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COVID 19 epidemic in India: impact on health, food security and nutritional status

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ABSTRACT

COVID-19 pandemic was a major challenge that tested the coping capabilities and resilience of nations and people. Two years after the last wave of the epidemic in India, might be the appropriate time to assess the:

- challenges the COVID-19 epidemic posed to the health, food security and nutritional status of the population
- appropriateness, timeliness, and adequacy of the interventions to minimise the adverse consequences and
- impact of these interventions on the health and nutritional status of the population.

India had three waves of the COVID-19 epidemic. The lockdown delayed and flattened the first wave; both cases and deaths were low. The devastating second wave infected millions of persons; the health system was overwhelmed and case fatality rates were high. The third wave infected millions but death rates were low. The age-standardized mortality and longevity reduction due to COVID-19 were low.

The stringent lockdown in 2020 resulted in economic contraction. Subsequently, economic growth recovered. During 2020 there was a steep rise in urban unemployment but the situation improved when lockdown was lifted. The demand for rural employment was high in 2020; demand continues to be higher than the pre-COVID-19 levels even now.

To combat food insecurity due to job loss and reduction in earnings, the provisions under the National Food Security Act were utilized to provide highly subsidized and free food grains to over 800 million persons; this enabled the population to remain hunger-free and food secure. The provision of food grain at low cost is being continued even now to prevent the adverse impact of stagnant earning and high food inflation on food security.

Data from the national surveys and our research study in urban low-middle-income families indicate that the COVID-19 epidemic did not result in increase in the prevalence of undernutrition or overnutrition, in children or adults.

These data suggest that the world's most populous country and its citizens had managed the health and food security challenges of the COVID-19 epidemic relatively well.

Keywords: COVID 19 pandemic, lockdown, health status, food security, coping strategies, nutritional status

Introduction

In the winter of 2019-2020, the highly contagious SARS CoV2 spread rapidly across the globalised world where billions travelled every day. Initial data from China, Italy and the USA showed that the infection was spreading rapidly and case fatality rates were high. On 11th March 2020, WHO declared coronavirus 2019 disease (COVID-19) a pandemic. India is China's neighbour, has a high population density and a relatively inadequate health system for the management of large-scale epidemics. In an attempt to delay the epidemic and flatten the epidemic curve, the country initiated a stringent national lockdown on 24th March 2020, when there were less than 300 reported cases[1]. The lockdown delayed the epidemic and provided the time needed for strengthening and reorganisation of the health system; the first wave of the COVID-19 epidemic was flattened and cases and deaths were relatively low[2].

The stringent lockdown caused a steep decline in GDP and sudden, severe urban job loss[3]. About 50 million migrant urban workers had no income; they and their families had no option but to get back to their villages. Men, women and children trekked hundreds of kilometres in hot summer, without shelter, assured transport, money or food; lack of food, dehydration, and heat exhaustion could potentially lead to illness and deaths. The ready availability of food grains under the National Food Security Act (NFSA) at a nominal cost averted severe food deprivation. The state and village committees tried to provide shelter, transport, two meals, water and essential health care to these persons during transit. Once they reached their village, the extended families provided the needed food until the migrant workers found employment. These interventions warded off hunger and prevented deterioration in the nutritional and health status of the population[3].

Between April and July 2021, India faced a devastating second wave of COVID-19 infection, caused by the highly contagious and virulent delta strain. Millions were infected, hospitals were overwhelmed with the number of persons requiring admission and case fatality rates were high[4]. The lockdown was for a short duration and did not have much impact on food security[4]. The third wave of COVID-19 began in January 2022 and was due to a highly infectious but mild omicron strain. Millions were infected but most did not require hospitalization and case fatality rates were low. This might be partly because the majority of the population had previously had one or more episodes of COVID-19 infection and one or two doses of COVID-19 vaccine. The lockdown was short and did not have any impact on the food security[5].

There have been a large number of studies and publications on the health care and economic costs of the COVID-19 pandemic in India. However, there have been very few publications on the impact of the COVID-19 epidemic on food security and the nutritional status of the population. Despite being self-sufficient in food production for four decades, the pace of decline in prevalence of under-nutrition especially in children in India is low[6]. Deterioration in food security during the COVID-19 epidemic could result in deterioration in nutritional status and ill health.

Two years after the last wave of the epidemic in India, might be the appropriate time to assess:

- the impact of the COVID-19 epidemic on the health, food security and nutritional status of the population,
- the appropriateness, timeliness, and adequacy of the interventions to minimise the adverse consequences of the COVID-19 epidemic on food security, nutritional status and
- the impact of these interventions on the health and nutritional status of the population.

During the COVID-19 epidemic in India, urban low-middle-income families were economically one of the worst affected segments of the population[3]. There had been very few publications on food security and nutritional status of these population

groups. Our institution had undertaken community-based studies on economic status, food security in urban low-middle-income families in Delhi, and nutritional status of women and children in these families prior to[7-12] and during COVID-19 epidemic. Data from these studies were analysed to document:

- coping strategies adopted by these families to reduce the impact of income reduction on food security in the first year of the epidemic, and
- changes if any in the nutritional status of children, women and men during COVID-19 epidemic.

These studies may provide insights into problems faced initially when the country and the families tried to cope with an unknown massive epidemic and whether with increasing knowledge and experience, there was improvement both in the country's response and families' ability to cope. The lessons learnt during COVID-19 pandemic may come in useful as and when the country faces a similar pandemic in the future.

Material and methods

In developing countries like India there are close linkages between economy, employment, poverty, food security, nutritional status and health. In the present study attempts were made to access data on impact of COVID 19 epidemic on each of these sectors at national, state levels and in an urban low-income community. The study consisted of two components.

COMPONENT 1 REVIEW OF NATIONAL DATA ON THE IMPACT OF THE COVID-19 EPIDEMIC IN INDIA

Impact on health:

In India, the Ministry of Health and Family Welfare (MOHFW) has been collecting, collating and reporting to WHO the number of cases and deaths due to the COVID-19 pandemic[3,4,5]. The WHO has been collecting, collating, and reviewing the number of cases and deaths due to the COVID-19 pandemic in countries and regions of the world[13,14]. The Global Burden of Disease Study 2021 (GBD 21) explored the impact of COVID-19 on longevity and age-standardised mortality across countries and regions of the world[15,16].

Data from the WHO COVID-19 dashboard and GBD 21 publications were used to compare the impact of the COVID-19 pandemic on health in India, South Asia and other regions of the world. The metrics used for the assessment were number of cases, number of deaths, age standardised death rates due to COVID-19 in 2020 and 2021, reduction in longevity due to COVID-19 pandemic between 2020 and 2021.

Impact on economy, employment and food security:

Between 2020 and 2022, the national economic surveys[3-5] provided yearly data on:

- the economic cost of lockdown in terms of GDP growth, job losses,
- economic costs of illness due to the COVID-19 and
- impact of household economic constraints on food security,
- interventions to minimise adverse impact of COVID-19 on food insecurity such as:
  - direct cash transfer and food grains provided totally free of cost to the needy,
  - job creation under employment guarantee programmes, and
  - provision of food grains at highly subsidised cost under the National Food Security Act.

These data and publications related to impact of COVID-19 epidemic on economy, employment and food security were reviewed.

Impact on nutritional status

The National Family Health Survey (NFHS) 4 carried out in 2015[17] provided pre-COVID-19 data on nutritional status at the national and state levels. The first phase of NFHS 5 was completed in 2019 (pre-COVID-19) and the second phase in 2021 (during the COVID-19 epidemic)[18]. Data from NFHS 4 and 5 were compared at the national and state levels, to assess the impact, if any, of the COVID-19 epidemic on the nutritional status of pre-school children, women and men.

COMPONENT 2: IMPACT OF COVID-19 PANDEMIC IN URBAN LOW-MIDDLE-INCOME FAMILIES

Before the COVID-19 epidemic, our institution had been undertaking community-based studies on the socio-demographic profile, employment, and food security status of the families, and nutritional status of members (mainly women and children) of low-middle-income families residing in selected blocks of Southwest Delhi[7-12]. During the lockdowns, the research team remained in touch with these families telephonically. When the lockdown was removed in October 2020, the research team contacted all the families residing in the study area, obtained consent from families who were willing to participate in studies to assess the impact of the COVID-19 epidemic on food security and nutritional status.

In 505 families who had been enrolled in January-March 2020 and had stayed in Delhi during lockdown, in-depth interviews were carried out between October 2020 and March 2022. The "coping strategy index" developed by FAO to rapidly assess food security and coping strategies during emergencies[19] was used to assess the impact of the 2020 lockdown and first wave of COVID-19 infection; impact on employment, earnings and strategies used by these families to prevent food insecurity despite the decline in income were assessed.

All families who were willing to participate in assessment of nutritional status were enrolled and followed up till December 2022. Efforts were made to weigh under-two children every month, get weight and height recorded once in three months in children 3-18 years; in adults height was measured at initial visit and weight was recorded once in three months. There were gaps in regular follow-up and measurements due to illness, isolation and lockdown due to COVID-19 epidemic. Data on number of families enrolled and followed up and persons in whom nutritional status was assessed in 2020-2022 is shown in Table 1.

