




# Is sago the best substitution for rice? An analysis of demand for rice in Papua

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## Abstract

One of several SDGs is to gain zero hunger which also means strong food security sustainability. As a strategic sector, agriculture reinforces the provision of food needs. The existence of diversification of food materials from the agricultural sector will also strengthen the food security of a country/region. Various alternative food-stuffs can prevent or avoid food crises in an area. However, another issue about what kind of staple food suits local habitants raised our awareness about the readiness stocks of rice and other local staple foods consumed daily by local society. There is no recent research about the position of this food in the ranking of staple foods. Factors that affect the elasticity of demand include prices, prices of other goods, tastes, incomes, and seasons. This paper answers whether Sago (*Metroxylon sago* Rottb.) acts as a complement or substitution product. The issue about rice and Sago supports the hypothesis that Sago has been consumed widely for long periods but might not be enough to substitute for rice. Using SUSENAS data in 2014 and 2018, this study analyses the demand for rice and runs a regression model to answer the research question. Demand for rice is affected by its price, sago price, and income. Therefore, this study considers the current issue that Sago has a negative position in the demand equation for rice, but research is still underway to prove this. The results show that Sago is a substitute product for rice. It can be seen from the positive cross-price elasticity. Thus, food security in Papua will be better if it is supported by policies that support Sago as a substitute staple food besides its function as local food.

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## Introduction

Indonesia is known as low food resilient nation. Low food resilience also means that there is an issue of social unrest vulnerability and the increase in global food prices usually occurs in this country (Harahap 2020). Recent data on YoY global trends has showed that the price of eggs and wheat flour, for instance, has increased. When the world price of oil increased, it would also be the factor that influences an increase in the price of food in Indonesia (World Food Program 2022). Food Security Agency in the Ministry Of Agriculture has reported that there are 16 provinces in Indonesia spend >65% for food (Ministry of Agriculture 2020). The indicator used to analyze the food security condition of poor households is the share of household food expenditure (Asmara et al. 2010). On the other side, SDG's targets are to gain zero hunger, which also means strong food security and sustainability (Vogliano 2021). As a strategic sector, agriculture reinforces the provision of food needs. The availability of eleven essential commodities including rice (Ministry of Trade 2017, 2020), for instance, is continually monitored, as well as the price and level of demand, to meet the population's basic needs for food. These 11 commodities include the following types of staple food: rice, corn, soya bean, onion, chilli, poultry and eggs, meat, sugar, cooking oil, fish as stated in the Presidential Regulation No. 125 concerning implementation of government food reserves (Government of Indonesia 2022). Besides, there are also local foods known as staple foods, which in Indonesia are very diverse. Sago, corn, and many types of tubers are some examples of local staple foods (Haryanto et al. 2015; Bairagi et al. 2020; Harahap 2020). The existence of diversification of food materials from the agricultural sector will also strengthen the food security of a country/region (Sidiq et al. 2022). Various alternative foodstuffs can prevent or avoid food crises in an area (Abdul 2020; Siddiqui et al. 2022).

Sago is an abundant carbohydrate resource but has not received adequate attention. The total land area (forest) of sago is 5.5 million ha spread over Sumatera, Kalimantan, Sulawesi, Maluku, and Papua. Most of them (95%) are in Papua and West Papua, so this area can become the epicentre of developing a modern and large-scale sago-based industry in Indonesia and at the same time in the world (Bantacut et al. 2020). The limitations of infrastructure, consumption and industry have caused the utilisation rate of Sago to be relatively low compared to its vast potential, so a lot of starch is wasted throughout the year because it is not harvested. According to Kit Lim et al. (2019), Pradipta (2019), Noer et al. (2022), and Sidiq et al. (2022), Sago has not been fully supported by stakeholders with policies from the industrial, production and consumption side as part of a type of food that can support food security.

Rice is the primary commodity for most people in Indonesia, and the increase in Indonesia's population has consequently increased the demand for rice from time to time (Efendi et al. 2021; Octania 2021). According to BPS (2022), population growth in Indonesia from 2018 to 2022 has increased by 4.4%. Monthly consumption per capita of rice in the 2014–2018 period has decreased by 4.69%, but the consumption of rice in food commodities containing rice increased by 13–140%. Furthermore, monthly average consumption per capita of rice (local, premium, imported rice) in 2018 was 4.8 kg and in 2022 has increased to 6.6 kg (BPS-Statistics Indonesia 2018, 2022).

