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Research Article

Analysis of Food and Nutrition Security in Pakistan: A Contribution to Zero Hunger Policies

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Abstract | Food and nutrition security is the foremost element of zero hunger policies. Food and nutrition deficiencies cause poor health, low productivity, and high medical costs. This study based on data from the Household Integrated Income and Consumption Survey 2015-16 of Pakistan is designed to ascertain and estimate the patterns of calorie intake in Pakistan and compare the same across various provinces. It also tracks the pattern and levels of consumption of various macro and micronutrients. The study indicates 38% of the households at the national level experience calorie deficiency (less than recommended calories). The corresponding figures for the urban and rural areas are 40.5% and 36.7%, respectively. Households experiencing deficiency in caloric intake in Balochistan and Sindh provinces are comparatively higher. Nutritional deficiencies in terms of essential macro and micronutrients indicate that 40% of households were deficient in protein, with 58% in urban and 44% in rural areas. Micronutrient deficiency analysis shows that 22% of the survey households in Punjab, 30% in Sindh, 11% in KP, and 37% in Balochistan are suffering from iron deficiency. Besides, 57% of households in Balochistan, 56% in Sindh, 35% in Punjab, and 26% in KP experience deficiency of zinc. The vulnerability analysis of the survey data found 12% of the households at the national level to be extremely vulnerable and food insecure in terms of their calorie intakes, balanced diet, and adequacy of micronutrients. The results call for coherent public policy interventions and programs to tackle food and nutrition insecurity and achieving zero hunger.

Introduction

Food and nutrition security has an important and vital role in the development of human capital and economic growth (Cook and Frank, 2008). The 1996 World Food Summit adopted a still more complex definition "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". It points out the four key dimensions of food security, including food availability, accessibility, utilization, and sustainability. This concept of food security highlights the multidimensional nature of food security and facilitates policy responses aimed at supporting and restoring livelihood options. Livelihood strategies are now central to the initiatives of international organizations (Clay, 2002). These

approaches are widely used for emergency response purposes. In short, the study of food insecurity as a social and political structure has emerged (Devereux and Maxwell, 2001). More recently, this definition is further refined in The State of Food Insecurity 2001: "Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2020). On the other hand, there is a significant difference between food and nutritional security. Food security is a necessary but not sufficient condition of nutritional security. The World Bank defines nutrition security as: "The ongoing access to the basic elements of good nutrition, i.e., a balanced diet, safe environment, clean water, and adequate health care (preventive and curative) for all people, and the knowledge needed to care for and ensure a healthy and active life for all household members" (ACF-International, 2014).

In addition, deficiencies in food and nutrition affect health, lower productivity, and raise medical costs. For children under the age of five, these deficiencies lead to stunting and wasting. Stunting and wasting enhance the probability of chronic diseases, premature death, and reduction in cognitive ability, and reduce lifetime earnings. At the economic level, childhood stunting is the direct cause of poor human capital and low productivity (World Bank, 2006; McGregor et al., 2007; Cook and Frank, 2008). Currently, millions of people from low and middle-income countries are still suffering from extreme hunger and malnutrition. The majority of the undernourished people (827 out of 842 million) belong to developing countries. The primary outcomes of food and nutrition insecurity are stunting, wasting, and micronutrient deficiencies (Mutisy et al., 2015). The incidence of stunting in developing countries is considerably higher and the vast majority of stunted children (87 million) live in Asia (FAO et al., 2017).

In terms of food and nutrition security, Pakistan is one of the most vulnerable countries in developing nations. Although the hunger index in Pakistan has declined continuously, progress has been inadequate as compared to other developing countries (IFPRI, 2017). The 2018 National Nutrition Survey based on the Food Insecurity Experience Scale (FIES) has reported that 36.9% of households were food insecure (GoP and UNICEF, 2019). Also, the Pakistan Demographic and Health Survey (PDHS) of 2017-18 based on anthropometric measurements has reported that 37.8% of the children under the age of 05 years were stunted, 38.2% in boys, and 37.1% in girls. The corresponding provincial statistics show that 30% of the children in Punjab, 50% in Sindh, 40% in KP, and 47% in Balochistan were stunted (NIPS and ICF, 2019). Pakistan has implemented a number of national programs with the cooperation and assistance of international donors and organizations, including the National Zero Hunger Program, the Special Cell National Zero Hunger Coordination Program to achieve zero hunger, School Nutrition Program, Micronutrient Initiative, Tawana Pakistan and several primary health care programs. However, in the spite of all these efforts, 20.3% of the population is undernourished and a large proportion of children continue to suffer from acute malnutrition. Further, with a score of 28.5 on the Global Hunger Index in 2019, Pakistan was ranked 94th out of 117 countries. Pakistan suffers from a serious degree of hunger and malnutrition which translates into stunting, wasting, and micronutrient deficiencies (Grebmer et al., 2019).

In Pakistan, as per article 38(d) of the Constitution, it is the responsibility of the Federation to provide for the social and economic well-being of all Pakistanis. Nevertheless, despite the constitutional guarantee, a large chunk of the population has been facing food and nutrition insecurity, and other deprivations in terms of various indicators of social well-being (Malik et al., 2014; Haider and Zaidi, 2017). The regional analysis indicates that a large number of households faced food insecurity, thriving on less than the required calorie intake (Spielman et al., 2016). Furthermore, previous studies have shown that households in urban areas are more food-insecure than those of rural areas because of the less dietary intake of calories than required (Ahmed et al., 2017; Ishaq et al., 2018).

With this background information, this study attempts to provide a detailed analysis of the food security situation in various regions and at the country level. This study has also provided estimates of macro and micronutrient deficiencies in food intakes at the national and provincial levels which was lacking in previous studies, on the subject in Pakistan (Sultana and Kiani, 2011; Bashir et al., 2012; Hussain et al., 2014; Malik et al., 2014; Jamal, 2017; Haider and Zaidi, 2017).

In the wake of increasing concerns with the global environment and climate change, implications for agricultural production in developing countries' regarding food and nutrition security are increasing the attention of researchers, governments, and international organizations. Despite the proliferation of literature on the subject, there are important gaps that need to be filled, especially in LDCs, such as measurement of calories including analysis of macro and micronutrients. The available literature on the food and nutrition security situation in Pakistan also suffers from the above-mentioned limitations. The current study provides a detailed analysis of the important aspects of the food and nutrition situation, based on the actual survey data, will not only attempt to fill in the gap mentioned above but also provide useful insights to design a robust policy framework to address the issues and challenges of food and nutrition security in the country. Further, this research study aims to provide a comprehensive empirical analysis of the food and nutrition security, at both national and regional levels for Pakistan. It also ascertains the patterns of calorie intakes including macro and micronutrients e.g. (proteins, fats, carbohydrates, calcium, phosphorus, iron, zinc, iodine, and vitamin B1, B2, B3, C, and A).

Materials and Methods

This section discusses various methods and indicators of food and nutrition security measurement, data requirements, and their limitations. It also explains the conceptualization of food security of households/members in terms of micro and macronutrients, conversion of raw data into caloric units of energy (Kcal) per adult equivalent per day, diet quantity, diet quality, and vulnerability.

Various methods and units are available to measure food and nutrition security. To ascertain the food security situation, the United States Department of Agriculture (USDA) has developed the Scale-Items approach, based on two types of Scale-Items. One consists of 6 Scale-Items and the other consists of 18 Scale-Items (Coleman et al., 2014; Jones et al., 2013). To assess the food security status and behavior at the regional and national levels, another approach based on Dietary Diversity Scores (DDS) is applied (Kennedy et al., 2011). The DDS approach is further divided into three categories: (1) Household Dietary Diversity Score (HDDS);

(2) Women's Dietary Diversity Score (WDDS); (3) Individual Dietary Diversity Score (IDDS).

