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The Household Food Insecurity Amidst the Covid-19 Pandemic in Indonesia

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Abstract

The Coronavirus Disease 2019 (Covid-19) pandemic creates both the demand and supply shocks problem that may affect the households' food insecurity. Among mechanisms, it ranges from the limited physical access to food due to social distancing to the drop in economic access to food due to (partial) lockdown. This study aims to lay out an early warning assessment of the food security situation in Indonesia amidst the Covid-19 outbreak. We use the cartogram analysis which visualize the geographical features throughout the Indonesia archipelago, both in the small and big island setting. The analysis involves the use of both the simple score and latent measurement-based scale of the Rasch model for the food insecurity based on the Susenas data from 2017-2019. The finding reveals that there existed a variation of the household proportion that suffers from severe food insecurity across the Indonesia archipelago. The more eastern the island, the worse the measure is. Papua and Maluku suffer more from such condition compared to the other big islands. As the government has applied any containment measures, the surge in Covid-19 cases may potentially worsen both the existing households under severe food insecurity and even create new households under such conditions.

Key words : Food Insecurity Experience Scale, Cartogram, Rasch Model, Indonesia Archipelago, Covid-19 Pandemic.

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INTRODUCTION

Since the Coronavirus Disease 2019 (Covid-19) outbreak had penetrated Indonesia in March 2020, the outbreak has created some shocks on human beings' behaviours concerning food insecurity. The shocks originated from natural responses to limit social interaction and containment measures by the government, such as the Government of Indonesia applying social and physical distancing, namely *Pembatasan Sosial Berskala Besar* (The Worldbank, 2020). This study aims to do an early warning assessment of the food insecurity situation during the pandemic. We use the cartogram visualization of the relatively new measure of food security throughout the Indonesia archipelago in the small and big island setting to identify where the households are experiencing severe food insecurity based on the pre-Covid-19 condition.

Food insecurity became one of the challenges to be alleviated according to the second goal indicator of Sustainable Development Goals (SDGs) to end all of the forms of hunger and ensure access by all people, in particular the poor people in the vulnerable situation including infants, to safe, nutritious, and sufficient food all year round by 2030 (UNDP & UNEP, 2015). Several countries have adopted a new rapid tool to provide the information by asking directly about households' experience regarding food insecurity, namely the food insecurity experience scale (FIES) for their national purposes (Cafiero et al., 2018). Nowadays, a global version is developed for international use and comparable among countries of the FIES.

The FIES is a most recent broadened concept of food insecurity considering anxiety to food access, while the first introduction to the food security concept regarding sufficient food production to support the population more than two decades ago (Sen, 1981). The concept is then further broadened to account for whether the availability, access, and utilization of food are stable over time (FAO, 1996).

The FIES is a global metric of the severity of food insecurity at the household level, which relies on eight questions regarding food access. The dichotomous response of the eight questions is enough to construct a latent measure using the Rasch model. The households' food insecurity experience is addressed, ranging from the severity of worry to the food access until the severity of skipping the food for a whole day with the constraint of money. According to the BPS-Statistics Indonesia survey, the prevalence of population categorized suffering from moderate and severe FIES in Indonesia is about 8.66% in 2017 and 6.86% in 2018 as categorized by Maitra & Rao (2017).

There are plenty of recent studies on food insecurity in the context of developing and developed countries. On the small island setting of such a developing country like Indonesia, food insecurity has existed through the households in the Kei island, Maluku. The small island communities are prone to fall under food insecurity conditions as the households rely on weather variation in performing their main income source on artisanal fisheries (Nasrudin et al., 2019). Food insecurity also persistently existed in the outer islands of Sumatera, many moved out from poverty, but the food insecurity measures continue (McCarthy, 2019).

In urban and rural areas, there existed some increasing trends of the self-reported experiential food insecurity measure in the last twelve months at the national, urban, and rural level in Malawi. The result is also consistent with the duration number of months of the households that experienced such food insecurity, the duration in the rural area last longer than in the urban area (Jolliffe, Seff, & de la Fuente, 2018). Still, in the same continent, the

households living under deforestation experienced food insecurity in Cameroon. More than half of the households suffered from moderate food insecurity. At least one-third of households reported severe food insecurity at all levels of deforestation primarily due to the lack of resources (Ngome, et al., 2019).

The food insecurity prevalence existed in developing countries and developed countries like the USA. The prevalence of households experienced food insecurity is around 10% across the Northwest, Midwest, South, and West area of the USA, including the capital of Washington DC. The disparities resulting in the inequities of food insecurity measures become a persistent problem in the USA (Gregory & Coleman-jensen, 2013; O'Hara & Toussaint, 2021).

