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The impacts of the COVID-19 pandemic on food accessibility and food security (case study of Central Java Province)

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ABSTRACT

Introduction: The COVID-19 pandemic has significantly impacted food security and accessibility in Central Java Province. This study aims to analyze the effects of the pandemic on food accessibility in three dimensions—physical, economic, and social—and on food security. **Methods:** The study was conducted in five cities and regencies with high COVID-19 case rates. The research method employs Structural Equation Modeling-Partial Least Square (SEM-PLS) to identify relationships between latent and manifest variables. Primary data were collected from 348 respondents, while secondary data were obtained from relevant agencies. **Results:** The findings reveal that the COVID-19 pandemic situation indirectly positively affects food security through improved physical access to food, supported by government policies such as large-scale social restrictions (PSBB) and community activity restrictions (PPKM), which allowed markets to operate with health protocols. However, economic and social access to food was not significantly impacted by the pandemic. Physical access was shown to have a direct positive impact on food security, while economic access was highly influenced by the respondents' economic conditions. **Conclusion:** In conclusion, food accessibility—particularly physical access—plays a crucial role in maintaining food security during the pandemic in Central Java.

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INTRODUCTION

The COVID-19 pandemic has significantly impacted the social and economic aspects of Indonesian society. The first COVID-19 case in Indonesia was detected on March 2, 2020, and it quickly spread, bringing devastating news across the country. By the end of December 2020, COVID-19 cases had reached all 34 provinces, with Java Island being the region with the highest growth in COVID-19 cases in Indonesia.

As the most populous island in Indonesia, Java Island experienced the brunt of the pandemic's effects. COVID-19 cases on Java Island accounted for 64.5% of the total cases in Indonesia, driven largely by its high economic activity. Central Java Province, in particular, faced the highest death rate, with cases representing more than 11.4% of the national total and fatalities reaching 30.2% of the deaths across Indonesia (Kemenkeu, 2021; Satgas Covid-19, 2022).

These alarming statistics prompted swift action from the government. Amid this surge in cases, government policies play a crucial role in shaping the long-term impact of the pandemic on society. The Covid-19 Task Force implemented large-scale social restrictions (*Pembatasan Sosial Berskala Besar*, PSBB) and implementation of community activity restrictions (*Pemberlakuan Pembatasan Kegiatan Masyarakat*, PPKM) across Java and Bali, aiming to curb the virus's spread. These policies included mandatory health protocols, restrictions on social and economic activities, and limitations on the operations of offices, markets, shopping centers, educational facilities, and places of worship. However, the PSBB policy faced backlash from the public (Khoirunurrofik *et al.*, 2021; Muhyiddin & Nugroho, 2021)

The implementation of PSBB and PPKM policies was perceived to have a negative economic impact. Restrictions on social activities were believed to have led to increased unemployment and decreased incomes, as businesses struggled to operate under the new constraints. This situation has resulted in a widespread decrease in purchasing power, with many individuals and families facing financial hardships. As a consequence, this reduction in income has

directly affected people's ability to meet their basic needs, particularly when it comes to accessing adequate food (Kemenkeu, 2021; Habtewold, 2021; Ikhsan & Virananda, 2021).

The economic impact of the pandemic extends beyond job and income losses; it has also exposed the vulnerabilities within the food supply chain, particularly in regions dependent on external distribution. In Central Java Province, disruptions in this supply chain have led to significant fluctuations in the prices of staple foods. The reliance on limited distribution channels, compounded by strict social restrictions, has made it difficult to meet the demand for food supplies. This situation has further worsened food accessibility and security, especially for the communities in Central Java Province.

On the theoretical side, access to food is a fundamental need. This also literally means access to fulfilling needs of food is a fundamental right for every individual; it involves ensuring adequate intake of carbohydrates, proteins, vitamins, and minerals. Food adequacy is a key indicator of food fulfillment. The importance of food adequacy cannot be underestimated. Food adequacy reflects the welfare of a society; and also has direct implications for public health, especially during the Covid-19 pandemic (Kar *et al.*, 2021; Prabowo, 2014; Rahman *et al.*, 2021).

Food accessibility refers to people's ability to obtain food using available resources, encompassing physical access, economic access, and social access. Physical access involves the availability of markets and the ease of reaching them, economic access pertains to the financial ability to purchase food based on household income and expenditure, and social access relates to the social dimensions of fulfilling food needs (Meliala *et al.*, 2013). Therefore, restrictions on social activities, including the closure or limited operation of markets and restrictions on transportation, have negatively impacted food accessibility (Ikhsan & Virananda, 2021; Kang *et al.*, 2021; Khoirunurrofik *et al.*, 2021).

Food accessibility is closely linked to food security; which is the ability to meet community food needs at an individual level, with considerations for quantity, quality, safety, and economic affordability. Both concepts are intertwined in ensuring that individuals in communities can meet their nutritional needs. A decline in food accessibility can undermine both food security and individual food access (Maskun *et al.*, 2021; Suryana, 2014). Thus, food accessibility and food security are not just interconnected but are also critical components in achieving comprehensive food fulfillment, ensuring that everyone has consistent access to sufficient, safe, and nutritious food. Food accessibility and food security are critical to achieving food fulfillment (Béné *et al.*, 2021; O'Hara & Toussaint, 2021).

Back to occurred conditions, the Covid-19 pandemic in Central Java Province disrupted food distribution. This extraordinary condition affects food supply and prices at the consumer (community) level (Anderson *et al.*, 2021; Cariappa *et al.*, 2021; Perdana *et al.*, 2020); particularly true in areas where strict social activity restrictions were enforced. The higher the number of Covid-19 cases in Central Java, the stricter the social restrictions, and the more adverse effects on food accessibility and security.

To fully understand the challenges posed by the COVID-19 pandemic on food accessibility and security, it is essential to recognize the intricate relationship between them. These two elements work in tandem to ensure that communities achieve food adequacy.

Thus, this research aims to analyze the impact of the COVID-19 pandemic on food accessibility and food security in Central Java Province. The urgency of this research lies in the need for a comprehensive analysis of how the Covid-19 pandemic has affected food accessibility and security. Additionally, this research seeks to provide insights that could guide future policy responses.

METHODS

Research data source

The research locations were strategically selected to include five cities, chosen based on the distribution of positive cases and death rates due to COVID-19 until December 2021. These locations were considered highly affected by the pandemic, making them critical areas of study. The research was conducted between June and September 2022, focusing on the following locations: (1) Semarang City, (2) Surakarta City, (3) Klaten Regency, (4) Magelang Regency, and (5) Wonogiri Regency.

This study utilizes both primary and secondary data. Primary data was collected through interviews with respondents, using convenience sampling to select participants that met specific research criteria (Etikan *et al.*, 2016). The total research sample was 348 respondents from the five cities/regencies, all of whom had been residing in the research locations from March 2020 to December 2021. Secondary data was obtained from relevant health agencies in each city or district, providing information on the COVID-19 situation in the respective areas.

