REVIEW ARTICLE

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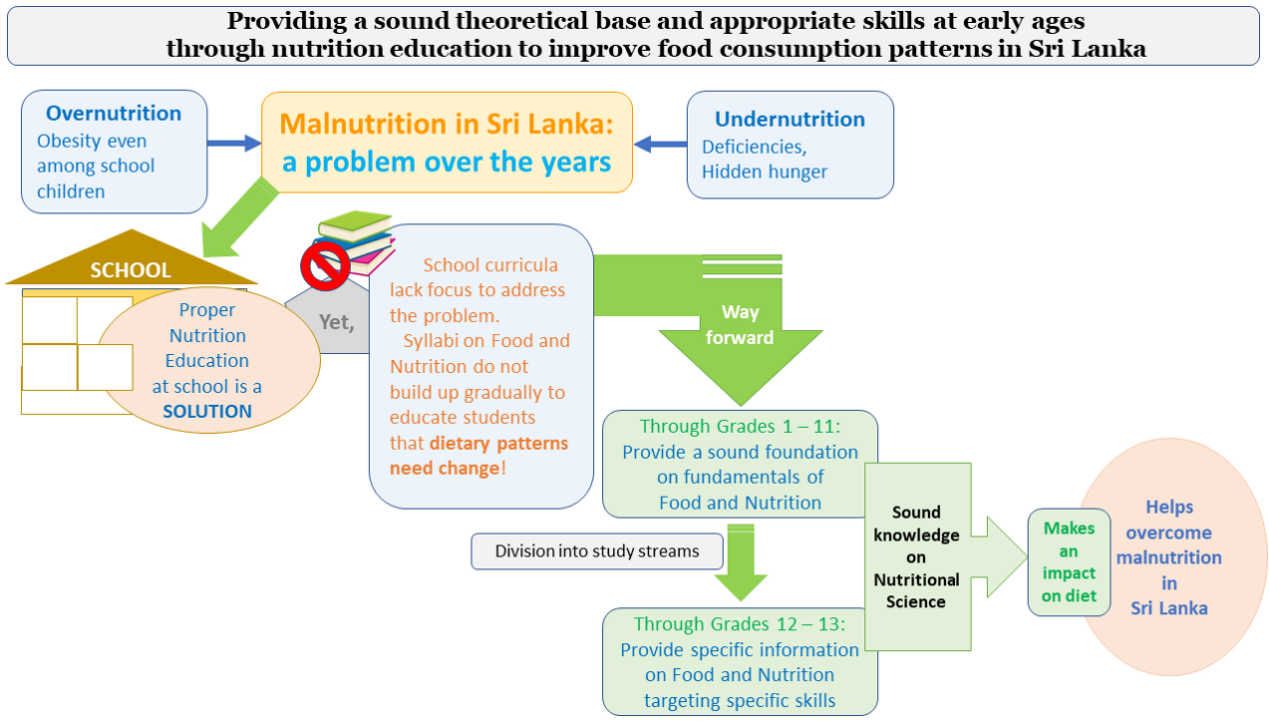

Highlights

- Indices on malnutrition in Sri Lanka have not changed considerably over the years.
- Currently knowledge gained by students is not applied in daily life.
- Giving a solid foundation on basic concepts of nutrition will be effective.
- The typical cereal based diet can be made wholesome by dietary diversification.
- Means to reorganize nutrition education in school curricula are suggested.

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Providing a sound theoretical base and appropriate skills at early ages through nutrition education to improve food consumption patterns in Sri Lanka

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Abstract: In Sri Lankan schools, the topic of food and nutrition is included from Grade 1 onwards until secondary school, and beyond depending on the field of specialization. In spite of that, national nutritional statistics indicate that the nation's food consumption patterns are far from satisfactory. Marginal deficiencies in micronutrients known as hidden hunger, and unhealthy excess weight gain associated with non-communicable diseases (NCDs) even among school children are current day issues pertaining to malnutrition. The cereal-based Sri Lankan diet typically low in animal sources of food could be converted to a more wholesome diet with only simple modifications. Educating the future generation on core nutritional concepts specified by the National Nutritional Policy will carry the message of nutrition to society and will enable strengthening the countrywide food security. The present review argues that deficiencies in food consumption patterns could be rectified with minimal changes to the school curricula by systematically introducing relevant nutritional information from Grade 1 onwards, gradually developing to secondary education level. Incorporating general nutritional concepts to the curricula, first concentrating on compulsory subjects, before grade 11 and thereafter providing specialized knowledge when the students are divided into different streams, thus aligning the content with the specialization called for, is envisaged to have an immediate impact on the society. This review identifies some topics to be included and skills to be developed at each level to provide a systematic means of rectifying unhealthy eating patterns. This is an endeavor where nutritionists and educationists have to work together with the common goal of resolving the nation's nutritional problems.

***Keywords*:** Nutrition education for primary and secondary schools; dietary diversification; malnutrition; hidden hunger; food security.

INTRODUCTION

The causes of malnutrition worldwide are multifactorial, with education playing a pivotal role in curbing its effects. In Sri Lanka, sources of nutritional information are diverse. Currently food and nutrition is a topic covered from Grade 1 onwards and continues up to secondary education. Apart from this formal source, the local public gets information on current trends in healthy eating through various other means. For instance, the local media (radio, television, and feature pages of newspapers) emphasize the need to have a healthy and nutritious diet through a multitude of programs. Additionally, there is an effort in Sri Lanka, in addressing specific nutritional problems through maternal education at ante-natal and post-natal clinics countrywide. Also, school lunch programs especially at preschools pay attention to providing a nutritious diet to the growing children while carrying the message of nutrition to their care givers. The Nutrition Division of the Ministry of Health, keeps updating related information on its website which is freely available for all interested parties. At an international level the World Health Organization (WHO) maintains a database with the acronym eLENA, e-Library Evidence for Nutrition Action, which is accessible on the internet and its aim is to help countries to successfully implement and scale-up nutrition interventions through their services: https://www.who.int/elena/using/en/.

However, based on nutritional statistics of Sri Lanka,it is obvious that the knowledge gained on nutrition has not made a significant impression on the nation's eating patterns (elaborated later in this review). Even achievements in combating malnutrition over the last few decades have been modest in Sri Lanka with malnutrition remaining as an unresolved health issue (Liyanage, 2016). A way to address a hitherto underexplored area in nutrition education, is to include practically applicable nutritional concepts in the school syllabi so that such ideas are channeled to the homes and the outcomes would materialize fast.

The school syllabi cover certain topics of nutritional concepts at different levels, starting from primary school (Grades 1-5), at secondary school before dividing into different streams of study (Grades 6-11, in the subjects of Science, Health and Physical Education and Home Economics) and after dividing into different streams in secondary school (Biology, Biosystems Technology, Home Economics and Agricultural Science). Each stream of specialization has its own unique potential contribution to improve the nutritional status of the country. The mother playing the pivotal role of providing a nutritious meal for the family, it is of interest to note that maternal education level below Grade 10, influences nutrition of the progeny (Samarasekara *et al*., 2019).Globally too, most analyses have found maternal education to have an inverse relationship with malnutrition (UNICEF, 2011).

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As the present day school children will be the future parents of this country, it is time to break the vicious cycle of malnutrition taken root in the country so that future generations will be free of this menace. For this, the message should reach the maximum number of students. Therefore, it is important that key nutritional concepts are incorporated into compulsory subjects before the subject streams are divided.

Having a good focus on the nation's nutritional problems will help in organizing the course content so that there is a gradual buildup of information starting from lower grades. The National Nutrition Policy guidelines (2010) is a valuable source to extract relevant information. Effectively converting the relevant information to lessons and skills to be included at each level, taking the mental maturity of the student into account in the lower grades, and aligning with the subject specialization at higher grades is the task of the pedagogical community. A well-planned curriculum is envisaged to help not only in resolving existing nutritional problems with an immediate impact but also will open novel employment opportunities. This paper looks at the key issues that should be addressed in nutrition education at school level to have an immediate impact on the nation's nutrition and health, in addition to having a positive impact on food security and the economy of the country.

With that objective, in this review, after appraising the typical diet of Sri Lankans over the years, specific ideas that could have a positive impact on solving nutritional problems of the society are discussed. The focus on the latter sections of this review is on relevant topics of nutrition that should be added to school curricula, while appraising the currently taught content. It looks at in perspective, the specified curricula and modifications necessary to achieve the objective with only minimal changes to the content taught. It is an endeavor where nutritionists and educationists have to work together. Before elaborating, it will be beneficial to sum up some key factors influencing nutrition status of the country's population.

Nutritional indices and influencing factors

To provide an understanding on the current nutritional problems, the content in this section concentrates on how malnutrition manifests in the country, specifically focusing on early life.

