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MORALITY BEFORE KNOWLEDGE

The relationship between vegetable price fluctuation and food expenditure share in indonesia during and after the COVID-19 pandemic (2020–2024)

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ABSTRACT

Background: The COVID-19 pandemic disrupted food systems globally, triggering price volatility and changes in household consumption patterns, especially in developing economies such as Indonesia. This study examines the relationship between vegetable price fluctuation and food expenditure share per capita in Indonesia during and after the COVID-19 pandemic (2020–2024). **Methods:** Five major vegetable commodities (shallots *Allium cepa* var. *aggregatum*, curly red chili *Capsicum annuum*, large red chili *Capsicum annuum*, bird's eye chili *Capsicum frutescens*, and garlic *Allium sativum*) were analyzed using secondary data from the Indonesian Central Bureau of Statistics (BPS). The analysis combined descriptive statistics with Pearson correlation and simple linear regression using SPSS. **Findings:** Results revealed a strong negative correlation ($r = -0.935$) between average vegetable price fluctuation and food expenditure share per capita, indicating that greater price stability was associated with higher food spending among households. This suggests that the normalization of vegetable markets and improved price stability in the post-pandemic period encouraged households to allocate a larger portion of their income to food consumption. Higher food expenditure shares are likely to support increased vegetable consumption, improved diet diversity, and better nutritional adequacy, particularly for micronutrient-rich foods. The regression model further showed that 87.4% of the variation in food expenditure share could be explained by changes in vegetable price fluctuation ($R^2 = 0.874$). **Conclusion:** These findings highlight the importance of maintaining price stability for perishable commodities as part of Indonesia's post-pandemic food security recovery strategy through improved supply chains, logistics, and market integration. Stable vegetable prices may play a critical role not only in stabilizing household food spending but also in promoting healthier and more diverse diets. **Novelty/Originality of this article:** This study provides one of the first empirical assessments of how vegetable price fluctuations during and after the COVID-19 pandemic influenced household food expenditure behavior in Indonesia. Unlike previous studies focusing mainly on staple foods or aggregate price indices, this research emphasizes perishable vegetable commodities and their role in shaping food-security and nutrition-related outcomes during the economic recovery period.

Keywords: COVID-19; food expenditure share; food security; household consumption; vegetable price fluctuation.

1. Introduction

Food security has become a global issue because it affects social, economic, and ecological dimensions of development (Wudil et al., 2022). Moreover, when combined with rapid population growth and ongoing land-use changes, future climate variability is expected to further intensify challenges to global food security (Molotoks et al., 2021). The

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COVID-19 pandemic further exacerbated these vulnerabilities, disrupting global food supply chains, altering consumption patterns, and driving unprecedented price volatility across agricultural commodities (FAO, 2022; Laborde et al., 2021).

According to the Food and Agriculture Organization (FAO) Food Price Index (FFPI), world food commodity prices reached 127.1 points in February 2025, representing an 8.2% increase over the same month in 2024 (FAO, 2025). A combination of climatic disruptions, pandemic-induced supply-chain bottlenecks, input cost inflation (fertilizers, fuel), and shifting trade policies have collectively shaped food price dynamics during and after the pandemic (Baldwin & Evenett, 2020; Obiora et al., 2023; Rabbi et al., 2023). These pressures underscore how external shocks such as the COVID-19 pandemic can amplify food market instability and threaten household food security.

In Indonesia, food price dynamics mirror these global trends but are further compounded by domestic structural challenges, including high poverty rates, income inequality, and logistic inefficiencies across the archipelago (Faharuddin et al., 2023; Mailena et al., 2024; Putra et al., 2020). During the pandemic, restrictions on mobility and disruptions in transportation networks led to regional price disparities, particularly for perishable commodities. The Central Bureau of Statistics reported that food consumption expenditure per capita continues to constitute a major share of household spending, indicating the sensitivity of Indonesian households to food price changes (BPS, 2024b).

Among food groups, vegetables hold a distinctive position in Indonesia and globally due to their dual characteristics (high consumption frequency and high perishability) making them highly sensitive to supply and price shocks (Ekawidyani et al., 2025; Rezitis & Pachis, 2020). In Indonesia, commonly consumed vegetables such as shallots, bird's eye chili, cabbage, potato, and curly red chili dominate daily meals across various traditional cuisines, creating substantial demand and market relevance (Susilawaty & Nugraheni, 2023). However, their short production cycles, perishability, and logistic complexity make vegetable prices particularly volatile, especially during crises like the COVID-19 pandemic (Alam & Khatun, 2021).

Beyond their economic importance, vegetables are widely recognized as essential components of healthy diets and a cornerstone of public health nutrition. Regular vegetable consumption contributes to dietary diversity and provides critical micronutrients, dietary fiber, and bioactive compounds that reduce the risk of non-communicable diseases and support overall nutritional adequacy (Vittoria et al., 2021). In developing countries, vegetables play a particularly important role in improving diet quality among low- and middle-income households, for whom micronutrient deficiencies remain a persistent public health concern (Harris et al., 2022).

From a conceptual perspective, food prices influence household food security not only through purchasing power but also through behavioral adjustments in food allocation and dietary choices (Darmon & Drewnowski, 2015). Price volatility can prompt households to modify consumption patterns by reducing the quantity, frequency, or diversity of nutrient-dense foods, including vegetables, in favor of cheaper and more calorie-dense alternatives (Headey & Alderman, 2019). During public health shocks such as the COVID-19 pandemic, these prices, behavior, nutrition linkages may become more pronounced as income uncertainty and mobility restrictions further constrain food access and dietary quality

Sharp price movements can strain household budgets, particularly among low- to middle-income groups that allocate a large portion of their expenditure to food (Green et al., 2013). Given that most Indonesians belong to lower-middle-income categories, even moderate price changes in essential commodities such as vegetables can significantly affect household welfare (Baladina et al., 2024). During the pandemic, these fluctuations not only increased household vulnerability but also altered expenditure priorities, highlighting the need for price stabilization mechanisms.

Previous studies have examined food price volatility and its impact on household welfare. Ivanic & Martin (2014) demonstrated that both short- and long-term changes in food prices significantly affect poverty and purchasing power, while Headey & Fan (2008) emphasized the social and economic consequences of rising food prices. In Indonesia,

Widarjono & Rucbha (2016) found that household food demand is highly sensitive to price and income variations, with low-income families allocating a larger share of their budget to food. These studies underline the importance of price stability, yet few have analyzed how vegetable price fluctuations during and after the COVID-19 pandemic specifically influenced household food expenditure share in Indonesia. In this context, food expenditure share serves as an important proxy for understanding how households respond to price fluctuations and economic shocks, reflecting shifts in consumption priorities that may have implications for diet diversity and nutrition security.

