amounts at one meal and nothing on other days.
8. While cooking vegetables try to combine starchy and non-starchy vegetable in one dish and avoid eating only starchy vegetables with rice or roti.
9. Eat different vegetables like gourds, cucumber, beans, okra and brinjal, cauliflower, cabbage, lettuce, spinach, onion, potato, carrot, radish, turnip, coriander, fenugreek and peas.
10. Avoid using Vanaspati ghee and oils that are semi solid at room temperature. Use canola or soybean oil for cooking.
11. Limit your intake of fats, and salt. Try to avoid eating too much of these ingredients across everything you eat. People eating roti with gravy are just eating roti with fats, salt and spices. Thus make sure that all family members eat some vegetable, dal or meat with roti or rice.
12. Most adults and children need to limit their intake of sugar also. Even at lower income group some people put too much sugar in tea and take several cups in a day. This lead to consumption of a lot of empty calories and make the diet less healthy.
13. Drink water regularly through drinking enough amounts of plain water (6-8 glasses a day for most adults).
14. Limit consumption of alcoholic beverages as these contain very little nutrition value and are linked to many health problems.
15. Expose yourself to sunshine as it helps in making of vitamin D in our bodies. People with dark complexion and women who cover their faces may need more time in the sun.
16. If for any reason you can't eat a balanced diet, you can take supplements after consulting your physician, to assure provision of required nutrient to your body.
17. For those who are overweight or obese reducing weight without depleting body's protein, vitamin and mineral resources can better prepare them for combatting COVID-19.

- **Diet for high risk groups**

18. People who are at should follow all the guidelines for general population more actively.

19. Taking nutrition supplements is important for people who are at high risk of getting COVID-19 and have not been taking adequate diet.

- ***Diet for non-hospitalized COVID-19 patients***

Along with following dietary recommendations for higher risk groups non-hospitalized COVID-19 patients need better nutrition care to assure supply of required nutrients.

For Non-hospitalized COVID-19 patients Nutritional needs and mode of supply of those nutrients would differ according to type and severity of symptoms. Fulfilling nutritional needs may be a challenge due to isolation. All such patient must have access to advice form dietitians, so that they may get individualized guidance if needed.

General dietary recommendation for all Non-hospitalized COVID-19 patients would include the following:

Take good care of hydration and try to drink water or clear liquid fluids frequently. Try to drink 60–120 ml (¼ to ½ Cup) of fluid every 15 minutes, drink small sips of liquids every few minutes if cannot drink large volumes of liquids at one time. Use a variety of liquids to avoid taste fatigue and keep liquids bedside to sip during the night. In case of vomiting or diarrhea, make sure to use an oral hydration solution in addition to water.

Eat easily digested freshly cooked or properly refrigerated foods to minimize chance of gastro intestinal problems. GIT problem can make you weaker and put extra demand on your body's resources that are required for combating the infection.

Avoid foods that can irritate mucous membranes like very cold, very hot, or very spicy foods.

Fats provide a lot of energy in a small amount. In general, high fat intake is not healthy. But if someone is unable to eat enough food to fulfil energy requirements through regular diet, the amount of fats in the diet needs to be increased. Easily digestible healthy fats can be added in foods to fulfil the energy requirement.

Eating whole fruit is better for people who can eat a normal diet. But during infection if normal amount of food cannot be eaten, fruit juices can be given

Frequent intake of sugary foods is not considered healthy. But during infection if normal amount of food cannot be eaten, milk shakes, desserts can be given to provide required nutrition through small amount of food.

Protein are required for almost all biochemical functions including immune functions. Due to infection and poor food intake body may lose its protein reserves. Animal protein that is found in milk, eggs, yogurt, cheese, meat/fish/poultry can fulfil the requirement with smaller amount of foods.

COVID-19 can be accompanied by nausea, vomiting and diarrhea. This can impair food intake, digestion, and absorption. Thus a good nutritional status is an advantage for people at risk of severe COVID-19.

