



Review Article

Food Safety, Immunity and COVID-19: A Review

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A B S T R A C T

Improving immunity against the coronavirus among all countries is one of the vital measures to combat the COVID-19 unprecedented threat to the entire world. People with a weak immune system and co-morbid conditions like cardiac disorders, hypertension, diabetes mellitus, and respiratory disorders are at high-risk population for COVID-19 disease complications. Immunity lower with conditions such as pregnancy, old age, and also bad habits like smoking, tobacco use, and alcoholism is aggravating the risk of COVID-19. This review aims to study food safety, hygiene, behavioural changes and their association with enhancement of immunity to defeat COVID-19. Totally 46 research articles were chosen from Google Scholar, ScienceDirect, PubMed, Foods, Food Science & Nutrition, Immunity perspective, and other reputed journals. Food safety is considered one of the best immunity-boosting key factors. All age groups especially young adolescents should be educated about the maintenance of a healthy lifestyle particularly food safety and prevention of infectious diseases like COVID-19. Strict implementation of food safety regulations such as food handling practices throughout the food chain in agriculture, food chain process, home kitchens, food handlers, and consumers to prevent food contamination by the means of physical, chemical, and pathogenic exposures like bacterial, viral, fungal and parasitic infections especially life-threatening. Unhygienic food practices lower the immunity power and result in vulnerable diseases like COVID-19. Practising standard food safety measures can be found very useful in boosting the immunity of the community and protecting the life of the people against COVID-19 health complications.

Keywords: Coronavirus, Food Contamination, Healthy Lifestyle, Social Responsibility

Introduction

A recent study estimated that approximately 0.5% to 1% of all infections are fatal, which is evident that a significant number of mortality related to infections occur every year in the World population. A strong and healthy immune system protects our body and fights off fatal infections. Nutrition, Food safety, and food hygiene are considered vital for

maintaining a healthy lifestyle and enhancing immunity.¹

Recently, widespread food safety concerns exhibited among all sections of people about the transmission of the virus especially COVID-19 through food and water. But there is no proof of COVID-19 transmission via food and water to humans. The chances of COVID-19 transmission through Food containers are one of the main concerns of the food



safety issues. Harmful habits like eating food together with the people by using a single plate or a single spoon and sipping out of the same cup must be considered as a dangerous act during COVID-19 Pandemic transmission. A suspected person with symptoms like cough and cold should avoid cooking food for others.²

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the virus that causes Coronavirus disease 2019 (COVID-19), and the COVID-19 disease outbreak identified in December 2019 and declared as a pandemic by World Health Organization (WHO) on 11 March 2020.³ As of 6 March 2020, initially four COVID-19 cases were reported in India and it was assumed as COVID-19 spread started from 31 January 2020 in India, when the first case was reported as a Indian scholar who came from China. As per the report of 16 April, 2020, more than 2 million cases of COVID-19 and 13700 deaths were registered in 210 countries around the World.^{4,5} Flu-like symptoms of COVID-19 include fever, chills, cough, sore throat, fatigue and body pain which usually start after 5-6 days of infection.⁶ It may cause loss of taste or smell also.⁷

COVID-19 mainly spreads from person to person through respiratory droplets during exhaling, coughing or sneezing by an infected person. These infective respiratory droplets that contain the Coronaviruses can be inhaled by another person or contaminated his eyes, nose, or mouth. People who are closer than 6 feet from the infected person are most likely to get infected.⁸⁻¹⁴ Personal Protective Equipment (PPE) such as face mask, gloves and eye goggles can help decline the spread of COVID-19. Currently, there is no evidence to support the transmission of COVID-19 associated with food. It may be possible that a person can get COVID-19 by touching a surface or object that has the virus on it and then touching their own mouth, nose, or possibly their eyes, but this is not thought to be the main way the virus spreads. In general, because of poor survivability of these coronaviruses on surfaces, there is likely a very low risk of spread from food products or packaging. As a precautionary measure, the food industry is advised to maintain social distancing following hygiene and sanitization. Hand washing before and after taking a meal is just as it comes under SOP (Standard Operation Procedures).¹⁵

Since food is essential for human survival, it should be easily accessible for people even during the COVID-19 pandemic related lockdown period. Strict lockdown of COVID-19 pandemic in many countries leads to more than 25% reduction in the availability of labour in food sectors which results in a severe shortage of food across the globe now. During this hardship of COVID-19 pandemic lockdown, if standard food safety measures are not followed strictly, deterioration of health and immunity are likely to happen.¹⁶

