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Cost of Nutrient Adequate Diet (CoNA) During Covid-19 Pandemic and its Affordability

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Abstract

The adverse effects of Covid-19 on our health have made nutritious diets more crucial than ever before. The study aims to calculate the cost of the nutrient adequate diet (CoNA) during the Covid-19 pandemic and estimate its affordability. A market survey was carried out in 48 markets of Bangladesh for collecting price data during the pandemic. CoNA diet was calculated through linear programming using Microsoft excel's solver (Simplex). A moderately active woman of reproductive age was used as the reference population. To gauge affordability, the cost of the diets was compared with the household income and expenditure data of 2016. CoNA was found to be 38.2 BDT per day at the national level and it was relatively higher in rural areas than the urban ones. The cost of attaining a nutritious diet was the highest in the Rangpur division and the lowest in the Barishal division. In Bangladesh, 1.6% of the households could not afford nutrient adequate diet (NAD). Disruptions in the food systems and economic shocks have led to higher prices of food and diminished purchasing power. It is high time to take the necessary steps and strategies for making nutritious diets affordable for all.

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1. Introduction

The COVID-19 pandemic and measures to mitigate it have amplified financial and food systems crises worldwide, especially in countries with economies in transition (e.g., Bangladesh) (Laborde et al., 2021). Such disruptions with unprecedented impact on the lives and livelihoods (e.g., income shortfalls, job losses, food shortages, and wastage of perishable food items due to inadequate storage and transportation facilities) are exacerbating food insecurity, poor diet quality, and micronutrient-malnutrition (Harris et al., 2020). Recently, it has been estimated that the COVID-19 pandemic may add at least 83 million people to the currently undernourished 690 million people worldwide (World Food Program, 2020). It is worrying that nutritional status is an important determinant of vulnerability to infections and their complications. So, it is not surprising that international health-related organisations emphasise improving overall health and strengthening the body's immune system to fight against covid-19 infections and boosting up immune responsiveness to vaccines when available.

Nutrition plays a critical role in boosting the immune system and can help individuals fight against COVID-19. However, as concluded in a systematic review, there is no concrete evidence that any (high-dose) nutritional supplements can prevent COVID-19 or accelerate its treatment (PT et al., 2021). Aman and Masood (2020) also advocated for a nutritious diet as they found no evidence of nutritional supplements' ability to cure the immune system (F and S, 2020). Similarly, a more recent prospective cohort study involving 31,815 Covid-19 patients provides empirical support to the association between high dietary quality and reduced risk and severity of Covid-19 (Merino et al., 2021). Thus, regular consumption of nutritious diets is crucial for maintaining optimal nutritional status, reducing the risk and progression of Covid-19 infections and promoting our body to recover from post-Covid complications speedily.

A recent technical report of the Bangladesh National Nutrition Council (BNNC) projected the effect of Covid-19 on malnutrition and micronutrient deficiency in Bangladesh by considering the reduction of income, employment, food security and coverage of nutrition services (Bangladesh National Nutrition Council, 2020). During the lockdown periods around, 63% of the primary earners in the families became jobless, and 11.1- 20.5 million people lost their jobs in the country (Rahman et al., 2020). Osmani stated in his latest publication that

according to World Bank, the economic growth of Bangladesh would come down to 1.2-2.9% in 2020-21 from 8 per cent in 2018-19 (Osmani, 2020). The Centre for Policy Dialogue (CPD) estimates that the projected GDP growth of the 2020 fiscal year is likely to fall from 8.2% to 2.5% (Centre for Policy Dialogue, 2020). Around 63% of the wage earners have become inactive (Rahman et al., 2020) and as a result, the prevalence of moderate food insecurity based on the Food Insecurity Experience Scale (FIES) was reported to be 31.5% in 2020 (Food Policy and Monitoring Unit, 2021). The 7-46% price increase of rice and other necessary food items (Shimul, 2020) has exacerbated household dietary quality in that 61% of families in Bangladesh reported consuming less diversified diets than their pre-pandemic diets (Kundu et al., 2021). Given the strong linkages between nutritious diets and increased immunity and protection from COVID-19 and its complications, data on the cost and affordability of nutrient adequate diet (NAD) are urgently needed.