Table 1 Urban Community based study in low middle income families

Year	Enrolled families	Assessment of nutritional status			
		Children < 5 years	Children 5-18 years	Women	Men
2020	1334	846	903	1576	341
2021	2295	1915	1781	2310	423
2022	2356	1844	1296	2759	584

Height was measured using wall mounted stature meter with 0.1cm accuracy; weight was measured using digital weighing machine with accuracy of 100g. The nutritional status of under-five children was assessed using WHO child growth standards for height for age, weight for age and BMI for age. The nutritional status of school-age children was assessed using WHO child growth standards for height for age, BMI for age. BMI was the parameter used to assess the nutritional status of adults.

The impact of the lockdowns and three waves of the COVID-19 epidemic on the nutritional status was assessed by the frequency distribution of weight for age in under-five-children, BMI for age in 5-18 year children, and BMI in adults (men and women) in the following periods:

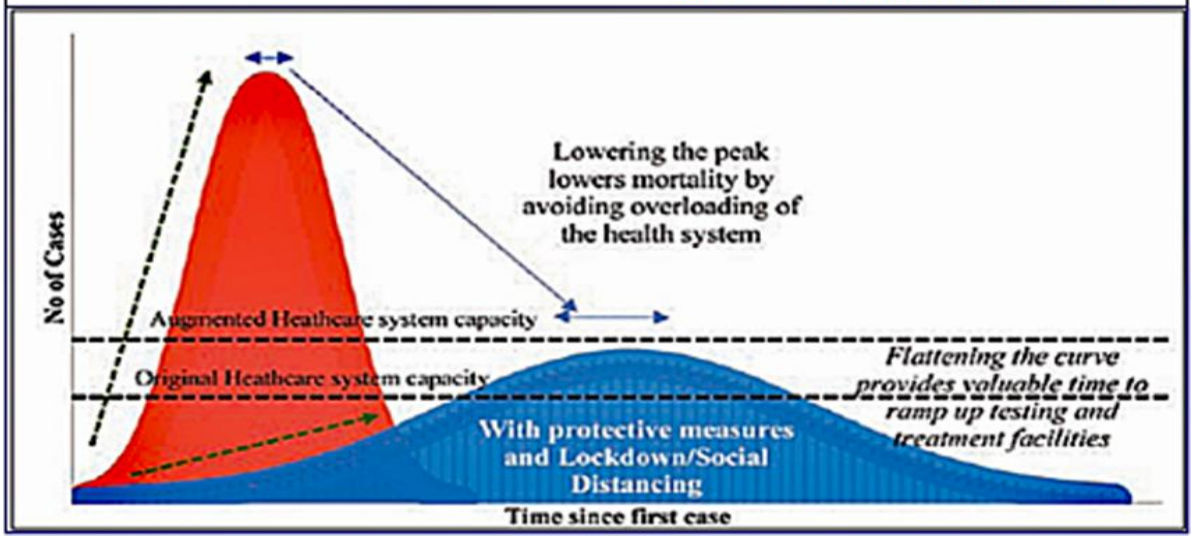
- 01.01.2020 to 31.03.2020 (pre-COVID period) and 01.10.2020 to 31.12.2020 (impact of lockdown and first wave of COVID epidemic);
- 01.01.2021 to 31.03.2021 (pre-second wave) and 01.10.2021 to 31.12.2021 (impact of the second wave and lockdown); and
- 01.01.2022 to 31.03.2022 (third wave) and 01.10.2022 to 31.12.2022 (post epidemic period).

Results

IMPACT OF THE COVID EPIDEMIC HEALTH STATUS IN INDIA

India imposed a nationwide lockdown on 24th March 2020, when there were less than 300 cases reported in the country. The lockdown was stringent, universal and compliance was high between April and June 2020; the lockdown was eased over the next three months and was lifted on 30.9.2020. The stringent lockdown and the widespread use of personal protective measures delayed the first wave of the epidemic till June 2020 and flattened the first wave (Fig 1). The peak of the first wave was reached on 13.9.2020 when 640,000 new cases were detected. There was a slow and progressive reduction in the number of cases and in February 2021 the number of new COVID-19 cases detected came down to 78,600 (Figs 2 and 3)[13]. Both the number of cases and the number of deaths were low compared to other regions of the world.

Fig 1 Flattening the epidemic curve: rationale and benefits
Source: Economic survey of India 20-21



In April 2021 the devastating second wave of COVID-19 caused by the highly contagious and virulent delta strain began. On May 9th 2021 2.7 million new cases were reported[13]. Patients requiring hospitalization were unable to access the needed level of health care. Hospitals were overwhelmed with the number of persons seeking admission and intensive care; case fatality rates were high (Figs 2 and 3)[14]. But the duration of the wave was relatively short; by the end of July 2021, the reported cases came down to 260,000. The third wave began in January 2022 and was due to the highly infectious but not virulent omicron strain. On 23.1.2022 there were 2.1 million new cases but the duration of the wave was short. The majority of cases were mild and case fatality rates were low (Figs 2 & 3).

Fig 2 Number of COVID-19 cases reported by India

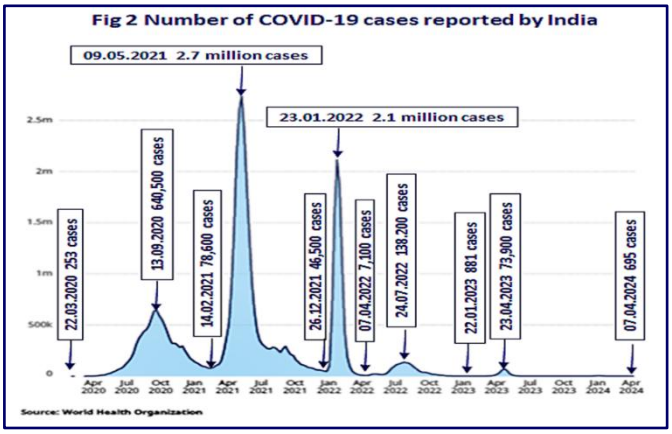
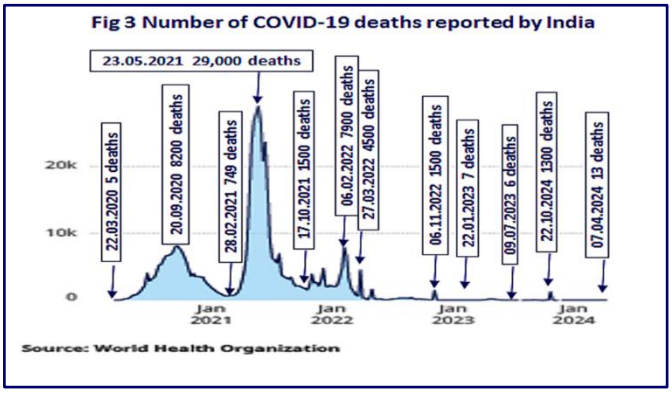
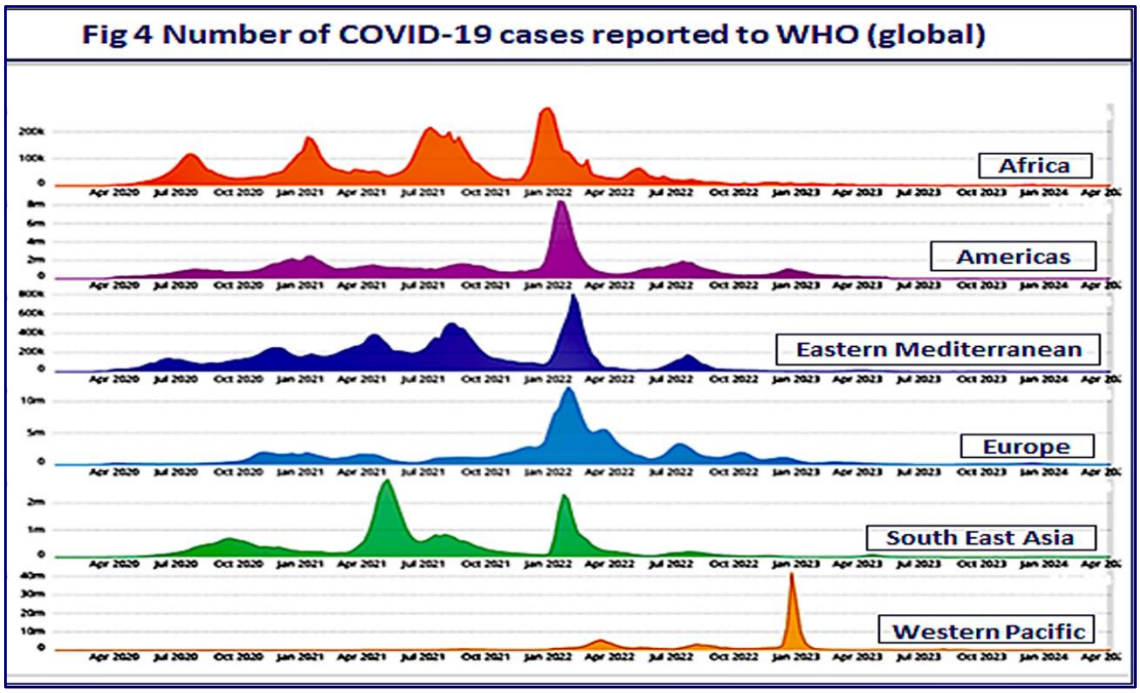


