Environmental determinants of obesity: A multidimensional assessment based on H.L. Blum's health model in Riau, Indonesia

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Abstract: The prevalence of obesity continues to increase globally and nationally, with Indonesia reporting a rising prevalence of 21.8% in 2018 and an increase in the number of obesity-related visits in Riau Province. Based on the H.L. Blum health model, this study examined the environmental determinants of obesity among 200 adults aged 15–59 years old who attended Posbindu PTM (*Pos Binaan Terpadu Penyakit Tidak Menular*/Integrated Development Post of Non-Communicable Diseases) in the working area of the Langsat Community Health Center (Puskesmas) in Pekanbaru City, Riau Province. Four environmental domains were assessed: socioeconomic factors, food availability, physical environment, and psychosocial conditions. Data were analyzed using Bivariate Analysis: Cramer's V Correlation Test to determine its correlation with Body Mass Index (BMI), which served as the outcome measure. Significant correlations were identified between BMI and factors such as type of employment, instant noodle consumption, sedentary work patterns, perceived advertising influence, and perceived social barriers. These findings underscore the significant role of environmental exposures in influencing obesity risk. An environment-based management model, grounded in Blum's framework, is proposed to assist policymakers in developing targeted interventions aimed at preventing further increases in obesity prevalence.

Keywords: Environmental determinants, Food environment, H.L. Blum model, Obesity, Psychosocial factors.

1. Introduction

Obesity has become one of the most significant global public health challenges, affecting populations across diverse socioeconomic and demographic groups. In Indonesia, obesity is defined as a Body Mass Index (BMI) of ≥ 25.1 kg/m² for adults regardless of sex [1]. Globally, the condition continues to rise at a concerning rate. In Europe and other advanced market economies, approximately 22% of children and 26% of adult men, as well as 31% of adult women, are classified as obese [2]. Similar trends are observed in the United States, where 25.3% of adult men and 24.6% of adult women meet the criteria for obesity. Across the Asia-Pacific region, rapid lifestyle transitions and increased exposure to obesogenic environments have contributed to a substantial rise in obesity and related metabolic disorders, particularly type 2 diabetes.

Indonesia mirrors this epidemiological pattern. The 2018 Basic Health Research (Riskesdas) reported a national obesity prevalence of 21.8%, demonstrating a steady upward trajectory [3]. At the provincial level, the Riau Health Office documented marked increases in obesity-related visits to the Integrated Non-Communicable Disease Surveillance Posts (Posbindu PTM) in 2020 and 2021 compared with 2018 and 2019, signifying a growing public health burden [4]. These trends highlight the need for a deeper understanding of the determinants that drive obesity in Indonesian communities.

Blum's Health Field Model identifies four major determinants of health: environment, behavior, heredity, and healthcare services, emphasizing the predominant role of the environment in shaping population health outcomes [5]. Environmental determinants encompass both physical and social dimensions, including cultural norms, educational attainment, socioeconomic conditions, built environment characteristics, and occupational contexts [6]. Despite strong evidence demonstrating the significance of environmental influences, public health responses often disproportionately emphasize individual-level behavior modification, thus underestimating the broader structural forces that shape obesity risk.

A growing body of research has established that obesity does not develop uniformly across populations. Variations in prevalence across sex, ethnicity, and socioeconomic strata underscore the complex interplay between social structure and individual health. The food environment is a particularly influential determinant. The widespread availability of inexpensive, energy-dense, and nutrient-poor foods disproportionately affects individuals with lower socioeconomic status, contributing to elevated obesity risk. Additionally, declines in occupational and transport-related physical activity over the past several decades have further intensified chronic energy imbalance [7].

