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Sociodemographic, Economic, and Gender Determinants of Household Food and Nutrition Security in Central Sulawesi

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ABSTRACT

Food security is a multidimensional problem in a country, with physical and economic access being important factors in determining conditions at the household and individual levels. The purpose of this study was to analyze the determinants of household food security and nutrition based on sociodemographics, socioeconomics and gender. This type of research uses a cross sectional design. The samples in this study were 300 samples from the province of Central Sulawesi, 150 samples from rural areas and 150 samples from urban areas, selected using clustered sampling. Data were analyzed using quantitative data analysis , P-value of less than 0.05 would be considered significant. The prevalence of food insecurity was higher in rural households (31.3%) than in urban households (18.6%). Maternal nutritional knowledge and individual decision-making on food menus were significant predictors of household food security ($p<0.05$). Stunting was associated with inadequate energy and protein intake in children and limited women's empowerment in household food allocation. Most households reported coping strategies such as relying on cheaper foods and reducing meal portions. The conclusion of this study is that food insecurity is associated with low maternal nutritional knowledge and individual decision making about food menus. The incidence of stunting in households in Central Sulawesi is associated with low energy and protein adequacy of children and inadequate empowerment of women in the household.

Key Messages:

- Maternal nutritional knowledge and women's empowerment in food decision-making are crucial determinants of household food security and child nutrition in Central Sulawesi.
- This study highlights rural–urban disparities in food insecurity and child stunting, emphasizing the need for targeted, context-specific nutrition and gender-focused interventions.

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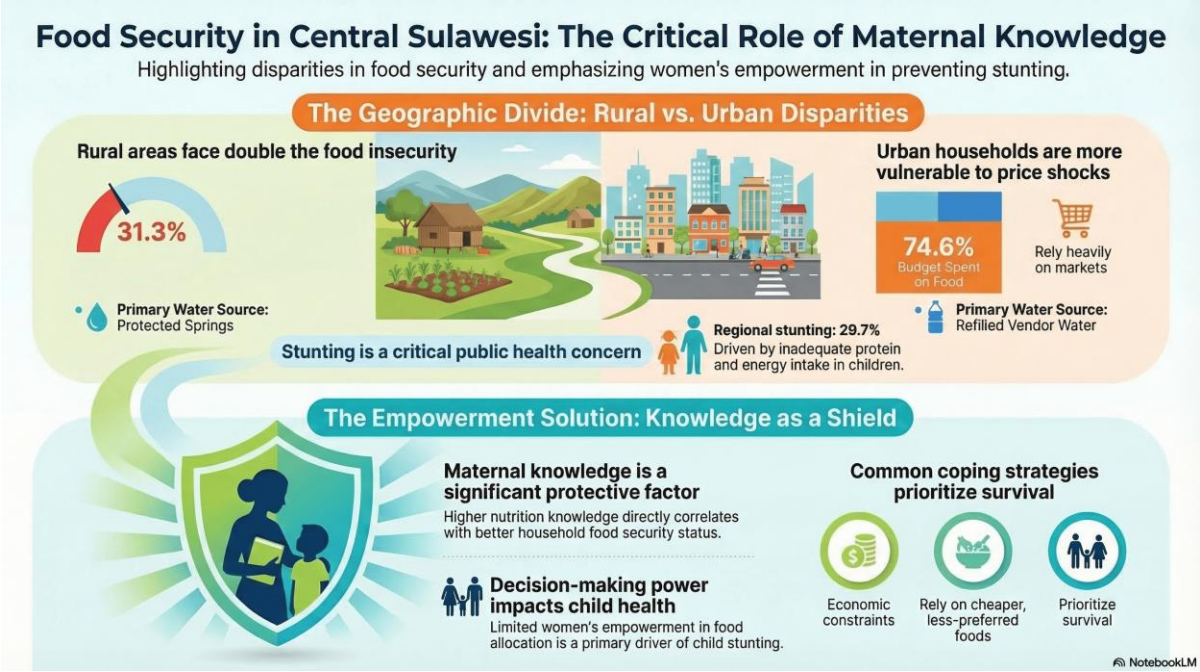
GRAPHICAL ABSTRACT



INTRODUCTION

Food security at the national level is achieved when "...all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life"(1). Even though more than 30% of the population works in the agricultural sector, Indonesia still faces a high prevalence of food insecurity in several regions. The latest report by the Food Security Agency shows that 17.1% of rural areas and 5.1% of urban areas in Indonesia have a low food security index value, meaning that people in these areas are vulnerable to food insecurity(2). In 2020, the number of people with calorie intake of less than 1400 kcal/capita/day is 8.47% of the total population, and the number of people who are food insecure is 5.42% of the population(2).

The disparity in the level of development between urban and rural areas is still one of the causes of differences in access to food between urban and rural populations. Despite Indonesia's rapid economic growth, people in rural areas benefit less than those in urban areas. Amrullah *et al* . (2019) found that 25.9 % of rural households were food insecure while only 14.1% of urban households. The study notes that rural households are more likely to become food insecure when facing economic shocks. Household human resources are characterized by the socio-economic characteristics of its members, such as education, income, employment and number of households. (3)

Social norms shape individual behavior (4), in this case including eating habits. Delormier *et al* . (2008) stated, "aspects of social context are integral in shaping the diets and dietary patterns of population groups, and that social context needs to be addressed in addition to individual preferences". Given that women are responsible for providing family food, women's nutritional knowledge is very important for the nutritional status of the household. Research by Oh *et al* . (2019) in Dakar, Senegal, proved that the level of mother's knowledge is related to nutritious feeding practices. It is also important to study the time spent providing food for the family, especially for women. Women have to set aside time to shop for food and cook it in between doing other household chores or working outside the home. The burden of mothers who have toddlers is getting heavier because they have to prepare special food for their babies and prepare time to breastfeed them. Domestic work is unpaid and more is done by women than men (5). (6,7)

Different demographic and socio-economic, ethnic and cultural characteristics can lead to different conditions of food security and nutrition. Therefore, comparative research covering many areas is needed. Based on geographical area and development, West Java (WJ) and East Kalimantan (EK) represent western Indonesia, while Central Sulawesi (CS) and West Nusa Tenggara (WNT) represent eastern Indonesia.

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Regarding the 2020 Human Development Index (IPM), WJ and EK are provinces with high HDIs, while CS and WNT have moderate HDIs. Likewise for Gross Domestic Product (GDP), WJ and EK are the top 10 provinces with the highest GDP (rank 3 and 8 respectively) . CS is ranked 19th , while WNT has the lowest GRDP compared to the other 3 provinces (ranked 23rd). The Sundanese (West Javanese ethnicity) are one of the major ethnic groups in Indonesia, accounting for 15.51 % of the population. The Bugis, Banjar and Sasak ethnic groups are the majority in CS, EK and WNT, with a proportion of 2.71%, 1.74% and 1.34% respectively. Central Sulawesi is recognized as one of the provinces with the highest stunting burden in Indonesia. Data from the 2021 Indonesian Nutrition Status Survey (SSGI) reported that the prevalence of stunting among children aged 0–59 months reached 29.7%, a figure that exceeds the national average. Substantial disparities also exist across districts, with Sigi having the highest prevalence at 40.7%, while Poso recorded the lowest at 26.7%. These rates far surpass the 20% threshold set by the World Health Organization (WHO) for identifying stunting as a public health concern (8). Such persistently high levels of stunting highlight the need to examine the sociodemographic, socioeconomic, and household gender-related factors that shape household food security and nutritional outcomes in both rural and urban areas of Central Sulawesi. Differences in parental education, household income, livelihood patterns, access to food, and gender roles in food acquisition, decision-making, and caregiving are likely to contribute to these disparities. Understanding how these determinants interact within the province's diverse geographic and social contexts is essential for designing targeted interventions to improve food security and child nutrition (9). The sociodemographic, socioeconomic and household gender determinants that influence household food security and nutrition in rural and urban areas in Central Sulawesi.

