Exploring the Mental Health Impacts of Food Insecurity in Indonesia

Evidence from the Sleman Health and Demographic Surveillance System

En utredning kring psykiska hälsoeffekter som orsakas av osäker livsmedelssäkerhet i Indonesien:

Evidens från Slemans hälsodemografiska databas

Jan Sert

Supervisor: Julia Schröders
Department: Epidemiology and Global Health, Umeå University

Second supervisor: Septikurnia Lestari
Department: Medicine, Global Health and Nursing, Gadjah Mada University

Abstract

Background: Food insecurity - limited access to safe nutritious food, has clear physical health effects, but its mental health implications remain underexplored, particularly in developing countries like Indonesia, where both food insecurity and mental health disorders have increased since the COVID-19 pandemic. Social network support may influence this relationship.

Objective: This study examines the association between food insecurity and mental health disorders among adults in Sleman Regency, Indonesia, and explores how social support and sociodemographic factors moderate this relationship.

Methods: A cross-sectional study was conducted using data from the Sleman Health and Demographic Surveillance System (HDSS) Wave 7 (2021–2022), involving adults aged 18 and above. Food insecurity was measured using the 9-item Household Food Insecurity Access Scale (HFIAS), while mental health was assessed using the WHO Self-Reporting Questionnaire, with a cutoff of ≥6. Logistic regression models tested associations, adjusting for sociodemographic variables and social support proxies (e.g., marital status, household size, social expenditure).

Findings: About 25% of respondents experienced food insecurity, and 19.5% reported symptoms of mental health disorder. Food insecurity was strongly associated with mental health disorder (OR: 4.79; 95% CI: 3.84–5.98). Higher odds of mental health disorder were found among women and those with lower education or socioeconomic status. Interaction analysis showed a higher predicted probability of mental health disorder among food insecure individuals (27%) compared to food secure ones (7%). Government and NGO support recipients reported higher food insecurity, likely reflecting targeted assistance. Cultural norms, such as Javanese collectivism, may shape social support patterns.

Conclusions: Food insecurity is significantly associated with mental health disorders in Sleman Regency, particularly among disadvantaged groups. These findings highlight the importance of addressing food insecurity as a public mental health issue. Further research is needed to explore causal links and how social networks may buffer mental health risks.

Abbreviations

- AIC = Akaike Information Criterion
- BIC = Bayesian Information Criterion
- FAO = Food and Agriculture Organization of the United Nations
- FI = Food Insecurity
- HFIAS = Household Food Insecurity Access Scale
- LMIC = Low-Middle Income Countries
- NGO = Non-Governmental Organisation
- Ref = Reference
- SDG = Sustainable Development Goal
- SES = Socioeconomic Status
- Sleman HDSS = Sleman Health and Demographic Surveillance System
- SRQ = Self-Reported Questionnaire
- UN = United Nations
- WHO = World Health Organisation

Introduction

Food insecurity refers to the lack of regular access to enough safe and nutritious food for normal growth, development and an active, healthy life. This may be due to a lack of resources or food unavailability. The issue of food insecurity has been a long-lasting problem around the world for decades. It is prioritized by the UN as one of the 17 Sustainable Development Goals (SDGs), in particular Goal 2, which is about ending hunger and minimizing human undernourishment globally. (1,2)

According to the 2024 FAO Report of The State of Food Security and Nutrition in the World, Food Insecurity has seen little change globally in recent years, with a sharp increase during the COVID-19 pandemic. In Asia, moderate or severe food insecurity rose from 21.4% in 2019 to 24.8% in 2023. Southern Asia was hit the hardest, with 41.1% of the population facing moderate or severe food insecurity, while Southeast Asia reported 17.1%. (3) A closer look at Southeast Asia will be done by focusing on the state of Indonesia. Indonesia is a designated low-middle-income country (LMIC) located in Southeast Asia with a population of roughly 282 million people, the world's fourth most populous country. (4) Although undernourishment has been an issue for years, Indonesia has, since 2001, managed to decrease the prevalence of undernourishment, from 18.2% in 2001 to 7.2% in 2022, a slight increase from the record-low 5.9% in 2018. Similar indications have been noticed in the World Bank's report about Food Insecurity in Indonesia during the COVID-19 pandemic. The report showcased a decrease in moderate or severe food insecurity prevalence from 8.66% in 2017 to 5.42% in 2019. However, after the COVID-19 outbreak in 2020, 37.7% of households in Indonesia reported eating less due to insufficient resources. (5)

Although the impact of food insecurity on nutritional status, growth, and development is well documented – for example, individuals experiencing food insecurity have increased risks of anaemia, diabetes, hypertension, asthma and cancer (6–10) – less is known about its non-nutritional impacts, such as on mental health (11–13), particularly in developing settings. Mental health is defined as *"a state of mental well-being that enables people to cope with stresses of life, realize their abilities, learn well and work well, and contribute to their community*" by the WHO. Examples of common mental health disorders are depression, anxiety, as well as mental disorders and states including significant distress, impairment in functioning and more (14). Food insecurity is a highly stressful experience, not only due to outright hunger but also because of its broader impacts on mental health. **Food insecurity is associated with poor mental health outcomes through several pathways** (15–17)**:**

Biological/Nutritional Pathway: Malnutrition resulting from poor access to nutritious food can lead to deficiencies in essential nutrients, such as vitamins and minerals, crucial for brain function and mood regulation. Additionally, the stress of food insecurity can trigger biological responses, such as increased cortisol and inflammation, which negatively impact mental health.

Material Pathway: Food insecurity is often a result of economic hardship, leading to financial stress. This material deprivation can cause anxiety, depression and other mental health problems.

Psychosocial Pathway: Worrying about the availability of food or the ability to provide for one's family leads to chronic stress, which contributes to anxiety, depression and psychological distress. Additionally, food insecurity can result in social isolation, as individuals may feel ashamed or embarrassed, withdrawing from social interactions and support networks, further exacerbating mental health issues.

Both food insecurity and mental health disorders have worsened due to the COVID-19 pandemic. The pandemic increased economic inequalities, disrupted food systems, and led to widespread job losses, heightening food insecurity. Simultaneously, pandemic-related stressors--such as isolation, health fears and financial uncertainty -- have contributed to a rise in anxiety and depression. Moreover, social support networks have been weakened by movement restrictions, distancing and economic hardships, reducing access to emotional and practical support (18,19). **This study focuses on the psychosocial pathway, with particular attention to the role of social network support as a potential buffer against the mental health impacts of food insecurity.**

Prior studies examining the age-standardized prevalence of mental disorders in the Southeast Asian region showcase that the prevalence of mental health and depressive disorders is higher in Indonesia than in other Southeast Asian countries and that anxiety and depression-related disorders are dominant in the overall mental health burden. The analysis also showed that 80% of the burden due to mental disorders occurred among individuals of working age (16-65 years). (20) In particular, Indonesian transitional-age youth face challenges and experiences that stem from age-transitioning into adulthood and with issues regarding good coping mechanisms. (21)

Food Insecurity is a pressing global issue with significant implications for health and wellbeing. While the physical health consequences of food insecurity are well-studied, the mental health impacts and pathways linking food insecurity to mental health are less explored, particularly in low-resource settings, such as Indonesia, where both food insecurity and poor mental health are prevalent. There is also a need to understand how protective factors, such as social network support, may buffer or exacerbate these effects. Strong social ties can reduce the psychological burden of food insecurity by providing emotional and practical support during times of crisis (22,23).