Neighborhood-level structural conditions play an equally critical role. Environmental deprivation characterized by physical disorder, vandalism, deteriorated infrastructure, vacant land, and high crime rates has been consistently linked to increased obesity risk. Individuals living in highly deprived neighborhoods have a 20% greater likelihood of being overweight or obese. Among urban women, substantial physical disorder is associated with a 1.43-fold increase in the probability of obesity, while exposure to high-crime environments reduces physical activity likelihood by 28%. In contrast, perceived neighborhood safety increases activity likelihood by 27%. Such environments also contribute to psychosocial stress, promoting maladaptive coping behaviors, including overconsumption of calorie-dense foods [7].

The consequences of obesity extend beyond individual morbidity. The condition substantially increases the risk of chronic illnesses, including type 2 diabetes, hypertension, coronary heart disease, gallbladder disease, osteoarthritis, and several cancers. Economically, obesity contributes to rising healthcare expenditures and decreased workforce productivity. In the United States, obesity-related medical expenditures were estimated at 24 billion USD in 1999 and later accounted for 5–7% of total national healthcare spending, amounting to approximately 75 billion USD annually [2]. Beyond direct medical costs, obesity contributes significantly to absenteeism and presenteeism. Annual direct and indirect costs among U.S. workers total 73.1 billion USD, with individuals with severe obesity accounting for nearly two-thirds of these costs. Furthermore, obesity is responsible for up to 12.6% of annual absenteeism and more than 8 billion USD in productivity losses [8]. Rising childhood obesity and an increasingly younger workforce suggest that the long-term economic implications may be even more severe [9].

Given the profound health and socioeconomic consequences of obesity, there is a critical need for integrative and context-sensitive approaches to prevention and management. Blum's conceptual framework offers a valuable lens for understanding how environmental determinants shape obesity risk and provides a foundation for designing comprehensive, community-level intervention strategies [5]. Accordingly, this study aims to examine key environmental determinants, including socioeconomic factors, food availability, physical environmental characteristics, and psychosocial influences associated with obesity, and to develop an evidence-based, environment-focused obesity management model to inform public health policy and action.

2. Literature Review

2.1. The Relationship between Environment and Health

The environment is a foundational determinant of human health, encompassing the physical, biological, social, and cultural conditions that shape life chances and well-being [10, 11]. In public health terms, environmental exposures such as housing quality, nutritional resources, occupational

hazards, and community conditions contribute substantially to the burden of disease and must be considered alongside biological and genetic causes. Occupational exposures, air and water contaminants, toxic chemicals, vector habitats, and other physical hazards are well-established drivers of chronic disease risk, and environmental medicine emphasizes prevention by identifying and mitigating these exposures [12].

Blum's Health Field Model situates the environment as the principal determinant of population health, followed by lifestyle, heredity, and medical care [5]. The environmental domain incorporates physical infrastructure, socioeconomic context, political determinants, and cultural systems. Individuals with higher education and income typically enjoy better environmental conditions, greater access to preventive services, and fewer risk behaviors, which collectively translate into improved health outcomes [6, 7]. Political and policy contexts that generate income inequality have been implicated in poorer population health via reduced social cohesion and elevated psychosocial stressors.

2.2. The Mandala of Health and Ecological Models

Ecological models of health exemplified by the Mandala of Health conceptualize health as the emergent product of nested systems: the individual (body, mind, spirit), the family, the community, culture, and the biosphere [13]. Personal behaviors are viewed not simply as individual choices but as outcomes shaped by long-term socialization, cultural norms, family practices, and environmental affordances. This multi-level perspective underscores that effective public health interventions must address structural determinants in addition to individual behavior change [5, 7].

2.3. Socioeconomic Status and Obesity Risk

A robust literature documents the association between socioeconomic status (SES) and obesity, although the direction and magnitude of that association vary by developmental context [14, 15]. In many high-income countries, lower SES groups exhibit higher obesity prevalence; conversely, in lower- and middle-income settings, obesity is often more prevalent among higher SES strata, a pattern that can shift over time with economic development [14, 16]. Economic development, urbanization, and related lifestyle changes in China illustrate this transition: between 1992 and 2002, dramatic shifts in diet and activity coincided with tens of millions of additional people classified as obese [14].