METHODS

This research uses a quantitative method with cross sectional design. This study aims to photograph the condition of food security and household nutrition in eastern Indonesia . Central Sulawesi represents the eastern region of Indonesia. In addition to exploring the differences between regions, it also explored the differences between urban and rural areas in the region. The selection of study areas was carried out purposively in accordance with the Decree of the Minister of National Development Planning of the Republic of Indonesia Number 42/M.PPN/HK/04/2020 concerning the Determination of District/City Expansion Focus Location for Integrated Stunting Reduction Intervention in 2021. The study was conducted for 2 months is June until July.

The sample is selected using clustered sampling. One district and one city from each region were selected based on the prevalence of stunting in the region. The subjects are households in each research location that are clustered according to their respective Posyandu (Posyandu), hereinafter referred to as posts. The sample size is based on the assumption that $\alpha = 5\%$ ($Z\alpha = 1.96$), test strength = 90% ($Z\beta = 1.28$). The Food Security Agency reported that the percentage of food insecurity in rural areas was P1=17.1% while in urban areas the percentage was P2=5.1% in the 2019 Food Security Index.

To anticipate the presence of subjects who dropped out of this study, the number of samples was added to 9 households for each group. The total subjects of the study were 150 households in urban areas and 150 households in rural areas.

Household data (household sociodemography, socioeconomic characteristics, food habits and consumption, food security, and gender) were obtained from interviews using a structured questionnaire with respondents. Mother was the main respondent for the research questionnaire. To obtain data on food culture, in-depth interviews were conducted with community leaders. Anthropometric measurements were also carried out to obtain data on the nutritional status of mothers and children.

Data on household sociodemographic and socioeconomic characteristics include household size, head of household, occupation, monthly income, monthly expenditure, education level, ethnicity, hygiene and sanitation, and knowledge of mother's nutrition. Household size, occupation, and education level were assessed from questions adapted from the 2018 Indonesian Basic Health Research Questionnaire (Ministry of Health 2018). Household income and expenditure were assessed using an instrument adapted from the 2020 National Socioeconomic Survey on household food expenditure and consumption as well as household income and income (10). Expenditure includes expenditure on food and non-food (clothing,

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house rent, transportation, education, fuel, health care and others). Mother's nutritional knowledge was assessed through pre-test questions about infant and child feeding (IYCF) and balanced nutrition. Household hygiene and sanitation was assessed with core questions on water, hygiene and sanitation (11). Questions include the availability of repaired water supply, repaired toilets and handwashing facilities . Mother's hand washing practices at critical times (before preparing food and after defecating) were also assessed in this section.

A child's daily nutritional intake was assessed using a multiple-passed 1 x 24-hour recall to the mother (12). The dietary diversity of a household is assessed using the Household Food Diversity Score (HDDS). HDS is calculated based on the food eaten by each household member. Respondents are responsible for preparing food for the household the previous day. At the same time , the target of interest is households (everyone living under the same roof sharing food). HDDS includes 12 groups: 1) cereals, 2) tubers and white roots, 3) vegetables, 4) fruits, 5) meat, 6) eggs, 7) fish and other seafood, 8) legumes , nuts and seeds, 9) milk and dairy products, 10) oils and fats, 11) sweets, and 12) spices, seasonings and beverages. The data collected includes food prepared inside the home and consumed inside or outside the home, food purchased or collected outside and consumed inside the home, and does not include food purchased outside the home and consumed outside (1).

Food security is measured using the Food Insecurity Experience Scale/FIES (13). There are eight questions asked by the mother during the last month. Using FIES, a household is classified at different levels of severity: “food insecure” (households that answered “no” to all questions about food insecurity related experiences) or “food insecure”. Households with mild food insecurity worry about how to obtain food, while households with moderate food insecurity compromise on quality and variety, reducing quantity and skipping meals. Households that are highly food insecure are experiencing hunger. The coping strategy mechanism is measured using the Reduced Coping Strategies Index (CSI) with a period of one week/last 7 days (14). Five standard coping strategies and weighted severity are: eating foods that are less preferred/expensive (1); borrow food or rely on help from friends and relatives (2); limiting portion sizes at mealtimes (1); limiting adult intake so that young children can eat (3) and reducing the number of meals per day (1). Answers to the simple question "In the last 7 days, if there were times when you did not have enough food or enough money to buy food, how many days did your household have to apply a particular food-based coping strategy " used to make CSI? For each household, a score is assigned for each coping strategy. The score is calculated by multiplying the frequency of using the coping strategy and the severity weight. The scores for each coping strategy are added up to give each household a combined score. Higher index values indicate more severe food insecurity.

The child's weight and height/length were analyzed using the WHO Anthro Analyzer , an online tool developed by WHO and UNICEF to comprehensively analyze anthropometric survey data. This software is available online via the link https://worldhealthorg.shinyapps.io/anthro/ . Data of z score of height for age (HAZ), weight for age z score (WAZ), and weight for height (WHZ) were obtained from the software. Maternal body mass index (BMI) is calculated by dividing body weight in kilograms by the square of height in meters. BMI was then categorized based on the recommended cut points for BMI categories as follows: <18.5, 18.5-24.9, 25.0-29.9, 30.0-34.9, 35.0-39.9, and ≥40.0 for underweight, normal weight, overweight, class I obesity , obesity class II and class III obesity respectively.

Data is presented descriptively in the form of tables, graphs and pictures. Data are presented as means and SD for continuous variables and proportions for categorical data. All statistical analyzes for quantitative data were performed using SPSS Version 22.0 for windows. A P-value of less than 0.05 would be considered significant..

CODE OF HEALTH ETHICS

This study has obtained ethical approval from the Human Research Ethics Committee of IPB University. The protocol was reviewed and approved under the approval letter number 680/IT3.KEPMSM-IPB/SK/2022, dated May 13, 2022.

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RESULTS

Table 1 present the types of data on the sociodemographic characteristics of the respondents. Respondents were predominantly of Kaili ethnicity in both rural and urban settings. Most fathers and mothers completed senior high school. Occupational patterns differed by area: fathers in rural regions largely worked as farmers, while urban fathers were more commonly employed in informal labor sectors. The vast majority of mothers were unemployed. These differences suggest agrarian livelihoods in rural settings versus greater market-driven economic dependence in urban areas, which may influence household income stability and food access.

