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Obesogenic behaviour and food insecurity on dietary intake of informal working mothers with children under five in the post-pandemic era

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ABSTRACT

Introduction: The COVID-19 pandemic has had a substantial impact on informal working mothers, who struggle to balance employment and childcare amid limited resources. These challenges have increased food insecurity and obesogenic behaviour, affecting their dietary intake. This study examined the association between food insecurity and obesogenic behaviour in informal working mothers in peri-urban and rural areas, focusing on their dietary patterns during the post-pandemic era. **Method:** This cross-sectional study was conducted in peri-urban and rural areas of Indonesia between November and December 2022. A total of 143 informal working mothers with children under five were recruited through consecutive sampling; data collection was carried out via home visits. Household food insecurity and obesogenic behaviour were assessed using validated questionnaires, while dietary intake was assessed using dietary recalls, with statistical analysis performed using multinomial logistic regression analysis. **Results:** Obesogenic behaviour was more prevalent in rural areas (59.1%), while food insecurity with hunger was more prevalent in peri-urban areas (60.5%). Obesogenic behaviour had no significant association with dietary intake. Regression analysis showed that food insecurity with hunger had lower odds of high protein intake (*OR*=0.30, *p*=0.038) and high carbohydrate intake (*OR*=0.26, *p*=0.024). The model suggested that additional social, economic, and environmental factors likely contributed to dietary differences. **Conclusion**: Household food insecurity was higher in peri-urban areas and significantly associated with energy, protein, and carbohydrate intakes, while obesogenic behaviour showed no significant link to dietary intake. Ensuring food security in families with informal working mothers requires comprehensive efforts.

Keywords: dietary intake, food insecurity, informal sector, obesogenic behaviour

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INTRODUCTION

The COVID-19 pandemic has exacerbated challenges for informal working mothers, who juggle employment and childcare with limited resources. Women continue to bear the primary responsibility for unpaid domestic work, while labour shifts from formal to informal sectors (Miranti, Sulistyaningrum & Mulyaningsih, 2022). An estimated 45–75% of households experienced income loss, with over 50% experiencing significant reductions (Béné, 2020; UNICEF *et al.*, 2021). Consequently, balancing work and childcare remains a major challenge (Rakhmawati, 2022).

Food insecurity during and after the pandemic disrupted food consumption patterns, including dietary diversity. Dietary diversity reflects both food quality and nutrient adequacy, which influence health status at both the family and individual levels (Dangura & Gebremedhin, 2017; Kementerian Kesehatan RI, 2014). Studies have shown a correlation between household food insecurity and dietary diversity in young children. Higher food insecurity scores are associated with lower dietary diversity (Suryana *et al.*, 2023). Poor maternal dietary diversity can contribute to micronutrient deficiencies, affecting both mothers and their children. Food-insecure families tend to consume only staple foods and plant-based proteins, leading to deficiencies in essential nutrients, especially in iron and vitamin A (Angeles-Agdeppa, Toledo & Zamora, 2021; Lopes *et al.*, 2023).

The pandemic fostered an environment conducive to obesogenic behaviours, including reduced physical activity, increased sedentary behaviour, and increased consumption of calorie-dense and low-nutrient foods because of stress and limited food choices (Trübswasser *et al.*, 2021; Vasile *et al.*, 2023). These behaviours persist post-pandemic and are associated with elevated intakes of protein and sodium (McCormack & Peng, 2024; Skalkos & Kalyva, 2023). For informal working mothers, the pressures of irregular working hours, childcare responsibilities, and financial constraints can exacerbate these behaviours. Obesogenic environments can coexist with undernutrition, leading to reduced diet quality despite adequate or excessive caloric intake. This double burden remains under-explored among vulnerable adult women in Indonesia.

Several areas in Jakarta and Depok are peri-urban, situated between urban and rural areas. Depok recorded a high number of COVID-19 cases, with 82,536 positive cases (Depok Health Care Office, 2022). The high number of COVID cases resulted in hampered economic conditions, especially for informal sector workers. Tangerang Regency comprises urban and rural areas, with some rural regions facing limited health and nutrition services and under-five malnutrition rates reaching 47% (Arlius, Sudargo & Subejo, 2017). Cianjur, in West Java, is a province with a high production of food crops, including vegetables and fruits, compared to other provinces in Indonesia. Despite this, the prevalence of stunting in Cianjur reaches 37%, with low dietary diversity among pregnant women contributing to this issue (Octaria *et al.*, 2021). However, limited studies have analysed food security and obesogenic behaviour among informal working mothers in peri-urban and rural communities in Indonesia, particularly in the post-pandemic period.