SES influences dietary practices (e.g., fruit and vegetable consumption), physical activity (e.g., farming versus sedentary employment), screen time, and occupational exposures. Education, income, and occupation thus operate through material and psychosocial pathways to shape obesity risk. Gender modifies these relationships in many settings; for example, higher education and income may be positively associated with overweight among men but inversely associated among women, reflecting complex social norms and access gradients [15, 16].

2.4. Dietary Patterns and Obesity Risk in Indonesia

Indonesia is undergoing a nutrition transition characterized by increased consumption of ultra-processed foods and declining physical activity trends driven by economic growth, urbanization, and globalization. Per capita availability of food energy has increased substantially over the past decades, with a notable rise in fat availability (e.g., palm oil). National surveillance data document widespread consumption of instant noodles, fried snacks, and sugar-sweetened beverages across children and adults, dietary patterns associated with higher BMI and overweight prevalence [17].

Urbanization has modified both the supply and demand sides of the food system. The rapid expansion of supermarkets and fast-food outlets in urban areas facilitates access to inexpensive, energy-dense products, while mechanization and occupational shifts reduce routine energy expenditure. Simulations indicate that large shifts toward urban living are associated with increases in fat and sugar as a share of total energy intake, amplifying population-level adiposity risk [17].
Distribution of Processed Food Consumption and Physical Activity

Survey data indicate a high prevalence of ultra-processed food consumption in Indonesia: in 2014,

approximately 60% of adults reported eating instant noodles in the prior week, and around 65% reported consuming fried snack foods, with consumption frequency often several days per week. Physical activity levels revealed gender disparities: a substantially larger proportion of men engaged in vigorous physical activity compared with women, and overall activity declined between 2007 and 2014. Over the period 1993–2014, overweight and obesity prevalence approximately doubled in both men and women, and the burden has expanded across rural and urban populations and wealth quintiles, signaling that overweight is now widespread among poorer groups as well [17].

2.5. Economic Development, Occupation, and Obesity

Indonesia's economic development has reshaped occupational structures and lifestyle patterns in ways that elevate obesity risk. As agricultural employment declines and service-sector jobs increase, the population's energy expenditure associated with work decreases. Higher education and wealth are associated with greater odds of overweight for certain demographic groups; skilled, sedentary occupations often correlate with higher obesity risk compared with physically demanding agricultural work [17].

2.6. Workplace Determinants of Obesity

The workplace is a critical environmental setting, linking obesity to working conditions, psychosocial stressors, shift patterns, and organizational culture. Obesity among workers imposes measurable costs through increased absenteeism, higher healthcare claims, and reduced productivity. Empirical estimates suggest that obesity-related absenteeism accounted for billions in economic losses in the United States; obese employees report more lost work days and higher rates of work limitation than their normal-weight counterparts [18].

Multiple workplace factors have been associated with weight gain: long working hours (>40 h/week), shift work (including night shifts), low job control, high job strain, interpersonal conflict, and hostile work climates. These elements influence dietary behaviors (e.g., limited access to healthy meals during night shifts) and sleep patterns, both of which affect energy balance and metabolic regulation. Longitudinal studies indicate that increasing work hours and exposure to adverse psychosocial working conditions are associated with subsequent BMI increases, particularly among women [18].

2.7. Psychosocial Determinants and Obesity

Psychosocial factors such as stigma, discrimination, body image dissatisfaction, and depression both result from and contribute to obesity [19]. Stigmatization of obesity is pervasive in many societies and exerts adverse effects on mental health, social participation, and employment opportunities. Evidence links obesity with an elevated prevalence of depressive symptoms, lower self-esteem, and increased suicidal ideation in some subgroups, especially young women [19]. Psychosocial stress functions as a chronic burden that can trigger emotional eating and other maladaptive coping strategies, thereby creating a feedback loop that sustains or worsens adiposity [19].