Reporting the continuum severity is important as many studies reported that a curvilinear relationship existed between the food insecurity level, the diverse physical and mental health outcomes, and early childhood development indicators (Pakravan-Charvadeh, et al., 2021). The severity of food insecurity may also serve as exposure to another social and economic measure. Using the food insecurity level as the continuum severity measure to rank households' food insecurity, the food insecurity level of moderate and severe become such a determinant to perform any migration intention of individuals specifically to the low and middle-income cohort across 153 countries (Smith & Floro, 2020; Perez-Escamilla, Vilar-Compte, & Gaitan-Rossi, 2020).

The Covid-19 outbreak has affected almost every single life activity of human beings, including the social distancing conducted by the Government to control the population movement to reduce the virus spread. Many recent studies both in panel and cross-section conducted to evaluate the outbreak as any containment measures applied have caused such limitation to food access across countries in the world. Abdul Latif Jameel Poverty Action Lab (J-PAL) Southeast Asia and partners have been surveying the 500 respondents followed weekly regarding their food insecurity outcome since late March 2020 as this Covid-19 penetrated Indonesia. The survey reported that as of week 14, food insecurity remains high. There is only 19% of households reported eating food as much as they are to eat in the last week, with 38% among households who ate less reported that they ate less than they should often due to financial constraints (Hanna, Olken, & J-PAL Southeast Asia, 2020).

The World Bank's recent study of the 4,000 samples of households spread over Indonesia concluded that 54% of households stopped working because of business closure to Covid-19 legal restrictions. Furthermore, the highest incidences of food insecurity are amongst the poorest, 37% experienced a shortage of foods, and 43% ate less. The households outside Java are more likely to suffer food insecurity (The World Bank, 2020). However, evaluating the Covid-19 impact on food insecurity is important. The social distancing that emerged may worsen the food insecurity measures.

Meanwhile, the population in the US experienced rising food insufficiency amid the Covid-19 as the consequence of holding any containment measures, including stay-at-home orders, changes in consumer demand, school closures, and rising unemployment (Nagata, et al., 2021). The same condition is also experienced by the population in India, of which the hunger statistics are the poorest in the world, the bad experience of food insecurity that may exacerbate the undernourishment

measure has existed even far away from the Covid-19 pandemic (Mishra & Rampal, 2020).

There are several solutions offered in alleviating the adverse impact of this Covid-19 pandemic. As best practice applied in Tehran to support the vulnerable population, the food-based intervention program needed to support the population dietary needs improvement, besides the good medical care and safety net program (Pakravan-Charvadeh, et al., 2021). However, addressing the policymaking regarding the Covid-19 impact is not that easy. Many considerations and rapid studies would be needed. Evaluating the Covid-19 impact on food insecurity through the severity levels is important. Tracking and reporting the food insecurity level as the continuum severity amongst the households may describe the economic shocks and global health emergencies during the Covid-19 pandemic at the regional level.

The main contribution of this study is to assess whether Indonesia's pre-Covid-19 food insecurity by geographical nature coincides or not toward the epicentre of the current pandemic. By doing so, we aim to assure whether the early warning concerning the potential implication of the pandemic on food insecurity presents or does not. The organization of the article is as follows. The following section explains the research method. Then it is followed by a section on results and discussion. The last section provides the conclusion and implication of the study findings.

METHOD

The basic idea of measuring the experiential measure regarding food insecurity is globally adapted from the widely-used experience-based food security scale, i.e. the Latin American and Caribbean Food Security Scale (Spanish acronym ELCSA), which origins derive from the US Household Food Security Survey Module (HFSSM), the Brazilian Food Insecurity Scale, and a similar scale adapted for Colombia. Based on these ideas and purposes, a global version is developed for international use and comparable among countries, namely Food Insecurity Experience Scale (FIES).

Table 1. Food Insecurity Experience Scale Module of Household Questions Reference Adopted by *Susenas*

During the last 12 MONTHS, was there a time when:	
Q1. You or others in your household worried about not having enough food to eat because of a lack of money or other resources?	0 No 1 Yes 98 Don't Know 99 Refused
Q2. Still thinking about the last 12 MONTHS, was there a time when you or others in your household were unable to eat healthy and nutritious food because of a lack of money or other resources?	0 No 1 Yes 98 Don't Know 99 Refused
Q3. Was there a time when you or others in your household ate only a few kinds of foods because of a lack of money or other resources?	0 No 1 Yes 98 Don't Know 99 Refused
Q4. Was there a time when you or others in your household had to skip a meal because there was not enough money or other resources to get food?	0 No 1 Yes 98 Don't Know 99 Refused
Q5. Still thinking about the last 12 MONTHS, was there a time when you or others in your household ate less than you thought you should because of a lack of money or other resources?	0 No 1 Yes 98 Don't Know 99 Refused
Q6. Was there a time when your household ran out of food because of a lack of money or other resources?	0 No 1 Yes 98 Don't Know 99 Refused
Q7. Was there a time when you or others in your household were hungry but did not eat because there was not enough money or other resources for food?	0 No 1 Yes 98 Don't Know 99 Refused
Q8. Was there a time when you or others in your household went without eating for a whole day because of a lack of money or other resources?	0 No 1 Yes 98 Don't Know 99 Refused

