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SUPPORTING DOCUMENTS FOR 3.3.2

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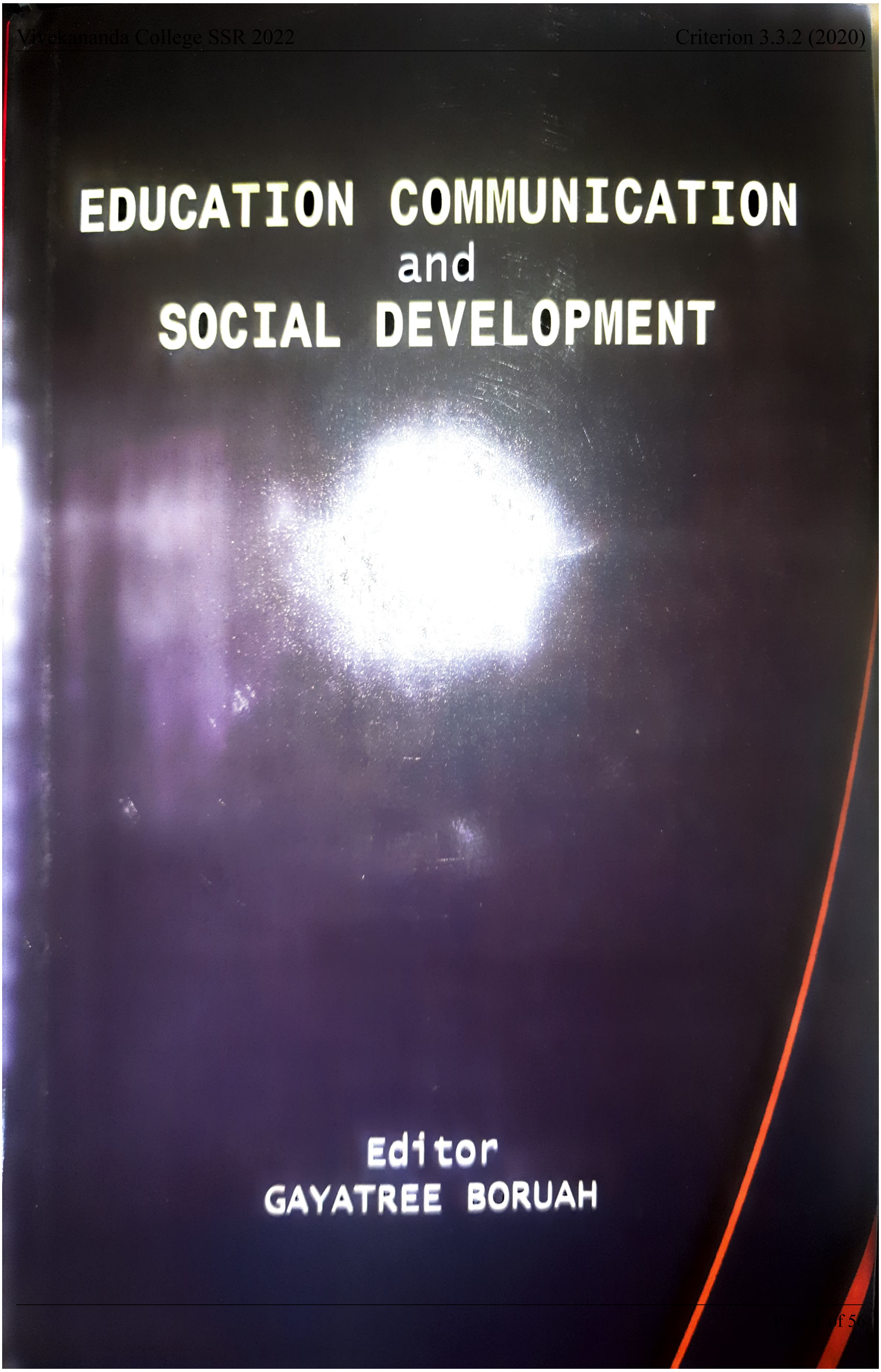
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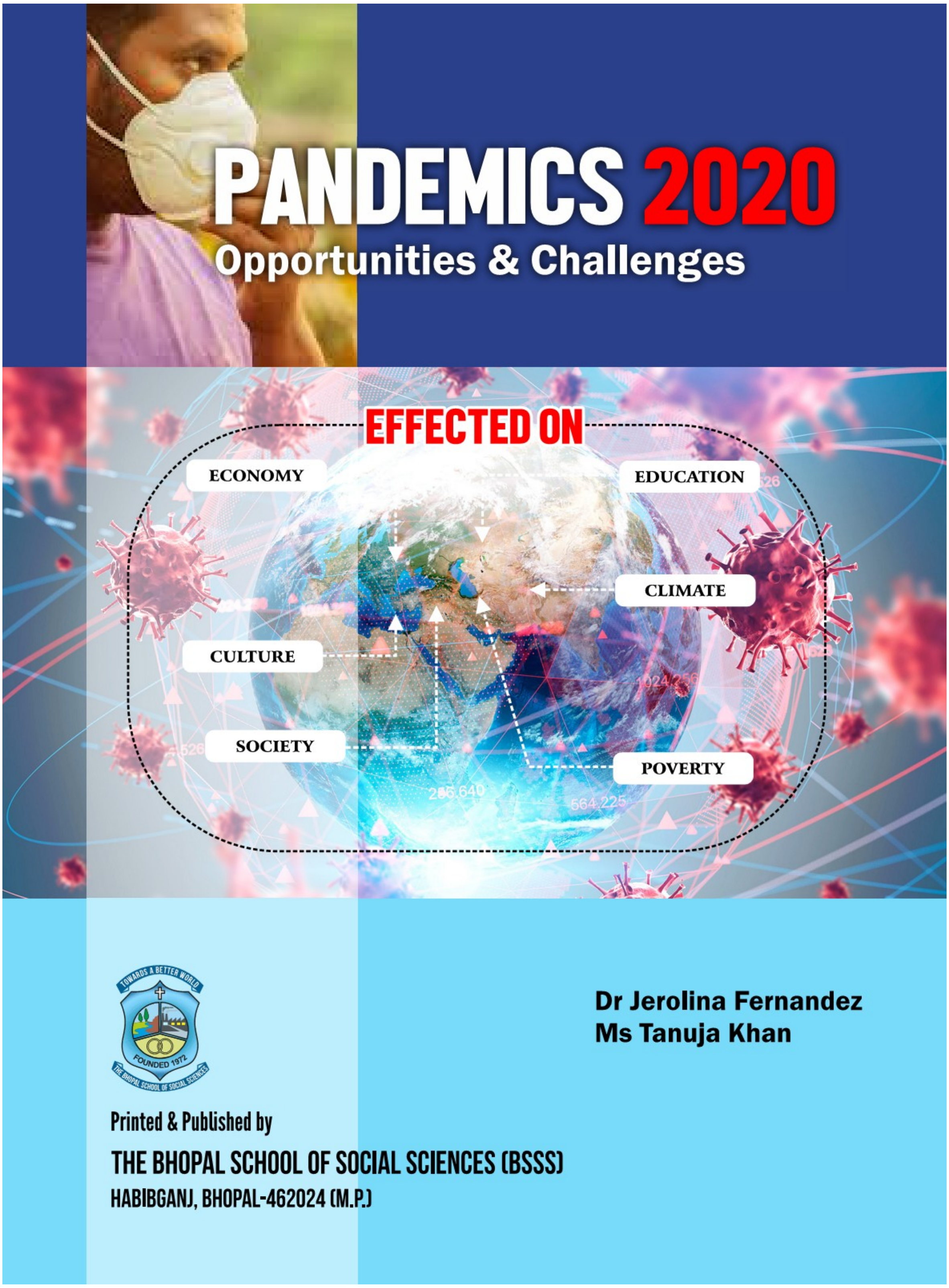
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Pandemics 2020: Opportunities & Challenges

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SOCIAL SUPPORT AND MENTAL HEALTH IN TIMES OF COVID-19

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Abstract

During the coronavirus (COVID-19) outbreak, governments issued public health guidelines suchas travel restrictions, social distancing, and, and quarantine to control the infection. Drawing from the earlier outbreaks SARS and Ebola, previous studies suggest that social isolation measures have been successful in controlling the spread. However, these measures have been found to develop mental health issues such as acute stress, anxiety, depression, post-traumatic stress disorder, low self-efficacy, and suicide. Researcheson protective factors have found the importance of social support in preventing the onset of emotional and psychological issues especially during negative events. Social support refers to an aid provided to the receiver by friends, family, neighbours, or any other social network, especially during difficult circumstances. People with a large network or support show high wellbeing, less mental health problems, and use effective coping skills to fight against odds than the people who are lonely or lack support. This chapter, thus, aims to emphasizethe significance of social supportin protection from potentially damaging effects on psychologicalwellbeing caused by thispandemic.It describes the nature and types of social support, models which explain the pathways of association between social

support and mental health, along with evidence in relation to COVID-19. The chapter ends with concluding remarks by highlighting the clinical, professional, and policy implications of social support.

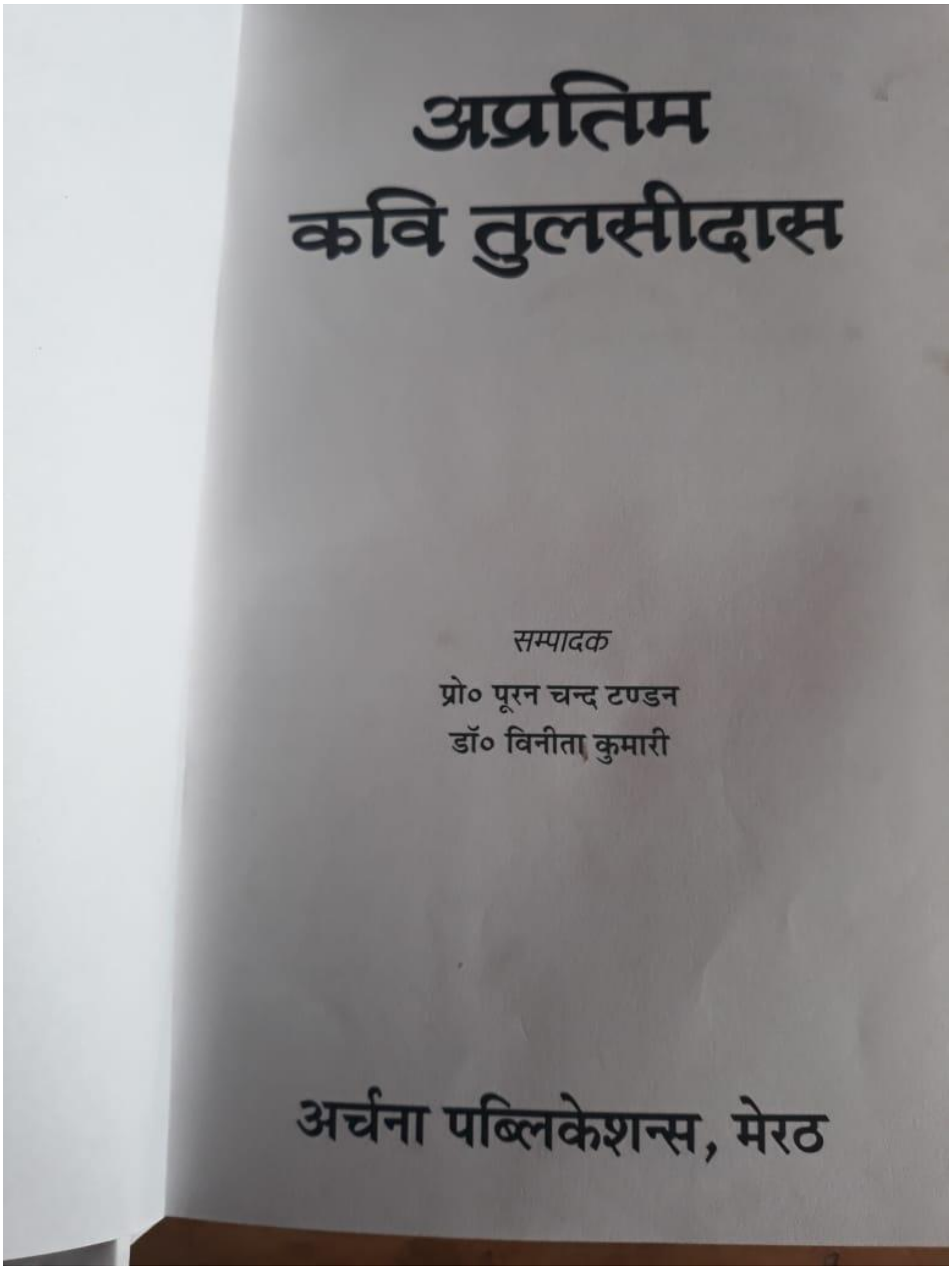
Keywords: Social Support, COVID-19, Pandemic, Social Isolation, Mental Health,

Background

The World Health Organization (WHO) confirmed the coronavirus a pandemic in March 2020. A pandemic refers to an epidemic happening over a wide region, crossing geographical boundaries, and typically influencing an enormous number of individuals (Porta, 2014). Therefore, pandemics areassessed based on their geographical range instead of the seriousness of the disease. For instance, rather than occasional flu, pandemic flu is characterized as a type of another flu that infects peoplewidely and rapidly, but people have not developed immunity to resistant to fight against the virus (WHO, 2010).Pandemics can cause abrupt, far-reaching grimness, and mortality just as societal, political, and economiccrisis. In the past, there have been a few noteworthy pandemicsincluding the Black Death, Spanish influenza, and Human Immunodeficiency Virus (HIV/AIDS), Severe Acute Respiratory Syndrome (SARS), and Ebola.