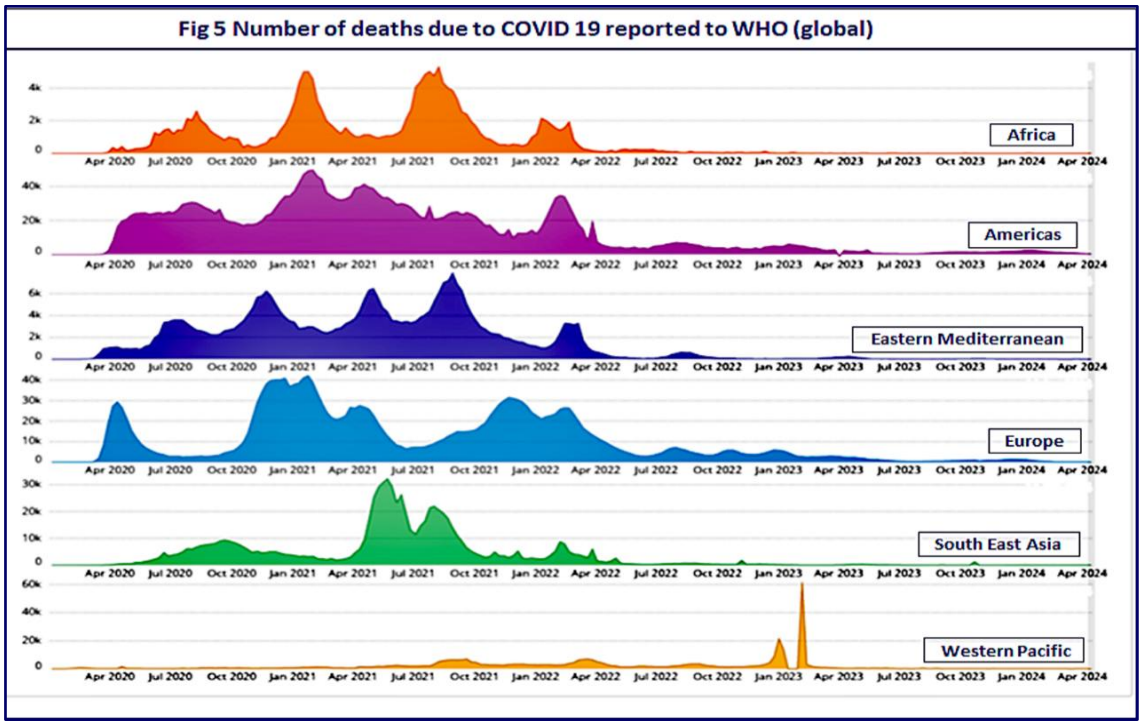
Fig 3 Number of COVID-19 deaths reported by India



INTER-REGIONAL DIFFERENCES IN HEALTH IMPACT OF COVID-19

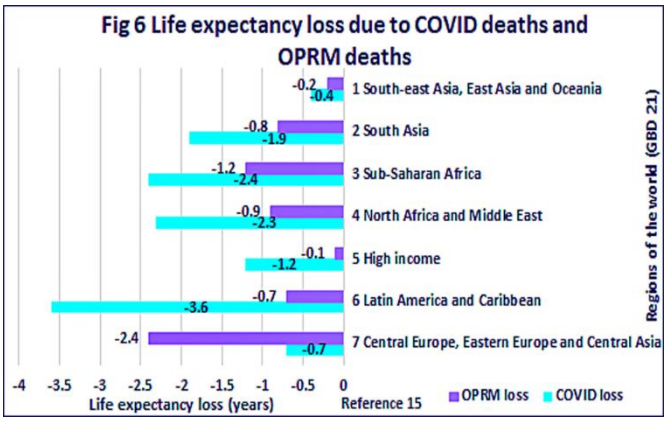
The International Health Regulations (IHR) Emergency Committee monitored data on the coronavirus 2019 disease (COVID-19) pandemic right from 2020. The WHO dashboard on COVID-19 pandemic between 2020-2023 showed that there were substantial differences in terms of the number of cases and deaths not only between regions (Figs 4 & 5)[13,14] but also between first and subsequent waves in the same region. India and South Asia reported relatively low number of cases and deaths due to COVID-19[14]. The number of deaths reported by India was lower as compared to the WHO estimate of deaths due to COVID-19 in India, but comparable to the estimate of deaths due to COVID-19 by GBD 21[15,16].





IMPACT OF COVID-19 ON LONGEVITY AND MORTALITY

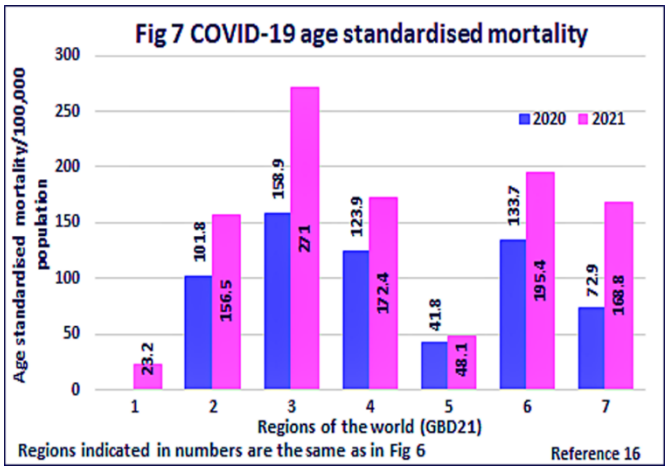
Systematic analysis of life expectancy and mortality rates can provide leads to understanding health impact of an epidemic with large-scale mortality spikes, such as those seen during the COVID-19 pandemic. Analysis of data from GBD 21 on the impact of the COVID-19 pandemic on life expectancy is given in Fig 6[5,16]. There was a reduction in global life expectancy of 1.6 years between 2019 and 2021 due to the COVID-19 pandemic and other pandemic-related mortality (OPRM). All regions of the world showed a reduction in life expectancy due to COVID-19 pandemic, but there were considerable variations between regions (Fig 6). Longevity reduction was lowest in Asia and high-income countries and highest in Latin America and sub-Saharan Africa[15,16].



Globally in 2019, the first four causes of age-standardized deaths (in descending order) were ischaemic heart disease, stroke, chronic obstructive pulmonary disease, and lower respiratory infections. During 2020 and 2021 COVID-19 replaced stroke as the second-leading age-standardised cause of death[15,16].

Analysis of data from GBD 21 on the impact of the COVID-19 pandemic on mortality in different regions and countries showed that:

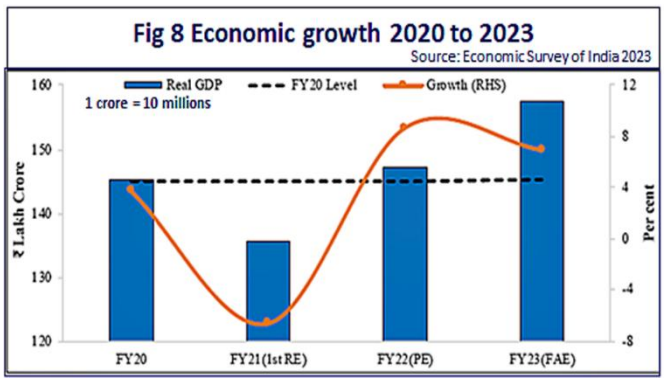
- Globally there were 4·80 million (95% 4·56-5·11) deaths due to COVID-19 in 2020, and 7·89 million (7·49-8·40) in 2021,
- overall mortality rates increased during the COVID-19 pandemic period (2020-21; 5·1% [0·9-9·6] increase),
- there was no increase in mortality in younger populations,
- global age-standardized mortality due to COVID-19 was 58.7 in 2020 and 94 in 2021,
- age standardised mortality rates due to COVID-19 pandemic was relatively low in high-income countries and Asia and highest in Sub-Saharan Africa and Latin America (Fig 7).



IMPACT OF THE COVID EPIDEMIC ON ECONOMY, FOOD SECURITY AND NUTRITIONAL STATUS

ECONOMIC GROWTH

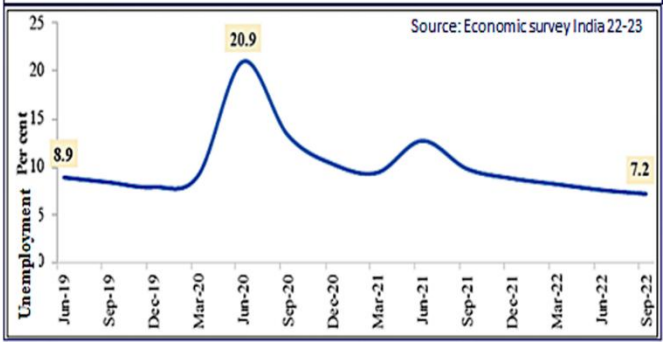
India imposed a stringent 100% lockdown in April and May 2020, and at over 75% till October 2020. The lockdown brought the economy to a standstill for two months and resulted in a 23.9% contraction in GDP as compared to the previous year's second quarter and a substantial contraction of GDP during 2020[3]. With the lifting of the lockdown economic growth steadily recovered and reached the pre COVID-19 levels in 2022. In 2023, economic recovery continued; economic growth surpassed the COVID-19 levels (Fig 8).