These approaches to measuring the food security situation have their merits and limits: DDS does not provide information on food quantities, nutrients, and the agreed-upon cutoff (Kennedy et al., 2011). Due to these limitations, this study relied on the Minimum Dietary Energy Requirement (MDER) method and the Atwater formula (Weingärtner, 2009). This technique is not exempt from limitations either because of self-reporting and recall of food consumption data (Moltedo et al., 2014). These procedures are adopted following two well-known and standardized approaches mentioned in the subject by (Moltedo et al., 2014) and Smith and Subandoro (2007).

Diet quantity, quality and vulnerability
The diet quantity means the total amount of food/energy intake per person or per household in a specific time period (Maxwell and Smith, 1992). It is estimated from the data on household food quantity and expenditures. The steps required in estimating energy from the household food quantity and expenditures data are given in Table 1. The data conversion into diet quantity consists of two steps (Moltedo et al., 2014; Smith and Subandoro, 2007). In the first step, the reported nonstandard (local units of measure) and standardized survey data are converted into standardized edible portions (EP) by the multiplication of conversion and refusing factors. In the second step, the standardized EP of food is converted into grams. At the end EP grams, arrived at the second step, are converted into various macro and micronutrients as per the information available from the Food Composition Table (FCT).

In the second step, missing calories are also derived, by the given steps in Table 1, from the survey data which reported only prices/expenditures of commodities without listing quantities. Therefore, all materials of sugars are converted into macro and micronutrients such as proteins, fats, carbohydrates, and vitamins. These nutrients are also used in calorie conversion. Finally, the following modified Atwater formula is used to estimate the calories:

$$Calories(Kcal) = \Pr otein(g)*4 + Fats(g)*9 + Av.Carbohydrates(g)*4 + Fiber(g)*2 + Alcohol(g)*7 \dots\dots\dots(1)$$

Where; Av. carbohydrates= total carbohydrates-fiber.

Table 1: *Diet quantity, quality and vulnerability estimation procedures.*

Dimensions	Steps	Measurements
Diet Quantity	Step 1: Conversion of food quantities into grams	Survey quantities are converted into standardized edible portions (EP) by the multiplication of conversion and refusing factors
	Step 2: Conversion of into grams	$FQ_{jh}(g) = FQ_{jh}(ml) * density_j (g/ml)$ Where; j is the reported food product h is household and FQ_{jh} is the quantity of j food product consumed by the household h.
	Step 3: Adjustment of non-edible food portion	$EFQ_j = FQ_j * (1 - \frac{refuse}{100})...(a)$ Or $EFQ_j = FQ_j * (EC)...(b)$ EFQ_j is the edible quantity of j food product, FQ_{ej} is the quantity of j food product after the step 1 and 2, and EC is the edible coefficient of the reported product.
	Step 4: Conversion of grams into nutrients	$Q_{ih} = \sum_{i=1}^{g}((EFQ_{jh} * Nutrient\,values_{ij}/100)$ Where; h is the given nutrient consumed by the household, j represents the respective food items, g is the total number of food items consumed by the household h and Q_{ih} is the total grams of nutrients as obtained from various food items.
	Step 5: Converting nutrients into calories	$N_{ih} = A_i * Q_{ih}$ Where, Q_{ih} is the total gram of the nutrients from the step 4, Ai is the Atwater coefficient of nutrients and N_{ih} is the dietary energy (Kcal) obtained by the household h from food item i.
	Step 6: Estimating calories per household	$DEC_h = \sum_i N_{ih}$ Where; DEC_h is the total dietary energy (Kcal) consumed by the household h.
	Estimation of missing diet quantity	
	Step 1: Proportion of calories from protein and fat	$SPORT_h = \frac{\sum_{j=1}^{g} PROT_{jh}}{\sum_{j=1}^{g} DEC_{jh}}...(a)$ $SFAT_h = \frac{\sum_{j=1}^{g} FAT_{jh}}{\sum_{j=1}^{g} DEC_{jh}}...(b)$ Where; $SPORT_h$ and $SFAR_h$ are the proportion of household h calories from already estimated protein and fat from procedure 1 for the household h and divided by the total household h energy intake (Kcal) from procedure 1.
	Step 2: Missing calories	$Uval_h = \frac{\sum_{j=1}^{k} FDEXP_{jh}}{DEC_h}...(a)$ $DEC_{kh} = \frac{FDEXP_{kh}}{Uval_h}...(b)$ Where; $Uval_h$ is the local currency value of per Kcal for the household h, $\sum_{j=1}^{g} FDEXP_{jh}$ is the expenditure on the food item j of household h, DEC_h is the total energy dietary (Kcal) from procedure 1, DEC_{kh} is the final energy dietary (Kcal) for the missing calories and $FDEXP_{kh}$ is corresponding median expenditure ($/Kcal) as per the area/region/income quantile level of other matching household.
	Step 3: Estimate protein, fat, and carbohydrate from corresponding calories	$PROT_{kh} = DEC_{kh} * SPORT_h - (a)$ $FAT_{kh} = DEC_{kh} * SFAT_h - (b)$ $CAR_{kh} = DEC_{kh} - (PROT_{kh} + FAT_{kh}) - (c)$ Where; $PROT_{kh}$, CAR_{kh} and CAR_{kh} are protein, fat and carbohydrate (including fiber) for the food item k by household h.
Diet Quality		• Average protein consumption (g/person/day) • Average carbohydrates consumption (g/person/day) • Average fats consumption (g/person/day) • Share of dietary energy consumption from protein (%) • Share of dietary energy consumption from carbohydrates (%) • Share of dietary energy consumption from fats (%) • Balanced diet analysis as per the WHO/FAO • Average of micronutrient deficiencies by national and regional level as per the FDA
Economic and Food Security Vulnerability		• Food Expenditure share by food groups • Food expenditure variation between expenditure quantiles • Deficiency of calorie intake, macro and micro nutrients translated into converted into extreme vulnerable, moderately vulnerable, vulnerable and non-vulnerable, measured using the following formula simple summation technique $X_i^z = \sum_{d=1}^{\infty} x_{id} c$, where $x_{id} = \sum_{k-1}^{kd} x_{id}^k / k_d$, x_{id}^k is the binary status of food insecurity in caloric intake, macro and micro nutrients, and K_d is the number of domains.

Source: *Moltedo et al. (2014)* and *Scutella et al., (2009)*; *Atkinson, (1998)*; *Hameed and Qaiser (2019)*.

The alcohol component is deleted from the above equation due to surveys that do not provide data on this. In addition, Government of Pakistan (Planning Commission) equivalent factors were used to convert dietary quantity into per adult equivalent per day (GoP, 2001, 2003). This study used recommended threshold calorie intakes of 2,230 per adult equivalent per day for urban areas and 2,550 per adult equivalent per day for the rural areas in line with the previous studies on poverty and food security in the country (Jamal, 2012, 2017; Malik *et al.*, 2010). Diet quality is determined by the percentage shares of food energy as derived from different food groups, macronutrients under the World Health Organization (WHO) and Food and Agriculture Organization (FAO) guidelines (Moltedo *et al.*, 2014) and micronutrients deficiencies as per the Food and Drug Administration (FDA) guidelines (FDA, 2020). The details of diet quality indicators are also given in Table 1.

The final dimension of food security vulnerability is calculated in two ways. Economic vulnerability is the key risk of failing to meet the food and nutrition needs of households or individuals due to income inequality, food scarcity and prices (Sileshi *et al.*, 2019; Smith and Subandoro, 2007; FAO *et al.*, 2019). Food security vulnerability of the households is also evaluated using calorie consumption, macro, and micronutrient deficiencies and classified into different states of vulnerability (see Table 1). This is a simple summation technique allowing equal weights to each of the domains (Scutella *et al.*, 2009; Alkire and Seth, 2009; Atkinson, 1998; Hameed and Qaiser, 2019). The overall food security vulnerability is calculated by using the following four scales:

- Extremely vulnerable households (whose diets are deficient in calorie intake, balanced diet and lacking in micronutrients such as zinc, iron, and vitamin A and C);
- Moderately vulnerable households (who are deficient in any two domains);
- Vulnerable (who are deficient in any domain) and;
- Non-vulnerable (whose diets are not deficient in any respect and domain).

