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PREFERENCES AND DEMAND FOR VEGETABLE CONSUMPTION IN KHYBER PAKHTUNKHWA PAKISTAN

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ABSTRACT

Research Background: *Vegetables play a crucial role in human nutrition, particularly for individuals with a dietary preference, especially in developing nations such as Pakistan. Households' consumption patterns and decisions are influenced by factors like income and prices.* ***Purpose:*** *The study is designed to investigate consumption of main vegetables and to estimate and compare vegetables own, cross price demand elasticities and expenditure elasticities in Khyber Pakhtunkhwa Pakistan.* ***Research Methodology:*** *The recently available data from the Household integrated Economic Survey of Pakistan is used and for analysis the Linear Approximate Almost Ideal Demand System (LA/AIDS) as a model is utilized.*

Results: *The results show that the negative and less than one values of both Marshallian and Hicksian for own-price elasticities (OPE) for all provinces categorized vegetables as necessities. The Marshallian cross-price elasticities (CPE) of demand for the majority of vegetables having negative sign shows that these are complements while few vegetables having positive sign shows substitutes in the study area. Positive signs of expenditure elasticities (ES) in all provinces were observed categorized them as normal goods, while tomatoes and others are classified as luxury commodities. Short-term price increases will lower real income for consumers, which may in turn lower demand for price-inelastic vegetables. Household would allocate a substantial portion of their income to basic needs. Policies aimed at stabilizing prices should be crafted to improve the minimum amount of food that a household needs to eat each day and ensure the right consumption of various food.*

Keywords: *Preferences, Fruits, LA/AIDS, Expenditure Elasticities, Hicksian and Marshallian Elasticities.*

INTRODUCTION

Food being the most essential elements for living things after water and air to provide the required energy for growth. For healthy growth food plays an important role and build immune system against diseases. In general, human food consists of grains, fruits, pulses, and vegetables. They offer vital nutrients like carbohydrates, proteins fats, vitamins and minerals required for balanced human growth (child *et al.*, 2019).

Pakistan's most significant industry is agriculture, which feeds its 241.49 million people and is expanding at a rate of 5.06 percent (GoP, 2023). Agriculture is mostly responsible for the nation's food security and the wellbeing of its population. Horticulture a significant sub-sector of agriculture, produces a lot of vegetables. Vegetable demand is rising in local and export markets because of population increase and consumers' awareness about the importance of vegetables. The government intends to increase investment in the agriculture sector to fulfill the increasing demand in the local and export markets. Pakistan having various agro-climatic condition permits to produce a variety of fruits and vegetable such as citrus, mango, apple, guava and apricot. Vegetables highly demanded include potatoes, onions, tomatoes, carrots, cauliflower, spinach and peas (Dhandevi and Jeewon, 2015).

Most of the vegetables produced in Pakistan are sold in local markets such as tomatoes, onions, and carrots etc. In 2021, a primary production of 7.07 million tonnes of vegetables were recorded for Pakistan. The Vegetables primary production in Pakistan experienced an increase from 1.43 million tonnes in 1972 to 7.07 million tonnes in 2021, with growth occurring at an average annual rate of 3.55% (Pakistan vegetables primary production, 2022). The exporters have a good system of sorting, grading and packaging that helps them to conserve quality and vigor of vegetables produced.

Vegetables are important part of our daily food and are compulsory for strong human body. The word vegetables came from old French in the early 15th century. Vegetables in the broad sense usually refers to the fresh edible part of certain herbaceous plants, such as stems, roots, flowers, leaves, fruit, and seeds. These plants are consumed fresh or prepared in a variety of ways. Vegetables consumption among adult falls short of the advised intake, despite an increased attention on their health advantages. As a result of a higher risk of non-communicable diseases (Budreviciute *et al,* 2020). In 2017, approximately 3.9 million people lost their lives due to insufficient access to vegetables. Including these essential foods in one's daily diet can significantly decrease the chances of developing various non-communicable diseases, such as cardiovascular issues and certain types of cancer (WHO, 2019). Throughout ancient civilizations in both the old and new worlds, certain vital vegetables have been acknowledged for their nutritional significance. Most fresh vegetables are low in calories and rich in water, containing approximately 3.5 percent protein and below than 1% fat. Additionally, vegetables are abundant in essential minerals like calcium and iron, as well as vitamins A and C. Most vegetables include high levels of dietary fibre and antioxidants. These vegetables are rich in folate and B vitamins, essential to produce new red blood cells in the body. Particularly important for children's health, folate also contributes to potentially reducing the risks of depression and cancer. Several researchers have investigated consumer's preference and their intake of Fruits and Vegetables. However, research studies focusing on several intake of vegetables in Pakistan consumer are few in number. More research studies are required to investigate customers' preferences and demand for vegetables and their response to change in own price, prices of other commodities and in their income. That's why the study is designed to fill out this research gap with the objectives to investigate consumption of main vegetables and to estimate and compare vegetables own, cross price demand elasticities and expenditure elasticities in Khyber Pakhtunkhwa Pakistan.