Findings will have implications for public health policy and practice. Understanding the pathways through which food insecurity affects mental health can support the design of targeted interventions to reduce psychological distress in food-insecure populations. Moreover, identifying the protective role of social networks can help inform community-based strategies that strengthen social resilience - particularly in settings where access to formal mental health services remains limited and levels of food insecurity are high.

Using population-based data from the Sleman district of Yogyakarta, Indonesia, this study aims to (i) examine the association between food insecurity and symptoms of mental health disorder; and (ii) assess whether indicators of social network support moderate this association. The specific two aims in this study are:

1. Food Insecurity and Mental Health in Sleman: This study aims to examine whether individuals experiencing more severe levels of food insecurity in the Sleman Regency, as measured by the Household Food Insecurity Access Scale (HFIAS), will report a higher number of mental health disorders.

2. Social Network Support as a Protective Factor: This study aims to assess whether indicators of social network support moderate the association between food insecurity and mental health in Sleman, by looking at controlled variables such as household size, marital status, social expenditures, and whether the household received support during the COVID-19 pandemic from friends, families, NGOs and the government.

Materials and Methods

Data Source and Population:

The Sleman Health and Demographic Surveillance System (HDSS) is a longitudinal, population-based surveillance system based in the administrative area of Sleman Regency of Yogyakarta, Indonesia, which is located on Java, the most populous island of Indonesia. (24) Sleman Regency, which spans an area of 574.82 km^2, is in a mountainous area on the slope of Mount Merapi, an active volcano, with a population of approximately 1,16 million inhabitants, as of 2020. Out of these, 49,7% are men and 50,3% are women. Roughly 61% of the population in 2020 had obtained formal education, either from junior, senior or vocational high school, while approximately 22% of the population obtained higher education, either by achieving their diploma or university degree. (25) The majority of the population in the region is of Javanese ethnicity, over 90%. (26)

Established to provide detailed, continuous data on demographic, health and socioeconomic indicators. Sleman HDSS successfully collected data from 19 724 residents across 5 147 households, spread across 216 clusters in all sub-districts of Sleman Regency, in its baseline survey. In multiple waves, the HDSS conducts regular household surveys on various topics, including mortality, morbidity, healthcare access, and socioeconomic factors. In Wave 7, a population of 5075 participants were registered. (27)

Study Design and Inclusion / Exclusion

This is a cross-sectional study based on data from the Sleman HDSS on adults aged 18 and older who participated in Wave 7 between September 2021 and January 2022.

For this study, the inclusion criteria were: 1) adults aged 18 years and older, 2) listed as respondents of the Sleman Health and Demographic Surveillance System (Sleman HDSS). Exclusion criteria were respondents below the age of 18 years. Based on the inclusion and exclusion criteria, the total population sample in this study was 3836 participants. Data will be utilised from adults aged 18 and older participating in Wave 7, which was collected between September 2021 and January 2022. (24,28)

Variables

Mental Health (Outcome / Dependent Variable): To capture mental health outcomes, measurements using the Self-Reporting Questionnaire (SRQ) will be used, a tool developed by the World Health Organisation (WHO) to screen for common mental disorders in LMICs. The SRQ is widely recognized for its simplicity, reliability and adaptability across diverse cultural contexts, making it a valuable resource in epidemiological studies and community health settings. Designed to assess general psychological distress, the SRQ helps identify individuals at risk of mental health disorders, particularly in environments where access to specialized mental health services is limited.

The standard SRQ includes 20 yes/no questions aimed at detecting symptoms of depression, anxiety, somatic complaints and other neurotic disorders. These questions assess various symptoms, such as sleep disturbances, feelings of sadness or hopelessness, difficulty concentrating, fatigue or lack of energy, and physical symptoms, such as headaches or back pain, anxiety, and tension. Each question asks whether the respondent has experienced the symptom in the past month. Following the SRQ User Guide, respondents are classified as having a mental health problem if they answered "yes" to six or more items out of the 20 questions. (29) For Mental Health Disorder, the outcome variable used in this analysis, a generated variable from HDSS Sleman was used, based on the cut-off scoring 6 or more questions out of the 20 SRQ-questions in total. A respondent who answered yes to six or more questions was considered to have an emotional, mental disorder or distress that may lead to mental problems. This instrument's validity has been validated in Indonesia and used in the Basic Health Research Indonesia (RISKESDAS). (30)

Some examples of the 20 SRQ-questions are: *Do you often have any headaches? Do you feel anxious, tense, or worried?* Respondents answered Yes (1 point) or No (0 points). Please see Table 6 in the supplement for the complete set of questions.

Food Insecurity (Predictor / Independent Variable): The Food and Agriculture Organisation (FAO), which monitors the levels of food insecurity globally, measures food insecurity across four dimensions: availability, access, utilisation and stability, and uses different scales to measure the food insecurity levels around the world. (31,32) One of the scales used to measure the severity of food insecurity through various indicators, including the prevalence of undernourishment and the severity of food insecurity in countries, is the Household Food Insecurity Access Scale (HFIAS), a tool developed by the Food and Nutrition Technical Assistance Project (FANTA), to assess the severity of food insecurity at the household level. (32) The HFIAS is widely used and validated across diverse low- and middle-income countries (LMIC) settings, making it an essential instrument for understanding the impact of food insecurity on health and well-being. The scale captures a household's experience related to food insecurity on a scale, ranging from anxiety about food availability to severe disruptions in food consumption patterns. The HFIAS consists of nine questions that reflect the frequency and severity of food insecurity over the past four weeks. These questions address key issues such as worrying about food, food quality and food intake. Examples of questions are: *"Is your household unable to eat preferred food? Is your household unable to eat preferred food?"*. The complete set of questions can be found in Table 7.

Responses are recorded on a four-point frequency scale: "no" (0 points), "rarely" (1 point), "sometimes" (2 points) and "often" (3 points). The cumulative HFIAS score is calculated by summing the responses, with higher scores indicating greater severity of food insecurity. This allows for the classification of households into categories of food insecurity: food secure, mildly food insecure, moderately food insecure, and severely food insecure. The cut-off values for every severity group were based on the official cut-off grading of the HFIAS scale. Food Secure was classified for households that scored 0 or 1 on question 1, and all subsequent items (Q2-Q9) were equal to 0. Mildly Food Insecure were classified if any of the following were reported: 2 or 3 points on question 1, if they reported 1, 2, or 3 points on question 2, 1 point on question 3 or 4, while responses on question 5 to question 9 remained 0. Moderately Food Insecure was based on respondents grading 2 or 3 points on question 3 or 4, 1 or 2 points on question 5 or 6, with questions 7 to 9 being scored 0 by the respondent. Respondents categorised as Severely Food Insecure met the criteria if they responded 3 points to question 5 or 6, or scored either 1, 2 or 3 points on questions 7, 8 and 9. (32)

When the regression analysis was conducted, the severity groups, moderately and severely food insecure, were combined into "food insecure" (Table 4).