Malnutrition is undernutrition and overnutrition

Nutritional indices on Sri Lankans show wide variations, pointing to the fact that existing nutrition related problems are diverse and complex. Improper nutrition, commonly referred to as malnutrition, may manifest as both undernutrition and overnutrition. In certain Districts of Sri Lanka such as Nuwara Eliya, Badulla, Ratnapura, and Trincomalee severe undernutrition is recorded as protein energy malnutrition, vitamin A deficiency, iron deficiency anemia, and iodine deficiency disorder (UNICEF, 2011). Countrywide escalation of non-communicable diseases (NCDs) linked to excessive consumption of digestible carbohydrates (such as refined white flour and sugar) and fat is also of concern (Katulanda *et al*., 2010; Jayawardena *et al*., 2012; Senarath *et al*., 2019).A study conducted in 2005 - 2006 reports that 75% of Sri Lankan adults have dyslipidemia and the risk factors are identified as physical inactivity, obesity, hypertension, and diabetes (Katulanda *et al*. 2018). It is appalling that obesity even amongst school children has become an actuality (UNICEF, 2011). The topic of obesity is taken up again when discussing specific nutritional problems.

Overnutrition has to be another aspect for nutritionists to deal with. It is apparent that unhealthy food intake patterns have contributed massively to the present scenario. Worldwide, over the years, changes towards unhealthy dietary patterns have occurred due to diverse social and economic transformations, that have led to a phenomenon known as nutrition transition, where traditional diets have gradually got replaced with diets having excess fat, refined carbohydrates, and salt. This has made the problem more complex. This trend is also coupled with reduced physical activity as a result of labor intensive occupations of the past gradually getting automated (Karunaratne, 2019). With regard to Sri Lanka, the traditional patterns of intake of rice and curry meals have not undergone much change (as elaborated later in this review), although less energy is required on a daily basis for most Sri Lankans than in the past.

Early life is critical

Appropriate nutrition is critical at every stage of life. Nutritional adequacy in early years is important not only for proper growth and development from infancy to adulthood, but also, in combating NCDs later in life. The Barker hypothesis upheld widely in numerous research investigations, put forward the idea that the health of an adult can be determined by how that individual grew as a fetus inside the mother's womb where reduced fetal growth is strongly associated with a number of NCDs which can occur later in life (Barker, 1990; Barker, 2004). The chances of an unhealthy mother giving birth to an unhealthy infant are high and hence nutrition cannot be neglected at any age.

A critical age group for which nutrition plays an important role, particularly in brain development is from birth to the preschool age (ages 6 - 59 months). Even when overt deficiency symptoms are absent, this age group is vulnerable to hidden hunger, leading to lethargy and poor performance in school (Muthayya *et al*., 2013). Hidden hunger is a subtle situation where the body is deprived of a number of essential micronutrients and hence body growth (height and weight gain) measured by various anthropometric parameters gets retarded, indicating a tendency towards inadequate immunity and probable retardation of brain development.

In Sri Lanka, as done globally, the nutrition level of preschool children is adjudged by three key anthropometric parameters, *i.e.*levels of stunting, wasting, and under-weightness. As reported in publications which are based on information gathered on the national nutrition surveys of 1989, 1993, 1996, and 2000 (Jayantha, 1983; Ratnayake and Weerasinghe, 1990; Gunasekera, 1996), and theabove

mentioned parameters for preschool children, are far from satisfactory. Based on this information, it appears that the stunted population of preschool children has decreased slightly after the 1980 decade, but there has not been a major improvement thereafter and wasted population has remained stagnant, if not slightly increased. Almost half the children appear to be underweight, in the surveys that have determined this parameter, *i.e.* 1993 and 2000 (Karunaratne, 2007). More recently, based on anthropometric information from 2006 to 2011, Liyanage (2016) reports that there are nutritional problems at different stages of life, with the prevalence of low birth weight fluctuating between 16.9% and 17.6%. The latest national figures for underweight, wasting and stunting are 20.5, 15.1, and 17.3 respectively (AHS, 2021), which shows that undernutrition parameters among preschool children still remain the same.

Filtering out critical facts

With such a multitude of influencing factors, deciding on the information that should be included in the school curricula should be done after much thought, concentrating on factors that would show an immediate impact. When one sees the number of students converging at bakeries and kiosks where such food is sold, soon after school hours, it is obvious that the information gained in the class has not left a lasting impression. The student seems to have merely gained knowledge, without an understanding of the facts. At a global level, considering the vast knowledge pool under the umbrella of the science of nutrition that keeps growing, it is important to filter out information that is immediately relevant to the Sri Lankan diet. The aim of such an attempt should be providing practical ideas to combat malnutrition in the country focusing both on undernutrition and overnutrition. What is clearly apparent is that while an ill-planned diet can cause various health issues, a well-planned wholesome diet can not only provide nutrition but also good health.

To explore explicit dietary factors to be addressed, after having a broader understanding of the Sri Lankan diet, we will glance through currently discussed nutritional problems linked to the typical rice and curry diet.

Typical diet of the nation and trends in nutrition related diseases

An overview of the current day diet will help in evaluating its nutritional adequacy in comparison to what was consumed historically. After looking at the dietary changes, the susceptibility to nutrition related diseases will be considered from information available from historical records. This in turn will help in evaluating the positives and negatives of the current day eating patterns.

The typical composition of the Sri Lankan diet

It can be assumed that the average Sri Lankan has three main cereal-based meals, with or without snacks in-between. The main meal (often the lunch) comprises mainly rice, some vegetables and sometimes an animal source of food. For dinner and breakfast, rice based products or wheat flour based products like hoppers, string hoppers, pittu, bread, buns, noodles, and flatbread like roti, or even a pulse as boiled seeds, or dosa are consumed. Typically, for such traditional dinner and breakfast meals, the number of accompaniments may be reduced to one, often a sambol (with or without scraped coconut) made with onions and lime juice and a coconut gravy as appropriate (Karunaratne, 2007). Dietary diversification, *i.e.* getting nutrients from a diverse variety of foods is promoted by nutritionists (Ministry of Health, 2016), not only to assure food security but also for better nutrition and health. Low dietary diversity is recognized as a contributory factor for under nutrition (UNICEF, 2011). In that backdrop, it is important to rethink of the daily menu of the average Sri Lankan.

Looking back at historical mentions, the diet of Sri Lankans over the years does not seem to have changed drastically (Table 1). According to Wikramanayake (2000), one of the first recorded intensive studies on the nutritional status of Sri Lankans addressing the composition of the diet has been by the eminent Englishman, Dr. Lucius A. Nicholls who served Sri Lanka, then Ceylon until 1945. It is of interest that, Dr. Nicholls has published his data (Nicholls, 1936) on an extensive country-wide nutrition survey (based on three levels of social status, encompassing three ethnic groups) in this same journal, Ceylon Journal of Science, 80 years ago. Nicholls (1936) has based his inferences on anthropometric measurements and 24 hour recall data on food intakes. Referring to the nutrition related problems in Sri Lanka, Nicholls (1936, 1939) highlights the improper diets of poorer classes (across all ethnic groups) of Ceylonese (Sri Lankans). Excess intake of carbohydrates and lack of vitamins and minerals (now referred to as micronutrients), are recognized as the problem at large rather than starvation (Nicholls, 1936). Now this condition is referred to as hidden hunger (Section 2.2). Display of low anthropometric parameters is an indication of hidden hunger and it is of interest to note that in the study of Nicholls (1936), the poorest classes showed the lowest anthropometric parameters and lightest birth weights. In a concurrent report by Nimalasuria (1939), the inferior quality of the diet of poorer Ceylonese (Sri Lankans) is highlighted. A common parameter highlighted in these pioneering studies, is the insufficient intake of milk, pulses, and animal sources of food. Also, polished rice consumption has been popular in this era (Jayaram, 1939; Nicholls, 1939). Even a decade later there has been concern regarding insufficiency of milk for the growing population of Ceylon (De Silva, 1955).

According to Table 1 milk has not been listed as a component in the diet before the 1960s. It is explicitly mentioned by Obeyesekere (1966) that milk was taken rarely in his cohort of hospitalized patients. Nicholls (1936) has advocated soyabean, quoting from the then situation in Japan where lack of milk has been compensated to a certain degree with soyabean. While milk consumption is still low in Sri Lanka compared to other countries in South Asia, since 1981 per capita consumption has exceeded by over 50%, *i.e.* from 13 kg/year to about 36 kg/year (Ibrahim *et al*., 2003). Presently the country imports more than half its

Table 1: The description of the diet consumed by Sri Lankans in a chronological sequence, as described in different research studies.