On the other hand, pressure on rice supply is also caused by the shift in public consumption in several regions in Indonesia from local food, which previously became staple foods such as sweet potatoes and Sago to rice. However, this shift in staple food did not lead to a decrease in the price of local food products, although demand declined. Some studies argue that market demand is negatively related to price or price is said to be the only determinant of demand *ceteris paribus*, is misleading because many factors determine demand (Chung and Tan 2015; Torquati et al. 2017; Ajiboye et al. 2019; Bakas and Triantafyllou 2020).

Demand for a product is affected by the price of the good itself, consumer income, prices of other commodities, consumer tastes, income distribution, population, consumer wealth, government policies, past demand levels, and past income levels. However, in the Demand Theory, the determining factor is only limited to four factors: the price of the commodity itself, the price of other goods, income and tastes. In the case of increasing demand for rice, of course, the price of this staple food will also continue to increase. Still, the Indonesian government's policies are contained in the Regulation of the President of the Republic of Indonesia (Government of Indonesia 2022) direct Indonesia concerning the implementation of Government Food Reserves and can control the price of 11 commodities, three of which are certain staple foods (rice, corn, and soya bean). The Ministry of Trade Regulation (Ministry of Trade 2020) can also protect producers and consumers against fluctuations in rice prices. These policies can help control the rate of increase in the price of rice.

The growing population is feared to increase food prices; even describes how unstable prices in agricultural products are a significant threat to food security in less developed countries (Ajiboye et al. 2019; Abdul 2020; Awad 2023). Three elements are reflected in demand for food: population, income, and prices. For instance, in the case of Uganda, there are 33% (15 million) of the 44 million poor people who initially consumed traditional food Matooke (cooked bananas), cassava, and sweet potatoes. Yet, after increasing income and urbanisation, people's consumption shifted to corn, wheat, and rice which is also increasing in demand. So, for food and nutrition security and to meet food demand, further investment in the agricultural sector is needed to increase domestic production capacity (Mottaleb et al. 2021). Fukase and Martin (2020) put forward a slightly different reason that developing countries in recent years have grown much faster than industrialised countries. This fact has implications for world food demand and agriculture due to increased demand for natural resources. Agricultural power occurs due to a shift in diet from staple foods derived from flour and animal products to fruits and vegetables.

Resource use based on food production and consumption measures is responsible for much higher production costs associated with animal foods. Hence, growth in per capita demand is a more critical driver of food demand than population growth.

Papua and West Papua are the eastern provinces of Indonesia, and almost all local inhabitants consume Sago for daily meals. Sago is one of the agricultural commodities in Indonesia and has considerable potential. More extensive area of sago palm in Indonesia totaling 1,528,917 ha, with 1,406,469 in Papua, 45,540 in Sulawesi, 41,949 in Maluku, 31,872 in Sumatra, 2795 in Kalimantan, and 292 ha in West Java. Sago palms in Indonesia are unevenly distributed, as is their genetic diversity. It is also been estimated that the diversity of sago as being higher in Papua than elsewhere in the country (Abbas 2018). Before 2000, the area of Sago reached 1.5 hectares, and 90% of its distribution was in Papua and West Papua (Jong and Widjono 2007). For instance, a result study from the South Sorong regency showed that the potential area of Sago reaches 311.5 thousand hectares and spreads over eight districts, whilst sago starch potential is approximately 2.9 million tons. The most expansive sago areas are located in the districts of Kais (63.8 thousand ha), Kokoda (61.3 thousand ha), Inanwatan (55.5 thousand ha), and Saefi (39.6 thousand ha) and northern Kokoda (34.5 thousand ha). The Sago tree density is 67 trees per ha. The estimation of sago production is about 9.7 tons per hectare (Haryanto et al. 2015).

