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Unraveling Nutritional Landscapes: A Holistic Examination of Food Utilization, Sustainability, and Childhood Nutrition in Pakistan

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The majority of developing countries have ongoing dietary problems. This comprehensive review delves into the multifaceted landscape of food utilization, sustainability, and nutritional challenges in Pakistan. The research scrutinizes food insecurity trends, dietary patterns, childhood obesity, and malnutrition. Drawing insights from a dataset encompassing 24,809 residences, the analysis focuses on 16,340 homes, evaluating various food categories and household food insecurity. Findings reveal an alarming increase in food insecurity from 58% (2005-2006) to 77.4% (2013-14), with urban households experiencing higher vulnerability. Seasonal variations in food consumption highlight the importance of tailored interventions. Examining sustainability, the study addresses environmental issues, water resource depletion, population growth, and governance disparities affecting future food supply stability. Sustainable Food and Nutrition Security is explored through socially, economically, and environmentally sustainable measures, emphasizing the necessity of shaping public policies for enduring food security. The study underscores the global concern of childhood obesity and persistent stunting in Pakistan, affecting 38% of children under five. Risk factors include socio-economic status, sedentary behavior, and inadequate physical activity. Recommendations emphasize targeted interventions, parental awareness, and informed initiatives to combat childhood nutrition challenges. Analyzing nutritional consumption patterns, the study unveils deficiencies in protein, vitamins A, B, C, and essential minerals. The income elasticity of consumption is explored through Engel curves, revealing shifts in dietary preferences with economic growth. Noteworthy variations in nutrient consumption across provinces and household sizes underscore the need for tailored policy approaches. In conclusion, the study advocates for poverty alleviation initiatives, such as direct cash transfers, as effective strategies for improving nutritional well-being. The findings emphasize the dynamic interplay between socio-economic factors and dietary choices, urging policymakers to consider holistic approaches for sustainable food security in diverse regions of Pakistan.

Keywords: Dietary Problems, Malnutrition, Environmental Issues, Socio-Economic Status, Sedentary Behavior.

Introduction:

The Food and Agriculture Organization (FAO) formulated the concept of food security in 1996, emphasizing food availability, accessibility, and utilization. Over time, global concerns have evolved into the broader framework of Food and Nutrition Security (FNS), managed globally by the United Nations System Standing Committee on Nutrition (UNSCN). FNS is achieved when everyone has sustainable access to sufficient, safe, and nutritious food

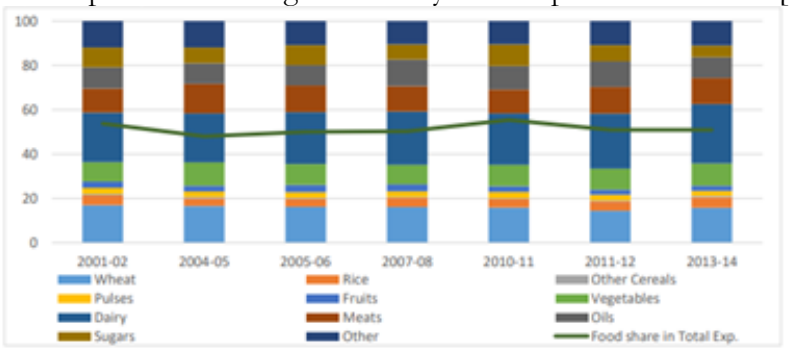
without physical, social, or economic barriers, ensuring dietary needs are met in a healthful environment [1]. The components of a food system, including production, treatment, distribution, and consumption, collectively contribute to FNS sustainability. Recognized as a fundamental aspect of the right to life, food security is a key focus for the UN, evident in various binding and non-binding instruments, such as the Universal Declaration of Human Rights (UDHR), the International Covenant on Economic, Social, and Cultural Rights (ICESCR), and treaties specific to refugees, children, women, and persons with disabilities. The Millennium Development Goals (MDG4, MDG5, MDG6) and Sustainable Development Goals (12 out of 17) are intricately linked to food security [2].

The COVID-19 pandemic has presented significant challenges globally, disrupting economies and impacting food supply chains. The resulting socioeconomic crisis has reshaped priorities at the household level, affecting food donations and highlighting the interconnectedness of health, education, employment, and social interactions. In response to such challenges, public policy should evolve to address emerging issues and establish structures that foster social behaviors conducive to preparedness [3]. In the case of Pakistan, the food security situation is troubling. A study spanning 2004 to 2016 revealed food security incidence ranging from 30 to 37 %, with urban areas experiencing 29 to 47 % and rural areas 26 to 32 %. A 2009 World Food Program (WFP) study indicated that nearly half of Pakistan's population was food insecure in 2008, worsening compared to 2003. The National Nutrition Survey 2018 reported stunted growth in 40 % of children below five years, 17.7 % suffering from food wastage, and 28.9 % found underweight. Severe food insecurity affected 18.3 % of households. The 2022 floods further exacerbated conditions, impacting millions of people and essential infrastructure. This study aims to assess whether food insecurity has intensified over time in terms of availability, accessibility, utilization, and sustainability, with current conditions reinforcing the need for urgent attention [4].