- ***Nutrition for hospitalized patients***

ESPEN's recommendations (Barazzoni, Bischoff, Breda, Wickramasinghe, Krznaric, Nitzan, Pirlich, & Singer 2020) indicated below needs to be applied for all hospitalized patients in Pakistan also

- ***For Nutrition for Hospitalized patients in ward***

1. All COVID-19 patients need to be screened for presence of pre-existing malnutrition by using standardized tools

2. Individualize nutrition care by qualified dietitian should be provided to all hospitalized patients having pre-existing malnutrition
3. Sufficient supplementation with vitamins and minerals to correct deficiencies and assure adequate reserves
4. Using oral nutritional supplements (ONS) to assure provision of required energy and nutrients,
5. Apply early enteral feeding
6. Consider parenteral nutrition where provision of adequate amount of required feeds is not feasible via enteral nutrition

- ***Nutrition for hospitalized patients in ICU***

7. Patients who cannot eat enough to fulfil energy needs, oral nutritional supplements (ONS) should be given. If energy needs are still not met enteral feeding should be started. If enteral feeding is not feasible or effective enough to fulfil energy needs, peripheral parenteral nutrition could be advised.
8. In COVID-19 intubated and ventilated ICU patients, enteral nutrition (EN) should be started through nasogastric or post-pyloric feeding even if the patient is to be kept in the prone position.
9. Parenteral nutrition may be considered if Patient does not tolerate full dose enteral nutrition (EN) during the first week in the ICU, and all strategies to maximize EN tolerance have been attempted.
10. In ICU patients with dysphagia, if swallowing is proven unsafe, EN should be administered.

- ***Diet during convalescence***

11. ICU stay has impact on patients' physical and mental health. It can affect their long-term prognosis. Loss of skeletal muscle mass and muscle function is a major issue in patient who survive ICU stay. Physical activity with supplemental amino acids or their metabolites has a potential to have a positive impact.
12. Balanced healthy diet and safe use of supplements can help in regaining physical and mental health

–

References

- Academy of Nutrition and Dietetics. Evidence Analysis Library. <https://www.andeal.org/> . 2020.
- Adhikari, S.P., Meng, S., Wu, Y.J., Mao, Y.P., Ye, R.X., Wang, Q.Z., Sun, C., Sylvia, S., Rozelle, S., Raat, H., & Zhou, H. 2020. Epidemiology, causes, clinical manifestation and diagnosis, prevention and control of coronavirus disease (COVID-19) during the early outbreak period: a scoping review. *Infect.Dis.Poverty*, 9, (1) 29 available from: PM:32183901
- Ahmad Fuzi, S.F., Koller, D., Bruggraber, S., Pereira, D.I.A., Dainty, J.R., & Mushtaq, S. 2017. A 1-h time interval between a meal containing iron and consumption of tea attenuates the inhibitory effects on iron absorption: a controlled trial in a cohort of healthy UK women using a stable iron isotope. *The American journal of clinical nutrition*, 106, 1413-1421
- Akhtar, S. 2015. Food safety challenges--a Pakistan's perspective. *Crit Rev.Food Sci.Nutr.*, 55, (2) 219-226 available from: PM:24915401
- Akhtar, S. 2016. Malnutrition in South Asia-A Critical Reappraisal. *Crit Rev.Food Sci.Nutr.*, 56, (14) 2320-2330 available from: PM:25830938
- Akour, A. 2020. Probiotics and COVID-19: is there any link? *Lett.Appl.Microbiol.* available from: PM:32495940
- Akuzawa, N. & Naito, H. 2015. Nutritional parameters affecting severity of pneumonia and length of hospital stay in patients with pneumococcal pneumonia: a retrospective cross-sectional study. *BMC.Pulm.Med.*, 15, 149 available from: PM:26608261
- Arboleda, J. & Urcuqui-Inc. Vitamin D supplementation: a potential approach for COVID-19 therapeutics? <https://osf.io/> . 2020.
- Arkin, N., Krishnan, K., Chang, M.G., & Bittner, E.A. 2020. Nutrition in critically ill patients with COVID-19: Challenges and special considerations. *Clin.Nutr.* available from: PM:32425291
- ASPEN 2020, *Nutrition and Hydration: Key Weapons in the Fight Against COVID-19, Recommendations for Non-ICU COVID-19 Patients.*
- Atzrodt, C.L., Maknoja, I., McCarthy, R.D.P., Oldfield, T.M., Po, J., Ta, K.T.L., Stepp, H.E., & Clements, T.P. 2020. A Guide to COVID-19: a global pandemic caused by the novel coronavirus SARS-CoV-2. *FEBS J.* available from: PM:32446285
- Azzolino, D., Arosio, B., Marzetti, E., Calvani, R., & Cesari, M. 2020. Nutritional Status as a Mediator of Fatigue and Its Underlying Mechanisms in Older People. *Nutrients*, 12, (2) available from: PM:32050677
- Barazzoni, R., Bischoff, S.C., Breda, J., Wickramasinghe, K., Krznaric, Z., Nitzan, D., Pirlich, M., & Singer, P. 2020. ESPEN expert statements and practical guidance for nutritional management of individuals with SARS-CoV-2 infection. *Clin.Nutr.* available from: PM:32305181
- Bjorklund, G., Dadar, M., Chirumbolo, S., & Aaseth, J. 2018. Fibromyalgia and nutrition: Therapeutic possibilities? *Biomed.Pharmacother.*, 103, 531-538 available from: PM:29677539
- Blankenship, J., Blancato, R.B., & Kelly, R. 2019. Quality Improvement as the Foundation for Health Care Advancement. *J Acad.Nutr.Diet.*, 119, (9 Suppl 2) S15-S17 available from: PM:31446939
- Braun, B.L., Fowles, J.B., Solberg, L., Kind, E., Healey, M., & Anderson, R. 2000. Patient beliefs about the characteristics, causes, and care of the common cold: an update. *J.Fam.Pract.*, 49, (2) 153-156 available from: PM:10718693