Source: FAO.org

The data of FIES used in this research are coming from the *Survei Sosial Ekonomi Nasional* (Susenas) survey module conducted by the BPS-Statistics Indonesia from 2017 – 2019. The FIES consists of eight short dichotomous (yes/no) item of questions which focused on self-reported, food-related behaviours, and experiences associated with increasing difficulties in accessing food due to resource constraints (see Table 1). The questions are designed in a sequence to capture the severity level of the hunger experience, which hypothetically has some stages. The aggregation of the responses (the sum of affirmation in Table 1) into a scale uses two approaches: a simple sum of the raw score and a Rasch scale. The simple sum approach puts the same weight on each question and does not consider the order of severity. On the contrary, the Rasch scale weights (W_n) each question based on its difficulty level (Nasrudin et al., 2020). The Rasch scale serves as a calibration method for the raw scale in which each response item is triangulated against the answer of similar respected individuals in the sample (see Appendix 3 for the validity check).

Maitra and Rao (2017) classified the food insecurity status based on the cut-offs corresponding raw score status over the item of questions on FIES of three, five, and seven, respectively. The four categories are known as high food secure (0≤ raw score <3), marginally food secure (3≤ raw score <5), moderately food insecure (5≤ raw score <7), and severely food insecure (raw score ≥7). The higher the raw score is, the higher the severity of food insecurity outcome.

The approach in analyzing the FIES data comes from Item Response Theory (IRT), a comprehensive method that permits the measurement of unobservable traits by analyzing responses to a survey. The FIES score would be rescaled using the Rasch Model, which assuming the invariance of latent traits so that the new scores could be compared among the households. A simple sum of the score over the FIES means that each item has the same weight over the item of questions. Meanwhile, the latent traits exist among the households in response to each severity of difficulty of the item on FIES, each response of item should not have the same weight. The specific IRT model applied to FIES data is the Rasch Model, which assumes invariance over the latent traits of households such as the respondents' intelligence.

Molenaar (1995) defines IRT specifying the Rasch Model as the estimator of limited dependent variable of:

$$\Pr(X_{nj} = x_{nj}|\theta_n, \delta_j) = \frac{\exp\left(x_{nj}(\theta_n - \delta_j)\right)}{1 + \exp\left(\theta_n - \delta_j\right)} \quad (1)$$

An application of the model to the measurement of food insecurity severity interprets the θ_n parameters as a measure reflecting the severity associated with the experience captured by the different questions and the δ_j parameters as the measure of the level of food insecurity experienced by household n. X_{nj} is a random variable representing the response of the nth household (n = 1,..., N) to the j-th item (j = 1,..., J), x_{nj} is the realization of response for each item of a household. In sum, the following equation (2) and (3) formulate the raw and Rasch score, respectively.

$$RAW_n = \sum X_{nj} \quad (2)$$

$$Rasch_n = \sum W_n(\theta_n, \delta_j) \cdot X_{nj} \quad (3)$$

Moreover, to ensure the reliability of the agregation, first, we identify missing data in the dataset. It is also known that a self-reported survey is very subject to memory recall, misunderstanding, and social and economic

desirability bias (Nord, 2014; Tadesse, Abate, & Zewdie, 2020; Althubaiti, 2016). We utilize a standard approach in dealing with missing data in FIES calculation using the Rasch approach.

The missing responses are imputed with the approach such that individuals with similar traits would answer a similar response in the particular item that is missing. It is analyzed with FIES score as a continuum variable of the eight items of questions. The *imputation* utilizes the command of imputerasch in Stata 16 at the province level. The imputation at the district level is not reliable due to sample number adequacy. The main feature of the imputation is modelling the complete data of every single province in Indonesia using the Rasch model, which is then used to predict/ impute the missing data (Nasrudin, et al., 2020).

RESULTS AND DISCUSSION

The FIES is measured at the household level and aggregated to the regional level as proportion measure. Table 2 shows the percentages of missing items at the household level for each FIES items through the period of 2017-2019. The magnitudes are still under 1%, suggesting that the non-response issue in the Susenas FIES is negligible.