Diet	Description	Reference
Polished rice, dhal, a few vegetables, coconut, and usually a little fresh or dried fish	Diet in general	Nicholls, 1939
Small amounts of green leaves and fruits, and the absence of milk	Diet in general	Nimalasuria, 1939
Polished rice consumption, wrong choice of vegetables (not specified) and low levels of food of animal origin	Diet of school children	Jayaram, 1939
Chiefly rice and flour with, dried fish, vegetables, coconut, and coconut oil. Little or no protein of animal origin was consumed and fresh milk was taken rarely	Hospitalized patients from 1955 -1962	Obeyesekere, 1966
Rice, bread, and wheat flour, yams, bread fruit, jak, pulses, meat, egg, dried fish, milk, and milk products, fruit and vegetables, leafy vegetables, sugar and jaggery, oils and fats	On estate workers, with emphasis on preschool children	Liyanage, 1984
A high intake of starchy accompaniments (jak fruit, bread fruit) and low intake of green leafy vegetables	Preschool children of 3 to 5 years	Karunaratne *et al*., 2008

requirements of milk to meet its demand (Vyas *et al*., 2020). The current popularity of fermented milk products such as yogurt and curd is a move in the right direction, considering the importance of including fermented foods in the diet as highlighted in Section 4.8. One of the contributory factors for slightly improved nutrition at present when compared to half a century ago may be the increase in milk consumption.

Specific nutritional problems in the Sri Lankan population, from early days to present

It is recorded that the global malnutrition burden in the first half of the 20th century was characterized by hunger and micronutrient deficiencies that led to the development of diseases such as beriberi (Ridgway *et al*., 2019) which manifests as a result of vitamin B1 (thiamine) deficiency. It is ironical that the word beriberi as given in the Oxford English Dictionary is derived from Sinhala language. Beriberi is primarily caused by the consumption of polished rice. Jayaram (1939) highlights this fact by reporting "While inadequacies in protein, vitamins and minerals have been highlighted in the diets of early dwellers, the main reason for this has been identified as polished rice consumption". Nicholls (1936; 1939) too elaborates that the state of nutrition of the lower class Ceylonese is poor not due to starvation but by deficiencies of minerals and vitamins (micronutrients). A later report (de Silva, 1955), documents that kwashiorkor, a disease that affects malnourished small children due to protein deprivation, existed among Ceylonese adults. Interestingly, de Silva (1955) also mentions that kwashiorkor was not as common in the young, perhaps implying that the children's meals were better planned than that of adults. Even as late as the 1960s the chief cause of death among preschool children is reported to be linked to micronutrient deficiencies (Fernando, 1962; 1963). Undernutrition has been a cause for hospitalization of adults between 1955 - 1966 (Obeyesekere, 1966). A study carried out two decades later also describes vitamin deficiencies in the aetiology of phyrnoderma (follicular hyperkeratosis) attributed to the typical diet of Sri Lankans, composed mainly of coconut and rice, which are poor sources of both tocopherol (vitamin E) and riboflavin (vitamin B2) (Christiansen *et al*., 1987). (While vitamin E is found abundantly in nuts and oilseeds, milk is a good source of riboflavin.) Vitamin A deficiency presented as keratomalacia and Bitot's spot have been common in the early to mid-20th century (Piyasena, 2001) although such acute deficiencies of vitamin A are not recorded in recent studies.

The above-mentioned reports seem to point to the fact that malnutrition in Sri Lanka is largely woven around insufficiency of micronutrients, although lack of food in certain segments of the population has to be addressed. It is noteworthy that getting a nutritionally balanced meal has been a challenge throughout the history of nutrition in the country. The problems of the majority could be assumed to be linked to poor eating habits and inappropriate methods of preparation of food as discussed later.

Making the problem more complex, with the turn of the current century, a strong correlation of obesity and susceptibility to NCDs is showing an upward trend in Sri Lanka, with the incidence of obesity escalating on the local population (Jayawardena *et al*., 2012; Jayawardana *et al*., 2017). Overnutrition, with regard to excessive consumption of starch, refined sugar and fat, along with lack of exercise, is seen as the causative factor for the prevalence of obesity (UNICEF, 2011). A branch of nutritional investigations done in Sri Lanka also focus upon combating NCDs such as cardiovascular diseases (Senarath *et al*., 2019), and metabolic syndrome (of which obesity is a key symptom), a risk factor for the development of a number of NCDs (Ranasinghe *et al*., 2017).

A critical evaluation of the nutritional adequacy of the current Sri Lankan diet

The factors affecting the diet are many and interrelated. However, to enable a discussion on such factors affecting the present day diet, this section is divided into nine

subtopics. These are the factors, which if not rectified, could lead towards malnutrition in the society.

Dietary diversity of meals unsatisfactory

What is plainly apparent from the descriptions of the diet in a chronological order hitherto discussed is that there have not been major changes in the composition of main meals. The typical diet of Sri Lanka with rice as the staple is described as high cereal based with low intake of animal food sources (Tudawe and Wikramanayake, 2000). Unresolved problems on the choice (quality and quantity) of the ingredients that make up the Sri Lankan diet are evident when appraising the nutritional parameters of children and adults. However the absence of widespread records of unhealthy skin and hair amongst recent research findings, and the records of lowered percentages of children suffering from kwashiorkor and marasmus, show that there has been some improvement over the years.

One of the major contributory factors that has reduced acute nutrient deficiencies reported in earlier studies, may be considered as the change in the consumption pattern of the staple rice. While the process of polishing is known to remove most of the micronutrients, parboiling before polishing is known to be helpful in retaining protein, health beneficial phytochemicals (Pal *et al*., 2018) and certain micronutrients (Karunaratne *et al*., 2008). The current trend of consumption of both raw rice (sometimes as flour in the preparation of various rice based breakfast and dinner menus) and parboiled rice alternatively, seems to have resolved some of the problems reported in earlier studies, at least partially.

Globally, nutritionists advocate dietary diversification, through which, inadequacies in one food will be compensated by the other. The lack of diversity in the diet that prevailed from historical times (Section 3.1) has remained almost the same, in spite of efforts taken at a national level to resolve this. The Nutrition Division of Ministry of Health (2016) tries to rectify this problem by keeping the public informed. The Food Pyramid provided for Sri Lanka has listed commonly consumed food in seven groups. A wholesome meal should include at least the five food groups from the base of the food pyramid with restricted intakes from the two groups at the tip (Ministry of Health, 2016). With various nutrients interacting positively and negatively in their process of absorption into the body, diversification of components that make up a meal by choosing diverse foods within and among specified food groups is of paramount importance to provide varied environments to intake specific nutrients.

Although rice and lentils compose of the main meal currently, all types of seeds including a variety of pulses have been an integral part of the Sri Lankan diet from ancient times. This has been discussed in a paper by Perera *et al*. (2010) which mentions that pulses were called Shimbi (meaning capsular seeds) and there have been more than 1500 traditional rice varieties divided into two groups as “Ma-vee” and “El-vee”. The elders of the rural community of Sri Lanka are much knowledgeable of the local food plants, and obviously it is a knowledge pool that is gradually slipping away from the youngsters. It is known that undernutrition is more prevalent in the rural poor than the urban rich (Samarasekara *et al*., 2019). Unfortunately, many resources readily available especially to the rural poor may not be included in their diet, due to mere lack of knowledge.

Excessive dependence on the starchy staple

Looking at the proportions in the rice and curry plate of an average Sri Lankan, depending excessively on the cereal staple to get the nutrients is evident. This habit tends to load the consumer with unwanted levels of energy leading to visceral fat deposition and obesity. The heavy dependence on the cereal staple to get most of the nutrients, namely digestible carbohydrate and protein but also some vitamins (specifically B group vitamins) and minerals adds excessive amounts of energy to the diet which is not healthy. Starch is the energy source in a cereal based diet, which provides approximately 4 kcal of energy per gram. In the specification of the WHO, popular starchy accompaniments such as jack fruit, breadfruit and yams are excluded as fruits and vegetables, obviously because starch is abundantly available from a variety of sources. This excess energy is obtained at the expense of losing some essential nutrients such as iron, zinc, and vitamin A. However, these starchy vegetables do have their specific micronutrients (Wanasundera and Ravindran, 1994; APAARI, 2012) which could supplement and enrich the meal. Therefore, despite that such starchy fruits and vegetables will add to the energy content of the meal, when they are added it is important to reduce the portion size of the cereal staple. This way these starchy vegetables that are available in plenty in Sri Lanka also can contribute to dietary diversification.

Based on the eating patterns of a country, the WHO specifies guidelines on how much energy each macronutrient (carbohydrate, protein, and lipid) should provide in a typical meal. The Food Based Dietary Guidelines (FBDG) for Sri Lanka which takes into account the country’s eating patterns and the guidelines set by the WHO, provides such information in a booklet titled Food Based Dietary Guidelines accessible on the Ministry of Health website (Ministry of Health, 2016).

Vegetarianism with inadequate consumption of pulses

A primarily a vegetarian diet should be planned wisely to meet the essential protein requirements, *i.e.* quantity and quality. Pulses complement with cereals in providing quality proteins by the phenomenon of protein complementation. Pulses are not only nutrient dense, but also rich in health promoting phytochemicals. A serving size of 100g (half a cup) of cooked pulses per day has been suggested (Mudryj *et al*., 2014; Marinangeli *et al*., 2017) for health benefits from phytochemicals in pulses.