- Cai, C., Koch, B., Morikawa, K., Suda, G., Sakamoto, N., Rueschenbaum, S., Akhras, S., Dietz, J., Hildt, E., & Zeuzem, S. 2018. Macrophage-derived extracellular vesicles induce long-lasting immunity against hepatitis C virus which is blunted by polyunsaturated fatty acids. *Frontiers in immunology*, 9, 723
- Calder, P.C. 2020. Nutrition, immunity and Covid-19. *BMJ Nutrition, Prevention & Health* bmjnph-2020
- Calder, P.C., Carr, A.C., Gombart, A.F., & Eggersdorfer, M. 2020. Optimal nutritional status for a well-functioning immune system is an important factor to protect against viral infections. *Nutrients*, 12, (4) 1181
- Carr, A.C. 2020. A new clinical trial to test high-dose vitamin C in patients with COVID-19. *Crit Care*, 24, (1) 133 available from: PM:32264963
- Centers for Disease Control and Prevention. Food Safety and Coronavirus Disease 2019 (COVID-19). <https://www.cdc.gov/> . 5-11-2020.
- Chen, L., Hu, C., Hood, M., Zhang, X., Zhang, L., Kan, J., & Du, J. 2020. A Novel Combination of Vitamin C, Curcumin and Glycyrrhizic Acid Potentially Regulates Immune and Inflammatory Response Associated with Coronavirus Infections: A Perspective from System Biology Analysis. *Nutrients*, 12, 1193
- Chianese, R., Coccarello, R., Viggiano, A., Scafuro, M., Fiore, M., Coppola, G., Operto, F.F., Fasano, S., Laya, S., & Pierantoni, R. 2018. Impact of dietary fats on brain functions. *Current neuropharmacology*, 16, 1059-1085
- Coleman, C.H. 2020. Equitably Sharing the Benefits and Burdens of Research: Covid-19 Raises the Stakes. *Ethics Hum.Res.* available from: PM:32410347
- Damanti, S., Azzolino, D., Roncaglione, C., Arosio, B., Rossi, P., & Cesari, M. 2019. Efficacy of Nutritional Interventions as Stand-Alone or Synergistic Treatments with Exercise for the Management of Sarcopenia. *Nutrients*, 11, (9) available from: PM:31443594
- Delgado-Roche, L. & Mesta, F. 2020. Oxidative Stress as Key Player in Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) Infection. *Arch.Med.Res.* available from: PM:32402576
- Dietitians of Canada. PEN: Practice-based Evidence in Nutrition. <https://www.pennutrition.com/index.aspx> . 11-11-2020.
- EUROPEAN COMMISSION. COVID-19 and food safety Questions and Answers. https://ec.europa.eu/food/sites/food/files/safety/docs/biosafety_crisis_covid19_qandas_en.pdf . 8-4-2020. 28-5-2020.
- Feng, Y., Marchal, T., Sperry, T., & Yi, H. 2020. Influence of wind and relative humidity on the social distancing effectiveness to prevent COVID-19 airborne transmission: A numerical study. *J.Aerosol Sci.* 105585 available from: PM:32427227
- Fioramonti, X. & Pénicaud, L. Carbohydrates and the Brain: Roles and Impact *Feed Your Mind-How Does Nutrition Modulate Brain Function Throughout Life?* : . IntechOpen . 2019.
- Food Standards Agency. Guidance for food businesses on coronavirus (COVID-19). <https://www.gov.uk/government/> . 18-5-2020. 28-5-2020.
- Galanakis, C.M. 2020. The Food Systems in the Era of the Coronavirus (COVID-19) Pandemic Crisis. *Foods*, 9, 523
- Ginde, A.A., Mansbach, J.M., & Camargo, C.A., Jr. 2009. Association between serum 25-hydroxyvitamin D level and upper respiratory tract infection in the Third National Health and Nutrition Examination Survey. *Arch.Intern.Med.*, 169, (4) 384-390 available from: PM:19237723
- Grace, D. 2015. Food Safety in Low and Middle Income Countries. *Int J.Environ.Res.Public Health*, 12, (9) 10490-10507 available from: PM:26343693
- Grace, D., Dipeolu, M., & Alonso, S. 2019. Improving food safety in the informal sector: nine years later. *Infect.Ecol.Epidemiol.*, 9, (1) 1579613 available from: PM:30891162