Covariates

These listed covariates are critical for adjusting the models to account for variations in the population and for exploring potential moderating effects, such as the role of social support in mitigating the impact of food insecurity on mental health:

- **Socio-Demographic Factors:** Age, Sex, Education level, and Socioeconomic status.
- **Social Network Support:** Marital status, Household/Family size, Social Support Availability, Expenditure on Social Activities

These covariates were selected mainly for their relevance to the psychosocial pathway linking food insecurity and mental health. Social factors such as marital status, household composition, and support from personal or institutional networks can shape individuals' exposure to stress, access to coping resources, and sense of social connectedness. By including these variables, the analysis aimed to capture not only demographic and socioeconomic differences, but also aspects of the relational and contextual environment that may buffer or exacerbate the psychological effects of food insecurity.

Socioeconomic status was derived from Sleman HDSS data on household consumption of food and beverages, homeownership, household expenditure and characteristics. The information was used to calculate a wealth index using principal component analysis. Based on this, the study's population sample was divided into five quintiles (1-5), where the higher score indicates better socioeconomic status. Socioeconomic status was divided into five groups, with 1 as the quintile with the lowest income (Low), and 5 classified as the highest income, respectively (High). (33)

To observe which variables were used, and the explanation for these, please see Table 1.

Data analysis

The statistical analysis was conducted in several steps to address the study's objectives. All analyses were performed using the statistical software R (RStudio version 2024.12.1 Build 563), and a significance level of 0.05 was applied throughout. The prevalence of food insecurity and mental health disorders was assessed using descriptive summary statistics. Prevalence rates were calculated for the total sample and subgroups based on socio-demographic factors and social network support. Proportions and 95% confidence intervals (CI) were reported in all descriptive analyses, and the descriptive results were shown as percentages (%). The bivariate relationship between food insecurity (total HFIAS score and individual components) and mental health outcomes was examined using chi-square or t-tests, depending on the nature of the variables. In addition, poststratification weighting, which was based on the sex and age group composition of the Sleman Regency population, was applied in all descriptive analyses. This method helps to reduce potential biases in the results by adjusting for differences in sampling probabilities across specific demographic groups, such as sex and age groups. It also improves how well the findings represent the overall population in the area.

Multivariate regression models assessed the association between food insecurity and mental health. The combined HFIAS score was the main predictor, controlling for socio-demographic and social-network covariates. This study used the combined HFIAS score to better understand the pathways linking food insecurity and mental health. The combined HFIAS score captured the overall severity of food insecurity, offering a broad assessment of its intensity.

The logistic regression models were presented with every variable's odds ratio (OR), confidence interval (CI) and P-value. Statistically significant p-values are in bold. The predictor variable groups "Moderately Food Insecure" and "Severely Food Insecure" have been combined into "Food Insecure". Four models were built using stepwise logistic regression. The four models include Model 1: The crude model, containing only the predictor variable (Food Insecurity Severity Levels) and the outcome variable (Mental Health Disorder). Model 2: The Sociodemographic Model adjusted for sociodemographic covariates. Model 3: The Social Network Model is adjusted for social network covariates and used as a proxy. Model 4 is the final model adjusted for all covariates, called "Full Model". Interaction terms and subgroup analyses were explored but did not yield meaningful improvements and were excluded from the final model presentation for parsimony.

Ethics

HDSS Sleman has started operating after obtaining ethical clearance from the Committee for Medical and Health Research Ethics, Faculty of Medicine, Public Health and Nursing, University Gadjah Mada. Continuing reviews are conducted annually. Wave 7 is cleared under number KE/FK/0640/EC/2021. Prior to each data collection, HDSS Sleman respondents were asked for their consent to participate in the survey. Respondents were asked to sign an informed consent form after receiving information about HDSS Sleman and stating their willingness to participate.

Results

Of the 3836 respondents, the majority were aged 40-59 (64.1%), female (68.8%), married (81.7%), had a higher education level (55.7%), and did not receive social support from the government during the COVID-19 pandemic (53.2%). Approximately 25% of respondents experienced some degree of food insecurity, and approximately 19.5% reported having a mental health disorder (Table 2).

The results of the chi-square test showed that a higher severity level of food insecurity was significantly associated with having a mental health disorder, as well as having a lower educational level and lower socioeconomic status. Respondents in the lowest socioeconomic status quintile reported the highest prevalence of mental health disorders (23%) compared to the highest socioeconomic status (13%, $p < 0.001$). Similar results were shown in the weighted analysis. Those who received assistance had a higher share of mental health disorder than those who did not receive support across all categories. For example, 27% of respondents who received help from friends or neighbours met the criteria for mental health disorder, compared to 19% among those who did not ($p = 0.002$). Individuals who were not married had a higher prevalence of mental health disorders compared to those who were married. See Table 3 for the full table.

In the logistic regression analysis, four models were included. The results did not change the estimates from the variables based on the four different models. The only exception where the estimate changed significantly between the Social Network Model and the Full Model, was the variable about social support from NGOs during COVID-19. See Figure 1 for the full forest plot including all the four models. Regression analysis showed the final model with a pseudo-R2 of 0.099. Having a mental health disorder was associated with being food insecure (OR: 4.79; 95% CI: 3.84 – 5.98). Women were associated with mental health disorder (OR: 1.50; 95% CI: 1.22 – 1.85) People who obtained social support from NGOs or private foundations were also associated with a higher prevalence of mental health disorders (OR: 1.95; 95% CI: 1.25 – 3.00). Other social support variables did not reach statistical significance in the multivariate regression model. See Table 4 for the full regression model results, and Figure 2 for a complete forest plot when adjusted for all variables in the Full Model. The predicted probability of experiencing a mental health disorder increased based on the severity

level an was highest among those in the Food Insecure group (0.27; 95% CI: 0.19-0.38), which can be observed in Figure 3.