As each plant source of food taken in isolation has deficiencies in certain amino acids that are considered essential in the human diet (*i.e.* essential amino acids), it is well established that mixing a pulse with a cereal is

especially useful when the meal is vegetarian to get the required quality and quantity of protein. Considering the low intake of meat, fish, and egg, protein complementation by including a pulse with rice (or any other cereal) is an important message that should be given to the nation.

Animal based foods to improve protein quality

Among the accompaniments to cereal based meals, consumption of animal based foods (meat, fish, eggs, milk) that serve as protein sources is varied, their choice being governed by various social factors. However, a UNICEF report based on Sri Lankan children states that association between a child not consuming fleshy foods and being underweight is marginal (UNICEF, 2011). Currently there are many studies that report that protein requirements do not have to be met by animal sources of food only.

With the Sri Lankan Government taking initiatives to improve the local dairy industry to meet the increasing demand on milk (Vyas *et al*., 2020) the practice of including a dairy product, as done in India, will improve the protein quality of the meal. Milk can compensate for the limiting amino acids in plant based foods (Schaafsma, 2012). While the Indian rice diet has a percentage digestibility of 77%, when milk too is consumed the digestibility increases to 87% (WHO, 2002). There is still no scientific evidence about the minimum amount of milk protein required to exert an adequate effect on weight gain and growth among children of different age groups, while the impact of other sources of protein and other beneficial compounds needs to be considered (Sherbaum and Srour, 2018).

Inadequacy of fruit and vegetable intake

Irrespective of country boundaries, the WHO has specified that one should consume at least 400 g of fruits and vegetables (excluding starchy fruits and vegetables). Hence, this specification is also given in the FBDG for Sri Lanka. In the Sri Lankan way of serving meals, with the higher proportion of rice (or bread), the contribution of nutrients from accompaniments is reduced. Such accompaniments, which are mainly vegetables, along with fruits play a key role in being sources of vitamins and minerals (micronutrients) and dietary fibre, as well as health promoting phytochemicals such as antioxidants. Both vegetables and fruits have essential roles in combating NCDs (Auneet *et al*. 2017). If we roughly estimate the amount of fruits and vegetables consumed per day, it is very likely it does not match this requirement. One of the authors (Karunaratne, 2019) demonstrated this by estimating the components that make up the typical diet of a Sri Lankan individual. A half a century ago Jayaram (1939) mentions of wrong choice of vegetables as the cause of malnutrition. Most probably, the wrong choice Jayaram mentions may include starchy vegetables such as jack fruit, bread fruit and yams available in plenty in rural areas. Such starchy accompaniments have been popular in a rice and curry meal even historically (Table 1). Presently, they are often consumed with wheat flour-based products such as bread and roti.

Dark green leafy vegetables, and yellow and orange colored fruits and vegetables are rich in carotenoid compounds which are known as pro-vitamin A. Depending on their specific structure, certain carotenoids convert to vitamin A in various proportions within the body. Although acute deficiency symptoms for vitamin A are not common presently, one factor that is strongly associated with the prevalence of under weightiness in preschool children has been insufficient consumption of vegetables that provide vitamin A (UNICEF, 2011). However, over the years, an important trend contributing to better nutrition than half a century ago, may be the more frequent addition of carotenoid rich vegetables, obviously knowledge gained from health care workers, mainly targeted to combat vitamin A deficiency. In addition, carotenoids also impart protective effects for NCDs through their antioxidant property.

Recipes and cooking methods that do not preserve nutrition

A major concern with regard to increasing vegetable accompaniments with rice, is the Sri Lankan style of making curries. It is the general habit to either add excessive amounts of oil or excessive amounts of coconut milk to the curries, and the curries are allowed to cook for a prolonged period of time. This method of cooking not only destroys some of the heat sensitive vitamins, but also concentrates the lipids in the curry. Therefore, when attempting to consume more vegetables in meeting the WHO recommendation, invariably such oil laden curries will lead to excess intake of fat which also contributes to susceptibility to NCDs. Including salads and boiled vegetables is a way to reduce the intake of oil in the meal.

Limited awareness on anti-nutrients

Another issue with regard to plant based foods is the presence of anti-nutrients in them. Pulses in spite of being nutritious and health promoting, are well known to be excessively laden with anti-nutrients. Therefore, it is important to get rid of their anti-nutrients before consumption. The excessive heating of vegetable curries as practiced in Sri Lanka, may destroy some of these anti-nutrients, unfortunately along with the nutrients and health promoting substances present in them. Perhaps the harsh cooking practices of our ancestors may have been woven around getting rid of the anti-nutritional substances in plant based foods. However, most vegetables need not be cooked for prolonged hours, and there are different ways to minimize the effects of anti-nutrients present in pulses. For instance, pulses which have a considerable number of anti-nutrients can be soaked overnight in water. Pressure cooking or excessive cooking on a stovetop is helpful in making pulses palatable with minimized anti-nutrients. Partial polishing of rice grains, rather than total polishing is another method to minimize the anti-nutrients present in the outer layers of the grain, while benefiting by the nutrients present in the same layers.

Lack of adaptability to include novel healthy foods

Sri Lankans can borrow many ideas from other countries to improve dietary diversity and nutrition of the daily diet by incorporating and adapting to suite our tongue. The lack of initiative to explore possibilities should be corrected by the education system. Only two examples are discussed here although the possibilities could be countless.

Sprouted seeds, microgreens, and baby greens

These are not only novel methods contributing to dietary diversity but also germinating the seed to different degrees help in reducing the effect of anti-nutrients. Micro greens and baby greens (Senevirathne *et al*., 2019) are different stages of germination achieved after sprouting of seeds. In the process of germination, the level of protein would decline, but such germinated seeds are an excellent source of many minerals and vitamins. It should be emphasized however, that sprouting reduces the level of a major anti-nutritional substance, phytic acid but it also reduces the protein content. Making a knowledgeable decision, including both seeds and germinated versions of them in the diet helps in the diversification of the diet. While the consumption of these germinated seeds are popular in several other countries, this form of consumption of seeds is not that well known and not that popular among most Sri Lankans.

Fermented foods

Many are the choices of foods such as seeds and vegetables that could be fermented to provide novel accompaniments to the rice and curry meal. Fermentation using health promoting microbes is another method of reducing the anti-nutritional substance phytic acid, resulted through microbial phytase produced by certain microorganisms used to ferment foods. In Sri Lanka, the most commonly consumed fermented products are curd and yogurt (Karunaratne, 2018). The cooked products made of fermenting black gram dough, such as dosa and wada will have less anti-nutrients (Seneviratne *et al*., 2012). There are many ideas of fermented foods that can be incorporated into the Sri Lankan diet. Sauerkraut, kimchi, beet kvass, and various recipes where fermented black gram (*Vigna mungo*), fermented chickpea also known as Benghal gram (Kadala in Sinhala, Kadalai in Tamil) (*Cicer arietinum*), rice based fermented product known as ricera, com-me, fermented soya bean (soybean) known as tempeh (soya Karawala)are just a few examples to try out (Karunaratne, 2018). Various countries have their own traditional fermented foods prepared at a household level based on techniques passed on from generation to generation. Despite this, fermented foods should be tried with caution given that they are made with the use of microorganisms. As it will be difficult to differentiate pathogenic microorganisms, it is important to see that the pH of the fermented product is below 4.6, the cut off pH for food safety. A specified amount of salt (sodium chloride) is added before allowing fermentation to prevent the growth of pathogenic microorganisms. Some of these techniques being totally novel to Sri Lanka, transfer of technology from the class room to the kitchen has to be done with expert advice.

Some key concepts and issues on which to base the school curricula

Having looked at the typical eating patterns of the nation along with the influencing factors, by now the reader should have an idea of the problems to be addressed. The cereal based diet of Sri Lankans typically low in animal food sources (Tudawe and Wikramanayake, 2000) could be made into a wholesome diet with only a little effort, by channeling suitable information through the modification of the school curricula. For this, a gradual buildup of ideas, making use of information readily available from the Nutrition Division of the Ministry of Health (2016),while being aware of the guidelines of National Nutrition Policy (National Nutrition Policy guidelines 2010) seems to be a good strategy to adopt.

Food pyramid

Improving nutrition of the diet needs to be addressed both at a qualitative level and a quantitative level. Internationally, nutritionists have divided food into different categories and present such information in the form of a food plate known as my plate or as a food pyramid. The food pyramid specified for Sri Lanka (Ministry of Health, 2016) has grouped food into seven groups (Section 4.1). The idea is to simplify the information for the general public to be aware of the necessity to include foods from different categories, so that even a person not knowledgeable in nutrition, knows what should be included in the daily diet.