2.8. Demographic, Social, and Economic Context of Riau Province

Riau Province occupies a strategic geographic position with extensive regional trade links and dynamic economic activity [4]. The province's demographic profile, characterized by a large working-age population and ongoing urbanization, intersects with social and economic inequalities to shape health risks, including obesity [20]. Income inequality has been associated with higher odds of overweight at the provincial scale, suggesting that broader structural disparities contribute to obesogenic exposures [20].

Local research indicates that age (35–64 years), female sex, lower educational attainment, and routine consumption of high-fat foods are significant predictors of obesity in Indonesian adult populations [21]. These findings are particularly relevant for Riau, where demographic and occupational structures place many residents at elevated risk.

2.9. Health Profile and Implications for Obesity Control in Riau

Health system indicators for Riau reflect limited coverage of preventive screening for productive-age and older adults [4]. Low screening penetration constrains early detection of obesity and related non-communicable diseases such as hypertension and diabetes. The Integrated Non-Communicable Disease Surveillance Posts (Posbindu PTM) represent a community-level platform for screening and health promotion, but strengthening their reach and capacity remains essential to curb obesity and its sequelae in the province.

3. Method

This study employed a mixed-methods design integrating quantitative and qualitative approaches to generate comprehensive insights into the environmental determinants of obesity. The quantitative component utilized structured questionnaires administered to adults aged 15–59 years who attended Posbindu PTM in the working area of Langsat Community Health Center, Pekanbaru. BMI was calculated following national surveillance standards [3, 4]. Variables examined were grounded in Blum's Health Field Theory, which highlights the predominant role of environmental determinants [5] and is complemented by ecological health frameworks emphasizing socioeconomic, food system, physical, and psychosocial influences on obesity [7, 13, 17]. Thus, four domains were measured: socioeconomic status, food availability, physical environment, and psychosocial factors, all previously identified in global and Indonesian obesity literature [14, 19].

The study population comprised all adult Posbindu PTM visitors residing in Pekanbaru City, an urbanizing region undergoing socioeconomic and nutritional transition [17, 21, 22]. A proportional random sampling method was used, and the final sample size of 200 respondents was determined using the Slovin formula with 5% precision [23]. Data collection occurred between August 2020 and January 2023 and was facilitated by trained Posbindu cadres who assisted respondents in completing questionnaires (4). Secondary data, including demographic profiles, health statistics, and published studies, were obtained from the Ministry of Health, Provincial Health Office, BPS, and peer-reviewed publications [2, 4, 17, 21, 22].

Data were analyzed using Cramer's V correlation, appropriate for examining associations among nominal variables [24]. This nonparametric approach was selected because the independent variables were categorical, such as education level, occupation type, and food consumption patterns. Cramer's V values were interpreted using established thresholds to identify the strength of association between each environmental determinant and BMI [18, 24]. Results from the analysis served as the empirical basis for developing an environmental-based obesity management model aligned with Blum's theoretical framework and contemporary ecological evidence [5, 7, 17].

4. Result and Discussion

4.1. Sample Characteristics

Table 1.
Sample Characteristics (BMI Categories).

BMI Category	Criteria	n	%
Underweight	≤18.4	15	7.5
Normal	18.5–25.0	98	49.0
Obese	≥25.1	87	43.5

Table 1 summarizes the distribution of Body Mass Index (BMI) classifications among the 200 respondents aged 15–59 years who attended the Posbindu PTM screening program. The findings indicate that a substantial proportion of respondents fall within the overweight and obese categories, reflecting a growing burden of elevated BMI in the community. The prevalence of obesity is particularly notable, aligning with national trends showing a steady increase in obesity rates in Indonesia. This

distribution highlights the need for environmental and behavioral interventions, as elevated BMI contributes to higher risks of non-communicable diseases (NCDs) and reduces overall health status.