The novel coronavirus (COVID-19) is an infectious disease which is caused by previous unidentified severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Sood, 2020). As of March 27, 2020, the total number of confirmed coronavirus cases 14,104,033 and 597,541 deaths were reported globally (WHO, 2020), which led to a worldwide health emergency. As a result, nations around the globe implemented a range of general wellbeing and social measures, including lockdown, isolation, social distancing, movement restrictions, closure of schools and universities, organizations, lockdowns in some regions, and worldwide travel restrictions to control the spread of the infection.

The measures such as quarantine and social isolation have been effective in controlling the spread of the disease in the past. These measures involve maintaining the physical distance between people, staying at home, reduced social interactions, and contact with contaminated surfaces or infected patients(Barbera et al., 2001; Mandavilli, 2003; Markel, 1993; Riss, 1992). On the flip side,reduced social interactionshave worsened psychological and emotionalwellbeing.The negative effects of social distancing on mental health has been examined in previous studies, which can be compared with the current state of confinement. Psychological issues



अप्रतिम कवि तुलसीदास

सम्पादक

प्रो० पूरन चन्द टण्डन

डॉ० विनीता कुमारी

अर्चना पब्लिकेशन्स, मेरठ

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"विरुद्धों का सामंजस्य, रामचरितमानस और हम"

(डॉ० मीना पाण्डेय)

'समय' वो सत्य है जो निरंतर परिवर्तनशील और नित नवीन रहता है, यह सम्पूर्ण चराचर, जीव-जगत इस सत्य से संचालित है और इसके अनुसार ही अपना पथ प्रदर्शन करता है। प्रातः, सायं और रात्रि निरंतर अपने चक्र से चलते रहते हैं और विभिन्न ऋतुएँ भी क्रमानुसार आती और जाती रहती हैं, किन्तु समय और परिवेश कभी एक से नहीं रहते। हमेशा कभी प्रातःकाल नहीं रह सकता और हमेशा कभी बसन्त नहीं रह सकता। प्रातः के पश्चात् रात्रि और बसन्त के बाद ग्रीष्म तो आएगा ही। मनुष्य भी इसी प्रकृति की देन है उसका निर्माण भी इन्हीं विरोधाभासी स्थितियों में हुआ है। समय और काल की अनुकूलता और प्रतिकूलता से उसका जीवन अछूता नहीं है। जीवन में सदैव सुख विद्यमान नहीं रहता और न ही दुख। इस सत्य का रहस्य जानने वाला कभी विचलित नहीं होता। जीवन में दुखों के होने से तात्पर्य समय और स्थिति का रुक जाना है, ऐसी सोच रखने वाला मनुष्य अपने साथ विकृतियों का जाल बुनते हुए चलता है, प्रतिकूल परिस्थितियों में स्वयं को अनुकूल बनाने वाला ही वास्तव में जीवन जीने योग्य है, आदर्श है और वीर है, गोस्वामी तुलसीदास जी ने भी संत जन की यही विशेषताएं बतायी हैं–

जड़ चेतन गुण दोषमय बिस्व कीन्ह करतार।
संत हंस गुन गहहिं पथ परिहरि बारि बिकार।।[1]

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बी.ए. प्रथम वर्ष

हिन्दी साहित्य, द्वितीय प्रश्नपत्र

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डॉ. सरोज कुमारी / हिन्दी विभाग

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SYLLABI-BOOK MAPPING TABLE

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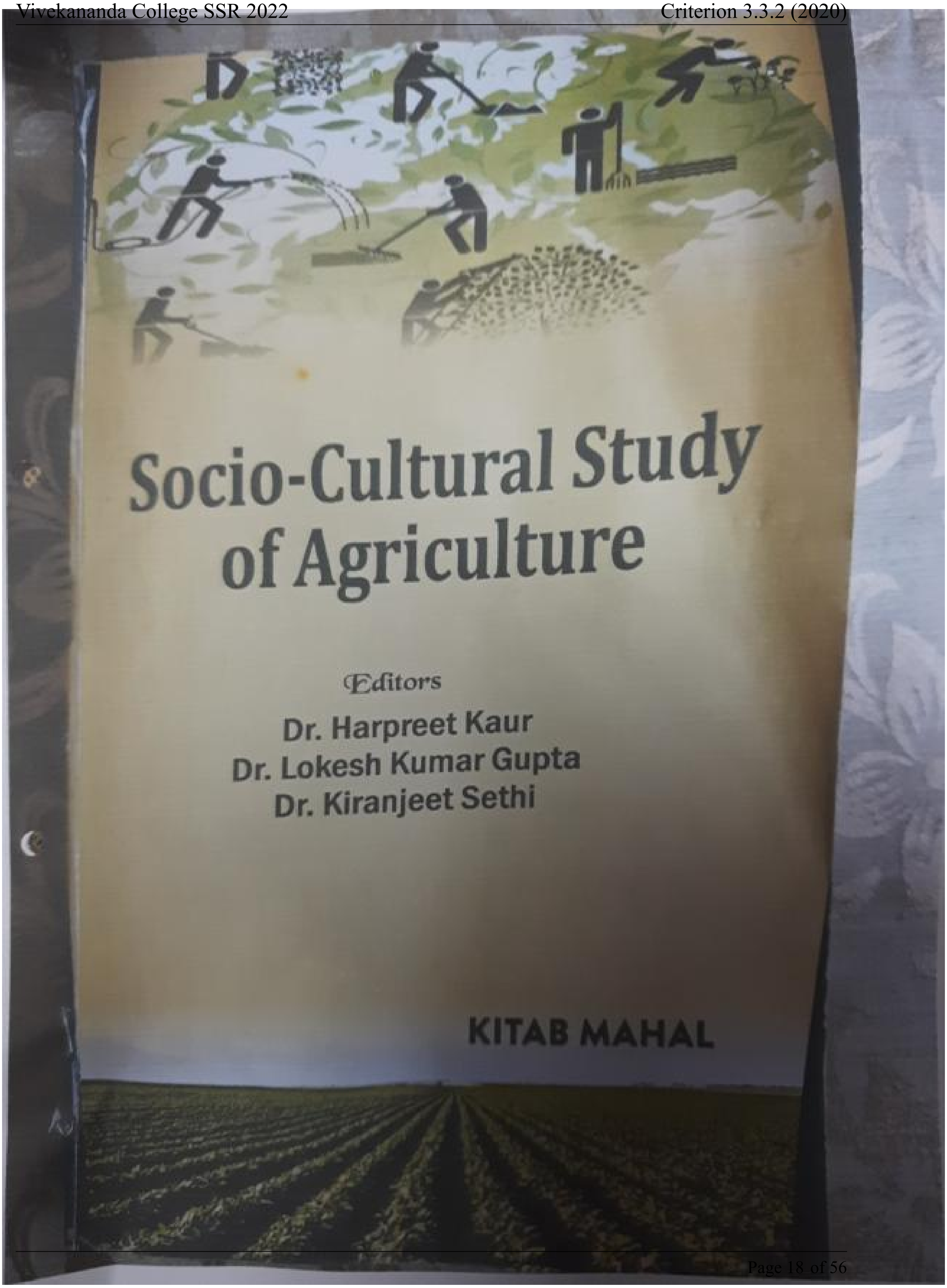
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ब्रिटिशकालीन भारत में कृषक संघर्ष

डॉ. स्वाती रंजन चौधरी

कई शताब्दियों से कृषि भारतीय अर्थव्यवस्था का प्रमुख अंग रही है। इसलिए भू-राजस्व भारतीय प्रशासन की आय का प्रमुख स्रोत था। भारत जैसे कृषि प्रधान देश मे प्रशासन चलाने के लिए उचित मात्रा में भू-राजस्व का निर्धारण और वसूली आवश्यक था। अंग्रेज जब भारत आए तब उन्होंने अपने आर्थिक हित की पूर्ति के लिए भारत मे प्रचलित भू-राजस्व व्यवस्था को परिवर्तित कर विभिन्न प्रणालियों को लागू करके, कठोरता से भू-राजस्व की वसूली की जिससे किसानों की स्थिति खराब हो गई और कृषि में गिरावट आई।

प्राक् ब्रिटिश भारत में कभी भी जमीन किसी की निजी सम्पत्ति नहीं रही। राजा तथा सामंतों को सिर्फ इतना अधिकार था कि वह गाँव से कर वसूली कर सकता था। ग्राम समुदाय ही गाँव की भू-संपत्ति का वास्तविक अधिकारी होता था। अंग्रेजों की भारत विजय के बाद पुरानी भू-व्यवस्था में परिवर्तन का सिलसिला आरम्भ हो गया। नई लगान व्यवस्था के कारण वर्षों से चली आ रही परम्परा खत्म हो गयी। ऐसा नहीं था कि मुगल काल मे भारत में किसान विद्रोह नहीं होते थे अठारहवीं सदी के पूर्वार्द्ध में मालगुजारी की बढ़ती माँगों के कारण किसानों की निर्वाह व्यवस्था प्रभावित हुई। जब ब्रिटिश व्यवस्था ने भारत में अपनी शक्ति बढ़ाई तब उन्होंने मुगलों द्वारा निर्धारित कर को अल्प मानकर अचानक बढ़ा दिए। बंगाल में मुगल शासन के अंतिम लेखावर्ष 1764–65 में कृषि कर की वसूली 8,18,000 पौंड थी। 1765–66 में ही ईस्ट इंडिया कंपनी ने इसकी मात्रा 14,70,000 पौंड कर दी। 1793 के इस्तमरारी बंदोबस्त या स्थायी भू-राजस्व प्रणाली के अंतर्गत ये मात्रा 30 लाख पौण्ड से अधिक की निश्चित कर दी।[1] भू-राजस्व में अत्यधिक वृद्धि के कारण परम्परागत ढाँचा टूट गया। इस व्यवस्था ने न केवल किसानों को बर्बाद किया बल्कि उन दयालु जमींदारों को भी नष्ट कर दिया, जो सरकार और किसान के बीच बिचौलिये की भूमिका में थे। ये जमींदार खराब फसल होने वाले वर्ष में किसानों को कर में राहत दे देते थे। अंग्रेजों ने ऐसे जमींदारों की जमींदारियाँ नीलाम कर दी।

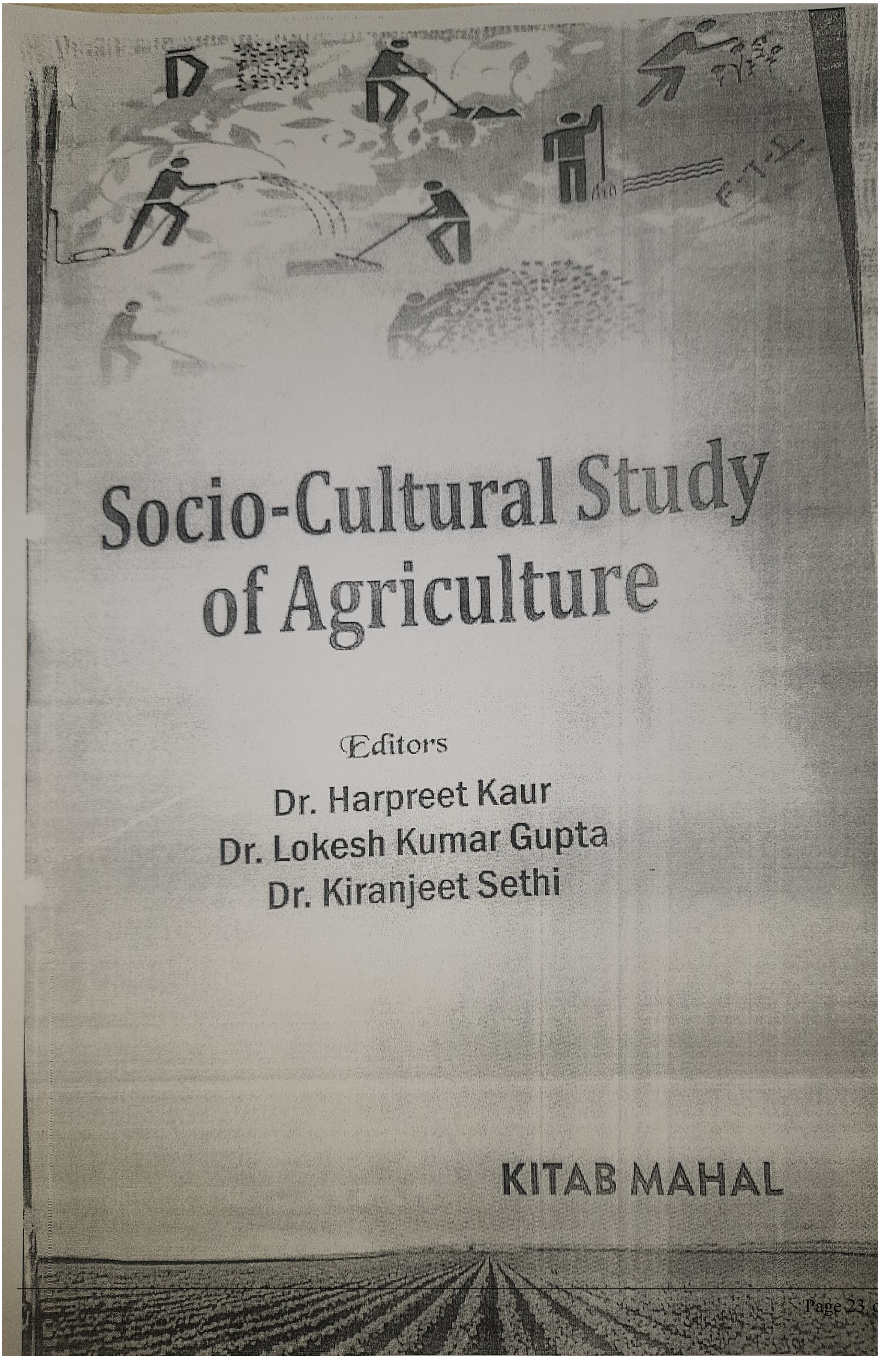
इस शोषणकारी नीति के परिणामस्वरूप 1770 में बंगाल में भयानक अकाल पड़ा जिसमें बंगाल की लगभग एक तिहाई आबादी समाप्त हो गयी। इस का प्रत्यक्ष कारण 1769 में बारिश का न होना था। औपनिवेशिक शोषण के कारण जनता के पास अन्न का कोई भंडार नहीं था। मुगल शासन जब