Discussion

The first aim in this study was primarily to examine whether individuals in Sleman Regency who experience more severe levels of food insecurity report a higher number of mental health disorders. The second aim in the study was to explore and assess whether indicators of social network support helped buffer this association. The findings in this study suggest a relationship between increased food insecurity and increased prevalence of mental health disorders in the surveyed population of Sleman Regency. While only 13% of food-secure individuals reported mental health disorders, 40% and 45% of the moderately and severely food-insecure reported mental health disorders, respectively. These associations were consistent across both the unweighted and weighted analyses and significant in both, which reinforces the robustness of the findings and indicates a pattern that worsening food insecurity corresponds with a rising prevalence of mental health disorders. The findings also align with prior studies and systematic reviews on the subject, which show a positive relationship between food insecurity and the risk of stress and depression. (34,35)

In addition to that, food insecurity was significantly more common among individuals with lower educational levels, lower socioeconomic status and specific age groups, which may reinforce the argument that structurally disadvantaged populations experience more severe mental health outcomes. When it comes to sex variables, women showcased significantly higher odds of experiencing mental health disorders in comparison to men (OR 1.50), which reflects the established gender disparities in vulnerability to stress and resource scarcity. In the final model, socioeconomic status showcases higher odds in the Low and Low-Middle groups compared to the richer groups. In the age variable, we could notice a U-shaped distribution in the regression. Age groups 25-29 and 50-59 showcased the highest odds ratios and the likelihood of being the most affected. This aligns with previous reports that showcase how well-being and mental ill-health levels are approximately U-shaped through the life course, being low in adolescence and retirement age. (36) However, other studies refuted this by suggesting a more linear improvement in mental health from young adulthood. (37)

To examine how social network support affects the individuals in our study, a selected group of variables was used as a proxy for social network support to explore the study's aim to determine whether people with stronger social connections can better cope with the stress of food insecurity. We observed a higher degree of food security among the population who did not receive support from the government or NGOs. In contrast, the people who received support from governments and NGOs showcased a higher degree of food insecurity. This does

not conclude that it represents social network support specifically, but showcases that support is given primarily to people most vulnerable to food insecurity. A strong association was also found regarding expenditure on social activities, where people with lower spending on social expenditure showed higher food insecurity. This may mean that families who spend more money on social activities also get stronger social support and have the financial means.

Other aspects regarding social network support and how they may affect mental health problems can be examined by looking at the cultural aspects of the population. Most of the population in the Yogyakarta region are Javanese. A prior study that has been done regarding the perception of mental health in Indonesia among Javanese people showed that multiple participants identified a lack of social support as a contributing factor to mental health problems while at the same time emphasising the importance of obtaining family and community support in lowering mental health problems. The cultural emphasis on collectivism in Javanese culture also underscores the importance of community ties and social harmony. (38) Additionally, a notable sociological concept in Javanese culture is *Gotong Royong*, which refers to individual actions performed for the common good without expecting compensation. In the practices of Gotong Royong, individuals facing financial difficulties may borrow money from family or friends; loans are typically given voluntarily and without interest. (39) This cultural framework likely explains the social support observed in our adjusted model. It also may explain why our adjusted model didn't find this informal support to be statistically protective, suggesting that assistance from family or friends is a culturally expected practice. Although this does not seem fully protective from the effects of mental health disorders in this dataset, this type of social network support may play an essential buffering role in the everyday life of the population. In reality, informal networks are so common to the degree where it doesn't distinguish individuals who's depressed, while formal services like NGOs tend to target people who need it most. The persistence of mental health disorders among those receiving support suggests that, while cultural practices like Gotong Royong offer some aid, broader structural issues like socioeconomic status and food insecurity still require targeted intervention.

These findings underscore the importance of integrating community support with formal mental health services and policy-level responses to reduce food insecurity and mental health disorder.

Strengths and Limitations

One strength of this study is that the sample size of the population is relatively large, with 3836 individuals, and there is a considerable variation of people in different age groups and socioeconomic statuses. This makes it easier to showcase patterns and generalise the findings to a larger population. However, while focusing on Sleman Regency provides valuable insights, the findings may not be generalisable to other countries in Southeast Asia or globally, due to cultural, economic and social differences.

In addition, HDSS Sleman has been a well-utilised database for multiple years that cooperates with local government and NGOs to ensure adequate data collection. Reviews are carried out annually, reinforcing the data's validity. Adding a single outcome variable and a single categorical predictor variable is also a strength of this study, as it aligns with the multivariate logistic regression method. The analysis also incorporates data from 2021-2022, which includes the impacts of the COVID-19 pandemic, which is particularly relevant given the significant shifts in food security and mental health caused by the pandemic.

A limitation of the study is that no proper variable exists to examine the impact of social networks specifically. Instead, variables collected regarding marital status, expenditure on social activities, and household size have been used as proxies for social networks. In an ideal case, variables that disclose more of an individual's social networks would have been collected.

Despite these limitations, the study's cross-sectional approach to the population in Sleman Regency provides valuable insights. While it does not establish a causal relationship between food insecurity and mental health, it does reveal significant patterns in the population, thereby contributing to our understanding of mental health disorders caused by food insecurity in the Sleman Regency.

Conclusion

The conclusion we can draw from this is that there seems to be a connection between worsening food insecurity and higher degrees of mental health disorder, where women and people with the lowest socioeconomic status and educational level are the worst affected. Individuals experiencing moderate to severe food insecurity were substantially more likely to report mental health disorders, with this relationship remaining robust, even after adjusting for sociodemographic and social network covariates.

While social network support, particularly informal assistance from family and friends, was prevalent in the community, it did not appear to fully buffer the negative mental health impacts of food insecurity.

These findings underscore the importance of addressing food insecurity through policy and economic measures, strengthening mental health services, and integrating culturally grounded forms of community support. Future research should aim to ask and capture the social network structures of the population more directly and explore these relationships longitudinally to better understand causality and potential interventions.

Use of generative AI

Use of generative AI (ChatGPT o3-mini-3.0) has been utilised to transfer current references into BibTeX format to easily import the prior references written in Word into the reference program Zotero. In addition, the generative AI tool ChatGPT o3-mini 3.0 has also been used to create codes in the statistical software R, to compile and create the statistical tables and figures that have been used in the result section of this report, for the weighted and unweighted analysis of the univariate analysis as well as the logistic regression analysis. The same AI-tool was also used to create the specific R-codes for the figures used in the report, such as the forest plots and the predicted probability analysis figure. Furthermore, this thesis has utilised Grammarly AI to correct spelling or grammatical errors in English and provide suggestions for phrasing sentences more concisely. Lastly, ChatGPT version 4o has been used to condense the abstract of this report.

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Figures

Figure 1. Forest Plot of Logistic Regression Results from all four models (including Reference Groups).