Figure 1 reflects the conceptual pathway of this pattern, in which food insecurity can lead to compromised dietary intake, which then increases the likelihood of obesogenic behaviour. This study aimed to explore the implications of obesogenic behaviour

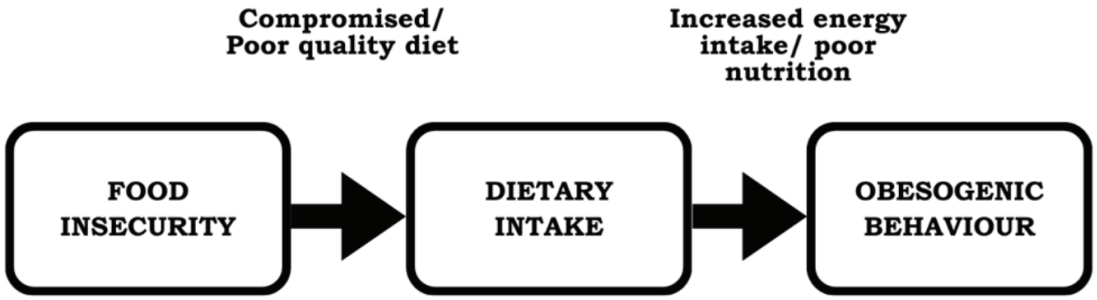

Figure 1. Conceptual model illustrating the pathway between food insecurity, dietary intake, and obesogenic behaviour

and food insecurity on dietary intake among informal working mothers in the post-pandemic era. Understanding the intersection of these factors is critical in assessing their collective impact on dietary intake among this vulnerable population in peri-urban and rural settings, providing different perspectives on the issue.

METHODOLOGY

Study design and sampling

This cross-sectional study was conducted between November and December 2022 in peri-urban (Jakarta and Depok) and rural (Tangerang and Cianjur) areas of Indonesia, selected for their high COVID-19 case rates. Tangerang Regency includes both urban and rural sub-districts, with limited access to health and nutrition services in several rural areas, notably Cisauk. Cianjur, in West Java, is a district with a high production of food crops, particularly vegetables and fruits. Peri-urban areas, defined as transitional zones between urban and rural regions (Ravetz & Sahana, 2025), are evident in parts of Jakarta and Depok, especially along riverbanks, characterised by informal settlements.

Study participants were mothers who worked in the informal sector, aged 18-50 years, were married, had at least one under-five child, lived with their families, and provided informed consent. Participants were recruited using consecutive sampling during visits to community health centres and neighbourhood gatherings in each area. Data collection was conducted through door-to-door home visits at each study site using face-to-face interviews. Minimum sample size was calculated using the one-proportion formula as follows:

$$n = \frac{Z^2P(1\text{-}P)}{d^2},$$

based on the proportion of working mothers' dietary diversity, which was 0.58 (Hasan *et al.*, 2019), with a significance level of 0.01 and a power of 95%. The minimum sample size was 94. However, this study recruited 143 mothers, exceeding the minimum requirement.

Study variables

Sociodemographic data were collected, including residency, maternal education, home ownership, maternal monthly income, maternal additional supportive monthly income, number of family members, and child's sex. Household coping strategies to survive during the pandemic were also recorded.

This study used the Indonesian-translated version of the United States Department of Agriculture Household Food Security Survey Module (USDA-

HFSSM), which consists of 18 question items: ten questions assessing adult food security and eight questions assessing child food security (Bickel *et al.*, 2000). Following the guidelines, responses were scored as either 1 or 0. The total score was then categorised as follows: a score of 2 or less as "food secure", a score of 3-7 as "food insecure without hunger", and a score of more than 7 as "food insecure with hunger".

Dietary intake was measured using a non-consecutive 24-hour recall, with portion sizes converted into household measures and nutrient values derived from the Indonesian Food Composition Table. Intakes of energy, protein, fat, and carbohydrates were analysed. Dietary adequacy was calculated by comparing dietary intake with the Estimated Adequacy Requirement (EAR) from the Indonesian Dietary Guidelines, classifying intake as low (<80%), normal (80-110%), and high (>110%) (Kementerian Kesehatan RI, 2019).