- Grant, W.B., Lahore, H., McDonnell, S.L., Baggerly, C.A., French, C.B., Aliano, J.L., & Bhattoa, H.P. 2020a. Evidence that Vitamin D Supplementation Could Reduce Risk of Influenza and COVID-19 Infections and Deaths. *Nutrients*, 12, (4) available from: PM:32252338
- Grant, W.B., Lahore, H., McDonnell, S.L., Baggerly, C.A., French, C.B., Aliano, J.L., & Bhattoa, H.P. 2020b. Evidence that vitamin D supplementation could reduce risk of influenza and COVID-19 infections and deaths. *Nutrients*, 12, 988
- Hamid, S., Mir, M.Y., & Rohela, G.K. 2020. Novel coronavirus disease (COVID-19): a pandemic (epidemiology, pathogenesis and potential therapeutics). *New Microbes.New Infect.*, 35, 100679 available from: PM:32322401
- He, Y. & Zheng, C. 2020. [Replication and transmission mechanisms of highly pathogenic human coronaviruses]. *Zhejiang.Da.Xue.Xue.Bao.Yi.Xue.Ban.*, 49, (1) 0 available from: PM:32298055
- Hemila, H. & Chalker, E. 2020. Vitamin C as a Possible Therapy for COVID-19. *Infect.Chemother.* available from: PM:32410417
- Hemila, H. 2017. Vitamin C and infections. *Nutrients*, 9, 339
- Hendley, J.O., Abbott, R.D., Beasley, P.P., & Gwaltney, J.M., Jr. 1994. Effect of inhalation of hot humidified air on experimental rhinovirus infection. *JAMA*, 271, (14) 1112-1113 available from: PM:8151855
- Iddir, M., Brito, A., Dingeo, G., Fernandez Del Campo, S.S., Samouda, H., La Frano, M.R., & Bohn, T. 2020. Strengthening the Immune System and Reducing Inflammation and Oxidative Stress through Diet and Nutrition: Considerations during the COVID-19 Crisis. *Nutrients*, 12, (6) available from: PM:32471251
- Ilie, P.C., Stefanescu, S., & Smith, L. 2020. The role of vitamin D in the prevention of coronavirus disease 2019 infection and mortality. *Infectious Diseases*
- Iqbal, K., Islam, N., Mehboobali, N., Asghar, A., Iqbal, S.P., & Iqbal, M.P. 2019. Relationship of sociodemographic factors with serum levels of vitamin D in a healthy population of Pakistan. *Pak.J Pharm.Sci*, 32, (1) 29-33 available from: PM:30772787
- Islam, M.S., Rahman, K.M., Sun, Y., Qureshi, M.O., Abdi, I., Chughtai, A.A., & Seale, H. 2020. Current knowledge of COVID-19 and infection prevention and control strategies in healthcare settings: A global analysis. *Infect.Control Hosp.Epidemiol.* 1-11 available from: PM:32408911
- Jadoon, S.A., Ahmed, A., & Alam, M.A. 2018. Vitamin D Deficiency In Pakistan: Tip Of Iceberg. *J Ayub.Med.Coll.Abbottabad.*, 30, (1) 78-80 available from: PM:29504336
- Kaul, D. 2020. An overview of coronaviruses including the SARS-2 coronavirus - Molecular biology, epidemiology and clinical implications. *Curr.Med.Res.Pract.* available from: PM:32363221
- KaviyarasiRenu, Prasanna, P.L., & Abilash, V.G. 2020. Coronaviruses pathogenesis, comorbidities and multi-organ damage - A review. *Life Sci.* 117839 available from: PM:32450165
- Kim, H., Jang, M., Kim, Y., Choi, J., Jeon, J., Kim, J., Hwang, Y.i., Kang, J.S., & Lee, W.J. 2016. Red ginseng and vitamin C increase immune cell activity and decrease lung inflammation induced by influenza A virus/H1N1 infection. *Journal of Pharmacy and Pharmacology*, 68, 406-420
- Kim, S.B. & Yeom, J.S. 2020. Reply: Vitamin C as a Possible Therapy for COVID-19. *Infect.Chemother.* available from: PM:32468742
- Kondjoyan, A., Portanguen, S., DuchÃˆne, C., Mirade, P.S., & Gandemer, G. 2018. Predicting the loss of vitamins B3 (niacin) and B6 (pyridoxamine) in beef during cooking. *Journal of Food Engineering*, 238, 44-53
- Korakas, E., Ikonomidis, I., Kousathana, F., Balampanis, K., Kountouri, A., Raptis, A., Palaiodimou, L., Kokkinos, A., & Lambadiari, V. 2020. Obesity and COVID-19: Immune and metabolic derangement as a possible link to adverse clinical outcomes. *Am.J.Physiol Endocrinol.Metab* available from: PM:32459524
- Korus, A. 2020. Changes in the content of minerals, B-group vitamins and tocopherols in processed kale leaves. *Journal of Food Composition and Analysis* 103464