Nutrient adequate diet (NAD) is a type of diet that provides adequate calories, a balanced mix of carbohydrates, protein, fat, essential vitamins, and minerals within the Tolerable Upper Limit (TUL) to prevent deficiencies and avoid toxicity. The oldest method of estimating the cost of nutrient adequate diet (CoNA) was developed by Stigler (1945), where he used linear programming to minimise the cost (Stigler, 1945). Later it was updated as the "Cost of Nutrient Adequacy" metric (Masters et al., 2018) and the "Cost of the Diet" (CotD) method by Save the Children (Deptford and Hall, 2013). In 2007, Save the Children first used the CotD method in Bangladesh to estimate the cost of nutrient adequate diets in the villages of the Rangpur division (Chastre et al., 2007). World Food Program (WFP), in their Fill the Nutrient Gap report of 2019, also estimated the cost and affordability of nutrient adequate diet using data from the household food and expenditure survey (HIES) of 2016 (World Food Program, 2019). These reports used households-reported price data collected in 2014-15 that do not fully reflect the impact of the current pandemic on food prices. With these considerations, this article aims to generate CoNA using the food prices collected from the market survey during the Covid-19 pandemic and estimate its affordability.

2 Methodology

We calculated the cost of nutrient adequate diet using linear programming. The goal function of the linear programming was to minimise the cost of the food while meeting the nutritional recommendations set as constraints. To meet this goal, linear programming may have chosen the least cost nutritious foods which are not

compatible with our habitual diet. Thus, CoNA only provides the costing meeting nutrient requirements without considering our dietary pattern and cultural preferences.

2.1 Generating food list and price data collection

Three household surveys of Bangladesh, such as Bangladesh Integrated Household Survey, 2015 (BIHS, 2015), Nutrition Survey of Bangladesh, 2017-18 (NSB, 2017-18), and Household Income and Expenditure Survey, 2016 (HIES, 2016), were used to identify the most commonly consumed food items. Foods present in three of the surveys were noted as highly consumed foods all over Bangladesh and were included in our food list. Thus, we prepared a comprehensive food list comprising 124 food items under nine food groups (considering leafy and non-leafy vegetables separately). For incorporating the regional variations, the enumerators were also told to record the food items apart from our list, which was available at the market on the day of data collection.

The Department of Agricultural Marketing (DAM) website was used to generate a list of markets across eight divisions of Bangladesh. A total of 48 markets were selected randomly from the list covering three rural and three urban areas from each division. A two-day training session was conducted with the enumerators to discuss the aims and the method of price data collection. The market survey was conducted from January 20 to February 5 2021. The weight of the foods was recorded in 100g and the price of a particular food was reported from four traders to reflect the actual price of the food items. Prices of the food items were collected without causing any disturbance to the traders. As the data collection took place amid the pandemic, all enumerators always wore masks and followed hygiene protocols according to the World Health Organization (WHO) instructions.

2.2 Cost of nutrient adequate diet (CoNA):

We calculated the cost of nutrient adequate diet through linear programming using Microsoft excel's solver (Simplex). A moderate active reproductive woman with an energy requirement of 2130 kcal was used as our reference. All references values of Estimated Energy Requirement (EER), Estimated Average Requirement (EAR) of vitamins and minerals, and Acceptable Macronutrient Distribution Range (AMDR) were taken from values set by the National Institute of Nutrition, Indian Council of Medical Research (National Institute of Nutrition, 2020). The nutrient values of foods were obtained from the food composition table of Bangladesh (Shaheen, 2014).