Framework and research variables

The primary objective of this research is to analyze the impact of the COVID-19 pandemic on food accessibility and food security in Central Java Province. To achieve this objective, a conceptual framework was developed to explain how the COVID-19 situation systematically and structurally affects food accessibility and food security in Central Java Province during the pandemic. By developing a conceptual framework, the study seeks to uncover the systematic and

structural factors that contribute to changes in food security during the pandemic. This framework not only helps identify the immediate effects but also lays the groundwork for understanding the long-term consequences of the pandemic.

Table 1. Latent variables and manifest variables of research

Latent variables		Manifest variables (indicators)	
Description	Notation	Description	Notation
Exogenous latent			
1. Covid-19 situation	CS	a. Number of positive cases of Covid-19	$X_{1.1}$
		b. Number of Covid-19 deaths	$X_{1.2}$
Endogenous latent			
1. Social conditions of the society during the Covid-19 pandemic	SC	a. The respondent had tested positive for Covid-19	$Y_{1.1}$
		b. Family members have tested positive for Covid-19	$Y_{1.2}$
2. Economic conditions of the society during the Covid-19 pandemic	EC	a. Respondent's employment status during the Covid-19 pandemic	$Y_{2.1}$
		b. Employment status of family members during the Covid-19 pandemic	$Y_{2.2}$
		c. Income during the COVID-19 pandemic	$Y_{2.3}$
		d. Changes in income during the Covid-19 pandemic	$Y_{2.4}$
		e. Changes in family members' income during the Covid-19 pandemic	$Y_{2.5}$
3. Food accessibility: physical access	PA	a. Total of traditional markets that can be visited with health protocol in 2 km radius	$Y_{3.1}$ $Y_{3.2}$
		b. Total of modern markets that can be visited with health protocol in 2 km radius	$Y_{3.3}$ $Y_{3.4}$
		c. Obstacles in accessing markets (traditional and modern)	
		d. Food availability in traditional markets (average of three energy sources and three protein sources)	$Y_{3.5}$
		e. Food availability in modern markets (average of three energy sources and three protein sources)	
4. Food accessibility: economic access	EA	a. Changes in monthly food expenditure before and during the Covid-19 pandemic	$Y_{4.1}$ $Y_{4.2}$
		b. Percentage of monthly expenses to family income	$Y_{4.3}$
		c. Family income plus the total value of assistance received	
5. Food accessibility: social access	SA	a. Receive assistance from the government	$Y_{5.1}$
		b. Percentage of the value of assistance from the government to total family income	$Y_{5.2}$
6. Food security of Central Java Province during the COVID-19 pandemic	KP	a. Availability of rice in traditional markets	$Y_{6.1}$
		b. Availability of rice in modern markets	$Y_{6.2}$
		c. Availability of white sugar in traditional markets	$Y_{6.3}$
		d. Availability of white sugar in the modern market	$Y_{6.4}$
		e. Availability of palm cooking oil in traditional markets	$Y_{6.5}$
		f. Availability of palm cooking oil in the modern market	$Y_{6.6}$
		g. Availability of chicken eggs in traditional markets	$Y_{6.7}$
		h. Availability of chicken eggs in the modern market	$Y_{6.8}$
		i. Availability of chicken meat in traditional markets	$Y_{6.9}$
		j. Availability of chicken meat in the modern market	$Y_{6.10}$
		k. Availability of beef in traditional markets	$Y_{6.11}$
		l. Availability of beef in modern markets	$Y_{6.12}$
		m. The average difference in rice prices in the market (traditional + modern)	$Y_{6.13}$
		n. Average difference in price of white sugar on the market (traditional + modern)	$Y_{6.14}$ $Y_{6.15}$
		o. Average difference in palm cooking oil prices in the market (traditional + modern)	$Y_{6.16}$ $Y_{6.17}$
		p. Average difference in price of chicken eggs in the market (traditional + modern)	$Y_{6.18}$
		q. Average difference in price of chicken meat in the market (traditional + modern)	
		r. The average difference in beef prices in the market (traditional + modern)	

This research first sets out to analyze its direct and indirect impact on food accessibility. Practically, the spread of COVID-19 is believed to have had significant negative disruptions on individual's social and economic. Furthermore, research considers how the individual experiences of the pandemic have shaped economic and social access to food. These disruptions also influence public facilities, particularly in terms of physical access to food. As markets faced operational challenges and people encountered difficulties in reaching them because of social restrictions, the pandemic's influence on food access became increasingly evident.

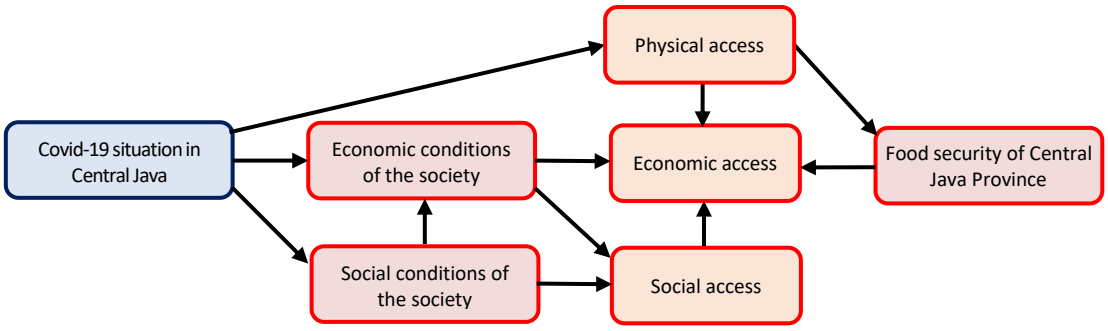

Figure 1. Research framework and relations between latent variables

Food security is reflected in the availability and affordability of staple foods. It is closely linked with food accessibility, emphasizing that food security is not merely the end goal of food fulfillment but a dynamic process intertwined with accessibility (Béné *et al.*, 2021; O'Hara & Toussaint, 2021). This study focuses on key staple foods, both carbohydrate sources (such as rice, white sugar, and palm cooking oil), and protein sources (including chicken eggs, chicken meat, and beef). Furthermore, food security is influenced by food accessibility, which encompasses both physical and economic access. The conditions of the COVID-19 pandemic are believed to have impacted these forms of access, thereby affecting overall economic access to food. This research rationale is summarized in Figure 1.

The research framework scheme shows the relationship between research variables; where each variable cannot be described and measured directly, and indicators are needed for measurement. Thus, the variables in the research framework scheme are latent variables, which are then described by measuring manifest variables. The research variables that are the data required in this research are shown in Table 1.