4.2. Descriptive Results of Environmental Factors

Table 2 presents a comprehensive overview of the environmental variables assessed in this study across four domains: socioeconomic status, food availability, physical environment, and psychosocial environment. These variables include age, sex, education, occupation, income, instant noodle consumption, fried food consumption, online food access, sedentary work patterns, housing conditions, exposure to advertising, community barriers, psychological stress, and job-related demands. The table illustrates the multidimensional nature of obesity determinants, consistent with Blum's Health Field Model, emphasizing that obesity arises from interrelated environmental, behavioral, biological, and systemic influences. This table serves as the foundation for subsequent correlation analyses exploring which factors significantly contribute to increased BMI.

Table 2.
Descriptive Environmental Factors.

Variable	Categories	n	%
Sex	Male	89	44.5
Sex	Female	111	55.5
Instant noodle consumption	Yes	125	62.5
Fried snack consumption	Yes	142	71.0
Food delivery access	Easy	118	59.0
Psychosocial stress indicators	Present	78	39.0
Advertising influence	High	61	30.5

4.3. Bivariate Analysis: Cramer's V Correlation Test

Table 3 displays the Cramer's V correlation coefficients measuring the strength of association between BMI and selected environmental determinants. Several variables demonstrate statistically meaningful associations with BMI, including occupation type, instant noodle consumption, sedentary work behavior, exposure to advertising, and perceived community barriers. These findings suggest that obesity in this population is influenced by both behavioral and psychosocial factors, reinforcing theories that link food access, occupation-related physical activity, and psychosocial stressors with obesity risk. While socioeconomic factors such as income and education showed weaker associations, the significant correlations highlight high-risk domains that may be targeted through community-based obesity prevention interventions.

Table 3.
Cramer's V Correlation Results.

Variable	Cramer's V	p-value	Interpretation
Type of Occupation	0.299	0.001	Strongest correlate of obesity
Instant Noodle Consumption	0.163	0.031	Higher frequency → higher BMI
Work Pattern	0.222	0.007	Sedentary work → increased obesity
Advertising Influence	0.198	0.020	Higher exposure → higher BMI
Community Stigmatization	0.185	0.033	The social environment affects BMI

4.4. Integrated Model of Obesity Determinants

The pathway model (Figure 1) illustrates interconnected determinants across the food environment, physical environment, psychosocial influences, and their collective impact on BMI. The findings of this study offer a comprehensive understanding of the environmental determinants of obesity among adults aged 15–59 years living in the working area of the Langsat Public Health Center, Pekanbaru. Consistent with the theoretical foundations presented in the Introduction and Literature Review, particularly Blum's Environmental Health Model (1), the Mandala of Health (2), and extensive research

on socioeconomic, food-related, physical, psychosocial, and epidemiological determinants, this study confirms that obesity in Indonesia is shaped by complex, multidimensional interactions rather than a single causal pathway. The significant associations identified in the quantitative analysis indicate that obesity in the Indonesian context, particularly in the Province of Riau, is deeply rooted in social and environmental conditions that have evolved alongside economic development, urbanization, and lifestyle shifts.