URBAN EMPLOYMENT

Between April and May 2020, it was reported that one in five workers in urban areas lost their jobs. In Delhi during the lockdown between April and June, nearly 80% of the migrant workers employed as causal labour faced job loss/reduction in wages. The severe second wave caused a rise in unemployment between April and June 2021 mainly due to illness and the COVID-19-related isolation. The third wave in January/February 2022 had no impact on employment and by the end of 2022 urban unemployment had come down to levels similar to the pre-COVID-19 period (Fig 9).

Fig 9 Urban unemployment



In the post COVID-19 era, stagnant wages and high food inflation are major challenges to household food security.

Table 2 Changes in Family income

	01.04.2020-30.06.2020	01.07.2020-30.09.2020	01.10.20-31.12.20	01.01.21-31.03.21
No change	45.7	61.2	88.9	90.9
Reduction by 30%	4.8	4.2	6.3	6.5
31-50% cut	1.4	1.2	1.0	1.0
>50% cut	1.0	0.8	0.2	0.2
No earning	47.1	32.7	3.6	1.4

IMPACT OF LOCKDOWN 2020 ON EMPLOYMENT AND EARNING IN URBAN FAMILIES

Impact of lockdown and relaxation of lockdown on family income is shown in (Table 2). In April to June 2020, 47% of families had no earning at all; a reduction in income of varying degrees was experienced by 8-10% of families; in 46% of families there was not much change in the income. When the lockdown was eased in July, many found jobs; only one-third of the families had no income. When the lockdown was phased out in October 2020, the number of families who had no income dropped steeply; by the end of the year, over 90% reached income levels similar to the pre-lockdown period.

STRATEGIES FOR COPING WITH ECONOMIC CONSTRAINTS

The strategies adopted by the urban families to cope with economic constraints during lockdown and when it was eased is given in Table 3. Immediately after lockdown about half of the families had to cut down the expenses on food. The families curtailed all other expenditures; expenses for education of their children were low because the schools were closed and classes were held online using mobile phones. Expenditure on health was low because the families avoided going to the hospitals partly because the access to services was limited and partly because of the fear that they may be at risk of getting infected with COVID-19. They sought health care mostly for emergencies and deliveries.

Table 3 Coping strategy used to manage economic constraints				
	01.04.20-30.06.20	01.07.20 - 30.09.20	01.10.20-31.12.20	01.01.21-31.03.21
Cut expenses on food	48.9	46.3	20.0	9.5
Cut other expenses	49.3	45.1	19.2	9.1
Send family to work	2.0	2.0	1.2	0.8
Used savings	49.3	29.1	7.7	3.4
Borrowed	11.5	8.9	3.2	1.6
Sold assets	1.8	0.4	0.6	0.4
Sent children to village	3.4	3.4	3.4	0.0
Sent family to village	1.4	1.0	0.4	0.0

STRATEGIES USED TO PREVENT FOOD INSECURITY

Between April and June 2020 about 46% of the families stated that there was no change in the food purchase practices. Majority of the families had made one or more alterations in the food purchase pattern (Table 4). About one-fourth stated that they bought cheaper food - a coarser variety of rice or cheaper wheat flour and lentils instead of pulses. About 1/8th of the families reduced the quantities of pulses and/or vegetables purchased. Nearly half of the families stopped purchase of fruits, reduced the amount/frequency of purchase of eggs/animal food/milk and milk products. Despite the high cost, there was no reduction in the amount of oil purchased.

Table 4 Changes in food purchase				
	01.04.20-30.06.20	01.07.20-30.09.20	01.10.20-31.12.20	01.01.21-31.03.21
No change	45.7	50.5	79.4	86.9
Bought cheaper food	24.2	21.8	8.1	4.6
Reduced pulse	13.7	12.5	5.0	3.0
Reduced vegetables	11.5	10.5	4.4	2.6
Stopped fruits	49.7	45.0	17.4	10.9
Reduced eggs/animal food	45.9	43.2	15.4	9.5
Reduced milk & milk products	45.9	42.2	15.0	8.3
Reduced oil	1.0	1.2	1.0	0.4

With the easing of the lockdown in October 2020, the job situation improved and earnings increased. As a result, over three-fourths of the families returned to the pre-COVID-19 food purchase patterns. The next three months brought further improvement in employment and earnings and return to the pre-COVID-19 pattern of food purchases both in terms of quantity and quality of foodstuffs. Cereals are the major source of energy and protein in Indian diets. Access to food grains at nominal cost through the public distribution system (PDS) between 1.4.2020 and 31.3.2021 enabled them to purchase the amount of food grains needed with minimum expenditure. Despite the reduction in earnings, the families were able to purchase other food stuffs needed, by using the amount saved from the purchase of food grains at low cost through the PDS.

Changes in food consumption patterns

During the first three months of the first lockdown, about half of the families stated that there was no

change in the food consumption patterns (Table 5). Over 40% of the families complained that they were not getting the preferred food or the variety of food that they relished. Less than 5% of families stated that the family as a whole or the adults in the family had less than the usual amount of food. It was noteworthy that none of the adults skipped a meal or slept hungry (Table 5). The situation improved after the lockdown was removed and by January 2021 nearly 90% of families reported that their food consumption had returned to the pre COVID-19 pattern.

Table 5. Changes in food consumption patterns

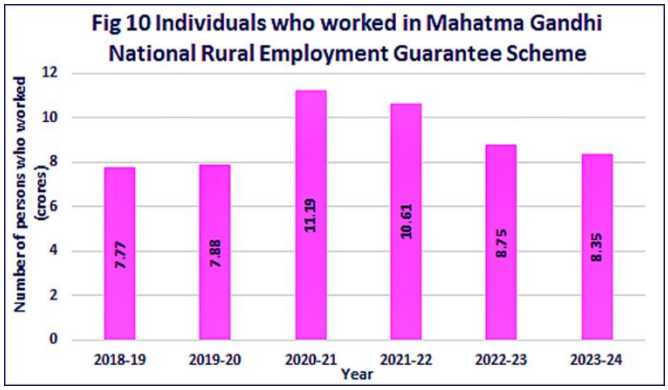
	01.04.20-30.06.20	01.07.20-30.09.20	01.10.20-31.12.20	01.01.21-31.03.21
No change	56.2	60.2	76.6	87.7
Did not get preferred food	43.8	39.8	23.0	11.7
Did not get a variety of food	44.6	40.6	24.0	12.5
Children got enough food but adults did not	3.4	3.0	1.0	1.0
Family had less food	0.4	0.4	0.2	0.2
Adults skipped a meal	0.2	0.2	0.2	0.2
Adults slept when hungry	0.0	0.0	0.0	0.0
Adults skipped meals for a day	0.0	0.0	0.0	0.0

PHYSICAL ACTIVITY

The physical activity of all members of the family was low even before the COVID-19 epidemic. There was a further reduction in physical activity, during the COVID-19 epidemic. Children stayed at home because schools were closed and classes were conducted online. Men went to work, returned home and stayed there. Most women stayed at home because of mobility restrictions and fear of infections.

RURAL EMPLOYMENT

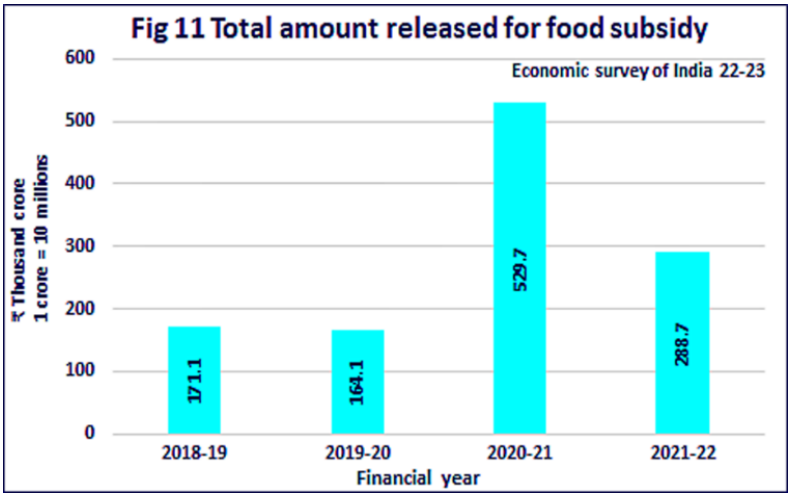
Agriculture and allied sectors employ about 42% of the labour force[3]. In the period before 2019, the rural workforce was undergoing a reduction and the urban workforce showed an increase because workers migrated to urban areas in search of full-time employment with better wages. The COVID-19 epidemic reversed this trend in 2020. With the return of migrant workers to villages, there was a steep increase in the number of persons requesting and obtaining rural employment under the National Rural Employment Guarantee Act (NREGA) (Fig 10)[23]. Even in 2023 individuals seeking and working under NREGA remained higher than the pre-COVID-19 levels. Under-employment, low stagnant wages and high food inflation posed challenges for food insecurity in rural families also.