Along with the lack of diversity, consumption of inappropriate proportions of different food categories leading to poor nutrition in the daily diet is an obvious problem. In the food pyramid portion sizes are stipulated for each group of food. The idea of depicting different food groups in the shape of a pyramid is to give a clue on the proportions to consume. At the base of the food pyramid are the numerous carbohydrate rich foods that Sri Lankans consume to get mainly energy. While it is necessary to consume a carbohydrate staple (rice, bread, starchy fruits, and starchy vegetables) in higher proportions than the accompaniments to get the daily energy requirements for the body, exceeding the former in proportions leading to excess intake of energy has a negative impact on the overall nutrition. Just above carbohydrate rich food are fruits and vegetables. All locally available fruits and vegetables, which may not have any commercial value, can be included in this group. Also, among the vegetables are the diverse green leaves that are locally available. The fruit and vegetable group provides micronutrients and additionally, bulk in the form of food fiber. While food fiber does not contribute to nutrition in a significant way, it is important to maintain good health; for instance to aid in bowel movements and to maintain a healthy gut flora. At the next level in the food pyramid are protein rich foods that include all animal sources of food and pulses pooled together as a single group. Just above in a separate group are, milk and milk products such as yogurt, curd, and cheese. At the summit of the pyramid are those food groups that should be consumed sparingly. Nuts and oilseeds are classified together. In addition to the fat soluble vitamins in such

fatty foods, there are two essential fatty acids, *i.e.* linoleic acid and alpha-linolenic acid that must be included in our diet. These can be obtained from invisible sources of fat too that are naturally present in all types of seeds, especially oilseeds and pulses. Linoleic acid is widely distributed in the plant sources of food, but alpha-linolenic acid is present only in a few natural plant sources, including soyabean.

Anthropometric parameters

The use of body measurements such as height, weight, waist circumference and hip circumference to get an idea about healthiness of the individual, and how calculations are done to determine various anthropometric parameters would be relevant for curricula. The degree of stunting, underweight, and wasting of preschool children (ages 6 - 59 months) as discussed (Section 2.2), will be important topics to include in the curricula. For children in Grade 1 and beyond, body mass index referred to as BMI [weight (Kg)/height^2 (m^2)] may be used to determine whether they have a healthy physique. Also being knowledgeable on the ratio of waist to height (Ashwell and Gibson, 2016), a parameter which is used to determine whether an adult has excess visceral fat (indicated by a value above 0.5 for this ratio) is important information to provide to the students. A positive spinoff of including this information in the school curricula and recording the data systematically is that such information will help in developing suitable national cutoff points for Sri Lankan children.

Recommended dietary allowances

While the food pyramid gives the rough portion sizes to consume, the amounts of nutrients needed based on level of activity of the individual, body weight, gender, and physiological status (pregnant or lactating) are provided in a Recommended Dietary Allowances (RDA) table. The RDA table for Sri Lankans could be downloaded from the website of the Medical Research Institute of Sri Lanka (http://www.mri.gov.lk/assets/Nutrition/2007-RDA-MRI-.pdf)).

Food composition tables

Food composition tables are also useful to determine the amounts of nutrients. International food composition tables may be downloaded from the internet. Confusions may arise with units used (*i.e.* for energy kilocalories and joules, for vitamins several units including milligrams, micrograms, international units) for which careful attention is needed. There are numerous reliable online sources of information pertaining to this, for instance, the Food and Agriculture Organization and the WHO, to obtain relevant information in the absence of local information.

Diverse dietary choices from each food group in the food pyramid

The carbohydrate providing foods include seeds of the monocotyledonous plant family Poaceae, such as cereals [rice, wheat, corn, sorghum (*Sorghum bicolor*), oats, barley, and different types of millets (Table 2)] and other cereal like seeds (pseudo cereals). A locally available pseudo cereal is the seed of the water lily, Olu (S), *Nymphaea lotus* var. *pubescens* of family Nymphaeaceae, which is eudicotyledonous. Also included in this carbohydrate providing category are yams available locally (Table 3). Ash plantain, jack fruit and bread fruit rich in starch, also belong to this category of carbohydrate rich food.

Another important aspect to educate students is to discuss on the different primary processed products in the market, *i.e.* parboiled and raw rice, semolina (wheat grits), and flaked rice (Habala Pethi in Sinhala, Avel in Tamil). These could be included in the diet adding to dietary diversification. It will be important to discuss on how the above mentioned primary processed products are made, and the nutrients they provide.

Protein requirement can be met by an array of sources including those of animal and plant origin. The plant sources of protein, *i.e.* pulses are known to have a diverse range of health promoting substances other than complementing cereal protein in the diet. Among the

Table 2: Names used in Sri Lanka and elsewhere, to refer to different millets.

Scientific name	English name	Sri Lankan vernacular names in Sinhala (S) and Tamil (T)
Echinochloacrusgalli	Barnyard millet	Vel-maruk (S)
E. colona	Barnyard millet	Gira-thana (S)
Eleusinecorocana	Finger millet	Kurakkan (S and T)
E. indica	Finger millet	-
Panicum miliaceum	Proso millet	Meneri (S) Shamai-Karunai (T)
Panicumsumatrense	Little millet	Heen-meneri (S)
Paspalumscrobiculatum	Kodo millet	Amu (S)
Pennisetumglaucum	Pearl millet	Kambu (S)
Setariaitalica	Italian/foxtail millet	Tana-hal (S), Tinai (T)

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Table 3: Starchy roots and tubers consumed in Sri Lanka.

Scientific name	English name	Sinhala name	Tamil name
***Colocasia esculenta*[1]**	Aroid	Gahala	Ceppankelangu
***Xanthosoma sagittifolium*[1]**	Aroid	Kiri-ala	_
***Alocasia macrorrhizos*[1]**	Aroid	Habarala	Parumsembu
***Amorphophallus paeoniifolius*[1]**	Elephant-foot yam	Kidaran	Karunai
***Canna edulis (C. indica)*[2]**	Indian shot	Buthsarana	_
***Helianthus tuberosus*[3]**	Jerusalem artichoke	_	_
***Ipomoea batatas*[4]**	Sweet potatoes	Batala	Velkelangu
***Dioscoreaalata (D. purpurea)*[5]**	Purple yam	Raja ala	Rasavallikelangu
***Manihot esculenta*[6]**	Manioc	Maiokka	Maravelikelangu
***Plectranthusrotundifolius*[7]**	Country potato	Innala	_
***Maranta arundinacea*[8]**	Arrowroot	Araluk-piti	_
***Solanum tuberosum*[9]**	Potatoes	Arthapal	Urulakelangu

* 1.Araceae 2.Cannaceae 3.Asteraceae 4.Convolvulaceae 5.Dioscoreaceae 6.Euphorbiaceae 7.Lamiaceae. 8. Marantaceae 9. Solanaceae

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pulses are soya bean, mung, cowpea, horsegram or kollu (*Macrotyloma uniflorum*,), chickpea, black gram, different types of peas *i.e.*green peas, yellow peas or vatana (*Pisum sativum*), pigeon pea (*Cajanus cajan*] and lentils such as regularly consumed Masoor dhal (*Lens culinaris*). Textured vegetable protein commonly referred to as TVP is made from soya beans after extracting oil. TVP has more than 50% protein but it is void of oil and nutrients linked to fat, *i.e.* essential fatty acids and fat soluble vitamins.

Nuts and oil seeds are grouped together in the food pyramid, and in spite of being nutritious, nuts are notorious for causing allergic reactions. In Sri Lanka however, the choice of nuts is limited mostly to groundnut and cashew-nuts, the latter may be beyond the reach of many, unless in the cashew growing areas. Coconut which is an integral part of Sri Lankan cooking can be classified as an oil seed. Sesame seeds known to have many health beneficial effects are used mainly in making sweet meats and sprinkling a few seeds on buns. Sesame could also be sprinkled on boiled vegetables and used in stir fried dry vegetable curries to add color and nutrition. In several other countries pumpkin seeds and sunflower seeds (*Helianthus annuum*) are used as healthy snacks although in Sri Lanka there is no attempt to promote the former and the latter are often scooped out before making a curry of pumpkin pulp. A word of caution however; sunflower pollen and seeds could cause allergies and aggravate asthma. The sunflower seeds from larger flower varieties are more palatable than those from smaller varieties as the seeds from the latter may have harder shells. These seeds may be boiled for a prolonged period and thereafter sundried and roasted to serve as a snack.

Except for fat and sugar group which should be consumed sparingly and hence placed at the summit of the food pyramid, an attempt should be made to include all other groups of food on a daily basis, being within the specified portion sizes. Cooking oils which are extracted from various seeds may contain some fat soluble vitamins in addition to providing energy unlike refined white sugar which provides only energy. As a word of caution, it is worth mentioning that repeated frying with the cooking oil once used, is not a good practice as this can lead to formation of unwholesome fatty acids in the fried food.

Dietary diversity is achieved not only by choosing from these different categories in the food pyramid, but also by diversifying within a category. In the choice of pulses in the local diet, lack of diversity is particularly apparent, but this seems to be the trend with regard to the consumption pattern from all categories in the food pyramid. Regardless of there being a variety of other pulses, the reason for opting for lentils (dhal) may be due to the acquired taste and its affordable price.