Data

This study is based on data from the Household Integrated Income and Consumption Survey (HIICS) 2015-16, conducted by the Pakistan Bureau of Statistics (PBS). This is the latest and the largest available data set on the consumption of food and non-food commodities and expenditures thereof. Two types of questionnaires were administered to the sample households, one for male and the other for female respondents. This survey provides information on several aspects of household assets and their socio-economic characteristics. In this survey data relating to 172 food items (quantities and expenditures) were obtained using the recall technique for fourteen days and the remainder for one month and values (quantities and expenses) reported into local units and Rupees only.

The sample for the 2015-16 HIICS comprised 1,668 Primary Sampling Units/blocks (PSUs) selected with Probability Proportional to Size (PPS). At the second stage of sampling 26,688households/Secondary Sampling Units (SSUs) were selected through systematic sampling. This is anticipated to provide robust results at the provincial level with urban and rural breakdown. Out of 1,668 PSUs this study uses data from 1,605 PSUs (518 rural and 1,087 urban PSUs) and 24,238 SSUs (8,083 rural and 16,155 urban SSUs). The province distribution of the sample is: 43% from Punjab, 25% from Sindh, 21% from KP, and 10% from Balochistan. At the data analysis, stage 545 households' data were found to be incomplete in various respects and thus rejected.

Empirical Analysis and Results

Diet quantity: For a healthy and productive life, judicious intake of food, providing adequate calories, proteins, fats, minerals, carbohydrates, etc. is of critical importance (Ergando and Belete, 2016). The mean and median values per adult equivalent per day calorie intake, as estimated from the survey data by province and region, are reported in Table 2. The standard deviations (SD) of the average values of caloric intake along-with values of T-test are also presented to help the reader to have an idea about the extent of dispersion and variation and statistical significance of the differences in the mean values of calories across various regions and groups.

The province-level analysis shows that the highest per adult equivalent calorie intake of 2,853 was observed in Khyber Pakhtunkhwa (KP), followed by 2,770 calories in Punjab, 2,670 in Sindh and 2,328 in Balochistan. The calorie intake in various provinces is characterized by high variability as reflected by large values of SD. To ascertain whether the provinces vary

in per adult equivalent consumption of food the mean difference tests with two-tailed alternative hypothesis were performed. As per these tests, the differences were observed to be statistically significant at 1% level in all pairs of provinces. To test for the urban-rural differences in food consumption, we also performed mean difference tests between the urban-rural calorie intakes in each province. These results indicate that differences in the mean values of calorie intakes are statistically significant across the urban-rural divide. These findings are in line with previous studies: Ahmad *et al*. (2004); Malik *et al*. (2014). The average calorie intake differences in rural areas are 374, 593, 159, 271, 94 Kcal per adult equivalent per day more than urban areas of Pakistan, Punjab, Sindh, KP, and Balochistan, respectively (Table 2).

Table 2: *Per adult equivalent daily calorie intake by province and region in Pakistan.*

	Mean value	Median value	Standard deviation	T-Test
Pakistan	2,719	2,533	961	
Urban	2,594	2,423	906	28.74*
Rural	2,968	2,816	1,017	
Punjab	2,770	1,566	1,026	
Urban	2,583	2,387	943	28.34*
Rural	3,176	3,088	1,080	
Sindh	2,670	2,502	904	
Urban	2,611	2,419	909	6.62*
Rural	2,770	2,637	887	
KP	2,853	2,674	879	
Urban	2,754	2,604	802	10.62*
Rural	3,025	2,826	977	
Balochistan	2,328	2,146	862	
Urban	2,304	2,114	854	2.31**
Rural	2,398	2,231	880	
Calorie intake comparison between provinces				
Punjab and Sindh	H0; diff=0, Ha: diff != 0 and Ha: diff>0			904.41*
Punjab and KP				4.91*
Punjab and Balochistan				19.25*
Sindh and KP				10.73*
Sindh and Balochistan				15.65*
KP and Balochistan				23.89*

Shows significant at 1% level. Null hypothesis for T-Test: there is no difference between the two means.

In light of the high degree of dispersion in the mean values of calorie intake, the study has preferred to focus further discussion relating to food consumption/

calorie intake on its median values which is one of the most popular indicators for such analysis as it can help in overcoming the variation among household or per capita levels income, expenditure, etc. at the generalization level, because a few higher or lower-income households may create a distorted picture about the socioeconomic standing of the sample.

Data on caloric intake depicted in Table 2 suggest that the average energy intake in Pakistan is sufficient in all the provinces except in Balochistan. The overall median value per adult equivalent per day calorie intake estimated at 2,533 calories compares favorably with the recommended dose of 2,350 calories. However, the province of Balochistan with a calorie intake of 2,146 is deficient, calorie intake falling much below the recommended level of 2,350 calories. The deficiency in calorie intake is worse in the urban areas as compared to the rural areas in the province.

There are large and significant, though varying, differences between per adult equivalent per day dietary intake of the lowest and highest quantiles of expenditure (income proxy) in the country (Balagamwala and Gazdar, 2013; Malik *et al*., 2014). At the national level, the percentage difference in calorie intake from the 3rd quantile to the lowest is only 14%, the 4th quantile to the lowest is 23% and the percentage difference in calorie intake from the highest to the lowest quantile is 47%. The results show 47% higher caloric consumption by rich households than the poorest households (Table A3). Thus, there are significant differences in calorie intake between different expenditure quantiles. It is noted that, at the country level, the highest quantile households consumed 1,015 calories more than those of the lowest quantile households. This translates into 47% higher caloric intake by rich households. Such inequalities ranged from 6 to 47% between the lowest and the highest quantiles, from 14 to 71% in urban areas and 14 to 53% in rural areas. Thus, urban areas were characterized by higher inequalities in their caloric intake.

On average, per adult equivalent per day calorie intake at the provincial level also reflected wide differences across different quantiles. In Punjab, differences in calorie intake between the lowest and the highest quantiles ranged from 1 to 34% with 11 to 64% in urban areas and from 15 to 42% in rural areas. In Sindh, data at the provincial level reflected a difference