दमनात्मक हो गया था तब भी प्राकृतिक विपदाओं के समय कर में छूट दी जाती थी, लेकिन कंपनी इन परिस्थितियों में भी निश्चित कर के लिए अड़ी रही और 22 मार्च 1793 को कंपनी ने यह घोषणा किया कि – "भविष्य में सूखा, बाढ़ या अन्य किसी भी प्राकृतिक विपत्ति के कारण वसूली की माफी या कर में छूट के लिए किसी भी बहाने, दावे या अनुरोध पर विचार नहीं किया जाएगा।"[2]

लगान निर्धारण में अनेक प्रयोगों के बाद लार्ड कार्नवालिस ने 1793 में बंगाल, बिहार और उड़ीसा में स्थायी बंदोबस्त को लागू कर दिया। इस नीति के तहत कर की दर को स्थायी कर दिया गया था जिसकी वसूली जमींदारों के माध्यम से की जाती थी। यदि ये जमींदार नियमित रूप से लगान का भुगतान नहीं करते थे तो उनकी जमींदारियाँ नीलाम कर दी जाती थी। इनके स्थान पर जमींदारों का ऐसा वर्ग तैयार हो गया जो किसान के हित को नजरअंदाज करके सिर्फ अपना हित देखते थे। इन प्रदेशों में सरकार ने एक ऐसे जमींदार वर्ग की रचना की जो अंग्रेजी हुकुमत के प्रति वफादार रहे और किसान विद्रोहों के खिलाफ ब्रिटिश शासन के हितों की रक्षा करें। इस स्थायी बंदोबस्त के कारण समाज में एक–दूसरे वर्ग का जन्म हुआ – महाजन, सूदखोर। जिस वर्ष फसल खराब हो जाती थी उस वर्ष किसानों को कर चुकाने के लिए इन महाजनों से ऋण लेना पड़ता था। महाजन कर्ज लेने वाले किसानों को अलाभकर कीमत पर फसल बेचने के लिए मजबूर करते थे। ऋण नहीं चुकाने पर इन किसानों को उनकी जमींनों से बेदखल कर दिया जाता था। बेदखली के बाद ये महाजन उन जमींनों के मालिक बन जाते थे और किसान अपनी ही जमीन पर मजदूरी करने के लिए बाध्य हो जाते थे। अंग्रेजों की कर संबंधी शोषणकारी नीति तथा महाजनों के शोषण ने अनेक किसान विद्रोहों को जन्म दिया।

रैयतवाड़ी तथा महलवाड़ी व्यवस्था में भी सरकार ने जमींदारों का स्थान ले लिया एवं भू-राजस्व की दर को अत्यधिक रखा। इन क्षेत्रों में भी भू-राजस्व अदा नहीं कर पाने पर किसानों की भूमि नीलाम कर दी जाती थी अथवा किसानों को महाजनों से ऊँचे दर पर कर्ज लेने के लिए विवश होना पड़ता था। जमीन के हाथ से निकल जाने, उद्योगीकरण एवं हथकरघा उद्योग के अभाव में जमीन पर बोझ बढ़ने लगा जिसके कारण लोग कम से कम मजदूरी पर काम करने के लिए विवश हो गये। इस प्रकार ब्रिटिश शासन के प्रारम्भिक वर्षों से ही किसान–संघर्ष आरम्भ हो गया।

किसानों ने अब ब्रिटिश राज की शोषणकारी नीति का प्रतिरोध करना आरम्भ कर दिया जिसमें बंगाल के उत्तरी जिलों रंगपुर और दिनाजपुर में 1783 में एक किसान विद्रोह हुआ। मालगुजारी वसूल करने वाले ठेकेदारों एवं कंपनी के अधिकारियों द्वारा मालगुजारी की अत्यधिक माँग तथा अन्य गैरकानूनी करों की वसूली के द्वारा किसानों का दमन करते थे। किसानों ने कम्पनी की सरकार से इंसाफ की माँग करते हुए एक प्रार्थना–पत्र भेजा पर सरकार के द्वारा इसे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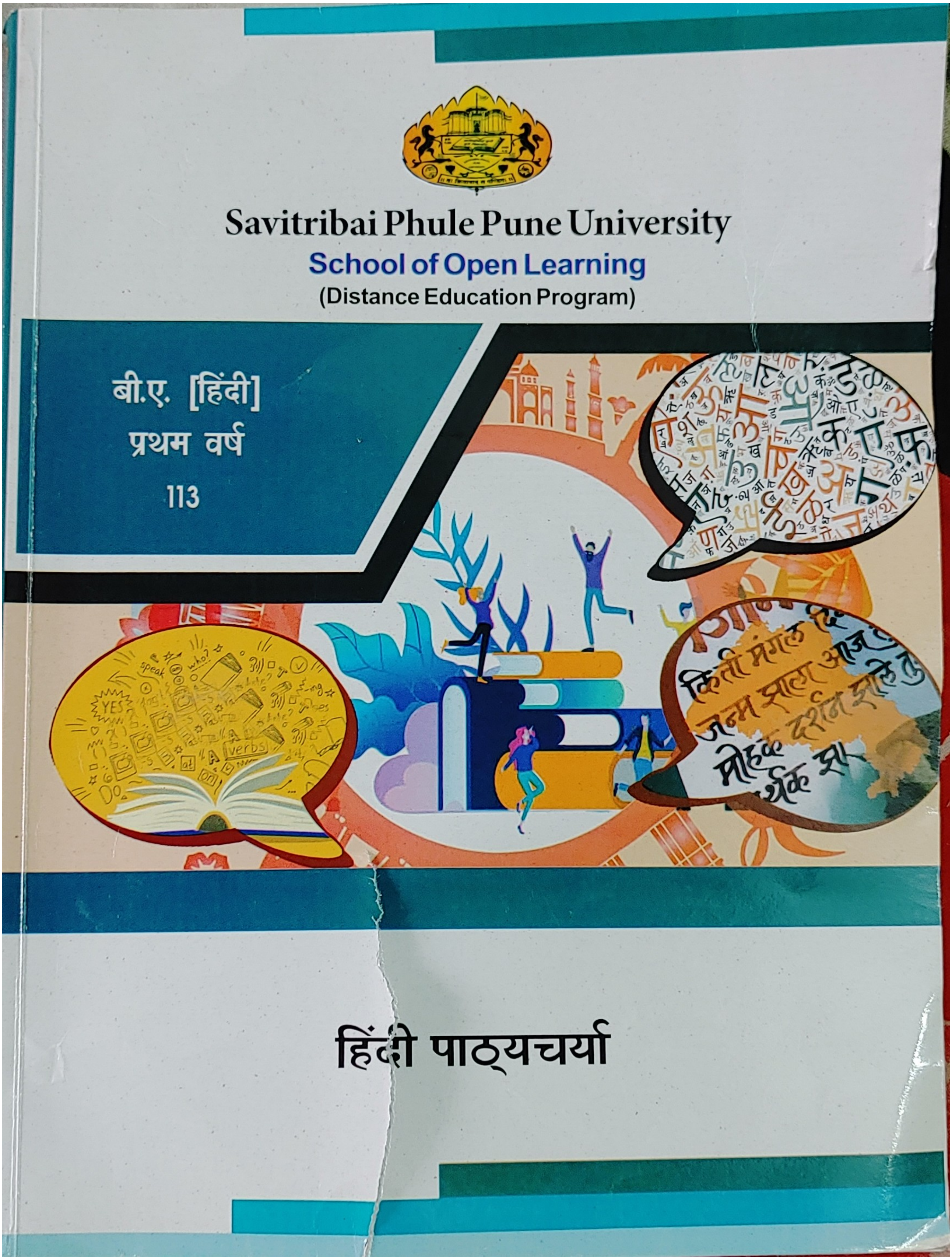
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Assessment of Body Composition for Nutrition Screening and Well Being: A Review

Shivani Rohatgi[1], Sukhneet Suri[2] and Praveen Kumar[3]

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Abstract—*Nutritional status of children is commonly assessed by anthropometric measurements such as weight, length/height and mid-upper arm circumference. However, such measures may give transient view of the potential variation in leanness and energy balance which can be misleading especially during phases of rapid weight gain such as catch-up growth. Alteration in the relative amount of body-fat/lean tissue during childhood is viewed as a health risk-factor such as for obesity, type-2 diabetes, hypertension and dyslipidaemia later in life.Under-nutrition during early years of life particularly first 1000 days has inter and intra generational impact on the health and well-being of populations through metabolic and genetic alterations.*

Despite consistent attempts made at national level, the double burden of malnutrition in our country continues to increase. As per Global Nutrition Report 2018, the country nutrition profile indicates the prevalence of under-five overweight as 2.4 percent (2015), which has increased slightly from 1.9 percent (2006). The national prevalence of under-five stunting and wasting is 37.9percent and 20.8percent, which is greater than the developing country average of 25percent and 8percent respectively.

Accurate and valid assessment of body composition is essential for screening, diagnostic evaluation of nutritional status, identifying relevant outcome measures and determining the effectiveness of current and future nutritional interventions. Also there is increasing interest in obtaining more direct data on body composition for nutritional assessment and wellbeing to set targets for achieving sustainable development goals especially 2 and 3. At present there is paucity of data on fat mass, fat-free mass at National level for various gender, age, ethnicity, demography etc. This paper aims to critically review the methodology of assessing body composition especially when used as a public health assessment tool in diverse population groups, with a primary focus on its use in screening monitoring of under-nutrition especially in under-five population.

Keywords: *Health, Body composition, Anthropometry, Under-nutrition.*

INTRODUCTION

The Government of India is committed to achieving the 2030 Sustainable Development Goal-3 (SDG-3). According to the UNICEF / WHO / World Bank Group (2019) children under five years of age face multiple burden of malnutrition; 150.8 million, 50.5 million beingstunted and wasted while 38.3 million are overweight. According to the National Family Health Survey – 4 (NFHS-4), the prevalence of overweight, stunting and wasting in the under-five population is 2.4percent, 37.9percent and 20.8percent respectively which is greater than that in several other developing countries. Nearly 1.5 million children die in India before reaching the age of 6 because of lack of care and protection and several are often not able to reach their full potential(USAID, DFID, BMGF, UNICEF, UNFPA, and MOHFW, GOI, 2020). **Table 1** provides a brief overview of the double burden of malnutrition in India from 1993-2018 reported through NFHS, Demographic and Health Survey (DHS) and Comprehensive National Nutrition Survey (CNNS). The data indicate that despite concentrated efforts in the form of several nutrition and health programs, no significant reduction has occurred in the prevalence of underweight, stunting, wasting and overweight over the past more than 2.5 decades among under five year old children.