Obesogenic behaviour was assessed based on the home food environment (Kegler, Hermstad & Haardörfer, 2021) and exposure to food marketing (Prasetyaningrum, Kertia & Gunawan, 2016). These behaviours were evaluated using a four-point Likert-scale questionnaire related to unavailability of healthy food, high exposure to food marketing, food shopping habits, infrequent family meals, consumption of high-density foods during family meals, and lack of positive interactions while eating. Each question was categorised based on the median score: food availability (less available/available), exposure to food marketing (easily exposed/not easily exposed), shopping habits (frequent/infrequent), frequency of family meals (seldom/often), type of meals shared with family (high density/low-density), interaction while eating (low/good). A cumulative obesogenic behaviour score was calculated based on all questionnaire responses.

Ethical considerations

The study protocol and methods were reviewed and approved by the Ethics Review Committee of the Medical and Health Research Ethics Committee Muhammadiyah Dr Hamka University, under the approval number 03/22.09/02038. To participate in this study, all participants were required to provide informed consent.

Statistical analysis

Variables associated with socio-demographic characteristics, including residency, maternal education, home ownership, maternal monthly income, additional household income, and the number of family members, were analysed. Dietary intake variables were analysed in relation to obesogenic factors and household food security using Pearson's chi-square test, Spearman's ordinal correlation test, and the Mann-Whitney U test. All statistical analyses were performed using the IBM SPSS Statistics for Windows version 25.0 (IBM Corp., Armonk, New York, USA). Prior to regression analysis, univariate and bivariate analyses were performed to examine variable distributions and calculate crude odds ratios (COR). Variables with a p-value of less than 0.25, as well as independent and dependent variables, were included in a stepwise backward elimination analysis. The multinomial regression model was adjusted for all selected covariates, with a p-value of less than 0.05 considered as statistically significant. Results were presented as odds ratios (*OR)*.

RESULTS

This study involved 143 informal working mothers with children under five from peri-urban (Jakarta and Depok) and

Table 1. Sociodemographic characteristics of informal working mothers based on residency

Variables	*Peri-Urban*	*Rural*	*p-value*
Residency	75 (52.4)	68 (47.6)	-
Maternal age (years)[†]			
18-29	9 (22.0)	32 (78.0)	<0.001[***]
30-39	53 (66.3)	27 (38.0)	
>39	13 (59.1)	9 (40.9)	
Maternal education[†]			
Primary education	5 (13.5)	32 (86.5)	<0.001[***]
Secondary education	10 (30.3)	23 (69.7)	
Tertiary education	47 (81.0)	11 (19.0)	
Diploma	13 (86.7)	2 (13.3)	
Home ownership[†]			
Private house	28 (45.2)	34 (54.8)	0.672
Rental house	26 (92.9)	2 (7.1)	
Parents house	21 (39.6)	32 (60.4)	
Mother as the sole income contributor[a‡]			
No	71 (52.6)	64 (7.4)	0.887
Yes	4 (50.0)	4 (50.0)	
Maternal occupation[†]			
Stall owner	56 (61.5)	35 (38.5)	0.004[**]
Housekeeper/nanny	9 (40.9)	13 (59.1)	
Daily labourer/farmer	7 (36.8)	12 (63.2)	
Others	3 (27.3)	8 (72.7)	
Social assistance programme[‡]			
Yes	43 (54.4)	36 (45.6)	0.666
No	32 (50.8)	31 (49.2)	
Number of family members[‡]			
≤ 4 persons	38 (51.4)	36 (48.6)	0.786
> 4 persons	37 (53.6)	68 (47.6)	
Maternal monthly income[‡]			
< Minimum wage	52 (53.6)	45 (46.4)	0.687
≥ Minimum wage	23 (50.0)	23 (50.0)	
Change in income[†]			
Increase	7 (58.3)	5 (41.7)	0.971
Stable	26 (50.0)	26 (50.0)	
Decrease	42 (53.2)	37 (46.8)	
Proportion of food cost[‡]			
< 60%	66 (58.4)	47 (41.6)	0.008[**]
≥ 60%	9 (31.0)	20 (69.0)	

to be continued...