Data analysis method

Analysis of the impact of the COVID-19 pandemic on accessibility and food security in Central Java Province was carried out using the SEM-PLS method with a model prepared based on the research framework scheme and the relationship between latent variables (Figure 1) using predetermined manifest variables (Table 1). The steps for analyzing the impact of the spread of COVID-19 cases on the level of food accessibility and food security in Central Java Province are as follows:

1. Model Identification and Specifications
   Identification and specification of measurement models (outer models) and structural models (inner models) based on the research framework scheme (Figure 1); formulated in the following equation:
   a. Measurement model (outer model)
      Exogenous latent variables for the Covid-19 situation in Central Java (CS) Province:

$$CS_1 = \lambda_{x1.1} X_{1.1} + \varepsilon_{x1.1} \quad \ldots\ldots (1)$$

$$CS_2 = \lambda_{x1.2} X_{1.2} + \varepsilon_{x1.2} \quad \ldots\ldots (2)$$

      Endogenous latent variables of social conditions in society during the Covid-19 pandemic (SC):

$$SC_1 = \lambda_{y1.1} Y_{1.1} + \varepsilon_{y1.1} \quad \ldots\ldots (3)$$

$$SC_2 = \lambda_{y1.2} Y_{1.2} + \varepsilon_{y1.2} \quad \ldots\ldots (4)$$

      Endogenous latent variable of community economic conditions during the Covid-19 pandemic (EC):

$$EC_1 = \lambda_{y2.1} Y_{2.1} + \varepsilon_{y2.1} \quad \ldots\ldots (5) \qquad EC_2 = \lambda_{y2.3} Y_{2.3} + \varepsilon_{y2.3} \quad \ldots\ldots (7) \qquad EC_5 = \lambda_{y2.5} Y_{2.5} + \varepsilon_{y2.5} \quad \ldots\ldots (9)$$

$$EC_2 = \lambda_{y2.2} Y_{2.2} + \varepsilon_{y2.2} \quad \ldots\ldots (6) \qquad EC_4 = \lambda_{y2.4} Y_{2.4} + \varepsilon_{y2.4} \quad \ldots\ldots (8)$$

      Endogenous latent variable food accessibility: physical access (PA):

$$PA_1 = \lambda_{y3.1} Y_{3.1} + \varepsilon_{y3.1} \quad \ldots\ldots (10) \qquad PA_3 = \lambda_{y3.3} Y_{3.3} + \varepsilon_{y3.3} \quad \ldots\ldots (12) \qquad PA_5 = \lambda_{y3.5} Y_{3.5} + \varepsilon_{y3.5} \quad \ldots\ldots (14)$$

$$PA_2 = \lambda_{y3.2} Y_{3.2} + \varepsilon_{y3.2} \quad \ldots\ldots (11) \qquad PA_4 = \lambda_{y3.4} Y_{3.4} + \varepsilon_{y3.4} \quad \ldots\ldots (13)$$

Endogenous latent variable food accessibility: economic access (EA):

$EA_1 = \lambda_{y4.1} Y_{4.1} + \varepsilon_{y4.1}$ .....(15) $EA_2 = \lambda_{y4.2} Y_{4.2} + \varepsilon_{y4.2}$ .....(16) $EA_3 = \lambda_{y4.3} Y_{4.3} + \varepsilon_{y4.3}$ (17)

Endogenous latent variable food accessibility: social access (SA):

$SA_1 = \lambda_{y5.1} Y_{5.1} + \varepsilon_{y5.1}$ .....(18) $SA_2 = \lambda_{y5.2} Y_{5.2} + \varepsilon_{y5.2}$ (19)

Endogenous latent variables for food security in Central Java Province (FS):

$FS_1 = \lambda_{y6.1} Y_{6.1} + \varepsilon_{y6.1}$ ..... (20) $FS_7 = \lambda_{y6.7} Y_{6.7} + \varepsilon_{y6.7}$ ..... (26) $FS_{13} = \lambda_{y6.13} Y_{6.13} + \varepsilon_{y6.13}$ ..... (32)

$FS_2 = \lambda_{y6.2} Y_{6.2} + \varepsilon_{y6.2}$ ..... (21) $FS_8 = \lambda_{y6.8} Y_{6.8} + \varepsilon_{y6.8}$ ..... (27) $FS_{14} = \lambda_{y6.14} Y_{6.14} + \varepsilon_{y6.14}$ ..... (33)

$FS_3 = \lambda_{y6.3} Y_{6.3} + \varepsilon_{y6.3}$ ..... (22) $FS_9 = \lambda_{y6.9} Y_{6.9} + \varepsilon_{y6.9}$ ..... (28) $FS_{15} = \lambda_{y6.15} Y_{6.15} + \varepsilon_{y6.15}$ ..... (34)

$FS_4 = \lambda_{y6.4} Y_{6.4} + \varepsilon_{y6.4}$ ..... (23) $FS_{10} = \lambda_{y6.10} Y_{6.10} + \varepsilon_{y6.10}$ ..... (29) $FS_{16} = \lambda_{y6.16} Y_{6.16} + \varepsilon_{y6.16}$ ..... (35)

$FS_5 = \lambda_{y6.5} Y_{6.5} + \varepsilon_{y6.5}$ ..... (24) $FS_{11} = \lambda_{y6.11} Y_{6.11} + \varepsilon_{y6.11}$ ..... (30) $FS_{17} = \lambda_{y6.17} Y_{6.17} + \varepsilon_{y6.17}$ ..... (36)

$FS_6 = \lambda_{y6.6} Y_{6.6} + \varepsilon_{y6.6}$ ..... (25) $FS_{12} = \lambda_{y6.12} Y_{6.12} + \varepsilon_{y6.12}$ ..... (31) $FS_{18} = \lambda_{y6.18} Y_{6.18} + \varepsilon_{y6.18}$ ..... (37)

With the hypothesis the loading factor value is as follows:

$\lambda_{x1.1}, \lambda_{x1.2}, \lambda_{y1.1}, \lambda_{y1.2}, \lambda_{y2.1}, \lambda_{y2.2}, \lambda_{y2.3}, \lambda_{y2.4}, \lambda_{y2.5}, \lambda_{y3.1}, \lambda_{y3.2}, \lambda_{y3.4}, \lambda_{y3.5}, \lambda_{y4.3}, \lambda_{y5.1}, \lambda_{y5.2}, \lambda_{y6.1}, \lambda_{y6.2}, \lambda_{y6.3}, \lambda_{y6.4}, \lambda_{y6.5}, \lambda_{y6.6}, \lambda_{y6.7}, \lambda_{y6.8}, \lambda_{y6.9}, \lambda_{y6.10}, \lambda_{y6.11}, \lambda_{y6.12} > 0$; and $\lambda_{y3.3}, \lambda_{y4.1}, \lambda_{y4.2}, \lambda_{y6.13}, \lambda_{y6.14}, \lambda_{y6.15}, \lambda_{y6.16}, \lambda_{y6.17}, \lambda_{y6.18} < 0$

b. Structural model (inner model)