NATIONAL INTERVENTIONS TO IMPROVE FOOD SECURITY

Agriculture was one sector that continued to grow during the period of the COVID-19 epidemic; production of food grains, pulses, vegetables and fruits were unaffected and there was adequate buffer stock of food grains[5]. Given these favourable circumstances, the provisions under the National Food Security Act (NFSA) were utilised fully and families

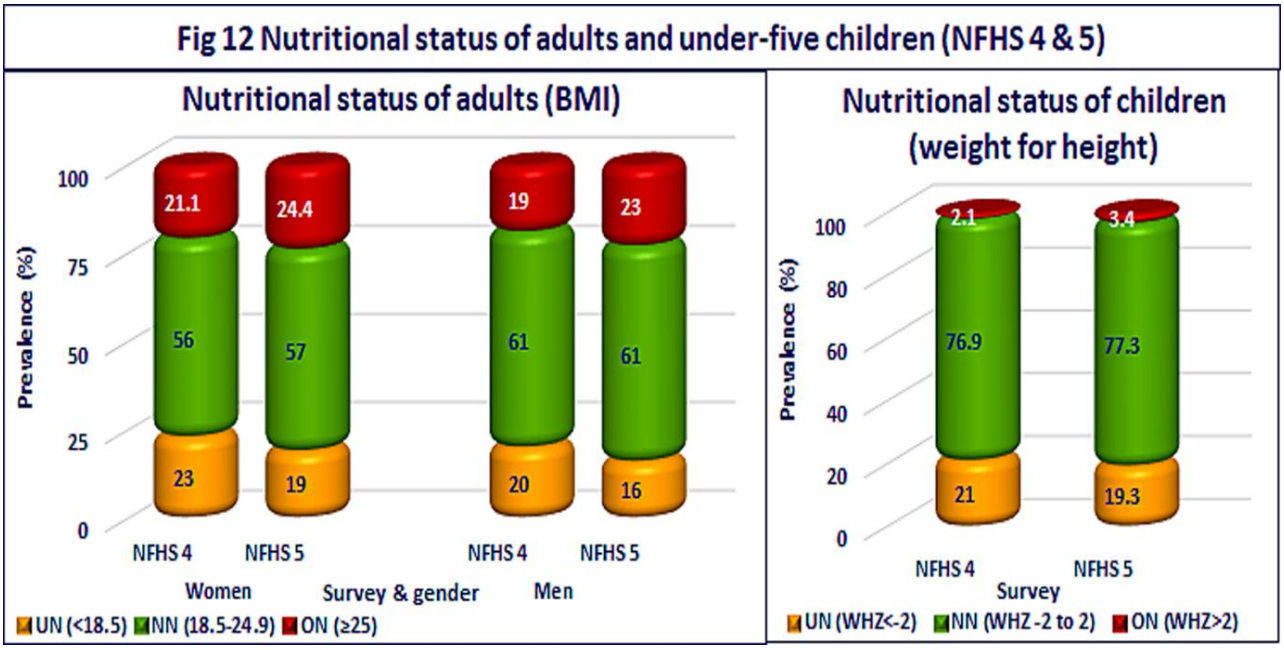
were provided 35 kg of food grains/family/month at the highly subsidised rate; in addition, 5 kg food grains and 1 kg pulses/month were provided totally free of cost to each family. These interventions began in April 2020 and continued right through the COVID-19 epidemic[3-5]. The food subsidy bill was higher during 2020-21 and 2021-22 in comparison to other years as a result of the food grain distribution under NFSA and free distribution of the food grains (Fig 11)[5]. This intervention kept the over 800 million vulnerable Indians hunger-free and relatively food secure.



NUTRITIONAL STATUS DURING COVID-19 EPIDEMIC

AT NATIONAL LEVEL

Data from NFHS 4 and 5 showed that at the national level, there was a reduction in the prevalence of under-nutrition in men and women; the trend was similar to that seen between NFHS 3 and NFHS 4 (Fig 12)[17,18]. There was some reduction in the prevalence of wasting in under-five children between NFHS 4 and NFHS 5 at the national level (Fig 12)[17,18]. There was an increase in prevalence of over-nutrition in men and women between NFHS 4 and 5 (Fig 15)[17,18]. This was similar to the increase in over-nutrition in men and women reported between NFHS 3 and 4. The prevalence of over-nutrition was low in pre-school children both at NFHS 4 and 5; there was no increase in the prevalence of over-nutrition in pre-school children (Fig 12).



AT STATE LEVEL

To assess whether there were changes in the prevalence of under-nutrition between NFHS 4 and 5 due to the COVID-19 epidemic, data on the prevalence of wasting in pre-school children and under-nutrition in adults in NFHS 5 and NFHS 4 were compared separately in states in which the survey was done in phase 1 and phase 2 (Tables 6 and 7) of NFHS 5[17,18]. There were substantial inter-state differences in changes in under-nutrition between NFHS 4 and 5. There were no significant differences in the trends or in the magnitude of the changes in under-nutrition between NFHS 4 and 5 in the states surveyed before the COVID-19 epidemic and those which were surveyed during the COVID-19 epidemic. It was reassuring to know that the changes in food security, dietary intake, or restricted mobility during the COVID-19 epidemic in India did not result in an increase in either under- or over-nutrition, in children or adults.

Table 6. Changes in nutritional status in men and women NFHS 4 and NFHS 5 Phase 1

State	Reduction in UN (NFHS 4-5)		Rise in ON (NFHS 5-4)	
	Women	Men	Women	Men
AP	2.8	-1.7	3.1	-2.4
AS	8.1	7.3	2	3.3
BH	4.8	3.9	4.2	2.1
Goa	0.9	-1.7	2.6	0
GJ	2	3.8	-1.1	0.2
HP	2.3	6.2	1.8	8.6
J & K	7	7.2	0	11.1
KA	3.5	2.2	6.8	8.8
KE	-0.4	-1.5	5.7	7.9
MH	2.7	2.9	0	0.9
TG	4.1	5.3	1.5	8.1
WB	6.5	4.8	2.8	2

AP Andhra Pradesh; AS Assam; BH Bihar; GJ Gujarat;
HP Himachal Pradesh; J&K Jammu & Kashmir; KA Karnataka; KE Kerala; MH Maharashtra; TG Telangana; WB West Bengal

Table 7. Changes in nutritional status in men and women NFHS 4 and NFHS 5 Phase 2

State	Reduction in UN (NFHS 4-5)		Rise in ON (NFHS 5-4)	
	Women	Men	Women	Men
CG	3.6	6.7	2.2	4.7
HR	0.7	-3.2	12.1	8.3
JH	5.3	6.7	1.6	4
MP	5.4	7.6	3	4.7
OD	5.7	4.2	6.5	5
PJ	-1	-1.6	9.5	4.4
RJ	7.4	8.7	-1.2	1.8
TN	2	0.3	0.5	8.8
UP	6.3	8	4.8	6
UK	4.5	-0.1	9.3	9.4
Delhi NCT	4.9	8.6	7.8	13.4

CG Chattisgarh; HR Haryana; JH Jharkhand; MP Madhya Pradesh; OD Odisha; PJ Punjab; RJ Rajasthan; TN Tamil Nadu; UP Uttar Pradesh; UK Uttarakhand

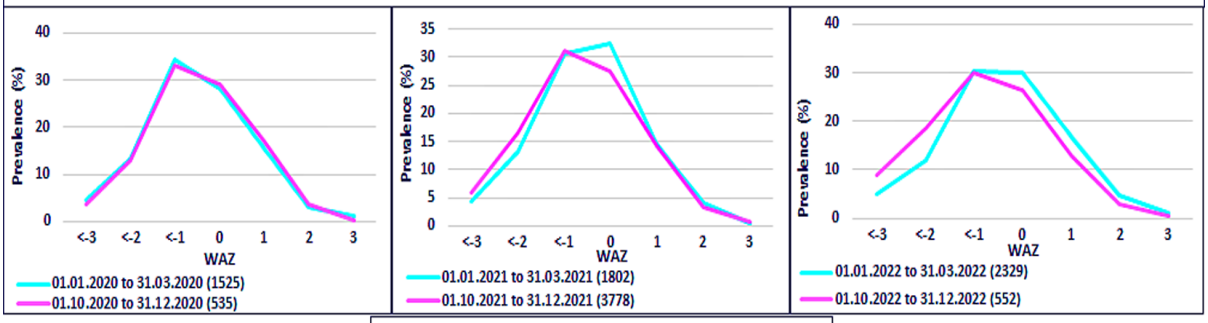
In urban low middle income families

To assess the impact of the lockdowns and the three-waves of the COVID-19 epidemic on the nutritional status, frequency distribution of weight for age in under-five children, BMI for age in 5-19-year children and BMI for adults (men and women) in the following periods were compared:

- 01.01.2020 to 31.03.2020 (pre-COVID-19 period) and 01.10.2020 to 31.12.2020 (impact of lockdown and first wave of the COVID-19 epidemic);
- 01.01.2021 to 31.03.2021 (pre-second wave) and 01.10.2021 to 31.12.2021 (impact of the second wave and lockdown); and
- 01.01.2022 to 31.03.2022 (third wave) and 01.10.2022 to 31.12.2022 (post epidemic period).