Therefore, this study aims to examine the relationship between vegetable price fluctuations and food expenditure share per capita in Indonesia during and after the COVID-19 pandemic (2020–2024). By focusing on a critical transition period, this research provides empirical insights into how price stabilization and market recovery affect food consumption patterns and household welfare. The findings are expected to inform policies related to agricultural-market resilience, logistics improvement, and food-security protection during economic recovery phases.

2. Methods

2.1 Data materials

The data used in this study are secondary data obtained from Statistics Indonesia (*Badan Pusat Statistik*/BPS). This research focuses on the period from 2020 to 2024. The study examines vegetable commodities, with a focus on five major vegetables that are among the most widely consumed in Indonesia, namely shallots *(Allium cepa var. aggregatum)*, curly red chili *(Capsicum annuum),* large red chili *(Capsicum annuum)*, bird's eye chili *(Capsicum frutescens)*, and garlic *(Allium sativum)*.

The selection of these five vegetable commodities was based on their economic and dietary relevance in Indonesia. Shallots, garlic, and chili varieties are among the most frequently consumed vegetables and essential ingredients in daily Indonesian diets, while also accounting for a substantial share of household food expenditure. In addition, these commodities are characterized by high perishability and strong seasonal supply fluctuations, making their prices particularly sensitive to market disruptions. As such, they provide a suitable representation of price volatility dynamics in Indonesia's vegetable markets during the COVID-19 and post-pandemic period.

The data utilized in this research include the average selling prices of vegetable commodities, the average food expenditure per capita, and the total expenditure per capita across all provinces in Indonesia from 2020 to 2024. The vegetable price data were used to analyze the Average Vegetable Price Fluctuation (%), while the data on average food expenditure per capita and total expenditure per capita were used to calculate the Food Expenditure Share (%).

The data on vegetable prices across Indonesian provinces for the 2020–2024 period were obtained from the Agricultural Commodity Price Statistics Book 2024 published by BPS. Meanwhile, data on average food expenditure per capita and total expenditure per capita were derived from the Average Monthly Per Capita Expenditure on Food and Non-Food in Urban and Rural Areas by Province (*rupiah*), 2011–2024, and Per Capita Expenditure by Province 2020–2024, both published by BPS.

2.2 Data analysis

The study employed both descriptive and correlational approaches using secondary data obtained from Statistics Indonesia (BPS). Descriptive analysis was conducted to illustrate the five-year trend (2020–2024) of average vegetable prices, price fluctuation, and household expenditure patterns, including food and total expenditure per capita. The year 2020 was treated as the baseline for descriptive analysis to capture the overall trend and to serve as the reference point for calculating annual price fluctuations. The average

price of vegetable commodities in Indonesia was obtained by calculating the mean value of five key vegetable commodities (shallots, garlic, curly red chili, large red chili, and bird's eye chili) across all provinces during the 2020–2024 period. The percentage of price fluctuation was then calculated based on the annual percentage change in the average price of each commodity compared to the previous year. This approach captures the variation in market stability and reflects how volatile vegetable prices were during the observed period. Meanwhile, the food expenditure share per capita was determined by dividing the average food expenditure per capita by the total expenditure per capita, and then multiplying the result by 100. This indicator represents the proportion of individual household spending devoted to food consumption relative to total expenditure. As a result, the correlation analysis was carried out using four annual observations (2021–2024), corresponding to the period where fluctuation data were available.

Food expenditure share was selected as a key indicator because it is widely used as a proxy for household consumption behavior and economic vulnerability to food price changes. Changes in food expenditure share reflect how households adjust their spending priorities in response to price fluctuations and economic shocks, even in the absence of direct dietary intake data. While this study focuses on the relationship between vegetable price fluctuations and food expenditure share, it is acknowledged that household consumption decisions may also be influenced by other factors such as income changes, general inflation, and broader macroeconomic conditions during the pandemic period. However, by analyzing food expenditure as a proportion of total expenditure, this study partially accounts for income-related effects and provides an exploratory assessment of price–expenditure dynamics using consistent official statistics across provinces.

The correlation and regression analysis were conducted using IBM SPSS Statistics (version 26). A Pearson correlation analysis was applied to examine the relationship between average vegetable price fluctuation (%) and food expenditure share per capita (%), with a significance level (α) set at 0.05. Furthermore, a simple linear regression analysis was performed to estimate the direction and strength of the relationship between the two variables. Graphical visualizations, including scatter plots with fitted regression lines, were also generated using SPSS to support the interpretation of the analytical results.

3. Results and Discussion

3.1 Average price of vegetable commodities in Indonesia

The average price of vegetable commodities in Indonesia refers to the mean selling price of selected vegetable products (shallots *(Allium cepa var. aggregatum)*, curly red chili *(Capsicum annuum),* large red chili *(Capsicum annuum)*, bird's eye chili *(Capsicum frutescens)*, and garlic *(Allium sativum)*) across different provinces within a specified time period (2020-2024). This indicator is calculated by aggregating the provincial-level market prices of each commodity and then computing their average, allowing for a representation of national price conditions rather than localized price variations. It provides a standardized measure for comparing price trends over time and assessing market stability in the vegetable sector.

Overall, all vegetable commodities experienced fluctuating selling prices between 2020 and 2024 (Fig. 1). From 2020 to 2024, bird's eye chili consistently had a higher selling price compared to other commodities. However, its price fluctuated across the years, showing a decline from 2021 to 2024. The highest selling price of bird's eye chili was recorded in 2021, at IDR 58,456 per kilogram, while the lowest price was observed in 2020, at IDR 43,621 per kilogram. Papua, Maluku, and North Maluku Provinces recorded the highest selling prices for bird's eye chili compared to other provinces. Meanwhile, in Java Island, which serves as the main production center for bird's eye chili (Fig. 2), the selling price was moderate, ranging between IDR 41,000 and 60,000 per kilogram. This finding indicates that Indonesian consumers have a strong preference for bird's eye chili, as it is widely used in traditional dishes and daily meals, contributing to its relatively high market demand.

Seasonal production cycles also play a major role in shaping price variability. Most vegetable commodities in Indonesia have short growing periods and are highly sensitive to rainfall, temperature changes, and pests, which cause production volumes to fluctuate sharply between harvest and lean seasons. When supply increases post-harvest, prices tend to fall, whereas reduced supply during off-season periods results in price spikes (Liu et al., 2018). For chilies in particular, excess rainfall has been linked to fungal and root-rot diseases, leading to yield losses and subsequent supply shocks (Dwi et al., 2025). These cyclical production patterns indicate that vegetable price volatility is structurally embedded in the production system rather than being solely driven by temporary market disruptions.