Table 1: Nutrition Status of Under five year Old Children (U5C) in India

Surveys	NFHS				DHS			CNNS
Reported Year	**1992-93**	**1998-99**	**2005-06**	**2015-16**	**1998-99**	**2005-06**	**2015-16**	**2016-18**
Underweight (percent of U5C)	53.4	47	40.4	36	–	–	–	33.4
Stunting (percent of U5C)	52	45.5	44.9	38	51.5	48	38.4	34.7
Wasting (percent of U5C)	17.5	15.5	22.9	21	19.5	19.8	21	17.3
Overweight (percent of U5C)	–	–	–	–	2.8	1.5	2.1	–

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If under and over nutrition are not significantly reduced, the country will not be able to meet its SDG targets for reduction of child morbidity and mortality. The consequent burden of non-communicable diseases will exert enormous cost on the development of India and reduce its contribution to global health and economic progress. Currently nutrition programmes dwell only upon the nutritional status based on anthropometry and not on overall health especially the body composition. Severity of fat free mass and fat mass deficits, hydration status remains inadequately documented (ACF, 2018; Chumlea WC, 1994; Ministry of Women and Child Development, 2018). Imbalance in the Fat free mass and Fat-Mass is closely associated with poor performance in studies/sports, high drop-out from schools, reduced social interactions, low self-esteem/confidence level, increased morbidity and mortality due to several non-communicable diseases such as impaired glucose tolerance, hyperinsulinemia, dyslipidemia, hypertension, cardio-vascular diseases etc.(Musaiger & Hazzaa, 2012; Frank WB, 2012; WHO, 2011; Maffetone PB, 2017). It can also have adverse intra-generational effects on health, productivity and socio-economic status to name a few.

India has made significant strides in improving various health and nutritional status indicators. The health strategies, policies and programmes of our country are based on the Integrated Sustainable Development Model (2017) and are focused on providing essential services to the entire population, especially the poor and vulnerable groups. The area of nutritional status assessment has been the subject of considerable research especially in paediatric age group. Commonly described methods for nutrition assessment and screening are anthropometry measurement, clinical and dietaryevaluation. Body-composition and biochemical assay methods are used in research settings. **(Figure 1)**.

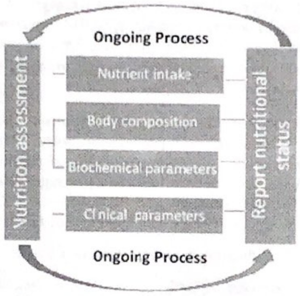

Figure 1: Nutrition Assessment Process

Body composition is a branch of human biology which mainly focuses on the in vivo quantification of body components, the quantitative relationships between components, and component alterations related to various influencing factors. In simple terms it is the ratio of water, lean muscle mass, and fat mass in the body which is often expressed in terms of percentage body-fat. (Wang ZM, 1992). It is the best long-term indicator of nutritional status. It is useful in quantification of body energy stores, precise estimation of long-term energy balance and analysis of fat depots and skeletal muscle

METHODOLOGY

Globally, there have been numerous experiences on body composition assessment for the purpose of nutrition screening primarily in the clinical settings and some from the perspective of public health. This review aimed to search for scientific published material, studies as well review articles, research papers, reports and policies pertaining to use of body composition as a tool for nutrition screening or diagnostic marker so as to achieve health and well-being of individuals and populations.

The aim of this non-systematic review is to:

- Critically evaluate the appropriateness of body composition analysis in field surveys
- Identify most appropriate method for assessing body compositionw.r.t. Indian population with special reference topediatric group.
- To collate and summarize published data on this topic.

Criteria for Considering Studies for this Review:

The following criterion was used to include a study in this review:

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Types of study subjects: Children, adolescents and adults

Types of outcome measures: Studies reporting public health perspective of using body composition, correlation between the nutritional status and altered body composition and also those, in which different models were used for assessment of both the variables, were considered while reviewing data for the present study. Whilst the primary objective of the review was to identify the relevance and standard operating procedures (SOPs) for assessing body composition especially when used as a public health assessment tool in diverse population groups, with a primary focus on its use in screening/monitoring of under-nutrition especially in under-five population. Information on socio-economic descriptors was also gathered, where possible, for all studies, so that interactions between these and other risk factors could be taken into account.

Types of study: Prospective and Retrospectives studies, review articles, reports and policies were used as an entry criteria for this review.

Source of data: Reference books and databases, including published articles in indexed journals assessing the issues linked with body composition assessment as well as the effect of socio-demographic variables on health and wellness as per SDGs, were included in this study.

Search Methods: Search engines on the topic were identified. Keywords related to the topic were short listed 'nutrition assessment', 'body composition', 'anthropometry', 'Nutrition screening', 'undernutrition', 'over nutrition', 'Bioelectrical Impedance', 'skinfold', 'nutrition surveillance', 'intervention', 'approach' and 'sustainable development goals'. A comprehensive search strategy was designed and applied to electronic bibliographic databases, including Medline (Pub Med), WHO Regional databases, Google Scholar databases, Inflibnet and the Cochrane Library with specific key words/concepts: The search was limited to literature published between 1985 and 2020. MeSH headings were used where available. Published and unpublished references and grey literature sources were searched electronically and manually.

SELECTION CRITERIA AND ANALYSIS

Initially, all titles and abstracts were screened to determine inclusion eligibility and full articles were independently assessed according to inclusion/exclusion criteria. For inclusion, papers had to cover research on at least one of the following topics: nutrition assessment, body composition (of human beings), determinants of malnutrition, double burden of malnutrition, body composition techniques and nutrition screening, impact of nutrition intervention on body composition, recommendations to use body composition, policies/programmes, SOPs for assessing body composition in field. The primary outcomes were the implication of using body composition in community setting and moving beyond anthropometry.

This paper deals with major issues associated / linked with body composition such as:

- The problem of 'double burden of malnutrition', data on targets for achieving SDGs especially 2 and 3 for nutrition assessment and wellbeing
- Association of under and over nutrition with body composition of children from low and middle income countries, techniques of body composition assessment,
- Comparison of Bioelectrical Impedance Analysis (BIA) with other techniques for assessing body composition as a tool for screening in large samples.
- Merits and demerits of using BIA in public health surveys/national programmes.
- SOPs for assessing body composition in the field/ for public health surveys/ non clinical settings

The paper concludes with discussion on policy and research recommendations pertaining to use of Bioelectrical impedance analysis (BIA) for assessing nutrition status, screening 'at risk' population and SOP required for using this technique for public health surveys.

RESULTS

Out of all the papers that followed the research results; reviews, opinions, letters to editor and articles not in English were excluded. Out of the remaining studies, an enormous number out of them were excluded which correlated only the impact of nutrition in several secondary complications as well as studies conducted on animals. Many of them did not meet the associated topic. Programmes and their reports were identified in which nutrition-specific and nutrition sensitive interventions had been implemented in India. Finally the studies included for full text review included a total of two hundred and twenty articles. Data from these papers were identified and reviewed by the authors and sixty six were selected for this study. Amongst all the papers reviewed, only few have considered the employability of using BIA as a tool for assessing nutritional status for public health. **(Figure 2)**.

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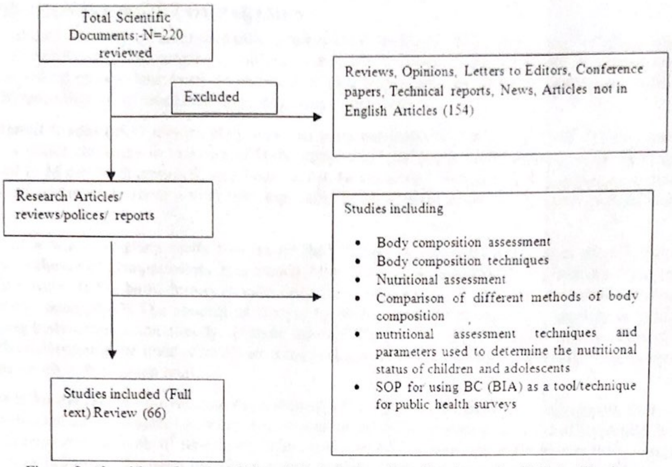

Figure 2: Algorithm of method followed for inclusion of studies chosen for Full-text Review

SIGNIFICANCE OF USING BODY COMPOSITION

Nutritional status of children is commonly assessed by anthropometric measurements (Aline SS, 2018). Change in body weight is a reflection of the changes in body water, fat, and/or lean tissue and the proportion of each contributes to the total body weight (Wells & Fewtrell, 2006;Chumela, 2008).To get a measure of malnutrition in an under-five population, children are often weighed and/or height is measured and the results compared to those of a 'reference population' (UNICEF / WHO / World Bank Group, 2019; Kumar, 2017;UNICEF, 2013). Despite its simplicity in identifying children most at risk of poor outcomes, conventional anthropometry cannot distinguish fat mass from lean mass (Lee & Gallagher, 2008). Thus, a child who is having normal body weight may still be at risk of developing metabolic diseases if the proportion of fat-mass is above normal levels and fat-free mass is sub-normal. Data generated from conventional anthropometry can therefore result in compromised inferences and subsequently wrong interventions (Khadgawat R, 2013).

Body composition assessment aims at quantifying body components: fat mass and fat-free mass in individuals and hence their nutritional status (ACF, 2018). The amount and distribution of body fat as well as the amount and composition of lean mass, are considered to be authentic health outcomes/measures of infants and child health (Lukaski CH etal, 1985). The quantity and quality of fat-free mass is associated with functional organs and tissues and may also be important for immune function (**Table 2**). Body composition has the potential that could improve identification of children most at risk of malnutrition and subsequent development of metabolic disorders later in life (Victora CG, 2010; Feldman RS, 2011; Friis H, 2015).

Body composition can be assessed by direct and indirect methods. The direct method includes Cadaver analysis where body fat is measured by direct examination of the adipocytes. Underwater weighing, total body potassium analysis, urinary creatinine excretion, and anthropometric measurements which include height/weight indices, body circumference, bone diameter, and skinfo1d thickness are indirect methods for estimating body composition (Lister, 1995).

Table 2: Proportion of body water and body weight amongst different age groups

Individual	Body Weight	Fat and dry solids (percent)	Intracellular water (percent)	Extra Cellular water (percent)
Premature infant (28 weeks)	1.2 kg	19	22	59
Term infant	3.6 kg	31	27	42
1 year	10 kg	40	28	32
Adult female	60 kg	51.4	25.9	22.7
Adult male	70 kg	45.7	30.9	23.4

Source: (Stump, 2008)

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MODELS OF BODY COMPOSITION COMPARTMENT

There is amplitude of data available on anthropometric measurements including Body Mass Index (BMI) and skinfold thickness at numerous sites, circumferences and lengths at various body parts or regions, and a number of weight for-stature indexes. These anthropometry-based models have been developed to predict body composition for all age groups (Ellis, 2000). **Table 3** summarizes the different components models for assessing body composition.

The two compartment model (2Cs) divides body into two parts basically Fat Mass (FM) and Fat free mass (FFM) i.e. all remaining tissues. A major challenge in majority of body composition technique is the direct measurement of body fat mass. However, if the total FFM can be determined, then body fat can be calculated indirectly as the difference between body weight and FFM. This model continues to serve a vital role, especially in the evaluation of newer technologies focusing on body fat assessment.

The hydrostatic or underwater weighing method works on the principle of the two compartment model. Whole body density depends on the size of these two compartments. It is assumed that the lean mass and fat component have a density of 1.10 kg/L and 0.90 kg/L respectively. If the body density is calculated then percent body fat can be converted by using Siri equation: percent fat= (495/body density)-450.The concept of computing body composition from body density is relatively simple, as compared to assessing body composition directly. Density can be defined as the ratio of mass of an object divided by its volume (D=M/V). Similarly, determining the mass of an object using scales is relatively easy in comparison to the volume of object that has an irregular shape such as the human body.

Three Compartment Model (3Cs): To overcome the limitation of 2Cs model, this model was developed. In the 3-C model, the FFM is further sub-divided into two parts i.e. water content and the fat free dry mass (protein, and minerals). In this model the ratio between the proteins and minerals of fat-free dry mass is assumed to be constant and it avoids the assumption that water content of fat-free mass is constant between individuals. Data on body mass, body volume from densitometry (e.g. under water weighing or air displacement plethysmography) and total body water (stable isotope dilution analysis or bioelectrical impedance analysis) is required in this model.

Four Compartments (4Cs) the extension to 4Cs model would estimate the protein and mineral compartments (bone mineral content by dual-energy X-ray absorptiometry), in addition to that of total body water. If one is interested in monitoring short-term changes in fat mass, approximation of the mineral mass is acceptable because this component of the 4-C model will not change significantly for the individual even over relatively long time periods. Changes in the mass of the protein component, however, may be more of a concern if not accounted for accurately. Furthermore, it is rare that significant changes in fat mass will not be accompanied by changes in the size of the body cell mass or protein mass (Ellis, 2000).

Multi-compartment Model that assesses 5-6 components. The five component model (5C) splits the total body mass into water, fat mass, protein mass, bone mineral mass and non-osseous mineral mass (notably soft tissue minerals).Wang et al. (1992) developed six component model that includes estimates for residual mass components soft tissue mineral and glycogen.These are placed to address the variability in composition of lean mass and to overcome the assumptions made in simpler models. Total Body Water (TBW) and bone mineral are specifically measured to improve accuracy in the outcomes.