- Krzak, A., Pleva, M., & Napolitano, L.M. 2011. Nutrition therapy for ALI and ARDS. *Crit Care Clin.*, 27, (3) 647-659 available from: PM:21742221
- LaChance, L.R. & Ramsey, D. 2018. Antidepressant foods: An evidence-based nutrient profiling system for depression. *World J.Psychiatry*, 8, (3) 97-104 available from: PM:30254980
- Laviano, A., Koverech, A., & Zanetti, M. 2020. Nutrition support in the time of SARS-CoV-2 (COVID-19). *Nutrition* 110834 available from: PM:32276799
- Liu, K., Zheng, J., Wang, X., & Chen, F. 2019. Effects of household cooking processes on mineral, vitamin B, and phytic acid contents and mineral bioaccessibility in rice. *Food chemistry*, 280, 59-64
- Ma, X., Vervoort, D., Reddy, C.L., Park, K.B., & Makasa, E. 2020. Emergency and essential surgical healthcare services during COVID-19 in low- and middle-income countries: A perspective. *Int J.Surg.*, 79, 43-46 available from: PM:32426019
- Mahan, L.K. & Raymond, J.L. 2016a. *Krause's Food & the Nutrition Care Process, Mea Edition E-Book* Elsevier.
- Mahan, L. K. & Raymond, J. L. 2016b, "Medical Nutrition Therapy for Upper Gastrointestinal Tract Disorders," *In Krause's Food & the Nutrition Care Process, Mea Edition E-Book*, Elsevier.
- Mann, J. & Truswell, A.S. 2017. *Essentials of human nutrition* Oxford University Press.
- Mesa, V.C., Franco, O.H., Gomez, R.C., & Abel, T. 2020. COVID-19: The forgotten priorities of the pandemic. *Maturitas*, 136, 38-41 available from: PM:32386664
- Mikkelsen, K. & Apostolopoulos, V. 2019. Vitamin B1, B2, B3, B5, and B6 and the Immune System. *Nutrition and Immunity* 115-125
- Moll, R. & Davis, B. 2017. Iron, vitamin B12 and folate. *Medicine*, 45, 198-203
- Mullis, L., Saif, L.J., Zhang, Y., Zhang, X., & Azevedo, M.S. 2012. Stability of bovine coronavirus on lettuce surfaces under household refrigeration conditions. *Food Microbiol.*, 30, (1) 180-186 available from: PM:22265299
- Naeem, N., Raza, S., Mubeen, H., Siddiqui, S.A., & Khokhar, R. 2018. Food safety knowledge, attitude, and food handling practices of household women in Lahore. *Journal of Food Safety*, 38, (5) e12513
- Naja, F. & Hamadeh, R. 2020. Nutrition amid the COVID-19 pandemic: a multi-level framework for action. *Eur.J.Clin.Nutr.* available from: PM:32313188
- NIH-NCCIH. In the News: Coronavirus and "Alternative" Treatments. <https://www.nccih.nih.gov/> . 2020.
- Oberemok, V.V., Laikova, K.V., Yurchenko, K.A., Fomochkina, I.I., & Kubyshkin, A.V. 2020. SARS-CoV-2 will continue to circulate in the human population: an opinion from the point of view of the virus-host relationship. *Inflamm.Res.* available from: PM:32350571
- Odeyemi, O.A., Sani, N.A., Obadina, A.O., Saba, C.K.S., Bamidele, F.A., Abughoush, M., Asghar, A., Dongmo, F.F.D., Macer, D., & Aberoumand, A. 2019. Food safety knowledge, attitudes and practices among consumers in developing countries: An international survey. *Food Res.Int*, 116, 1386-1390 available from: PM:30716930
- Oh, J., Yun, K., Chae, J.H., & Kim, T.S. 2020. Association Between Macronutrients Intake and Depression in the United States and South Korea. *Frontiers in psychiatry*, 11, 207
- Pacht, E.R., DeMichele, S.J., Nelson, J.L., Hart, J., Wennberg, A.K., & Gadek, J.E. 2003. Enteral nutrition with eicosapentaenoic acid, gamma-linolenic acid, and antioxidants reduces alveolar inflammatory mediators and protein influx in patients with acute respiratory distress syndrome. *Crit Care Med.*, 31, (2) 491-500 available from: PM:12576957
- Pakistan Bureau of Statistics. Household Integrated Economic Survey (HIES) 2015-16. <http://www.pbs.gov.pk/> . 1-1-2020.