1. Literature of Review

Zhou (2015) carried out a study and used the almost ideal demand system to examine shrimp demand along with beef, hog, and chicken in the US food industry, all of which contribute significantly to expecting supply policies, customer favourites and policy making. To achieve the objective, the study conducted an annual analysis spanning 37 years from 1970 to 2006. The focus was on examining the elasticity of expenditure share, price, and expenditure changes, both individually and in relation to each other. Using an Almost ideal demands system model and two alternative specifications nonlinear and linear, the study estimated expenditures share equations for ocean prawns, beefs, penaeids, chickens, and pork. Subsequently, the experimental outcomes gained from the nonlinear AIDS model were linked to those from the LA/AIDs model, revealing several disparities between the two. The nonlinear results demonstrated higher predictability and alignment with microeconomic theory than the LA model's findings. Furthermore, the results revealed that numerous major slope coefficients and their incorrect signs did not conform to microeconomic theory. This might be due to heteroscedasticity, autocorrelation, data limitations, or shrimp being a completely different product. Ullah *et al.*, (2019) conducted a study on a cross-sectional analysis of food demand in KP, Pakistan, to realize the demand for various food commodities and to evaluate the contribution of significant commercial influences such as pricing, and income using a Linear approximate almost ideal demands system. The aim was to evaluation food demand system using the Pakistan household integrated economic data. The study encompassed fourteen food groups: dairy products, meat, fruit, sugar, vegetables, drinks, wheat & flour, rice, pulses, oils and fats, tea and coffee, baked products, and other food items. The researchers collected data on product prices, amount consumed, household food costs, and socioeconomics variables through a survey to accomplish this. The results indicated for dairy products, fruits, and baked products was >1 for the uncompensated own price elasticity, suggesting that these food groups were highly responsive to price changes. The prices of these foodstuffs would remain uniform. Any sales tax could result in a significant decrease in the consumption of such commodities. Milk has an expenditure elasticity of 1.5, while tea and coffee have an elasticity of 1.33, whereas meat, dairy products, fruits, other cereals, tea, and coffee are considered luxuries. The elasticity values for various food groups varied, with beverages having a range of 0.28 and essential pulses demonstrating the highest elasticity at 0.91. On the other hand, milk, meat, fruits, other grains, coffee and tea, and baked products showed greater responsiveness to changes in total food expenditures (income). Consequently, if an income tax is imposed on personal household income, it is expected to decrease the consumption of these food groups in the province. Such measures could lead to food security concerns, particularly for low-income and middle-income households. Mufeeth *et al.*, (2021) carried out research on evaluation of food in Sri Lanka for demand of coconut using a model of almost ideal demands system. Coconut, the second most important food in Sri Lanka, is in high demand as a significant agricultural commodity. The research relied on secondary and time series data from various publication from 1995 - 2016. Employing the almost ideal demands system, the researchers computed the local coconut income demands elasticity and the compensated and uncompensated price elasticities. Supply shocks and price fluctuations were identified as substantial issues affecting coconut consumers. Over the years, both the demand for coconut consumption and its price have shown an upward trend. The results indicated that the projected income elasticity of coconut was 0.825, while the Hicksian compensated and Marshallian uncompensated price elasticities were 0.725 and 0.758, correspondingly. These findings reveal the coconut's expenditure and price demand were inelastic, classifying as it is a necessary goods in Sri Lanka. The demand was anticipated to expand rapidly with Sri Lanka's population expansion, necessitating an increase in the country's coconut production. Hameed *et al.*, (2021) researched the estimation of food consumption in Pakistan and used the Ideal Demand system. The data on HIES for 2015 to 16 was obtained from the Pakistan Bureau of Statistics (PBS). The study's conclusions revealed the demand for most commodities, except fruits, flesh, sugar, and other goods, has a lower than unit elasticity in response to expenditure elasticity at the national and regional levels. On a national and regional level, cross-price elasticity demonstrated that Pakistan's most nutritious food commodities, such as fruits, milk, and meat, complement wheat, pulses, and vegetables. According to the regional analysis, the gross and net substitution impact in urban regions is greater than in rural areas. The study recommended that policymakers and other government institutions reassess the relationship between consumption, pricing, and income for national and regional food security. The government should support or subsidize the rise in food prices, particularly for nutritional goods for low-income people. Furthermore, the government should promote job possibilities for rural populations in livestock farming, agriculture, and the industrial sector. Shaheryar *et al.*, (2022) conducted research in Pakistan using Linear approximate, almost demands system to investigative the demand for vegetables. To achieve this objective, data was from the household integrated economic survey for the fiscal year 2018-19 were utilized, and a linear approximate virtually ideal demand system was employed. The data set comprised 28,409 households from 1,802 urban and rural primary sampling units (PSU). The research findings indicated that all vegetables' uncompensated and compensated own price elasticities were negative, classifying them as necessities. Additionally, the cross-price elasticities demand for vegetables was positive, suggesting that they act as substitutes, while other commodities exhibited negative values, demonstrating complementary relation to the overall demand in Pakistan. Vegetable expenditure elasticities in Pakistan are positive, indicating that these are regarded as normal products. The total price elasticities of vegetables are inelastic; therefore, price changes will result in large expenditures on vegetables by the consumers. As a result, price stabilization programs must protect the food-insecure portions of society. The government must also give income-generating possibilities to help customers afford the necessary quantity and quality of vegetables.

2. Theoretical Modelling and Data

This part of the study used the Linear Approximate, Almost Ideal Demand System (LA/AIDS) model to estimate demand elasticities for vegetables in Khyber Pakhtunkhwa, Pakistan. This research aimed to calculate the own price, cross-price, and expenditure elasticities of main vegetables.

2.1 Universe of the Study

This study was conducted in the Khyber Pakhtunkhwa of Pakistan to investigate the vegetable consumption patterns of consumers. As Pakistan is a developing economy and ranks as the world's fifth most populous country, it is a significant area of interest for research. With the world's tenth-largest labor force and a population growth rate of 1.80 per cent, the country covers an area of 796,096 sq km. According to the latest Pakistani census, the population stood at 241.49 million, where residing in rural areas are 144.53 million and in urban region, the residents are 84.69 million. In 2023, the projected population are 241.49 million. Pakistan is geographically divided into 4 provinces. Which are Punjab, Sindh, Khyber Pakhtunkhwa (KP), and Baluchistan, each with distinct culture, traditions, lifestyle patterns, and consumption habits. Being an agricultural country, Pakistan's rural and urban regions exhibit variations in dietary preferences and vegetable consumption due to income inequality and differences in food quantity, quality, and expenditure. The population of Khyber Pakhtunkhwa (KP) is 40.85 million, as per the latest data from the Government of Pakistan (GoP, 2023). The demographic disparities significantly influence the dietary habits and vegetable intake patterns in the four provinces of Pakistan. Each of the four provinces in Pakistan possesses distinct cultures, traditions, lifestyle patterns, and consumption habits. Being an agricultural country, a significant portion of the population resides in rural and urban areas, contributing to different consumption patterns. Furthermore, income inequality exists across the four provinces, resulting in variations in the quantity and quality of food consumed and changes in expenditure patterns. These differences in socioeconomic factors shape the food consumption patterns observed in each province of Pakistan.