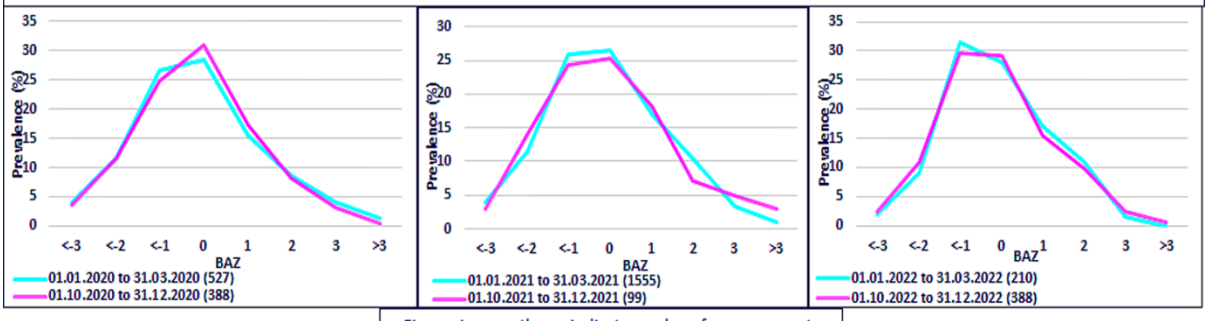
There was no substantial shift in the frequency distribution of weight for age for the under-five children, BMI for age for the 5-19 year children or BMI in adults between the defined periods in any of the three years (Figs 13, 14 and 15). These data suggest that there was no deterioration in the nutritional status due to the lockdown or COVID-19 waves through 2020-2022 either in children or adults in the urban low-middle-income families investigated.

Fig 13 Nutritional status (weight for age) of under-five children



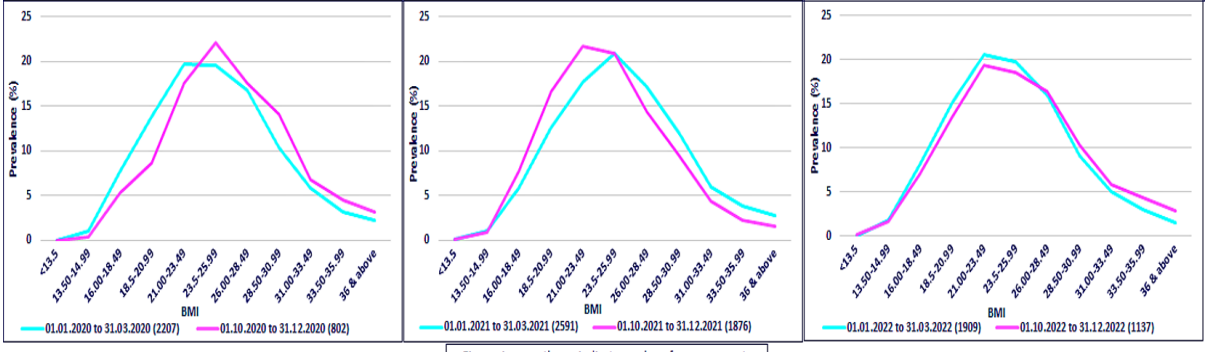
Figures in parentheses indicate number of measurements

Fig 14 Nutritional status (BMI for age) of 5-18 year children



Figures in parentheses indicate number of measurements

Fig 15 Nutritional status of adults (women and men)



Figures in parentheses indicate number of measurements

Discussion

IMPACT OF THE COVID-19 EPIDEMIC ON HEALTH STATUS

Confronted with a rapidly spreading epidemic with high morbidity and mortality, India initially responded with:

- pre-emptive stringent lockdown to delay and flatten epidemic curve,
- extensive testing of 'at-risk' persons for early detection of infection,
- isolation of the infected persons in institutions,
- hospital admission and aggressive management of persons with moderate or severe infection.

The worried population complied with these measures.

Concurrently, a massive health education campaign regarding the importance of personal protective measures for preventing the spread of the COVID-19 infection such as physical distancing, wearing masks and hand washing was carried out using all the channels of communication. Compliance with personal protective measures was high in crowded urban localities.

Lockdown and the widespread use of personal protective measures delayed the epidemic; the number of COVID-19 cases reported between April and June 2020 were relatively low. By June 2020 the health system had been reorganized to cope with a large-scale COVID-19 epidemic. Protocols for testing, contact tracing, isolation and management of the COVID-19 cases had been evolved, infrastructure put in place and personnel trained in providing needed care at various levels[1,2]. The health system, which had been strengthened and reorganized, was not overwhelmed by the flattened first wave and provided needed care for patients with moderate and severe infections and co-morbidities. The reported case fatality rates in India were lower than those reported by many other countries (Figs 2 and 3)[14]

In April 2021 the devastating second wave of COVID-19 caused by the highly contagious and virulent delta strain began. A national lockdown was imposed between April 5th and June 21st 2021. By April 2021 India had ramped up the laboratory testing for COVID-19 infections and had operationalized a digital COVID-19 reporting system. However, availability and access to accurate screening tests varied between states and between urban and rural areas; timely reporting was sub-optimal in some states. These might account for some of the differences between states in the reported numbers of cases. On May 9th 2021 2.7 million new cases were reported[13].

Having learnt from the experience during the first wave, the health system and the people attempted to cope with the second wave by:

- extensive screening for detection of infection,
- home isolation and care for asymptomatic infected persons, persons with mild infection and their families, and
- hospitalisation and rational appropriate care for persons with moderate and severe infection.

The citizens complied with extensive testing and identification of the infected persons. Compliance with home isolation was high because they had home food, home comforts, and could spend quality time with family. The economic cost, physical and psychological hardship of institution-based quarantine were to a large extent minimized. Infected persons who developed mild symptoms were advised home care; the family members who were also in home isolation provided needed care for the patient.

Despite these measures, hospitals were overwhelmed with the number of persons seeking admission and intensive care. Patients requiring hospitalization were unable to access the needed level of health care. Case fatality rates were high (Figs 2 and 3)[14]. But the duration of the second wave was relatively short; by the end of July 2021, the reported cases came down to 260,000.

India began its COVID-19 vaccination programme on 16 January 2021, offering either Covishield

(Oxford-AstraZeneca COVID-19 vaccine) or Covaxin (COVID-19 vaccine developed in India) to all healthcare workers and other front-line workers. From 1st March 2021, all persons above 60 years of age and those aged 45 years or above with co-morbidities were offered vaccination free of cost. From 1st April 2021 all persons above 45 years and subsequently all adults (18 years or above) were given access to the COVID-19 vaccine free of cost. The population witnessing the high morbidity and mortality during the severe delta wave, readily accepted the vaccine. By December 2021 over 90% had received the first dose and over 80% had received the second dose of the COVID-19 vaccine[4,5].

The third wave began in January 2022 and was due to the highly infectious but not virulent omicron strain. On 23.1.2022 there were 2.1 million new cases but the duration of the wave was short. The majority of cases were mild and case fatality rates were low (Figs 2 & 3). This might be because by then majority of Indians had developed some immunity as they had previously had one or more episodes of COVID-19 infection and/or had received one or two doses of the COVID-19 vaccine. After the relatively mild third wave of COVID-19 in early 2022, there was a steep fall in vaccine acceptance; only 20% (predominantly elderly or those who had co-morbidities) took the third dose of vaccine during 2022[5].

INTER-REGIONAL DIFFERENCES IN HEALTH IMPACT OF COVID-19

The International Health Regulations (IHR) Emergency Committee monitored data on the coronavirus 2019 disease (COVID-19) pandemic right from 2020. The WHO dashboard on COVID-19 pandemic between 2020-2023 showed that there were substantial differences in terms of the number of cases and deaths not only between regions (Figs 4 & 5)[13,14] but also between first and subsequent waves in the same region. As compared to other countries/regions, India reported a relatively low number of cases and deaths due to COVID-19[13,14]. The number of deaths reported was lower as compared to the WHO estimate of deaths in India, but comparable to the estimate of deaths due to COVID-19 by GBD 21[15,16].

In India, the registration of deaths is still not universal and clear documentation on the cause of death based on medical certification is inadequate. Despite intensive efforts during the COVID-19 epidemic, there were lacunae both in the completeness of registration of deaths and the cause of death. This could be a factor responsible for the relatively low number of reported deaths. It is also possible that mortality rates due to COVID-19 in India were lower because:

- there were only three waves of the COVID-19 epidemic,
- the stringent lockdown delayed the first wave, and gave the health system the needed time to strengthen and reorganize and;
- the number of deaths during the first and the third waves was low.

Systematic analysis of life expectancy and mortality rates can provide leads to understanding variations in large-scale mortality spikes, such as the those seen during the COVID-19 pandemic. All regions of the world showed a reduction in life expectancy due to COVID-19 pandemic, but there were considerable variations between regions (Fig 6). Longevity reduction was lowest in Asia and high-income countries and highest in Latin America and sub-Saharan Africa[15,16]. Mortality rates increased during the COVID-19 pandemic period (2020-21; 5·1% [0·9-9·6] increase). Global age-standardized mortality due to COVID-19 was 58.7 in 2020 and 94 in 2021. Contrary to the apprehension in the early days of the pandemic, there was no increase in mortality in younger populations. The age-standardized mortality rates due to COVID-19 were relatively low in high-income countries and Asia and highest in Sub-Saharan Africa and Latin America (Fig 7).

Research studies showed that the spread of infection varied depending on the contagiousness of the organism; morbidity and mortality were related to the virulence of the strain of the organism. Timeliness and appropriateness of the

lockdowns, the proportion of the population who consistently used personal protection measures, access to diagnostics, steps taken for isolation of persons with infection and the proportion of the population who had received vaccines were important factors that modified the total number of cases; severity of the infection and access to appropriate health care were major determinants of the case fatality rates. Further in-depth analysis of the large databases on the COVID-19 pandemic may provide leads on how to improve epidemic preparedness and management, especially in those regions and countries that were severely affected.