World Health Organization stated the COVID-19 virus is

threatening the entire world that has not happened before. All nations are advised to practice food safety measures to prevent COVID-19 transmission which is one of the best possible control measures for COVID-19 transmission.¹⁷ Also, World Health Organization emphasized on good hygiene and food safety measures need to be followed while handling fresh fruits and vegetables. The food can be contaminated if not washed properly or not covered to protect from houseflies without following food hygienic knowledge.¹⁸

Consumers are now moving to healthier diet to gain immunity and willing to follow food safety measures. The whole world is adopting the change in the food system, humanity, economy subsequently.¹⁹ Ensuring food safety and food security will enhance the human immune system which lead to a new era after the COVID-19 pandemic crisis.³

Method followed for Review

By using the following keywords like, "Food Safety", "Food Hygiene", Immune System", "Immunity Health", "COVID-19", "Foodborne diseases", "Immunity Disorders", and "Immunity Boosters", the review papers were searched and selected. This review paper has chosen 46 research articles as they were sourced citation in both local and global witness derived studies, by carrying out repeated literature searches selected from Google Scholar, PubMed, ScienceDirect, Foods, Food Science & Nutrition, Immunity Perspective and other reputed journals.

Food Safety

Food safety means safe food which has evolved as the biggest global threat with international business and public health intervention. Low- and middle-income countries have more concerns about food safety and its impacts in public health due to largely increasing population and poverty which dangerously results in poor nutritional health and lower immunity among their people.²⁰ COVID-19 outbreak is threatening global public health as well as food safety issues. Ongoing challenges faced by people during COVID-19 indicate that governing bodies of all the countries need to harden the rules of food safety and hygiene.

Surprisingly, a large proportion of foodborne disease incidents are caused by foods improperly prepared or mishandled at home. In developing countries, households are considered as the main contributor to foodborne diseases outbreak with evidence of their substandard food safety practices such as contamination of cooked foods with raw food items, improper cooking, storage of foods and unhygienic food handling habits at home. Worldwide improvement in food safety requires huge efforts in food chains all over the field which vary from country to country.

COVID-19 pandemic crisis has vastly increased the shortage of labours which widely affected the food supply chain.

Increased workload affects the health of the food industry workers which leads to a low standard of food safety among the community. Food-borne diseases mostly spread in places like restaurants, hospitals, and schools. Educational efforts should be made to ensure food safety measures like maintenance of food employee's health and personal hygiene, using personal protective equipment such as cap, facemask, apron and gloves, sanitization of surfaces and working environments, safe handling, preparation and delivery of food, and maintenance of social distance are the main contributing factors to combat the food safety-related issues in current COVID-19 situation. Although there is no published evidence regarding specific food that can reduce the risk of COVID-19, yet general public health measures like consumption of safe, healthy and hygienic balanced diet is considered as one of the primary requirements for protection from COVID-19 in the present scenario.²¹

Immunity and Health

Good health is essential for the effective immune power of the body. The immune system works as a protective shield against invaders outside and kept the body's inner side safe. In case of power failure, the shield allowed the invader to enter into the body and slowly started to destroy the body systems. If the power did not resume, all the body systems would be lost and dysfunctional. The body engines always work to bring back the power into the immune system by repairing the protective shield of the immune system.

Our immune system is our shield for protecting the body's health and if food and water are lost, then our immune system became weakened. Modern lifestyle includes alcoholism, consumption of excessive sugar, soft drinks, eating inflammatory foods, smoking, drug abuse, and unhygienic food handling practices that slowly damage the immune system which leads to overworking of compensatory body mechanism and further poor sleep as well as lack of rest, which is the possible way for foreign invaders to enter into the body. COVID-19 virus-like pathogens can be threatening our protective shield and potentially dangerous to life. So we require better health by eating nutritious foods, which act as fuel for the protective shield of the immune system.²²

A well-functioning immune system and well-effective immune responses against infective agents are essential for survival. Generally, the immune system can be classified into innate immunity and adaptive immunity. The innate immune response is the first response to an invading pathogen. Adaptive immunity targets specific threats to the body. The immune system required optimal nutrition to function efficiently. If infection occurs, the immune cells demand more energy to activate immune responses against infective agents. Appropriate and adequate nutrition is essential for the development and regulation of an efficient

immune system during the entire life course of the human to prevent infection and chronic inflammation.²³

The maintenance of a strong, healthy immune system helps to protect against disease-causing pathogens. A good and strong immune system is one of the healthy body signs. A series of steps is required to strengthen the human immune system for fighting against infections, which further reduces the risk of getting highly contagious diseases like COVID-19.