Table 2. The Percentage of Missing Item Response on FIES, 2017-2019 (%)

Item of FIES	2017	2018	2019
FIES Item 1	0.642	0.381	0.365
FIES Item 2	0.895	0.439	0.515
FIES Item 3	0.606	0.338	0.308
FIES Item 4	0.573	0.298	0.289
FIES Item 5	0.621	0.316	0.310
FIES Item 6	0.557	0.280	0.253
FIES Item 7	0.579	0.291	0.270
FIES Item 8	0.480	0.232	0.231

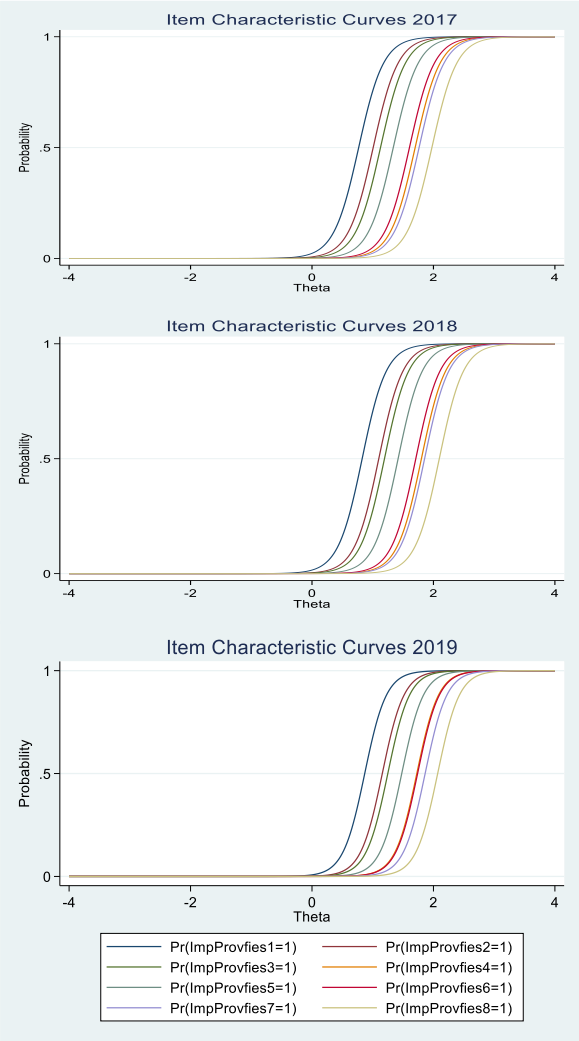
Source: Susenas, processed using Stata 16

One of the post analyses resulting from the Rasch model is the Item Characteristic Curves (ICC). The ICC is used to identify the value of the determination coefficient, measuring the relationship between affirming each item in the FIES questionnaire and the latent measure of food insecurity level. Figure 1 shows that the ICCs behave as expected in which the probability of affirming each item increases with the value of the latent measure. The pattern is consistent across the three periods of the survey years. And each of ICC tends to move to the right along the continuum value of θ (theta) by years suggesting the improvement of food security in Indonesia.

The ICC also addresses the difficulty level of each item of FIES, given the respondents' ability to answer the associated item. The difficulty level of each item is identified based on the item's position in the curves. According to Figure 1, most of the question's difficulty level follow the order of the questions being asked in Susenas. This means that their position in the ICC correctly indicates each item's difficulty level to affirm from the easiest one to the most hardly affirmed one over the whole FIES questionnaire. The order of the questions well captured the stages of food insecurity severity.

The order of items is on the ICC figure consistent for all years of 2017-2019. The easiest item is the first item located in the left at the ICC figure which addresses whether the household personals are worried about not having enough food to eat for the last 12 months on the constraints of money lacking or other resources. The most difficult item in the FIES is the last item in the questionnaire located in the right at the ICC figure addressing whether the household personals is skipping eating for a whole day.

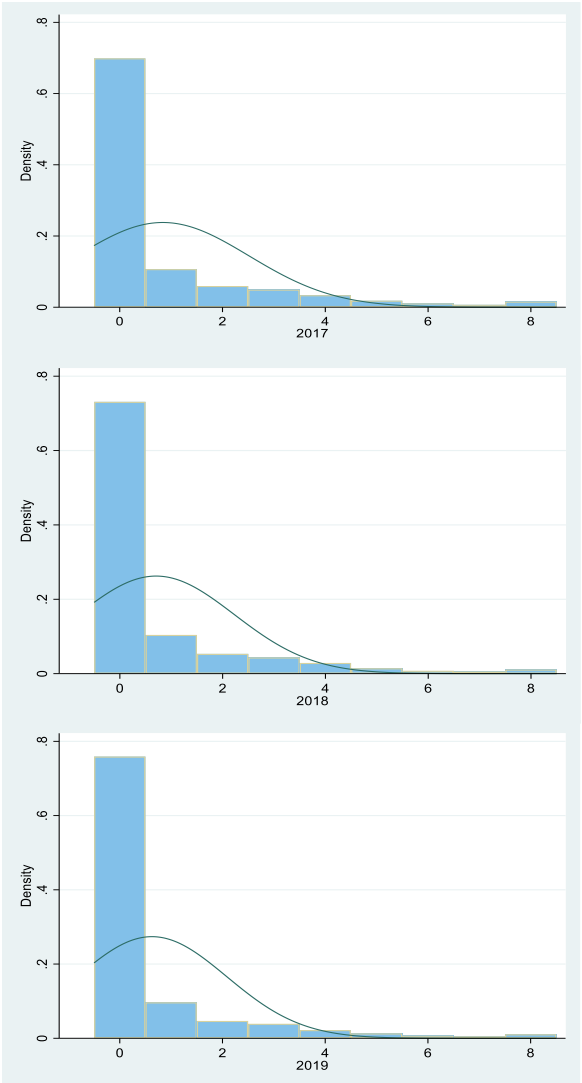
Figure 1. Item Characteristic Curves (ICC) at Indonesia level, 2017-2019