$SC = \gamma_{1.1} CS + \zeta_1$ ..... (32)

$EC = \gamma_{2.1} CS + \beta_{2.1} SC + \sigma_{2.1} CS + \zeta_2$ ..... (32)

$PA = \gamma_{3.1} CS + \zeta_3$ ..... (35)

$EA = \beta_{4.1} EC + \beta_{4.2} SA + \beta_{4.3} PA + \beta_{4.4} FS + \sigma_{4.1} CS + \sigma_{4.2} CS + \sigma_{4.3} CS + \sigma_{4.4} CS + \sigma_{4.5} CS + \sigma_{4.6} CS + \sigma_{4.7} CS + \vartheta_{4.1} SC + \vartheta_{4.2} SC + \vartheta_{4.3} SC + \vartheta_{4.4} EC + \vartheta_{4.5} PA + \zeta_4$ ..... (34)

$SA = \beta_{5.1} SC + \beta_{5.2} EC + \sigma_{5.1} CS + \sigma_{5.2} CS + \sigma_{5.3} CS + \vartheta_{5.1} SC + \zeta$ ..... (33)

$FS = \beta_{6.1} PA + \sigma_{6.1} CS + \zeta_{6.}5$ ..... (36)

With the hypothesis, the coefficient values of direct influence and total indirect influence are as follows:

$\beta_{2.1}, \beta_{4.1}, \beta_{4.2}, \beta_{4.3}, \beta_{4.4}, \beta_{5.1}, \beta_{5.2}, \beta_{6.1}, \vartheta_{4.1\text{-}3}, \vartheta_{4.4}, \vartheta_{4.5}, \vartheta_{5.1} > 0$; and $\gamma_{1.1}, \gamma_{2.1}, \gamma_{3.1}, \sigma_{2.1}, \sigma_{4.1\text{-}7}, \sigma_{5.1\text{-}3}, \sigma_{6.1} < 0$

Where:

λ_{xij} = factor loading of the manifest variable on the exogenous latent variable

λ_{yij} = factor loading of the manifest variable on the endogenous latent variable

X_{ij} = manifest variable in the exogenous latent variable

Y_{ij} = manifest variable in the endogenous latent variable

γ_{ij} = coefficient of the direct influence of the exogenous latent variable on the endogenous latent variable

σ_{ij} = coefficient of the indirect influence of exogenous latent variables on endogenous latent variables

β_{ij} = coefficient of the relationship between the direct influence of the endogenous latent variable on the endogenous latent variable

ϑ_{ij} = coefficient of the indirect influence of the endogenous latent variable on the endogenous latent variable

$\varepsilon_{xij}, \varepsilon_{yij}$ = residuals in the measurement model

ζij = residual in the structural model

2. Model Estimation

Model estimation in PLS uses the least squares method. The calculation is carried out in an iterative manner, which will stop if a convergent condition has been reached.

3. Model Evaluation

The model evaluation stage consists of two, analysis of the measurement model (outer model) and structural model (inner model) (Arnis, 2018). The measurement model analyst defines how each indicator is related to the latent variable. Structural model analysis is used to ensure that the model built accurately describes the relationship between latent variables (Sholiha & Salamah, 2015). The assessment criteria for the measurement model and structural model analysis are shown in Table 2.

External model evaluation shows that convergent validity and internal consistency are generally considered good when the absolute value of the loading factor, Cronbach's alpha, and composite reliability exceed 0.7. Convergent validity measures the extent to which indicators of a construct are highly correlated with each other, while internal consistency measures the extent to which items in a test or questionnaire consistently measure the same construct. Cronbach's alpha is one of the most commonly used measures to assess internal consistency, with values above 0.7 indicating good consistency.

However, results with loading factor values above 0.5 are still acceptable, because loading factors greater than 0.5 are considered practically significant (Abdillah & Jogiyanto, 2015). This means that even though the loading factor value does not reach 0.7, the indicator still makes a significant contribution to the construct being measured. In the context of research, accepting loading factor values above 0.5 allows researchers to retain more indicators in their models, which can increase the overall reliability and validity of the measurement.

Table 2. Assessment criteria in measurement model analysis and structural models

Assessment method	Assessment criteria
Evaluation of the measurement model (outer model)	
Convergent validity	The absolute value of loading factor > 0.5
Internal consistency	The absolute value of Cronbach's alpha > 0.5 and the absolute value of composite reliability > 0.5
Evaluation of the structural model (inner model)	
Coefficient of determination	The R^2 value is based on: (1) > 0.67 (good), (2) 0.33–0.67 (moderate), and (3) < 0.67 (weak)
Relevance of predictions (Q^2)	The Q^2 value > zero means that the model has predictive relevance.

Source : Abdillah & Jogiyanto (2015)

4. Model Interpretation and Improvement
   Model improvements are carried out if the model results do not meet the criteria in model evaluation. Next, model interpretation is carried out based on hypothesis testing through a bootstrapping procedure (Sholiha & Salamah, 2015). Hypothesis testing uses α = 5%, with the criteria shown in Table 3.

Table 3 . Model interpretation criteria

Direction of influence	Hypothesis	Criteria
Direct	◦ Exogenous latent versus endogenous latent	Prob. (t-stat) < α : (significant exogenous/endogenous variables)
	◦ Endogenous latent against endogenous latent	Prob. (t-stat) > α : (exogenous/endogenous variables are not significant)
Indirect	◦ Exogenous latent versus endogenous latent	Prob. (t-stat) < α : (significant exogenous/endogenous variables)
	◦ Endogenous latent against endogenous latent	Prob. (t-stat) > α : (exogenous/endogenous variables are not significant)

RESULTS AND DISCUSSION

Covid-19 model evaluation results

Based on the results of the model evaluation, it is known that the model used requires modification. The external model evaluation of convergent validity shows that not all manifest variables form the intended latent variables; this is indicated based on the absolute value of the loading factor in Figure 2. The loading factor value indicates how much the manifest variables describe and form the latent variables. Latent variables are variables that cannot be explained directly; meanwhile, manifest variables are variables that are manifestations of latent variables, which are the key to describing them. In this context, model modification is needed to improve convergent validity, which means fixing or eliminating manifest variables that do not have adequate loading factors. This is important to ensure that latent variables are measured accurately and consistently. This process may involve reviewing the indicators used and conducting further analysis to determine which indicators are most relevant and significant in describing the latent variables.