2.2 Data and Data Sources

This study draws upon several previous works, including Haq et al. (2011), Fayaz *et al.* (2014), Haider and Zaidi (2018), Nasir *et al.* (2015), Jalil and Khan (2018), Ullah *et al.* (2018), and Hameed *et al.* (2021), which utilized Pakistan's Households Integrated Economic Survey (HIES) provided by the Pakistan Bureau of Statistics (PBS). The aim is to ensure precise and consistent estimation despite inconsistencies among population members. Additionally, data from the latest available Household Integrated Economic Survey (HIES) Pakistan Social part of Living Standards Measurements (PSLM) was used in this study for analysis in STATA- 17 software.

2.3 Conceptual Framework

Since Richard Stone's initial estimation of demand equations based on consumer theory in 1954, researchers have continuously explored substitute specifications and functional forms. Among the numerous models proposed, the original Linear Expenditure system, the Rotterdam model, and the Translog model are the most utilized in present-day research. These models have been employed to assess demand theory's homogeneity and symmetry constraints. In this study, we have developed a novel model known as the Almost Ideal Demand System (AIDS), which exhibits the comparable level of generality to the Rotterdam and Translog models. Our model offers significant advantages over both of these models. One key advantage is that our AIDS model provides a flexible and convenient approximation for any demand system, allowing for various applications and analyses. AIDS is suggested for improving conventional demand analysis.

In 1954, Stone introduced the Linear Expenditure system (LES) by initially developing the LES model. The LES represents the expenditure on goods i (where i =..., n) as a linear function of its price (pi) and the individual's income (M).

$$p_i q_i = p_i a_i + \beta_i \left[m - \sum_{j=1}^{n} p_j a_j \right] \dots\dots\dots\dots\dots\dots\dots 3.1$$

The sustenance parameter, represented by ai, signifies that the individual purchases ai units of good i at the price Piai, which is referred to as "dedicated" or "subsistence" consumption. $\sum p_j a_j$ represents the overall cost of sustenance. The remaining expenditure, $m - \sum p_i a_i$, is categorized as "extraneous expenditure." The ß's in the model reflect how consumers allocate their extraneous spending among various products. The value of a_i sometimes comes positive (+) or negative (-). A positive a_i indicates inelastic demand, while a negative a_i indicates elastic demand (Chang and Fawson 1994). A decade later, Thiel (1965) and Berten introduced the Rotterdam system, similar to Stone's linear expenditure method. The model's parameters are linear in econometric terms and conveniently relate to theoretical limitations. Instead, it works in differentials at the level of logarithm (Ullah et al., 2018).

$$\bar{W}_{ixt} \Delta \ln q_{ixt} = \sum_{j=1}^{n} b_{ij} \Delta \ln p_{jxt} + b_1 \left(\sum_{j=1}^{n} \bar{W}_{jxt} \Delta \ln q_{jxt} \right) \dots\dots\dots\dots (3.2)$$

Where $\bar{W}_{ixt}$ denotes the expenditure share for i_{th} commodity (i = 1, 2..., N) by individual x (x= 1, 2...., X) at time t (t= 1, 2......T) while, p_{jxt} and q_{ixt} represents the respective prices and quantities.

The expression $\bar{W}_{ix} = (W_{ixt} + W_{ixt=1}) / 2, b_{ij}$ and bi is constant coefficients (Mountain, 1988).

The Indirect Translog System, devised by Christensen et al. (1975), is achieved using the logarithmic second ordering. The Translog system can represent the demand for required, extravagant, and inferior products and alternative and complementary relationships.

$$\log V(p, x) = \alpha_o + \sum_{i=1}^{n} \alpha_i \log \frac{p_i}{x} + 1/2 \sum_i^n \sum_j^n \gamma_{ij} \log \frac{p_i}{x} \log \frac{p_j}{x} \dots\dots\dots (3.3)$$

The total expenditure on goods is denoted by x, and p_j is the price of good j. The parameters αo, α_i, and γ_{ij} are unknown in the context. The logarithmic version of Roy's identity can be employed to derive the equation determining the expenditure share on each good. This identity ensures that prices and income are normalized and exhibit homogeneity of degree zero.

$$w_i = \frac{\alpha_i + \sum_{j=1}^{n} \gamma_{ij} l \log \left(p_j / x \right)}{1 + \sum_k^n \sum_j^n \gamma_{ij} \log \left(p_j / x \right)}, \ i = 1, \dots\dots, n \dots\dots\dots\dots\dots\dots\dots (3.4)$$

In 1980, Deaton and Muelbauer introduced the Almost Ideal Demand System (AIDS) to address the issue of constant marginal budget shares while utilizing a widely used Hicksian demand function. The model inevitably satisfies the communal constraint by incorporating simple parametric constrictions such as balance and homogeneousness. This approach remains consistent with household budget data and can accommodate non-linear Engel curves.

2.3.1 Derivation of LA/AIDS

The Linear Approximation of the Almost Ideal Demand System (LA/AIDS) model can be written as;

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i l n(x/p) + \mu_i \dots\dots\dots\dots\dots\dots\dots\dots\dots (3.5)$$

The parameters αi, βi, and γij must be estimated in the model. The variable wi denotes the budget share of the kth consumer allocated to the ith good, pj represents the price of the jth good, and x represents the total expenditure of the kth consumer. Additionally, P represents an aggregate price index that is defined by certain criteria or formulas, which may vary depending on the specific context or methodology used in the analysis.

$$lnp = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \ln p_i \ln pj \dots\dots\dots\dots\dots (3.6)$$

Where $\gamma_{ij} = \frac{1}{2} \left(\gamma^*{}_{ij} + \gamma^*{}_{ji} \right) = \gamma_{ji}$ for two goods $i \ and \ j$ .... (3.7)

In the AIDS model, the price coefficients for w_i become non-linear when the price index is used in equation 3.7, leading to a complex non-Linear system. Deaton and Muellbauer (1980) recommended replacing the price index (P) with Stone's price index p^* to simplify this relationship. This linearization approach helps in making the model more manageable and interpretable.