Source: Susenas Data 2017-2019 (processed using Stata 16)

As the FIES questionnaire comprises eight items of questions, it is important to plot the data distribution of each item to understand the composition of the item responses. The histogram of the raw scores in Figure 2 describes dominating value of zero score, which means that most households affirmed "No" to all items on the FIES questionnaire. This result is consistent to the histogram of the raw score over the year of 2017-2019. The distribution indicates that most households reported their states in the food-secure condition. Last, the response valued above 0 means that the households are experiencing food insecurity. It ranges from anxiety to running out of food for the past twelve months. Yet, their shares in the distribution are low. Moreover, over years, we see improvement in the value of zero score that indicates improvement in food security in Indonesia. This pattern is consistent with the result of ICC shifts by year in Figure 1.

Figure 2. Histogram of Raw Score by Year, 2017-2019



Source: Susenas 2017-2019 (processed using Stata16)

Based on the cartogram of Figure 3, there existed such variation of household food insecurity measures across Indonesia's archipelago. The particular measure used in this research is the proportion of households with severe food insecurity. It is defined as the condition of households whose simple sum of the raw score is 7 or 8, as classified by Maitra and Rao (2017). This classification captures the households that experienced hungry and skipping eating for the last 12 months of the survey period. The five quintile legend of the first cartogram highlights the systematically different levels of severe food insecurity across islands. The severe food insecurity measure is ranging from 0.83% to 4.69% of household are severely food insecure. Java and non-Java island contrast strikes. All of Sumatra, Kalimantan, Sulawesi, Maluku, and Papua are more severe regarding their food insecurity compared to Java island.

The most severe islands regarding their food insecurity are dominated by the eastern area comprising Papua and Maluku with their magnitude of 4.69% and 4.44% of the household population. On the contrary, the other islands' magnitudes are all under 1.6% of the population comprising of Sumatera, Java, Sulawesi, Bali, and Nusa Tenggara. To sum up, the proportion of the household population under severe food insecurity conditions in Maluku or Papua is about four times compared to Java.

Figure 3. The Cartogram of Proportion Household with Severe Food Insecurity by Island across Indonesia Archipelago, 2019

Source: Susenas data processed using Arcgis 10

The Figure 3 describes cartogram of the eastern and the western food insecurity gap emerged by some factors on the demand or the supply side. In the archipelagic setting, the supply side of food in the eastern area maybe not as good as in the western area. Considering that most food is produced in Java, distributing the food to the eastern area is costly. This factor may affect the population in Maluku and Papua on the demand side that they cannot afford enough food for a living.

The population in Java captures each item more toward the lack of money or other resources than outside Java. Meanwhile, the figure 4 shows cartogram of the district level (Kabupaten/Kota) of the thematic map containing the severe food insecurity variation in the archipelago across all Indonesia's districts. Since the severe food insecurity measures range from 0 to 0.336% of household

living in such condition. The darker the bluish colour indicates more households under severe food insecurity in the associated district. We observe that the food insecurity situation is worst in two types of geographical set-up: landlocked and remote/isolated small islands. Based on the cartogram colour degradation, the district experienced such severe food insecurity over the mean value almost existed in each island and are prominently located in Papua, Maluku, and Kalimantan. The Kabupaten Puncak Jaya is the highest district of which the proportion of households under severe food insecurity is about 33.35% of the population or equivalent to 10,934 households. As its location is one of the extreme highlands in Papua, it might be hard and costly to access the food and its distribution.

Figure 4. The Cartogram of Proportion Household with Severe Food Insecurity by District Level across Indonesia Archipelago, 2019

Source: Susenas data processed using Arcgis 10

The population in Java captures each item more toward the lack of money or other resources than outside Java. Meanwhile, the figure 4 shows cartogram of the district level (Kabupaten/Kota) of the thematic map containing the severe food insecurity variation in the archipelago across all Indonesia's districts. Since the severe food insecurity measures range from 0 to 0.336% of household living in such condition. The darker the bluish colour indicates more households under severe food insecurity in the associated district. We observe that the food insecurity situation is worst in two types of geographical set-up: landlocked and remote/ isolated small islands. Based on the cartogram colour degradation, the district experienced such severe food insecurity over the mean value almost existed in each island and are prominently located in Papua, Maluku, and Kalimantan. The Kabupaten Puncak Jaya is the highest district of which the proportion of households under severe food insecurity is about 33.35%t of the population or equivalent to 10,934 households. As its location is one of the extreme highlands in Papua, it might be hard and costly to access the food and its distribution.