Table 1. Sociodemographic Characteristics in Central Sulawesi

Sociodemographic Characteristic	Parigi (Rural) n= 150	Palu (Urban) n= 150	Total n= 300
Characteristics of The Fathers			
Age (year), mean ± SD	34.78 ± 7.984	33.60 ± 7.148	34.19 ± 7.566
Ethnicity, n (%)			
- Sundanese	0 (0.0)	1 (0.7)	1 (0.3)
- Jawa	7 (4,7)	4 (2.7)	11 (3.7)
- Bali	2 (1.3)	0 (0.0)	2 (0.7)
- Bugis	10 (6.7)	16 (10.7)	26 (8.7)
- Kaili	124 (82.7)	127 (84.7)	251 (83.7)
- Dampelas	1 (0.7)	0 (0.0)	1 (0.3)
- Makassar	0 (0.0)	1 (0,7)	1 (0.3)
- Gorontalo	1 (0.7)	0 (0.0)	1 (0.3)
- Minahasa	1 (0.7)	0 (0.0)	1 (0.3)
- Pamona	1 (0.7)	0 (0.0)	1 (0.3)
- Saluan	1 (0.7)	0 (0.0)	1 (0.3)
- Lauje	2 (1.3)	0 (0.0)	2 (0.7)
- Toli-toli	0 (0.0)	1 (0.7)	1 (0.3)
Education, n (%)			
- Did not go to school	0 (0.0)	2 (1.3)	2 (0.7)
- Did not finish elementary school	2 (1.3)	3 (2.0)	5 (1.7)
- Graduated from elementary school	49 (32.7)	30 (20.0)	79 (26.3)
- Graduated from junior high school	39 (26.0)	26 (17.3)	65 (21.7)
- Graduated from senior high school	56 (37.3)	73 (48.7)	129 (43.0)
- Graduated from vocational school	3 (2.0)	8 (5.3)	11 (3.7)
- Graduated from higher education	1 (0.7)	8 (5.3)	9 ()
Occupation, n (%)			
- Unemployed	1 (0,7)	3 (2,0)	4 (1,3)
- Civil servant	0 (0.0)	15 (10,0)	15 (5,0)
- Private sector employee	4 (2,7)	9 (6,0)	13 (4,3)
- Entrepreneur	15 (10,0)	24 (16,0)	39 (13,0)
- Farmer	95 (63,3)	20 (23,3)	115 (38,3)
- Laborer/driver/domestic helper	16 (10,7)	75 (50,0)	91 (30,3)
- Others	19 (12,7)	4 (2.7)	25 (8.3)
Characteristics of the mothers			
Age (year), mean ± SD	31.20 ± 7.03	30.75 ± 5.962	61.95 ± 6.496
Ethnicity, n (%)			
- Sundanese	1 (0.7)	2 (1.3)	3 (1.0)
- Arab	2 (1.3)	0 (0.0)	2 (0.7)
- Bugis	12 (8.0)	10 (6.7)	22 (7.3)
- Buol	0 (0.0)	1 (0.7)	1 (0.3)
- Buton	1 (0.7)	0 (0.0)	1 (0.3)
- Gorontalo	1 (0.7)	2 (1.3)	3 (1.0)
- Jawa	1 (0.7)	4 (2.7)	5 (1.7)
- Kaili	129 (86.0)	130 (86.7)	259 (86.3)
- Madura	1 (0.7)	0 (0.0)	1 (0.3)
- Mori	0 (0.0)	1 (0,7)	1 (0.3)
- Toraja	2 (1.3)	0 (0.0)	2 (0.7)
Education, n (%)			
- Did not go to school	1 (0.7)	3 (2.0)	4 (1.3)
- Did not finish elementary school	8 (5.3)	6 (4.0)	14 (4.7)
- Graduated from elementary school	28 (18.7)	30 (20.0)	58 (19.3)
- Graduated from junior high school	33 (22.0)	27 (18.0)	60 (20.0)
- Graduated from senior high school	59 (39.3)	66 (44.0)	125 (41.7)
- Graduated from vocational school	15 (10.0)	15 (10.0)	30 (10.0)
- Graduated from higher education	6 (4.0)	3 (2.0)	9 (3.0)
Occupation, n (%)			
- Unemployed	119 (79,3)	130 (86,7)	249 (83,0)
- Civil servant	4 (2,7)	1 (0,7)	5 (1,7)
- Private sector employee	4 (2,7)	6 (4,0)	10 (3,3)

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Sociodemographic Characteristic	Parigi (Rural) n= 150	Palu (Urban) n= 150	Total n= 300
- Entrepreneur	3 (2,0)	5 (3,3)	8 (2,7)
- Farmer	3 (2,0)	0 (0.0)	3 (1,0)
- Labourer/driver/domestic helper	0 (0.0)	1 (0,7)	1 (0,3)
Characteristics of the households			
Number of household members (person), mean ± SD	4 ± 1	5 ± 1	4 ± 1
Employment status of family members ≥15 years of age, n (%)			
- Employed	148 (98.6)	150 (100)	298 (99.3)
- Employed, but temporarily laid off	1 (0.6)	1 (0.6)	2 (0.6)
- Unemployed, just recently laid off	0 (0.0)	0 (0.0)	0 (0.0)

Table 2 presents the results of data related to household income and expenditure. Average income and total expenditure were higher in urban compared to rural households. Nevertheless, the proportion of food expenditure was considerably higher in urban households, indicating greater market reliance and economic vulnerability to food price fluctuations. In both settings, spending remained concentrated on rice, fish, and cigarettes, highlighting limited dietary diversification and a persistent allocation of household resources to non-nutritive consumption like cigarettes.

Table 2. Household food income and expenditure, and non-food expenditure in Central Sulawesi

Household income and expenditure (IDR/cap/month) in Central Sulawesi	Parigi (Rural) n = 150	Palu (Urban) n = 150	Total n = 300
Household income and expenditure			
Income (IDR/cap/month), mean ± SD	498,692 ± 927,325	578,770 ± 816,460	535,731 ± 871,892
Expenditure (IDR/cap/month), mean ± SD			
Food	353,526 ± 246,094	385,279 ± 233,301	369,402 ± 239,697
Non-Food	349,508 ± 977,901	242.026 ± 199.392	295,767 ± 588,646
Total Expenditure	703,034 ± 1,019,680	600.305 ± 333.727	651,670 ± 676,703
Proportion of Expenditure, (%)			
Food	50.28	74.66	62.4
Non-Food	49.71	25.33	37.5
Household food expenditure, mean ± SD			
Grains and cereals	84.804 ± 55.076	87.706 ± 89.133	86.255 ± 72.104
Tubers	5.886 ± 14.212	6.971 ± 20.949	6,458,77 ± 17,580
Fish and seafoods	34.370 ± 34.190	38,899 ± 39,428	36,385.15 ± 36,809
Meats	11.216 ± 16.999	11.065 ± 15.290	11.140 ± 16.145
eggs	13.726 ± 21.732	14,680 ± 15,389	14.203 ± 18.562
Milk and its processed products	20.282 ± 32.172	20,003 ± 35,698	20.142 ± 33.935
Vegetables	18,229 ± 25,349	21.992 ± 26.426	20.111 ± 25.887
Legumes	10.238 ± 13.073	11.670 ± 14.226	10.954 ± 13.649
Fruits	6.664 ± 9.727	5,745 ± 8,656	6.205 ± 9.192
Cooking oil	19,690 ± 21,792	18.214 ± 13.428	18,952±17,610
Beverages	18.127 ± 24.841	16.111± 15.539	17,119 ± 20,190
Spices	25.134 ± 29.702	24,506 ± 27,384	24,820 ± 28,543
Snacks (incl. one dish meal and processed food)	30.720 ± 91.342	25.250 ± 34.618	27,985± 62,980
Packaged beverages	5.058 ± 8.271	8.776 ± 16.103	5.058 ± 12.187
Beverages containing alcohol	8.33 ± 102.06	0.0 ± 0.0	4.17 ± 51.0
Cigarettes	49.367 ± 79.621	46,686 ± 76,184	48.026 ± 77.902
Total food	353,526 ± 246,094	385,279 ± 233,301	369,402 ± 239,697
Household non-food expenditure, mean±SD (%)			
Housing and household facilities:			
- Rent, maintenance, minor repairs	19.214 ± 127.908	13.510 ± 67.535	16.362 ± 97.722
- Electricity	17.571 ± 28.155	20.426 ± 24.190	18.998 ± 26.173
- water	1.377 ± 2.053	2.703 ± 7.651	2.040 ± 4.852
- Fuel	37,593 ± 48,862	38.968 ± 39.366	38,280 ± 44,114
- Gas	16,559±13,295	13.861 ± 10.962	15,210±12,128
- Charcoal, firewood, etc	783.33 ± 2.900	471.70 ± 1.741	627.52 ± 2.321
- Communications	23,745 ± 38,429	19.015 ± 22.101	21,380 ± 30,265
Hygiene and sanitation products:			
- Bath soap, toothpaste, toothbrush, shampoo, laundry soap, etc	19.646 ± 20.260	19.868 ± 15.201	19.757 ± 17.730
- Beauty products (incl. sanitary pads)	14.808 ± 32.723	15.086 ± 30.449	14.947 ± 31.586