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The strong correlation found between socioeconomic status and obesity aligns with international literature showing that SES remains one of the most robust predictors of obesity risk [3, 5]. In Indonesia, similar to other countries undergoing rapid nutrition transition, individuals with higher income or sedentary occupations tend to have increased access to calorie-dense foods and reduced levels of physical activity [6, 9]. These findings echo studies documenting that urbanization, greater consumption of ultra-processed foods, and increasing reliance on motorized transport contribute to rising obesity prevalence, particularly in middle-income countries [8]. The present study reinforces these observations by demonstrating that education, occupation type, residence, and income are directly associated with BMI status, confirming SES as a central determinant in the ecological model of obesity.
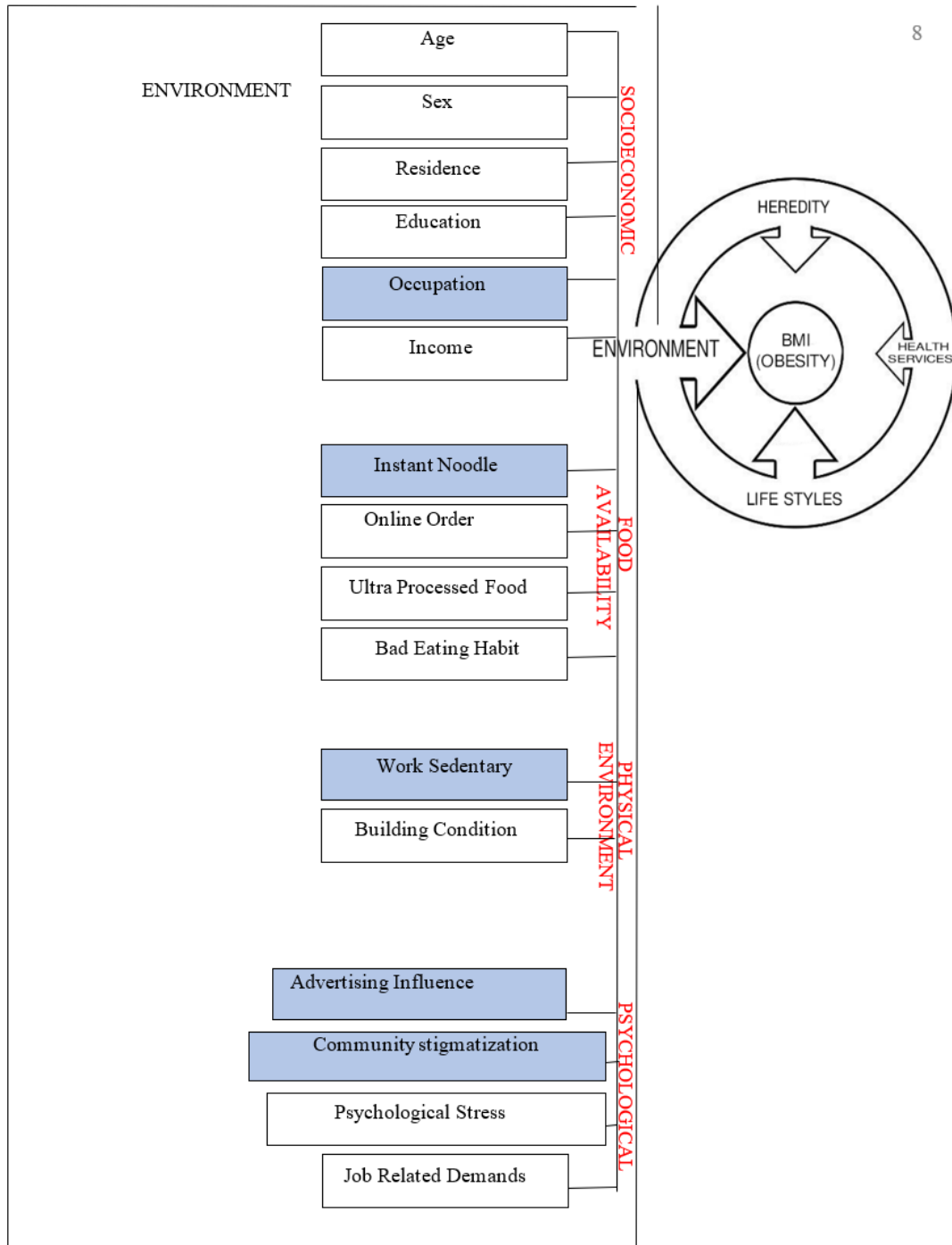
Figure 1.
Conceptual Pathway Model of Environmental Determinants of Obesity Based on H.L Blum's theory.