Improvements to the model were carried out by eliminating 11 manifest variables with the absolute loading factor value < 0.5; the variables are: (1) employment status of family members during the Covid-19 pandemic ($Y_{2.2}$, loading factor 0.326), (2) changes in income during the Covid-19 pandemic ($Y_{2.4}$, loading factor -0.456), (3) changes in family members' income during the Covid-19 pandemic ($Y_{2.5}$, loading factor 0.300), (4) obstacles in accessing markets ($Y_{3.3}$, loading factor -0.252), (5) changes in monthly food expenditure before and during the Covid-19 pandemic ($Y_{4.1}$, loading factor 0.347), (6) availability of palm cooking oil in traditional markets ($Y_{6.5}$, loading factor 0.259), (7) availability of palm cooking oil in the modern market ($Y_{6.6}$, loading factor 0.287), (8) average difference in price of white sugar on the market ($Y_{6.14}$, loading factor -0.311), (9) average difference in palm cooking oil prices in the market ($Y_{6.15}$, loading factor 0.388), (10) average difference in price of chicken eggs in the market ($Y_{6.16}$, loading factor 0.412),

and (11) average difference in price of chicken meat in the market ($Y_{6.17}$, loading factor 0.042). This step aims to ensure that the model uses manifest variables that are more reliable in describing the targeted latent variables.

The results of model evaluation on the improved model show that the model used is quite good. This is shown based on the loading factor value in Figure 3, where all the loading factor values are> 0.5 and are considered practically significant. This result shows that all manifest variables form the intended latent variable (Abdillah & Jogiyanto, 2015).

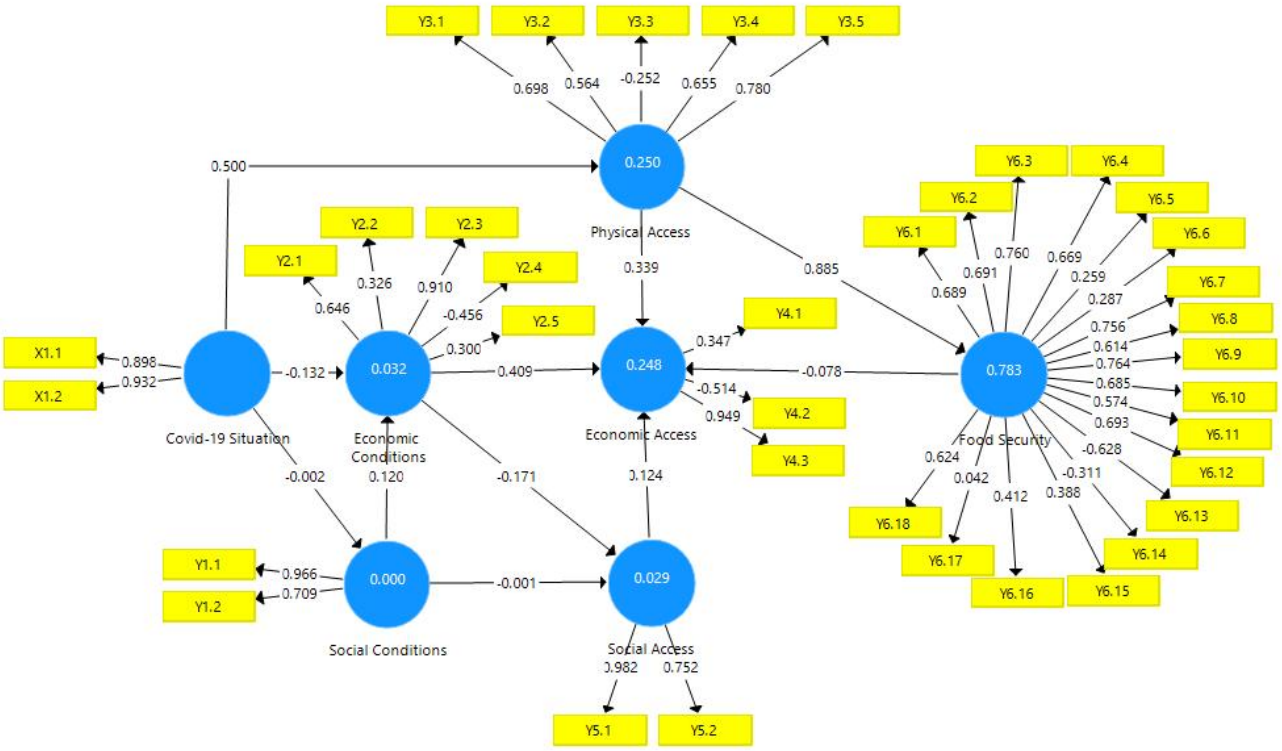

Figure 2. Loading factor value for evaluating the outer model of convergent validity

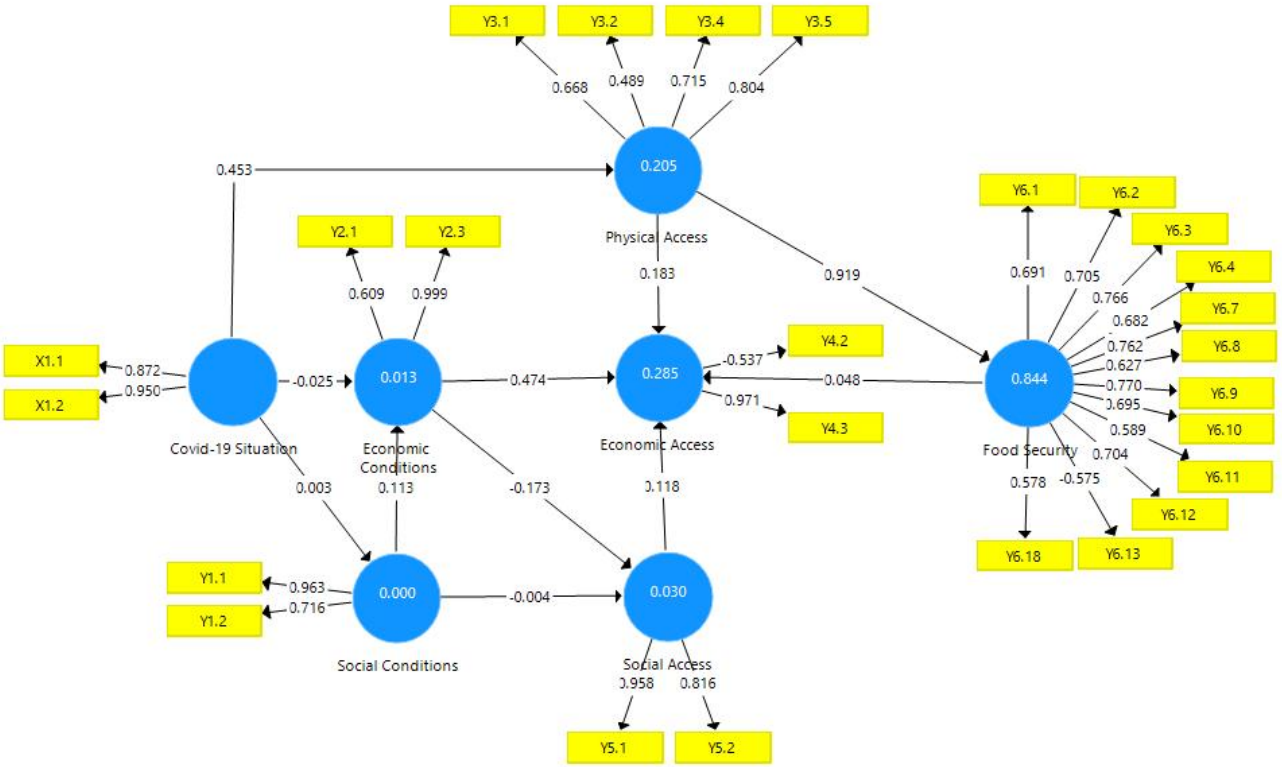

Figure 3 . Loading factor value for evaluating the outer model of convergent validity on the improved model