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Household income and expenditure (IDR/cap/month) in Central Sulawesi	Parigi (Rural) n = 150	Palu (Urban) n = 150	Total n = 300
Health costs (hospitals, doctors, medicine)	2.464 ± 7.321	1.935 ± 6.455	2,200 ± 6,888
Education costs	15,986 ± 42,196	13.965 ± 27.656	14,975± 34,926
Transportation and accommodations	3,203 ± 12,628	5.294 ± 13.917	4.249 ± 13.273
Wage of domestic helpers	833.33 ± 7.192	0.00 ± 0.00	416.67 ± 3.596
Clothing and footwear	20,841 ± 28,810	20,925 ± 31,209	20.883 ± 30.010
Taxes, levies, loans, instalments	60,897 ± 299,322	22,455± 62,420	41,676 ± 180,871
Special expenses (party, ceremony, funeral, etc)	94.126 ± 840.138	33,548 ± 140,797	63,837 ± 490,468
Total	349,508 ± 977,901	242.026 ± 199.392	295,767 ± 588,646

Based on the results in table 3 which shows data on the source of water used in households, Water sources varied markedly by location: rural households mainly relied on protected natural springs, whereas urban households depended on refilled water and drilled wells. Most households used pour-flush toilets, although a proportion still lacked safely managed sanitation. Handwashing practices were reported to be high in key hygiene moments, despite gaps in dedicated handwashing facilities. This indicates good hygiene knowledge even where infrastructure remains limited.

Table 3. Water sources, sanitation facilities, and hygiene practices in Households in Central Sulawesi

Water sources, sanitation facilities, and hygiene practices in households	Parigi (Rural) n = 150	Palu (Urban) n = 150	Total n = 300
Type of water sources			
Water for drinking, n (%)			
- Bottled water	1 (0.7)	0 (0.0)	1 (0.3)
- Vendor provided water	48 (32.0)	78 (52.0)	126 (42.0)
- Public standpipes	13 ((8.7)	14 (9.3)	27 (9.0)
- Metered tap water	1 (0.7)	0 (0.0)	1 (0.3)
- Drilled/pumped wells	16 (10.7)	34 (22.7)	50 (16.7)
- Protected dug well	2 (1.3)	5 (3.3)	7 (2.3)
- Protected water springs	62 (41.3)	16 (10.7)	78 (26.0)
- Unprotected water springs (unimproved)	2 (1.3)	1 (0.7)	3 (1.0)
- Rainwater collection	0 (0.0)	1 (0.7)	1 (0.3)
- Surface water (eg, river, dam or lake) (unimproved)	6 (4.0)	5 (3.3)	11 (3.7)
Water for cooking, n (%)			
- Bottled water	1 (0.7)	0 (0.0)	1 (0.3)
- Vendor provided water	12 (8.0)	32 (21.3)	44 (14.7)
- Public standpipes	18 (12.0)	26 (17.3)	44 (14.7)
- Metered tap water	2 (1.3)	0 (0.0)	2 (0.7)
- Drilled/pumped wells	43 (28.7)	69 (46.0)	112 (37.3)
- Protected dug well	3 (2.0)	4 (2.7)	7 (2.3)
- Protected water springs	66 (44.0)	18 (12.0)	84 (28.0)
- Unprotected water springs (unimproved)	2 (1.3)	0 (0.0)	2 (0.7)
- Rainwater collection	0 (0.0)	1 (0.7)	1 (0.3)
- Surface water (eg, river, dam or lake) (unimproved)	5 (3.3)	4 (2.7)	9 (3.0)
Water for bathing and washing, n (%)			
- Public standpipes	30 (20.0)	35 (23.3)	65 (21.7)
- Metered tap water	2 (1.3)	0 (0.0)	2 (0.7)
- Drilled/pumped wells	42 (28.0)	86 (57.3)	128 (42.7)
- Protected dug well	3 (2.0)	4 (2.7)	7 (2.3)
- Protected water springs	59 (39.3)	20 (13.3)	79 (26.3)
- Unprotected water springs (unimproved)	5 (3.3)	0 (0.0)	5 (1.7)
- Rainwater collection	0 (0.0)	1 (0.7)	1 (0.3)
- Surface water (eg, river, dam or lake) (unimproved)	9 (6.0)	3 (2.0)	12 (4.0)
Type of sanitation facilities			
Defecation facilities, n (%)			
- Private facilities, used only by specific household members	14 (9.3)	7 (4.7)	21 (7.0)
- Private facility, used by household members	111 (74.0)	130 (86.7)	241 (80.3)
- Shared facility, used by specific households (unimproved)	4 (2.7)	3 (2.0)	7 (2.3)

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Water sources, sanitation facilities, and hygiene practices in households	Parigi (Rural) n = 150	Palu (Urban) n = 150	Total n = 300
- Public facility, used by everyone (unimproved)	17 (11.3)	6 (4.0)	23 (7.7)
Toilet types, n (%)			
- flush	97 (64.7)	113 (75.3)	210 (70.0)
- Pit latrines with slabs	26 (17.3)	24 (16.0)	50 (16.7)
- Open pit latrines (unimproved)	1 (0.7)	0 (0.0)	1 (0.3)
- Hanging latrines (unimproved)	4 (2.7)	2 (1.3)	6 (2.0)
- None (unimproved)	15 (10.0)	7 (4.7)	22 (7.3)
Fecal waste disposal types, n (%)			
- Septic tanks	95 (63.3)	107 (71.3)	202 (67.3)
- Piped sewer system	3 (2.0)	1 (0.7)	4 (1.3)
- Pond/rice field (unimproved)	0 (0.0)	0 (0.0)	0 (0.0)
- River/lake (unimproved)	17 (11.3)	2 (1.3)	19 (6.3)
- Pits (unimproved)	34 (22.7)	29 (19.3)	63 (21.0)
- Field/yard (unimproved)	0 (0.0)	4 (2.7)	4 (1.7)
- Others (unimproved)	5 (3.3)	1 (0.7)	6 (2.0)
Hygiene indicators			
Handwashing facilities, n (%)			
- Have separate handwashing facility, n (%)	50 (33.3)	41 (27.3)	91 (30.3)
- Clean water is available for hand washing	116 (77.3)	123 (82.0)	239 (79.7)
- Soap is available for hand washing	115 (76.7)	118 (78.7)	233 (77.7)
Handwashing time, n (%)			
- Before preparing and cooking food	126 (84.0)	128 (85.3)	254 (84.7)
- Before and after eating	149 (99.3)	150 (100.0)	299 (99.7)
- After using the toilet	147 (98.0)	149 (99.3)	296 (98.7)
- After changing diapers or helping children in the toilet	120 (80.0)	125 (83.3)	245 (81.7)
- After holding animals	117 (78.0)	123 (82.0)	240 (80.0)
- After handling trash	117 (78.0)	125 (83.3)	242 (80.7)
- When hands look dirty	119 (79.3)	124 (82.7)	234 (81.0)