The present study has sparked considerable interest in investigating the relationship between income and dietary patterns. Initial findings, based on available data, indicate that dietary issues may stem from inadequate energy intake, as suggested by calorie consumption patterns. It is important to note that calorie elasticities while demonstrating a correlation between income and calorie intake within families, do not offer insights into the consumption of essential nutrients [5]. Thus, a significant correlation between income and calorie intake does not necessarily imply an increase in nutrient consumption. The study underscores the need for a more nuanced understanding of dietary challenges, emphasizing the importance of assessing not only overall calorie intake but also the quality and diversity of essential nutrients within the diet [6]. On the contrary, this suggests a preference for consuming calorie-dense meals. Research conducted by French et al. indicates that dietary habits may play a role in the variations in the quality of nutrient intake associated with poverty. As financial resources decline, households may opt for items with similar calorie contents, altering their overall calorie requirements. Colen et al. found that diets characterized by high ambitions but low basic nutritional qualities tend to exhibit higher elasticities concerning wealth, while diets rich in essential qualities demonstrate lower elasticities [7].

When households consume fewer meat, vegetables, eggs, and milk, there could be a noticeable reduction in the intake of these essential nutrients. While estimates of calorie income elasticity exist, there is limited understanding of the nutritional intake patterns in societies with nutrient-deficient cultures, such as Pakistan. Examining these trends is crucial as it can shed light on similarities and differences in how households manage their finances and make purchasing decisions [8]. Considering the current nutritional security concerns in the country, it becomes vital to scrutinize trends in household nutritional consumption at the provincial level. Consequently, a comprehensive examination using various research methods is essential to understand how income influences the nutritional value of food, especially in

Pakistan where dietary habits are undergoing changes. To ascertain the extent to which a higher income significantly improves an individual's nutritional status, there is a need to reassess the relationship between changes in dietary consumption and income [9].



Source: Author's calculations from several issues of HIES

Figure 1: National-Level Consumption Bundles [8].

This could significantly impact initiatives aimed at alleviating malnutrition. Additionally, with the rise of diet-related non-communicable diseases, such as obesity, in developing countries like Pakistan, addressing these issues becomes crucial. The primary objective of this study is to shed light on the factors influencing the dietary habits of households in Pakistan, considering the importance of dietary adjustments and their anticipated implications for the country. The central focus of this research is to explore the nutritional consumption patterns of Pakistani households on both a national and provincial scale, recognizing the diverse dynamics that may exist across regions [10]. The study employs a multi-level approach to underscore geographical variations by examining data at different levels. Initially, it delves into provincial household consumption trends concerning nutrition. Furthermore, it encompasses macronutrients such as calories, protein, carbohydrates, fat, fiber, and cholesterol, along with micronutrients like vitamins and minerals. This broad spectrum of nutritional components not only enhances the relevance of policy outcomes but also contributes to a more nuanced comprehension of dietary patterns.

Regularly conducting a comprehensive analysis of the current state of affairs serves to alleviate strain on limited resources and provides decision-makers with valuable insights, enabling them to formulate more tailored and effective policies. The study goes on to calculate the income elasticities of 17 nutrients, utilizing data sourced from household surveys. This analytical approach aims to unravel the intricate relationship between income and nutrient consumption, providing a more comprehensive understanding of the dynamics influencing dietary habits at various levels [11]. Implementing this strategy will yield more precise insights into the income elasticities of nutrients, with profound implications for both national and local nutritional policies in Pakistan. The ultimate goal is to promote a healthy lifestyle, emphasizing the consumption of a diverse and nutritious diet. A well-balanced diet not only supports the healthy growth and development of children but also mitigates the risk of obesity and other chronic disorders in this demographic. Beyond childhood, an optimal diet contributes to longevity and reduces the likelihood of adult-onset health issues such as obesity, heart disease, type 2 diabetes, and various cancers. For individuals managing chronic illnesses, adhering to a balanced diet can enhance condition management and reduce the risk of complications. The study's findings are poised to offer valuable guidance to Pakistani households, assisting them in making informed choices for nutrient-dense, well-balanced foods rich in both micro- and macronutrients. This guidance empowers individuals to make wise dietary decisions, fostering a healthier lifestyle [12].