Table A1: *Food budget share (%).*

Food Groups	Punjab			Sindh			KP			Balochistan			Pakistan		
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Share of food expenditure in total expenditure (%)	38.70	38.40	38.60	46.20	52.80	47.80	42.80	46.60	43.90	43.10	46.80	43.90	41.80	44.80	42.50
Wheat	10.40	12.40	10.90	9.20	11.20	9.70	13.50	16.60	14.50	15.90	18.40	16.50	11.40	13.80	12.00
Rice	3.20	3.50	3.20	4.10	5.00	4.30	2.70	4.50	3.20	3.20	2.60	3.10	3.30	4.10	3.50
Other Cereals	2.50	3.10	2.60	3.50	4.90	3.90	1.90	2.80	2.20	1.70	1.70	1.70	2.50	3.40	2.70
Pulses	2.40	3.60	2.70	1.90	2.50	2.10	2.80	3.60	3.10	3.40	4.10	3.50	2.50	3.30	2.70
Fruits	6.00	5.50	5.90	4.50	3.30	4.20	6.20	6.10	6.20	3.60	3.10	3.50	5.40	4.90	5.30
Vegetables	9.20	13.20	10.10	8.10	12.30	9.20	10.00	13.00	10.90	10.80	13.10	11.30	9.30	12.90	10.20
Dairy	29.30	18.50	26.90	21.30	16.20	19.90	20.50	11.80	17.90	15.10	8.70	13.70	23.70	15.00	21.50
Meats	7.90	7.00	7.70	10.70	9.20	10.30	10.70	10.50	10.70	14.20	15.10	14.40	9.90	9.40	9.80
Oils and Fats	7.20	10.50	7.90	6.30	8.70	6.90	6.40	7.80	6.90	7.60	9.00	7.90	6.80	9.10	7.40
Sugars	5.00	7.90	5.60	5.40	8.80	6.30	6.00	8.90	6.90	7.70	10.00	8.20	5.60	8.70	6.40
Condiments and Spices	3.90	4.80	4.10	4.40	5.40	4.60	3.70	3.60	3.70	3.70	3.90	3.80	4.00	4.50	4.10
Soft drinks and Juices	2.40	2.00	2.30	3.10	1.40	2.60	1.50	1.10	1.40	1.10	0.70	1.00	2.20	1.50	2.00
Coffee, Tea	2.10	3.70	2.50	3.10	4.60	3.50	2.80	4.40	3.30	3.20	3.90	3.40	2.60	4.20	3.00
Ready-made food products															
Overall	8.60	4.20	7.60	14.60	6.70	12.50	11.10	5.30	9.30	8.70	5.80	8.10	10.70	5.30	9.40
Wheat	1.00	0.40	0.90	1.20	0.30	1.00	2.20	0.80	1.80	2.30	1.10	2.10	1.50	0.60	1.30
Rice	0.20	0.10	0.10	0.70	0.30	0.60	0.20	0.00	0.20	0.10	0.10	0.10	0.30	0.10	0.30
Vegetables and Pulses	0.80	0.50	0.70	0.60	0.40	0.50	1.00	0.50	0.90	0.90	1.30	1.00	0.80	0.60	0.70
Meats	1.90	0.80	1.70	4.50	0.90	3.60	3.80	2.30	3.30	2.20	1.00	2.00	3.00	1.30	2.60
Others	4.70	2.40	4.20	7.60	4.90	6.90	3.90	1.60	3.20	3.20	2.30	3.00	5.10	2.90	4.50
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table A2: *Share of total and food expenditure and Engle ratio by expenditure quantile at national and regional level.*

	Pakistan		Punjab		Sindh		KP		Balochistan	
	Total expenditure	Inequality	Total expenditure	Inequality	Total expenditure	Inequality	Total expenditure	Inequality	Total expenditure	Inequality
Lowest quantile	2,331	1.00	2,374	1.00	2,354	1.00	2,316	1.00	2,073	1.00
2nd	2,940	1.26	3,090	1.30	2,901	1.23	2,825	1.22	2,688	1.30
3rd	3,579	1.54	3,809	1.60	3,587	1.52	3,433	1.48	3,033	1.46
4th	4,462	1.91	4,788	2.02	4,655	1.98	4,223	1.82	3,656	1.76
Highest quantile	7,547	3.24	8,556	3.60	8,929	3.79	6,688	2.89	5,089	2.45
Lowest quantile	1,233	1.00	1,147	1.00	1,357	1.00	1,287	1.00	1,166	1.00
2nd	1,455	1.18	1,384	1.21	1,552	1.14	1,486	1.15	1,404	1.20
3rd	1,676	1.36	1,621	1.41	1,826	1.35	1,705	1.32	1,474	1.26
4th	1,960	1.59	1,930	1.68	2,226	1.64	1,970	1.53	1,583	1.36
Highest quantile	2,759	2.24	2,808	2.45	3,710	2.73	2,534	1.97	1,973	1.69
	Engle ratio	Inequality	Engle ratio	Inequality	Engle ratio	Inequality	Engle ratio	Inequality	Engle ratio	Inequality
Lowest quantile	52.9	1.00	48.3	0.91	57.7	1.09	55.6	1.05	56.3	1.06
2nd	49.5	0.94	44.8	0.85	53.5	1.01	52.6	0.99	52.2	0.99
3rd	46.8	0.88	42.6	0.81	50.9	0.96	49.7	0.94	48.6	0.92
4th	43.9	0.83	40.3	0.76	47.8	0.90	46.7	0.88	43.3	0.82
Highest quantile	36.6	0.69	32.8	0.62	41.5	0.78	37.9	0.72	38.8	0.73

Table A3: *Average (median) calorie intake per adult equivalent per day and inequality by expenditure quantiles at national and regional level.*

	Pakistan		Punjab		Sindh		KP		Balochistan	
	Calorie	Inequality	Calorie	Inequality	Calorie	Inequality	Calorie	Inequality	Calorie	Inequality
Overall										
Lowest quantile	2,161	1.00	2,301	1.00	2,152	1.00	2,247	1.00	1,750	1.00
2nd	2,297	1.06	2,331	1.01	2,279	1.06	2,449	1.09	1,997	1.14
3rd	2,453	1.14	2,399	1.04	2,481	1.15	2,546	1.13	2,267	1.30
4th	2,651	1.23	2,598	1.13	2,609	1.21	2,816	1.25	2,496	1.43
Highest quantile	3,176	1.47	3,074	1.34	3,225	1.50	3,259	1.45	3,181	1.82
Urban Area										
Lowest quantile	1,822	1.00	1,835	1.00	1,765	1.00	2,035	1.00	1,687	1.00
2nd	2,068	1.14	2,040	1.11	2,051	1.16	2,254	1.11	1,921	1.14
3rd	2,297	1.26	2,214	1.21	2,281	1.29	2,443	1.20	2,190	1.30
4th	2,541	1.39	2,456	1.34	2,535	1.44	2,754	1.35	2,445	1.45
Highest quantile	3,115	1.71	3,017	1.64	3,190	1.81	3,213	1.58	3,168	1.88
Rural Area										
Lowest quantile	2,415	1.00	2,737	1.00	2,301	1.00	2,399	1.00	1,938	1.00
2nd	2,750	1.14	3,144	1.15	2,626	1.14	2,724	1.14	2,156	1.11
3rd	3,025	1.25	3,193	1.17	3,112	1.35	2,893	1.21	2,557	1.32
4th	3,255	1.35	3,400	1.24	3,240	1.41	3,151	1.31	3,131	1.62
Highest quantile	3,690	1.53	3,876	1.42	3,889	1.69	3,492	1.46	3,718	1.92

Table A4: *Average (%) households that food insecure in micronutrient deficiencies by national and regional level.*

Micronutrient (mg)	Pakistan			Punjab			Sindh			KP			Balochistan		
	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
Calcium (mg)	93	95	93	90	92	89	98	97	99	97	98	97	99	100	99
Phosphorus (mg)	64	82	54	54	74	43	80	91	69	75	89	72	89	96	86
Iron (mg)	23	36	16	22	38	13	30	35	24	11	15	10	37	41	35
Zinc (mg)	40	59	29	35	57	24	56	66	44	26	35	24	57	60	56
Iodine (ppm)	99	98	99	99	98	99	99	98	100	95	99	95	100	100	99
Vitamin B1 (mg)	12	19	8	12	21	7	18	18	18	3	5	2	14	15	13
Vitamin B2 (mg)	74	84	69	65	77	59	87	92	83	84	91	82	94	97	92
Vitamin B3 (mg)	70	88	60	61	83	50	84	94	73	78	90	76	89	96	87
Vitamin C (mg)	86	84	87	86	83	87	88	85	92	77	76	78	96	94	96
Vitamin A (mcg)	38	33	40	37	34	38	37	30	44	45	40	47	32	33	32

of 6 to 50% with 16 to 81% in urban areas and 14 to 69% in rural areas. In KP, the overall variation was observed to range from 9 to 45%, with 11 to 58% difference in urban areas and 14 to 46% in rural areas. In Balochistan, the average calorie intake variation ranged from 14 to 82% with 14 to 88% in urban areas and 11 to 92% in rural areas. The caloric intakes in Balochistan and Sindh provinces reflect higher inequality as compared to those observed in Punjab and KP (Table A3). The previous studies on food consumption in Pakistan have also noted the regional and interprovincial inequalities in caloric intake (Spielman *et al.,* 2016; Ahmed *et al.,* 2017; Ishaq *et al.,* 2018). These studies show that poor households were consumed less than the wealthiest household. On average, 1776 per adult equivalent per day of calorie intake was observed in the lowest quartile and 2760 per adult equivalent per day of calorie intake was observed in the highest quartile. The average calorie consumption difference between the lowest and the highest quartile was 55% (Spielman *et al.,* 2016).