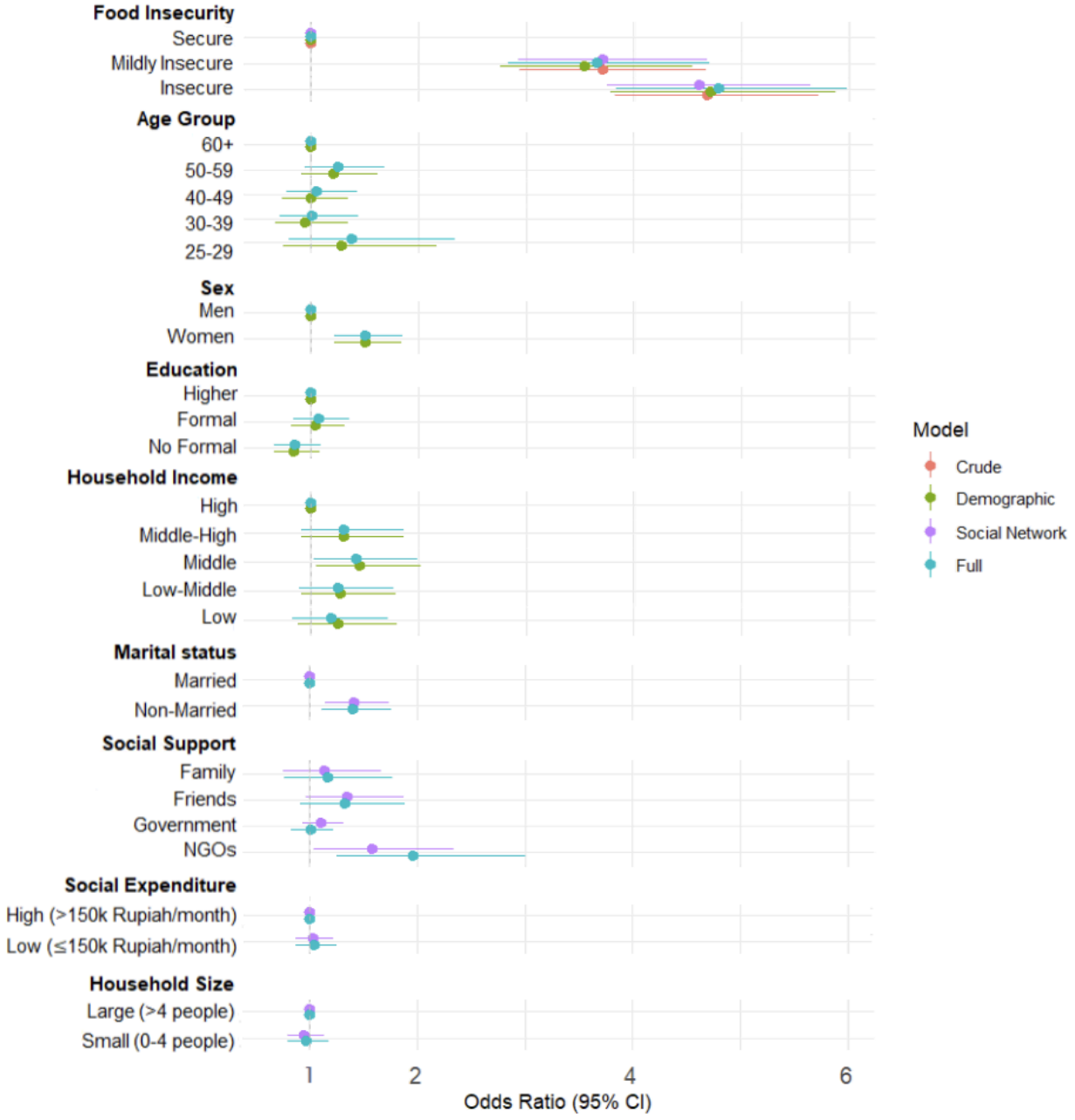
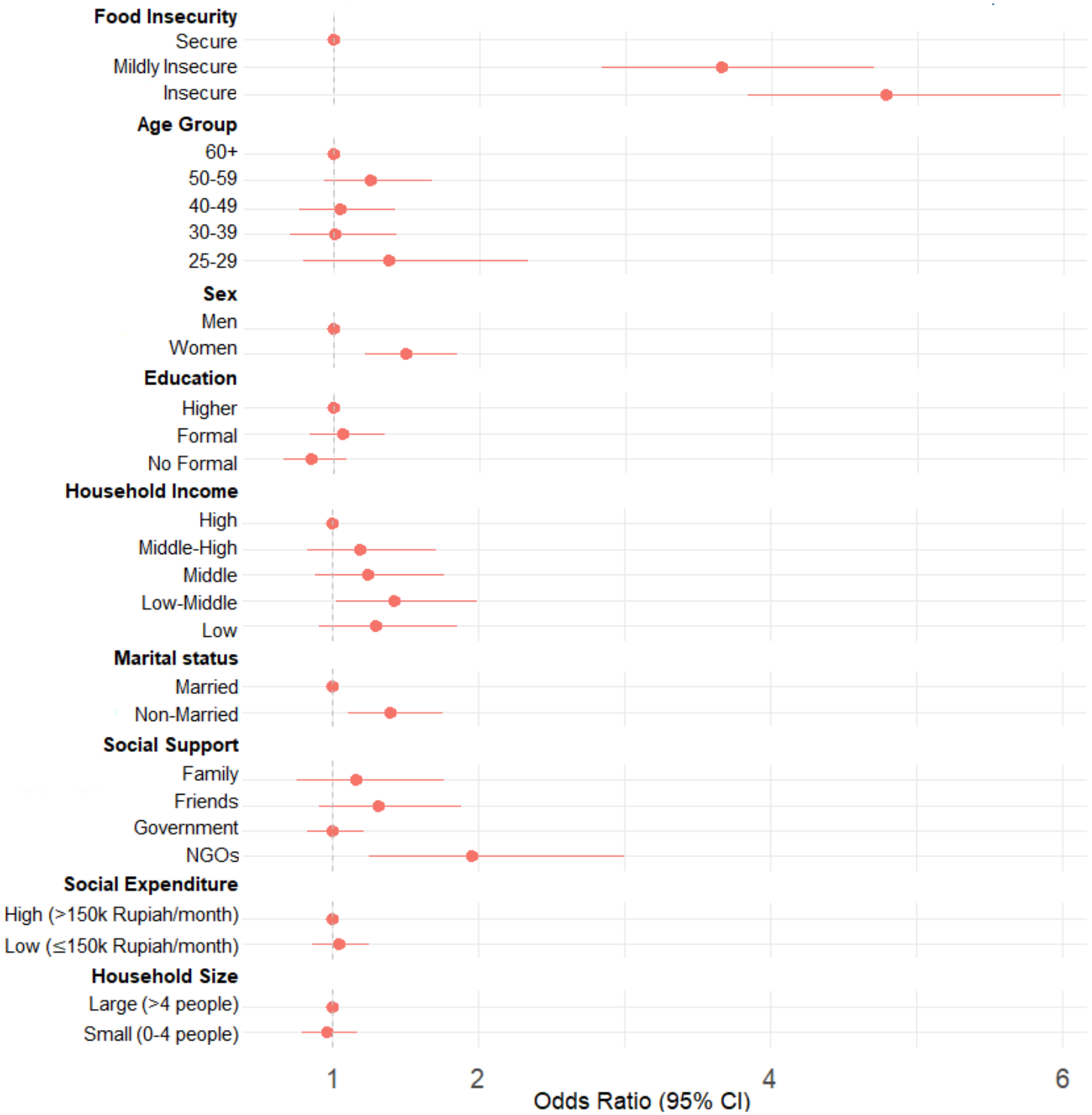


Figure 1

The forest plot contains odds ratios (OR) and 95% confidence intervals (CI) from a multivariate logistic regression model, that assess the association between food insecurity and mental health disorders. The model contains all the assessed models separately.