- Pakistan Bureau of Statistics. Household Integrated Economic Survey (HIES) 2015-16. <http://www.pbs.gov.pk/> . 11-11-2020.
- Perez-Escamilla, R., Cunningham, K., & Moran, V.H. 2020. COVID-19, food and nutrition insecurity and the wellbeing of children, pregnant and lactating women: A complex syndemic. *Matern.Child Nutr.* e13036 available from: PM:32458574
- Pivina, L., Semenova, Y., DoÅŸya, M.D., Dauletyarova, M., & BjÅŸrklund, G. 2019. Iron deficiency, cognitive functions, and neurobehavioral disorders in children. *Journal of Molecular Neuroscience*, 68, 1-10
- Polonikov, A. 2020. Endogenous Deficiency of Glutathione as the Most Likely Cause of Serious Manifestations and Death in COVID-19 Patients. *ACS Infect.Dis.* available from: PM:32463221
- Pourhassan, M., Angersbach, B., Lueg, G., Klimek, C.N., & Wirth, R. 2019. Blood Thiamine Level and Cognitive Function in Older Hospitalized Patients. *J.Geriatr.Psychiatry Neurol.*, 32, (2) 90-96 available from: PM:30572755
- Pressman, P., Naidu, A.S., & Clemens, R. 2020. COVID-19 and food safety: risk management and future considerations. *Nutrition Today Online*
- Raposo, S.E., Fondell, E., Strom, P., Balter, O., Bonn, S.E., Nyren, O., Plymoth, A., & Balter, K. 2017. Intake of vitamin C, vitamin E, selenium, zinc and polyunsaturated fatty acids and upper respiratory tract infection- a prospective cohort study. *Eur.J.Clin.Nutr.*, 71, (4) 450-457 available from: PM:28074891
- Razzaque, M. COVID-19 Pandemic: Can Maintaining Optimal Zinc Balance Enhance Host Resistance? preprints.org . 2020.
- Reckefuss, N. 2020. [Medical nutrition therapy in intensive care medicine : Summary of the updated DGEM guideline]. *Med.Klin.Intensivmed.Notfmed.* available from: PM:32399612
- Ren, S.Y., Wang, W.B., Hao, Y.G., Zhang, H.R., Wang, Z.C., Chen, Y.L., & Gao, R.D. 2020. Stability and infectivity of coronaviruses in inanimate environments. *World J.Clin.Cases.*, 8, (8) 1391-1399 available from: PM:32368532
- Reyes, L., Arvelo, W., Estevez, A., Gray, J., Moir, J.C., Gordillo, B., Frenkel, G., Ardon, F., Moscoso, F., Olsen, S.J., Fry, A.M., Lindstrom, S., & Lindblade, K.A. 2010. Population-based surveillance for 2009 pandemic influenza A (H1N1) virus in Guatemala, 2009. *Influenza.Other Respir.Viruses.*, 4, (3) 129-140 available from: PM:20409209
- Rhodes, K.S. & Kirkpatrick, C.F. 2018. The value of incorporating medical nutrition therapy by a registered dietitian nutritionist in clinical practice. *J.Clin.Lipidol.*, 12, (5) 1109-1110 available from: PM:30190112
- Riaz, H., Finlayson, A.E., Bashir, S., Hussain, S., Mahmood, S., Malik, F., & Godman, B. 2016. Prevalence of Vitamin D deficiency in Pakistan and implications for the future. *Expert.Rev.Clin.Pharmacol.*, 9, (2) 329-338 available from: PM:26582317
- Saedisoemelia, A. & Ashoori, M. 2018. Riboflavin in Human Health: A Review of Current Evidences. *Adv.Food Nutr.Res.*, 83, 57-81 available from: PM:29477226
- Sanu, A. & Eccles, R. 2008. The effects of a hot drink on nasal airflow and symptoms of common cold and flu. *Rhinology*, 46, (4) 271-275 available from: PM:19145994
- Scheen, A.J. 2020. [Obesity and risk of severe COVID-19]. *Rev.Med.Suisse*, 16, (695) 1115-1119 available from: PM:32462841
- Sevim, S., Kalegasi, H., & Tasdelen, B. 2017. Sulbutiamine shows promising results in reducing fatigue in patients with multiple sclerosis. *Mult.Scler.Relat Disord.*, 16, 40-43 available from: PM:28755683
- Shi, Y., Wang, G., Cai, X.P., Deng, J.W., Zheng, L., Zhu, H.H., Zheng, M., Yang, B., & Chen, Z. 2020. An overview of COVID-19. *J.Zhejiang.Univ.Sci.B*, 21, (5) 343-360 available from: PM:32425000
- Short, K.R., Kedzierska, K., & van de Sandt, C.E. 2018. Back to the Future: Lessons Learned From the 1918 Influenza Pandemic. *Front Cell Infect.Microbiol.*, 8, 343 available from: PM:30349811
-