Data on the composition of caloric intake at the country level, presented in Table 3, indicate that 39.3% of calorie intake was derived from wheat and other cereals. This was followed by 13.4% contribution of oils and fats, while dairy products and sugar each accounted for more than 9% of the calories' intake. Other studies on the subject in Pakistan (Malik *et al.*, 2014; Haider and Zaidi, 2017) have also highlighted the dominance of cereals in food intake. Healthy diet is more essential for better nutrition than caloric intake. In Pakistan, food is mainly made up of grains and cereals. Cross-section data from 2001-2014 indicate that wheat is the main ingredient in caloric intake. The average share of wheat in caloric intake was calculated at 48% in Pakistan, with 50% in rural areas and 44% in urban areas (Haider and Zaidi, 2017). There are some differences in the dietary patterns of urban and rural areas. As per the data set out in Table 3, sources of calorie intake in terms of cereals in the rural regions are more diversified where cereals other than wheat and rice are estimated to contribute 20.3% of the total calories as compared to only 7.4% in the urban areas. However, the contribution of cereals (wheat, rice and other cereals) estimated at 62.7% of the total calories in the rural areas is much higher compared to 53.5% of the urban. Interestingly, the share of wheat in urban areas estimated at 40.5% is higher as compared to 37.3% in rural areas. The shares of fruits, oils, and fats in the urban areas are also higher as compared to the rural areas. The dependence of the urban population on soft drinks and juices as a source of their calorie intake is also higher as compared to the rural population (Table 3).

Table 3: *Caloric shares of different foods in Pakistan (%).*

	Overall	**Urban**	**Rural**
Wheat	39.3	40.5	37.3
Rice	5.4	5.6	5.1
Other Cereals	12.4	7.4	20.3
Pulses	2.2	2.5	1.8
Fruits	1.5	1.8	1.0
Vegetables	3.8	4.1	3.2
Dairy	9.1	9.7	8.2
Meats	1.6	2.0	1.1
Oils and Fat	13.4	14.6	11.4
Sugars	9.4	9.6	9.0
Condiments and Spices	1.1	1.2	0.8
Soft drinks and Juices	0.4	0.5	0.2
Coffee, Tea and Cocoa	0.4	0.5	0.4

Source: *Authors' estimates.*

The data on the proportions of households, population and children (%) consuming less than the recommended level of calories per adult equivalent per day are shown in Table 4. The sample weights have been used to draw implications for population level analysis to portray the situation of food security by regions and provinces in Pakistan. As per the results of empirical analysis, 38% of the households in Pakistan are estimated to have had daily calorie intake below the recommended level. The corresponding numbers for the urban and rural areas were estimated at 40.5 and 36.7%, respectively. The 2018 National Nutrition Survey based on the Food Insecurity Experience Scale (FIES) has reported that 36.9% of households were food insecure (GoP and UNICEF, 2019). In addition, the Pakistan Demographic and Health Survey (PDHS) of 2017-18 based on anthropometric measurements has reported that 37.8% of the children under the age 05 years were stunted, 38.2% in boys and 37.1% in girls. The corresponding provincial statistics show that 30% of the children in Punjab, 50% in Sindh, 40% in KP and 47% in Balochistan were stunted (NIPS and ICF, 2019).

In this study, population level analysis indicates that 68 million food insecure people at the country level, 33.8 million (45.4%) of whom were children (less than 15 years of age). Out of these 68 million people, 26.2 million were living in urban areas and the rest in the countryside. According to provincial analysis, 35.3% of the households in Punjab do not consume sufficient calories. The corresponding statistics for the urban areas were estimated at 42.7% and 31.6% in the rural areas. These results showed that out of the overall food insecure population of 35 million in Punjab, 16.9 million were children. About 14.4 million food insecure persons were living in the urban areas and 20.6 million people belonged to rural areas (Table 4). About 41.2% of the households in Sindh were estimated to suffer from food insecurity. The incidence of food insecurity in urban Sindh was estimated at 38.4% as compared to 44.4% in rural areas. As a whole, 19.2 million people in Sindh did not have the recommended intake of calories which included 9.6million children. As per the analysis, 9.3 million people in urban Sindh and 9.9 million in the rural areas were suffering from inadequate intake of calories. Out of these people, almost 50% were children (Table 4).

In KP, 35.8% of the households did not have the

recommended intake of daily calories. The proportion of such households in urban areas was 25.6% and 38.2% in rural areas. There were about 9 million people in all who did not have sufficient intake of calories in the KP. An overwhelming majority of such people, 7.7 million were living in the rural KP and only 1.3 million in the urban centers. The number of food insecure children in the KP worked out to be 4.7 million, 0.6 million in urban areas and 4.1 million in rural areas (Table 4).

In Balochistan, more than 50% of the households were estimated to suffer from hunger as they did not have the recommended level of caloric intake. Approximately, 55.3% of the households in the urban area of Balochistan were estimated to suffer from food insecure as compared to 69.2% in rural areas. Thus, 5.2 million people in the province were found to be food insecure out of these 2.6 million were children. Out of these 5.2 million, 1.3 million belonged to urban areas and 3.9 million to rural areas.

Diet quality

The recommended calorie intake is a necessary condition, while balanced diet is a sufficient condition for food and nutrition security. Food consumed in addition to meeting the calorie requirements, inter alia, must cater for the varying requirements of carbohydrates, proteins, minerals, vitamins and essential macro and micronutrients to ensure good health and a productive lifestyle (Jones *et al.*, 2013). Malnutrition as a result of consuming food lacking

in essential nutrients may cause poor health, low productivity leading to significant economic losses. Chronic malnutrition in children can have severe consequences in the form of stunting and wasting (WHO, 2013).

A unique feature of the current study is the assessment of the status of various macro and micronutrients and deficiencies thereof in food intakes at the national and provincial levels. Moreover, these assessments have been made for both the urban and rural populations. Macronutrients are most important for a balanced diet. For a balanced diet, a sufficient amount of proteins, fats and carbohydrates are required for the efficient functioning of the human body (Moltedo *et al.*, 2014).

Data on the contributions of proteins, fats and carbohydrates in per adult equivalent intake of daily foods are presented in Table 5. As per the data average diet in Pakistan is dominated by carbohydrates, contributing 76% of the total calories, followed by fats making up 12.4% of the calories and proteins contributing about 11.6% of the calories. The other important indicator of diet quality is the judicious and balanced use of important food groups and of various macronutrients. In our assessment; whether a diet is balanced or otherwise, we have adopted the WHO thresholds of various food groups. As per these thresholds, the proportion of dietary energy provided by protein in a balanced diet is between 10% and 15%, of fats between 15% and 30%, and that of carbohydrates between 55% and 75% (Moltedo *et al.*, 2014).