According to the definition established at the World Food Summit in 1996, food and nutrition security pertains to the continuous possession of adequate financial and material

resources by individuals or households. This enables them to consistently acquire sufficient quantities of nutritious food that not only meets their dietary needs and preferences but also empowers them to lead active and healthy lives. The definition encompasses both the current state of food and nutrition as well as the regularity and reliability of maintaining this condition, emphasizing its sustained nature.

Our proposed conceptual framework identifies three pivotal factors including food availability, food access, and food utilization that collectively influence an individual's or household's food and nutrition status. Additionally, the concept of stability within this framework is characterized by two significant qualities: vulnerability and adaptability, making it responsive to the dynamic circumstances of the moment. This comprehensive framework aims to provide a holistic understanding of the multifaceted nature of food and nutrition security [12]. The relationship between food and nutrition status is not linear, and the stability of this relationship is complex. Considering both population size and density, Pakistan is the sixth most populous country globally, with over 227 million people. It ranks 33rd in terms of total land area, covering 340,509 square miles or 881,913 square kilometers. This substantial land area is influenced significantly by its sizable Muslim population. Pakistan shares borders with Afghanistan to the west, China to the northeast, Iran to the south, and India to the east. The country has a coastline stretching 1,046 kilometers (650 miles) southward along the Gulf of Oman and the Arabian Sea.

Literature Review:

The exploration of consumer behavior traces its origins back to the 17th century, marked by the publication of the first empirical demand schedule in 1700 by Davenant, as referenced by [13]. The investigation into how consumers allocate their budgets began in northern Europe in the 1840s, gaining significant influence through the work of Stigler in 1954, who acknowledged the contributions of [14]. Engel's seminal study, based on Ducpetiaux's survey of 153 Belgian families, established a foundational law asserting that "a poor family allocates the greatest share of their expenditure to food, and as the family income increases, this share becomes smaller." This empirical observation remains a cornerstone in modern microeconomics.

Following Engel's study, numerous researchers such as [15], and [16]delved into the topic, employing diverse quantitative approaches that significantly contributed to the field of consumer behavior and budget allocations. In his 1954 study, Stigler provided a comprehensive history of the seminal works of these researchers. The serious exploration of consumer behavior and demand estimation techniques began in the early decades of the 1900s. [17]utilized budget data from the Columbia district to calculate expenditure shares based on variables such as family size and income, incorporating an "equivalent adult" scale. For Italian household data, Stigler referred to the work of [18], who, in estimating the demand for coffee, made the first application of multiple correlations to demand. Post [18] study, a series of subsequent studies introduced various variables and techniques to incorporate different aspects of consumer behavior. The evolution of this field is ongoing, taking different shapes with improved data collection and estimation techniques. Future researchers are expected to incorporate more variables, even those not currently available, further advancing our understanding of consumer behavior. The study of consumption patterns is not confined to micro-level issues; it extends its influence to macroeconomic considerations. Policies designed solely for consumers can have significant repercussions on other economic players in a highly integrated economy. Therefore, understanding how consumers make choices is crucial for formulating effective micro or macro-level policies and forecasting future economic trends.

In the 1960s, Pakistan adopted a policy based on trickle-down economics, aiming to facilitate those who allocate a greater portion of their income to savings. The underlying objective was to boost national savings, leading to increased investment and overall

improvement in national income. Entrepreneurs, considered to have a higher marginal propensity to save, were targeted by this policy. [19], based on primary household data from urban Karachi, found that entrepreneurs exhibited a lower marginal propensity to consume compared to workers. This disparity could be attributed to the higher income bracket of entrepreneurs, making them more inclined to save.

Household behavior is not uniform across a country, and regional disparities can be significant. Several studies have explored regional consumption disparities in Pakistan, such as [20]. This study aims to investigate various dimensions of food consumption patterns, including consumption preferences and nutritional disparities measured by daily calorie intake. It seeks to extend the existing research by exploring differences in food consumption patterns between rural and urban regions, among provinces, and within provinces using the Quadratic AIDS technique. The study also aims to highlight intra-provincial disparities, contributing to the existing literature.