With the enormous potential of Sago on the island of Papua, the existence of Sago should be a prospect or solution to the issue of food security on the island. According to Nurhemi et al. (2014), differences in farming culture and staple foods between regions also affect people's choices in agricultural commodities. The Food Security Agency has compiled a map of food security and insecurity in Indonesia, showing Java and Sumatra dominate the areas categorised as food secure (in green). In contrast, areas of food insecurity are showed in red areas (Papua and West Papua Provinces) (Fig. 1). It has been noted in mass media that food security has become one of the strategic issues for the two provinces in recent years, in addition to health and poverty issues. BBC News (2018) reported that the measles and malnutrition epidemic in Papua occurred not only in Asmat Regency but also in the Bintang Mountains area, which is 286 km from Agats, the capital of Asmat.

Meanwhile, the number of victims continues to increase. Nearly 100 people died in the two districts, primarily children. Other areas that have ever been reported as experiencing vulnerability are Yahukimo (Akbar 2019) and Maybrat Regencies (Wambrauw 2015; Larastiti 2020; Ola et al. 2021). With rice as a staple commodity in Indonesia, the provinces of Papua and West Papua are still facing the challenge of food insecurity. On the other hand, Sago has been listed as a commodity with the world's second-largest potential. With this condition, Sago should be a substitute for rice and can guarantee sustainable food security in Papua. A strategy to support sago sustainability is by placing indigenous people as the main players with environmental perspective as well as creators of added value in the sago industry (Firdaus and Wibowo 2020). This has been continuously developed although various obstacles faced by indigenous people (Sidiq et al. 2022). In fact, in West Papua Province sago has become the concern of the local government and in collaboration with NGOs opened special schools to learn how to cultivate and use sago. The EcoNusa Foundation, for example, is implementing a sago school which is part of a follow-up plan

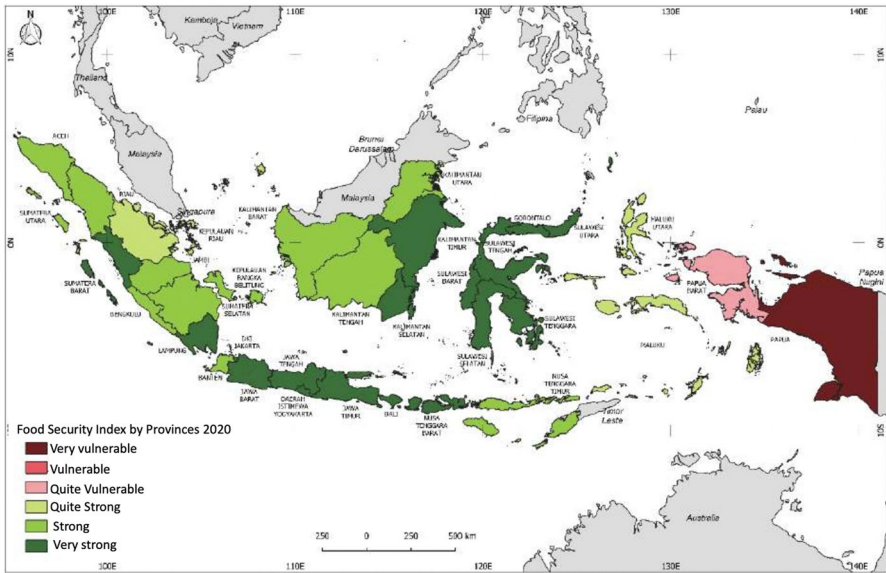


Fig. 1 Map of Indonesia’s Food Security Index, 2021; Source: Rozaki (2021)

designed by Social Transformation School (STS) participants in Mogatemin Village, Kais Darat District, South Sorong Regency, at the end of March 2022 (Putra 2022).

A strategy to open up the market is to impose a policy in which each civil servant in South Sorong regency would get Sago of 10 kg/month as an implementation of the use of local production for food security. This strategy is hoped to open up the economic activities in the region of South Sorong (Haryanto et al. 2015). In terms of industry, the commercialisation of sago products is still inadequate, and the sago industry is still at its earliest stage. However, the potential of sago plants is very diverse (Kusuma et al. 2013). In general, the potential of sago can contribute to the economy, social, environmental, and cultural aspects (Thahir et al. 2005; Firdaus and Wibowo 2020; Sidiq et al. 2022) and also can be used to increase the family income. Many studies have been conducted on using Sago as a food ingredient with various products, but not many sago products have been commercialised.