CURRENT STATUS OF SARS COV-2 INFECTION

The International Health Regulations (IHR) Emergency Committee of WHO in its 15th meeting on 4.5.2023, noted the decreasing trend in COVID-19 cases, deaths, COVID-19-related hospitalizations, intensive care unit admissions and the high levels of population immunity to SARS-CoV-2 in the last few months and stated that COVID-19 infection was no longer a 'public health emergency of international concern' (PHEIC), but an established and ongoing health issue[20]. To guide the countries transitioning to long-term management of COVID-19, WHO published the Strategic Preparedness and Response Plan for 2023-2025[21]. This plan outlines actions to be taken by countries in the following five areas: collaborative surveillance, community protection, safe and scalable care, access to counter-measures and emergency coordination. Effective surveillance has to be kept up to provide early warning for the re-emergence of known infections and new emerging infections. Health systems have to be prepared to ensure that steps are taken to:

- minimize the spread of infections,
- ensure early detection, and
- provide effective, timely and appropriate interventions so that morbidity and mortality are minimised.

IMPACT OF COVID-19 ON THE ECONOMY

In developing countries like India there are close linkages between economy, employment, poverty, food security, nutritional status and health. Seven decades ago, the country was not self-sufficient in food production. Over 80% of the population were poor, food insecure and under-nourished; longevity at birth was 33 years. In the 1970s, the Green Revolution ensured that the country produced sufficient food grains to meet the needs of the growing population and was food secure at the national level. But prevalence of poverty, household food insecurity, under-nutrition and ill health continued to be high. National programmes were initiated to improve:

- economic growth and income to alleviate poverty, and
- food security of the poor by:
  - increasing purchasing power through employment guarantee programmes,
  - providing subsidized food grains to families below the poverty line, and
  - providing supplementary feeding under the Integrated Child Development Services (ICDS), and school midday meal programme (MDM) to bridge the gap between dietary requirement and actual dietary intake in children, pregnant and lactating women[24].

Over the next four decades there had been substantial improvement in all these; COVID-19 pandemic caused serious disruption in economy, posed challenges to food security and health of the population.

The lockdown between April and June 2020 brought the majority of economic activities to a standstill and caused a steep fall in economic growth. In 2021 the second wave of the COVID-19 epidemic had a devastating impact on health; there was considerable absenteeism due to illness and isolation. The lockdown was for a short duration; the contraction in GDP due to lockdown was not high[4]. Economic activities and economic growth were not affected by the third wave in 2022 (Fig 8) and GDP was higher than the pre-pandemic level in 2019-20[5]. The economic recovery continued through 2023.

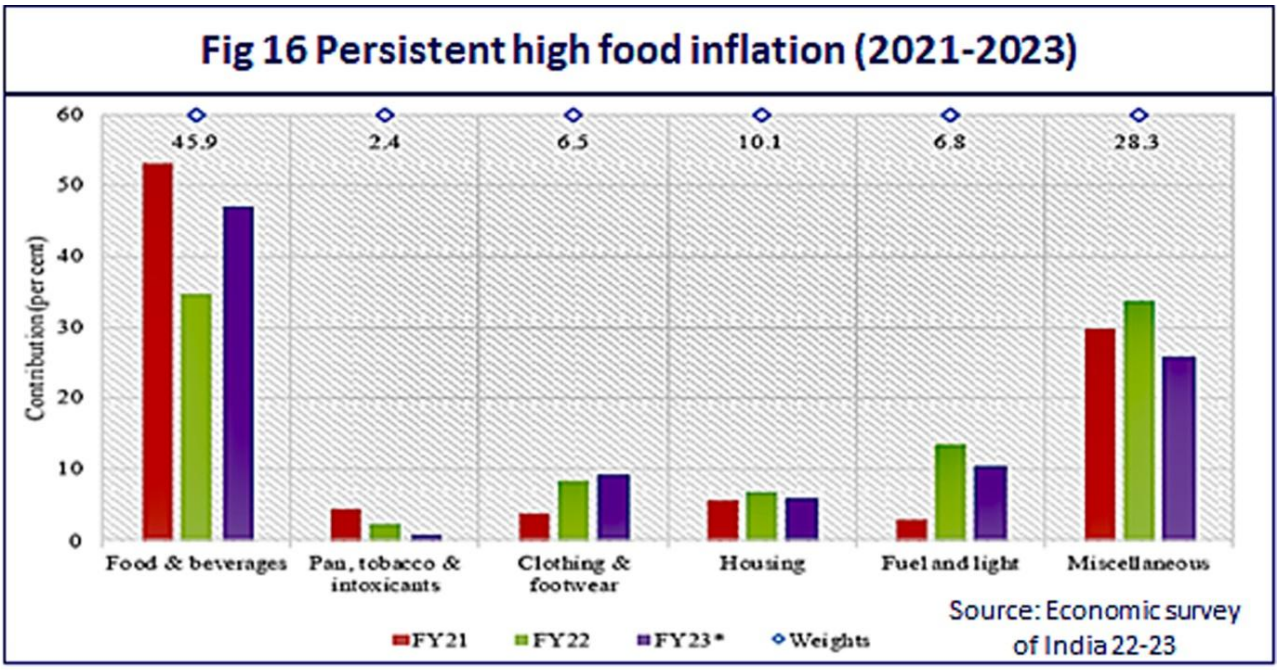
Currently, India is one of the fastest-growing economies in the world. Some economists believe that the economic recovery was V-shaped and that the country will continue along a high GDP growth trajectory. Others suggest that the economic recovery was K-shaped and economic growth was mainly in the high-income groups; disparities in incomes between the top and bottom centiles of the population are increasing. The economic growth in 2021-2023 was not accompanied by employment growth and an increase in wages.

Available data on time trends in household income and expenditure from quarterly surveys conducted by the Centre for Monitoring Indian Economy between 2019 and 2023[22] showed that:

- in 2020 there was a fall in both per capita household income and expenditure;
- recovery in per-capita household income to pre-COVID-19 levels took longer than recovery in GDP;
- consumption expenditure exceeded pre-COVID-19 levels in 2022 but rise in income was lower;
- the gap between expenditure and income resulted in a fall in household savings.

The Economic survey showed that between 2021 and 2023, there was stagnant wages and persistently high inflation, especially food inflation (Fig 16)[5]; these could adversely affect household food security. Taking into account the potential adverse impact of these factors on food security in the poorer segments of the population, the country continued to provide 35 kg of food grain at nominal cost to over 800 crore persons right through the financial year 2023-24 also.

Fig 16 Persistent high food inflation (2021-2023)



IMPACT ON EMPLOYMENT

Urban unemployment rates were high even before the COVID-19 pandemic. Interventions to minimise the spread of COVID-19 such as lockdown; physical distancing and minimizing personal contact reduced employment in service sectors, wholesale and retail trade, hospitality, arts and entertainment. Between April and May 2020, it was reported that one in five workers in urban areas lost their jobs. In Delhi, during the lockdown between April and June, nearly 80% of the migrant workers employed as causal labourers faced job loss/reduction in wages. The severe second wave caused a rise in unemployment between April and June 2021 mainly due to illness and the COVID-19-related isolation. The third wave in January/February 2022 had no impact on employment and by the end of 2022 urban unemployment had come down to levels similar to the pre-COVID-19 period (Fig 9). Interventions

aimed at reversing the decline of urban employment included the provision of funds needed to resume activities to medium, small, and micro enterprises (MSME) which employ a large number of persons, debt moratoria and liquidity support to improve the economic output of MSMEs. However, in the short term, the impact of these interventions was limited due to the low absorptive capacity of these enterprises and dwindling demand for the products due to economic constraints faced by the consumers[3-5].

It was estimated that job loss due to the stringent lockdown was 50 million; these jobless workers had to go back to rural areas despite lockdown-related travel restrictions[4]. Those who returned to villages were often kept isolated outside the main village for a week or ten days before they were allowed to join their extended family members in the villages. This was done as a precaution to prevent the spread of the COVID-19 infection from potentially infected persons returning from urban areas to the villages. The returning migrant workers joined the unemployed rural workers in search of employment; consequently, there was a steep increase in the requests for employment under the rural employment guarantee programme[3-5] (Fig 10).

COPING STRATEGIES USED BY URBAN FAMILIES TO MINIMISE FOOD INSECURITY

Urban low middle-income families were one of the worst affected segments of the population during the COVID-19 epidemic in India. Studies undertaken by our institution in urban low-middle-income families before the COVID-19 epidemic had shown that they were food secure[7-12]. Our institution under took an in-depth study to assess how urban low-middle income families who stayed in Delhi during the lockdown in 2020 tried to cope with job loss, economic constraints and the threat to food security. Families faced with job loss of the head of the household, usually try to send other family members to find work. However, this strategy could not be followed when the job loss was due to the lockdown. Rent was a major item of expenditure. Families tried to negotiate for a reduction in the rent; but as the owners' income was from rent, they were neither willing nor able to allow a reduction in rent. The migrant workers tried to manage paying the rent and buying food in the first month of lockdown by using savings and borrowing money, but they could not continue doing this indefinitely. They curtailed all types of expenditure including expenditure on food, education and healthcare. During lockdown half of the families had to cut down the expenses on food by buying cheaper food; reducing the quantities of pulses, vegetables and animal food and stopping buying fruits.