Figure 1 shows that the lowest average selling price among the analyzed commodities was observed for garlic, declining to IDR 29,725 per kilogram in 2021 and then increasing steadily from 2022 to 2024. Provinces with the lowest garlic prices were East Java and Bali, averaging around IDR 27,000 per kilogram, while North Maluku and West Papua recorded the highest garlic prices, ranging between IDR 46,000 and 49,000 per kilogram. Overall, these results suggest that regional variations in transportation costs, production centers, and consumer preferences contribute to differences in the average price of vegetable commodities across Indonesia. Additionally, the gradual stabilization of prices after 2022 indicates improving supply chain efficiency and market balance in the post-pandemic period.

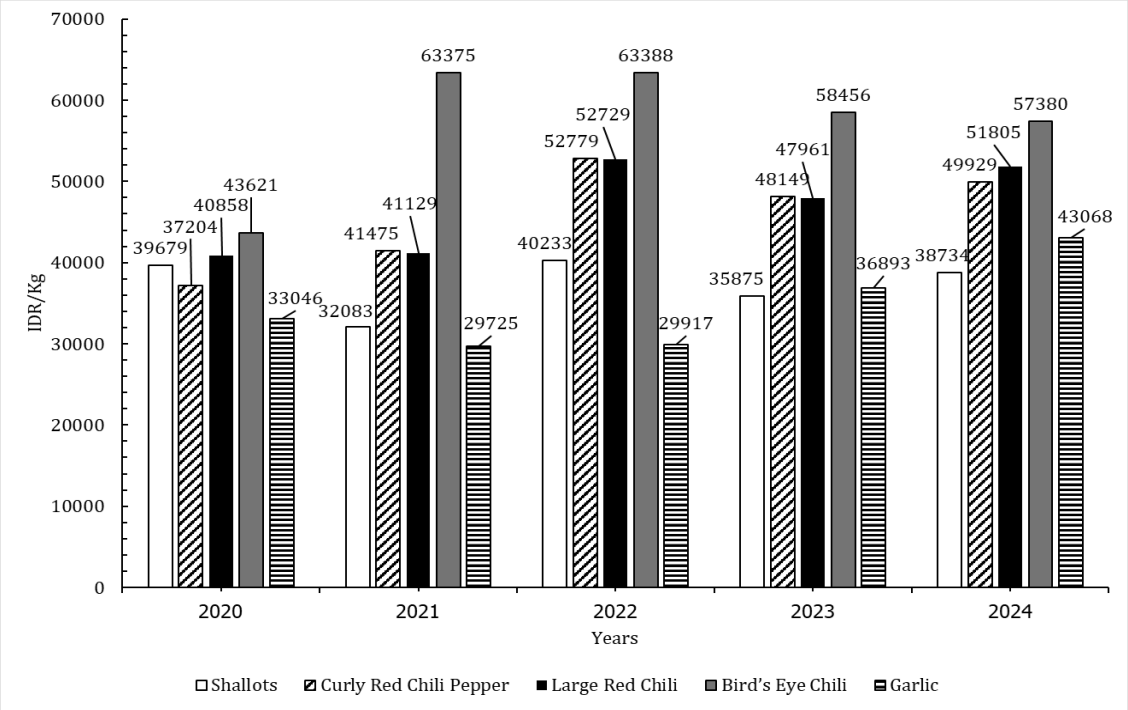

Fig. 1. Average price of vegetable commodities in Indonesia from 2020-2024 (Ministry of Agriculture of the Republic of Indonesia, 2024)

High prices of vegetable commodities are driven by climatic shocks, long and fragmented supply chains, and the intrinsic perishability of produce(Esteso et al., 2021; Theresia et al., 2025). World Bank (2019) reported that food prices tend to be higher in regions with the highest levels of poverty and malnutrition, such as Papua and Maluku Provinces, which have the highest poverty rates in Indonesia. Persistently higher vegetable prices in eastern Indonesia may constrain affordability and access to nutrient-dense foods, particularly for lower-income households, with potential implications for dietary diversity during the post-pandemic recovery (Choudhury et al., 2025; Darmon & Drewnowski, 2015). In addition, since most vegetable production centers are located on Java Island, regions outside Java incur higher logistical costs. Java island serves as the primary production center for most vegetable commodities, such as shallots, cayenne peppers, and curly red

chilies. Consequently, agricultural commodity prices there tend to be lower and more stable than other islands. Meanwhile, several provinces farther from Java have experienced significant price increases for vegetable commodities due to long supply chains, low local production capacity, small market size, and high shipping costs. Theresia et al (2025) reported that logistical challenges and delays in transportation and distribution contribute to price fluctuations, particularly for perishable commodities such as chili and shallots. Moreover, population size plays a significant role in determining food prices across provinces, with nearly 60% of Indonesia's population living on Java Island, making it both the most densely populated region and the primary production center for many vegetable commodities (Webb & Kosasih, 2016).

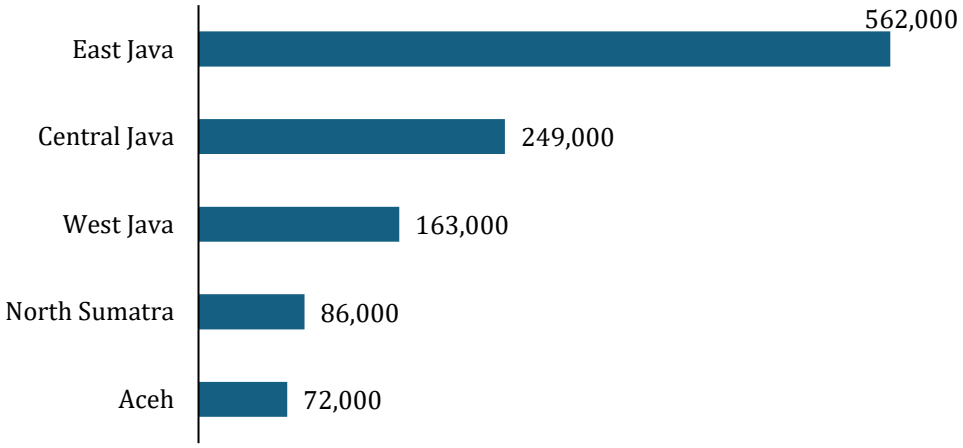

Fig. 2. Distribution of bird's eye chili Production in Indonesia
(Susilawaty & Nugraheni, 2023)

3.2 Vegetable price fluctuations in Indonesia

Figure 3 presents the annual fluctuation percentage of five major vegetable commodities in Indonesia (shallots, curly red chili, large red chili, bird's eye chili, and garlic) from 2020 to 2024. The year 2020 served as the baseline year, with fluctuation values set to zero because no prior data were used for comparison. In 2021, all commodities began to show price variations, with bird's eye chili exhibiting the highest fluctuation (45.29%), indicating strong market instability and supply disruptions during that period. This sharp increase was likely influenced by extreme weather conditions and logistic constraints following the COVID-19 pandemic, which affected chili production and distribution.