Recent studies have declared the influence of staple food prices over the price of rice in the North Sumatera. The demand for rice is also significantly handled by the price of rice, the population and GDP, but it was not affected by the price of corn-which is believed to be a rice substitution in some regions (Harahap 2020). Previously, a study has also determined that the demand for local rice is higher than its substitute. The increase in demand for it has been positively affected by its quality and quantity but negatively affected by the household size, household income, year of formal education and bid amount (Ajiboye et al. 2019). Regardless of other regions in Indonesia, Papua dan West Papua has multibackground citizens who differentiate its habits in the food consumption traditions from other citizens in other regions. This suggestion means that it is the rice not only usually eaten by residents but also some other staple foods known as Sago and

taro. According to BPS data, people in Papua province consumed 0.6 kg sago and 7.54 kg taro per month, whereas in West Papua province, people consumed 8.61 kg sago and 7.28 kg taro per capita per month (BPS Provinsi Papua 2021; BPS Provinsi Papua Barat 2021).

The food needs of a region will continue to increase along with the rate of population growth which follows a geometric progression. For this reason, ensuring the availability of staple food in an area is critical and indirectly supports human development through improving food quality and nutrition. However, another issue about what kind of staple food suits local habitants raised our awareness about the readiness stocks of rice and other local staple foods consumed daily by local society. There is no recent research about the position of this food in the ranking of staple foods. According to Jong and Widjono (2007), sago conservation efforts have been carried out to ensure the sustainability of Sago and the people who cultivate it. Yet, it is a matter of lack of partnership efforts compared to the partnerships created for rice sustainability. Some people believe that rice is the only staple food for all regions and citizens in Indonesia, but others argue that local food should be in the top ranking of staple food in that region. Factors that affect the elasticity of demand include prices, prices of other goods, tastes, incomes, and seasons.

Past studies about demand and its elasticity for staple food were done (Kuntjoro 1982; Suriani et al. 2018; Arifin et al. 2019; Fitriah et al. 2020). Results of this study stated that income elasticity is directly proportional to the quantity and quality of rice. In addition, its finding shows that the demand for rice outside Java is higher than the average production level. Thus, a more intensive distribution system is needed from rice surplus to non-surplus areas. The question that then arises from the results of this research is what about the consumption of essential ingredients other than rice, and how is the elasticity?

The government of Indonesia has implemented Raskin (Beras Miskin) to overcome the poverty issue and, at the same time, target zero hunger in Indonesia. Some studies showed that rice for the poor (Raskin) or subsidised rice consumption on the food demands elasticity of poor households is significant. The result indicated that rice had the highest price coefficients, and income was spent on Raskin over the other goods in the poor household's total expenditure (Suriani et al. 2018). This study neglected the assumption that other goods can replace rice as its demand remains high. However, in some regions in Indonesia, residents consume rice for their primary daily consumption. For instance, people consume Sago and tubers besides rice on Papua Island. Consumption of these staple foods almost substitutes the demand for rice occasionally.

Furthermore, a study estimated that Sago stock will be sufficient to consume until 2044 without any conservation efforts (Thahir et al. 2005). This prediction indicates that sago trees will be extinct if Sago is frequently consumed. On the other hand, the elasticity of demand over Sago on this island has limited numbers. Therefore, this paper answers whether Sago acts as a complement or substitution product for staple food, i.e., rice in Papua, and this is also the hypothesis of this study. The issue about rice and Sago supports the hypothesis that Sago has been consumed widely for long periods but might not be enough to substitute for rice.

## Research methods

Using secondary data from SUSENAS data in 2014 and 2018, this study analyses the demand for rice. Both of these time periods are still relevant to this research because the consumption patterns of the Indonesian people have not changed in the long run, where rice is still the staple food (BPS-Statistics Indonesia 2010, 2022; Arifin 2018; Saliem et al. 2019). It runs a regression model to answer the research question about the elasticity of sago. SUSENAS is one of the surveys conducted by the Central Bureau of Statistics (Badan Pusat Statistik/BPS) to collect socio-economic data on a relatively large population in the community. This survey is conducted twice a year, in March and September, and this research has used Susenas data in March, which had a larger sample size than in September. This study uses data on households living in Papua and West Papua Provinces. A sample of this study is 133,104 households taken from SUSENAS data. Demand for rice is affected by its price, sago price, and income. Therefore, this study considers the current issue that Sago has a negative position in the demand equation for rice. This research is quantitative, which is used to show the effect of the independent variable on the dependent variable, namely the demand for Sago.