Understanding regional disparities is crucial, as a single policy may not be applicable to all regions due to differing responses from diverse demographics. [21]highlighted that, on average, cereal consumption in West Pakistan exceeded recommended intake levels by nearly 23 %, with deficiencies in nutrients such as calcium, riboflavin, Vitamin A, and Vitamin C. Regional preferences can also contribute to consumption differences, as evident in the strong preference for rice and fish in East Pakistan compared to West Pakistan's preference for cereals. [22] found that West Pakistanis consumed more tonnage of food than East Pakistanis but obtained fewer calories. Urban consumers exhibited more diversified diets and consumed higher-quality food than their rural counterparts. Changes in income distribution, influenced by governmental policies and foreign remittances since the 1980s, have played a role in shaping Pakistan's economic landscape. The study recognizes the importance of understanding these regional and income-related dynamics for effective policy formulation and economic development. Geographically, Pakistan is administratively divided into four distinct regions or provinces: Sindh, Punjab, Khyber Pakhtunkhwa, and Baluchistan. Punjab, with an estimated population of 110 million according to the 2017 Pakistan Census, is the most populous province. The Household Integrated Economic Survey 2018-2019 reveals that Punjab has an average household size of about six people. Additionally, the combined monthly expenditures and earnings of households in Punjab amount to PKR 183,664, considering a conversion rate of 1 US dollar to PKR 180.

Moving towards the southeast, Sindh is another province in Pakistan, that contributes to the diverse demographic and economic landscape of the country. This rich contextual information lays the groundwork for a more nuanced understanding of the complexities involved in addressing food and nutrition security at both the national and provincial levels in Pakistan [23]. Sindh, despite being the third-largest province in terms of land area, boasts the second-highest population in Pakistan, with approximately 47,890,000 residents, as per the 2017 Pakistan Census. The HIES 2018-2019 data indicates that the average household size in Sindh is around 6.7 people. Considering an exchange rate of one US dollar to PKR 180, the total monthly revenue after expenses for households in Sindh is PKR 182,192.

Moving to Khyber Pakhtunkhwa, situated in the northwest along the border with Tajikistan and adjacent to the Durand Line, the province ranks third in both GDP and population in Pakistan. The 2017 Pakistan Census reports an approximate population of 35,530,000 for KP. According to HIES 2018-2019 data, the average family size in Khyber Pakhtunkhwa is 7.3 members, with a total monthly income and spending of PKR 191,212, based on a 1 USD = PKR 180 exchange rate[24] [25] [26] [27]. Baluchistan, located mostly in the southwest, has a relatively low population density due to its vast land area. According to the 2017 Pakistan Census, approximately 12,340,000 people reside in Baluchistan. The HIES 2018–2019 data indicates an average household size of 7.3 people, with families earning and

spending PKR 194,058 each month (assuming a 1 USD = PKR 180 exchange rate) [28] [29] [30] [31] [32]. The empirical estimate led to the selection of Pakistan and its four provinces as the target, with a focus on examining household and customer preferences for various goods and services as part of demand analysis. Understanding consumer demand requires a comprehensive study of customer preferences, including how they allocate their income among different products and services. This approach provides valuable insights for shaping economic policies and strategies at both the national and provincial levels [33] [34] [35].

Food Utilization:

Food utilization involves the effective use of accessed food by households or individuals, emphasizing dietary diversity, including essential micronutrients. In Pakistan, food insecurity has seen an increase from 58 % in 2005-2006 to 77.4 % in 2013-14. Notably, urban households experience higher levels of food insecurity compared to rural ones, with rates of 82.2 % and 74.9 %, respectively. There are significant differences in food consumption patterns, dietary diversity, food variety, and calorie intake between winter and summer. During winter, diversity stands at around 30 % in food variety, 13 % in dietary diversity, and 8 % in calorie intake. Interestingly, rural households tend to consume more nutritious food in winter than their urban counterparts. Beyond factors like age, education, and socio-cultural constraints, addressing food utilization challenges requires promoting proper cooking training, creating awareness about the benefits of nutritious food, efficient management, and planning to ensure a balanced and healthy diet while reducing gender-based discrimination.

Food Sustainability:

Food sustainability revolves around the consistent availability of food, unaffected by shocks, stresses, or cyclical calamities. The concept of 'sustainable food' primarily focuses on the ability or potential to maintain a steady food supply. Sustainable Food and Nutrition Security involves a food system's capacity to provide Food and Nutrition Security through socially, economically, and environmentally sustainable measures. The stability of the future food supply faces challenges due to environmental issues, water resource depletion, population growth, and governance disparities. Achieving a sustainable diet is linked to governing the future food system on a sustainable basis, with goals centered on a nutritious diet and health, cultural acceptance, economic viability, and environmental protection. The condition of sustainability is met when costs, duration, and the chain of related activities align with demand. Addressing these issues is essential for shaping public policies that ensure food security in Pakistan [36].