Estimated Energy Requirement (EER) and Estimated Average Requirement (EAR) values of protein, four minerals (calcium, magnesium, iron, and zinc), and

eight vitamins (Thiamine, riboflavin, niacin, vitamin B6, folate, vitamin B12, vitamin C, and Vitamin A) were used as constraints. To avoid toxicity, we used tolerable upper limit for calcium, iron, zinc, niacin, vitamin B6, folate, vitamin C,

Table 1: Nutrient intake constraints of linear programming for calculating CoNA

Nutrients	Constraints
Energy (kcal/d)	2130
Protein (g/d) *	≥ 36-≤ 80
Fat (g/d) **	35.5-82.3
Carbohydrate (g/d) ***	239.62-346.12
Iron (mg/d)	≥ 15-≤ 45
Calcium (mg/d)	≥ 800-≤ 2500
Magnesium (mg/d)	≥310- ≤ 350
Zinc (mg/d)	≥ 11-≤ 40
Thiamine (mg/d)	≥1.4
Riboflavin (mg/d)	≥2
Niacin (mg/d)	≥12-≤ 35
vitamin B_6 (mg/d)	≥1.6-≤ 100
Folate (µg/d)	≥180-≤ 1000
vitamin B_{12} (µg/d)	≥2
vitamin C (mg/d)	≥55-≤ 2000
vitamin A (µg/d)	≥390-≤ 3000

* 5-15% of the EER, **20-35% of the EER, ***45-65% of the EER

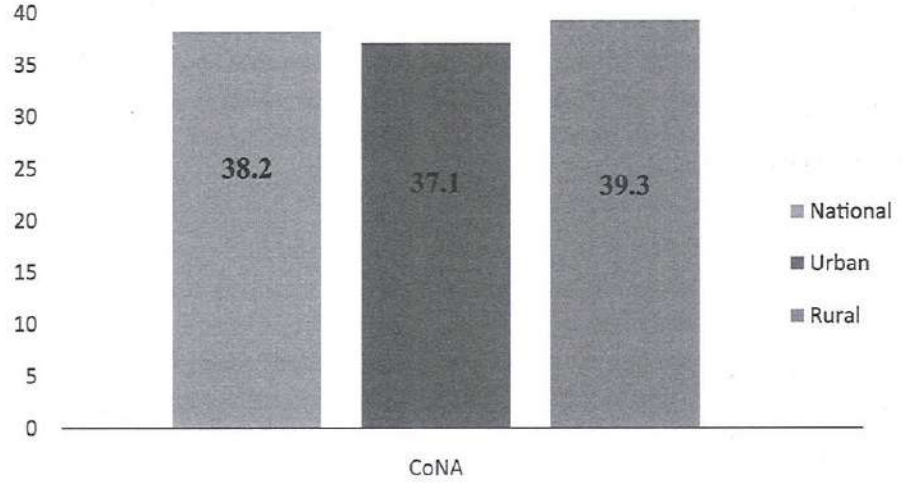
and vitamin A, and Acceptable Macronutrient Distribution Range (AMDR) values as a per cent of EER (%EER) for carbohydrate, fat, and protein (Table 1).

2.3 Affordability of CoNA

To estimate the affordability, we compared CoNA with household income and food expenses as reported in the HIES, 2016 (Bangladesh Bureau of Statistics, 2016). The per cent of households from the whole country and each division, which were unable to afford nutrient adequate diet was determined.

For our analysis, we took the household expenses and household size from the survey data. As the costs were calculated for an individual, we had to adjust the household size with adult male equivalent (AME) values for determining the cost for households. As food prices were collected in 2021, we multiplied the cost of nutrient adequate diet by a deflation factor and adjusted it according to the price of the latest household survey of 2016. Then the deflation adjusted cost for every household was divided by its daily food expenditure, and the results were expressed in ratios. Ratios above 1 indicated the cost as unaffordable as it exceeded the average food expenditure of a household.

Figure 1: Cost of nutrient adequate diet at national, urban and rural level



3 Results

The cost of nutrient adequate diet was 38.2 BDT per day at the national level for a moderately active woman of reproductive age. The cost was higher in rural areas than in urban areas nationally (Figure 1).

Though CoNA was higher in rural areas at the national level, there are divisions where the scenario is vice versa. In Chattogram nutrient adequate diet cost was more in urban areas (40.7 BDT) than rural ones (31.5 BDT). Likewise, Rajshahi and Sylhet presented the same results. The cost of nutrient adequate diet was the highest in Chattogram rural area and the lowest in the urban area of Rangpur division (Table 2).