- Simonnet, A., Chetboun, M., Poissy, J., Raverdy, V., Noulette, J., Duhamel, A., Labreuche, J., Mathieu, D., Pattou, F., & Jourdain, M. 2020. High prevalence of obesity in severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) requiring invasive mechanical ventilation. *Obesity. (Silver.Spring)* available from: PM:32271993
- Singh, M., Singh, M., Jaiswal, N., & Chauhan, A. 2017. Heated, humidified air for the common cold. *Cochrane.Database.Syst.Rev.*, 8, CD001728 available from: PM:28849871
- Skalny, A.V., Rink, L., Ajsuvakova, O.P., Aschner, M., Gritsenko, V.A., Alekseenko, S.I., Svistunov, A.A., Petrakis, D., Spandidos, D.A., & Aaseth, J. 2020. Zinc and respiratory tract infections: Perspectives for COVID-19. *International Journal of Molecular Medicine*, published online ahead of print, 2020 Apr 14, (2020) 1107-3756
- Sriwijitalai, W. & Wiwanitkit, V. 2020. COVID-19 in forensic medicine unit personnel: Observation from Thailand. *J.Forensic Leg.Med.*, 72, 101964 available from: PM:32452454
- State Bank of Pakistan. The State of Pakistan's Economy - Third Quarterly Report 2018 - 2019: Special Section 2: The State of Food Security in Pakistan. <http://www.sbp.org.pk> . 1-1-2019.
- Suresh Kumar, V.C., Mukherjee, S., Harne, P.S., Subedi, A., Ganapathy, M.K., Patthipati, V.S., & Sapkota, B. 2020. Novelty in the gut: a systematic review and meta-analysis of the gastrointestinal manifestations of COVID-19. *BMJ Open.Gastroenterol.*, 7, (1) available from: PM:32457035
- The Food and Drug Administration USA. Food Safety and the Coronavirus Disease 2019 (COVID-19). <https://www.fda.gov/> . 27-5-2020. 28-5-2020.
- The Lancet, G.H. 2020. Food insecurity will be the sting in the tail of COVID-19. *Lancet Glob.Health*, 8, (6) e737 available from: PM:32446335
- van, D.N., Bushmaker, T., Morris, D.H., Holbrook, M.G., Gamble, A., Williamson, B.N., Tamin, A., Harcourt, J.L., Thornburg, N.J., Gerber, S.I., Lloyd-Smith, J.O., de, W.E., & Munster, V.J. 2020. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. *N.Engl.J.Med.*, 382, (16) 1564-1567 available from: PM:32182409
- Voelkel, N. & Rounds, S. 2009. *The pulmonary endothelium: function in health and disease* John Wiley & Sons.
- Vorilhon, P., Arpajou, B., Vaillant, R.H., Merlin, E., Pereira, B., & Cabailot, A. 2019. Efficacy of vitamin C for the prevention and treatment of upper respiratory tract infection. A meta-analysis in children. *Eur.J.Clin.Pharmacol.*, 75, (3) 303-311 available from: PM:30465062
- Weger-Lucarelli, J., Carrau, L., Levi, L.I., Rezelj, V., Vallet, T., Blanc, H., Boussier, J.Ã., Megrian, D., Coutermarsh-Ott, S., & LeRoith, T. 2019. Host nutritional status affects alphavirus virulence, transmission, and evolution. *PLoS pathogens*, 15, (11)
- WHO. COVID-19 and Food Safety: Guidance for Food Businesses. <https://www.who.int/> . 7-4-2020.
- Wildman, R.E. 2018. *Advanced human nutrition* Jones & Bartlett Learning.
- Yang, C., Ma, Q.Y., Zheng, Y.H., & Yang, Y.X. 2020. [Transmission routes of 2019-novel coronavirus (2019-nCoV)]. *Zhonghua Yu Fang Yi.Xue.Za Zhi.*, 54, (4) 374-377 available from: PM:32268644
- Yeo, C., Kaushal, S., & Yeo, D. 2020. Enteric involvement of coronaviruses: is faecal-oral transmission of SARS-CoV-2 possible? *The Lancet Gastroenterology & Hepatology*, 5, (4) 335-337
- Zakaryan, H., Arabyan, E., Oo, A., & Zandi, K. 2017. Flavonoids: promising natural compounds against viral infections. *Arch.Virol.*, 162, (9) 2539-2551 available from: PM:28547385
- Zhang, L. & Liu, Y. 2020. Potential interventions for novel coronavirus in China: A systematic review. *J.Med.Virol.*, 92, (5) 479-490 available from: PM:32052466