$lnp^{*} = \sum_i w_i \, lnp$ ... ... (3.8)

"LA/AIDS" model utilizes Stone's pricing index. However, since prices are never perfectly collinear, using the Stone index introduces some unit of measurement error as discussed in Asche and Wessells, 1997, Moschini, 1995, and Alston, Foster, and Green, 1994. Moschini (1995) suggests using a Laspeyres pricing index to compensate for measurement mistakes. Equation 10 provides the log-linear counterpart of the Laspeyres price index by replacing a mean budget share. $\overline{w_i}$ by w_i

$ln(p^L) = \sum_i \overline{w}_i \, ln\,(p_i)$............ ....(3.9)

The LA/AIDS model with the Laspeyres pricing index is denoted as:

$$w_i = a^{**} + \sum_k \delta_{ik} \eta_k + \sum_j \gamma_{ij} \, ln(p_j) \; \beta_i \left(ln(x) - \sum_j \overline{w}_j \, ln(p_j) \right) + \mu_i^{**} \text{.......... (3.10)}$$

$$a^{**} = \alpha_i - \beta_i \left(\alpha_0 - \sum_j \overline{w}_j \, ln(\overline{P}_j) \right) \text{.................... (3.11)}$$

Where w_i is the i_{th} good budget (expenditure) share; δ_{ik} is the vector of parameters. η_k is a matrix of demographics variables such as age, household size, marital status, and provinces among others. p_j is the j_{th} good nominal price; $ln\,X$ is total expenditure; $ln\,p_i$ is the translog price index, U_i is the stochastic error term; and α_i, β_i and γ_{ij} are the parameters that must be evaluated.

2.3.2 Derivation of Demand Elasticities for the LA/AIDS model

Extensive research has been conducted on the elasticity derivations for the LA/AIDS models. To determine the expenditure elasticity e_i, one can take the derivative of Equation 3.10 in relation to ln(x), following the suggestions of Buse (1994) and Green and Alston (1990):

$$e_i = 1 + \left(\frac{1}{w_i}\right) \left(\frac{\partial w_i}{\partial ln\,(x)}\right) = 1 + \left(\frac{\beta_i}{w_i}\right) \text{.. (3.12)}$$

Price elasticity can be calculated in two ways: uncompensated elasticity (which takes into account both substitution and income effects) and compensated elasticity (which just takes into 1account substitution effects). Taking the derivative in terms of ln pj, we may calculate uncompensated and ln pi cross-price (j ≠ i) and own-price (j = i) price elasticities, $e_{ij}^{LA/AIDS}$, and eii can be calculated:

$$e_{ij}^{LA/AIDS} = -\delta_{ij} \left(\frac{i}{w_i}\right) \left(\frac{\partial w_i}{\partial p_j}\right) = -\delta_{ij} + \left(\frac{\gamma_{ij}}{\overline{w}_i}\right) - \left(\frac{\beta_i}{\overline{w}_i}\right) \overline{w}_j \quad \forall_i j = 1,,\, n \text{ ..... (3.13)}$$

Where δ_{ij} is the Kronecker delta and it is equal to one for own price and zero for cross-price elasticities. The compensated price elasticities, $s_{ij}^{LA/AIDS}$, is as follows:

$$s_{ij}^{LA/AIDS} = e_{ij} + e_i w_j = -\delta_{ij} + \left(\frac{\gamma_{ij}}{\overline{w}_j}\right) + \overline{w}_j \quad \forall_i j = 1, \ldots, n \text{.............. (3.14)}$$

2.3.3 Theoretical Consistency

The parameters of the AIDS model can be restricted in the following ways:

The resulting parameter limitations are implied by adding up.

$$\sum_{i=1}^{n} \alpha_i = 1 \sum_{i=1}^{n} \beta_i = 0 \sum_{i=1}^{n} \gamma_{ij} = 0 \quad \text{............ (3.15)}$$

Homogeneity requires that $\sum_{i=1}^{n} \gamma_{ij} = 0$ .... (3.16)

Symmetry is satisfied for two goods $i \; and \; j$ if $\gamma_{ij} = \gamma_{ji}$.. (3.17)

Negativity does not appear on its own, but it can be verified by estimating all of the compensated own-price elasticities.

3. RESULTS & DISCUSSIONS

3.1 Empirical Analysis

The estimated findings for each vegetable from the LA/AIDS model are presented in this section. The empirical results of the given demand functions indicate that every estimated coefficient is in agreement with a previous theoretical expectation.

3.1.1 Marshallian Own Price Elasticities

According to economic theory, a good's own price elasticity should be negative and exhibit a downward sloping demand curve. The response of consumer's reactions to price changes revealed through own and cross-price elasticities. To analyse the impact of price fluctuations on welfare, both Hicksian and Marshallian OPE of the demand curve were calculated. All OPE of vegetables had an appropriate sign as shown in table 1. The Hicksian own price elasticity of demand suggests the substitution effect for change in price keeping utility fixed while the

Marshallian elasticity of demand shows both the income and substitution effect. All the Marshallian OPE of vegetables have negative sign. The estimated result show that the households were relatively responsive to the change in the price level of vegetables. The Marshallian own price elasticity for potato (-0.6768); onion (-0.2775), tomato (-0.6768), cauliflower & cabbage (-0.0495), eggplant & cucumber (-0.3578), bottle gourd & indian squash (-0.2004), carrot & radish (-0.2116), peas (-0.2001), sponge gourd (-0.0571), garlic (-0.2079) and others (-0.5202). The own price elasticity value is maximum for potato (-0.6768) and minimum for cauliflower & cabbage (-0.0495). The estimated own-price elasticities for vegetables reported by Ullah et al. 2018 was (0.58), Hameed et al. 2021 was (-0.763) are similar to our study.

Table 1: Marshallian Own Price Elasticities

Variables	Elasticities Values
Potato	-0.6768 (0.000)
Onion	-0.2775 (0.000)
Tomato	-0.6768 (0.000)
Cauliflower & cabbage	-0.0495 (0.000)
Biter gourd, lady finger, eggplant, cucumber	-0.3578 (0.000)
Bottle gourd & Indian squash	-0.2004 (0.000)
Carrot & radish	-0.2116 (0.000)
Peas	-0.2001 (0.000)
Sponge gourd	-0.0571 (0.000)
Garlic	-0.2079 (0.000)
Others	-0.5202 (0.000)

Source: Authors' estimation using HIES data, 2018-19., * figures in the parenthesis shows P-values.