The dataset comprises a total of 24,809 residences. However, the study focused on data from 16,340 homes, as consumption data for certain goods were not available. The analysis encompasses the examination of various food categories, including cereals and cereal products, beans, fruits, vegetables, dairy products, meat and meat products, fish and poultry products, ghee and oil, sugar, sweets, and drinks. Table 1 illustrates household food insecurity in relation to socio-demographic factors. The marital status, whether single, married, divorced, or separated, did not exert a significant impact on the food insecurity status, recording rates of 67%, 61%, and 69%, respectively, with a p-value of 0.014.

Childhood Obesity and Malnutrition in Pakistan:

Childhood obesity has become a critical global public health concern. The number of obese school-age children and adolescents increased significantly from 11 million to 124 million between 2016 estimates. Additionally, in 2016, it was predicted that 216 million people were overweight but not obese. The issue extends to younger children, with almost 38 million children under 5 years old being overweight or obese in 2017. The prevalence is particularly high in Southeast Asia, where approximately 42 million children aged 5 to 9 were overweight or obese in 2016, marking a 21% increase between 2010 and 2016. In developing or emerging countries, a third of all children under five are stunted, with 70% of these children residing in

South Asia. Although Pakistan has seen a decrease in overall child malnutrition, stunting remains a severe concern, affecting 38% of children under five, one of the highest rates globally. In Sindh, 50% of children exhibit signs of stunting, particularly impacting girls [37].

Table 1: Socio-Demographic and Lifestyle Factors Associated with Adherence to Major Dietary Patterns among Pakistani Adults (n=535) [38]

Characteristics	Household's Food Insecurity				
	Food Secure	Mildly Food Insecure	Moderately Food Insecure	Severely Food Insecure	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	*p*-value*
HH Diet Diversity	2.5±1.6	2.7±1.2	2.3±1.0	1.9±1.5	0.006
Average HH monthly income (n=352)	**62,059.5**±31,496.1	**60,448.2**±477.5.6	**49,742.8**±43,138.1	**51,250.5**±42,997.6	**0.063**
Number of family members (n=408)	5.6±2.5	5.8±2.5	5.6±3.0	6.6±2.6	0.026
	n (%)	n (%)	n (%)	n (%)	*p*-value**
Age groups (n=358)					
≤35 years	125 (62.2)	5 (2.5)	20 (10.0)	51 (25.4)	0.056
>35 years	106 (67.5)	8 (5.1)	20 (12.7)	23 (14.6)	
Marital status					
Single	115 (67.3)	4 (2.3)	10 (5.8)	42 (24.6)	0.014
Married	199 (1.2)	21 (6.5)	44 (13.5)	61 (18.8)	
Divorced/Separated	27 (69.2)	4 (10.3)	2 (5.1)	6 (15.4)	
Education level					
No education	23 (25.6)	4 (4.4)	32 (35.6)	31 (34.4)	<0.001
Primary	34 (54.0)	5 (7.9)	13 (20.6)	11 (17.5)	
Secondary/Intermediate	123 (9.1)	6 (3.9)	5 (2.8)	43 (24.2)	
Graduation	109 (79.0)	6 (4.3)	4 (2.9)	19 (13.8)	
Masters	52 (78.8)	7 (10.6)	2 (3.0)	5 (7.6)	
Ethnicity					
Urdu Speakers	88 (77.2)	3 (2.6)	7 (6.1)	16 (14.0)	0.031
Sindhi	60 (54.5)	6 (6.4)	17 (15.5)	26 (23.6)	
Punjabi	66 (62.3)	5 (4.7)	13 (12.3)	22 (20.8)	
Balochi	60 (58.3)	11 (10.7)	11 (10.7)	19 (20.4)	
Pashto	67 (65.7)	3 (2.9)	8 (7.8)	24 (23.5)	
Employment status					
Unemployed	128 (72.7)	6 (3.4)	5 (2.8)	37 (21.0)	<0.001
Employed	148 (54.2)	21 (7.7)	47 (17.2)	57 (20.9)	
Self-employed (Business)	65 (75.6)	2 (2.3)	4 (4.7)	15 (17.4)	

Notes: **p*-value calculated using ANOVA analysis. ***p*-value calculated using Chi-square analysis.

A study focused on children aged 4 to 10 revealed a prevalence of 13.6% for overall stunting, with girls being more affected than boys. Additionally, 4.3% of children were identified as obese based on BMI. These figures are consistent with global trends, highlighting the urgency of addressing both malnutrition and obesity in the pediatric population. Several risk factors contribute to these health issues, including socioeconomic status, age, frequency of meal intake, and hours of physical activity. Only 67.4% of the surveyed children engaged in less than an hour of physical activity daily, indicating a concerning trend of sedentary behavior. Socioeconomic disparities were evident, with children in the low socioeconomic group exhibiting higher rates of stunting [39].