A protective fight against pathogens is exemplary for the strong immune system. An amino acid arginine, antioxidants such as cysteine, glutathione, vitamins, minerals, zinc, vitamin-C, and vitamin-A are essential to generate well-effective immune responses against pathogenic infections and to ensure quick and efficient ways to boost the immune system. Following food safety measures without these nutrients loss improves immune health. The necessity of lifestyle modification is the better way to neutralize the protective shield of the immune system.

During the COVID-19 pandemic period, the fact could be realized that human responsibility of learning to live a healthy lifestyle depends on their way, which helps in fighting against many more diseases, health problems, and mental health imbalance of the body health.²⁴

Interaction of Food Safety and Immunity:

The immune system is the first line of defence in our body, it protects us from pathogens and infections. Sometimes over activated immune system due to any foreign body (bacteria, virus, etc.) becomes problematic, because it starts killing host cells.²⁵

The Addis Ababa international food safety conference (2019) and the Geneva international food safety forum (2019) reinstated the significance of food safety standards in attaining the immunity and nutritional aspects information. Government should give importance to the sanitation of public places. It should also develop a policy for food safety that maintains good immunity power.²⁶ Food safety is an assurance that the consumed food is not harmful and prepared in keeping hygiene and sanitation in mind.²⁷ Currently, food-borne infections make their life-threatening by affecting immune systems. The other peoples who also need to be taken care of food safety are young children, elderly people, and pregnant women due to the increased risk of severely affecting foodborne disease-causing microorganisms. Food safety is also important for patients whose treatment of certain diseases is ongoing such as HIV/AIDS, cancer, etc.^{28,29}

Presently most countries are seriously discussing that very little evidence of information available related to the COVID-19 virus survival on different surfaces and food items in the particular conditions which indicates for further studies regarding COVID-19 transmission linked with food

safety. Undergoing research trials try to look out for a connection between consumption of contaminated food with COVID-19 virus and the possibility of developing COVID-19 disease that affect people with poor immune health.³⁰

Kendall P et al. conducted a web-based study on the special importance of food handling practices in lowering the risk of foodborne diseases among antenatal mothers, children, old age and immune-compromised people. The findings revealed that the food handling behaviours were linked to 13 pathogens of foodborne diseases. The data of this study suggested the critical need for specialized focus and efforts on effective food handling behaviours among the vulnerable population to prevent foodborne diseases.³¹

Clements SJ, Carding RS investigated diet, the intestinal microbiota, and immune health in ageing. The findings indicated a significant association between the role of specific, hygienic, and nutritious diet intake and modifications in intestinal microbes' metabolism. The study suggested specific, food hygienic, and nutritious dietary interventions that might help improve immune health.³²

Overview of food safety related to microbiological aspects, a low microbial diet (LMD) is advised to protect vulnerable immune-suppressed people that increase their susceptibility to foodborne disease.³³ Nutritional therapy of low microbial diet is considered as a key supportive aspect of care given to the immune-compromised people additionally along with their medical treatment. Due to this therapy, the immune-compromised clients get enough to carry out various body functions, prevent them from infection and also enhance their immune system. Critical need for standard food safety measures among the people with lower immunity is essential to save their life.³⁴

Hanekom SM et al. investigated the level of food safety and food hygiene in a South African hospital food service unit serving low microbial diets among clients with lower immunity.

Table 1 shows that significantly low standards of food safety with an average score of 41.1% were found in all areas of South African hospital food servicing unit serving low microbial diets among clients with lower immunity. The pathetic condition was found in quality assurance and records which scored only 5.6%. The findings revealed that poor food safety knowledge, attitude, and practices were found among staff of the hospital food servicing unit, which significantly increased the risk of foodborne diseases among clients with lower immunity. The study suggested that strict measures of food safety protocols be followed to reduce the food safety risks among hospitalized clients with lower immunity.³⁵

Table 1. Audit Report of the Level of Food Safety Standard in South African Hospital Food Servicing Unit serving Low Microbial Diets among Clients with Low Immunity

Areas in Hospital Food Servicing Unit	Percentage of Food Safety Standard
Reception	45.5
Dry and refrigerated storage	32
Sub-zero storage	16.3
Preparation and production	48.4
Service and distribution	69.4
Customer area	68
Premises and equipment hygiene	45.2
Staff standards	61
Sanitary facilities	20
Quality procedures and records	5.6
Average percentage of food safety standard in hospital food servicing unit	41.1