Table 4: *Food security situation in Pakistan by regions and provinces.*

	Total Households (millions)	% of Food insecure HHs	Total Population (millions)	% of Food insecure Population	Total children (millions)	% of Food insecure Children
Pakistan	25.4	38.1	161.2	42.5	74.5	45.4
Urban	9.3	40.5	56.4	46.5	23.7	49.8
Rural	16.1	36.7	104.8	40.3	50.8	43.4
Punjab	14.9	35.3	90.6	38.6	40.9	41.4
Urban	5.0	42.7	30.0	47.9	12.5	50.9
Rural	9.9	31.6	60.6	34.0	28.4	37.2
Sindh	6.5	41.2	40.7	47.1	18.6	51.6
Urban	3.4	38.4	20.3	45.8	8.4	50.0
Rural	3.1	44.4	20.4	48.5	10.2	52.9
Khyber Pakhtunkhwa (KP)	3.0	35.8	22.1	40.7	11.2	41.9
Urban	0.6	25.6	4.0	31.7	1.8	33.7
Rural	2.4	38.2	18.2	42.7	9.3	43.5
Balochistan	1.0	65.4	7.7	67.7	3.9	67.7
Urban	0.3	55.3	2.1	60.5	1.0	62.4
Rural	0.7	69.2	5.6	70.4	2.9	69.6

Source: *Authors' estimates.*

Table 5: *Diet quality status by regions and provinces in Pakistan.*

	Protein				Fat				Carbohydrate			
	Share in Calories	Balanced diet (10% to 15%)	Below <10%	Over > 15%	Share in Calories	Balanced diet (15% to 30%)	Below <15%	Over > 30%	Share in Calories	Balanced diet (55% to 75%)	Below <55%	Over >75%
	%	% HH			%	% HH			%	% HH		
Pakistan	11.6	60.2	39.7	0.1	12.4	82.9	4.0	13.1	76.0	92.5	4.1	3.3
Urban	11.8	56.0	43.7	0.2	13.0	73.8	1.7	24.6	75.2	89.5	8.9	1.6
Rural	11.5	59.9	40.0	0.1	11.0	88.2	5.4	6.5	77.5	94.3	1.4	4.3
Punjab	12.2	70.7	29.1	0.2	13.1	80.5	4.2	15.2	74.7	91.8	5.2	3.0
Urban	12.2	65.0	34.7	0.3	14.0	68.6	1.2	30.1	73.8	86.6	12.2	1.2
Rural	12.1	73.6	26.3	0.1	10.7	86.6	5.8	7.6	77.2	94.5	1.6	3.9
Sindh	11.3	38.0	61.9	0.1	12.4	83.7	3.1	13.2	76.3	93.4	3.3	3.3
Urban	11.5	43.4	56.3	0.2	13.0	78.0	1.8	20.2	75.5	92.9	5.5	1.6
Rural	11.1	32.0	68.0	0.0	11.2	90.2	4.5	5.3	77.7	94.0	0.8	5.2
KP	11.8	60.5	39.5	0.1	11.6	90.8	4.1	5.1	76.6	94.7	1.6	3.7
Urban	11.7	63.0	37.1	0.0	11.9	88.9	2.5	8.7	76.3	94.5	3.1	2.4
Rural	11.5	50.3	49.7	0.0	10.9	91.2	4.5	4.3	77.6	94.7	1.3	4.0
Balochistan	11.0	45.8	54.2	0.0	11.4	89.0	5.8	5.2	77.6	90.9	1.4	7.6
Urban	10.9	34.0	66.0	0.0	11.5	85.1	5.4	9.5	77.6	89.8	3.6	6.6
Rural	11.0	62.6	37.4	0.1	11.0	90.5	5.9	3.5	78.1	91.4	0.6	8.1

Source: *Authors' estimates.*

As per the results of the analysis of households' diet in terms of its balanced nature, Table 5, the overall picture emerging is that of protein deficiency, as 39.7% of the households' food intake fell short of the recommended requirements of protein. Further analysis at the national level confirmed 4% of the household's food deficient in fats and another 4.1% of households' food wanting in terms of its carbohydrate contents.

As already discussed, a large proportion of the calorie intake in Pakistan, around 80% are acquired from wheat, rice, maize, millet, oils and fats and sugar (Table 3). These food groups are generally lacking in protein. The major sources of protein are mutton, beef, various meats, fish, and beans/pulses. Malnutrition can make the population vulnerable to many health problems and diseases (FAO, 2015). This is especially true for children. In Pakistan, half of the children under-five are reported to have been facing malnutrition and stunting. The inadequacy of protein is an important cause of malnutrition in Pakistan. The children suffering a protein deficiency in their childhood may never realize their true potential (World Bank, 2006). The prices of foods rich in protein have spiked very high in Pakistan, making them out of the reach of the average household aggravating protein deficiency, especially among the lower-income households.

Other factors culpable in this context, inter alia, include lack of awareness about the importance of a balanced and healthy diet, traditional patterns of food preparation and consumption, and inadequate access to protein rich foods.

Protein is the main source for defining the quality of calorie intake in terms of macronutrients. The provincial analysis shows that protein deficiency is widespread in all the provinces. The overall incidence of protein deficiency in Punjab is estimated at 29%, with 34.7% in urban and 26.3% in rural areas, 62% in Sindh with 56.3% in urban and 68% in rural areas, 39.5% in KP with 37.1% in urban and 49.7% in rural areas and 54.2% in Balochistan with 66% in urban and 37.4% in rural areas. The daily calorie intake of these households had contained less protein than the recommended levels for a healthy life (Table 5). On the other hand, carbohydrate is the key source for defining the inferior quality of calorie intake in macronutrients and for a balanced diet. The provincial and regional level analysis shows that on average more than 90% of households across the provinces and regions were consuming carbohydrate oriented foods which supplied more than 80% calories as compared to recommended levels of 55 to 75% for a balanced diet.

Table 6: *Incidence of use of unbalanced diet in Pakistan (millions).*

	Urban Population			Rural Population			Overall Population		
	Total	Food insecure	% of Food insecure	Total	Food insecure	% of Food insecure	Total	Food insecure	% of Food insecure
Pakistan	56.4	32.9	58	104.8	45.8	44	161.2	78.7	49
Punjab	30.0	15.7	52	60.6	20.4	34	90.6	36.1	40
Sindh	20.3	13.9	68	20.4	13.9	68	40.7	27.8	68
KP	4.0	1.8	44	18.2	8.3	46	22.1	10.1	46
Balochistan	2.1	1.6	73	5.6	3.2	57	7.7	4.8	62

Source: *Authors' estimates.*

Data about the population consuming an unbalanced diet are provided in Table 6. As per these data around half of the survey respondents (78.7 million) do not eat a balanced diet in terms of having the desired combination of carbohydrates, protein, and fats. The proportion of survey respondents eating an unbalanced diet in urban areas was estimated at 58% (32.9 million populations) whereas for the rural areas the corresponding number was 44% (45.8 million).

As far as the provincial analysis of the population having an unbalanced diet is concerned the emerging situation is as follows. The overall incidence of the consumption of unbalanced food in Punjab was estimated at 40% (36.1 million). There was a large variation in the incidence of the consumption of unbalanced food between the urban and rural populations. About 52% of the population (15.7 million) in urban areas and 34% (20.4 million) in rural areas were estimated to use an unbalanced diet in Punjab. As per the empirical results, the incidence of the use of unbalanced food in the provinces of Sindh and Balochistan were comparatively higher, being 68% (27.8 million) in Sindh and 62% (4.8 million) in Balochistan. The comparable figure for KP was estimated at 46% (10.1 million). Generally speaking the incidence of the population having unbalanced food was higher among the urban population as compared to the rural population in all the provinces.

In addition to the use of a balanced diet in terms of macronutrients, adequate presence of micronutrients such as calcium, iron, zinc, iodine, vitamin B1, B2, B3, C and A in the diet is imperative as they help in producing enzymes and hormones for body development and its proper functioning (Burchi et al., 2011). The lack of these nutrients and or their inadequate availability can pose serious health problems. No doubt nobody has a perfect combination of various macro and micronutrients on account of various socioeconomic and cultural factors/constraints. However, for a healthy life and productive lifestyle, a reasonable quantity of various macro and micronutrients has to be there in the daily food intake of the household members.

A consistent lack of micronutrients in the diet in general and of children, in particular, can lead to serious health problems at later stages in life. Among the female children, it may result in a vicious circle. The adult age maternal nutrition deficiencies may lead to poor development of baby with a high risk of complications in pregnancy. Low birth weight babies are more likely to suffer from childhood stunting and higher vulnerability to diseases in adulthood. For optimal health and reducing the risk of chronic and infectious diseases, micronutrients are very important for normal energy for physical and mental well-being.