The study emphasized the need for targeted interventions considering various factors such as income, dietary habits, and physical activity levels. It also highlighted the importance of parental awareness regarding children's nutritional status and the necessity of informed initiatives to combat childhood obesity and malnutrition. However, the study acknowledged limitations, including the cross-sectional design and potential recall bias. Generalizing findings to non-school-attending children and addressing the lack of randomization in school selection were also recognized as challenges in the study. Nevertheless, the insights provided contribute to the understanding of the complex landscape of childhood nutrition in Pakistan.

Findings:

To conduct the study, food items were converted into various nutritional components, including calories, protein, fat, carbohydrates, fiber, ash, calcium, phosphorus, iron, zinc, thiamine, riboflavin, niacin, vitamins A, B, and C, and cholesterol. This conversion was based on the food composition frequency data from the Household Integrated Economic Survey of 2018–2019. It's noteworthy that the dataset is available in three distinct versions: weekly, bimonthly, and monthly, providing flexibility in the analysis of consumption patterns over different time intervals [40]. To determine the total amount of food consumed by the household each month, the data from the weekly and 14-day periods were first converted into monthly statistics [40]. This dataset provides information on both the number of individuals residing in a household and the total monthly expenses incurred by that household. The total household expenses encompass various categories such as cereals, grains, diverse foods, apparel, textiles, shoes, fuel, lighting, housing, durable household goods, transportation, travel, communication, leisure, entertainment, healthcare, cleaning, laundry, and other sporadic costs.

Given the potential transitory nature and measurement errors associated with income data, the study employs alternative indicators such as monthly nutrient consumption, household size, and overall expenses. This approach provides a more robust understanding of the economic dynamics within households. The dataset also includes data on the average daily and monthly nutritional consumption for each individual in the household. Notably, the average monthly intake for Pakistani households was reported at 362,068 kilocalories. The study encompasses individuals across various age groups, including adults, adolescents, and those in younger and older age brackets with differing energy requirements. This diverse representation validates the chosen calorie count, ensuring a comprehensive analysis of nutritional consumption patterns in Pakistani households [41]. The findings reveal that the average monthly protein consumption for households is 6,381 grams, indicating an inadequacy in meeting the required protein intake. This suggests that Pakistani households may be consuming an insufficient amount of protein through their diet. On the other hand, the mean monthly fat consumption, averaging 7,191 grams, falls within the permissible range.

Carbohydrate consumption is reported at 30,830 grams per month on average, which is less than the recommended amount. Furthermore, the mean vitamin composition indicates potential deficiencies in fat-soluble vitamin A, water-soluble vitamin C, and vitamin B relative to the suggested requirements. These results suggest that Pakistani households may be at risk of insufficient intake of these essential vitamins. In summary, the data indicates that deficiencies in vitamins A, B, and C are still prevalent in Pakistan, emphasizing the importance of addressing nutritional gaps and promoting a balanced diet to ensure the well-being of the population [42]. The data indicates that meals in Pakistani households have lower mineral content than required, signaling deficiencies in calcium, phosphorus, iron, and zinc. Notably, the average zinc concentration falls below the necessary cutoff. The coefficients of variation for average nutritional intakes demonstrate that energy consumption exhibits the least variation, while cholesterol and vitamin A consumption shows the largest range.

On average, a Pakistani household consists of seven individuals, with a net monthly income of PKR 186,145.24 after deducting all expenses. The demographic breakdown of the household, organized by age and gender, is provided in the appendix. The total cost divided by total income is used to calculate the ratio of total cost to total revenue (Y), with amounts denominated in Pakistani Rupees (PKR). The variable HZ represents household size, which is currently at 6, indicating the number of individuals residing in the household.

The study offers both overall estimated nutritional Engel curve results for Pakistan and estimated nutrient Engel curve results for each of the four provinces. These results provide valuable insights into the relationship between household income and nutrient consumption, helping to inform policies aimed at addressing nutritional deficiencies in various regions of the

country [43]. The diagnostic evaluation of all estimated Engel curve regressions revealed that all income elasticities were positive and highly statistically significant at the 1% level, as indicated by the results of R-squared and F statistics. These findings suggest the presence of an income elasticity of consumption, signifying a link between family income and nutrient consumption. To be more precise, the demand for nutrients increases with household income, and conversely, nutrient consumption decreases with income. Furthermore, the models accurately represent the observed facts.