Table 4 shows the distribution of nutritional knowledge among a cohort of 300 participants, stratified equally by rural (Parigi) and urban (Palu) residency in Central Sulawesi. Quantitative assessment reveals that the rural population had a marginally higher mean nutritional knowledge score (75.61 ± 15.27) than the urban population (74.33 ± 12.77). Categorically, a larger proportion of the rural participants attained a "Good" knowledge level (45.3% vs. 32.7%), whereas the urban cohort was more frequently classified within the "Moderate" (56.7%) and "Poor" (10.7%) knowledge brackets.

Table 4. Nutritional knowledge in Central Sulawesi

Nutritional knowledge categories	Parigi (Rural) n=150	Palu (Urban) n=150	Total n=300
Poor (<60)	9 (6.0)	16 (10.7)	25 (8.3)
Moderate (60-80)	73 (48.7)	85 (56.7)	158 (52.7)
Good (>80)	68 (45.3)	49 (32.7)	117 (39.0)
Mean ± SD	75.61 ± 15.27	74.33 ± 12.77	74.97 ± 14.02

Table 5 shows the specific nutritional knowledge competencies of the rural (Parigi) and urban (Palu) cohorts across 20 itemized questions concerning Infant and Young Child Feeding (IYCF) and Balanced Nutrition. Analysis of the item-level responses reveals a robust foundational understanding of general nutritional principles across the total population (n=300), with over 90% of participants accurately identifying that daily food intake boosts immunity (95.3%) and that milk is an abundant source of calcium (91.0%). However, significant knowledge deficits and prevalent misconceptions persist regarding specific practical applications, particularly within the IYCF domain and the evaluation of certain processed foods; notably, approximately 40% of the overall cohort incorrectly believed that 2-to-3-month-old infants are permitted to eat solid foods like bananas or papaya (59.3% correct), that newborns should only receive breastmilk for three months (58.3% correct), and that sweetened condensed milk is more nutrient-dense than standard milk (58.0% correct). Furthermore, while broader knowledge trends remained consistent across regions, distinct geographic variations emerged in specific competencies, with the urban cohort demonstrating slightly better awareness regarding the proper timeline for exclusive breastfeeding (63.3% vs. 53.3%), whereas the rural cohort exhibited higher accuracy in recognizing the qualitative superiority of breastmilk over infant formula (72.5% vs. 61.3%).

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Table 5. Proportion of respondents who answered the nutritional knowledge questions correctly in Central Sulawesi

Nutritional knowledge questions	Parigi (Rural) n=150	Palu (Urban) n=150	Total n=300
Infant And Young Child Feeding (IYCF)			
1. Babies that are 2 or 3 months old are permitted to eat bananas or papaya (false)	91 (60.7)	87 (58.0)	178 (59.3)
2. From birth to three months old, new-borns only receive breastmilk (false)	80 (53.3)	95 (63.3)	175 (58.3)
3. Fish and eggs are good for a child's growth (true)	139 (92.7)	127 (84.7)	266 (88.7)
4. Breastmilk alone, without any other food or drink, should be given to infants until they are 6 months old (true)	116 (77.3)	111 (74.0)	227 (75.7)
5. For children older than six months, complementary feeding is provided (true)	127 (84.7)	127 (84.7)	254 (84.7)
6. It is deemed sufficient to breastfeed a child until they turn one year old (false)	94 (63.1)	107 (71.3)	201 (67.2)
7. Breastmilk equals the quality of infant formula (false)	108 (72.5)	92 (61.3)	200 (66.9)
Balanced Nutrition			
8. Vegetables are essential to consume because they frequently serve as sources of protein (false)	103 (68.7)	106 (70.7)	209 (69.7)
9. Compared to powder or liquid milk, sweetened condensed milk is more nutrient-rich (false)	81 (54.0)	93 (62.0)	174 (58.0)
10. Protein is a growth-promoting nutrient (true)	136 (90.7)	132 (88.0)	268 (89.3)
11. Compared to lunch or dinner, breakfast is less important (false)	88 (58.7)	89 (59.3)	177 (59.0)
12. Consuming iodized salt is advised to avoid goiter (true)	116 (77.3)	105 (70.0)	221 (73.7)
13. Calcium is abundant in milk (true)	131 (87.3)	142 (94.7)	273 (91.0)
14. Iron is necessary for the formation of bones and teeth (false)	104 (69.3)	97 (64.7)	201 (67.0)
15. We need nutrient-dense, varied food in our diets (true)	135 (90.0)	123 (82.0)	258 (86.0)
16. Eggs, carrots, and green beans are all iron-rich foods (false)	87 (58.0)	94 (62.7)	181 (60.3)
17. Food that we eat every day helps to boost immunity (true)	147 (98.0)	139 (92.7)	286 (95.3)
18. Milk, fish, tofu are sources of animal protein (false)	119 (79.3)	115 (76.7)	234 (78.0)
19. Vegetables are vitamin and mineral sources (true)	132 (88.0)	127 (84.7)	259 (86.3)
20. Both oil and avocado are sources of fat (true)	121 (80.7)	122 (81.3)	243 (81.0)

Table 6 shows the household food habits among a cohort of 300 respondents, stratified by rural (Parigi) and urban (Palu) residency in Central Sulawesi. Overall dietary patterns exhibit high consistency across both geographic areas, characterized by a nearly identical mean daily eating frequency (2.86 ± 0.56 times/day) and the vast majority of the total population consuming three meals daily (76.5%). A strong cultural emphasis on communal dining is universally evident, as 88.7% of all surveyed households report a routine of eating meals together with family, primarily motivated by a sense of "togetherness" (70.3%) and established familial habit (49.7%). While dinner serves as the predominant communal meal across both demographics (76.0% overall), notable geographic divergences emerge regarding earlier meals; rural households exhibit a substantially higher prevalence of sharing breakfast (51.3% vs. 38.7%) and lunch (38.0% vs. 26.0%) together compared to their urban counterparts, a variance that likely reflects differences in occupational structures, daily commuting constraints, or domestic routines inherent to rural versus urban lifestyles.