Figure 3 shows the manifest variables that describe and form the latent variables. The latent variable Covid-19 situation manifested by: (1) data on positive cases of Covid-19 ($X_{1.1}$, loading factor 0.872), and (2) data on Covid-19 deaths ($X_{1.2}$, loading factor 0.950). The latent variable social conditions of society during the Covid-19 pandemic manifested by: (1) the respondent had tested positive for Covid-19 ($Y_{1.1}$, loading factor 0.963), and (2) family members have tested positive for Covid-19 ($Y_{1.2}$, loading factor 0.716). The latent variable economic conditions of society during the Covid-19 pandemic manifested by: (1) the respondent's employment status during the Covid-19 pandemic ($Y_{2.1}$, loading factor 0.609), and (2) income during the Covid-19 pandemic ($Y_{2.3}$, loading factor 0.999). The latent variable Food accessibility: physical access manifested by: (1) the total of traditional markets that can be visited with health protocol in 2 km radius ($Y_{3.1}$, loading factor 0.668), (2) total of modern markets that can be visited with health protocol in 2 km radius ($Y_{3.2}$, loading factor 0.489, tolerated because close to 0.5), (3) food availability in traditional markets ($Y_{3.4}$, loading factor 0.715), and (4) food availability in modern markets ($Y_{3.4}$, loading factor 0.804). The latent variable food accessibility: economic access manifested by: (1) the percentage of monthly expenses to family income ($Y_{4.2}$, loading factor -0.537), and (2) family income plus the total value of assistance received ($Y_{4.3}$, loading factor 0.971). The latent variable food accessibility: social access manifested by: (1) receiving assistance from the government ($Y_{5.1}$, loading factor 0.958), and (2) percentage of the value of assistance from the government to total family income ($Y_{5.2}$, loading factor 0.816). The latent variable food security in Central Java Province during the Covid-19 pandemic manifested by: (1) availability of rice in traditional markets ($Y_{6.1}$, loading factor 0.691), (2) availability of rice in modern markets ($Y_{6.2}$, loading factor 0.705), (3) availability of white sugar in traditional markets ($Y_{6.3}$, loading factor 0.766), (4) availability of white sugar in modern markets ($Y_{6.4}$, loading factor 0.682), (5) availability of chicken eggs in traditional markets ($Y_{6.7}$, loading factor 0.762), (6) availability of chicken eggs in modern markets ($Y_{6.8}$, loading factor 0.627), (7) availability of chicken meat in traditional markets ($Y_{6.9}$, loading factor 0.770), (8) availability of chicken meat in modern markets ($Y_{6.10}$, loading factor 0.695), (9) availability of beef in traditional markets ($Y_{6.11}$, loading factor 0.589), (10) availability of beef in modern markets ($Y_{6.12}$, loading factor 0.704), (11) average difference in rice prices in the market ($Y_{6.13}$, loading factor -0.575), and (12) average difference in beef prices in the market ($Y_{6.18}$, loading factor -0.578).

Furthermore, the internal consistency evaluation also shows that all endogenous and exogenous latent variables are assessed as reliable based on Cronbach's alpha value. Cronbach's alpha measures the lower limit of the reliability value of a construct. However, based on the composite reliability value, the latent variable food accessibility: economic access is considered not yet reliable (shown in Table 4).

Table 4 . *Outer model internal consistency* evaluation results

Indicator		Results
1. *Cronbach's alpha*	Covid-19 situation	= 0.807(reliable)
	Social conditions	= 0.669 (reliable)
	Economic conditions	= 0.722 (reliable)
	Food accessibility: physical access	= 0.612 (reliable)
	Food accessibility: economic access	= -0.939 (reliable)
	Food accessibility: social access	= 0.763 (reliable)
	Food security	= 0.831 (reliable)
2. *Composite reliability*	Covid-19 situation	= 0.908 (reliable)
	Social conditions	= 0.834 (reliable)
	Economic conditions	= 0.803 (reliable)
	Food accessibility: physical access	= 0.769 (reliable)
	Food accessibility: economic access	= 0.197 (less reliable)
	Food accessibility: social access	= 0.883 (reliable)
	Food security	= 0.884 (reliable)

Composite reliability testing is used to test the internal consistency of the data obtained; which measures the actual value of the reliability of a construct. The condition of inconsistency (less reliable) in the latent variable data on food accessibility: economic access can occur due to several things, namely: (1) the type of data used is *cross-section data*, (2) the economic characteristics of respondents are heterogeneous, (3) there are tendencies of respondents provide estimated answers or leave answers blank (because of personal matters). So based on these conditions, simplification steps are needed by prioritizing substance and relevance in the model used; namely making a compromise on the condition of the latent variable food accessibility: economic access which indicates the possibility of inconsistent data.

The results of the evaluation of the structural model through testing the coefficient of determination show that most of the endogenous latent variables have a weak coefficient of determination R^2 (shown in Table 5). The coefficient of determination shows how much a latent variable can be explained by other latent variables (exogenous and endogenous). Conditions where the coefficient of determination R^2 is weak indicate that a latent variable is not strong enough to be explained using other latent variables (exogenous and endogenous). This condition can occur due to (1) the type of data used is cross-section data, (2) the characteristics of respondents are heterogeneous, and (3) the

placement of latent variables is deliberately based on the substance of the research. Thus, conditions where the coefficient of determination R^2 is weak are very likely to occur in the structural model. In line with this, the SEM-PLS method uses manifest variables to explain exogenous and endogenous latent variables; where the loading factor shows how big the correlation is between the manifest variable and the latent variable. So based on this, this research made a compromise on the test value of the weak coefficient of determination R^2, by requiring and prioritizing the loading factor value that was considered practically significant.