Before comparing eating habits across the four provinces, we analyzed data obtained from Pakistan. All projected income elasticities (βk) for the nutrients were found to be less than one. This implies that while the other nutrients are considered essential, cholesterol is perceived as a luxury nutrient. The nation's low purchasing power, often associated with poverty, influences how the population responds to changes in income, with an emphasis on prioritizing the consumption of wholesome food [30]. Cholesterol exhibits a higher degree of income elasticity compared to other dietary intakes, signifying that as incomes rise, there is a corresponding increase in demand for cholesterol. According to the current study, this suggests that economic growth could contribute to a higher prevalence of obesity and related health issues, given the substantial income elasticity of cholesterol. These findings align with a previous investigation conducted in Pakistan.

Notably, similar trends have been observed in China, where economic growth has been associated with a significant increase in the prevalence of obesity and overweight. This highlights the potential impact of economic factors on dietary patterns and health outcomes. Conversely, energy has a low income elasticity, implying that increases in income would not lead to a proportionally faster growth rate in energy consumption. This insight is crucial for understanding how different nutrients and dietary components respond to changes in economic conditions, providing valuable information for public health and policy considerations [9]. In Pakistani homes, where economic growth has remained steady over the past decade, there is a perceived validity to this conclusion. Consequently, as the nation experiences increased prosperity, its adaptability in managing energy diminishes. Additionally, the study's calculated income elasticities indicate a shift in the dietary preferences of Pakistani households. Traditional animal-based food items, rich in fat and protein, are being substituted with simpler meals such as cereals supplemented with carbohydrates. This shift is attributed to the fact that in relation to income, fat and carbohydrates exhibit higher elasticities.

The consumption of fruits, poultry, and dairy products, primary sources of vitamins and fiber—has observed a modest increase. The noteworthy and positive income elasticities for fiber and water-soluble vitamins like B and C provide supporting evidence for this trend. Several minerals display positive but relatively lower income elasticities, indicating that the consumption of specific minerals rises proportionally with increased wealth. Notable minerals in this context include calcium, phosphorus, zinc, and iron. These findings align with conclusions drawn in other relevant studies [23]. Conversely, the demand for fat-soluble vitamin A exhibits a notably robust income elasticity, indicating its relative constancy even with increasing wealth. One plausible explanation for this insensitivity to wealth could be the substantial existing affluence in Pakistani households. Upon examining household size elasticities (βj) for Pakistan, it was observed that, with the exception of thiamine and cholesterol, all major nutrient household size elasticities were positive and statistically significant. This suggests a direct correlation between family size and nutritional requirements, highlighting a reciprocal relationship. These findings align with another study that identified a connection between smaller family sizes and reduced food needs.

Analyzing the anticipated income elasticities across the four provinces, it becomes evident that dietary patterns in Khyber Pakhtunkhwa (KP) and Punjab share similarities, as do those in Sindh and Baluchistan. Except for thiamine in KP and cholesterol in Punjab, all

predicted income elasticities for nutrients were less than one in both regions [11]. This suggests that, while both thiamine and cholesterol are recognized as essential nutrient requirements, thiamine is considered non-essential in KP, and cholesterol is deemed non-essential in Punjab. In these provinces, there is a higher income elasticity for thiamine and cholesterol compared to other dietary intakes. A clear and direct correlation is evident, indicating that as household incomes rise, there is an increased demand for these crucial nutrients. The findings highlight a pattern of nutrient-rich diets being consumed in households of these two provinces. Due to their elevated purchasing power and similar household incomes, these regions exhibit comparable dietary trends. Additionally, residents in these provinces have the flexibility to opt for nutrient-dense meals. It is anticipated that Baluchistan will demonstrate higher income elasticities than Sindh [12].

The income elasticities for most nutrients in the provinces of Sindh and Baluchistan are below one, except for fat, thiamine, vitamin A, and cholesterol. This suggests that, despite being considered luxury foods, these nutrients remain essential for a healthy diet. The findings indicate a deviation from prescribed dietary standards in households in these provinces, possibly due to lower purchasing power and limited knowledge about selecting nutrient-dense foods. It is strongly recommended that residents in these areas exercise caution in their food choices, opting for nutrient-rich options. This may be crucial as studies suggest that such choices play a pivotal role in attaining proper nourishment, and a lack thereof may result in restricted calorie and nutrient intake. Another contributing factor could be the limited availability of foods rich in cholesterol, fat, thiamine, and vitamin A in regions such as Sindh and Baluchistan. These results align with a previous African study that identified higher income elasticities for vitamins, proteins, and lipids.