Table 6. Household food habits in Central Sulawesi

Household food habits	Parigi (Rural) n = 150	Palu (Urban) n = 150	Total n = 300
Eating frequency (times/day), mean ± SD	2.83 ± 0.56	2.90 ± 0.56	2.86 ± 0.56
Category of eating frequency, n (%)			
- 1 time	4 (2.6)	5 (3.3)	9 (2.95)
- 2 times	24 (16.0)	17 (11.3)	41 (13.65)
- 3 times	115 (76.0)	116 (77.3)	231 (76.5)
- >3 times	7 (4.6)	12 (8.0)	19 (7.0)
Habit of eating together with family, n (%)	132 (88.0)	134 (89.3)	266 (88.7)
Common mealtime of eating together with family, n (%)			
- Breakfast	77 (51.3)	58 (38.7)	135 (45.0)
- Lunch	57 (38.0)	39 (26.0)	96 (32.0)
- Dinner	117 (78.0)	111 (74.0)	228 (76.0)
Meaning of eating together with family, n (%)			
- Togetherness	111 (74.0)	100 (66.7)	211 (70.3)

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Household food habits	Parigi (Rural) n = 150	Palu (Urban) n = 150	Total n = 300
- convenience	51 (34.0)	47 (31.3)	98 (32.7)
- Sharing happiness	52 (34.7)	51 (34.0)	103 (34.3)
- The food is more delicious	45 (30.0)	48 (32.0)	93 (31.0)
- It is already a habit	76 (50.7)	73 (48.7)	149 (49.7)

Table 7 shows the average daily nutrient intake and corresponding percentage of nutritional adequacy among rural (Parigi) and urban (Palu) cohorts in Central Sulawesi, revealing distinct geographic dietary patterns alongside widespread micronutrient vulnerabilities. While both populations exhibit slightly suboptimal overall energy adequacy (~88%) and a substantial over-adequacy in protein intake (>142%), the urban demographic demonstrates marginally higher energy, fat, and iron consumption compared to rural residents. A significant geographic disparity emerges regarding calcium, where the rural group achieves markedly higher absolute consumption (535 mg; 73.92% adequacy) than the urban group (251.89 mg; 39.01% adequacy). Despite these variations, both cohorts display critical deficiencies in essential micronutrients—including iron, zinc, vitamin A, and vitamin C—with adequacies consistently falling below 70% of recommended daily values.

Table 7. Average Intake of Nutrients in Central Sulawesi

	Parigi (Rural) n = 150	Palu (Urban) n = 150	Total n = 300
Intake of Nutrients			
Energy (kcal)	1082.00 (849.61-1275.88)	1204.24 (905.18-1338.70)	1136.10 (877.31-1313.60)
Fats (g)	139.39 (100.43-182.58)	156.23 (120.46-202.33)	147.29 (104.00-196.86)
Proteins (g)	29.21 (20.69-46.49)	30.39 (21.57-40.46)	29.78 (21.16-43.37)
Carbohydrates (g)	11:45 p.m. (12.97-37.62)	26.79 (16.27-42.97)	24.88 (15.21-40.43)
Calcium (mg)	535 (309.75-704.00)	251.89 (148.3-377.28)	366.14 (194.68-586.25
Iron (mg)	3.81 (2.45-6.59)	4.39 (3.23-6.53)	4.16 (2.79-6.56)
Zinc (mg)	2.27 (1.54-3.34)	2.40 (1.67-3.12)	2.43 (1.65-3.21)
Vitamin A	189.99 (65.10-365.77)	187.00 (46.62-498.48)	187.20 (52.70-416.93)
Vitamin C	1082.00 (849.61-1275.88)	1204.24 (905.18-1338.70)	1136.10 (877.31-1313.60)
Percentage energy and nutrient adequacy			
Energy (kcal)	85.61 (72.06-96.68)	89.62 (76.87-97.15)	88.23 (75.82-97.04)
Fats (g)	71.46 (51.38-98.54)	81.61 (58.82-102.88)	76.66 (55.60-100.29)
Proteins (g)	142.23 (93.99-228.08)	143.90 (103.01-197.17)	143.12 (98.32-204.96)
Carbohydrates (g)	51.43 (30.34-84.86)	58.02 (35.95-95.01)	56.38 (31.78-88.33)
Calcium (mg)	73.92 (55.94-92.30)	39.01 (22.24-6.77)	57.66 (34.08-82.90)
Iron (mg)	46.40 (30.28-93.40)	55.05 (39.96-76.61)	51.74 (34.30-81.75)
Zinc (mg)	62.10 (43.61-90.21)	66.61 (50.59-90.35)	64.04 (45.59-90.34)
Vitamin A	46.73 (15.53-87.25)	46.75 (11.66-119.96)	46.75 (13.17-96.74)
Vitamin C	12.58 (3.08-49.82)	18.59 (3.15-83.85)	15.10 (2.99-67.63)

Table 8 comprehensively evaluates household dietary diversity, food insecurity experiences, and associated coping mechanisms among rural (Parigi) and urban (Palu) cohorts in Central Sulawesi. Despite a substantial majority of both rural (78%) and urban (75.3%) households achieving a "High" Household Dietary Diversity Score (HDDS >7 food groups) characterized by the widespread consumption of varied nutritional sources including animal proteins, vegetables, and fruits, this diversity paradoxically coexists with pervasive underlying food insecurity. Specifically, while mild food insecurity is the most common experience across the total population (57.65%), rural households exhibit a notably higher vulnerability to moderate (25.3% vs. 14.0%) and severe (6.0% vs. 4.6%) food insecurity compared to their urban counterparts. This heightened rural vulnerability is further corroborated by their increased reliance on food provision coping strategies; rural residents more frequently employ compensatory measures such as relying on less preferred, inexpensive foods (mean frequency 1.53 vs. 0.99) and borrowing food or relying on help (0.63 vs. 0.38), indicating that while dietary variety is currently maintained, rural food access remains structurally more precarious and dependent on active coping behaviors.

Table 8. Household dietary diversity score (HDDS) category in Central Sulawesi

HDDS category	Parigi (Rural) n = 150	Palu (Urban) n = 150	Total n = 300
Low dietary diversity (≤5 food groups), n (%)	12(8)	9(6)	21(7)
Medium dietary diversity (6-7 food groups), n (%)	21(14)	28(16,6)	49(16,3)
High dietary diversity (>7 food groups), n (%)	117(78)	113(75.3)	230(76.7)
Mean ± SD	10.01±3.33	9.54±3.15	9.77±3.2

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Food group consumed by ≥50% households by dietary diversity in Central Sulawesi			
District	**Low dietary diversity (≤ 5 food groups)**	**Medium dietary diversity (6-7 food groups)**	**High dietary diversity (>7 food groups)**
Parigi (Rural)	Cereals eggs Pulses, legumes, nuts	Cereals eggs Oils/fats Fish and seafood Sugar/honey Miscellaneous	Cereals Vegetables Fruits Meat, poultry, offal eggs Fish and seafood Pulses, legumes, nuts Oils/fats Sugar/honey
Palu (Urban)	Cereals eggs Oils/fats	Cereals eggs Oils/fats Fish and seafood Pulses, legumes, nuts Sugar/honey Miscellaneous	Cereals Vegetables Fruits Meat, poultry, offal eggs Fish and seafood Pulses, legumes, nuts Oils/fats Sugar/honey