Table 1. Sociodemographic characteristics of informal working mothers based on residency *(continued)*

Variables	*Peri-Urban*	*Rural*	*p-value*
Proportion of other costs (%)[§]			
Health	1.41	0.97	0.895
Clothes	1.75	2.03	0.006**
Education	6.05	3.05	0.047*
Ceremonial	1.57	2.26	0.189
Savings	3.44	2.09	0.753
Hygiene	1.71	0.77	<0.001***
Cosmetics	2.40	0.93	0.005**
Instalment credit	17.38	12.67	0.756
Housing	6.67	0.64	<0.001***
Transportation	7.00	6.15	0.826
Others	14.87	6.76	<0.001***
Coping mechanism[†]			
Maintain the current situation without taking action	24 (38.7)	38 (61.3)	<0.001***
Sell assets	1 (16.7)	5 (83.3)	
Take out a loan	15 (41.7)	21 (58.3)	
Cut down on healthcare expenses	4 (66.7)	2 (33.3)	
Adults skip one meal a day	15 (100.0)	0 (0.0)	
No response	16 (88.9)	2 (11.1)	

[a]Sole income contributor refers to the mother being the only household member engaged in paid work
[†]Spearman's ordinal correlation test
[‡]Pearson's chi-square test
[§]Mann-Whitney U test
*p<0.05; **p<0.01; ***p<0.001

rural (Cianjur and Tangerang) areas (Table 1). Maternal age and education differed significantly by location (p<0.001), with younger mothers and lower education levels more commonly observed in rural areas. Employment type also varied significantly (p=0.004), with stall ownership predominant in peri-urban areas, while housekeeping, labour, and farming were more prevalent in rural areas. No significant differences were found in home ownership, family size, income levels, or additional financial assistance.

Peri-urban households mostly allocated a higher proportion of their expenses to housing (p<0.001), hygiene (p<0.001), education (p=0.047), cosmetics (p=0.005), and miscellaneous needs (p<0.001) than rural households. In contrast, rural households spent more on clothing (1.75% vs. 2.03%; p=0.006) and ceremonial (2.26% vs. 1.57%; p=0.189). The proportion allocated to savings (3.44% vs. 2.09%) and instalment credit (12.67% vs. 17.38%) was higher in peri-urban, but not significant. Transportation costs were

Table 2. Dietary intake, food security, and obesogenic behaviour of informal working mothers based on residency

Variables	*Peri-Urban n (%)*	*Rural n (%)*	*p-value*
Energy intake†			
Low	56 (65.9)	29 (34.1)	<0.001***
Normal	16 (39.0)	25 (61.0)	
High	3 (17.6)	14 (82.4)	
Protein intake†			
Low	49 (60.5)	32 (39.5)	0.049*
Normal	18 (47.4)	20 (52.6)	
High	8 (33.3)	16 (66.7)	
Fat intake†			
Low	34 (63.0)	20 (37.0)	0.003**
Normal	19 (67.9)	9 (32.1)	
High	22 (36.1)	39 (63.9)	
Carbohydrate intake†			
Low	43 (55.8)	34 (44.2)	0.023*
Normal	25 (61.0)	16 (39.0)	
High	7 (28.0)	18 (72.0)	
Obesogenic behaviour‡			
Obesogenic	27 (40.9)	39 (59.1)	0.008**
Non-obesogenic	48 (62.3)	29 (37.7)	
Food availability‡			
Less available	25 (51.0)	24 (49.0)	0.805
Available	50 (53.2)	44 (46.8)	
Food marketing‡			
Not easily exposed	54 (67.5)	26 (32.5)	<0.001***
Easily exposed	21 (33.3)	42 (66.7)	
Shopping habits‡			
Infrequent	19 (28.4)	48 (71.6)	<0.001***
Frequent	56 (73.7)	20 (26.3)	
Family meals‡			
Seldom	32 (55.2)	26 (44.8)	0.590
Often	43 (50.6)	42 (49.4)	
Type of meal shared with family†			
High density foods	21 (61.8)	13 (38.2)	0.213
Low density foods	54 (49.5)	55 (50.5)	
Interaction while eating‡			
Low	31 (44.3)	39 (55.7)	0.056
Good	44 (60.3)	29 (39.7)	
Food security†			
Food insecure with hunger	52 (60.5)	34 (39.5)	0.007**
Food insecure without hunger	14 (56.0)	11 (44.0)	
Food secure	9 (28.1)	23 (71.9)	

†Spearman's ordinal correlation test‡
‡Pearson's chi-square test
*p<0.05; **p<0.01; ***p<0.001

similar across groups (7.00% vs. 6.15%; $p=0.926$). These differences suggest that peri-urban families prioritise investment in education, housing, and savings, while rural households allocate a larger share of expenditure to clothing and cultural ceremonies. Additionally, coping strategies during economic hardships also significantly differed ($p<0.001$), with rural households more likely to sell assets or take out loans, while peri-urban households more frequently reduced their healthcare spending or skipped meals.