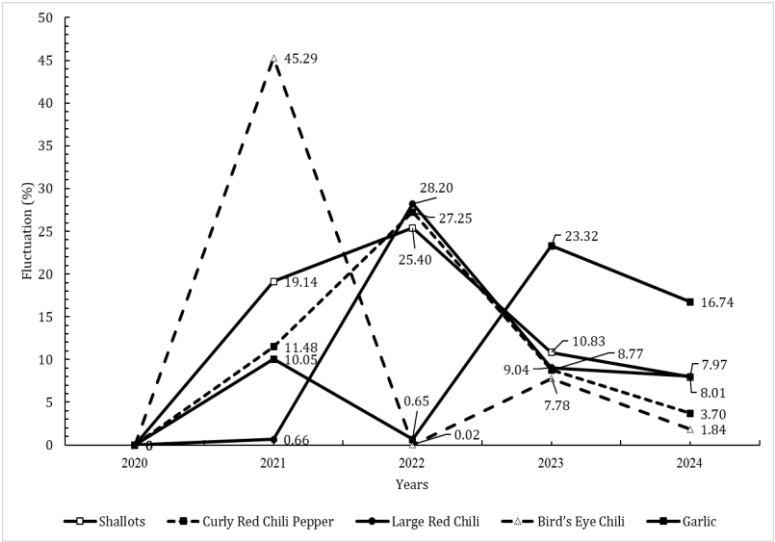

Fig. 3. Fluctuation percentage of vegetables from 2020-2024

Ikhsan & Virananda (2021) reported that the COVID-19 pandemic affected food security in Indonesia, leading to unstable prices, particularly for vegetable commodities. In addition, weather conditions and long logistical supply chains have also contributed to price fluctuations of vegetable commodities in Indonesia (Muflikh et al., 2021; Theresia et al., 2025). Septarena et al (2025) found that high rainfall levels caused crop failures in chili production, as chili plants are susceptible to root rot diseases during the rainy season, leading to plant death. This finding is consistent with data from the Meteorology, Climatology, and Geophysics Agency (BMKG) in 2021, which reported that rainfall levels in Indonesia were relatively high throughout the year (BMKG, 2021).

Meanwhile, shallots (19.14%) and curly red chili (11.48%) also experienced moderate fluctuations, while large red chili (0.66%) and garlic (10.05%) remained relatively stable. In 2022, price fluctuation intensified across most commodities, particularly for large red chili (28.20%), curly red chili (27.25%), and shallots (25.40%) (Fig. 3). The high fluctuations in this commodity reflect the imbalance in supply and demand as well as the effects of seasonal production, especially for perishable vegetable crops (Kumar et al., 2023). Simillary, Haroon et al (2020) reported that prices of onions, tomatoes and cabbage in Lahore follow a pattern of low prices post-harvest and high prices pre-harvest, indicating strong seasonal effects. However, bird's eye chili showed a sharp decline in fluctuation (0.02%) after the 2021 peak, suggesting a temporary recovery in its supply chain. A general decline in fluctuation was observed in 2023, when all commodities recorded lower values compared to the previous year. Among them, garlic showed the most significant increase in variability (23.32%), which may be attributed to its high dependency on import policies and global price movements. Santanu (2024) reported that a country's import policies can affect food price stability.

By 2024, fluctuation levels for all commodities continued to decline, indicating a trend toward price stabilization in Indonesia's vegetable market. The lowest fluctuation rates were observed in curly red chili (3.70%) and bird's eye chili (1.84%), while garlic (16.74%) and shallots (7.97%) still exhibited some level of variation. Overall, these results reveal that the period of highest fluctuation occurred between 2021 and 2022, followed by a gradual stabilization from 2023 to 2024. This pattern suggests that post-pandemic recovery, improved distribution systems, and government market interventions played a crucial role in moderating vegetable price fluctuations in recent years.

The period of extreme price fluctuations in 2021–2022 reflected the instability of Indonesia's supply chain at the time. Climate anomalies, particularly high rainfall associated with La Niña, led to widespread crop failures in chilies and shallots (Nugroho et al., 2025). Pandemic-era mobility restrictions created additional disruptions to inter-island transportation and distribution networks. These pressures collectively created conditions where even small supply declines triggered significant price fluctuations, particularly for highly perishable commodities like bird's eye chilli. In contrast, garlic volatility was driven not by domestic conditions but by a global container shortage and delays in the import licensing system, demonstrating how dependence on international trade directly impacts domestic food security (Kiloes et al., 2024).

Overall, these results reveal that the period of highest fluctuation occurred between 2021 and 2022, followed by a gradual stabilization from 2023 to 2024. Vegetable price volatility in Indonesia is closely linked to the structural characteristics of the supply chain. Most vegetable producers are smallholder farmers with limited access to cold storage and post-harvest handling facilities, making the supply highly sensitive to weather variability and harvest timing. As a result, production surpluses often lead to rapid price declines, while supply disruptions quickly trigger price spikes (Tadesse et al., 2013). Additionally, distribution networks between production centers in Java and consumption regions outside Java remain fragmented, leading to high transportation and logistics costs that contribute to regional price disparities (Timmer, 2010). For garlic, which relies heavily on imports, fluctuations are further influenced by global price trends and import regulation policies, making the domestic market particularly vulnerable to external shocks (Kiloes et al., 2024). These structural vulnerabilities indicate that price instability is not merely driven by short-

term disruptions such as COVID-19 but is rooted in systemic supply chain constraints. Therefore, long-term stabilization efforts must involve strengthening domestic production capacity, improving storage and distribution infrastructure, and ensuring more transparent and responsive market regulation.