Figure 2. Forest Plot including the Final Model.



The forest plot contains odds ratios (OR) and 95% confidence intervals (CI) from a multivariate logistic regression model, that assess the association between food insecurity and mental health disorders. The model, also called final model, controls for crude model containing predictor and outcome variables, sociodemographic variables and social network variables. The reference groups are indicated at the top of each category. Error bars represent 95% confidence intervals.

Figure 3. Predicted probability of Mental Health Disorder by Food Insecurity

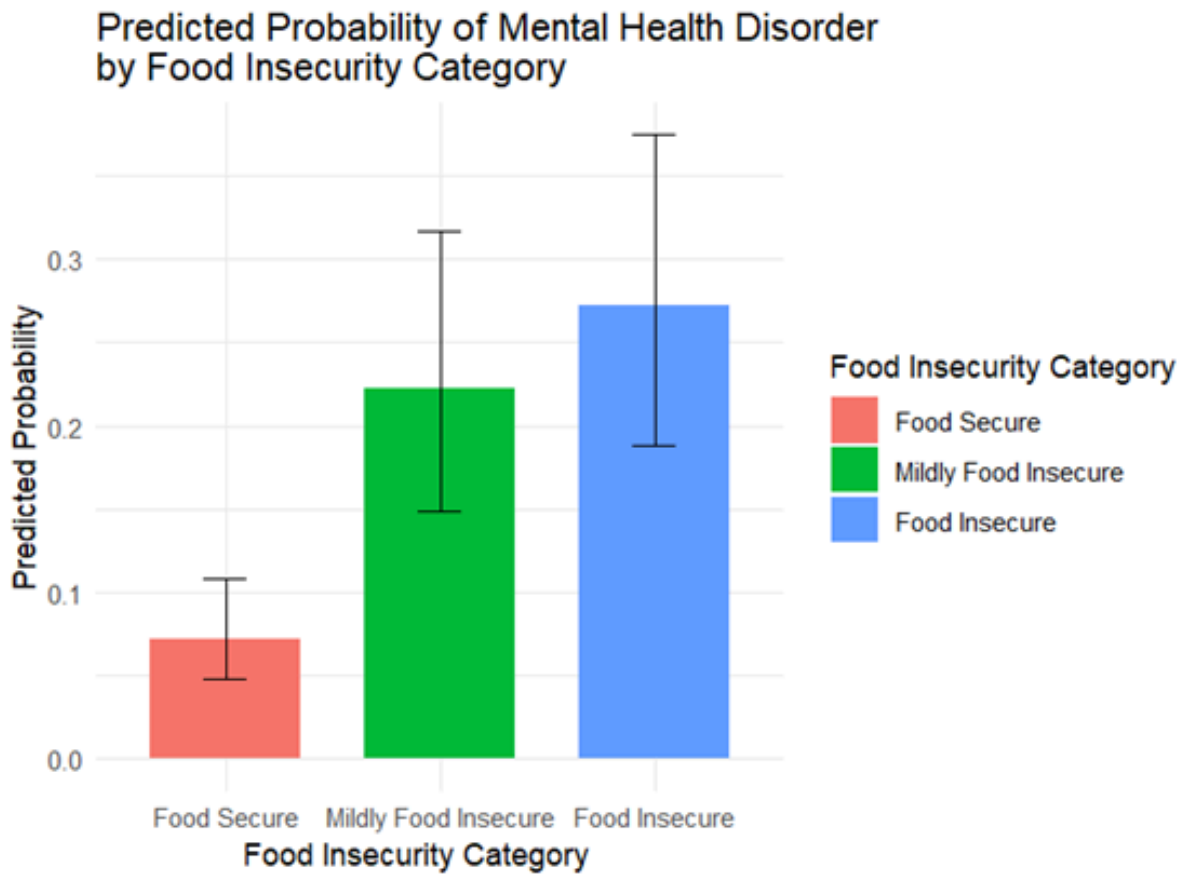


Figure 3

This bar graph showcases the predicted probability of experiencing a mental health disorder based on the three severity levels of food insecurity: Food Secure, Mildly Food Insecure and Food Insecure (containing Moderately and Severely Food Insecure). Predicted probabilities were derived from a multivariable logistic regression model. Error bars represent 95% CI. Individuals classified as Food Insecure has the highest predicted probability (0,27; 95% Cl: 0-19-0.38) while Food Secure individuals had the lowest predicted probability (0,07; 95% Cl: 0.05-0.11).

Tables

Table 1. Covariates used and explanation for these

In Table 1, the covariates used are presented with an explanation of each respective variable groups obtained from the Sleman HDSS Questionnaire. (40)

Variables	Groups and explanations
Sex	Male
	Female
Age	25-29
	30-39
	40-49
	50-59
	60+
Education	No Formal Education = including as 1. No formal schooling (Sleman HDSS)
	Formal Education = including 2. Elementary School, 3. Junior high school, 4. Senior high school (Sleman HDSS)
	Higher Education = including 5. Diploma, 6. Undergraduate, 7. Postgraduate (Sleman HDSS)
Socioeconomic Status	Low = classified as quintile number 1 in Sleman HDSS
	Low-Middle = quintile number 2
	Middle = quintile number 3
	Middle-High = quintile number 4
	High = quintile number 5
Marital status	Married = classified as Group 2. Married and 6. Reconciled in Sleman HDSS
	Non-Married = classified as Group 1. Not married, Group 3. Divorced, Group 4. Widowed, Group 5. Separated
Social support from Government (Did you receive assistance/help from government?)	Yes
	No
Social Support from Family	Yes
	No
Social Support from Friends and Neighbours	Yes
	No
Social Support from NGOs and private foundations	Yes
	No

Expenditure on Social Activities (Average household expenditure on parties and social activities, in thousands of Rupiah) Based on the distribution of the sample, Dichotomization was done by dividing into two groups based on the median spending, at 150 000 Rupiah/month.	Lower Social Spending (≤150 000 Rupiah/month)
	Higher Social Spending (>150 000 Rupiah/month)
Household Size (Number of Household member who has resided or plan to stay in this household for the next six months) Based on the distribution of the sample, dichotomization was done by dividing two groups based on the median household size, at 4 people.	Small Household (≤4 people)
	Large Household (>4 people)

Table 2.

Table 2 showcase the distribution of participants in every variable based on demographic characteristics, social network variables, mental health disorder and food insecurity severity levels. Both unweighted and weighted population sample in percentage.