In terms of dietary intake (Table 2), energy intake was significantly higher among rural residents, with 82.4% having a high intake compared to only 17.6% in peri-urban areas ($p<0.001$). A similar trend was observed for protein intake ($p=0.049$), fat intake ($p=0.003$), and carbohydrate intake ($p=0.023$), where rural households were more likely to report high intake of these macronutrients. These findings suggest that rural populations are more likely to consume more energy-dense foods, while peri-urban residents experience greater food insecurity, which may contribute to lower dietary intake.

Obesogenic behaviour was more prevalent in rural areas (59.1%) than in peri-urban areas (40.9%) ($p=0.008$). Exposure to food marketing also showed a significant difference ($p<0.001$), with rural residents more easily exposed (66.7%) than peri-urban residents (33.3%). Similarly, shopping habits differed significantly ($p<0.001$), as peri-urban residents had easier access to shopping facilities (73.7%) compared to rural residents (26.3%). However, food availability did not show a significant difference between the two groups. Eating habits and family interactions during meals also showed no statistically significant differences between the two groups, although there was a trend towards better mealtime interaction in

Table 3. Associations of obesogenic behaviour and food security with dietary intake of informal working mothers

Variables	Dietary Intake															
	Energy				*Protein*				*Fat*				*Carbohydrate*			
	Low	*Normal*	*High*	*p-value*	*Low*	*Normal*	*High*	*p-value*	*Low*	*Normal*	*High*	*p-value*	*Low*	*Normal*	*High*	*p-value*
Obesogenic behaviour†																
Obesogenic	41 (62.1)	18 (27.3)	7 (10.6)	0.533	38 (59.1)	17 (25.8)	10 (15.2)	0.555	28 (42.4)	8 (12.1)	30 (45.5)	0.555	29 (59.1)	16 (24.2)	11 (16.7)	0.819
Non-obesogenic	44 (57.1)	23 (29.9)	10 (13.0)		42 (54.5)	21 (27.3)	14 (18.2)		26 (33.8)	20 (26.0)	31 (40.3)		38 (49.4)	25 (32.5)	14 (18.2)	
Food security†																
Food insecure with hunger	59 (68.6)	20 (23.3)	7 (8.1)	0.001**	55 (64.0)	20 (23.3)	11 (12.8)	0.004**	33 (38.4)	18 (20.9)	35 (40.7)	0.232	53 (61.6)	22 (25.6)	11 (12.8)	0.002**
Food insecure without hunger	16 9 (64.0)	6 (24.0)	3 (12.0)		15 (60.0)	7 (28.0)	3 (12.0)		14 (56.0)	2 (8.0)	9 (36.0)		15 (60.0)	6 (24.0)	4 (16.0)	
Food secure	10 (31.3)	15 (46.9)	7 (21.9)		11 (34.4)	11 (34.4)	10 (31.3)		7 (21.9)	8 (25.0)	17 (53.1)		9 (28.1)	13 (40.6)	10 (31.3)	

†Spearman's ordinal correlation test

*$p<0.05$; **$p<0.01$; ***$p<0.001$

peri-urban areas (p=0.056). Food security status differed between peri-urban and rural areas. Food insecurity with hunger was more prevalent in peri-urban areas (60.5%) compared to rural areas (39.5%) (p=0.007), whereas food security was higher in rural areas (71.9%) than in peri-urban areas (28.1%).

Table 3 shows the relationship between obesogenic behaviour, food security, and dietary intake. Although obesogenic behaviour was not significantly associated with nutrient intake (p>0.05), most individuals in this group had low energy (62.1%), protein (59.1%), and carbohydrate (59.1%) intakes, while 45.5% had a high fat intake. However, despite having low energy, protein, and carbohydrate intakes, individuals in the obesogenic group were more likely to have a high fat intake compared to those in the non-obesogenic group. In contrast, food security status was significantly associated with energy (p=0.001), protein (p=0.004), and carbohydrate (p=0.002) intakes. Individuals experiencing food insecurity with hunger were more likely to have low energy (68.6%), protein (64.0%), and carbohydrate (61.6%) intakes, while food-secure individuals were more likely to have higher intakes of all nutrients, particularly fat (53.1%) and protein (31.3%).