Table 3: Body Composition Compartment Models (*Ellis K.J,2000*)

Level	Information obtained (Body Mass)	Number of compartment	Methods/ Techniques
Atomic	• Carbon (20percent) + Hydrogen (15percent) + Oxygen (60percent)+ Nitrogen (1percent) + Calcium (1percent)+ Others: Na, K, Cl, P, Mg, S (3percent)	11	• Whole body counting of total body potassium • Neutron Activation analysis • Hydrometry (Isotope dilution)
Molecular	• Fat Mass (15percent)+Fat-Free Mass* (FFM) (85percent)	2	• Isotope dilution • magnetic resonance spectroscopy (MRS) • Dual-energy X-ray absorptiometry (DXA)
	• Fat Mass+ Bone Mineral+ Residual	3	
	• Fat Mass + Total Body Water + Non Fat Solids	3	
	• Fat Mass + Total Body Water + Total Body Proteins +Minerals	4	
	• Mineral (6percent) +Protein (18percent) + Fat (15percent) + Glycogen (1percent) + Water (60percent)	5	

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	• Fat Mass +Total Body Water +Total Body Protein+ Bone Mineral + Soft Tissue Mineral +Carbohydrate	6	
Cellular	• Cells + Extra Cellular Fluid+ Extra Cellular Solids	3	• Isotope dilution • Bioelectrical impedance analysis (BIA)
	• Fat (18percent) + Extra Cellular Solids (9percent) +Extra cellular Fluids (27percent) + Intra Cellular Solid (12percent) +Intra cellular Fluids (34percent)	5	
Functional / Tissue Organ	• Blood (29percent) + Bone (10percent) +Adipose Tissue (25percent) +Skeletal Muscle (36percent)	4	• Computer tomography (CT) • Magnetic resonance imaging (MRI) • ultrasound, near Infrared Interactance • DXA
	• Adipose Tissue + Skeletal Muscle + Bone +Visceral Organs + Other Tissues	5	
Whole Body	• Head + Trunk + Appendages	3	• Anthropometry, • Densitometry (Hydrostatic underwater weighing, Air displacement plethysmography • BIA • 3D photonic scan

METHODS OF ASSESSING BODY COMPOSITION

There are number of methods available for assessing nutritional status through body composition viz: (weight, height stature, abdominal circumference), BMI, Mid upper arm circumference (MUAC) Waist circumference, Skinfolds thickness measurements, Bioelectrical Impedance (BIA), Dual Energy X-Ray Absorptiometry (DXA)(Bhutta ZA, 2008; Thibault R, 2012). More complex methods include bioelectrical impedance, dual-energy X-ray absorptiometry, body density, and total body water estimates, Quantitative Computed Tomography (QCT), dilution techniques, Air displacement plethysmography, Three-dimensional photonic scanning, Quantitative magnetic resonance, Magnetic Resonance Imaging (MRI)/ Magnetic Resonance Spectroscopy (MRS).

Assessing body composition can improve the monitoring of treatment progression. Alteration in the relative quantities of fat during childhood is viewed as a health risk factor later in life (Garenne M, 2006; Popkin BM, 2019; Victora CG, 2008; Black RE, 2013).

The scope, merits and demerits of anthropometric measurements such as weight, height, MUAC and skinfold thickness are well known and have been therefore outlined in the **Table 4.** Other newer methods have been discussed in detail below with special reference to Bioelectrical Impedance analysis (BIA).

Underwater Weighing

It is a direct measure to determine whole-body density which includes underwater (hydrostatic) weighing (Indorato, 2001). It is based on Archimedes' principle i.e. the volume of an object submerged in water equals the volume of water the object displaces. The density can be calculated once the volume and mass are known. Though it yield good results, this method is not always practical, involves significant training to perform, and also requires considerable cooperation of the subjects being measured because they must be submerged under water and should remain motionless during the period of assessment (Lee RD, 2003).

Total Body Potassium

This method can also be used to study body composition because more than 90percent of the body's potassium is found in fat-free tissues. Measurements are taken through a special counter that is fitted with multiple gamma-ray detectors interfaced with a computer.It is expensive and not always readily available. Not all researchers agree on the exact concentration of potassium in fat-free tissue. Moreover,gender, aging process, and obesity can compromise the results obtained by this method. (Stump, 2008; Wang ZM, 1992; Chumela, 2008)

Bioelectrical Impedance (BIA)

BIA is a non-invasive, simple, safe and rapid testing technique and is gaining popularity in view of its accuracy, precision, portability and objectivity(Rutherford, 2011). It is being used in large-scale community studies and/or for screening purposes. In these set up portable field methods are desirable for the prediction of body composition. This is a cost effective method for assessment and tracking body composition at community level but not sufficiently accurate to monitor change within an individual due to the error within the measurement. This technique is widely used in clinical medicine, sports medicine and weight reduction programmes.

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This method is based on the principle that relative to water, lean tissue has a higher electrical conductivity and lower impedance than adipose tissues because of its electrolyte content determines the electrical impedance, or opposition to the flow of an electric current through the body. Since adipose tissue is a poor electrical conductor due to its small water content, larger impedance values are observed for individuals with higher levels of body fat(Coufalová & Cochrane, 2019). The analysis of body composition by BIA produces estimates of total body water (TBW), fat-free mass (FFM), and fat mass by measuring the resistance of the body as conductor to a very small alternating electrical current (Chumela, 2008).

Most BIA devices, are small, easy to transport, and relatively inexpensive when testing large groups. They provide more authentic information as compared to the body composition scales. The BIA devices estimate the FFM and percent body fat and can store multiple sets of whole-body and segmental impedance data.BIA involves attaching electrodes to the right hand, wrist, ankle, and foot of a patient and passing a small electrical current through the body. For better results subject should be well hydrated, have not exercised in the previous 4 to 6 hours; and not consumed alcohol, caffeine, or diuretics in the previous 24 hours. If the person is dehydrated, a higher percentage of body fat than really exists is measured. Fever, electrolyte imbalance, and extreme obesity also affect the reliability of measurements(Stump, 2008) Based on the strength of the impedance along with height and weight metrics, the BIA scale will estimate fat-free body mass and body fat percentage. Bioelectrical impedance analysis (BIA) has been widely used to measure body composition and body fluid in large-scale studies because of its safety, cost-effectiveness, convenience, and easy applicability. It has high repeatability and unlike BMI and waist hip ratio, can provide information on body fat distribution but has questionable accuracy and variability of results dependent on hydration level.(Forde C, 2015)

BIA has been found to be a reliable measurement of body composition (fat-free mass and fat mass) when compared with BMI or skin-fold measurements or even height and weight measurements (Kyle, 2001). It is easy to use, accurate and economical if compared to DEXA (Chumlea WC, 1994; Hume PA, 2017;Madise NJ, 1999;Mupere E, 2019).Rush EC (2006)has recommended that bio impedance based equations (developed specifically for Asian Indians) can be used in field studies to measure body composition for Asians to predict FFM. Dehghan M (2008) in their study emphasized the need for developing specific calibration equations for different groups especially South Asians or Middle Easterners or African to cross validate existing BIA equations on new populations.According to Classy JL (2011), BIA is easy, safe, and economical method for determining body composition and can be used with a high degree of confidence in research, clinical, and field settings specifically for use in young children.

Dual Energy X-Ray Absorptiometry (DXA)

Dual energy X-ray absorptiometry, or DXA (formerly DEXA), is a newer method for estimating body fat percentage, and determining body composition and bone mineral density. X-rays of two different energies are used to scan the body, one of which is absorbed more strongly by fat than the other. A computer can subtract one image from the other, and the difference indicates the amount of fat relative to other tissues at each point. A sum over the entire image enables calculation of the overall body composition. DEXA also allows for body fat distribution analysis. It therefore helps in identifying distribution pattern of fat in various parts of the body. In the past, DEXA was only used to measure bone mineral density for osteopenia and osteoporosis in older individuals. The procedure uses a body scanner with low dose x-rays, so it's completely safe, and takes about 10-20 minutes.

It's based on a three-compartment model that divides the body into total body mineral, fat-free soft (lean) mass and fat tissue mass. Hydrostatic Weighing on the other hand only uses a 2 compartment model (fat free mass and fat mass). This technique is very accurate but is expensive and not repeatable. This technique needs a clinical setting so it is difficult to utilize this technique in public health setting.(Gupta, 2015)

Computed Tomography

Computed tomography, or CT scan, has been useful for studying nutrition status. It has been particularly helpful for assessing the deposition of subcutaneous and intraabdominal fat, which aids in determining nutritional risk associated with morbidity and mortality. It does involve the use of ionizing radiation.

Dilution Methods

The basic principle of the dilution techniques for body composition analysis is that the volume of a compartment can be defined as the ratio of the dose of a tracer, administered orally or intravenously, to its concentration in that body compartment within a short time after the dose is administered.

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Air Displacement Plethysmography

ADP is a two-compartment model that measures percent body fat and percent lean mass using Bod Pod technology. ADP uses a very precise scale to determine mass and the Bod Pod chamber to determine density. Body density is assessed to determine percent body fat and percent lean mass.

Quantitative Magnetic Resonance (QMR)

This method employs the differences in the nuclear magnetic resonance properties of hydrogen atoms in organic and non-organic environments to fractionate signals originating from whole body. It can therefore be used to measure fat, lean tissues, free water (not bound in various tissues), and total body water (TBW, water contained in all the liquids and in tissues) of live animals including humans. QMR differs from MRI in that the processed signal is obtained from the whole body at once (without spatial encoding) and it differs from MRS in that the time domain signal (rather than spectrum) is processed directly (Napolitano A, 2008).

Magnetic Resonance Imaging

MRI is an imaging technique that estimates the volume rather than the mass of adipose tissue. By analysing the absorption and emission of energy in the radio frequency range of the electromagnetic spectrum, the technique produces images based on spatial variations in the phase and frequency of the energy absorbed and emitted. Despite of high quality of imaging data obtained by MRI, there are difficulties in comparing results with those obtained by other techniques. The main advantage of MRI is its capacity for estimation of regional body composition, and it is currently the only accurate and viable approach for the estimation of intra- abdominal adipose tissue. It is however, expensive and not practical for use in public health surveys.

Table 4: Summary of different techniques, primary measurements, their advantages and disadvantages(Nassisa GP, 2006;Wells JCK, 2006; Gallagher, 2008;Goran MI, 1993; Schaefer F, 1994;Fiorotto ML, 1987)

Methods	Parameter Assessed	Capability to measure Total Fat	Capability to assess Fat Distribution	Applicability to large scale	Advantages	Disadvantages
Mid Upper Arm Circumference (MUAC)	Circumference of mid-upper arm	• Low	• Low	• Very High	• Very Simple and quick • Inexpensive • Widely used in the community setting • Sensitive	• It is Subject to observer biasness • Age specific i.e can be used only for children 6-59 months
Skinfold thickness (Gupta, 2015; Reuven, 2014)	Subcutaneous fat layer	• Moderate	• Moderate	• High	• Simple • Useful Index to assess regional fatness • Inexpensive • Dependable if measured by trained technician • Moderate suitability in community setting	• It is population specific • Moderate accuracy. • Body fat prediction is dependent on specific equation assumptions. • Requires trained personnel • It is subjected to biasness • Time consuming

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Body Mass Index (Sampaio AS, 2018; WHO, 2020)	Measurement of body fat based on height and weight	• Moderate	• Low	• Very High	• Simple and Inexpensive • Suitable for large scale studies	• Assessment of fat and lean masses and changes in fat cannot be done. • Does not allow assessment for muscle mass • Can be used for population above 5years • Sometimes over estimates the risk for some (healthy, muscular people)
Waist Circumference	Fat located in the abdominal region at the level of umbilicus(visceral fat) visceral adipose tiss ue	• Low	• High	• Very High	• Simple and quick, • Strong measure of abdominal fat • Low Cost	• Not so accurate as measure of internal visceral fat • Racial/ ethnic differences • Measurements are not always reproducible
Bioelectrical Impedance Analysis (BIA); Bio Impedance Spectroscopy (BIS);	TBW, extracellular and intracellular fluid solids, fat-free body mass and body fat percentage.	• Moderate	• Moderate	• High	• Simple and safe • It is Inexpensive. • Quick and Portable. • It provides information on the direction of longitudinal changes in lean mass • Does not intrude subject privacy • More accurate when compared to skinfold thickness	• It is population specific (age, region etc) • It has moderate accuracy in individuals and groups • Trained scientific personnel required
Dual Energy X-Ray Absorptiometr y (DXA)	Total body fat, lean mass and regional body fat and lean mass, bone mineral content and Bone mineral density (BMD)	• Very High	• High	• Moderate	• Easy to use • Radiograph radiation exposurelow • Accurate for total body mineral, fat-free soft (lean) mass and fat tissue mass • Information provided can be used as a base for estimating nutritional requirements or drug doses	• Not portable • Expensive equipment • It has low specificity • It is biased to body size, fatness, gender • Trained scientific personnel required