Examining the expected household size elasticities across the four provinces reveals intriguing insights. In Punjab, an increase in household size is positively and statistically significantly correlated with increased nutritional demand across all nutrients, as evidenced by the computed household size elasticities. This suggests that larger families may require additional nutrients in proportion to their size. In Sindh, except for cholesterol, all computed household size elasticities exhibit statistically significant positive values for each nutrient. This implies that the nutritional needs for a healthy diet rise in direct proportion to the size of the household, while the requirement for cholesterol remains constant. A previous study indicates that smaller households in rural Pakistan allocate a smaller %age of their budget to nutrient-dense meals compared to larger families. This pattern makes sense, as larger families in developing nations often have more earners, leading to higher household incomes and increased nutrient consumption. Across Baluchistan, positive and statistically significant household size elasticities are observed for energy, protein, ash, phosphorus, iron, zinc, riboflavin, niacin, vitamin B, and vitamin C. These findings suggest a heightened demand for a nutrient-dense diet with increasing family sizes, with no impact on the need for cholesterol, vitamin C, or thiamine. Conversely, the calculated household size elasticities for fat, cholesterol, thiamine, and vitamin A are negative and statistically significant, indicating that the household size significantly influences the need for these specific dietary intakes.

In summary, existing empirical research on nutritional consumption patterns in Pakistan suggests that significant changes in dietary practices are likely influenced by variations in household income. Additionally, there is a predicted increase in the demand for cholesterol with rising household incomes. All necessary nutrients except for thiamine and cholesterol are anticipated to increase with family size, assuming other factors remain constant. The analysis of income elasticities reveals comparable nutrition patterns in KP and Punjab, as well as in Sindh and Baluchistan. Fat, thiamine, cholesterol, and vitamin A consumption in Sindh and Baluchistan are more responsive to changes in wealth compared to other nutritional intakes. Similarly, thiamine and cholesterol in Punjab exhibit stronger reactions to changes in income

than other dietary intakes. This suggests that households in Punjab and KP opt for a diet richer in nutrients than those in Sindh and Baluchistan. The growth in Punjab's population contributes to increased dietary needs. In KP, larger household sizes lead to higher demand for all nutritional intakes, excluding cholesterol, vitamin C, and thiamine. In Sindhi families, the rising size drives up the demand for all food items except cholesterol. Baluchistan displays notable heterogeneity in nutritional consumption, with varying needs for protein and vitamins across regions. The surge in household obesity is linked to factors like increased protein and vitamin C consumption. As a significant number of individuals lack the financial means to purchase nutrient-rich food, achieving a balanced diet is contingent upon increased income.

Conclusion:

This study delves into the dietary habits of households across various provinces in Pakistan, utilizing data from the 2018–2019 Household Income and Expenditure Survey. Employing the log-linear Engel's curve methodology, the research experimentally estimates associations to understand the impact of changes in household income on dietary patterns. Recent empirical analyses of nutritional consumption in Pakistan highlight that shifts in household income predominantly drive dietary variations. Assuming all other factors remain constant, an increase in the number of family members is associated with a heightened requirement for essential nutrients, excluding cholesterol and thiamine [39].

Through the examination of income elasticities, our study identifies similar dietary patterns in Khyber Pakhtunkhwa (KP) and Punjab, as well as comparable trends in Sindh and Baluchistan. Notably, the research reveals distinctive eating habits between households in Punjab and KP compared to those in Sindh and Baluchistan. Consequently, the study suggests that, rather than emphasizing various product-specific subsidy plans, elevating income levels may prove to be a more effective strategy for enhancing the nutritional well-being of the nation. Poverty alleviation initiatives, such as the recently introduced Ehsaas (subsidy) Program by the Pakistani government, should prioritize boosting household income through direct cash transfers to significantly enhance the consumption of essential nutrients in Pakistani families.

Descriptive statistics from the study underscore that Pakistan's food supply falls short of providing adequate amounts of nutrients. To address this, the study recommends establishing a robust collaborative partnership between the Federal Ministry of Food and Nutritional Insecurity in Pakistan and the respective ministries overseeing food and nutritional security in the four provinces. This collaborative effort aims to improve household food consumption patterns. According to our research, a family's size significantly influences their food requirements, suggesting that implementing diverse population control strategies could elevate the nutritional standards of Pakistani households. Future investigations could extend to district-level consumption trends and refine the initial approximations of nutritional requirements in the current study. Additionally, ongoing research may enhance nutritional demand estimates to inform more effective policy formulation.

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