Table 4 presents the multinomial logistic regression results assessing the relationship between residency, obesogenic behaviour, food security status, and dietary intake. Urban residency was significantly associated with higher odds of high energy intake (OR=8.70, p=0.002) and high fat intake (OR=2.90, p=0.011). Food insecurity with hunger was significantly associated with lower odds of high protein intake (OR=0.30, p=0.038) and high carbohydrate intake (OR=0.26, p=0.024). Obesogenic behaviour did not show statistically significant associations with dietary intake across energy, protein, fat, or carbohydrate (p>0.05). The model's explanatory power (pseudo-R^2) was 21.1% for energy, 10.4% for protein, 16.1% for fat, and 14.5% for carbohydrate intakes, implying that additional social, economic, and environmental factors likely contributed to dietary differences.

DISCUSSION

Food insecurity remains a concern for many low-income households, creating disruptions in access to affordable and nutritious foods. Indonesia has a low household-level food stock availability, ranging from 13% to 22% (Kang *et al.* 2021). During the pandemic, a study found that 59.2% of the population experienced food insecurity, influenced by factors such as education level, monthly income, and home ownership status (Elsahoryi *et al.,* 2020).

Food insecurity with hunger was more prevalent in peri-urban areas compared to rural areas. This finding suggests that despite greater access to markets in peri-urban settings, food insecurity remains a challenge. Continuous social restrictions may limit access to jobs for individuals with low education, and the high monthly rents faced by informal settlers could contribute to this issue. Without access to quality childcare, informal women workers, especially in peri-urban areas, may lose income or be forced into low-paid, vulnerable jobs that offer flexibility to balance work and caregiving (International Labour Organization & Women in Informal Employment Globalizing and Organizing, 2020).

In this study, food security status was found to be significantly associated with energy, protein, and carbohydrate intakes. Regression analysis revealed that peri-urban residency was strongly associated with higher energy and fat intakes, while food insecurity with

Table 4. Multinomial regression analysis on the relationship between residency, obesogenic behaviour, food security status, and dietary intake of informal working mothers

	β	*Std error*	*Sig*	*Exp B*	*95%CI*
Energy					
Normal intake					
Intercept	-1.107	0.796	0.164	-	-
Residency (Urban)	1.004	0.430	0.020*	2.729	1.174-6.341
Obesogenic (Yes)	-0.360	0.425	0.397	0.697	0.303-1.604
Food security					
Food secure	Reff	-	-	-	-
Food insecurity with hunger	-1.138	0.652	0.081	0.320	0.089-1.150
Food insecurity without hunger	-1.219	0.504	0.016*	0.295	0.110-0.794
High intake					
Intercept	-3.900	1.385	0.005*	-	-
Residency (Urban)	2.164	0.715	0.002*	8.702	2.141-35.365
Obesogenic (Yes)	-0.658	0.607	0.278	0.518	0.158-1.700
Food security					
Food secure	Reff	-	-	-	-
Food insecurity with hunger	-0.913	0.850	0.283	0.401	0.076-2.122
Food insecurity without hunger	-1.212	0.687	0.078	0.298	0.007-1.144
Protein					
Normal intake					
Intercept	-0.634	0.814	0.436	-	-
Residency (Urban)	0.423	0.425	0.320	1.526	0.663-3.511
Obesogenic (Yes)	-0.191	0.416	0.647	0.826	0.366-1.868
Food security					
Food secure	Reff	-	-	-	-
Food insecurity with hunger	-0.875	0.518	0.091	0.417	0.151-1.151
Food insecurity without hunger	-0.635	0.640	0.321	0.530	0.151-1.859
High intake					
Intercept	-1.611	1.005	0.109	-	-
Residency (Urban)	0.959	0.531	0.071	2.609	0.921-7.387
Obesogenic (Yes)	-0.379	0.510	0.458	0.685	0.252-1.862
Food security					
Food secure	Reff	-	-	-	-
Food insecurity with hunger	-1.202	0.578	0.038*	0.301	0.097-0.933
Food insecurity without hunger	-1.260	0.788	0.110	0.284	0.061-1.328
Fat					
Normal intake					
Intercept	0.777	1.005	0.440		
Residency (Urban)	-0.214	0.553	0.699	0.808	0.273-2.387
Obesogenic (Yes)	-0.850	0.524	0.105	0.428	0.153-1.195
Food security					
Food secure					
Food insecurity with hunger	-0.781	0.633	0.217	0.458	0.133-1.583
Food insecurity without hunger	-2.021	0.937	0.031*	0.133	0.021-0.831

to be continued...