Figure 2 shows the regional variation of the cost of a nutrient adequate diet. CoNA differed significantly with regions and across eight divisions of Bangladesh. It was the highest in the Barishal division (39.8 BDT) and the lowest

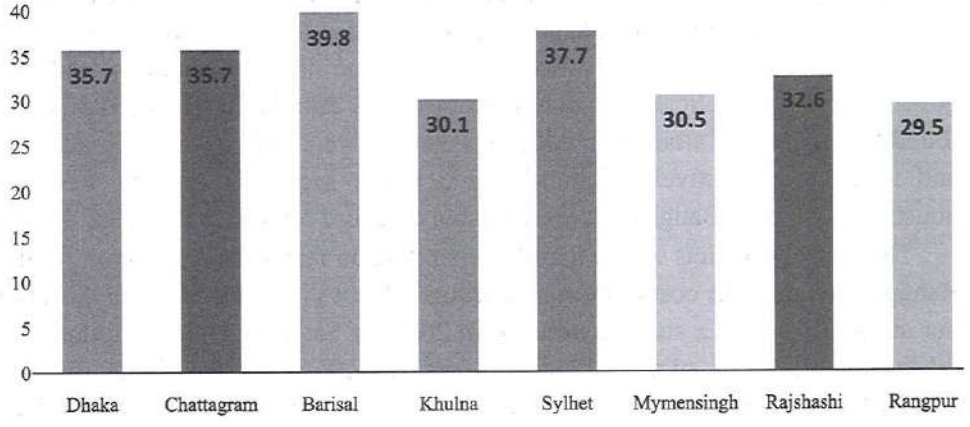
Table 2: Variation of CoNA diet by residence (urban and rural)

Locations	Areas	Cost of nutrient adequate diet (BDT)
Dhaka	Urban	30.9
	Rural	36.5
Chattogram	Urban	40.7
	Rural	31.5
Mymensingh	Urban	31.1
	Rural	41.2
Barisal	Urban	27.1
	Rural	36.2
Rajshahi	Urban	31.9
	Rural	29.1
Khulna	Urban	28.2
	Rural	33.1
Sylhet	Urban	41.1
	Rural	37.5
Rangpur	Urban	26.1
	Rural	33

in the Rangpur division (29.5 BDT). The people living in Dhaka and Chattogram had to pay the same amount of money to get nutrient adequate diet (35.7 BDT).

At the national level, 1.6% of households could not afford a nutrient adequate diet. It was most unaffordable in the Rangpur division (2.7%), followed by Barishal (2.5%) and Mymensingh (2.4%). The affordability also differed with residential

Figure 1: Regional variation of CoNA



areas; only 0.3 per cent of households could not afford CoNA in urban areas, but 2.1 per cent of households living in rural areas could not afford it (Table 3).

Table 3: Percent of households unable to afford a nutrient adequate diet

	Area	% Households
By administrative unit	National	1.6
	Barishal	2.5
	Chattogram	1.9
	Dhaka	0.7
	Khulna	0.7
	Mymensingh	2.4
	Rajshahi	1.7
	Rangpur	2.7
	Sylhet	1.0
By residence	Rural	2.1
	Urban	0.3

4 Discussion

Lockdowns and quarantine measures implemented from the onset of the pandemic have led to disruptions in the food systems and widespread unemployment in formal and informal sectors. As a response to these dynamic changes and income shortfalls, both physical and economic access to safe, nutritious foods have been largely reduced (Belanger et al., 2020). Assessing the cost of a nutritious diet (Hamadani et al., 2020) and making the assumption of its affordability in the wake of Covid-19 will help the stakeholders and the government adopt policies to make nutritious diets affordable for all. This study found that the cost of attaining a nutritious diet was 38.2 BDT at the national level and it was comparatively higher in rural areas. Moreover, around 1.6% of households all over Bangladesh were unable to afford a nutrient adequate diet.