3.1.2 Hicksian Own Price Elasticities

The Hicksian OPE for all vegetables are inelastic & has a negative sign in Khyber Pakhtunkhwa. The Hicksian OPE of vegetables for potato (-0.1202), onion (-0.3090), tomato (-0.4633), cauliflower & cabbage (-0.0495), eggplant & cucumber (-0.2835), bottle gourd & Indian squash (-0.1479), carrot & radish (-0.1666), peas (-0.1579), sponge gourd (-0.0154), garlic (-0.1526) and others (-0.4101). The Hicksian OPE value is maximum for tomato (-0.4633) and minimum for sponge gourd (-0.0154). The estimated Hicksian own-price elasticities reported by sheheryar et al. (2022) for tomato and garlic was –0.3721, -0.1798 shows similarity to our results.

Table 2: Hicksian Own Price Elasticities

Variables	Elasticities Values
Potato	-0.1202 (0.000)
Onion	-0.3090 (0.000)
Tomato	-0.4633

	(0.000)
Cauliflower & cabbage	-0.0495 (0.000)
Biter gourd, lady finger, eggplant, cucumber	-0.2835 (0.000)
Bottle gourd & Indian squash	-0.1479 (0.000)
Carrot & radish	-0.1666 (0.000)
Peas	-0.1597 (0.000))
Sponge gourd	-0.0154 (0.217)
Garlic	-0.1526 (0.000)
Others	-0.4101 (0.000)

Source: Author's Own Estimation, 2018-19., * figures in the parenthesis shows P-values.

3.1.3 Marshallian Cross-Price Elasticities for Khyber Pakhtunkhwa

Table (3) shows the Marshallian CPE for vegetables in Khyber Pakhtunkhwa including substitution, complementary and supplementary relation among all vegetables. When a household faces fluctuations in disposable income whether positive or negative the usual approach is to determine the percentage change in spending or savings before making decisions on adjustments to expenditures. Vegetables exhibiting positive and significant CPE indicate that they serve as substitutes. The Marshallian CPE for potato in relation to prices of onion (-0.0210), cauliflower & cabbage (-0.0620), eggplant & cucumber (-0.1199), Indian squash, pumpkin, bottle gourd (-0.0453), carrot & radish (-0.0698), peas (-0.0708), sponge gourd (-0.0609) and garlic (-0.0172) have negative sign and significant based on these vegetables are complements while positive sign and statistical significant, Marshallian CPE for potato in relation to prices of tomato (0.0214) and others (0.0301) shows that these vegetables are substitutes. The cross-price elasticities of onion in relation to prices of tomato (-0.0750), cauliflower & cabbage (-0.0785), eggplant & cucumber (-0.0697), Indian squash, pumpkin, bottle gourd (-0.0661), carrot & radish (-0.0616), peas (-0.0595), sponge gourd (-0.0664) have negative sign and significant based on these vegetables are complements while positive sign and statistical significant Marshallian CPE for potato in relation to prices of garlic (0.0185) and others (0.0306) shows that these vegetables are substitutes. Similarly, the CPE for tomato in relation to prices of cauliflower & cabbage (-0.0426), eggplant & cucumber (-0.0772), bottle gourd & Indian squash (-0.0191), carrot & radish (-0.0614), sponge gourd (-0.0455), garlic (-0.0339) and others (-0.0137) have negative sign and significant based on these vegetables are complements. The Marshallian CPE for peas in relation to prices of sponge gourd (-0.0207) and others (-0.1203) have negative and significant based on these vegetables are complements. The Marshallian CPE for sponge gourd in relation to prices of garlic (-0.0821) and others (-0.1165) have a negative sign and significant based on these vegetables are complements. The Marshallian CPE in relation to prices of garlic with others (-0.1824) have a negative sign and significant based on these vegetables are complements.

3.1.4 Hicksian cross price elasticities Khyber Pakhtunkhwa

All the Hicksian cross price elasticities reveal both positive and negative sign in table (3). The positive sign indicates these vegetables commodities are substitutes, implying that an increase in the price of one vegetable can lead to an increase in the quantity demanded for another whereas those with negative sign indicates that these vegetables serve as complements shows an increase in the price of one vegetable corresponds to a decrease in the quantity demanded for another. The Hicksian CPE for onion in relation to prices of tomato (0.0760), cauliflower & cabbage (0.0725), eggplant & cucumber (0.0813), bottle gourd & Indian squash (0.0849), carrot & radish (0.0894), peas (0.0915), sponge gourd (0.0846), garlic (0.1696) and others (0.1818) have positive sign and significant categorized them as substitutes. The Hicksian CPE for carrot & radish in relation to prices of others (-0.0206) having negative sign and significance level greater than 0.05, classified these vegetables as supplements. The Hicksian CPE for peas in relation to others (-0.0854) have a negative sign and significance level below than 0.05 categorized these vegetables as complements.