Food availability also emerged as a critical factor, consistent with Indonesia's ongoing shift toward ultra-processed, energy-dense dietary patterns [8-10]. The consumption of instant noodles, fried snacks, fast food, and sugar-sweetened beverages, previously documented as rising across Indonesian households, was strongly associated with increased obesity risk. These findings are aligned with

national health surveys showing that unhealthy food consumption habits are widespread and increasing across socioeconomic groups [9]. Moreover, the ease of food access through delivery applications, the proliferation of modern food outlets, and changes in household food culture due to urban lifestyles appear to accelerate this risk. These results reinforce the proposition that food environments are not merely individual choices but are structurally shaped by economic and market systems [10].

The physical environment, including occupational activity level, neighborhood safety, building conditions, and exposure to disease vectors, also showed a meaningful association with obesity. This affirms ecological models suggesting that obesogenic environments arise when communities lack safe sidewalks, green spaces, and opportunities for active living, combined with occupational structures that limit physical movement [2, 25]. In Pekanbaru, where rapid urban expansion has not been matched by pedestrian infrastructure or recreational amenities, physical inactivity becomes an expected outcome rather than a personal failing. These findings mirror studies from other developing urban centers where city design and workplace structures reinforce sedentary lifestyles [11, 25].

Psychosocial factors, including stress, workplace demands, social stigma, advertising influence, and emotional well-being, were also significantly related to obesity. This corresponds with evidence that chronic stress, depression, low self-esteem, and workplace pressures contribute to weight gain by altering health behaviors, sleep patterns, and endocrine responses [12, 16]. The observation that individuals experiencing psychosocial strain are more likely to be obese aligns with global findings that mental health and social conditions are major but often underestimated contributors to obesity risk. The influence of media and food advertising, particularly in low-SES populations, further amplifies unhealthy eating patterns, as widely documented in previous studies [14, 15].

Overall, the results strongly validate Blum's assertion that environmental factors are the dominant determinants of health, constituting a larger influence than lifestyle, genetics, or medical care [1]. The study also reinforces the Mandala of Health framework, demonstrating that obesity arises from interactions among biological, behavioral, psychosocial, and environmental systems rather than isolated behaviors [2]. These findings highlight that obesity in urban Indonesia should be approached as a structural public health challenge shaped by socioeconomic inequities, food environments, urban planning, work conditions, and psychosocial stressors. Therefore, policies should move beyond individual-based interventions toward community and environmental strategies that address upstream determinants.

5. Conclusion

This study demonstrates a continued increase in the number of obesity-related visits to Posbindu PTM in Riau Province during 2020 and 2021, reflecting a growing public health concern. Statistical analyses of environmental determinants indicate that only specific variables within each category showed significant associations with Body Mass Index (BMI). Among socioeconomic factors, occupation was the sole variable significantly correlated with BMI. Among food availability factors, instant noodle consumption exhibited a significant association with BMI. Physical environmental influences were observed through the significance of sedentary occupational patterns (sitting versus active work). Psychosocial factors also contributed meaningfully, with respondent perceptions and perceived societal barriers showing significant correlations with BMI. Based on these findings, an environmentally based obesity management model focusing on occupation type, instant noodle consumption, sedentary work patterns, and psychosocial perceptions can serve as a practical framework for policymakers and communities to mitigate the rising prevalence of obesity.

6. Recommendation

Several recommendations are proposed for stakeholders involved in environmental-based obesity management. First, stronger surveillance and reporting mechanisms are needed to improve the accuracy and continuity of obesity data from Posbindu PTM, community health care facilities (FKTP), and secondary or tertiary care facilities (FKRTL). Second, comprehensive public education should be

strengthened to promote healthier dietary choices, including appropriate consumption of instant noodles, as well as awareness of occupational demands, sedentary behaviors, and psychosocial perceptions related to obesity, while encouraging balanced physical activity. Third, stakeholders should develop and institutionalize operational guidelines based on the proposed environmental obesity management model to prevent further increases in obesity prevalence. Lastly, future studies are recommended to refine and validate this environmental model in broader populations and under varying public health contexts, including future pandemics.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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