Data about the availability of important micronutrients in the daily intake of food at the national level are given in Table 7 while information regarding micronutrients deficiencies is detailed in Table A4. Micronutrient shortages have been calculated as per the (FDA) guidelines based on 2000 calories a day for adults and children over four years of age due to unavailability of the local level guidelines. Though this guideline required daily allowance for calcium, phosphorus, cholesterol, vitamin B, and C are not given. These are the standard guidelines to measure micronutrient deficiencies. As per the data set out in Table 7, on average an adult in Pakistan obtains 593.6 mg calcium, 877 mg phosphorus, 21.9 mg iron, 56.8 ppm iodine, 0.9 mg vitamin B2, 10.5 mg vitamin B3 and 51.5 mg vitamin C per day from the consumption of various foods. These intakes are generally less by varying degrees than the recommended thresholds. In addition, the per capita estimate of Vitamin A intake at the national level is quite high, perhaps due to the abundant use of roots vegetables, spinach, spices, and fruits such as mango, watermelon and cantaloupe (Table 7).

Table 7: *Average (median) quantity of micronutrients per adult equivalent per day in Pakistan.*

	Pakistan	Punjab	Sindh	KP	Balochistan	Threshold
Calcium (mg)	593.6	687.5	572.7	568.8	367.3	1,300.0
Phosphorus (mg)	877.0	996.9	843.2	879.2	658.5	1,250.0
Iron (mg)	21.9	22.6	20.5	23.8	19.4	18.0
Zinc (mg)	11.3	11.4	10.4	12.5	10.4	11.0
Iodine (ppm)	56.8	58.7	59.8	54.9	43.9	150.0
Vitamin B1 (mg)	1.8	1.8	1.6	2.2	1.8	1.2
Vitamin B2 (mg)	0.9	1.0	0.8	0.8	0.6	1.3
Vitamin B3 (mg)	10.5	10.9	10.2	11.1	8.8	16.0
Vitamin C (mg)	51.5	51.0	49.2	62.6	39.4	90.0
Vitamin A (mcg)	1,377.5	1,243.6	4,557.3	1,115.8	5,320.8	900.0
Cholesterol	73.0	81.1	74.5	71.4	46.5	<300

Source: *Authors' estimates.*

The deficiencies of micronutrients are a matter of serious concern. On average, 93% of the households at the country level were found to be deficient in calcium with 95% in urban and 93% in rural areas, 64% in phosphorus with 82% in urban and 54% in rural areas, 23% in iron 36% in urban and 16% in rural areas, 40% in zinc with 59% in urban and 29% in rural areas, 12% in vitamin B1 with 19% in urban and 8% in rural areas, 74% in vitamin B2 with 84% in urban and 69% in rural areas, 70% in vitamin B3 with 88% in urban and 60% in rural areas, 86% in vitamin C with 84% in urban and 87% in rural areas and 38% in vitamin A with 33% in urban and 40% in rural areas. The above-mentioned micronutrient deficiency analysis reported that on average, the consumption of micronutrients, including iron, zinc, and vitamins B and A, as well as the consumption of calorie intake at the national level are close to the thresholds. However, it does not mean that the average intake of micronutrients is adequate as the average conceals gaps in its distribution. It is noted that the country's highest quantile households consumed 1,015 calories more than those of the lowest quantile households. This translates into a 47% higher caloric intake by rich households (Table A3). The data on micronutrients deficiencies at the provincial level indicate that more than 90% of households across provinces are food insecure in calcium, 77 to 96% in vitamin C, 32 to 45% in vitamin A, 65 to 97% in vitamin B2, and 61 to 89% in vitamin B3. About 22% of households in Punjab, 30% in Sindh, 11% in KP, and 37% in Balochistan suffered from iron deficiency. Also, zinc deficiency is more prevalent in Balochistan (57%) and Sindh (56%), followed by Punjab (35%) and KP (26%) respectively (Table A3). The National Nutrition Survey (2018) also reports high micronutrient deficiencies among women of reproductive age (15-49 years): 41.7% faced with anemia, 79.7% have had vitamin D deficiency, and 27.3% were deficient in vitamin A, 18.2% deficient in iron while 22.1% suffered from zinc deficiency (GoP and UNICEF, 2019).

Economic and food security vulnerability
Economic insecurity or vulnerability at the national or household level is the key to the risk of failing to meet the food and nutritional needs of households or individuals due to income inequality, food scarcity, and high prices (FAO *et al*., 2019). Food expenditure analysis is most important for economists, food security, and poverty analysis because it is usually recognized that poor households in the developing nations spend higher proportions of their incomes or resources on basic food and are also economically vulnerable in food acquisition (Alderman, 1986). This study evaluates the food expenditures of the survey households to analyze their economic vulnerability situation. As per the results of the analysis of monthly budgets, expenditure on food items accounted for 42.5% of total expenditures at the aggregate level. Food expenditures constituted 44.8% of the monthly household budget in rural areas and 41.8% in urban areas. Important items of food expenditures at the national level were observed to be milk and other dairy products followed by wheat and its products. Some important differences in the consumption patterns of urban and rural areas were as under. In urban areas, households expended a higher proportion of their food budget (23.7%) on milk and dairy products while rural households were noted for their higher shares of budgets on wheat and vegetables (26.7%). The

provincial comparisons of the results indicate that in the Punjab share of food expenditure (38.6%) is low/less as compared to the corresponding shares in other provinces; (47.8% in Sindh, 43.1% in KP, and 43.9% in Balochistan (Table A1). Food expenditure patterns as ascertained in this study seem to be consistent with those of previous studies Haider and Zaidi (2017); Malik *et al.* (2014) on the subject. The previous studies on the subject show that the proportions of total spending on food and important food items reflect a lot of variation at national and regional levels, dairy products being at top of the list and followed by wheat, meat, and vegetables (Haider and Zaidi, 2017). In urban areas eating out or the use of ready-made food is becoming increasingly popular. According to the results of our analysis urban household's spend 10.7% of their food budget on ready-made foods including eating out. As such facilities are not that well developed in the rural areas their corresponding shares worked out to less than 50% of the urban areas. Income or expenditure inequality is another key to understand risk in food security and acquisition. Understanding the gap between the procurement of food and the recommended nutritional requirements among vulnerable groups is necessary and critical to policy development (Rosen and Shapouri, 2001). The data on the share of food expenditure by the expenditure quantiles and Engel's Law are presented in Table A2. The data on food expenditure suggest that on average the poorest (1st quantile households) households' monthly per capita expenditure on food was 16.3% higher as compared to the corresponding share of the highest expenditure quantile households (5th quantile) in Pakistan. It means the poorest households' per capita monthly expenditure on food was higher by Rs.380as compared to that of the highest income group. At the provincial levels per capita monthly food expenditures of the poorest households (1st quantile) as compared to those of the highest expenditure quintile were higher by 15.5% in the Punjab, 16.2% in Sindh, 17.7% in KP and 17.5% in Balochistan. According to Engel's Law the country's living standards reflect how much poor households spend on food compared to rich households. The Engel's Law presented in the Engle ratios in Table A2 shows that poor households at the national level spend more than 69% of their per capita income on food. The corresponding statistics for provinces were: 62% in Punjab, 78% in Sindh, 72% in KP and 73% in Balochistan. The respective shares of rich households on food expenditures were 36.6% at the national level

and 32.8% in Punjab, 41.5% in Sindh, 37.9% in KP, and 38.8% in Balochistan.