Table 5. *Internal model* evaluation results

Indicator	Results	
1. Determination coefficient R^2	Social conditions	= 0.000 (weak)
	Economic conditions	= 0.013 (weak)
	Food accessibility: physical access	= 0.205 (weak)
	Food accessibility: economic access	= 0.285 (weak)
	Food accessibility: social access	= 0.030 (weak)
	Food security	= 0.844 (good)
2. Relevance of predictions (Q^2)	Q^2 = 0.881 (good, the model has *predictive relevance*)	

The results of the evaluation of the structural model through testing the relevance of Q^2 predictions show that the model has a good predictive value (shown in Table 5). This is indicated by a Q^2 value of 0.881 (Q^2 value > zero); where it can be interpreted that the model used can explain the information in the research by 88.1 percent.

Overall, through model improvements, it was found that the model used was considered good. The model can be used to analyze the impact of the COVID-19 pandemic on food accessibility and security in Central Java Province. Next, estimation is carried out using the bootstrapping procedure which is used for hypothesis testing and model interpretation. Model interpretation is based on hypothesis testing (with α = 5%) on direct and indirect effects; shown in Table 6.

Table 6. Estimation results and t-test of variables in the model

Direction of influence	Path diagram	Estimation parameters	t- *stat.*	Prob.
Direct influence	• Covid-19 Situation → Social Conditions	0.003	0.059	0.953
	• Covid-19 Situation → Economic Conditions	-0.025	0.24	0.811
	• Covid-19 Situation → Physical Access	0.453	9,704	0,000*
	• Social Conditions → Social Access	-0.004	0.074	0.941
	• Social Conditions → Economic Conditions	0.113	1,079	0.281
	• Economic Conditions → Economic Access	0.474	3,048	0.002*
	• Economic Conditions → Social Access	-0.173	2,608	0.009*
	• Physical Access → Economic Access	0.183	1,606	0.109
	• Physical Access → Food Security	0.919	116,539	0,000*
	• Social Access → Economic Access	0.118	1,623	0.105
	• Food Security → Economic Access	0.048	0.438	0.661
Total indirect influence	• Covid-19 Situation → Food Security	0.416	10,031	0,000*
	• Covid-19 Situation → Economic Conditions	0,000	0.049	0.961
	• Covid-19 Situation → Economic Access	0.092	1,836	0.067
	• Covid-19 Situation → Social Access	0.004	0.213	0.832
	• Social Conditions → Social Access	-0.02	1,000	0.318
	• Social Conditions → Economic Access	0.051	1,124	0.262
	• Economic Conditions → Economic Access	-0.02	1,536	0.125
	• Physical Access → Economic Access	0.044	0.438	0.662

Note : α = 5%

The impact of the COVID-19 pandemic on food security and food accessibility in Central Java Province

The COVID-19 pandemic situation, surprisingly, had a significant indirect positive effect on food security in Central Java Province. Structurally, this happens because the COVID-19 pandemic situation directly and significantly has a positive effect on food accessibility: physical access. The results, in other words, show that the COVID-19 pandemic situation directly and significantly improved physical food accessibility. Furthermore, food accessibility: physical access also has a direct and significant positive effect on food security in Central Java Province.

Interestingly, the results of the analysis produce conclusions that are different from the research hypothesis. This research hypothesis assumes that the COVID-19 pandemic situation has a direct negative effect on food accessibility: physical access in Central Java Province. Meanwhile, food accessibility: physical access has a direct positive effect on

food security in Central Java Province during the COVID-19 pandemic. Thus, the COVID-19 pandemic situation is thought to have had an indirect negative effect on food security in Central Java Province during the COVID-19 pandemic. These contrary results challenge the initial assumption (hypothesis).

This unexpected outcome can occur because of the rapid response from the government and the Covid-19 Task Force to the Covid-19 pandemic situation through the implementation of PSBB and PPKM, and the implementation and supervision of health protocols at traditional and modern market locations. In practical terms, when there was a situation of increasing cases of the Covid-19 pandemic, the government and the Covid-19 Task Force increased the number of traditional markets and modern markets that implemented and monitored health protocols. Food accessibility: physical access during the COVID-19 pandemic refers to market availability with the use of health protocols, ease of accessing locations, and availability of food ingredients. Thus, food accessibility: physical access in Central Java Province also increased when there was an increase in cases of the COVID-19 pandemic. So, people can still access traditional markets and modern markets as places to buy food by implementing health protocols (Meliala *et al.*, 2013).

The rapid response of the government and the COVID-19 Task Force to the COVID-19 pandemic situation in Central Java Province through the implementation of PSBB and PPKM is something that needs to be appreciated. This rapid response is something that must be maintained when there is an extraordinary situation such as the Covid-19 pandemic. This refers to the positive influence of the Covid-19 pandemic situation on food accessibility: physical access in Central Java Province; where as has been explained, in practice the Covid-19 pandemic situation encourages a rapid response from the government and the Covid-19 Task Force (Maskun *et al.*, 2021).

Availability of food accessibility: physical access in Central Java Province is not only needed by the community as consumers; but also by traders and suppliers of food in traditional markets and modern markets. Good physical access ensures that food supplies can reach traditional and modern markets; so that the availability of food becomes more guaranteed. The availability of food is one of the main indicators of food security (Kang *et al.*, 2021; Maskun *et al.*, 2021).

The results of the analysis also revealed other unexpected conclusions that are different from the research hypothesis; that the COVID-19 pandemic situation does not have a significant indirect effect on food accessibility: economic access and social access. Structurally, this happened because the COVID-19 pandemic situation in Central Java Province did not have a significant direct effect on the social and economic conditions. However, the results show that the COVID-19 pandemic situation in Central Java Province has a negative influence on the social and economic conditions of the community. The social and economic conditions of the people of Central Java Province are intermediate variables between the COVID-19 pandemic situation and the food accessibility of the people of Central Java Province. The social condition of the community refers to the experience of respondents and their families testing positive for Covid-19; while economic conditions refer to respondents' employment conditions and income during the Covid-19 pandemic.

In practice, the influence of the COVID-19 pandemic situation on the social and economic conditions of society is a complex interaction; Thus, the model in this research simplifies it to prioritize the substance of the research. As a model developed based on a practical and empirical framework, the direction of the relationship between latent variables (indicated by parameter values) is emphasized more as a model assessment. The significance of the relationship between variables in the model is not an indicator of the suitability of the model. Thus, this study does not draw an empirical conclusion that there is no influence of the Covid-19 pandemic situation on the social and economic conditions of the community. Instead, this study continues to emphasize the importance of the government's role in dealing with extraordinary situations such as the Covid-19 pandemic.

Food security in Central Java Province during the Covid-19 pandemic

Based on the results of the analysis, structurally, food security in Central Java Province during the COVID-19 pandemic was only directly and significantly positively influenced by food accessibility: physical access. Food security is the fulfillment of community food needs at the individual level. The benchmarks for food security during the COVID-19 pandemic in this research are the availability of food (quantity side) and changes in food prices.