The cost of the diets varied mainly depending on residence and region. In the Rangpur division, the cost of nutrient adequate diet was the lowest (29.5 BDT) in our study. However, a study conducted in 2007 by Save the children found that the average daily cost of a nutritious diet was 61 BDT for a family in the villages of the Rangpur division (Chastre et al., 2007). In the present study, the nutrient density of individual food was employed in linear programming to formulate the

nutrient adequate diet. Another study conducted by the World Food Program (WFP) in 2019 estimated the cost of nutritious diets across the lifecycle, starting from children under one year through adolescents to adults and up to the elderly (World Food Program, 2019). According to the report, the cost of nutrient adequate diets ranged from 10 BDT to 49 BDT for different age groups.

On the other hand, we chose a non-pregnant, non-lactating reproductive woman doing moderate physical activity as our reference. The main reason behind choosing this particular group was that the reference group's energy requirement (2130 kcal) is the closest to the energy level used to calculate the poverty line of Bangladesh, which is 2122 kcal. Apart from this, women of this reference group also suffer from various macro and micronutrient deficiencies due to social practices and customs.

The unaffordability estimates reported in this study represent the proportion of households unable to afford CoNA in 2016. In a recent study conducted in Bangladesh, the authors revealed that one-third of their respondents stated that their income decreased drastically due to Covid-19 (Kundu et al., 2021). In light of the adverse shocks of Covid-19, the Centre for Policy Dialogue (CPD) estimated that reduced income would increase the national poverty rate to 35%, which was 24.3% before (Centre for Policy Dialogue, 2020). As the employment opportunities were significantly curtailed in lockdown, the per capita income of extremely poor, moderately poor, and vulnerable non-poor is sharply decreased to 73%, 75%, and 67%, respectively (Rahman et al., 2020). The burden of unemployment was higher in urban slums (71%) relatively to the rural population (55%), which resulted in the monthly household incomes coming down from US$212 to US$59 (Rahman et al., 2020). Moreover, the price of rice, pulses, oil, and chicken hiked by 9.8-12.5% during the first lockdown, and in the second lockdown, it steeply reached 48%. For example, the highest price increase was observed in coarse Aman (41%), coarse Boro (33%), and local Musur dal (24%), which are the most essential and basic food items, especially for the poor (Shimul, 2020). To cope with the high prices of foods, around one-fourth to one-third of the poor had to cut off their expenditure on food (Rahman et al., 2020). Considering these unprecedented impacts on livelihood, income, and food prices brought about by Covid-19, it can be easily assumed that the prevalence of unaffordability may have increased in current times compared to the unaffordability estimates of 2016.

Linear programming has been extensively used in public health research for assessing the feasibility of achieving nutritional requirements and estimating the minimum cost of a nutritionally adequate diet (Gazan et al.,2018). Though widely

applied, one concern for using this method is that it may sometimes produce unrealistic and unpalatable results (Deptford et al., 2017). This was one of the limitations of our study as linear programming calculated the cost of the nutrient adequate diet without addressing our food preferences and dietary behaviour. If we adapt the nutrient adequate diet according to our habitual diet, CoNA might increase. Another drawback of our study was that we could not measure the actual unaffordability of CoNA at present due to a lack of data. For future research, current household income and expenditure data can be collected to estimate the prevalence of unaffordability of a nutritious diet after Covid-19. The study results can help the government implement and design newer programs and strategies to make nutritious diets affordable.

5 Conclusion

The extended lockdowns and steps taken to tackle the spread of the virus have hampered economic growth and severely impacted the per capita income of the population. Due to the negative impacts of Covid-19 on the economy, the prices of food items had skyrocketed than ever before, which resulted in higher cost of nutritious diets. The higher costs of diets and sufferings brought about by Covid-19 have made the affordability of nutritious adequate diets more challenging to achieve. For increasing affordability of nutritious diets, the government should enhance the coverage of existing social protection programs (e.g., open market sales, employment generation programs, vulnerable group development and cash for work) to protect purchasing power of the Bangladeshi population.

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