Food insecurity experience in the past month, n (%)	**Parigi (Rural) n = 150**	**Palu (Urban) n = 150**	**Total n = 300**
Food safety (score 0)	23 (15.3)	29 (19.3)	52 (17.3)
Mildly food insecure (score 1-3)	80 (53.3)	93 (62.0)	173 (57.65)
Moderately food insecure (score 4-6)	38 (25.3)	21 (14.0)	59 (19.65)
Severely food insecure (score 7-8)	9 (6.0)	7 (4.6)	16 (5.3)
Coping strategy mechanism of food provision in the past week in Central Sulawesi			
Relying on less preferred and less expensive food	1.53 ± 1.93	0.99 ± 1.55	1.26 ± 1.74
Borrow food, or rely on help from a friend or relative	0.63 ± 1.19	0.38 ± 0.93	0.50 ± 1.06
Purchase food on credit	0.47 ± 1.41	0.40 ± 1.22	0.43 ± 1.31
Gather wild food, hunt, or harvest immature crops	0.17 ± 0.55	0.15 ± 0.68	0.16 ± 0.61
Consume seed stock held for next season	0.09 ± 0.35	0.11± 0.47	0.1 ± 0.41
Send household members to eat elsewhere	0.16 ± 0.71	0.11 ± 0.44	0.05 ± 0.57
Send household members to bag	0.05 ± 0.24	0.05 ± 0.25	0.05 ± 0.24
Limit portion size at mealtimes	0.13 ± 0.49	0.15 ± 0.56	0.14 ± 0.52
Restrict consumption by adults in order for small children to eat	0.19 ± 0.63	0.19 ± 0.68	0.19 ± 0.64
Feed working members of HH at the expense of non-working members	0.07 ± 0.59	0.04 ± 0.35	0.06 ± 0.47
Reduce the number of meals eaten in a day	0.17 ± 0.54	0.21 ± 0.78	0.19 ± 0.66
Skip entire days without eating	0.03 ± 0.16	0.01 ± 0.12	0.02 ± 0.14

The results of Table 9, based on the analysis of the determinants of household food insecurity in Central Sulawesi, show that in the overall sample, maternal nutrition knowledge was a significant protective factor against household food insecurity. Meanwhile, household size, food expenditure proportion, parental occupation, and maternal education showed no significant associations, indicating that structural socioeconomic characteristics alone may not fully explain household food security status. Stratified analyses revealed contextual differences. In urban areas, maternal nutrition knowledge remained a significant determinant of food insecurity, suggesting that knowledge-driven decision-making plays a stronger role where food is predominantly accessed through the market. Conversely, no determinant reached significance in rural areas, implying that food insecurity may be influenced by broader environmental or seasonal constraints rather than household-level characteristics.

The results of table 9 based on the analysis of the determinants of household nutrition insecurity At the provincial level, energy and protein adequacy were significantly associated with household nutrition insecurity, highlighting diet quality as a critical underlying factor in nutritional outcomes. In rural households, both energy and protein adequacy were consistently significant predictors, reinforcing concerns around chronic nutritional insufficiency linked to agrarian livelihoods. In urban households, lower maternal education was associated with higher nutrition insecurity, indicating that knowledge-related socioeconomic disparity may affect nutritional access and decision-making in market-dependent settings. Households with adequate energy intake were 2.37 times more likely to achieve nutritional security compared to those with inadequate intake.

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Table 9. Determinants of household food insecurity in Central Sulawesi

Determinants of household food insecurity in Central Sulawesi	OR	95% CI	p.s
Household size	0.959	(0.753; 1.222)	0.734
Mothers' nutritional knowledge	0.983	(0.709; 0.958)	0.025*
% Food expenditure	1010	(0.992; 1.028)	0.293
Fathers work as non-employees	0.626	(0.183; 2.139)	0.455
Working mothers	1,478	(0.608; 3.595)	0.389
Low mothers' education	0.723	(0.342; 1.526)	0.394
Mothers/girls eat last	2,294	(0.438; 12.014)	0.326
Household Food Insecurity in Rural Central Sulawesi (Parigi)	**OR**	**95% CI**	**p.s**
Household size	1.2613	0816-1948	0.296
Mothers' nutritional knowledge	1.0008	0.9642-1.0389	0.398
% Food expenditure	1.00	0	0.063
Fathers work as non-employees	41945.8321	(0.0000-3.2386)	0.965
Working mothers	0.5483	(0.1361-2.2092)	0.047**
Low mothers' education	3.0592	(0.9417- 9.9384)	0.972
Mothers/girls eat last	1.7201	(0.1914- 15.4608)	0.628
Household Food Insecurity in Urban Central Sulawesi (Palu)	**OR**	**95% CI**	**p.s**
Household size	1.0400	(0.7414; 1.4590)	0.820
Mothers' nutritional knowledge	1.0532	(1.0080; 1.1004)	0.021***
% Food expenditure	0.9967	(0.9675; 1.0267)	0.826
Fathers work as non-employees	2.5016	(0.6008; 10.4167)	0.208
Working mothers	0.9611	(0.2109; 4.3807)	0.959
Low mothers' education	0.9781	(0.2957; 3.2361)	0.971
Mothers/girls eat last	0.0000	(0.0000;7.1425)	0.959
Household Nutrition Insecurity in Central Sulawesi	**OR**	**95% CI**	**p.s**
Household size	1013	(0.833; 1.233)	0.894
Mothers' nutritional knowledge	1.019	(0.997; 1.041)	0.090
% Food expenditure	1,000	(0.985; 1.016)	0969
Fathers work as non-employees	0.668	(0.261; 1.712)	0.401
Working mothers	0.834	(0.405; 1.716)	0.622
Low mothers' education	1.165	(0.620; 2.188)	0.635
% Energy adequacy	2,371	(0.1.029; 5.463)	0.043****
% Protein adequacy	2,320	(1.356; 3.971)	0.002****
Mothers/girls eat last	0.620	(0.180; 2.131)	0.448
Household Nutrition Insecurity in Rural Central Sulawesi (Parigi)	**OR**	**95% CI**	**P**
Household size	1.3774	(0.9663; 1.9635)	0.077
Mothers' nutritional knowledge	1.0004	(0.9722; 1.0294)	0.980
% Food expenditure	0.9945	(0.9700; 1.0197)	0.667
Fathers work as non-employees	1.1859	(0.000;1.2981)	0.951
Working mothers	0.7533	(0.2808; 2.0209)	0.574
Low mothers' education	1.1874	(0.4707; 2.9953)	0.716
% Energy adequacy	4,456	(1,269;15,639)	0.020*****
% Protein adequacy	2,304	(1,140;4,656)	0.020*****
Mothers/girls eat last	1.1160	(0.1677; 7.4252)	0.910
Household Nutrition Insecurity in Urban Central Sulawesi (Palu)	**OR**	**95% CI**	**p.s**
Household size	0.8120	(0.6039; 1.0917)	0.168
Mothers' nutritional knowledge	0.9790	(0.9485; 1.0104)	0.188
% Food expenditure	0.9817	(0.9575; 1.0066)	0.148
Fathers work as non-employees	2.6188	(0.8482; 8.0850)	0.094
Working mothers	1.2975	(0.4072; 4.1339)	0.660
Low mothers' education	0.3847	(0.1551; 0.9541)	0.039******
% Energy adequacy	1,568	(0.660; 3.724)	0.308
% Protein adequacy	1,456	(0.757; 2.802)	0.260
Mothers/girls eat last	1.3003	(0.2915; 5.8007)	0.731

*Logistic regression, p<0.05, r^2 = 15.20%
**Logistic regression, p<0.05, r^2 = 13.2%
***Logistic regression. p<0.05. r2 = 16.08%
****Logistic regression, p<0.05, r2 = 13.70%
*****Logistic regression, p<0.05. r^2 = 10.64%
******Logistic regression, p<0.05, r2 = 13.02%

DISCUSSION

Determinants of Food Security

The results obtained from the variable knowledge of maternal nutrition are expressed in statistical values (OR=0.983, 95% CI=0.709; 0.958, p value=0.025), which means that there is a relationship between maternal nutritional knowledge and household food security. Mother's knowledge is obtained from her educational background. This finding is in line with the research which reported that households with highly educated mothers would especially influence household consumption patterns, where mothers or

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housewives consumed more fruit, fish and vegetables. more milk , thereby affecting the nutritional quality of the food prepared by the mother/housewife (15).