The availability of traditional markets and modern markets with the implementation of health protocols is the key to maintaining community food security. As has been explained, with the existence of traditional markets and modern markets that implement and monitor health protocols, food ingredients can enter traditional markets and modern markets; so that the availability of food becomes more guaranteed. Through the availability of sufficient food, food prices are more controlled. The condition of food security in Central Java Province is explained in Table 7.

The people of Central Java Province predominantly rely on traditional markets for purchasing food. Despite the lower levels of health protocol implementation and supervision in traditional markets compared to modern markets, these markets remain the primary choice for the community. As a result, during the COVID-19 pandemic, traditional markets had a greater availability of food than modern markets.

The availability of palm cooking oil in Central Java Province was notably affected by the scarcity of this commodity during the pandemic. This shortage wasn't isolated to Central Java but was a nationwide issue, impacting various

regions across Indonesia. Consequently, the scarcity led to a significant increase in palm cooking oil prices throughout Central Java during the pandemic.

Table 7. Conditions of availability and changes in food prices in Central Java Province during the COVID-19 pandemic

Commodity	Availability [1]		Price change (IDR) [2]
	Traditional market	Modern market	
Rice	Many/abundant	Many/abundant	190.56
Sugar	Many/abundant	Many/abundant	949.39
Palm cooking oil	Enough	A little	1,627.09
Chicken eggs	Many/abundant	Many/abundant	-113.09
Chicken meat	Many/abundant	A little	512.23
Beef	Many/abundant	A little	3,400.18

Note : [1] Based on respondent's assessment via questionnaire
[2] Based on changes in average prices in traditional and modern markets before the Covid-19 pandemic (2018-2019) and during the Covid-19 pandemic (2020-2021)

During the COVID-19 pandemic, food prices in Central Java Province generally saw an upward trend, except for chicken eggs. The most significant price hikes were observed in beef and palm cooking oil. As previously mentioned, the surge in palm cooking oil prices was driven by a national shortage during the pandemic. Meanwhile, the rise in beef prices was attributed to a decrease in market supply. These price fluctuations inevitably impacted community food security during the pandemic. However, the analysis indicates that changes in beef prices had a more substantial effect on food security, as evidenced by the loading factor values (Figures 2 and 3).

The analysis further reveals that food security in Central Java Province during the COVID-19 pandemic did not have a direct significant effect on food accessibility, specifically economic access. This outcome is likely because food accessibility in terms of economic access is more closely tied to people's income levels. This topic will be explored in greater detail in the following sub-chapter.

Food accessibility in Central Java Province during the Covid-19 pandemic

Food accessibility is the ability of people to obtain food with existing resources. Food accessibility is assessed through three main dimensions: physical access, economic access, and social access. The results of the analysis show that structurally food accessibility: physical access, economic access, and social access do not significantly influence each other. However, the analysis also reveals that structurally both food accessibility: physical access, and social access have a positive influence on food accessibility: economic access; aligning with the initial hypothesis.

Structurally, food accessibility: the physical access of communities in Central Java Province is only directly and significantly positively influenced by the COVID-19 pandemic situation. Food accessibility: physical access during the COVID-19 pandemic refers to market availability with the use of health protocols, ease of accessing locations, and availability of food ingredients. As explained previously, this could happen because of the rapid response of the government and the COVID-19 Task Force in dealing with the COVID-19 pandemic situation, namely through the implementation of PSBB and PPKM, and the implementation and supervision of health protocols at traditional market locations and modern markets. So, even though there are closures of traditional market locations and modern markets, these closures are temporary. Traditional markets and modern markets are generally closed for a maximum of 14 days. Furthermore, health protocols were implemented and monitored at traditional and modern market locations. So, people can still access traditional markets and modern markets as places to buy food (Meliala *et al.*, 2013).

Table 8 . Food accessibility conditions: physical access in Central Java Province during the COVID-19 pandemic

Food accessibility indicators: physical access [1]	Condition
1. Number of traditional markets that can be visited with health protocols within a 2 km radius	1-2 market locations
2. Number of modern markets that can be visited with health protocols within a 2 km radius	2-3 market locations
3. Obstacles in accessing traditional and modern markets	Constrained
4. Food availability in traditional markets	Many/abundant
5. Food availability in modern markets	Enough

Notes : [1] Based on respondents' answers via questionnaire

Even though the government and the COVID-19 task force have made various efforts to strengthen food accessibility: and physical access in Central Java Province, people still experience obstacles in accessing traditional and modern markets. In sequence, the obstacles most frequently mentioned by respondents were: (1) implementation of

PSBB and PPKM (222 respondents), (2) health risks (217 respondents), (3) implementation of health protocols (190 respondents), (3) access to transportation (157 respondents), and (4) market closure (134 respondents). These obstacles naturally occur when the PSBB and PPKM are implemented, and the closure of traditional and modern markets. However, this is only temporary.

Food accessibility: the economic access of the community in Central Java Province was only directly and significantly positively influenced by the economic conditions of the community during the COVID-19 pandemic. Food accessibility: economic access is the economic ability to purchase food based on household income and expenditure; while economic conditions refer to the respondents' employment status and income during the Covid-19 pandemic. Thus, the results of the analysis are theoretically and practically appropriate, namely that people's employment status and income determine the extent of people's purchasing power for food; which is also the main factor underlying food accessibility: community economic access.

Food accessibility: social access of the community in Central Java Province was only directly and significantly positively influenced by the social conditions of the community during the COVID-19 pandemic. Food accessibility: social access during the Covid-19 pandemic refers to social assistance (especially from the government) related to providing food for the community; while the social conditions of the community refer to the experience of respondents and their families testing positive for Covid-19. Social assistance from the government is provided to households affected by Covid-19; both socially (tested positive for Covid-19) and low economic groups. Lower economic communities have a higher risk of being affected by the Covid-19 pandemic. Thus, the results of the analysis are theoretically and practically appropriate, namely that social conditions are the main factor underlying food accessibility: community social access.

CONCLUSION

The Covid-19 pandemic has a significant positive indirect effect on food security, and a significant positive direct effect on food accessibility: the physical access of people in Central Java Province during the Covid-19 pandemic. The COVID-19 pandemic has no significant indirect effect on food accessibility: economic access and social access for communities in Central Java Province.

Food security in Central Java Province during the COVID-19 pandemic was only directly and significantly positively influenced by food accessibility: physical access. Food accessibility: the physical access of people in Central Java Province is only directly and significantly positively influenced by the COVID-19 pandemic situation. Food accessibility: the economic access of the community in Central Java Province was only directly and significantly positively influenced by the economic conditions of the community during the COVID-19 pandemic. Food accessibility: social access of the community in Central Java Province was only directly and significantly positively influenced by the social conditions of the community during the COVID-19 pandemic.

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