Table 8: *Food security vulnerability by regions and provinces in Pakistan (% of HH).*

	Extremely vulnerable	Moderately vulnerable	Vulnerable	Non vulnerable
Pakistan	12.1	38.3	36.9	12.8
Urban	13.1	37.2	36.7	13.0
Rural	11.5	38.9	36.9	12.7
Punjab	12.3	40.0	36.1	11.6
Urban	13.3	36.1	39.3	11.3
Rural	11.8	41.9	34.5	11.8
Sindh	9.3	35.9	38.9	15.9
Urban	12.8	38.8	33.4	15.1
Rural	5.4	32.7	45.2	16.7
KP	12.7	40.7	34.4	12.3
Urban	11.2	41.4	33.1	14.4
Rural	13.1	40.5	34.7	11.8
Balochistan	24.7	22.1	41.3	12.0
Urban	16.5	30.2	39.5	13.8
Rural	27.8	19.0	42.0	11.3

Source: *Authors' estimates.*

The vulnerability in food security is critical in determining the extent of high risk of hunger and malnutrition and understanding of the same is important for federal and provincial governments to develop social protection programs and policies at the regional level (FAO *et al.*, 2019). The second indicator of food security vulnerability calculated based on caloric intake, balanced diet, and micronutrient criterion are presented in Table 8. As per the results of the vulnerability analysis, 12% of the survey households at the country level were estimated to be extremely vulnerable and food insecure in terms of quantity of their calorie intakes, balanced diet, and micronutrients. The number of such households in urban areas was 13% as compared to 11% in rural areas. Besides, 20 to 42% of households were estimated to suffer from a reasonable deficiency in food security domains, including calorie intake, balanced diet, and micronutrients. More than 80% of the households were estimated to be deficient in one food security domain. The analysis of food security vulnerability at the provincial levels indicated 9.3% of households in Sindh, 12.3% in Punjab, 12.7% in KP, and 24.7% in Balochistan suffering from extreme vulnerability. The analysis further suggested a higher incidence of such vulnerability in urban areas of Sindh while the opposite

was the case in KP and Balochistan. Balochistan was found to be suffering from the highest level of food insecurity and vulnerability.

These findings don't portray a healthy picture of food security in the country. If the government and related food security agencies at the national level and concerned international organizations do not take remedial measures to improve food security, especially among the children, the incidence of stunting and wasting, already quite high, will further aggravate and result in tremendous wastage of human capital in the country.

Conclusions and Recommendations

The empirical analysis suggests that average per adult equivalent daily calorie intake in all provinces of Pakistan other than Balochistan is sufficient. However, 38% of the households at the national level experienced caloric deficiency (less than recommended caloric intake) of varying amounts. The corresponding figures for the urban and rural areas are 40.5 and 36.7%, respectively. Households experiencing a deficiency in caloric intake in Balochistan and Sindh provinces are comparatively higher. The incidence of caloric deficiency in rural areas of Sindh, KP, and Balochistan is estimated to be higher while the opposite is the case in Punjab.

For a balanced diet and food security, quantity of food intake in terms of caloric though a necessary but is not a sufficient condition. The proportion of households suffering from protein deficiency at the national level was estimated at 40%. The bulk of the calorie intake, 62%, at the national level was derived from wheat, oils and sugars. Nevertheless, these foods cannot provide enough protein. Due to the traditional dominance of these foods, a large number of households in Pakistan are understood to experience protein deficiency in their diets. Due to protein deficiency, on average 49% of the population at the national level are using unbalanced diet, lacking in protein and other essential macronutrients. The corresponding statistics for urban and rural Pakistan were estimated at 58 and 44%, respectively. The results of the analysis of the quality of diet by province indicated much higher levels of the incidence of unbalanced diet in Sindh (68%) and Balochistan (62%). The corresponding figures for the Punjab and KP stood at 40%and46%. Nutritional deficiencies in terms of essential macro

and micronutrients cause poor health to impair productivity and raise health related costs.

Protein inadequacy in food can cause malnutrition, kwashiorkor and marasmus conditions in children under five in developing countries (Shetty, 2003). Micronutrients play an important role in achieving good physical and mental health and in reducing the risk of chronic and infectious diseases among human beings. The deficiency of micronutrients is a matter of serious concern in Pakistan; 93% of survey households found deficient in calcium, 64% in phosphorus, 23% in iron, 40% in zinc, 12% in vitamin B1, 74% in vitamin B2, 70% in vitamin B3, 86% in vitamin C and 38% in vitamin A. The situation at the provincial and regional levels is not much different either, reflecting varying deficiencies of important micronutrients and low diet efficiency, primarily because of poverty and low purchasing power. About 22% of the survey households in Punjab, 30% in Sindh, 11% in KP and 37% in Balochistan were estimated to be suffering from iron deficiency. Also, households suffering from zinc deficiency were estimated at 57% in Balochistan, 56% inSindh, 35% in Punjab and 26% in KP.

The vulnerability analysis of the survey data found 12% of the households at the national level to be extremely vulnerable and food insecure in terms of their calorie intakes, balanced diet, and adequacy of micronutrients. The number of households experiencing moderately deficiency in terms of the above-mentioned dietary characteristics varied from 20 to 42% across various provinces. It is estimated that more than 80% of the survey households were deficient in one or the other aspect of food and nutrition security. The province of Balochistan was noted to be the most vulnerable. Food expenditures are correlated with food acquisition. Food expenditures average 42.5% of total expenditures at the national level, constituting 44.8% of the household budget in the rural areas and 41.8% in urban areas. Important items of food expenditures at the national level were observed to be: milk and other dairy products followed by wheat and its products.

Because of the high incidence of food and nutrition insecurity, it is imperative to address the various issues of food insecurity highlighted in this study and achieve zero hunger on a priority basis in order to avoid catastrophic losses and wastage of human capital in the country. As a short-run strategy, government,

social organizations, and international agencies need to create awareness among the masses through all kinds of media about the impending losses of human resources on account of food and nutrition insecurity and arrange to provide micro-nutrient fortified foods amongst the most vulnerable segments of the population through the emergency relief program, including the school base, basic health unit and community level. As majority of the population is micronutrient deficient, thus programs can be initiated to provide free of cost micronutrient supplements on annual basis like immunization programs at the national level. According to previous experience in these projects, national and local government, structural limitations have been the key obstacles to zero hunger. Nevertheless, these limitations or structural shortcomings may be minimized or resolved by non-governmental organizations. In addition, the Government of Pakistan can play a major role in achieving zero hunger through the target feeding program under the National Social Safety Nets system, along with monitoring and evaluation by third parties.

For long-run policy, there is a need for inclusive and sustainable growth in agriculture and industry to combat poverty, reduce food insecurity and promote balanced nutrition and healthy foods in the country. The analysis, quantitative as well as qualitative of the food and nutritional security situation in Pakistan as discussed this study highlights the need for concerted and coordinated actions by all the concerned government institutions, policymakers, community-level organizations, political parties, and non-profit organizations to formulate development policies at the regional and community levels for a radical improvement in the situation and to realize the cherished goal of zero hunger in the country. Following a policy of inclusive growth, involving all segments and sections of the population with a specific emphasis on commodity-producing sectors, trade-oriented and income-generating activities facilitating forward and backward links with the rest of the economy will help in this direction. This will nevertheless also require greater attention on social sectors like health, education, and social capital. Therefore, the federal and provincial governments, in particular, should focus on the provision of economic opportunities, education, and health facilities to improve the regional and community level well-being.

Novelty Statement

This study attempts to provide a detailed analysis of the food security situation in various regions and at the country level. This study has also provided estimates of macro and micronutrient deficiencies in food intakes at the national and provincial levels which was lacking in previous studies.

Author's Contribution

Abdul Hameed: Principal author is a PhD scholar and this article is a part of his PhD dissertation.
Ihtsham Ul Haq Padda: Verified analytical methods and supervised the findings of this work.
Abdul Salam: Supervised the overall direction and planning of this work and verified the theoretical and implication frame work.

Conflict of interest
The authors have declared no conflict of interest.

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