Misconceptions on food

Among the misconceptions on food that have pervaded the Sri Lankan society is that mushrooms are rich in protein. While mushrooms have mainly water and minerals, their level of protein is approximately 3%, which is similar to the amount provided by green leaves and therefore they should be classified under vegetables. Even leguminous pods have about 2-2.5% protein and also should be classified as vegetables. In Sinhala they are called Bonchi (Cothu in Tamil) which translates as beans in English giving the wrong idea that they are pulses (grain legumes). Even winged bean (Dambala in Sinhala) pod is only a vegetable, and is not a rich source of protein. Additionally, wholegrain rice does not have to be red in color. The red color is due to the pigment anthocyanin, and wholegrain rice without the red color have a brown color before

polishing. Another misconception for generations has been that tomato has oxalic acid. While tomato is considered a health food mainly because of the carotenoid pigment lycopene, if one is not sensitive to it, tomatoes must be added to the daily diet frequently. However, lycopene is one of the few carotenoid pigments that does not serve as pro-vitamin A. Also, most if not all of the sago in the Sri Lankan market is obtained from manioc flour and it does not have the properties expected of sago from the sago palm (*Metroxylonsagu*). The authentic sago is obtained by the same process described in the obtaining of Kitul flour *i.e.* from the pith of the plant.

Two other misconceptions to be considered; what we throw away as waste is really not so. For instance, when we consume banana inflorescence, habitually we use only the inner tender floral parts with the spathe, after discarding the outer flowers, along with the outer spathes. In other countries such as India and Thailand, the brightly colored outer spathes are not consumed just like we do, but they separate out, the outer tender flowers and consume these outer flowers after removing the gynoecium (as it is tough to chew) of each flower (Karunaratne, 2019). Also, the shell of passion fruit is a rich source of pectin, which is recorded as conferring various health benefits. The boiled peel, after removing the outer papery skin, can be stewed in the juice of the fruit and consumed as a dessert or could even be mixed into a fruit salad.

Vegetarianism: specific problems to address

One major concern for a strict vegetarian who does not consume even milk and dairy products, is the absence of vitamin B_{12} in plant based foods. However, it is available in milk and dairy products, lactic-fermented products, and vitamin B_{12} fortified foods. One important message for strict vegetarians is, to include a reliable source of vitamin B_{12} in their diet (vitamin fortified foods or supplement).It is worth noting that persons taking vitamin B_{12} tablets should chew them slowly or allow them to dissolve under the tongue to optimize absorption (Agnoli *et al*., 2017).

The effects of antinutrients should be minimized through various preparatory methods (Section 4.7). A general lack of knowledge of preparatory methods to reduce or remove anti-nutrients typically present in plant based foods seems to be a contributing factor for nutritional problems among vegetarians. Protein complementation is of paramount importance to get quality protein. Including soyabean in the diet is also important to get a good supply of alpha-linolenic acid (Section 5.1).

Converting knowledge to understanding and skills

Appropriate teaching methods are of immense importance in converting knowledge to an understanding and acquired skills. After having discussed in detail the key concepts and issues (Section 5), this section highlights a few ideas where key information on nutrition could be converted to teaching material. As food is a part of the living process, unlike any other subject it is close to life, and hence should be easier to grab the attention of the student.

The subject of food and nutrition is covered from Grade 1 onwards, to give a general awareness of the food one eats and some basic information on nutrients. Additionally, food safety issues and methods of processing and preserving of food are covered significantly at various levels in different Grades. The content of the subject of nutrition mainly concentrates on the nutrients and deficiency diseases with mentions of NCDs. The subject matter does not seem to be developed in a gradual manner to build up relevant knowledge and skills, to leave a lasting impression. Several activities can be suggested to rectify/ improve this.

Many activities could be designed with the use of the food pyramid. An excellent classroom activity would be to place different foods under each category making students participate actively by providing information they have collected as a take-home assignment. When more and more choices have to be included into the food groups, there may be doubts about, to which food group a chosen food would belong. The teacher should be able to reason out with the students based on the main nutrient provided by the food source in question. Even commonly consumed starchy accompaniments (Section 5.5) should be moved to the carbohydrate rich food group. If all students actively participate one could expect to see many underutilized ignored fruits and vegetables in the surroundings getting listed in the food pyramid. Currently there is a global trend to include certain flower petals in salads to get health beneficial substances present in their pigments (Karunaratne, 2019).

Sri Lanka being a tropical country with an abundance of vegetation with high diversity, finding food plants, including those with no commercial value will not be a difficult task particularly in rural surrounding. To be able to identify diverse plants of which the leaves are edible in the school compound and in the locality of homes together with the help of knowledgeable elders will be a fascinating activity for the students. Being able to open up and interact with the society to get such information, will also help students develop soft-skills in outreach activities which will be helpful as he/she reaches adult-hood. Being able to identify food plants and their edible parts is an important skill to develop. Particularly, differentiation of pulses from cereals, and familiarizing with the range of pulses and cereals available for consumption (Section 5.5) could serve as an essential skill to develop. Also in this exercise, attempting to classify other edible seeds that do not fit as cereals and pulses will be a learning experience.

There is no place in the food pyramid for the numerous spices and herbs added to the Sri Lankan dishes. These are rich in many micro-nutrients and antioxidants (health promoting phytochemicals). Given that spices like chilies, coriander, garlic, ginger and similar spices are used almost on a daily basis, their contribution to our health and nutrition cannot be underestimated. Due to their immense health beneficial effects, addition of spices in appropriate combinations and proportions may be encouraged in curry preparations and exploring their combined effects on various dishes can be a skill development activity.

Learning cooking methods that retain nutrition of the end product would be an engaging activity. For instance, this can be done with regard to preparation and cooking of pulses by employing methods to remove anti-nutritional substances. Appropriate cooking methods (including traditional methods, being aware of the scientific basis) may be tried out in the classroom. For instance, a nutritionally important pulse is soya bean. Soya beans are rich in both protein and oil containing essential fatty acids. However, cooking soya beans has to be done correctly, to remove anti-nutrients. The beans have to be steeped and cooked for a prolonged time to remove these substances. Another such example is taking precautions to prevent formation and getting rid of cyanogenic glycosides in manioc in the process of harvesting, storing, and cooking. This is an example where the traditional empirical methods have a strong scientific reasoning.

Presentation of dishes which are appealing and nutritious is another area to get the students engaged. This involves designing menus as well. Combining a cereal and a pulse to the meal is an excellent method to improve protein nutrition. Pulses and green leaves are rich in many minerals and vitamins, and therefore including them in any dish will improve its wholesomeness. The ultimate aim should be to get the student to reap from the knowledge gained, thus making a dish that is not only nutritious but also attractive.

Diversifying healthy choices hitherto confined only to certain dishes may be encouraged. For instance, the green-leaf porridge (Kola-Kende in Sinhala) could be made more wholesome by blending a pulse (either whole or ground) into it. Also, as a means to incorporate green leafy vegetables to children's plates, novel colorful ideas can be generated, such as adding finely cut leaves to the dough, blending and adding the juice with the debris to vegetable curries. Finding palatable and nutritious alternatives for the excessive addition of coconut milk to curries is also important. This could involve adding soya bean flour or chickpea flour, or even ground boiled lentils to thicken the curry. Providing nutritious meals by introducing various green leaves and pulses in a colorful and appealing manner in dishes will attract even those who dislike these. Novelty foods can be designed with minimum resources. For instance, making sprouts, micro greens and baby greens will be exciting classroom exercises.

Activities of attempting to cultivate food plants, and in turn use them in dishes will not only be adventurous but also would help school children in developing their innovative skills. For instance such skill development would include growing them, harvesting, storing, and cooking, and sometimes even preserving. With regard to cultivating of plants, the Department of Agriculture provides a free service of advice to such problems through their hotline 1920 which would help in getting relevant information to improve the skills of students.

Attempting to convert locally available foods of plant origin with little commercial value, to value added products is another activity that could challenge young creative minds. Many colorful locally available fruits with some amount of water, such as Jambu (*Syzygium jambos*), Kamaranga (*Averrhoa carambola*), Nelli (*Phyllanthus emblica*), and even pumpkin pulp can be preserved by chopping them up and sprinkling sugar (roughly a third of the weight of cleaned fruit) and keeping overnight for the water to seep out. Thereafter heating in the same liquid while stirring after adding an appropriate spice such as a stick of cinnamon or a clove would make a delicious preserve.

Making secondary foods from available resources can become an interesting activity. For instance, making of soya-tofu by curdling soy bean milk with an appropriate coagulant (food additive) is a fun-filled way of introducing a nutritious product to school children. The necessary information on making tofu is given in a booklet written in Sinhala language by a former Director of Food Research Unit of the Department of Agriculture (Ekanayake, 2020). As discussed (Section 5.5), an unexplored oilseed in Sri Lanka is pumpkin seeds. Processing pumpkin seeds as snacks will be adventurous for the students. The mature pumpkin seeds can be cleaned, sundried and roasted to make a healthy snack. For the young innovative minds, such engaging activities will provide opportunity to enhance their creativity and build on the skills acquired.