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Quantitative Computed Tomography (QCT)	Specific regional bone density	• Moderate	Very High	• Low	• High accuracy and • Highly reproducible	• Risk for high-radiation exposure, • Expensive equipment • Trained scientific personnel required
Dilution techniques	Total Body Water and extracellular fluid	• High	Very Low	• Moderate	• Acceptable in all age groups • Easy to administer isotopes. • Could estimate whole body lean mass if hydration known, and could potentially aid calculation of dialysis fluids	• Inaccurate in diseases state • Expensive equipment and • Manpower intensive
Air displacement plythsmograph y	Total body volume and total body fat	• Very High	• Very Low	• Low	• Relatively high accuracy in healthy population • Quick	• Reduced accuracy if used in disease states • Expensive equipment • Trained scientific personnel required
Three-dimensional photonic scanning	Total and regional body volume	• High	• Very High	• Low	• Can accommodate extremely obese persons • Easy to use • Suitable for both research and clinical applications	• Expensive • Few scanners available thus far • Trained scientific personnel required
Quantitative magnetic resonance	TBW and total body fat	• High	• Very High	• Low	• Easy to use • safe • fast • Trained scientific personnel required	• Expensive equipment • Clinical limitations • Not widely used
Magnetic Resonance Imaging (MRI)/ Magnetic Resonance Spectroscopy (MRS)	Total and regional adipose tissue (visceral, subcutaneous, and intermuscular), skeletal muscle, organs (liver, heart, kidney, pancreas, and spleen), lipid content in liver and muscle	• High	• Very High	• Low	• High accuracy and • Highly reproducible for whole body and regional adipose tissue and skeletal muscle • Content text and pictorial representation of results.	• Expensive • Non Quantifiable • Clinical setting required • Trained scientific personnel required

Standard Operating Procedures (SOPs) pertaining BIA

BIA is based on 2C model that is being used for estimating body composition. It is indirect method of assessing body composition in which the impedance is recorded and FFM is calculated.BIA is used as a parameter of nutritional status and for monitoring changes in body composition and as a variable in the calculation of protein needs.BIA can be used in children and adult population but it is not recommended in conditions like pregnancy, fever (>39 degrees Celsius), burns and / or pressure

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ulcers, pacemaker and normal hydration status e.g. edema, ascites, dehydration, dialysis.(NIHR. 2020; NHNES, 2000; Zweers H, 2018)

The measurement is based on four simple concepts

Resistance (R)	Reflects the opposition of the tissue to the flow of electrons. It is related to the amount of water present in tissues
Reactance (Xc)	Indicates the capacitive losses caused by cell membranes
Impedance(Z)	Resistance and reactance are used to calculate the impedance (Z): Impedance $(Z)^2$ = Resistance $(R)^2$ + Reactance $(Xc)^2$
Phase angle	Phase angle could be interpreted as a measure for the integrity of the cell membrane, cell function and amount of fat free mass. Arctan (reactance / resistance) x (180 / π) (Heidi Zweers, 2018).

The Z is related to the volume of body water and basically used to estimate fat free mass (FFM). Usually it is assumed that 73percent of the body's FFM is water. BIA can be analysed by using different instruments based on population setup (clinical, field) etc.

Bioelectrical impedance analysis (BIA) instruments use contact electrodes that send the electrical signal through the body. These electrodes are either patch types (similar to ECG electrodes) or stainless steel plates Different instruments unlike. Single frequency BIA (SF-BIA) has frequency of 50kHz while Multi frequency BIA (MF-BIA) has frequencies upto 800 kHz. Bioelectrical Impedance Spectroscopy(BIS) have different dimensions detailed in **Table 4.**Some BIA systems simultaneously measure impedance and body weight with a force sensor once incorporated into digital electronicscales.

Determinants in the equations to calculate fat free mass (FFM) are resistance, reactance, age, sex, height, weight and age.

Table 4: Assessment of Body Composition using different BIA instruments

Instrument	FFM	FM	TBW	ECW	ICW	Body cell mass (BCM)	Central and Peripheral FFM and FM	Total abdominal fat and visceral fat
SF-BIA	Yes	Yes	Yes	No	No	No	Yes*	No
MF-BIA	Yes	Yes	Yes	Yes	Yes	No	Yes*	Yes*
BIS	Yes	Yes	Yes	Yes	Yes	Yes	No	No

* By using multi sectoral approach only

** With few scanner only

Guidelines for preparation of equipment and subject for taking measurements

- Before starting the procedure the general settings in the apparatus can be adjusted and details needs to be entered about gender, height and weight. However, in the field setting, while collecting large scale data, the apparatus is usually adjusted to standard mode where such information may be entered separately. The requirement of the trained manpower reduces error. In this mode the output contains only reactance and resistance values.
- The device must be calibrated daily once(NHNES, 2000).
- The subject must be explained about the procedure before performing the measurements. Bladder of the subject must be empty. During the procedure subject should not eat or drink (except water) and should avoid alcohol and caffeine. No diuretics within 7 days of the test and to should minimize physical activity for at least 8 hours preceding the measurement.All metal ornaments, belts, phone, keys, braids jewelry like earrings, straps should to be removed.

Note: Standard conditions are recommended in research setting. However, these conditions are not always feasible in clinical settings& public surveys and for severely malnourished a fasting state is not recommended.

Taking Measurements

- As per standard procedure weight and height needs to be recorded.
- Before taking measurement the subject should remain in supine position for 5-10 minutes

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- Usually to standardize the technique, measurement should be performed on the right side of the body. Except in case if any artificial knee or hip, metal pins, glucose sensors, porto cad, shunts, and infusions. If any of these are present, measurements should be taken on the other side of the body and this must be reported.
- The subject must be in relaxed position and must not move during the measurement. The legs must be spread at an angle of 45° and the arms should be at an angle of 30° to the trunk.In case the subject is very obese, then insulating material e.g. towelsshould be placed between the legs and between the arms and the trunk.
- The cables must be correctly connected to the subject, they should not be near high voltage apparatus e.g. computer monitor, neithertangled nor broken.

DISCUSSIONS AND CONCLUSIONS

In this paper, trends and issues linked to body composition were identified. It can be concluded that more detailed and accurate assessment of body composition is need of the hour. Through this review challenges and gaps in research and methodological approaches were identified to lead future research. *There is paucity of data on fat mass, fat-free mass at National level on various population groups.* Data on the association between undernutrition and body compositionfrom Low and Middle income countries has revealed that there is inconsistency in the congruence of thoughts in certain areas of work such as:

- There is paucity of data on FM and FFM of free living population.
- Results of nutrition screening on the basis of body composition analysis through BIA are different as compared to those obtained through the use of conventional anthropometry. The extent of variation in identifying wasted children needs to be documented especially in case of developed and developing countries with large population.
- All forms of undernutrition adversely impact FFM in proportion to linear growth and growth retardation but the severity/amount of change is not well known.
- There is short term impact of undernutrition on muscle and organadiposity, however, the extent of change in the amount needs more documentation.
- BIA has frequently been used in clinical settings. However, the feasibility and ease of its use in field for public health surveys needs to be ascertained. Thus, there might be a need to create need-specific SOP.

Accurate measurement of body fat can be done by various techniques like under-water weighing, DXA, BIA, etc. In recent times, DXA has emerged as a tool of choice for clinical studies. BIA is also non-invasive, simple and quick method for nutritional assessment in the community and aswell as facility setting.Conventional methods yield compromised results. However, if conventional methods are applied in combination with BIAit may reduce the likelihood of misdiagnosis of high or low lean mass. This combination may not be successful when application is on disease states as regional tissue distribution will differ from those of healthy children.Currently several nutrition and health programme include anthropometric measurements for assessment of nutritional status. Now it's time to move and think beyond anthropometry for measuring body composition.BIA is the best tool for community researches due to its cost effectiveness as compared to other indirect methods. This will contribute in generating the reference values of Indian population. Accurate and valid assessment of body composition is essential for screening, diagnostic evaluation of nutritional status, identifying relevant outcome measures and determining the effectiveness of current and future nutrition interventions and thereby contributing to achieve SDGs.

However, it is important to note that if BIA is used for assessing body composition in public health surveys there would be economic implications for the following reasons:

- BIA is more expensive as compared to weighing machine, stadiometer, MUAC tape and skinfold calipers
- Need of a trained scientific manpower would be increased
- There would be requirement of a portable table and BIA equipment
- Awareness regarding the advantages of assessing body composition through BIA would need to be created among staff and general masses.

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Quality of Oils: Food Safety and Surveillance System

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Abstract—*Nations across the globe have made consistent efforts to promote availability of safe, wholesome and higher quality edible fats and oils by exerting their sovereign rights and formulating/implementing food control and food safety surveillance systems regulations. At the international level the Codex Alimentarius Commission is primarily responsible for all matters pertaining to the implementation of the Joint FAO/WHO Food Standards. At National level, India's surveillance system has the Food Safety and Standards Act 2006, draft regulation on* "***Quality of Vegetable Oil for Repeated Frying, 2017***"*, the EEE strategy for recycling of used cooking oils and the Export Inspection Council, China's National Health and Family Planning Commission (NHFPC), the Canadian Food Inspection Agency, South Korea's Ministry of Food and Drug Safety, Singapore Food Agency, Food Standards Australia New Zealand and the Europe Food Safety Authority provide regulations and directives for the food operators at various levels. The Food and Drug Administration (FDA) of the Department of Health and Human Service provides safety regulations in USA. In addition to the above, the public sector is also increasingly becoming a stakeholder in contributing towards the maintenance and enhancement of standards related to quality of edible oils.*

This review paper shall discuss the various components of food safety and surveillance system such as the quality assessment standards for edible oils and fats given by Codex, European Commission, Australia New Zealand, Canada, China, Korea, Singapore, India. Such information would give a comparative overview of quality assurance strategies adopted by several countries and help enhance the effectiveness of our edible oils quality management system.

Keywords: *Food safety surveillance system, fat and oils, FAO, CODEX*

INTRODUCTION

Quality of edible oils is closely associated with the health status, trade and economic growth of a nation. Deteriorated oil/fat quality is associated with retarded growth, irregular intestinal activities, enlarged liver and kidney, anemia as well as cancer. Substandard fats/oils also have detrimental impact on export (Xian 2012; Chuang 2013; Taraka 2015).Rising per capita income is directly related to increased consumption of edible oils. According to FAO, (2018) the per capita annual consumption of edible oils is expected to reach 24 kg and 28 kg in India and china respectively; the countries witnessing around 1.0% and 0.8% growth rate per annum. The annual per capita edible oil consumption pattern is outlined in table 1.

Table 1: Per Capita Edible Oil Consumption Pattern in Various Countries (FAO,2018)

Country	2005-2007 (kg/cap)	2015-2017 (kg/cap)	Projected/ estimated(2027)(kg/cap)
India	11	17	24
China	17	25	28
USA	40	39	41
European Union	25	26	25
LDCs	8	10	12
MENA	17	20	22

Rising intake of oils/ fats means greater processing, handling and trading. Having an understanding of the national level food safety surveillance systems of various countries can help in attaining greater compliance, improved policy decisions and hence attainment of enhanced quality standards. Attempt was therefore made to conduct an in-depth review/study of the food surveillance system components pertaining to the processing, handling and consumption of edible oils/fats.

METHODOLOGY

This review paper compares the definitions, acts, regulations/standards and covers the key concerns associated with various components of food safety and surveillance system such as the quality assessment standards for edible oils and fats. In this review paper websites of various food regulatory authorities were explored such as National Health and Family Planning

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Commission (NHFPC) of China, the Canadian Food Inspection Agency, Ministry of Food and Drug Safety(South Korea), Singapore Food Agency, Food Standards Australia New Zealand, the Europe Food Safety Authority, The Food and Drug Administration (FDA) and Food Safety and Standards Authority of India. Data were also taken from the gazettes, official government publications, research papers, review papers, reports of International and National Organizations. Information and desired data were collected via several electronic databases such as Medline (Pub-med Version), NLIST (Program of INFLBNET) and GOOGLE SCHOLAR. The following keywords were used such as food safety surveillance system, edible fat and oils, FAO, CODEX, Singapore Food Agency, Food Standards Australia New Zealand, the Europe Food Safety Authority, and Canadian Food Inspection Agency, Food Safety Modernization Act etc. Since all regulatory information was not accessible on public domain; the information was supplemented with research / review papers/ original articles/ scientific reports. Initially the objective was to compare all the salient components of food safety surveillance system of India with that of other countries. However, due to paucity of resources, review could be done only for:

- Regulatory authorities of various countries
- Chemical and physical specifications for various oils
- **Contaminants, toxins and residues**
- Import and Export regulations
- Advertisements and Claims
- Fortification

A total of thirty two scientific data sources primarily websites of national/government regulatory authorities were tapped. Based upon the information gathered, discussed below are the salient components of edible oil/fat surveillance system which have been developed and implemented in Australia/ New Zealand, Canada, China, Korea, Singapore, India and Europe/ USA, CODEX. Such information would give a comparative overview of quality assurance strategies adopted by several countries and help enhance the effectiveness of our edible oils quality management system.

FOOD SAFETY SURVEILLANCE

Surveillance means specific extension of monitoring where obtained information is utilized and measures are taken if certain threshold values related to diseases status have been found. The main objective of surveillance is outbreak detection, monitoring trends in endemic diseases, evaluating interventions and monitoring programme performance and progress towards a predetermined control objective. (FAO, 2003)

The food safety surveillance system comprises of a food control strategy. Food control encompasses a number of activities to provide consumer protection and ensure that all foods provided for human consumption are safe, wholesome, conform to safety and quality requirements, and are honestly and accurately labelled as prescribed by law. Most countries have some sort of food control system in place to achieve this goal (FAO, 2003). The food management systems or programmes developed to achieve these goals tend to be country specific. Such food management systems also need to consider international perceptions of food risks, international standards, and any international commitment in the food protection area. Therefore, when establishing a food control system it is necessary to systematically examine all the factors that may affect objectives and performance of the system (FAO, 2003). India's efforts to develop food safety surveillance system have been outlined in table 2.