Table 3: Hicksian Cross Price Elasticities for Khyber Pakhtunkhwa

Explanatory variables	**Potato**	**Onion**	**Tomato**	**Cabbiage**	**Bitter Gour**	**Indian Squ Gourd**	***Turnip***	***Peas***	***Pepper, sp gourd***	***Garlic***	***Others***
Potato	0.6768 (0.000)	-0.0210 (0.000)	0.0214 (0.046)	-0.0620 (0.000)	-0.1199 (0.000)	-0.0453 (0.000)	-0.0698 (0.000)	-0.0708 (0.000)	-0.0609 (0.000)	-0.0172 (0.042)	0.0301 (0.001)
Onion		-0.2775 (0.000)	-0.0750 (0.000)	-0.0785 (0.000)	-0.0697 (0.000)	-0.0661 (0.000)	-0.0616 (0.000)	-0.0595 (0.000)	-0.0664 (0.000)	0.0185 (0.000)	0.0306 (0.000)
Tomato			-0.6768 (0.000)	-0.0426 (0.000)	-0.0772 (0.000)	-0.0191 (0.000)	-0.0614 (.0000	-0.0034 (0.434)	-0.0455 (0.000)	-0.0339 (0.000)	-0.0137 (0.048)
Cauliflower & cabbage				-0.0495 (0.000)	-0.1014 (0.000)	-0.0285 (0.010)	0.0247 (0.011)	-0.0321 (0.000)	-0.0043 (0.589)	-0.0015 (0.889)	-0.0674 (0.000)
Biter gourd, lady finger, eggplant, cucumber					-0.3578 (0.000)	0.0267 (0.010)	0.0158 (0.079)	0.0502 (0.000)	0.0965 (0.000)	0.0354 (0.001)	0.0345 (0.000)
Bottle gourd & Indian squash						-0.2004 (0.000)	-0.0201 (0.055)	-0.0537 (0.000)	-0.0304 (0.001)	0.0113 (0.350)	-0.0732 (0.000)
Carrot & radish							-0.2116 (0.000)	0.1159 (0.000)	0.0024 (0.785)	-0.0080 (0.000)	-0.0460 (0.000)
Peas								-0.2001 (0.000)	-0.0207 (0.028)	0.0086 (0.505)	-0.1203 (0.000)
Sponge gourd									-0.0571 (0.000)	-0.0821 (0.000)	-0.1165 (.0000
Garlic										-0.2079 (0.000)	-0.1824 (0.000)
Others											-0.5202 (0.000)
Hicksian Cross Price Elasticities for Khyber Pakhtunkhwa											
Potato	-0.1202 (0.000)	0.1363 (0.000)	0.1787 (0.000)	0.0953 (0.000)	0.0373 (0.000)	0.1120 (0.000)	0.0875 (0.000)	0.0865 (0.000)	0.0964 (0.000)	0.1401 (0.000)	0.1875 (0.000)
Onion		0.3090 (.0000	0.0760 (0.000)	0.0725 (0.000)	0.0813 (0.000)	0.0849 (0.000)	0.0894 (0.000)	0.0915 (0.000)	0.0846 (0.000)	0.1696 (0.000)	0.1818 (0.000)
Tomato			-0.4633	0.1707	0.1361	0.1942	0.1519	0.2099	0.1679	0.1794	0.1996

			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cauliflower & cabbage				-0.0495 (0.000)	-0.0547 (0.000)	0.0181 (0.101)	0.0714 (0.000)	0.0144 (0.115)	0.0422 (0.000)	0.0451 (0.000)	-0.0207 (0.009)
Biter gourd, lady finger, eggplant, cucumber					-0.2835 (0.000)	0.1011 (0.000)	0.0902 (0.000)	0.1245 (0.000)	0.1709 (0.000)	0.1098 (0.000)	0.1088 (0.000)
Bottle gourd & Indian squash						-0.1479 (0.000)	0.0324 (0.002)	-0.0011 (0.904)	0.0221 (0.013)	0.0640 (0.000)	-0.0206 (0.019)
Carrot & radish							-0.1666 (0.000)	0.1610 (0.000)	0.0475 (0.000)	0.0370 (0.003)	-0.0009 (0.920)
Peas								-0.1597 (0.000)	0.0196 (0.038)	0.0490 (0.000)	-0.0854 (0.000)
Sponge gourd									-0.0154 (0.217)	-0.0403 (0.001)	-0.0748 (0.000)
Garlic										-0.1526 (0.000)	-0.1270 (0.000)
Others											-0.4101 (0.000)

Source: Author's Own Estimation, 2018-19.,* figures in the parenthesis shows P-values

3.1.5 Expenditure elasticities

The consumption pattern of households in Pakistan changes according to variations in their income levels based on the estimated expenditure elasticities. The expenditure elasticities of vegetables are shown in table 4. The resulting expenditure elasticities indicate that all vegetables have positive sign and are considered as essential commodities in Khyber Pakhtunkhwa. The maximum and minimum expenditure elasticities range from 0.88 to 1.00. The expenditure elasticities for potato (0.8819) onion (0.9874), tomato (1.0202), cauliflower & cabbage (0.5964), biter gourd, ladyfinger, eggplant, cucumber (0.5473), bottle gourd Indian squash (0.6162), carrot & radish (0.6128), peas (0.6008), sponge gourd (0.6363), garlic (1.0353) and others (1.0056) are categorized as necessities. The expenditure elasticities reported by Ullah et al. 2018 was (0.77), Hameed et al. 2021 was (0.20) for vegetables were found similar as compared to our study The estimated expenditure elasticities reported by sheheryar et al. (2022) for tomato and garlic was 1.0175, 0.9111 shows resemblance as compared to our findings.

Table 4: Expenditure Elasticities for Khyber Pakhtunkhwa

Variables	Elasticities Values
Potato	0.8819
Onion	0.9784
Tomato	1.0202
Cauliflower & cabbage	0.5964
Biter gourd, lady finger, eggplant, cucumber	0.5473
Bottle gourd & Indian squash	0.6162
Carrot & radish	0.6128
Peas	0.6008
Sponge gourd	0.6363
Garlic	1.0353
Others	1.0056

Source: Author's Own Estimation, 2018-19.

Conclusion

The current study investigated preferences and demand for vegetables consumption in Khyber Pakhtunkhwa, Pakistan. The Marshallian own-price elasticities of demand for vegetables for all vegetables is less than unity categorized them as necessities. The Marshallian cross-price elasticities for majority vegetables were negative and significant showing complementary behaviour while few have positive sign such as garlic and others are substitutes. Based on the positive sign of expenditure elasticities for all vegetables suggests them as normal vegetables. While, for tomatoes and others were categorized as luxury commodities.

Recommendations

Based on the finding of the study it is recommended that short-term price increases will lower real income for consumers, which may in turn lower demand for price-inelastic vegetables. They would allocate a substantial portion of their income to basic needs. Policies aimed at stabilizing prices should be crafted to improve the minimum amount of food that a household needs to eat each day and ensure the right consumption of various food. An increase in household income could mitigate the overall price increase on vegetables consumption.