Meanwhile, the district under mild food insecurity with a proportion of severe food insecurity households below its mean value is dominated in Sumatera, Java, Central Kalimantan, and Sulawesi. The districts of which a low proportion of households under

severe food insecurity on that islands are spatially distributed.

Many small islands in Indonesia distributed from the western to eastern and south to the north. Besides the big islands of Indonesia, some outer Islands over the Indonesian archipelago need to be considered. It might hard to access some highlands within the islands in Indonesia, but it's also hard to access such outer islands that are dominantly located in the remote area from east to west Indonesia. Some specific ships might need to pass the sea to access them. Starting from the outer island of Sumatera, namely Sabang Island, the proportion of households under severe food insecurity is about 0.26% of the population or equivalent to 24 households. This measure might be just a little compared to Mentawai Island in west Sumatera, of which 1,719 households and Nias Island have about 7,664 households under such a situation. Moreover, as one province separated by the sea from the big Island of Sumatera, Riau islands have two districts of which proportion of households under severe food insecurity over the national mean value comprising of the Batam city and Bintan island.

The outer islands in the eastern area of Indonesia also need to be concerned compared to the western area as it might be harder to access. The Morotai Island, located in the northern of Maluku, serves as the highest proportion of households under severe food insecurity in the eastern area of Indonesia. The measure is about 9.37% or equivalent to 1,355 households in 2019. Compared to the neighbouring islands, the Sangihe and Talaud Islands, comprising three districts located in the northern of Morotai Island, are still lower in their severe food insecurity measure. The corresponding measure is about 1%. The Miangas island, as a part of the Talaud islands, which is familiarly called the northern island of Indonesia and neighbouring to the Philippines, also suffers from severe food insecurity. Still, the measure is lower than some near districts on the big island of Sulawesi.

As Indonesia serves as an archipelagic country dominated by many small islands in the middle area, analyzing the islands located somewhere in between the big islands is also important. As an example, the Taliabu island is located somewhere between Maluku and Sulawesi. The proportion of households under severe food insecurity is about 6.67&, equal to 803 households in 2019. Compared to its neighbouring island, Banggai Island, the number of households suffers less, about 143 households. The same story goes to Tual Island, which is located between Papua and Maluku suffers more than Buru Island but less than Aru island. So, it tends to come to the fact that the closer the island to the eastern area, the more the proportion of households under severe food insecurity is.

The Seribu island is the closest continuum island to the metropolitan capital city of Indonesia-DKI Jakarta also suffers from severe food insecurity. The associated measure is about 5.85% of the population. The proportion is higher compared to the cities in Jakarta itself, which is about ten times. But in numbers, the households suffer such a condition that the Seribu island is consistently lower than the megacities of Jakarta as the proportion measure is relative to numbers of regional households.

The Rote Ndao district is the outer island of Indonesia in the south and is a neighbouring country-border to the Australian continent. Based on the survey, the district did not experience any severe or moderate food insecurity even. As the raw score range decreased to be under the score of 5, this district, unfortunately, suffers the marginal food insecurity. The proportion of the households under the condition is about 9.74%. The insightful plot and the explanation of the simple

raw score against its associated corrected measures using the Rasch method are prepared as in Appendix 3**.**

As of late December 2020, Indonesia reached 8,000 of the Covid-19 daily new cases distributed throughout 34 provinces as in Appendix 1 and the accumulated number of death as in Appendix 2. It becomes important to address the prevalence of Covid-19 infections related to the potential adverse effect on food insecurity among regions in Indonesia. We use the pre-Covid-19 situation as an early and rapid assessment of the potential effect. The assessment would serve as the baseline notice to the Government of Indonesia or the public to anticipate a deteriorating food insecurity situation. The main concerns are twofold. First, we want to know whether the pre-Covid-19 food insecurity concentrations coincide with the epicentre of the Covid-19 spread. If yes, the food insecurity vulnerability of those living in the epicentre of the pandemic needs attention. Secondly, even though it is no coincidence, we still want to calculate how many vulnerable households in the pandemic epicentre locations to stock, taking the potential number of any social safety net beneficiaries concerning food insecurity.

Java island is among the places in Indonesia to become the most affected by the spread of the Covid-19. Figure 5 is a cartogram containing the figures of Covid-19 prevalence and the associated number of households under severe food insecurity in each province. Based on the data, DKI Jakarta province is the highest prevalence of Covid-19, followed by East Java, West Java, and Central Java. Meanwhile, Yogyakarta is the lowest one among the six provinces in Java by late December 2020. These numbers differ as each local government adopt different containment measures and varying public awareness to implement health protocol in stopping the infection.