3.3 Food expenditure percapita in Indonesia

Figure 4 shows a consistent increase throughout the observed period for food expenditure per capita in Indonesia from 2020 to 2024. Bina et al (2023) reported an increase in household spending on food during and after the COVID-19 pandemic. The average annual food expenditure per capita increased from IDR 7,238,829 in 2020 to IDR 9,021,467 in 2024, marking an overall growth of approximately 24.6% over five years. The sharpest increases occurred during 2022–2024, reflecting improved household income and food affordability as the national economy recovered. This positive trend aligns with greater market stability, as reflected by the decline in vegetable price fluctuations over the same period. The steady pattern of food expenditure suggests that Indonesian households have been able to maintain or even increase their level of consumption, which can be interpreted as an indication of improved food security and a recovery in purchasing power following the economic impacts of the COVID-19 pandemic. The increase in food expenditure per capita is also associated with rising food price inflation and gradual recovery in household incomes during the post-pandemic period.

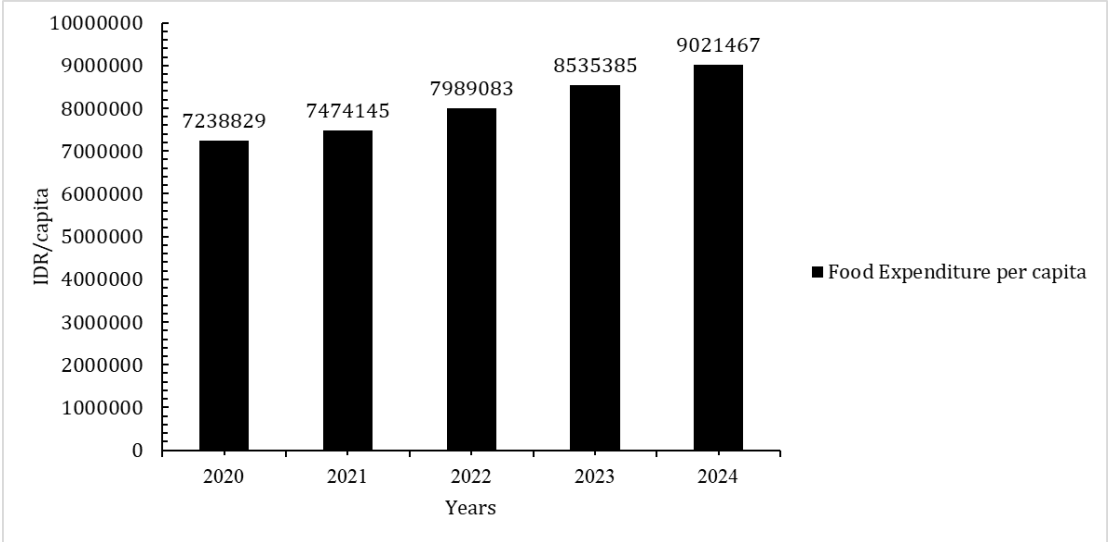

Fig. 4. Food Expenditure per capita in Indonesia
(BPS, 2024b)

This upward trend also reflects changes in consumption behavior. According to the Asian Development Bank (2023), household consumption patterns tend to shift as economic activity resumes, allowing families to allocate more spending toward diverse and higher-quality food products. This pattern aligns with Engel's Law, which states that the proportion of income spent on food decreases as income rises; however, in lower- and middle-income households the share remains relatively large (Barrett et al., 2018; Gbadebo et al., 2022). The persistent dominance of food spending in Indonesia indicates that many households remain in the lower-middle income group, where food affordability is a primary component of economic welfare. Therefore, an increase in food expenditure share may signify improved consumption capacity, but it may also reflect the vulnerability of households to rising food prices. This condition highlights the need for stable supply chains and price stabilization policies to ensure sustained food security.

Although the rise in food expenditure per capita may indicate improved consumption capacity, it does not necessarily imply a proportional improvement in dietary quality.

Several studies have shown that when food prices rise, households in lower-income groups tend to maintain calorie intake but reduce consumption of nutrient-rich foods such as vegetables, fruits, and animal-based proteins (Headey & Ruel, 2023). This suggests that even with increased total food spending, diet diversification may remain limited for many households. Additionally, the increase in food expenditure share may reflect disparities in economic recovery, where urban middle-income households experience faster improvements in purchasing power compared to rural or low-income households (Waryoba, 2023). These conditions highlight that food expenditure patterns are influenced not only by price dynamics and income recovery but also by structural inequalities in market access, employment stability, and nutritional awareness. Therefore, ensuring equitable food affordability requires not only price stabilization efforts but also targeted interventions such as subsidies for nutrient-rich foods, improved distribution of perishable commodities, and support programs for vulnerable households to maintain dietary diversity and nutritional security.

3.4 Total expenditure per capita in Indonesia

Total expenditure per capita refers to the average amount of total household spending allocated to all consumption needs (food and non-food) divided by the number of household members. This indicator is commonly used to measure household welfare, purchasing power, and living standards, where higher expenditure per capita generally reflects better economic well-being (Haughton & Khandker, 2009). Figure 5 presents the trend of total expenditure per capita in Indonesia from 2020 to 2024. Similar to food expenditure, total per capita expenditure showed a gradual upward trend, increasing from IDR 11,013,000 in 2020 to IDR 12,341,000 in 2024. This represents an overall increase of about 12% during the five-year period.

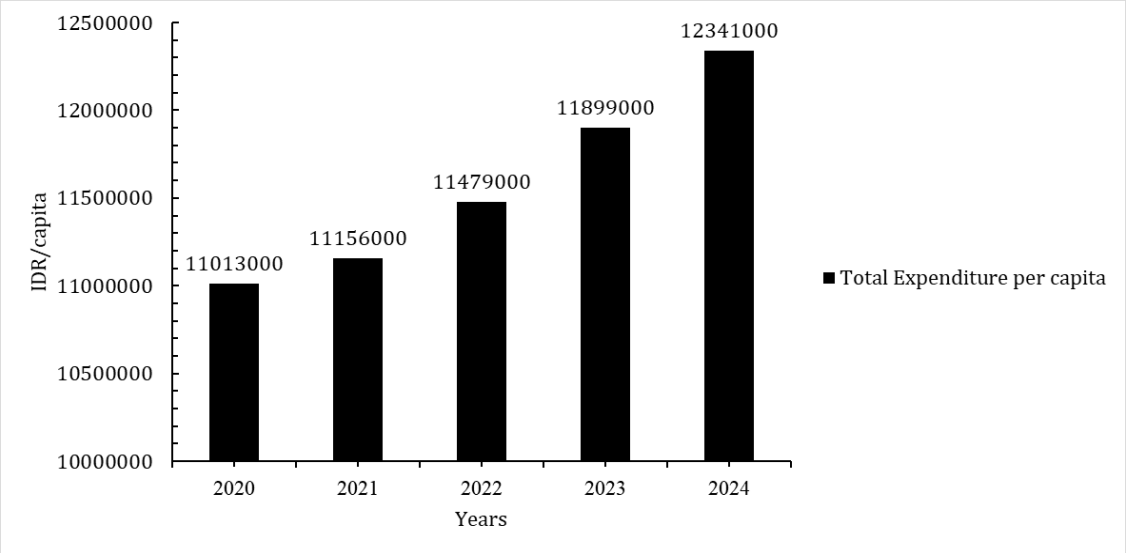

Fig. 5. Total Expenditure per capita in Indonesia
(BPS, 2024a)