References

Abdulai, A., Jain, D.K. & Sharma, A. K. (1999). Household food demand analysis in India. *Journal of Agricultural Economics*, *50*(2), 316-327. https://doi.org/10.1111/j.1477-9552.1999.tb00816.x

Ahmad, N., Sheikh, M. R., & Saeed, K. (2015). Rural urban food consumption analysis in Pakistan: Expenditure elasticities approach. *Pakistan Journal of Commerce and Social Sciences (PJCSS)*, 9(1), 159-170. https://www.econstor.eu/bitstream/10419/188187/1/pjcss226.pdf

Akbay, C., Boz, I., & Chern, W.S. (2007). Household food consumption in Turkey. *European Review of Agricultural Economics*, *34*(2), 209-231. https://doi.org/10.1093/erae/jbm011

Alston, J. M., Chalfant, J.A., & Piggott, N. E. (2002). Estimating and testing the compensated double-log demand model. *Applied Economics*, *34*(9), 1177-1186. Doi:10.1080/0003684011008600 3

Altson, J. M., Foster, K.A., & Gree, R. D. (1994). Estimating elasticities with the Linear Approximated Almost Ideal Demand System: some Monte Carlo Results: *The review of Economics and Statistics*, 7(2), 351-356. https://www.jstor.org/stable/2109891

Asche, F., & Wessels, C. R. (1997). Own price indices in the almost ideal demand system. *American Journal of Agricultural Economics*, 79(4), 1182-1185. http://hdl.handle.net/10.2307/1244275

Awal, M. A., Sabur, S.A., & Mia, M. I. A. (2008). Estimation of vegetable demand elasticities in Bangladesh: application of almost ideal demand system model. *Bangladesh Journal of Agricultural Economics*, *31*(2), 35-60. https;//www.10.22004/ag.econ.200179

Aziz, B., Mudassar, K., Iqbal, Z., & Hussain, I. (2011). Estimation of food demand elasticities in Pakistan: An application of almost ideal demand system. *Forman Journal of Economic Studies*, 7(1), 24.

Balazs, S. E., & Leigh, M. (2007). The linear approximation of the almost ideal demand system (LA/AIDS) model: application to aggregated data. *Buletin USMAW-CN*,*64*(2), 418-4222. https://www.cabidigitallibrary.org/doi/pdf/10.5555/20083146696

Banks, J., Blundell, R., & Lewbel, A. (1997). Quadratic Engel curves and consumer demand. *Review of Economics and statistics*, 79(4), 527-539. https://doi.org/10.1162/003465397557015

Basarir, A. (2013). An almost ideal demand system analysis of meat demand in UAE. *Bulgarian Journal of Agricultural Science*, *19*(1), 32-39. https://www.agrojournal.org/19/01-05.pdf

Britannica, The Editors of Encyclopaedia. "vegetable". *Encyclopedia Britannica*, 27 Jun. 2023, https://www.britannica.com/topic/vegetable. Accessed 9 August 2023. https://www.britannica.com/plant/taro-plant

Budreviciute, A., Damiati, S., Sabir, D. K., Onder, K., Schuller-Goetzburg, P., Plakys, G., & Kodzius, R., (2020). Management and prevention strategies for non-communicable (NCDs) and their risk factors. *Frontiers in public health*, *8*, 574111. https://doi.org/10.3389/fpubh.2020.574111

Cashin, P., (1991). A model of the disaggregated demand for meat in Australia. *Australian Journal of Agricultural Economics*, *35*(3), 263-283. https://doi.org/10.1111/j.1467-8489.1991.tb00509.x

Chang, T., & Fawson, C. (1994). An application of the linear expenditure system to the pattern of consumer behavior in Taiwan. *Economics Research Institute Study Paper*, *94*(7), 1-13. https://digitalcommons.usu.edu/eri/37/

Childs, C. E., Calder P.C., & Miles, E. A. (2019). Diet and Immune Function. *Nutrients*, *11*(8), 1933. https://doi.org/10.3390/nu11081933

Christensen, L. R., Jorgenson, D. W., & Lau, L. J. (1975). Transcendental logarithmic utility functions. *The American Economic Review*, *65*(3), 367-383. https://www.jstor.org/stable/1804840

Deaton, A., & Muellbauer, J. (1980b). An almost ideal demand system. *The American Economic Review*, *70*(3), 312-326. https://www.aeaweb.org/aer/top20/70.3.312-326.pdf

Deaton, A., & Muellbauer, J. (1980a). Economics and consumer behavior. *Cambridge university press.*

Dhandevi, P. E. M., & Jeewon, R. (2015). Fruit and vegetable intake: Benefits and Progress of nutrition education interventions-narrative review article. *Iranian journal of public health*, 44(10), 1309-1321. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4644575

FAO, Food and Agricultural Organizaton 2003. Available online at: https://www.who.int/gho/ncd/mortality_morbidity/en/ (accessed January 03, 2020).https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases

Fayaz. M., A. Ullah Jan, A., & Jan, D. (2014). Quality elasticity of vegetable consumption in Pakistan: A comparison of Urban and Rural Households. *Sarhad Journal of Agriculture*, 30(4), 451-458. https://www.cabidigitallibrary.org/doi/full/10.5555/20153325505

Metrics, I. (2019). Evaluation, Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2016 (GBD 2016) Results. *Institute for Health Metrics and Evaluation Seattle*. https://ghdx.healthdata.org/record/ihme-data/global-burden-disease-study-2019-gbd-2019-reference-life-table

Government of Pakistan 2023. Economic Survey of Pakistan Government of Pakistan Finance Division. https://www.finance.gov.pk/survey_2023.html government of pk 2023

Hameed, A., & Salam, A. (2021). Estimating food consumption patterns in Pakistan by using almost ideal demand system. *Sarhad Journal of Agriculture*, 37(1), 92-103. http://dx.doi.org/10.17582/journal.sja/2021/37.1.92.103

Han, T., & Wahl, T. I. (1998). China's rural household demand for fruit and vegetables. *Journal of Agricultural and Applied Economics*, 30(1), 141-150. https://doi.org/10.1017/S1074070800008129

Haq, Z., Nazli, H., Meilke, K., Ishaq, M., Khattak, A., Hashmi, A. H., & Rehman, F. U. (2011). Food demand patterns in Pakistani Punjab. *Sarhad Journal of Agriculture*, 27(2), 305-311. https://www.aup.edu.pk/sj_pdf/24-FOOD%20DEMAND%20PATTERNS%20IN%20PAKISTANI%20PUNJAB.pdf

Henneberry, S. R., & Hwang, S. H. (2007). Meat demand in South Korea: An application of the restricted source-differentiated almost ideal demand system model. *Journal of Agricultural and Applied Economics*, 39(1), 47-60. https://doi.org/10.1017/S1074070800022744

https://knoema.com/atlas/Pakistan/topics/Agriculture/Crops-Production-Quantity-tonnes/Vegetables-primary-production 2022.