Figure 5. The Cartogram of Covid-19 Prevalence and the Households under Severe Food Insecurity by the Provinces in Java Island, 2019

Source: BPS-Statistics Indonesia and BNPB (processed using Arcgis 10)

Figure 5 suggests a mixed trajectory. While Jakarta province potentially has the largest number of infection cases among provinces in Java Island, its burden to have a vulnerable household with severe food insecurity is relatively low. On the other hand, the West Java Province, with a relatively low number of cases compared to Jakarta Province, has a considerably high number of households under severe food insecurity. With the second-highest of the number Covid-19 prevalence, the spread of the Covid-19 in this province may worsen the existing households under severe food insecurity conditions when tighter containment measure and social distancing is imposed.

The remaining two other provinces in third and fourth place concerning active cases are Central Java and East Java Province. Yet, these two provinces are also pocketing for households with severe food insecurity in the Island with a non-trivial number of households. A cautious food security program anticipating the worsening situation is crucially important in these four provinces whenever the negative income shocks and supply of food shock occurring. The full measures of this case are as prepared in Appendix 1.

Regions are currently having a small number of cases but potentially would have a high number of additional households with the severe food security of landlocked districts. Small island communities are extremely needed cautious attention to limit the spread to these places. Non-stoppable cases in these places imply that governments are forced to apply a tight containment measure to reduce the virus spread applied, which likely reduces both the physical and income access to the population's food and raises severe food insecurity at the end of the day.

Moreover, Indonesia has been struggling and controlling against the pandemic to reduce the potential socio-economic fallout, leading to food insecurity. Failing to control the pandemic would emerge the severely worsen following waves as recently experienced by India of which the daily new cases reaches 300 thousands of the Covid-19 infections. As the overcoming actions from the Government of Indonesia, millions of vaccination doses were used and expected to control the virus spread. The effort targets health workers and public-service workers who indicated as the vulnerable population to become the receptors. Nevertheless, the emerging new variant found in the United Kingdom may cause some uncertainty about the vaccination effectiveness in the upcoming months.

CONCLUSION

Such variation of households suffers from severe food insecurity in Indonesia as an archipelagic country both in the small and big island setting. The proportion of households under such conditions becomes worse when it comes to the eastern area compared to the western area. Maluku and Papua suffer more severe such conditions than Sumatera, Java, Kalimantan, and Sulawesi. In the context of the small island, the outer islands of Indonesia suffer from severe food insecurity. The small islands located somewhere in between the big islands also suffer such condition, the more eastern the island, the more severe the measure is.

The concentration of households with severe food insecurity partially coincides with active cases concentration, especially in some provinces in Java Island. In places where food insecurity is prone to small islands and landlocked places, yet cases are still low, the public needs to greatly reduce the spread to

these locations to limit the adverse effect of the pandemic on food insecurity.

Food insecurity becomes challenging as it related to the pandemic that the world is facing today. The measure would exist as the households undergo any containment measure such as social and physical distancing. The public policymaker should beware of the fastening Covid-19 spread that potentially worsen both existing households under severe food insecurity and create new households under such conditions. An unfortunate circumstance that reverse back the progress of food security improvement in the last three years.

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APPENDICES

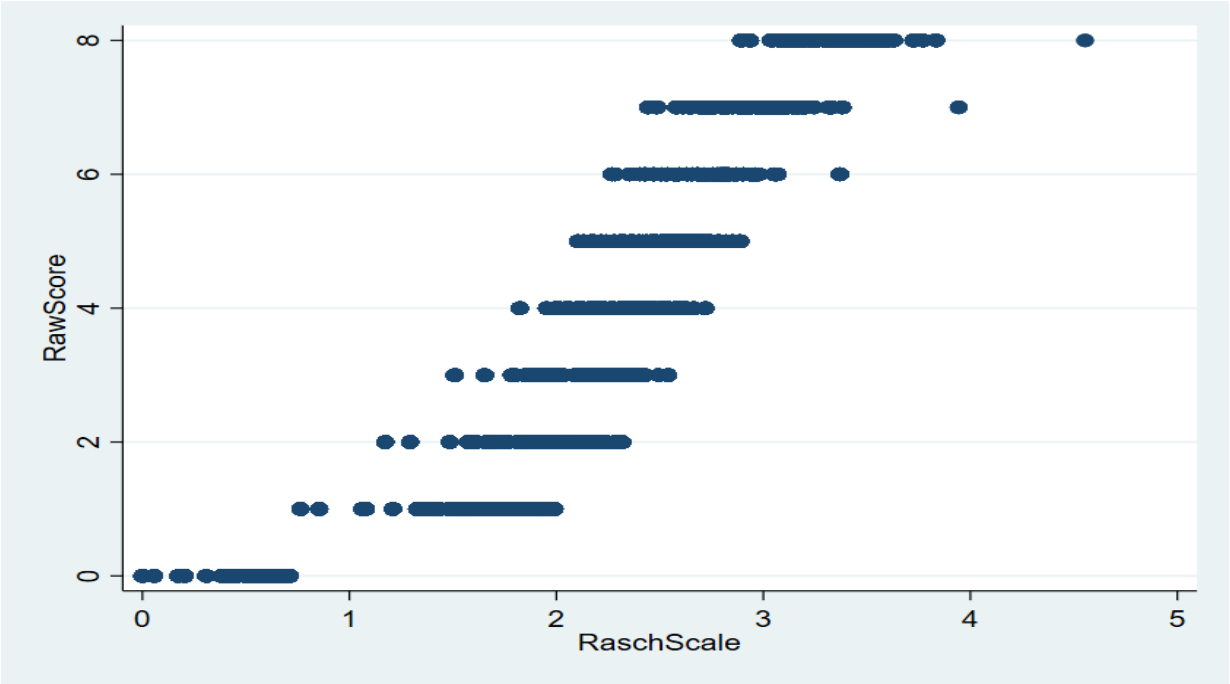
Appendix 1. The Number of the Covid-19 Prevalence Infections, Households Under Severe Food Insecurity, and Population, by Provinces