An idea that should be instilled from a primary level, *i.e.* up to grade 5 should be to distinguish between natural foods and foods containing high amounts of refined ingredients, *i.e.* refined sugar, oils, refined flour, and salt. The need to cut down but not totally eliminate certain processed foods containing refined ingredients could be discussed as the student progresses on appreciating the fact that no food *per se* is perfect but refined ingredients have to be used sparingly mainly to make the food appealing and it provides as a means for diversifying the diet. An important message to be conveyed here is, when one is excessively dependent on processed products, which include bakery products, the resultant excess intake of refined starch, sugar, oil, and salt present in them will be detrimental for the health. Presently the use of traffic light system on packages of processed products to inform the public of the amounts of sugar, salt, and fat in the product, is an important message to convey to the students. The student should get the idea that such products are convenient, but excessive intake is not suitable. It will be an opportunity for the students to bring out their creativity in finding natural alternatives for these highly processed refined ingredients.

Suggestions to re-arrange the content in subject-wise curricula in a hierarchical order

At present the aforementioned information (Sections 5 - 6) is covered to different extents in the school syllabi from Grades 1 - 13. Critically evaluating the relevant teachers' guides (NIE Teachers' Guides, 2015 - 2020) shows that the same material provided in the different Grades could be reshuffled and made into an effective way of delivering information coupling with skill development. For a discussion on this we will attempt to look at ideas in a hierarchical order of school Grades.

Primary Education: Grades 1-5

In Grades 1 to 5 different types of food, food for a healthy life and food habits are covered. During this phase of primary education, as appropriate, the food pyramid could be introduced in a more focused manner, giving the idea of the need to promote dietary diversity leading to wholesomeness of the diet. Healthy foods could be named as natural foods, and unhealthy foods could be categorized as those that contain excess oil and excess digestible carbohydrates (such as white flour and white sugar) along with a high content of table salt and chemical additives.

Targeting the topic Science in Grades 6 to 10

From Grades 6 to 11, Science is a compulsory subject while other subjects (Agriculture and Food Technology, Health and Physical Education, and Home Economics) are optional. Therefore, it is important that key nutritional information is not omitted from the Science syllabus. The concept of BMI (Section 5.2) along with the introduction of other anthropometric parameters should be introduced at this level so that the student is aware that he/she should maintain a healthy physique through both a wholesome diet and physical activity. At present BMI is covered only in Grade 12 Home Economics and Grade 13 Agriculture streams.

The idea that all plant based natural foods provide all the nutrients in different proportions is an important message to be given to the students at this level. Therefore, the food pyramid should be handled in the Science subject rather than in the subject of Health and Physical Education which is not a compulsory subject. All students should get the idea that different food groups in the pyramid are classified based on the most significant nutrient they provide (*i.e.* carbohydrate rich food, protein rich food, micro-nutrient rich foods, etc.) so that they appreciate the fact that consuming natural foods in mixed meals in appropriate proportions is important. Laboratory classes on food analysis conducted at different Grades will help in reiterating the idea that several nutrients are present in different proportions in different food groups classified in the food pyramid.

In Grade 6 there is a brief mention on nutrition while nutrition related content is not covered in Grade 8. In Grades 7 and 9, the subject of Science has concentrated on the different nutrients. One good activity at this level as the student progresses, is that he/she should gain the skill of visualizing the portion sizes of the foods consumed and make a near accurate judgment of the weight. This can first start with weighing the fruits consumed, while gradually progressing to components that make up cooked mixed meals.

At a higher level, *i.e.* Grades 10,food composition tables too could be introduced. Developing skills in being able to use a food composition table will enable them to determine how the complement of nutrients has improved in a novel dish they themselves have created. However, it is important to inculcate on the students that nutritional values depicted in different food composition tables for the same food would differ as nutritional composition is highly influenced by field management of the crops, geographic location, climate, and cultivar. Additionally in the modern day, there are many Genetically Modified (GM) foods such as soya and the user should be able to make an intelligent decision on which values to be taken. For animal food products as well, the nutrition provided by farm animals will differ from that of foraging animals. It is a well-known fact that milk from grazing ruminants has a significantly high level of health promoting omega 3 fatty acids (Butler *et al*., 2011). Such information should be provided to the student, so that the student is aware of limitations in food composition tables and is not inclined to blindly depend on them.

When discussing about serving food, the need to consider portion sizes should be emphasized, giving the basic idea of cutting down on the carbohydrate rich foods, and increasing the intake of fruits and vegetables as well as pulses. This information could be covered with the topic of malnutrition already specified in the Grade 10 syllabus. The idea of protein complementation by including a pulse in cereal based meals should be emphasized in the Science syllabus. When discussing nutritional requirements, the concept of Recommended Dietary Allowances may be introduced using the RDA table for Sri Lanka (Section 5.3). The concept of Basal Metabolic Rate (widely known as BMR), and calculation of the energy requirements based on one's level of activity, could be done at Grades 10 and 11, before the students are segregated for streams to specialize. Currently BMR is covered only in the Biology syllabus of Grade 13. This could be linked to show how the diet could be altered to make it more wholesome for the individual concerned, connecting the idea with the use of anthropometric parameters. This way, the message "change in lifestyle is a cause for some non-communicable diseases" as given in the Grade 11 Science teachers' guide, will carry more weight.

Grade 11- the critical and pivotal point

Grade 11 is the final grade before dividing students into different streams of study. Therefore, it is important to provide a sound foundation on key concepts and skills related to food and nutrition while all students are still together, before they are divided to streams of specialization. While the activities currently suggested in the syllabus are obviously designed to provide opportunity to the student to bring out their originality, unfortunately such activities like preparing a booklet or a poster on wholesome food are given without an adequate foundation in nutrition. With this scheme of introducing nutritional concepts in a gradual manner, when the student reaches Grade 11, he/she will have a solid foundation on the subject of nutrition obtained from lower classes, to engage in specified activities with an in-depth understanding of concepts.

Currently in the Grade 11 Science syllabus, the content covered on nutrition is minimal with only a discussion on NCDs built up with minimal background information. In the Grade 11 Health and Physical Education

syllabus, the health promoting properties of selected spices, such as cinnamon, garlic, turmeric and ginger are covered with the suggested activity of preparing a list of facts on their health promoting properties. While this is an important activity, at this point, such an exercise on the different food categories in the food pyramid will be much more useful for the student not only to be aware of diverse foods that could be included in the daily diet, but also to be aware of their nutrition and health promoting effects. The idea that there are health promoting as well as anti-nutritional substances in all foods will be important knowledge to impart to the students. Also in the same syllabus, the idea that natural foods are better than processed products in the market is emphasized. In spite of this, there is no discussion on why there is an inclination towards processed foods in them, and what ideas could be employed to convert natural foods into convenient snacks in place of processed products frequently consumed. In the syllabus the idea is conveyed that the food additives in processed products are unwholesome. This message should also give the idea that limiting the intake of such products is better if they cannot be totally avoided. This is not only because of the additives, but also because of the refined ingredients they often contain. According to the Food Act of Sri Lanka (already mentioned in the syllabus) the industry has to use food additives which are generally regarded as safe (GRAS) additives (Ministry of Health, 2016) as done internationally. However, some individuals may be allergic or sensitive to certain food additives. In the same light, natural foods too can cause allergies and sensitivities and therefore, such problems are not linked to food additives alone.

In the Grade 11 Biology syllabus, there is nothing substantial on the topic of food and nutrition with a direct reference to improving the daily diet but there is a topic on food-miles. If viewed from the standpoint of improving nutrition, what is more important and practical at this stage is to provide the student with the concepts of food security and dietary diversity by encouraging home gardens with innovative ways (*i.e.* vertical gardening systems, hydroponics) of growing by including diverse plant groups they study. Further, with the awareness created on different organisms on earth (which is in the syllabus), it is important to be knowledgeable on those that serve as food among them. Also, when discussing on the food culture in the country, it is important to look at the deficiencies in such preparations and menus, and make the student bring out ideas in making amends to get wholesome meals by incorporating a wider choice of food from different food categories, and using innovative and effective methods in preparations of dishes giving emphasis to diverse plant groups and plant families.

In Grade 11 Home Economics syllabus, different aspects of food and nutrition are covered. There is a topic on preparing diet charts for persons with special requirements. However, before discussing on special requirements, it is important to discuss on the normal requirements. For instance, getting the recommended amount (400 g) of fruits and vegetables (Section 4.5), by still being within the healthy levels of oil and sugar intake is not easy considering the current way of preparation of curries and desserts. This task may be given as a challenge to the students. The need to redesign the traditional Sri Lankan meals including string hoppers, pittu, and roti based menus, with emphasis on the ingredients and preparation methods, could be addressed effectively in this class with novel ideas obtained from the students themselves. How desserts could be made attractive using underutilized fruits (Section 6) with reduced or no use of refined sugar could also be discussed.