CURRENT FOOD LAWS AND REGULATIONS

Governments of various countries have exerted their sovereign rights to formulate food safety regulations for their nations. Food regulations are announced by the sovereign states. However, they operate within the framework of the rules and agreements. Over the years multi-lateral rules have been developed and they are much more stringent on the development and use of standards (Josling, 2006) as compared to their former counterparts. Various measures have been taken to protect consumers against the intake of unsafe foods. At the international level is the well-known Codex Alimentarius Commission. It develops food standards and guidelines for protecting the health of consumers and ensuring fair trade practices in the food trade. The commission began to give its recommendations as early as in 1969 by recommending the 'General Principles of Food Hygiene (CXC-1-1969). Codex has set several standards for edible fats and oils. Some countries such as USA have laid down specific requirements for edible fats and oils in addition to adhering to codex standards keeping in mind their respective circumstances (CODEX, 2019).

Salient Codex Standards related to edible fats/oils include:

(A) The Codex General Standard for Contaminants and Toxins in Food and Feed (CODEX STAN 193-1995) sets out the maximum levels of contaminants and toxins such as arsenic and lead in edible fats and oils. Codex has also developed standards specific for different edible fats and oils such as:

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(B) The Codex Standard for Named Animal Fats (CODEX STAN 2111999). It applies to lard, rendered pork fat, premier jus and edible tallow;

(C) The Codex Standard for Named Vegetable Oils (CODEX STAN 210-1999). It applies to 24 tpes of vegetable oil including arachis oil, maize oil, canola oil, soya bean oil and sesame seed oil;

(D) The Codex Standard for Olive Oils and Olive Pomace Oils (CODEX STAN 33-1981). It applies to various types of olive oils and olive-pomace oils; and

(E) The Codex Standard for Edible Fats and Oils not covered by Individual Standards (CODEX STAN 19- 1981). It applies to edible fats and oils such as poultry fat, tea seed oil and walnut oil.

The International Organization for Standardization also recommends voluntary food standards. For example, theISO 22000 is a standard developed by the International Organization for Standardization dealing with food safety. The ISO 22000 international standard specifies the requirements for a food safety management system that involves interactive communication, system management, prerequisite programs, and principles of the Hazard Analysis and Critical Control Points (HACCP).The government of India revamped its food safety surveillance system by introducing the Food Safety and Standards Act in 2006 and implemented it through the Food Safety and Standards Authority of India. The primary mandate of the Act is to provide a single reference point or window for dealing with all matters related to food safety and standards. It operates on the concept of single line of command (Paul et al., 2015 and FSSAI, 2019). All countries have some or the other form of regulatory authorities which work in accordance with the stipulated Acts/legislations framed by their respective governments. The food safety authorities and acts/legislations are listed in table 3.

DEFINITION OF EDIBLE OILS AND FATS

Various food surveillance systems/regulatory bodies have defined edible oils/fats variably for example according to Food Safety and Standards Authority of **India** (2011) "*Edible oils refers to Vegetable Oils and fats but does not include any margarine, vanaspati, bakery shortening and fat spreads as specified in the Prevention of Food Adulteration Act, 1954 (37 of 1954) and rules made thereunder, for human consumption*" (FSSAI, 2011).

The **Australia New Zealand** food standard code (2016)gives a more of scientific definition i.e. "Edible oil means the triglycerides, diglycerides, or both the triglycerides and diglycerides of fatty acids of plant or animal origin, including aquatic plants and aquatic animals, with incidental amounts of free fatty acids, unsaponifiable constituents and other lipids including naturally occurring gums, waxes and phosphatides"

According to the **Singapore** Food Agency (2005) "Edible fats and oils shall mean the fats and oils modified or not and commonly recognized as wholesome foodstuffs. Unless otherwise specified, the peroxide value of edible fats and oils shall not be more than 10 milliequivalents of peroxide oxygen per kg of fat or oil. They may contain permitted anti-oxidants and anti-foaming agents".

According to the Food and Drug Regulation (2019) of Canada "*Vegetable fats and oils* shall be fats and oils obtained entirely from the botanical source after which they are named, shall be dry and sweet in flavour and odour and, with the exception of olive oil, may contain emulsifying agents, Class IV preservatives, an antifoaming agent, and B-carotene in a quantity sufficient to replace that lost during processing, if such an addition is declared on the label. ***Animal fats and oils*** shall be fats and oils obtained entirely from animals healthy at the time of slaughter, shall be dry and sweet in flavour and odour and may contain: with the exception of milk fat and suet, Class IV preservatives; and with the exception of lard, milk fat and suet, an antifoaming agent".

According to **Codex**, 2019 defines edible fats and oils as "food which is in a state for human consumption and is composed of glycerides of fatty acids of vegetable, animal or marine origin. They may contain small amounts of other lipids such as phosphatides, of un-saponifiable constituents and of free fatty acids naturally present in the fat or oil. Fats of animal origin must be produced from animals in good health at the time of slaughter and be fit for human consumption".

SALIENT COMPONNENTS OF FOOD SURVEILLANCE SYSTEM RELATED TO EDIBLE FATS AND OILS

Regulatory authorities of various countries have developed rules/ regulations/ standards which are followed by edible oil processors/ handlers and food business operators in order to protect the consumers and also to ensure fair trade practices. These are discussed under various heads below:

Food Additives in Edible Oils/Fats

The Food Safety and Standards(Food Additives) Regulation, 2011 of India provide various quality check parameters standards for severalfat/oil products. Some definitions related to use/presence of additives in oils are given below:

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- Refined vegetable oil means any vegetable oil which is obtained by expression or solvent extraction of vegetable oil bearing materials, de-acidified with alkali and/or by physical refining and/or by miscella refining using permitted food grade solvents and/or degumming followed by bleaching with absorbent earth and/or activated carbon and deodorized with steam without using any other chemical agents.
- "Refining" of vegetable oils refers to a process by which an expressed vegetable oil or a solvent-extracted oil has been de-acidified by:
- With alkali
- By physical refining, or both
- By miscella refining using permitted food grade solvent, followed by bleaching with absorbent earth and/or activated carbon or both of them and deodorized with steam without using any other chemical agent: (iv)

Refining (if required) may include the process of degumming using phosphoric or citric acid.

Oil should be clear and free from rancidity, suspended or other foreign matters, separated water, added colouring or flavouring substances, or mineral oil. Standards have been developed for refractive index, saponification value, iodine value and acid value by various countries for edible vegetable oils to help maintain their quality during the manufacturing process. These standards vary slightly from one country to another. A comparative overview of the standards given by FSSAI (2011), Singapore Food Agency (2019) and the Food and Drug Regulation of Canada (2019) is given in table 4.

While the above standards ensure maintenance of quality at the processor's level, increased consumer awareness and rising incidence of non-communicable diseases is necessitating development and adherence to quality standards by food service providers such as hotels, restaurants, mess, hostels, canteens, kiosks etc.It is increasingly being accepted that there is need to prevent misuse of oil especially oils which have been exposed to high temperatures repeatedly for long durations such as during commercial frying operations. Thus, in order to ensure food safety, manage effluent discharge and promote recycling, some countries and regions in Asia, Europe and North America have been regulating waste cooking oils. Regulatory measures include licensing or registration of collectors/disposers of waste cooking oils, restricting the delivery of waste cooking oils to designated disposal facilities only and keeping complete transaction records. India and several other countries have established regulatory limits for total polar compounds (TPCs) in frying oils. The cut-off values for TPC are given in table 5. TPC (Total Polar Compound) is an established quality index for assessing the degradation status of oils used for frying after which oil is considered unfit for consumption and can be sent for recycling. Waste cooking oil can be recycled to produce various non-edible products such as soap, biodiesel etc. (Karakaya and Simsek 2011).

Table 5: Cut off values for Total polar compounds (Firestone,1993 and FSSAI ,2017).

S. No	Country	TPC Cutoff value
1	Austria	Not more than 27%
2	Belgium	Not more than 25%
3	France	Not more than 25%
4	Germany	Not more than 27%
5	Italy	Not more than 25g/100g
6	Spain	Not more than 25 %
7	Hungary	Between 25-30%
8	India	Not more than 25%

Standards related to Contaminants, Toxins and Residues

The FSS regulation on **Contaminants, Toxins and Residues, 2011 provides crisp information regarding the tolerance levels of various chemical and biological contaminants, toxins and residues in edible fats and oils.**"Crop contaminant means any *substance not intentionally added to food, but which gets added to articles of food in the process of their production (including operations carried out in crop husbandry, animal husbandry and veterinary medicine), manufacture, processing, preparation, treatment, packing, packaging transport or holding of articles of such food as a result of environmental contamination*".At present, some jurisdictions across the world have set out the maximum levels of contaminants and toxins, including arsenic, lead, erucic acid, aflatoxin and/Benzo(a) pyrenor enzoyren, allowed in edible fats and oils.

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In 2005, the Joint Food and Agriculture Organization of the United Nations/World Health Organization Expert Committee on Food Additives stated that "the estimated intakes of polycyclic aromatic hydrocarbons (PAHs) including B[a]P were of low concern for human health". In order to protect public health and address public concerns, the CFS has set an action level of 10 µg/kg for B[a]P in edible oils. The level has been endorsed by the Expert Committee on Food Safety and is also applicable to fats. The Expert Committee noted that based on local consumption data, even in the unlikely event that all edible oils consumed by a person are contaminated with B[a]P at 10 µg/kg, the derived Margin of Exposure (MOE) will be greater than 10 000, indicating an estimated intake of B[a]P which is of low concern for human health.

Aflatoxins can cause both acute and chronic toxicity. Aflatoxin B1 is the most potent aflatoxin and can cause acute liver damage and cirrhosis in animals. Naturally occurring aflatoxins, including aflatoxin B1, has been classified as a human carcinogen (Group 1) by the International Agency for Research on Cancer (IARC). Aflatoxin M1 is also classified by IARC as a possible human carcinogen (Group 2B). The level of aflatoxin can be substantially reduced in the refining process of vegetable oils. B[a]P is toxic to genes and can cause cancer in human. B[a]P is a kind of polycyclic aromatic hydrocarbons (PAHs). PAHs are ubiquitous in the environment. When cooking oil is heated during processing, B[a]P may also be generated. Refining processes can reduce the level of B[a]P in cooking oil and the final levels depend on the refining conditions adopted (Legislative proposal, Hong Kong, 2015).

Table 2: Timeline of Acts/Laws/Regulations in India

S. No.	Year	Name of Act/ law/regulation
1	1947	Vegetable Oil Products (control) Order
2	1954	The Prevention of Food Adulteration Act
3	1967	Solvent Extracted Oil, De oiled Meal, and Edible Flour (Control) Order
4	1998	Edible Oils Packaging (Regulation) Order
5	2006	Food Safety and Standards Act
6	2011	Food Safety and Standards (Licensing and Registration of Food Businesses) Regulation
7	2011	Food Safety and Standards (Food Products Standards and Food Additives) Regulation
8	2011	Food Safety and Standards (Prohibition and Restriction of Sales) Regulation
9	2011	Food Safety and Standards (Packaging and Labelling) Regulation
10	2011	Food Safety and Standards (Contaminants, Toxins and Residues) Regulation
11	2011	Food Safety and Standards (Laboratory and Sampling Analysis) Regulation
12	2016	Food Safety and Standards (Health Supplements, Nutraceuticals, Food for Special Dietary Use, Food for Special Medical Purpose, Functional Food and Novel Food) Regulations.
13	2017	Food Safety and Standards (Food Recall Procedure) Regulation
14	2017	Food Safety and Standards (Import) Regulation
15	2017	Food Safety and Standards (Approval for Non-Specific Food and Food Ingredients) Regulation
16	2017	Food Safety Management System – Edible fats/Oils (GMP/GHP)
17	2018	EEE Strategy and RUCO (Repurpose Used Cooking Oil)
18	2018	Food Safety and Standards (Fortification of Food) Regulation
19	2018	Food Safety and Standards (Food Safety Auditing) Regulation
20	2018	Food Safety and Standards (Recognition and Notification of Laboratories) Regulation
21	2018	Food Safety and Standards (Advertising and Claims) Regulation, 2018
22	2018	Food Safety and Standards (Packaging) Regulation
23	2019	Food Safety and Standards (Recovery and Distribution of Surplus food) Regulation

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Table 3: Salient Food Safety Acts/Regulation and Standards Related to Edible Fats/Oils in Various Countries

Country	Authority	Salient Act/Law/ regulation/ Standards
Australia New Zealand	Food Standards Australia New Zealand	- Food Standards Code (2003) - Standard 2.4.1 Edible Oils - Standard 1.4.1 Contaminants and Natural Toxicants
Canada	Canadian Food Inspection Agency	- Food and Drug act. 1985 (amended 2019) - Food and Drug Regulation (amended 2019)
China	- State Council (Department of Health) - Food safety Committee for Risk Analysis and Assessment	- Food Hygiene Law 1995 - Comprehensive Food Safety law of the People's Republic of China, 2009
Europe	- European Commission	- General Food Law, regulation (Reg.) EC NO. 178/2002 - Codex committee on Fats and Oils, 2013 - Directive on HACCP programme (96/3/EC)
India	- Food Standards and Safety Authority of India	- Food Safety and Standards Act, 2006 - Food Safety and Standards Regulations, 2011 onwards
Singapore	- Singapore Food Agency	- Food Regulations (Sale of Food Act) - Food Prohibition Regulations 2019
South Korea	- South Korea's Ministry of Food and Drug Safety	- Food Code: Article 2. Common Standards & Specifications for General Foods; - Article 5. Standards and Specifications for Each Food Product
USA	1 The US Department of Agriculture (USDA) Food and Drug Administration (FDA) of the department of Health and Human Service	• Food Safety Modernization Act. (FSMA 2017).