Index	Province	Household under Severe FIES	Covid-19 Prevalence (per late Dec 2020)	Population (Per 2019)
1	Aceh	15,070	8,727	5348846
2	Sumatera Utara	50,944	17,892	14,525,652
3	Sumatera Barat	17,268	23,139	5,426,368
4	Riau	32,823	24,599	6,932,217
5	Jambi	12,613	3,127	3,610,933
6	Sumatera Selatan	24,120	11,540	8,445,499
7	Bengkulu	3,895	3,474	1,984,670
8	Lampung	33,462	6,015	8,428,378
9	Bangka Belitung Island	2,139	2,138	1,481,512
10	Riau Island	13,810	6,911	2,176,252
11	DKI Jakarta	16,327	177,604	10,535,216
12	West Java	233,342	79,992	49,157,861
13	Central Java	90,049	78,770	34,661,301
14	DI Yogyakarta	10,317	11,320	3,832,887
15	East Java	94,830	81,512	39,649,219
16	Banten	64,203	17,608	12,867,536
17	Bali	12,510	17,045	4,325,697
18	West Nusa Tenggara	21,598	5,532	5,056,163
19	East Nusa Tenggara	319	2,058	5,434,920
20	West Kalimantan	17,741	3,056	5,052,188
21	Central Kalimatan	9,026	9,542	2,701,098
22	South Kalimantan	9,252	15,102	4,228,672
23	East Kalimantan	15,251	26,079	3,703,164
24	North Kalimantan	2,677	3,518	735,694
25	North Sulawesi	13,586	9,493	2,501,322
26	Central Sulawesi	17,106	3,107	3,043,095
27	South Sulawesi	29,383	29,462	8,831,377
28	Southeast Sulawesi	5,736	7,791	2,691,882
29	Gorontalo	2,268	3,676	1,198,326
30	West Sulawesi	4,779	1,877	1,374,042
31	Maluku	12,360	5,683	1,795,568
32	North Maluku	16,944	2,748	1,249,949
33	West Papua	8,403	13,084	954,032
34	Papua	43,964	5,936	3,365,026
	Total	958,141	719,148	267,306,562

Appendix 2. The Cartogram of the Confirmed Daily New Cases of the Covid-19 Infections by Provinces in Indonesia, Late December 2020

Source: BNPB

Appendix 3. Scatter Plot of Raw Score against the Associated Rasch Scale of FIES in Indonesia, 2017-2019



Source: Susenas 2017-2019 (processed using Stata16)

We notice that some districts in Indonesia have zero percentage of households living with severe food insecurity. These figures might raise doubt about respondent validity in answering the survey questionnaire in the corresponding districts. There are two potential possibilities related to this case. First is that the respondents who were randomly sampled have truly experienced no anxiety about food insecurity. Secondly is that the bias resulting from measurement error in affirming the FIES item question. In overcoming this problem, the scholars used the Rasch Method to correct the measures. The Rasch model is a method of correcting the raw score since the Rasch model can eliminate the latent traits among households so that the new score is now comparable. The Rasch Scale is now ranging from 0 to 4.55 of scale as the maximum value suffering for correction. As shown in Appendix 3, the scatter plots every single value of the raw score to the associated Rasch scale. There are many households of which FIES scores of zero corrected to be nonzero in the Rasch Scale as the consequences of imputing and corrected using the Rasch Model. This correction also applied to the remaining raw score with a similar pattern, all of the raw scores used in the analysis above were corrected altogether.