The increase in total spending is closely linked with economic reopening, income recovery, and improved employment conditions in the post-pandemic period. According to World Bank (2023), Indonesia experienced renewed growth in household consumption as mobility restrictions eased and labor market participation improved. This suggests that households had greater financial capacity to allocate spending across various needs, including food, housing, transportation, and social activities. However, the rise in total expenditure per capita does not necessarily imply proportional improvements in real purchasing power. Inflationary pressures (particularly on food commodities) may have contributed to higher spending without a corresponding increase in consumption volume.

This effect has been documented in several developing-country contexts where food price shocks lead to welfare losses despite increased nominal spending (Layani et al., 2020). Moreover, household consumption expenditure is sensitive to both income dynamics and price inflation, especially in lower-income segments (Madudova & Corejova, 2024).

3.5 Indonesia's food expenditure shares

Figure 6 illustrates the trend in food expenditure share per capita in Indonesia from 2020 to 2024. The share increased steadily from 65.73% in 2020 to 73.10% in 2024, indicating that food continued to dominate household spending throughout the period. The most notable increase occurred after 2022, when the proportion rose from 69.60% to 73.10%, suggesting that food-related expenses grew faster than total household expenditures. This upward trend reflects the interaction between income recovery and persistent food price inflation. Although household incomes improved during the post-pandemic period, rising food prices limited the extent to which these income gains translated into enhanced purchasing power. In this case, households may have increased nominal food spending without significantly increasing the volume or diversity of food consumed. This phenomenon has been widely observed in lower- and middle-income settings, where food remains a non-discretionary necessity (Madudova & Corejova, 2024).

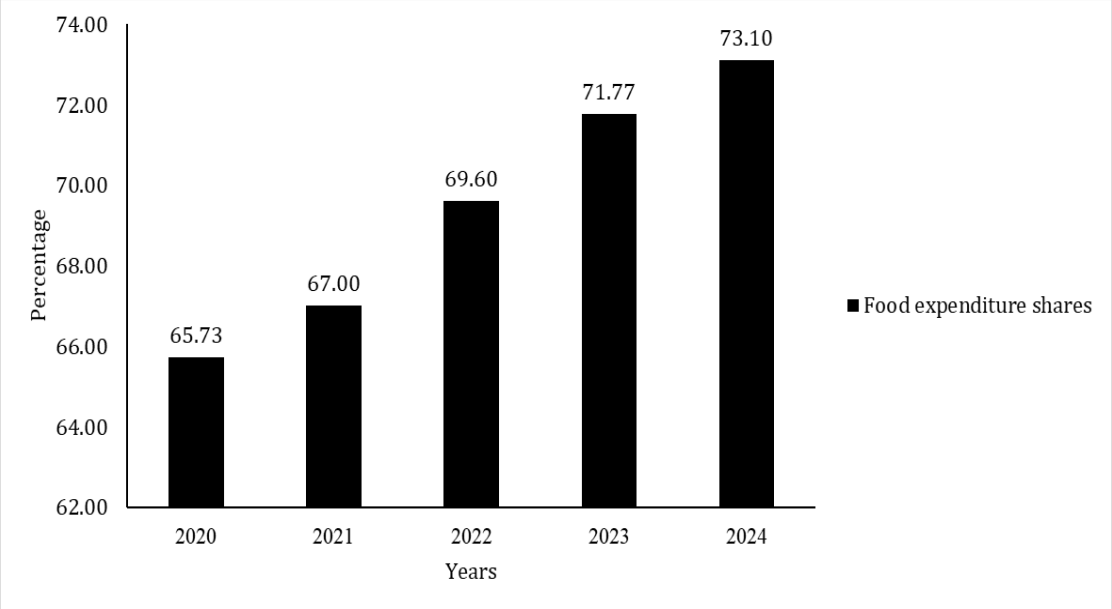

Fig. 6. Food expenditure shares (%) in Indonesia

The observed pattern is also consistent with Engel's Law, which states that the proportion of income spent on food tends to decline as income rises. However, in lower- and middle-income households, such as those prevalent in Indonesia, food still accounts for a substantial share of total expenditure (Clements & Si, 2017). This is reaffirmed by Mulamba (2022), who found that food expenditure share is inversely related to household income, meaning that households with limited financial capacity are more vulnerable to food price changes.

The sustained dominance of food spending in Indonesia suggests that many households remain in the lower-middle income segment, where even moderate price increases can directly affect dietary quality, nutritional intake, and economic welfare. This pattern implies that food affordability remains a significant determinant of household resilience, especially during periods of price volatility. Therefore, policies aimed at stabilizing food prices, improving distribution efficiency, and strengthening local food supply chains are essential for supporting household purchasing power and ensuring broader food security.

3.6 Relationship between vegetables prices fluctuations and food expenditure shares

The Pearson correlation analysis (Table 1) revealed a strong negative relationship between average vegetable price fluctuation and food expenditure share per capita in Indonesia during 2021–2024 (r = –0.935). This strong inverse association indicates that when the fluctuation in vegetable prices decreases, the proportion of household expenditure allocated to food tends to increase. In practical terms, when vegetable prices are more stable, households tend to maintain or increase their food consumption rather than substituting cheaper or less nutritious options. Price stability reduces uncertainty in budgeting and enables households to allocate expenditures more predictably (Rakotoarisoa et al., 2011). This finding is particularly relevant in the context of Indonesia as a lower-middle-income country where food remains a large share of household expenditure. When staple or commonly consumed vegetables experience price shocks, households may respond by reducing food quality or quantity to protect non-food expenditure needs, such as education and utilities (Minot, 2014). Therefore, stable vegetable prices can help sustain dietary adequacy and prevent nutritional vulnerability, especially among low-income households.

During the COVID-19 pandemic, increased attention to diet quality and health awareness contributed to greater vegetable consumption, particularly among families with children and elderly members (Hajipoor et al., 2023; Hristov et al., 2022). However, high price volatility during the pandemic disrupted food purchasing power. Thus, the strong negative correlation found in this study suggests that post-pandemic price normalization played an important role in enabling households to maintain food consumption levels.