The results obtained from working mothers are expressed in statistical values (OR = 0.5483, 95% CI = 0.1361-2.2092, p value = 0.047), which means that there is relationship between working mothers and household food security. This finding is supported by other research which says that a mother's employment status, whether working or not working, has no effect on the level of household food security (16).

The results obtained from the mother's nutritional knowledge variable are expressed in statistical values (OR = 1.0532, 95% CI = 1.0080; 1.1004, p value = 0.021), meaning that there is a relationship between maternal nutritional knowledge and household food. security . From other studies, it was revealed that there was a significant relationship between maternal nutritional knowledge and household food security. With knowledge of nutrition, housewives are expected to be skilled in choosing and determining the type of food consumed by all family members quickly and precisely, so that even though they belong to a poor family, they still have food security status (17). Fry *et al* also suggested to housewives who are literate and able to access the media, in order to use it to significantly increase nutritional knowledge, so as to reduce the risk of food insecurity status (18). Maternal nutritional knowledge demonstrated mixed results, showing significance in urban areas but not in rural settings. Urban households, where food procurement depends more heavily on purchased foods, may benefit from higher nutrition knowledge that supports more appropriate food choices (19).In contrast, rural households often depend on locally produced foods, making nutrition knowledge less central to food access.

The analysis of household food security in Central Sulawesi shows that most sociodemographic and socioeconomic variables—including household size, maternal education, maternal employment, and fathers' occupations—did not exhibit significant associations with food security in either rural (Parigi Moutong) or urban (Palu) areas. These findings contrast with several global studies suggesting that larger household size and lower education are typically linked to reduced food access (20). In the context of Central Sulawesi, the absence of these associations indicates that household food security is shaped not by demographic characteristics alone but by broader structural and contextual factors.

Economic variables such as food expenditures and employment status were also not consistently related to food security (21). This pattern mirrors findings from other low- and middle-income contexts where monetary indicators do not fully capture household resilience. In rural Central Sulawesi, households often rely on non-market food sources—home gardens, livestock, fish ponds, and forest products—which help buffer against income fluctuations (22). Such coping strategies have been widely documented in Asian and African rural communities.

Overall, these findings highlight that food security in Central Sulawesi is shaped by the interplay of gender roles, food environments, and livelihood systems. The lack of significant associations for many demographic and socioeconomic predictors underscores the need for integrated interventions that strengthen local food systems and improve access to diverse foods.

Determinants of Food Security

The results obtained from the energy adequacy variable are expressed in statistical values (OR=2.371, 95% CI=0.1029; 5.463, p=0.043), which means that there is a relationship between energy adequacy and household food security. This finding is in line with research which reported a correlation between energy adequacy and family food security (23). The results of measuring the level of energy adequacy can describe the quantity of food consumption.

The results obtained from the protein adequacy variable are expressed in statistical values OR = 2.320, 95% CI = 1.356; 3.971, p value = 0.002), which means there is a relationship between protein adequacy and household food security. This finding is in line with a report from a study by Masthalina (2021) concerning food insecurity that occurs in households tends to affect the protein and energy intake of household members (24). Families that fall into the food insecure category tend to have an energy and protein adequacy level of only 20.8 – 29.2%. Suppose this condition of food insecurity occurs in the long term. In this case it will reduce the quality and quantity of food which can cause nutritional problems for family members.

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The results obtained from the energy adequacy variable are expressed in statistical values (OR=4.456, 95% CI=1.269 ; 15.639 , p=0.020) which means that there is a relationship between energy adequacy and household food security. This finding is in line with the research of Sihite and Tanziha (2021) which resulted in the majority of the households in their research sample having an energy adequacy level in the severe deficit category (43.3 %)(25). The status of food security can be measured from the level of energy adequacy, where if the level of sufficiency is <90% then the household is included in the category of food insecurity, whereas if the level of sufficiency is > 90% then the household is included in the category of food security (26). In addition, according to Sihite and Tanziha (2021), the results of this study indicate that the household sample in this study falls into the food insecure category (25).

The results obtained from the protein adequacy variable are expressed in statistical values (OR=2.304, 95% CI=1.140; 4.656, p value=0.020), which means that there is a relationship between protein adequacy and household food security. The results of another study show that most of the coastal areas in Sidoarjo Regency (<75%) are experiencing food insecurity. This condition is also coupled with the description of the adequacy of the respondents' protein consumption, which on average is approximately 47 g/day (lower than the total protein requirement per day) (27). According to the Food Security Agency, a protein adequacy level of <75% EER is included in the food insecurity category, while moderate food security is stated to be around 75 – 100% EER (28).

The results obtained from the low mother's education level variable are expressed in statistical values (OR=0.3847, 95% CI= 0.1551; 0.9541, p value=0.039) which means that there is a relationship found between the low mother's education level and household food. security . Other studies explain that the higher the level of education, the higher the pattern or amount of household consumption. Adequate education will influence household consumption patterns. This is in line with the results of Putri *et al's research* which states that the education level of housewives has an important role in influencing household consumption (29).

Indicators related to dietary adequacy—particularly energy and protein sufficiency—emerged as important predictors of nutritional insecurity. Households with inadequate energy and protein intake were more likely to experience food insecurity, consistent with global literature showing that nutrient adequacy reflects diet quality and household capacity to access diverse foods (30). Nutrient intake therefore serves not only as an outcome of food insecurity but also as an indicator of household vulnerability. Other variables, including household demographics, parental education, and employment status, did not show consistent associations with nutritional insecurity (31). This suggests that nutritional insecurity in Central Sulawesi is more strongly linked to food consumption patterns than socioeconomic background. Limited dietary diversity—driven by high reliance on staple foods—remains a key challenge for households in both rural and urban settings (32).

Rural and urban differences also shape nutritional insecurity. While rural households may be more resilient through subsistence food production, their diets are often less diverse. Urban households may have greater food variety available but depend heavily on income and market prices (33). These dynamics reflect global observations that nutritional insecurity results from the interaction between food systems, market access, and dietary behavior.

Overall, addressing nutritional insecurity requires strategies that improve dietary diversity, ensure access to nutrient-rich foods, and strengthen household food production and coping mechanisms. Considering the persistent high rates of stunting in Central Sulawesi, enhancing nutrient adequacy remains a critical priority (19).

CONCLUSION

This study concludes that household food security and nutritional status in Central Sulawesi are shaped by a combination of sociodemographic, socioeconomic, and gender-related factors. Food insecurity in the province is primarily associated with low maternal nutritional knowledge and limited decision-making power of women in determining household food choices, indicating the importance of gender dynamics in shaping food access and consumption. Furthermore, stunting among children is closely linked to inadequate energy and protein intake, reflecting the persistent challenges in achieving sufficient dietary

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quality at the household level. Overall, the findings highlight that improving food and nutrition security in Central Sulawesi requires strengthening women's empowerment in household food management and enhancing access to nutrient-rich foods. Interventions should prioritize food-based nutrition programs that address dietary adequacy and support families in achieving balanced and diverse food consumption. These efforts are essential to reducing food insecurity and preventing stunting in the region.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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