About the author

Dr. Ruibina Hakeem is the Principal and Professor of Nutrition, at Raana Laiqat Ali Khan College of Home Economics, Karachi. She has served as Professor at Taibah University, Madinah Saudi Arabia for three years.

She has published more than 60 research papers, and has worked for the promotion of optimum nutrition care through various national and international platforms.



She got masters from Karachi University and Doctorate from University of London UK. She is a founder member and ex-President of Pakistan Nutrition and Dietetic Society. Chairperson of Nutrition foundation of Pakistan, Member of: British Dietetic Association, World Public Health Nutrition Association, International federation of Home Economics, Diabetes in Asia Study group. She is a fellow of Association for Nutrition UK. Fellow of Academy of Nutrition and Dietetics and is registered as dietitian with health professions council UK.

She has received several awards in recognition of her services to the field of nutrition, diabetes, higher education and research.

Role of Food and Nutrition in Managing COVID-19 In Low Middle Income Countries

RUBINA HAKEEM and NFP COVID-19 Group

Copy Right © 2020 by Rubina Hakeem-Chairperson NFP.

First Edition: June 2020.

All rights reserved. No part of this book may be reproduced in any manner whatsoever without written permission except in the case of brief quotations embodied in critical articles or reviews.

Contact: info@nutrition.org.pk, nutrition.pakistan@gmail.com