Although the correlation was not statistically significant at the 0.05 level ($p \approx 0.065$), the limited number of observations (N = 4) likely constrained the statistical power of the test (Table 1). In macroeconomic time-series studies with small annual datasets, emphasis is placed more on effect size and economic rationale than significance alone (Wooldridge, 2012). Therefore, the direction and magnitude of the coefficient still provide meaningful insights into the structural relationship between price stability and food expenditure behavior.

Overall, the findings underscore that stabilizing prices of key perishable vegetables is essential for supporting household food security and economic resilience in Indonesia. This aligns with previous research emphasizing that market stabilization measures (improving supply chain efficiency, strengthening distribution networks, and reducing seasonal production risks) can protect household welfare in developing economies (Dorosh, 2008; Gouel, 2013).

Table 1. Pearson correlation between average vegetable price fluctuation and food expenditure share per capita (2021–2024)

Variable	Avg. Price Fluctuation (%)	Food Expenditure Share per Capita (%)
Average Price Fluctuation (%)	1	–0.935
Food Expenditure Share per Capita (%)	–0.935	1

N=4, Sig. (2-tailed) = 0.065

The relationship between the two variables is further illustrated in Figure 7, which presents the linear regression model in Equation 1, where y represents the food expenditure share (in percent), and x denotes the average vegetable price fluctuation (in percent).

$$y = -0.5627x + 77.856 \quad \text{(Eq. 1)}$$

The regression analysis further supports the correlation findings, showing a negative relationship between average vegetable price fluctuation and food expenditure share per capita, as indicated by the negative regression coefficient (β = –0.5627). This result suggests

that a 1% increase in vegetable price fluctuation is associated with a decrease of approximately 0.56 percentage points in the share of household expenditure allocated to food. In other words, when vegetable prices become more volatile, households tend to reduce the proportion of their spending on food, likely shifting their expenditures toward cheaper or lower-quality substitutes to manage budget uncertainty.

The coefficient of determination (R^2 = 0.874) indicates that 87.4% of the variation in food expenditure share can be explained by changes in vegetable price fluctuation (Fig. 7). The relatively high R^2 value indicates that vegetable price fluctuation explains a substantial share of the variation in food expenditure share within the observed period. However, this explanatory power should be interpreted cautiously given the simplicity of the model and the limited sample size. A stable price environment reduces the need for households to reallocate spending away from food and helps maintain nutritional quality and consumption consistency (Timmer, 2010). These findings align with previous studies demonstrating that volatile food prices increase household economic vulnerability, especially among lower- and middle-income groups whose budgets are more sensitive to price changes (Minot, 2014). When vegetable prices fluctuate sharply, households often reduce consumption of fresh foods and shift toward processed or calorie-dense alternatives, which can have long-term implications for diet quality and public health (Trijsburg et al., 2019). Conversely, stable prices enable households to make more predictable food purchasing decisions, supporting both dietary adequacy and welfare.

The results also support theoretical and empirical work emphasizing the importance of market stability and supply chain efficiency in food systems. Headey & Fan (2008) argue that controlling volatility in essential food commodities can mitigate welfare losses and maintain consumption levels. Likewise, Ivanic & Martin (2014) found that price shocks in basic foods disproportionately affect poorer households by reducing real purchasing power. Overall, the regression findings underscore that vegetable price stabilization policies, such as improving domestic production capacity, reducing reliance on weather-sensitive supply chains, and strengthening distribution efficiency are essential to support household food security and resilience, particularly in the post-pandemic recovery context.

While the correlation and regression results indicate a strong statistical association between vegetable price fluctuation and food expenditure share, these findings should be interpreted with caution. The analysis is based on a simple bivariate model and a limited number of annual observations, which does not allow for causal inference. Therefore, the estimated coefficients should be understood as indicative of an association rather than a direct causal effect. Other factors, such as income dynamics, general inflation, and broader macroeconomic conditions, may also influence household expenditure behavior during the study period.

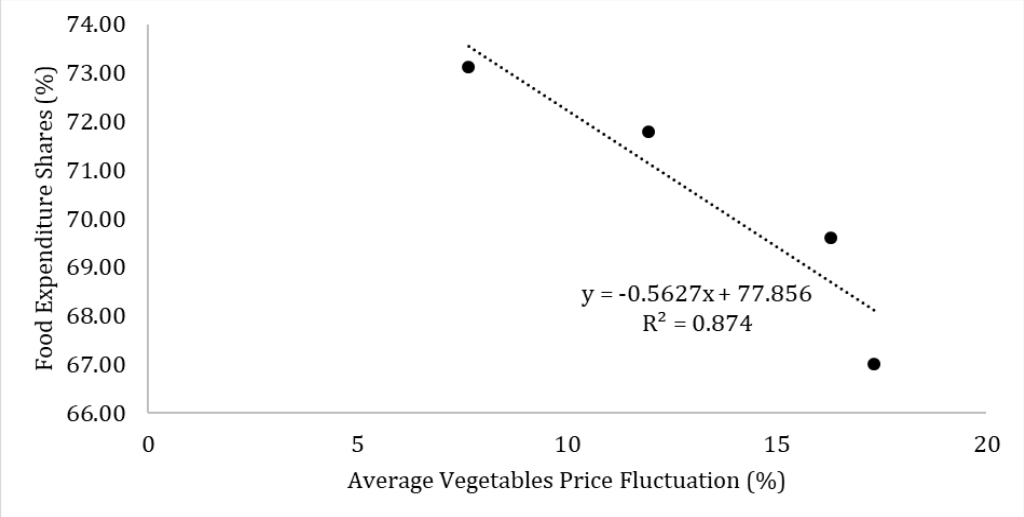

Fig. 7. Relationship between Average Vegetables Price Fluctuation and Household Food Expenditure Share in Indonesia (2021–2024)

The findings of this study illustrate a complex interaction between vegetable price dynamics, household consumption decisions, and broader structural characteristics of Indonesia's food system during and after the COVID-19 pandemic. Beyond the statistical relationships observed, the results reveal deeper behavioral and economic mechanisms that explain how households adjust their spending patterns when faced with uncertainty in essential food markets. A central outcome of this research is the strong negative relationship between vegetable price fluctuation and food expenditure share. Although this may initially seem counterintuitive, the finding aligns with a behavioral interpretation of consumption decisions. Households respond not only to price levels but also to their predictability. When price volatility decreases, households become more confident in planning their food budgets, allowing them to allocate a larger portion of their total expenditures to food. This behavioral pattern aligns with evidence showing that consumers, particularly in developing countries, derive substantial welfare benefits from stable prices. Bellemare et al (2013) explains that price uncertainty itself can reduce household welfare, regardless of whether prices increase, because unpredictable movements create risk that households must manage. Chavas et al (2019) emphasize that food price volatility creates price risks that complicate budget planning. When faced with this uncertainty, households tend to adopt risk-averse strategies such as reducing purchases of perishable vegetables, replacing them with cheaper alternatives, or relying more on non-perishable goods. This response becomes more pronounced as price fluctuations increase, indicating that uncertainty plays a crucial role in influencing food consumption behavior.