The method used to answer the purpose of this research is ordinary least square (OLS), with the following equation specifications:

$$\ln Qd_i = \alpha + \beta \ln P_i + \gamma I_i + e_i, \quad (1)$$

where  $Qd$  is demand for rice commodity,  $P$  is rice price, and  $I$  is income. Notation  $i$  represents household. The coefficient  $\beta$  is demand elasticity for rice. The model in Eq. (1) is modified to see whether Sago is a substitute or complementary good, as follows:

$$\ln Qd_i = \alpha + \beta \ln P_i + \delta Psago_i + \gamma I_i + e_i, \quad (2)$$

where a sign  $Psago$  is the sago price. The coefficient  $\delta$  represents the cross-price elasticity of Sago and rice. If  $\delta$  is positive, Sago is a substitute for rice, and if that coefficient is negative, Sago is complementary good for rice.

## Results and discussion

### Statistic description

Table 1 shows that household income in the provinces of Papua and West Papua tends to increase in the two observation periods (2014 and 2018). The increase in income was not accompanied by an increase in the average consumption of rice and sago commodities. The amount US\$ 83,60 or 38.52% was an average increase in household income. In contrast, rice consumption decreased by 0.86 kg per month and sago by 1.77 kg per month. The consumption pattern of people who tend to like fast food is one of the factors that cause a decrease in household consumption of

**Table 1** Statistic description of Susenas data, 2014

Variables (1)	Mean (2)	Standard deviation (3)	Minimum (4)	Maximum (5)
Income per month	217.07	295.61	20.89	5,176.00
Rice consumption (kg)	5.36	3.67	0.33	54.74
Rice expenditure (per month)	3.60	2.54	0.21	43.79
Sago consumption (kg)	7.40	6.64	0.50	139.78
Sago expenditure (per month)	1.64	1.44	0.12	26.90
Price of rice (per kg)	0.67	0.07	0.53	0.86
Price of sago (per kg)	0.22	0.02	0.16	0.26

Number of observations 133,104 households in Papua and West Papua Province; 1US\$ = IDR14,500

staple foods (rice and sago) in Papua and West Papua Province. However, monthly expenditure from households increased by US\$ 0.49 for rice and sago commodities by US\$ 0.12. This increase was caused by an increase in prices, where the price of rice increased by 28.58% and 43.05% for sago commodities within four years (2014–2018). The percentage in the text has been calculated from the price of rice and sago data in Tables 1 and 2.

## Estimation and discussion

The estimation results in Table 3 show that there are different conditions for the own price elasticity aspect of the rice commodity in the provinces of Papua and West Papua at the two-time points of observation. In 2014, the price elasticity for rice commodities showed a negative value, meaning that increasing rice prices would impact a decrease in rice demand. Rice commodity is classified as inelastic because it has a price elasticity of less than one but greater than zero ( $0 < e < 1$ ). This result means that households are less sensitive to changes in the price of rice commodities because rice is the staple food of most people in the provinces of Papua and West Papua. Meanwhile, in 2018, the own price elasticity value of the rice commodity

**Table 2** Statistic description of Susenas data, 2018

Variables (1)	Mean (2)	Standard deviation (3)	Minimum (4)	Maximum (5)
Income per month	300.67	267.71	29.61	2,686.46
Rice consumption (kg)	4.50	3.67	0.32	42.04
Rice expenditure (per month)	3.89	3.18	0.28	35.17
Sago consumption (kg)	5.63	6.10	0.20	108.08
Sago expenditure (per month)	1.77	1.90	0.07	34.14
Price of rice (per kg)	0.86	0.01	0.81	0.93
Price of sago (per kg)	0.32	0.03	0.22	0.37

Number of observations 162,285 households in Papua and West Papua Province; 1US\$ = IDR14,500