The Grade 11 Agriculture and Food Technology syllabus appears to cover many topics on food and nutrition. However, key concepts to improve the daily diet as discussed (Section 5); particularly protein complementation, the need to consume healthy oils without exceeding its daily requirement, measures taken to increase the daily intake of fruits and vegetables could additionally be discussed. As the subject comprises agriculture, trying out innovative but practically realizable methods of growing fruit and vegetable plants too could be projects that will drive the message home.

Secondary education - beyond Grade 11

At the secondary education level, after dividing students into different streams of study (Grades 12 and 13), the subject of essential amino acids and essential fatty acids is covered in the Biology syllabus. The Agriculture syllabus covers nutritional problems in Sri Lanka and related remedial measures. While it is important to give such information at this higher level of education, it would be more worthwhile if such information is merged with the knowledge gained in lower Grades. If so, the student would be able to build up a deeper understanding based on the fundamental concepts grasped. The concepts of nutrition learnt in lower grades can be gradually built up and linked to the specialized subject content at this level. For instance in Grade 13 Biology syllabus, when discussing ecosystems, the field surveys already given in the syllabus, could focus on the food plants in the surroundings. When discussing on microorganisms, those used for food fermentations (vegetable, seed, and meat fermentation) may be focused on, without restricting to milk alone. Even in Grade 13, Science for Technology, currently curd making is given as an activity, while there are a multitude of activities related to food fermentation (Section 4.8). In most disciplines in Grade 13, curd and yogurt making are the only specified activities related to food fermentations. In Grade 13 Biosystems Technology, food diversification is given as a topic, and hence, a diverse range of skill development activities based on key concepts (Section 5) may be included to the syllabus. In disciplines directed towards higher studies, the knowledge gained at lower classes may be substantiated by providing the scientific basis. For instance, the idea that each plant protein taken in isolation is incomplete as the full complement of essential amino acids cannot be found in a single plant, can be highlighted, thus revisiting protein complementation. As some of the information specified at secondary school may have been already covered in lower Grades, newer topics may be included to avoid repetition of information. For instance more information on anti-nutritional substances and health

promoting substances of phytochemicals linked to the idea of antioxidants already in the syllabus, could be provided, so that the message is inculcated on the student that there are no absolutely good or bad foods among natural foods, but what is important is to aim for dietary diversity. The concept of food security too could be dealt with in detail at this level with an encouragement for all students to maintain a home garden, to the best of their ability, as a skill development activity. Having regular discussions and sharing of resources such as planting material will help in building team effort too. Also environmental issues pertaining to food production may be handled at these higher levels using skill development activities such as debates, orations, posters, booklets etc.

The larger picture of food choice: environmental and social issues

The environmental and social issues regarding food also need to be addressed in appropriate lessons pertaining to the subject. The choice of food of a nation will affect its environment both in the process of manufacturing and disposing of waste. Whatever the dietary choice, planning the diet to obtain proteins and necessary micro-nutrients without getting excess digestible carbohydrates and fats is of paramount importance. Limiting excess energy consumption from main meals and reducing inclination towards discretionary food choices are recommended not only to avoid dietary imbalances but also to reduce the burden they place on the natural resource base, biodiversity and greenhouse gas emissions (Ridgway *et al*., 2019).

While excess meat consumption is a risk factor in many diet-related diseases (Gardner *et al*. 2019), it is noteworthy that currently at a global level, a major concern is on the impact of animal based foods on the environment. In this regard five countries (Brazil, Canada, Sweden, Qatar and Germany) have successfully integrated environmental sustainability considerations into their dietary guidelines by inclining towards plant based foods (Ridgway *et al*., 2019). This is an additional reason to sustain on a primarily plant based diet, as already practiced in Sri Lanka. Also in support of this idea is the work of Popkin and Gordon-Larsen (2004) who expressed their concern over the production of animal sources of food which has become a global food activity, transforming the grain markets for animal feed. They noted that it leads to resource degradation and rapid increases in feed grain imports. Concentrating on climate change, Steib *et al*. (2020) report that 1kg of soaked and boiled legumes (meaning pulses) is responsible for 0.3 kg of CO_2 emissions, whereas 1 kg of prepared beef emits 45.9 kg CO_2. It is well recorded that low consumption of animal based foods reduces greenhouse gas emissions with reduced carbon footprints (Segovia-Siapco and Sabaté, 2019). The typical Sri Lankan diet has all along been in line with the global trend of reducing intake of meat.

Globally, there is a trend to move towards vegetarianism due to many reasons including, religious reasons, awareness on animal rights and environmentalists highlighting the carbon footprint in the production of animal sources of food. Besides, many studies point out that vegetarianism is a healthy choice (Gardner *et al*., 2019). Being a total vegetarian or a non-vegetarian is an individualistic choice based on religious or cultural bindings. Yet, in a country like Sri Lanka this choice may also depend on the family income, as animal sourced foods are generally more expensive while plant based foods are available even from the surroundings, for many. A vegetarian diet can be made wholesome when the diet includes a variety of plant based foods and calorie intake is adequate (Agnoli *et al*., 2017).It is well established that vegetarian diets have a protective effect from NCDs (Segovia-Siapco and Sabaté, 2019). In the same note, monotonous vegetarian diets may result in nutrient deficiencies with deleterious effects on health (McEvoy *et al*., 2012). This is one of the major issues with regard to the Sri Lankan diet which is leaning towards vegetarianism.

While the composition and ratios of components that make up main meals can be adjusted to provide a healthy diet, the present episode of obesity is obviously linked to social factors manifested as preference of discretionary foods over main meals. Commercially available plentiful unhealthy bakery products readily cater to those caught up in the current rat race who willingly or unwillingly replace their rice and curry meals by attractively displayed easy to consume alternatives, for sheer survival (Karunaratne, 2019). Popkin and Gordon-Larsen (2004) compare activities of youth populations in different countries and note the attraction youth display to sedentary media for entertainment, and linked to that show how obesity has shifted to the developing world, specifically to the poor. The global phenomenon of nutrition transition has obviously occurred in Sri Lanka considering the growing obese population that increasingly depends on freely available excessively oily and/or sugary fast foods. These are not only appealing, but also are hassle free to consume while on the go. While providing nutritious alternatives for the busy but sedentary individuals of the society is a lacuna that has to be filled by creative minds, suggestions of healthful lifestyle changes acceptable for this group can be taken up as a challenge in appropriate lessons such as in the syllabi of Health and Physical Education.

CONCLUSION

Poor eating habits (choice and amounts) rather than availability of food seem to contribute to countrywide malnutrition largely. Systematically educating the younger generation focusing on immediate measures to be taken to improve the daily diet seems to be an effective strategy to overcome this problem that has become stagnant. Appraising the historical and current data, it may be assumed that the countrywide tendency for low dietary diversity, is a significant contributory factor for undernutrition. Having said that, sheer lack of food in certain communities and regions should be acknowledged but the problem must be tackled by a different means. There are specific dietary issues to address based on food intake patterns in different regions of the country, due to preference and availability and most importantly on maternal nutrition. Also tackling problems of overnutrition and obesity through changes in social habits (such as promoting physical activity, reducing

high caloric intake) in addition to promoting dietary diversity is important.

The currently consumed typical Sri Lankan diet seems to have certain shortcomings which can be overcome easily by suitable combinations of food groups in mixed meals and by modifying preparatory and cooking methods. As reiterated throughout this paper, the presence of many anti-nutritional substances especially in pulses, has to be taken into account in preparing them for consumption, which include soaking overnight and boiling for prolonged periods of time. Obviously, lack of knowledge and competence in preparation methods, and the shortage of appealing recipes, debars the use of certain pulses available in the local market.

As the typical Sri Lankan diets are mixed (composed of foods representing different groups of the food pyramid), deficiencies from one group of food can be covered by another group. If the diet is well planned it gives an excellent opportunity to provide a wholesome meal, with modifications made keeping dietary diversification and protein complementation in mind. All in all, the wholesomeness of the Sri Lankan diet may be improved with little innovation. Targeting school children by incorporating important ideas into the relevant sections of the curricula without making it an additional burden to the currently specified study load, seems to be one effective way to handle malnutrition in Sri Lanka.Referring to dealing with malnutrition in the country, an eminent paediatrician of the yesteryear, Prof C.C. De Silva (De Silva, 1955) mentions the importance of coordination and corporation among different Government Ministries including Education. If a sound nutrition education is provided in schools, all other areas will fall in line eventually to combat malnutrition in the country and provide food security. With the sudden emergence of the COVID-19 pandemic the issue of food security is felt more than ever before, and therefore making the younger generation aware of the importance of nutrition is felt as a need of the hour.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no competing interests.

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