Table 4. Multinomial regression analysis on the relationship between residency, obesogenic behaviour, food security status, and dietary intake of informal working mothers *(continued)*

	β	*Std error*	*Sig*	*Exp B*	*95%CI*
High intake					
Intercept	-0.835	0.827	0.312	-	-
Residency (Urban)	1.063	0.416	0.011*	2.896	1.282-6.540
Obesogenic (Yes)	-0.289	0.405	0.475	0.749	0.339-1.656
Food security					
Food secure	Reff	-	-	-	-
Food insecurity with hunger	-0.484	0.537	0.367	0.616	0.215-1.764
Food insecurity without hunger	-1.028	0.645	0.111	0.358	0.101-1.226
Carbohydrate					
Normal intake					
Intercept	1.203	0.836	0.150	-	-
Residency (Urban)	-0.428	0.440	0.330	0.652	0.275-1.543
Obesogenic (Yes)	-0.316	0.416	0.448	0.729	0.323-1.649
Food security					
Food secure	Reff	-	-	-	-
Food insecurity with hunger	-1.370	0.531	0.010*	0.254	0.090-0.719
Food insecurity without hunger	-1.362	0.671	0.042*	0.256	0.069-0.955
High intake					
Intercept	-1.519	1.061	0.152	-	-
Residency (Urban)	0.984	0.50	0.068	2.675	0.929-7.706
Obesogenic (Yes)	-0.362	0.503	0.471	0.696	0.260-1.865
Food security					
Food secure	Reff	-	-	-	-
Food insecurity with hunger	-1.345	0.597	0.024*	0.261	0.081-0.840
Food insecurity without hunger	-1.155	0.747	0.122	0.315	0.073-1.362

Exp(B): Odds Ratio; CI: Confidence Interval
Multinomial logistic regression was performed using maximum likelihood estimation.
The reference category for dietary intake is "low intake".
Reference groups: *Rural* for residency. *No* for obesogenic behaviour, and *Food secure* for food security.
Food insecurity with hunger and food insecurity without hunger are classified based on the USDA Household Food Security Survey Module.
*p<0.05; **p<0.01; ***p<0.001

hunger was associated with lower protein and carbohydrate intakes. No significant difference was observed in fat intake across food security statuses, because all subjects exhibited increased fat intake during the post-pandemic period. Despite higher energy and fat intakes, food insecurity was more prevalent in peri-urban areas, indicating that some households may still struggle with food availability or quality. Urban environments may facilitate greater access to high-energy and high-fat foods, potentially due to dietary transitions and increased exposure to processed or convenience foods (Popkin & Ng, 2022).

Peri-urban mothers tended to have significantly lower macronutrient adequacy compared to rural mothers. They also had lower food expenditures. A study in Jakarta found that 75.2% of households were affected by the

COVID-19 pandemic in both urban and semi-urban areas (Syafiq, Fikawati & Gemily, 2022). The significant impact of the pandemic was a reduction in family income, with nearly half of the respondents experiencing occasional food shortages (Syafiq *et al.*, 2022).

Rural residents were more likely to experience greater exposure to food marketing and face more limited shopping access compared to their peri-urban counterparts. Due to limited income and a cash-based economy, rural consumers are more likely to make frequent, small-value purchases (Chhatwal, 2024), which may explain why they tend to spend their money more easily on food in small amounts compared to urban consumers. Some rural households allocated a greater proportion to clothing, ceremonial expenses, and instalment credit. This variation is possibly related to the quality of maternal education in rural areas, which tends to be lower than in urban areas.

Obesogenic behaviour in this study was characterised by several components, including the limited availability of healthy foods, high exposure to food marketing, shopping habits, infrequent family meals, consumption of high-density foods during family meals, and lack of positive interactions while eating. Overall, obesogenic behaviour was found to be more common in rural areas than in peri-urban areas. Previous research has shown that sedentary behaviour is more prevalent in urban areas than in rural areas. However, it is associated with a higher risk of overweight and obesity in both urban and rural areas (Nurwanti *et al.*, 2019).