Jabarin, A. S., & Al-Karablieh, E. K. (2011). Estimating the fresh vegetables demand system in Jordan: A linear approximate almost ideal demand system. *Nong Ye Ke Xue Yu Ji Shu*, 5(3), 321-323. https://www.researchgate.net/publication/368336421

Jalil, A., & Khan, H. (2018). Consumption Patterns and demand elasticities of selected horticulture products in Pakistan. *WORKING PAPER 04* (18), 1-24.

Khan, M.J., Qasim Ayub, I. H. Mehmood, A., Arif, N., Mehmood, S., Shehzad, Q., & Haq, N. U. (2020). Responses of persimmon (Diospyros kaki) fruits to different fruit coatings during postharvest storage at ambient temperature. *Journal of Pure and applied Agriculture*, 5(3), 26-32. https://ojs.aiou.edu.pk/index.php/jpaa/article/view/1102

Karagiannis, G., Katranidis, S., & Velentzas, K. (2000). An error correction almost ideal demand system for meat in Greece. *Agricultural Economics*, 22(1), 29-35. https://doi.org/10.1016/S0169-5150(99)00035-3

Meyer, S., Yu, X., & Abler, D. G. (2011). Comparison of several demand systems. 1-24. https://ageconsearch.umn.edu/record/103736

Mehmood, A., Naveed, K., Jadoon, N., Ayub, Q., Hussain, M. & Hassaan, M., (2021). Phytochemical screening and antibacterial efficacy of black cumin (Nigella sativa L.) seeds. *FUUAST Journal of Biology*, *11*(1), 23-28. https://fuuastjb.org/index.php/fuuastjb/article/view/592

Moschini, G. (1995). Units of measurement and the stone index in the demand system. *American journal of agricultural economics*, 77(1), 63-68. https://doi.org/10.2307/1243889

Mountain, D.C. (1988). The Rotterdam model: An approximation in variable space. Econometrica: *Journal of the Econometric Society*, *56*(2), 477-484. https://www.jstor.org/stable/1911084

Mufeeth, M. M., Thariq, M. M., & Nuffile, A. A. M. (2021). Estimation of demand for coconut in Sri Lanka: An Application of Almost Ideal Demand System (AIDS). *Journal of Business Economics*, 3(1), 80-87. https://www.seu.ac.lk/jbe/publication/v3n1/paper8.pdf

Park, J. L., Holcomb, R. B., Raper, k. C., & Capps Jr, O, (1996). A demand systems analysis of food commodities by US households segmented by income. *American Journal of Agricultural Economics*, 78(2), 290-300. https://doi.org/10.2307/1243703

Pollack, R. A., & Wales, T. J. (1981). Estimation of complete demand system from household budget data: the linear and quadratic expenditure systems. *The American Economic Review*, 68(3),348-359. https://www.jstor.org/stable/1805266

Rehman, A. U., Mehmood, A., Naveed, K., Haq, N.U., Ali, S., Ahmed, J., & Shahzad, Q. (2022). Integrated effect of nitrogen and sulphur levels on productive traits and quality of black cumin (Nigella Sativa L.). *Journal of Xi'an Shiyou Uni, Natural Science Edition*, *18*(10), 38-58. https://www.xisdxjxsu.asia/viewarticle.php?aid=1269

Shaheryar, M., S., Ali, I. U., S. A.U. Shah, S. A., Siraj, M., Uçak, H., & Haq, N. U. (2022). Examining the demand for vegetables In Pakistan: Evidence from linear approximate almost ideal demand system. *Journal of Xi'an Shiyou University, Natural Science Edition*, *18*(10), 758-784. https://www.xisdxjxsu.asia/V18I10-66.pdf

Shah, S.U., Ayub, Q., Hussain, I., Khan, S. K., Ali, S., Khan, M. A., & Brahmi, N. C. (2021). Effect of different growing media on survival and growth of Grape (Vitus Vinifera) cuttings. *Journal Advances of Nutrition Science and Technology*, *1(3)*, 117-124. 10.15228//ANST.2021.v01.i03.p03

Shahzad, Q., Sammi, S., Mehmood, A., Naveed, K., Azeem, K., Ahmed Ayub, M.H., & Shokat, O. (2020). 43. Phytochemical analysis and antimicrobial activity of adhatoda vasica leaves. *Pure and Applied Biology (PAB)*, 9(2), 1654-1661. https://www.thepab.org/index.php/journal/article/view/1333

Sheng, T. Y., M.N. Shamsudin, M. N., Mohamed, Z., Abdullah, A. M., & Radam, A.
(2008). Complete demand systems of food in Malaysia. *Agricultural Economics*, *54*(10),467-465. https://agricecon.agriculturejournals.cz/pdfs/age/2008/10/03.pdf

Stone, R. 1954. Linear expenditure systems and demand analysis: an application to the pattern of British Demand. *The Economic Journal*, 64(255), 511-527. https://doi.org/10.2307/2227743

Taran, S. N. U., Ali, S. A., Haq, N.U., Faraz, A., Ali, S., & Rahman, T. U. (2022). Antioxidant and antimicrobial activities, proximate analysis and nutrient composition of eight selected edible weeds of Peshawar region. *Journal of Xi'an Shiyou University, Natural Science*, *18*(9), 517-545.

Ullah, I. (2018). Food consumption in Pakistan: Application of Linear Approximate
Almost Ideal Demand System. *Biomedical Journal of scientific and Technical Research*, *5*(5), 1-8.

https://doi.10.26717/BJSTR.2018.05.001265

Verbeke, W., & Ward, R. W. (2001). A fresh meat almost ideal demand system incorporating negative TV press and advertising impact. *Agricultural economics*, *25*(2),359-374.https://doi.org/10.1111/j.1574-0862.2001.tb00215.x

Wadud, M. A. (2006). An analysis of meat demand in Bangladesh using the almost ideal demand system. *The Empirical Economics Letters*, *5*(1), 29-35. https://doi.org/10.1016/S0169-5150(01)00092-5

World Health Organization Non-Communicable Diseases (NCD).2019. Available online at: https://www.who.int/gho/ncd/mortality_morbidity/en/ (accessed January 03, 2020).

Zhou, X. (2015). Using almost ideal demand system to analyze demand for shrimp in US food market. *International Journal of Food and Agricultural Economics (IJFAEC)*, *3*(3), 31-46. https://ageconsearch.umn.edu/record/208848.