Variable	Group	Participants (n)	% (unweighted)	% (weighted)
Total respondents		3836	100	100
Mental Health Disorder	Yes	751	19.5	19.7
	No	3085	80.5	80.3
Food Insecurity Severity Level	Food Secure	2875	75.0	74.8
	Mildly Food Insecure	402	10.5	10.6
	Moderately Food Insecure	376	9.8	9.8
	Severely Food Insecure	183	4.7	4.8
Sex	Male	1195	31.2	29.7
	Female	2641	68.8	70.3
Age	25-29	141	3.7	3.8
	30-39	639	16.7	17.6
	40-49	1218	31.8	35.8
	50-59	1239	32.3	31.3
	60+	599	15.6	11.5
Education	No Formal Education	852	25.2	23.1
	Formal Education	650	19.2	19.5
	Higher Education	1885	55.6	57.4
Socioeconomic Status	Low	637	17.3	17,0
	Low-Middle	785	21.4	21.4
	Middle	888	24.2	24.4
	Middle-High	640	17.4	17.8
	High	720	19.6	19.4
Marital status	Married	3136	81.7	82.4
	Non-Married	700	18.3	17.6
Social support from Government	Yes	1794	46.8	47.2
	No	2042	53.2	52.8
Social Support from Family	Yes	184	4.8	4.8
	No	3652	95.2	95.2
Social Support from Friends and Neighbours	Yes	266	6.9	7.0
	No	3570	93.1	93.0
Social Support from NGOs and private foundations	Yes	146	3.8	3.9
	No	3690	96.2	96.1
Expenditure on Social Activities	Lower Social Spending (≤150 Rupiah/month)	1660	50.8	50.9
	Higher Social Spending (>150 Rupiah/month)	1609	49.2	49.1
Household Size	Small Household (≤4 people)	2584	67.4	66.8
	Large Household	1252	32.6	33.2

	(>4 people)			

Table 3. Prevalence of Mental Health Disorder by Different Variables, Univariate analysis (Unweighted and Weighted)

	Unweighted			Weighted		
Characteristic	**Without Mental Health Disorder** N = 3 085[1]	**With Mental Health Disorder** N = 751[1]	**p-value**[2]	**Without Mental Health Disorder**	**With Mental Health Disorder**	**p-value**[2]
Food Insecurity Levels			**<0.001**			**<0.001**
Food Secure	2 499 (87%)	376 (13%)		87%	13%	
Mildly Food Insecure	258 (64%)	144 (36%)		64%	36%	
Moderately Food Insecure	224 (60%)	152 (40%)		60%	40%	
Severely Food Insecure	104 (57%)	79 (43%)		55%	45%	
Sex			**<0.001**			**<0.001**
Men	1 004 (84%)	191 (16%)		(84%)	(16%)	
Women	2 081 (79%)	560 (21%)		(79%)	(21%)	
Age Group			0.14			0.205
25-29	106 (75%)	35 (25%)		(75%)	(25%)	
30-39	514 (80%)	125 (20%)		(80%)	(20%)	
40-49	985 (81%)	233 (19%)		(81%)	(19%)	
50-59	981 (79%)	258 (21%)		(79%)	(21%)	
60+	499 (83%)	100 (17%)		(83%)	(17%)	
Education			**0.038**			**0.032**
No Formal Education	670 (79%)	182 (21%)		(79%)	(21%)	
Formal Education	498 (77%)	152 (23%)		(76%)	(24%)	
Higher Education	1 528 (81%)	357 (19%)		(81%)	(19%)	
Socioeconomic status (quintiles)			**<0.001**			**<0.001**
Low	493 (77%)	144 (23%)		(77%)	(23%)	
Low-Middle	618 (79%)	167 (21%)		(78%)	(22%)	
Middle	694 (78%)	194 (22%)		(78%)	(22%)	
Middle-High	524 (82%)	116 (18%)		(82%)	(18%)	
High	629 (87%)	91 (13%)		(87%)	(13%)	
Marital status			<0.001			<0.001
Married	2 554 (81%)	582 (19%)		(81%)	(19%)	
Non-Married	531 (76%)	169 (24%)		(75%)	(25%)	
Assistance/help from Government			<0.001			<0.001
Yes	1 391 (78%)	403 (22%)		(77%)	(23%)	
No	1 694 (83%)	348 (17%)		(83%)	(17%)	
Assistance/help from family			0.018			0.023
Yes	135 (73%)	49 (27%)		(74%)	(26%)	
No	2 950 (81%)	702 (19%)		(81%)	(19%)	
Assistance/help from friends or neighbours			0.002			0.002
Yes	194 (73%)	72 (27%)		(73%)	(27%)	

Characteristic	Unweighted			Weighted		
	Without Mental Health Disorder N = 3 085[1]	With Mental Health Disorder N = 751[1]	p-value[2]	Without Mental Health Disorder	With Mental Health Disorder	p-value[2]
No	2 891 (81%)	679 (19%)		(81%)	(19%)	
Assistance/help from NGOs/private foundation			**0.035**			**0.026**
Yes	107 (73%)	39 (27%)		(73%)	(27%)	
No	2 978 (81%)	712 (19%)		(81%)	(19%)	
Household Size			0.5			0.579
Small Household (≤4 people)	999 (80%)	253 (20%)		(81%)	(19%)	
Large Household (>4 people)	2 086 (81%)	498 (19%)		(80%)	(20%)	
Social Expenditure			0.2			0.279
Higher Social Spending (>150k Rupiah/month)	1 319 (79%)	341 (21%)		(79%)	(21%)	
Lower Social Spending (≤150k Rupiah/month)	1 766 (81%)	410 (19%)		(81%)	(19%)	

[1]n (%), [2]Pearson's Chi-squared test

Table 3 showcase the results of the univariate analysis, among the unweighted and weighted populations, respectively.

Table 4. Logistic Regression Models with Displayed Reference Groups and Fit Statistics

Table 4 showcase the results from the logistic regression (bivariate analysis) containing all four constructed models used. Odds ratios, confidence intervals and p-values are shown, with statistically significant values **bolded**.

Below, the results of the observations is showcased, Tjur's R^2 and AIC/BIC.