Table 4: Specifications for edible oils/ fats of various countries

Country	Refractive Index	Saponification Value (mg KOH/g oil)	Iodine Value (Wjis)	Acid Value (KOH)/(mg/g)
Soyabean oil				
India	1.464-1.471 (40°C)	189-195	120-141	Not more than 2.50
Singapore	1.472-1.476 (20°C)	189-195	120-141	NA
Canada	1.466-1.470 (40°C)	189-195	120-143	Not more than 0.6
Virgin Olive oil				
India	1.460-1.463 (40°C)	184-196	75-94	Not more than 6.0
Singapore	1.468-1.471 (20°C)	185-195	77-94	NA
Canada	1.467-1.470 (40°C)	184-196	75-94	Not more than 6.6
Cotton seed oil				
India	1.463-1.466 (40°C)	190-198	98-112	Not more than 0.50
Singapore	1.472-1.474 (20°C)	190-198	100-116	NA
Canada	1.458-1.466 (40°C)	189-198	99-119	Not more than 0.6
Peanut oil				
India	1.462-1.464 (40°C)	188-196	85-99	Not more than 6.0
Singapore	1.468-1.472 (20°C)	188-195	84-105	NA
Canada	1.460-1.465 (40°C)	187-196	80-106	Not more than 0.6
Safflower seed oil				
India	1.467-1.468	186-196	135-148	Not more than 6.0
Singapore	1.472-1.476 at 20°C)	186-198	135-150	NA
Canada	1.467-1.470	186-198	135-150	Not more than 0.6

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Palmolein oil				
India	1.455-1.461	195-205	54-62	Not more than 6.0
Singapore	NA	NA	NA	NA
Canada	NA	NA	NA	NA
Rapeseed oil (Mustard oil)				
India	1.464-1.466	168-177	96-112	Not more than 6.0
Singapore	NA	NA	NA	NA
Canada	NA	NA	NA	NA

Table 4: Continued

Country	Refractive Index	Saponification Value (mg KOH/g oil)	Iodine Value (Wjis)	Acid Value (KOH)/(mg/g)
Coconut oil				
India	1.448-1.4491	Not less than 250	7.5- 10	Not more than 6.0
Singapore	1.448-1.450	250-264	7-11	NA
Canada	NA	NA	NA	NA
Sunflower oil				
India	1.464-1.469	188-194	100-145	Not more than 6.0
Singapore	1.474-1.477 (20°C)	185-195	118-141	NA
Canada	1.467- 1.469 (40°C)	188-194	110-143	Not more than 0.6
Corn oil				
India	1.463-1.467	187-195	103-128	Not more than 0.50
Singapore	1.473-1.475(20°C)	187-193	103-128	NA
Canada	1.465-1.468	187-195	103-128	Not more than 0.6
Sesame oil				
India	1.464-1.466	188-193	103-120	Not more than 6.0
Singapore	1.472-1.476(20°C)	188-195	103-116	NA
Canada	NA	NA	NA	NA
Palm oil				
India	1.449-1.455(50°C)	195-205	45-56	Not more than 10.0
Singapore	NA	NA	NA	NA
Canada	NA	NA	NA	NA

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Table 6: Recommendations on Safety Parameters for Edible Fats and Oils in Different Countries

Parameter	Codex	European Commission (EC)	Australia/ New Zealand	Canada	China	Korea	Singapore	India
Aflatoxins	NA	NA	NA	≤15ppb (nuts and nut products; the aflatoxin content of a nut or nut product shall be calculated on the basis of the nut meal portion.)	Aflatoxin B1 ≤20ppb (peanuts oil, corn oil); ≤10ppb (other vegetable oils)	≤10ppb (peanut, nuts and their processed food (grinding, cutting etc.)	Aflatoxin B1: 5ppb (Any article of food except food for infants or young children); Aflatoxins, total (B1, B2, G1 and G2): 5ppb (Any article of food except food for infants or young children)	30μg/kg (all articles of food)
Arsenic	≤0.1mg/kg				≤0.1mg/kg		≤0.1mg/kg	0.1mg/kg

Table 6 Continued

Parameter	Codex	European Commission (EC)	Australia/ New Zealand	Canada	China	Korea	Singapore	India
Benzo[a]pyrene	NA	≤2ppb (oils and fats (excluding cocoa butter and coconut oil) intended for direct human consumption or use as an ingredient in food)); ≤2ppb (Coconut oil intended for direct human consumption or use as an ingredient in food)	NA	NA	≤10ppb (Edible fats and oils and their products)	≤2ppb (edible oil)	NA	NA
Erucic acid	≤2% (Low-erucic acid rapeseed oil)	≤50g/kg (Vegetable oils and fats);	≤20,000mg/kg (edible oils)	NA	low-erucic acid rapeseed oil: Not detected-3%, general rapeseed oil: 3-60%	NA	NA	NA

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Lead	≤0.1mg/kg	≤0.1ppm (Fats and oils, including milk fat)			≤0.1 mg/kg (Edible fats and oils and their products)		≤0.1mg/kg (Edible oils and fats)	0.1(parts per million by weight)
Reference	Codex General Standard for Contaminants and Toxins in Food and Feed (Codex Stan 193-1995)	Commission Regulation (EC) No. 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs	Australia New Zealand Food Standards Code Standard 1.4.1 Contaminants and Natural Toxicants , 2017	Food and Drug Regulations	China's National Health and Family Planning Commission (NHFPC)	Food Code: Article 2. Common Standards & Specifications for General Foods; Article 5. Standards and Specifications for Each Food Product	Food Regulations, 2005	FSSAI, 2017

IMPORT AND EXPORT REGULATION OF EDIBLE FATS AND OILS

Food Safety and Standards (Import) Regulations, 2017 lay down the procedure for clearance of food products imported into India and include various provisions related to licensing of food importer, clearance of imported food by the food authority,food import clearance for specific purposes, compliance with standards for packaging and labeling, storage and sampling of imported food; analysis of samples of imported food; prohibitions and restrictions on imports of certain foods/their products.In India government has established the Directorate General of Foreign Trade and APEDA (Agricultural and Processed Food Products Export Development Authority) to facilitate export and import such as of agricultural produce. Focus of these organizations is on good governance, and accountable delivery systems. In order to facilitate international trade, these organizations work in close coordination with various Export Promotion Councils as well as Trade and Industry bodies from time to time (Foreign Trade policy, 2017).

At the international level, several countries have outlined the safety parameters of oils imported to their country such as in case of USA and the European countries; the standards being similar to those advocated by their homeland food laws/ CODEX standards. In Singapore, importers of processed food (including edible fats and oils) are required to maintain regulated source documentation and produce them when requested by the relevant enforcement agency. These documents may include Certificate of HACCP (Hazard Analysis Critical Control Point), Certificate of GMP (Good Manufacturing Practices), health certificate, food factory license etc.

As for export requirements, exporting countries/places generally do not require that edible fats and oils for exported must be accompanied by official health certificates. Nevertheless, different countries/places issue health certificates for specific edible fat and oil products, if required, by the importing countries/places. Examples include the veterinary certificate for lard issued by the Taiwan Food Authority, the health certificate for peanut oil issued by the Mainland's Entry-Exit Inspection and Quarantine Bureau, the sanitary certificate for olive oil issued by the Italian Food Authority, the "Phytosanitary Certificate" for olive oil and grape seed oil issued by the Spanish food authority, the health certificate for corn oil by South Korea, the veterinary certificate for the export of lard and rendered fats by the Netherlands, etc. For edible oils of animal origins, the Canadian Food Inspection Agency (CFIA) issues a standard export certificate for meat and meat products to companies seeking to export such products. For edible oils of plant origins, no official certificate is issued. However, for canola oil manufactured in Canada, a "Manufacturer's Declaration for Export of Food Products manufactured in Canada" could be completed by the manufacturer and countersigned by the CFIA stating that the CFIA would have no objection to the sale of the product in Canada. Currently, the US Food and Drug Administration (FDA) does not issue any health certificate for export of edible plant oils. The FDA only issues "Certificates of Free Sale" for the products concerned, certifying that the products are marketed in the US or eligible for export, and that the FDA has no enforcement action taken or pending against the particular manufacturer.

FORTIFICATION OF FOODS

The Food Safety and Standards (Fortification of Foods) Regulations, 2018 provides recommendations related to fortification of edible fats and oils. This regulation came into force w.e.f. 1st January, 2019. The provisions of these regulations have superseded standards on fortification of food set out in any other regulations, orders, or guidelines issued under the Act. In India, oils can be fortified with micronutrients namely Vitamin A and vitamin D. Table 7 gives the recommended values of micronutrient fortification of edible vegetable oils.

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Table 10: Recommended Levels for Fortified Vegetable Oils

S. No	Nutrient	Level of nutrient	Source of nutrient
1	Vitamin A	6µg RE- 9.9 µg RE per gm of oil	Retinyl acetate or Retinyl palmitate
2	Vitamin D	0.11 µg- 0.16 µg per gm of oil	Cholecalciferol or Ergocalciferol

Note: Vitamin A (retinol): 1 IU= 0.3 µg RE (Retinol Equivalent); Vitamin D (Cholecalciferol or Ergocalciferol): 1 IU= 0.025 µg

Mandatory fortification refers to a condition or recommendation by a regulatory authority when food manufacturers are required to add certain vitamins or minerals to a specified food or foods. These are added in response to a significant public health need. For example in Australia, manufacturers must add vitamin D to edible oil spreads such as margarine. 'Table Edible Oil Spread must be edible oil spread which contains no less than 55 µg/kg of vitamin D (Australia New Zealand Food Standard Code 2016).

ADVERTISING AND CLAIMS REGULATIONS

Food Safety and Standards Authority of India provides the regulations pertaining to claims and advertisements (2018) by food business operators in respect of their food products. These regulations are aimed at establishing fairness in claims and advertisements of food products and make food businesses accountable for such claims /advertisements so as to protect consumer interests.

Many claims, listed in various schedules of **Food Safety and Standards (Advertising and Claims) Regulation** with related criteria, are permitted to be made by food business operators without the need for seeking prior approval from the food regulator. However, other types of claims not standardized under this regulation may require approval from the food authority and should be supported with sound scientific basis. With a detailed procedure for approval of claims included in these regulations, food businesses may seek prior approval from FSSAI for reduction of disease risk claims other than those specified in these regulations. These regulations contain several sections detailing definitions; general principles for claims and advertisements; criteria for nutrition claims (including nutrient content or nutrient comparative claims), non-addition claims (including non-addition of sugars and sodium salts), health claims (reduction of disease risk), claims related to dietary guidelines or healthy diets, and conditional claims; claims that are specifically prohibited; and procedures for approval of claims and redressal of non-compliances under these regulations.

Most countries provide details of the prohibited claims on edible fats and oils. For example Regulation 9 of the food regulatory authority of Singapore provides details of the claims which are prohibited on food labels and advertisements such as '*false or misleading statements, words, brands, pictures, or marks purporting to indicate the nature, stability, quantity, strength, purity, composition, weight, origin, age, effects, or proportion of the food or any ingredients are not allowed to be used on food labels and advertisements, unless otherwise specified. The use of claims for therapeutic or prophylactic action; claims which could be interpreted as advice of a medical nature from any person; claims that a food will prevent, alleviate or cure any disease or condition affecting the human body; and claims that health or an improved physical condition may be achieved by consuming any food, is also prohibited.*

CONCLUSION

During the preparation of this review, it was observed that official websites of food regulatory authorities are more useful in gathering necessary information as compared to research papers and original articles. Some organizations have 'paid access' component for retrieving data which is not supportive for preparation of such review works. The review indicated that the regulatory authority for each target jurisdiction/country utilizes its own regulatory framework. Although the definitions, regulations and approval processes may vary among various countries, in general there are many similarities in the food surveillance system pertaining to edible oils/fats and their products. In all cases, the main purpose of each regulatory authority is to establish a framework of action and maintain/enforce regulations to ensure the safety of food consumed/sold both within as well as outside their respective jurisdiction. Research needs to be given impetus on an on-going basis to support development of proof-based standards. Capacity building is critical for further improvement of the food safety monitoring and management surveillance system especially in under -developed and developing nations.

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