Obesogenic behaviour contributes to obesity by encouraging unhealthy eating habits, a lack of physical activity, or prolonged sedentary lifestyles (Trübswasser *et al.*, 2021). The pandemic fostered an environment conducive to obesogenic behaviour; individuals were forced to adapt their habits, including food purchasing habits and preferences, to the new routine (Skalkos & Kalyva, 2023). Meanwhile, obesogenic behaviour did not appear to directly affect dietary intake, implying that factors such as food access and economic conditions may have played a more significant role in shaping dietary patterns.

The absence of an association between food insecurity and obesogenic behaviour was likely due to an imbalanced dietary pattern and insufficiency of some nutrients, thus not leading to excess weight gain. Among informal working mothers, food insecurity tends to lower diet quality due to economic constraints and psychological stress, which can lead to obesogenic behaviour from alternating periods of food restriction and overeating. However, positive family habits, such as supportive interactions during meals, are linked to better nutritional outcomes. Analysis of obesogenic components suggests a trend where positive interactions during meals are associated with higher carbohydrate intake and that positive emotions, compared to unpleasant ones, are associated with increased consumption of hyperpalatable energy-dense foods (Desmet & Schifferstein, 2008).

A systematic review highlighted that urban poverty presents unique and complex challenges to food access, making it difficult for families to maintain healthy and nutritious diets (Vilar-Compte *et al.*, 2021). As indicated in previous studies, rural communities living in areas vulnerable to climate change are likely to experience negative impacts on crop and livestock production, potentially increasing their risk of food insecurity. However, many rural households tend to

be self-sufficient in staple foods, relying on harvesting crops and livestock to meet household food needs. Conversely, previous studies stated that individuals relying on a personal monthly income below the poverty line remain at risk of food insecurity in both urban and rural areas (Elsahoryi *et al.*, 2020).

This study highlighted that food insecurity remains prevalent among informal working mothers, especially in peri-urban areas, due to unstable income, high living costs, and limited childcare access. Food insecurity with hunger was linked to lower intakes of energy, protein, and carbohydrates, reflecting nutritional vulnerability among this group. This result supports the first part of the correlation pathway (Figure 1), but not the second pathway regarding the connection between dietary intake and obesogenic behaviour. The obesogenic behaviour was more directly related to poor diet quality patterns than any other behaviours such as physical inactivity or irregular eating habits. The only behaviour consistent with the model was frequent consumption of energy-dense foods. This finding clearly showed that food insecurity affects dietary intake, suggesting that dietary intake may influence obesogenic behaviour through additional factors such as stress, increased variability and unpredictability in eating patterns, and changes in diet quality, such as high intakes of carbohydrates and ultra-processed foods (Bateson & Pepper, 2023).

Recommendations for improving food security include strengthening social protection programmes to improve food access for low-income mothers. Community-based nutrition education and food assistance programmes can help bridge dietary gaps between rural and peri-urban households. Local governments and NGOs can enhance women's food security through livelihood programmes like home-based food production, urban gardening, and micro-enterprise support.

It is important to acknowledge several limitations. Firstly, the cross-sectional design limits the ability to draw causal inferences, allowing only for the identification of associations. Secondly, the reliance on non-consecutive 24-hour dietary recalls may not fully reflect habitual intake and is thus subject to recall bias, as no food frequency intake was assessed. Although the inclusion of peri-urban and rural settings enriched contextual understanding, variations in infrastructure and service access may have influenced outcomes in ways not fully accounted for. A key strength of this study was the use of primary data collected through face-to-face interviews, enabling context-specific and reliable assessments of household characteristics, food security, and dietary behaviour among informal working mothers. The application of validated tools to assess food security and obesogenic behaviour further enhanced the study's methodological robustness.

CONCLUSION

Household food insecurity was found to be more prevalent in peri-urban areas than in rural areas. In this study, food security status was significantly associated with energy, protein, and carbohydrate intakes. In contrast, no significant association was found between obesogenic behaviour and dietary intake, except for the frequent consumption of energy-dense foods in food-insecure families. Comprehensive strategies are needed to improve food security in households with informal working mothers.

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Authors' contributions

Fayasari S, principal investigator, designed the study, conducted the study, prepared the draft of the manuscript and reviewed the manuscript; Agestika L, conceptualised the study, led the data collection and enumerators, advised on data analysis and interpretation, and reviewed the manuscript.

Conflict of interest

The authors declare that there are no conflicts of interest.

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