	Mental Health Disorder (Crude Model)			Mental Health Disorder (Sociodemographic Model)			Mental Health Disorder (Social Network Model)			Mental Health Disorder (Full Model)		
Predictors	**OR**	**CI**	**p**	**OR**	**CI**	**p**	**OR**	**CI**	**p**	**OR**	**CI**	**p**
Food Security												
(Intercept)	0.15	0.13 – 0.17	**<0.001**	0.09	0.06 – 0.13	**<0.001**	0.13	0.10 – 0.16	**<0.001**	0.07	0.05 – 0.11	**<0.001**
Food Secure	*Ref*			*Ref*			*Ref*			*Ref*		
Mildly Food Insecure	3.71	2.94 – 4.67	**<0.001**	3.55	2.76 – 4.55	**<0.001**	3.71	2.93 – 4.68	**<0.001**	3.66	2.84 – 4.70	**<0.001**
Food Insecure	4.68	3.83 – 5.72	**<0.001**	4.72	3.79 – 5.88	**<0.001**	4.61	3.76 – 5.65	**<0.001**	4.79	3.84 – 5.98	**<0.001**
Age Group												
Age Group 25–29				1.28	0.74 – 2.16	0.369				1.38	0.80 – 2.34	0.242
Age Group 30–39				0.95	0.67 – 1.34	0.760				1.01	0.71 – 1.44	0.964
Age Group 40–49				0.99	0.74 – 1.35	0.964				1.05	0.77 – 1.2	0.779
Age Group 50–59				1.21	0.91 – 1.61	0.198				1.25	0.94 – 1.68	0.129
Age Group 60+	*Ref*			*Ref*			*Ref*			*Ref*		
Sex												
Men	*Ref*			*Ref*			*Ref*			*Ref*		
Women				1.50	1.22 –1.85	**<0.001**				1.50	1.22 – 1.85	**<0.001**
Educational Level												
Higher Education	*Ref*			*Ref*			*Ref*			*Ref*		
Formal Education				1.04	0.82 – 1.32	0.756				1.07	0.84 – 1.36	0.589
No Formal Education				0.84	0.65 – 1.08	0.170				0.85	0.66 – 1.09	0.199
Marital Status												
Married	*Ref*			*Ref*			*Ref*			*Ref*		
Non-Married							1.41	1.15 – 1.74	**0.001**	1.40	1.11 – 1.76	**0.005**
Household Size												
Large Household (>4 people)	*Ref*			*Ref*			*Ref*			*Ref*		
Small Household (≤4 people)							0.95	0.79 – 1.14	0.556	0.96	0.79 – 1.18	0.719

Expenditure on Social Activities												
Social Expenditure (≤150k/month)							1.03	0.87 – 1.22	0.762	1.04	0.87 – 1.25	0.654
Social Expenditure (>150k/month)	*Ref*			*Ref*			*Ref*			*Ref*		
Social Support												
Social Support from Family							1.13	0.76 – 1.66	0.545	1.17	0.76 – 1.77	0.472
Social Support from Friends							1.35	0.96 – 1.87	0.080	1.32	0.91 – 1.89	0.135
Social Support from Government							1.11	0.93 – 1.31	0.249	1.01	0.83 – 1.22	0.953
Social Support from NGOs							1.57	1.04 – 2.34	**0.028**	1.95	1.25 – 3.00	**0.003**
Socio-economic status												
Low				1.25	0.88 – 1.80	0.211				1.19	0.83 – 1.72	0.352
Low-Middle				1.27	0.91 – 1.79	0.165				1.25	0.89 – 1.76	0.210
Middle				1.45	1.05 – 2.02	**0.026**				1.42	1.02 – 1.99	**0.038**
Middle-High				1.30	0.92 – 1.86	0.144				1.30	0.91 – 1.86	0.148
High	*Ref*			*Ref*			*Ref*			*Ref*		
Observations	3836			3265			3836			3265		
R^2 Tjur	0.081			0.091			0.089			0.099		
AIC	3518.798			3040.868			3508.010			3031.163		
BIC	3537.554			3126.142			3570.532			3159.074		

Table 5. Survey-Weighted Logistic Regression Full Model

Variable	OR	Lower CI	Upper CI
(Intercept)	0.074	0.047	0.120
Food Secure	Reference	Reference	Reference
Mildly Food Insecure	3.64	2.81	4.70
Food Insecure	4.83	3.86	6.04
Age Group 25-29	1.36	0.79	2.33
Age Group 30-39	1.00	0.70	1.43
Age Group 40-49	1.03	0.76	1.40
Age Group 50-59	1.23	0.93	1.65
Age Group 60+	Reference	Reference	Reference
Sex Women	1.47	1.18	1.82
Sex Men	Reference	Reference	Reference
Education No Formal Education	0.84	0.65	1.07
Education Formal Education	1.07	0.84	1.37
Education Higher Education	Reference	Reference	Reference
Socioeconomic Status Low	1.21	0.83	1.76
Socioeconomic Status Low-Middle	1.29	0.91	1.82
Socioeconomic Status Middle	1.43	1.02	2.00
Socioeconomic Status Middle-High	1.30	0.91	1.86
Socioeconomic Status High	Reference	Reference	Reference
Marriage – Non-Married	1.42	1.12	1.80
Marriage – Married	Reference	Reference	Reference
Social Support from Government	1.00	0.82	1.21
Social Support from Family	1.11	0.72	1.73
Social Support from Friends	1.34	0.93	1.93
Social Support from NGOs	1.95	1.27	2.97
Social Expenditure (0-150k/month)	1.038	0.86	1.25
Social Expenditure (>150k/month)	Reference	Reference	Reference
Household Size Small Household (≤4 people)	0.97	0.80	1.18
Household Size Large Household (>4 people)	Reference	Reference	Reference

Table 5 contains survey-weighted information about the odds ratios and confidence intervals used in the full model of the logistic regression.

Table 6. <u>Mental Health (SRQ) questions (Outcome Variables)</u>

- **Question 1**: Do you often have any headaches?
- **Question 2:** Do you lose your appetite?
- **Question 3**: Do you experience restless sleep?
- **Question 4:** Do you easily get frightened?
- **Question 5:** Do you feel anxious, tense, or worried?
- **Question 6:** Do you find that your hand is shaking?
- **Question 7:** Do you have digestive issues?
- **Question 8:** Do you have trouble in thinking clearly?
- **Question 9**: Do you feel unhappy?
- **Question 10:** Do you cry more than usual?
- **Question 11:** Do you find it difficult to enjoy your daily activities?
- **Question 12:** Do you find it difficult to make decisions?
- **Question 13:** Is your daily activity/assignment abandoned?
- **Question 14:** Do you feel incapable of making a significant contribution in life?
- **Question 15:** Have you lost interest in things?
- **Question 16**: Do you feel worthless?
- **Question 17:** Do you have any thoughts to end your life?
- **Question 18**: Do you feel tired all the time?
- **Question 19:** Do you have any stomach-ache?
- **Question 20:** Are you easily tired?

Table 7. <u>Food Insecurity questions (Predictor Variables)</u>

- **Question 1:** Does your household worry about food?
- **Question 2:** Is your household unable to eat preferred food?
- **Question 3**: Does your household eat just a few kinds of food?
- **Question 4:** Does your household eat foods they really do not want to eat?
- **Question 5:** Does anyone in your household eat a smaller meal than needed due to a lack of resources?
- **Question 6**: Due to lack of food, has anyone in your household had to eat fewer meals than the number typically eaten?
- **Question 7:** Does the household experience a situation where they have no food to eat of any kind in the home?
- **Question 8**: Does anyone in the household go to sleep hungry?
- **Question 9**: Does anyone in the household not eat from the time they awoke in the morning to the time they awoke the next morning, due to lack of food?

Table 8. <u>Social Network Variables Questions</u>

- What is the number of household members who has resided or plan to stay in this household for the next six months?
- What is the average household expenditure: Party/Social in thousands of Rupiah?
- Did you receive any assistance/help during the COVID-19 pandemic?
- If yes, who gave you the assistance/help? Government
- If yes, who gave you the assistance/help? Family
- If yes, who gave you the assistance/help? Friends/neighbours
- If yes, who gave you the assistance/help? NGOs/private foundations