**Table 3** Results for price elasticity, cross price elasticity, income elasticity

Variables	Demand for rice (Susenas, 2014)		Demand for rice (Susenas, 2018)	
	ln Demand	ln Demand	ln Demand	ln Demand
(1)	(2)	(3)	(4)	(5)
ln price of rice	-0.828*** (0.014)	-0.831*** (0.014)	1.323*** (0.085)	1.581*** (0.086)
ln price of sago		0.186*** (0.014)		0.190*** (0.017)
ln income	0.501*** (0.003)	0.505*** (0.003)	0.634*** (0.002)	0.628*** (0.002)
Constant	1.733*** (0.126)	0.204 (0.174)	-20.764*** (0.801)	-24.703*** (0.845)
Observations	133,104	133,104	162,285	162,285
R-squared	0.262	0.264	0.384	0.385

Robust standard errors in parentheses

\*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$

was positive, meaning that an increase in rice prices would impact increasing rice demand. Rice commodity in this period has its price elasticity value greater than one or elastic. This result means that households are very responsive to price changes and will respond to a 1% price increase by increasing their consumption by 1.321–1.581 per cent. The two conditions at this point further emphasise that rice is the staple food for households in Papua and West Papua provinces.

Cross-price elasticity can be used to see whether goods can be categorised as complementary or substitute goods. The observations in two periods (2014 and 2018) on rice and sago commodities show the same pattern. The two observation points indicate that Sago is a substitute for rice. This result can be seen from the positive cross-price elasticity value ( $e > 0$ ). This result means that an increase in the price of Sago will increase the demand for rice. The estimation results show that an increase in the price of Sago 1% will increase the demand for rice by 0.186 per cent in 2014 and 0.190 per cent in 2018.

The threat of food shortages which is very real in the future, both due to epidemics and climate change, should be overcome by utilising the very high potential of Sago as food. Weather conditions significantly impact agricultural production, affect water availability, disrupt water systems and watersheds, and cause social problems (Wario et al. 2012). This threat will have an impact on future food supplies that are not safe (Immerzeel et al. 2010). Thus, it is necessary to look for alternative food ingredients, one of which is Sago. Sago is one of the food crops inherited from the nation's ancestors, which is relatively undisturbed by climate change due to its specific nature and growing conditions.

Sago has not yet entered into the staple food politics regulated by the central and local (province and regency/city) governments. Local governments have mobilised the use of Sago sporadically due to budget constraints to build infrastructure and logistics on encouraging sago-based industries' growth. Several local governments in the provinces of Papua and West Papua have issued regulations related to using Sago as the primary commodity in every event organised by the government. This

condition needs to be continued to increase public consumption, and an institutional system is needed that is strengthened by various regulations (Bantacut 2008).

Food self-sufficiency is the priority government program through the Ministry of Agriculture, which relies on rice and corn for the following reasons: the basic food needs of the majority of the community, its availability is fast (seasonal plants), and the production/stock of many upstream–downstream technologies is adequate. The Food Self-Sufficiency Program until 2045 does not rely on re-diversification (back to local food diversity) to fulfil the number and strengthen food security. Re-diversification is only a minor program in overall development. The massive use of local food such as sorghum, cassava, corn, and Sago is not reflected in the volume of activities and financing. Until 2020, the average availability of sago flour is 1.34 kg/capita/year. The limited use of sago flour shows that Sago is insufficient as a staple food in Indonesia. Therefore, the government is essential in developing Sago as a staple food commodity through budgetary politics in upstream and downstream sectors.

## Conclusions

The results show that Sago is a substitution product for rice. Thus, food security in Papua and West Papua provinces will be better if it is supported by policies that support Sago as a substitution besides its function as local food. From the results of this study, several strategies are recommended in the form of planning and budgeting politics related to Sago as local food. Second, local governments in the provinces of Papua and West Papua need to establish particular food security institutions for Sago. Lastly, infrastructure development is highly needed to support Sago as a local staple food.

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**Author contributions** YPR: introduction, research methods, analysis of results, interpretations, discussions, conclusions, citations, references and Mendeley, additional materials for submission, submission process, correspondence. AGA: analysis from SUSENAS data, analysis methods, analysis data, results analysis,

Interpretations. UY: literature reviews and theory, results analysis. ERS: literature reviews, article reviews, results analysis.

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**Availability of data and materials** The datasets generated and/or analysed during the current study are available in the Bureau Statistics of Indonesia under the SUSENAS repository.

## Declarations

**Conflict of interest** On behalf of all authors, the corresponding author states that there is no conflict of interest.

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