Calder PC, Jackson AA evaluated the relationship between undernutrition, infection, and immunity. The review described that the two main reasons for increased diseases and deaths in developing countries are undernutrition and infection. Undernutrition decreased the immunity level of the human body, which permits the pathogens to cause various infections. Infections can also alter the nutritional status of the body through decreased functions of ingestion, digestion, and absorption of food as well as increased elimination of body nutrients. The estimated global burden of malnutrition and infectious diseases among children is very high. Infection might be impaired the growth and development of the children. To protect the children from infection, breastfeeding is vital to boost their immunity. Supplementation of Vitamin A, iron, and zinc among children with malnutrition results in improving immunity as evidenced by decreasing the number of deaths and infectious diseases such as measles, diarrhoea, and respiratory infections. The study reinforced the integration of health education to all mothers regarding nutrition, food safety, food hygiene, personal hygiene, and environmental hygiene along with universal immunization programs to eradicate infectious diseases among children.³⁶

Borchers A et al. states food safety is affected by many pathogens and the potential for various foodborne diseases. Fungal toxins can cause chronic infections, impairment of immunity, and systemic toxicities. Excessive

industrial production of toxic metals and chemicals can contaminate the entire food chain and a potential threat for food poisoning and carcinogenic exposure. Genetically modified foods are threatening possible health risks to the human population. The findings suggested that critical understanding is required regarding risk factors of food safety to ensure safe food supply and prevention of foodborne diseases among the human population.³⁷

Schlundt J et al. investigated emerging foodborne zoonotic pathogens contamination in the food chain system and its exposure to the human population. The investigation revealed that a high level of the emerging foodborne zoonotic pathogenic contamination in the food production chain is considered as one of the major cause for global foodborne disease burden and its related mortality such as approximately 1.9 million diarrhoeal disease deaths comprising mostly the young children occurs in the world every year. The study recommended a critical need for specific scientific interventions to control the food contamination throughout the food chain and effective prevention of foodborne diseases.³⁸

Thorburn AN et al. carried out the review related to diet, metabolites, and “Western-Lifestyle” inflammatory diseases. The findings highlighted that lack of safe and healthy food intake affects dietary and bacterial metabolites production. Inadequate dietary and bacterial metabolites production causes disturbances in the controlling functions of various immune pathways which might lead to the development of inflammatory disorders in human populations.³⁹

Tilg H, Moschen AR evaluated the relationships between food, immunity, and the microbiome. Further, the article was recommended that the development of food safety-based interventions is essential for the prevention and management of many disorders.⁴⁰

Ucar A et al. analyzed food safety problems and their solutions. The review described that consumption of contaminated food containing pathogens results in foodborne illness, health disorders by affecting immunity, which can be serious or even fatal. Food safety knowledge and hygienic food handling practices help in the prevention of unknown diseases by strengthening the immune system. Safe and healthy food means clean and nutritious foodstuffs. A safe food supply is a critical need for consumers. Therefore it's highly recommended that developing widespread food safety knowledge regarding the prevention of food contamination in a whole food chain stages from harvest to food consumption, which likely to results in the prevention of unpredictable low immunity disorders throughout the World.⁴¹

Food, when contaminated with houseflies, mosquitoes, and pests such as rats, can be harmful as it might contain

bacteria, viruses, fungal or chemical toxins.⁴² The agricultural practices which involve weedicide, pesticide, and insecticide in excessive quantity can enter into the food chain may also be harmful. Similarly, poor food hygiene such as improper washing vegetables, fruits, etc. can cause bioaccumulation.⁴³ Unhygienic food can cause malnutrition, diseases such as typhoid, diarrhoea, etc. It can appear as a global health hazard because of fast food becoming popular among youngsters. Infants, young children, pregnant women, and elderly people need more attention towards food safety and should be aware of a balanced diet, nutrition, and immunity.⁴⁴

Food Safety is one of the key measures to maintain a healthy and strong immune system. Food Safety can help to boost your immune system during this COVID-19 pandemic and also ever.⁴⁵ COVID-19 infection can spread by food industry workers who affected with COVID-19, through his contaminated hands as well as sneezing and coughing during preparation and packaging of food. Following standard food safety protocols such as good hygienic food handling practices are always important to reduce the risk of COVID-19 infection.⁴⁶

Conclusion

By the conclusion of this review article, it was understood that the probable connection among COVID-19 virus is linked with immunity which also has a significant correlation with food safety and hygiene. Implementation of strict food safety regulations is need of the hour to boost the immunity of people in order to lower the risk of COVID-19 infection spread among the community. More research studies are required to find a link between food safety and the development of immunity in the prevention of COVID-19 infection. This review recommends further explorative research on the impacts of food safety in boosting immunity and prevention of COVID-19 infection.

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