From a nutrition perspective, the observed relationship between vegetable price stability and food expenditure behavior has important implications for dietary behavior and nutrition security during Indonesia's post-pandemic economic recovery. Stable and affordable vegetable prices enable households to sustain regular vegetable intake and maintain dietary diversity, which are critical components of nutrition-sensitive food system recovery. Conversely, high price volatility disproportionately constrains access to fresh and nutrient-dense foods, particularly for low-income households, leading to reduced vegetable consumption and a shift toward calorie-dense but nutritionally poorer alternatives (Darmon & Drewnowski, 2015; Miller et al., 2016). As economic recovery progresses, ensuring vegetable affordability and price stability is therefore essential not only for protecting household welfare, but also for supporting diet quality, micronutrient adequacy, and long-term nutrition security.

3.7 Policy implications

Taken together, the findings indicate that fluctuations in vegetable prices are closely linked to household food expenditure patterns and overall welfare in Indonesia. When prices become more stable, households are able to allocate spending more confidently toward food consumption, reflecting improved affordability and resilience. These results suggest several policy-relevant implications for strengthening food security.

First, stabilizing vegetable prices is essential, as price volatility disproportionately affects low- and middle-income households that allocate a large share of their budgets to food. Strengthening supply chain integration between production centers in Java and consumption regions outside Java can help reduce logistic inefficiencies and regional price disparities (Kalkuhl & Braun, 2016). This may include improving transport infrastructure, expanding cold-chain distribution systems for perishable commodities, and minimizing inter-island distribution bottlenecks.

Second, enhancing domestic vegetable production resilience is necessary to reduce climate-related supply shocks. Programs promoting climate-resilient varieties, improved irrigation systems, and farmer extension services can help stabilize production (Wheeler & Braun, 2013). Encouraging greater regional diversification of vegetable production beyond Java would also decrease dependency on a small number of supply regions.

Third, increasing market information transparency can reduce price uncertainty for both farmers and consumers. Strengthening digital price monitoring platforms and real-

time market reporting systems can support better decision-making and reduce speculative behavior (Timmer, 2010).

Finally, targeted consumer protection policies, such as temporary subsidies during price spikes or social assistance programs for vulnerable households, may help maintain food access and nutritional quality during periods of market stress. In the context of post-pandemic recovery, these measures are essential to support household resilience and ensure sustained progress toward national food security goals.

3.8 Limitations and future research

In addition to the implications discussed above, it is also important to acknowledge the limitations of this study and potential directions for future research. This study has several limitations that should be acknowledged. First, the analysis is based on aggregated provincial-level data, which does not capture intra-household variation in food consumption behavior. Future research using household microdata could provide more nuanced insights into how different income groups respond to vegetable price volatility. Second, the study focuses only on five major vegetable commodities (shallots, curly red chili, large red chili, bird's eye chili, and garlic); expanding the commodity scope could better represent the complexity of Indonesia's food system. Third, the statistical analysis relies on a limited number of annual observations (N = 4 for correlation and regression), which reduces statistical power. Future studies may incorporate higher-frequency data (e.g., monthly or quarterly) to improve robustness. Additionally, incorporating other explanatory variables such as household income, climate variability, and market integration indicators may help clarify the pathways linking price fluctuation to food expenditure behavior.

4. Conclusions

This study examined the relationship between vegetable price fluctuation and food expenditure share per capita in Indonesia during and after the COVID-19 pandemic (2020–2024). The findings show that the pandemic triggered substantial volatility in vegetable prices, particularly in 2021–2022, due to mobility restrictions, supply-chain disruptions, and adverse climatic conditions. Bird's eye chili exhibited the highest price fluctuation, followed by shallots and curly red chili. After 2022, price volatility gradually declined, reflecting improvements in supply-chain performance and market stabilization during the post-pandemic recovery period. Concurrently, household food expenditure per capita and its share of total spending increased, indicating that improved price stability enabled households to allocate a larger portion of their budget to food consumption. The strong negative association between vegetable price fluctuation and food expenditure share suggests that price stability plays a critical role in enhancing food affordability and access.
Beyond economic welfare, these findings have important implications for nutrition-sensitive food policies. Vegetables are essential for dietary diversity and nutritional adequacy, yet they remain highly vulnerable to price volatility. Persistent or unpredictable price fluctuations may constrain vegetable affordability, particularly for lower- and middle-income households, potentially limiting dietary quality during periods of economic recovery. Therefore, vegetable price stabilization should be recognized not only as a market objective but also as a public health and nutrition policy priority.

From a policy perspective, the results underscore the need for integrated price stabilization mechanisms, including strengthening domestic vegetable production, improving cold-chain infrastructure, enhancing interregional market integration, and reducing logistical bottlenecks for perishable commodities. In addition, nutrition-sensitive interventions, such as targeted subsidies for nutrient-dense foods, market monitoring to prevent excessive price spikes, and consumer protection measures for vulnerable households can help ensure that improvements in food expenditure capacity translate into more diverse and nutritionally adequate diets. By aligning price stabilization strategies with

nutrition and consumer protection objectives, Indonesia can strengthen food system resilience and support equitable dietary outcomes during post-pandemic recovery.

Future research should extend this analysis by incorporating household income dynamics, inflation, regional production variability, and climate-related risks to better capture the complex interactions between food prices, consumption behavior, and nutrition security across Indonesia.

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Author contribution

The author confirms sole responsibility for the conception and design of the study, data collection and analysis, interpretation of results, and manuscript preparation.

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Data Availability Statement

The data used in this study are publicly available from the Indonesian Central Bureau of Statistics (Badan Pusat Statistik, BPS). The datasets can be accessed through the official BPS website at https://www.bps.go.id

Conflicts of Interest

The author declare no conflict of interest.

Declaration of Generative AI Use

During the preparation of this work, the author used Grammarly to assist in improving grammar, clarity, and academic tone of the manuscript. After using this tool, the author reviewed and edited the content as needed and took full responsibility for the content of the publication.

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Biography of Author

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