In 2020, the country provided 35 kg of food grains at a nominal cost and 5 Kg of cereals and 1 kg of pulses free of cost through the PDS. This intervention enabled families to purchase needed cereals with minimum expenditure; the families were able to purchase other food stuffs needed, by using the amount they saved by buying food grains at nominal cost.

Families were able to cook and feed the family using their habitual cooking practices, in none of the families, adults skipped a meal or went to sleep without food. But due to economic constraints, they were unable to afford the preferred food stuffs and get a variety of food preparations. The Delhi government and some philanthropists provided two hot cooked meals (one at noon and the other in the evening) to all those who came to the designated sites. None of the families in our study accessed these hot-cooked meals. The needy persons who were living alone without their families tended to access these hot-cooked meals.

When the migrant workers found that the lockdown was likely to be prolonged, they had no option but to get back with their families to their villages as and when transport was available. Once they reached their villages, they tried staying with their extended family in the village to minimise the expenditure; the availability of highly subsidized food grains kept hunger away. Many requested for and obtained employment under the National Rural Employment Guarantee Act (NREGA); but

income from rural employment was low. After the lockdown was lifted in October 2020, many workers returned to urban areas in search of remunerative employment. Once they found employment, they brought back their families to urban areas.

RURAL EMPLOYMENT

Agriculture and allied sectors employ about 42% of the labor force[3] but generate only 16 % of the GDP. Rural workers, are often under-employed and do not receive remunerative wages. In the period before 2019, rural workers migrated to urban areas in search of full-time employment with better wages; as a result, the rural workforce was undergoing a reduction and the urban workforce showed an increase. In 2020, the COVID-19 epidemic reversed this trend. The lockdown resulted in the return of migrant workers to villages. There was a steep increase in the number of persons requesting and obtaining rural employment under NREGA (Fig 10)[23]. Even after the COVID-19 epidemic waned in 2022, individuals seeking and working under NREGA remained higher than the pre-COVID-19 levels. Under-employment, low stagnant wages and high food inflation continue to pose major challenges for food security both in urban and rural families. To minimize food insecurity due to these problems, the provision of food grains at nominal cost under NFSA has been continued till March 2024.

INTERVENTIONS TO PREVENT FOOD INSECURITY DURING COVID-19 PANDEMIC

India enacted the National Food Security Act (NFSA) in 2013 to improve household food security[24,25]. The NFSA provides highly subsidized food grains (rice, wheat and millets at Rs 3, 2 and 1/kg respectively) as a legal entitlement to 50% of urban and 75% of rural families and subsidized food grains for the food supplementation programmes under ICDS and MDM. The Government launched a citizen-centric and technology-driven scheme in 2019 called the "One Nation One Ration Card" (ONORC). This scheme enabled migrant workers to continue accessing the subsidised food grains[4,5].

During the COVID-19 epidemic, the production of food grains, pulses, vegetables, and fruits was unaffected and there was adequate buffer stock of food grains. Given these favourable circumstances, the provisions under the NFSA were utilized to provide highly subsidized food grains. The very needy families received direct cash transfers. These interventions began in April 2020 and were continued right through COVID-19 epidemic[3-5]. Despite teething problems, the ONORC scheme enabled a substantial proportion of the migrant labourers and their families to access their rations wherever they were. The highly subsidized and free food grains provided under the National Food Security Act kept the over 800 million Indians hunger-free and relatively food secure.

In the last two years high food inflation (Fig 16) and stagnant real wages have been posing a major threat to food security among poorer segments of the population[5]. Taking into account the potential adverse impact of these factors on food security the country continued to provide 35 Kg of food-grains at nominal cost to over 800 crore persons right through the financial year 2023-24.

NUTRITIONAL STATUS DURING COVID-19 PANDEMIC

NATIONAL

Data from NFHS 4 and 5 showed that at the national level, there was a reduction in the prevalence of under-nutrition (BMI <18.5) in men and women; the trend was similar to that seen between NFHS 3 and NFHS 4. There was a small reduction in the prevalence of under-nutrition (weight for height <-2 SD) in pre-school children (Fig 12)[17,18]. These data suggest that nationwide interventions in terms of providing employment under NREGA, direct cash transfer to selected vulnerable groups and supplying food grain at a highly subsidized rate under NFSA prevented deterioration in household food security and nutritional status of children and adults during COVID-19 epidemic.

There had been speculations that the reduction in physical activity during the COVID-19 epidemic, coupled with a carbohydrate-rich diet may accelerate the increase in over-nutrition both in children and adults. There was an increase in the prevalence of

over-nutrition in men and women between NFHS 4 and 5 (Fig 12)[17,18]. This was similar to the increase in over-nutrition in men and women reported between NFHS 3 and 4. The prevalence of over-nutrition was low in pre-school children both in NFHS 4 and 5; there was no increase in the prevalence of over-nutrition in pre-school children (Fig 12)[17,18].

The lack of the adverse impact of COVID-19 on nutritional status at national level might be because the survey was completed before the COVID-19 epidemic in nearly half the states. To assess whether there were changes in the prevalence of under-nutrition between NFHS 4 and 5 due to the COVID-19 epidemic, data on the prevalence of wasting in pre-school children and under-nutrition in adults in NFHS 5 and NFHS 4 were compared separately in states in which the survey was done in phase 1 and phase 2 (Tables 6 and 7) of NFHS 5[17,18]. There were substantial inter-state differences in changes in under-nutrition between NFHS 4 and 5. There were no significant differences in the trends or in the magnitude of the changes in under-nutrition between NFHS 4 and 5 in the states surveyed before the COVID-19 epidemic and those which were surveyed during the COVID-19 epidemic. It was reassuring to know that the changes in food security, dietary intake or restricted mobility during the COVID-19 epidemic in India did not result in an increase in under-nutrition, in children or adults.

NUTRITIONAL STATUS OF CHILDREN AND ADULTS IN URBAN LOW-INCOME GROUP

Data from the mixed longitudinal study in urban low middle income group families showed that there was no substantial shift in the frequency distribution of weight for age for the under-five children, BMI for age for the 5-18 year children or BMI in adults between the defined periods in any of the three years (Figs 13, 14, 15). Urban low middle income group was one of the worst affected segments of the population during the COVID-19 epidemic in India. It was reassuring to note that mixed longitudinal studies even in this population showed that there was no deterioration in the nutritional status due to the lockdown or COVID-19 waves through 2020-2022 either in children or adults.

Summary and conclusion

The once-in-a-century COVID-19 pandemic severely tested the coping capabilities and resilience of nations and people across the globe. Confronted with a rapidly spreading epidemic with high morbidity and mortality, India initially responded with:

- pre-emptive stringent lockdown and health education on personal protection measures to delay and flatten the first epidemic curve,
- extensive testing of 'at-risk' persons for early detection of infection,
- isolation of the infected persons and their family, and
- hospital admission and aggressive management of persons with moderate or severe infection.

The worried population complied with these measures.

India had only three waves of the COVID-19 epidemic, both cases and deaths were low in the first wave; both cases and deaths were high in the second wave; cases were high but deaths were low in the third wave. GBD 21 estimates suggest that the impact of COVID-19 epidemic in terms of reduction in longevity and increase in age-standardized mortality rates were relatively low in India as compared to many regions of the world.

The lockdown in 2020, delayed and flattened the first wave but had severe adverse impact on economy and employment. The debate whether similar health outcomes could have been achieved without the severe lockdown continues even today.

Both urban and rural unemployment increased during the COVID-19 epidemic. Economic incentives were provided to MSMEs and by 2022-23 there was reduction in urban unemployment. Demand for rural employment was high during the epidemic and the demand persists at a higher level even now. Additional allocations were made under NREGA to meet the high demand for rural employment and these are being continued even now.

Provision of 35 kg of food grains at nominal cost to over 800 million Indians between 2020 and 2022, enabled the population to remain hunger-free and relatively food secure. Currently provision of food grain at low cost is being continued to prevent adverse impact of stagnant wages, low savings and high food inflation on food security. The food subsidy cost had been very high since 2020. There is a need to assess whether in the post COVD-19 era, the identification of the needy and providing them with the required food grains at a nominal cost can help to achieve the food security at a lower cost.

Data from the national surveys and our research study in urban low-middle-income families indicate that the COVID-19 epidemic did not have any adverse impact on the prevalence of either under-nutrition or over-nutrition in children or adults.

These data suggest that the world's most populous country and its citizens coped with the health, food security and nutrition challenges posed by the COVID-19 epidemic and succeeded in minimizing the adverse consequences.

Conflict of interest statement:

None

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Contribution of each author:

Prema Ramachandran: Formulating the research question(s), designing the study, monitoring the study, interpretation of results, writing the first draft of the manuscript.

Honey Kumari Conducting the research study in the community, monitoring and supervising the data collection by the study team, monitoring data entry and correcting errors, assisting in data tabulation.

K Kalaivani Reviewing the study protocol, monitoring the study, data cleaning and analysis, interpretation of the results, reviewing and modifying the draft manuscript.

All the authors have reviewed and approved the final version sent for publication.

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