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OBESOGENIC ENVIRONMENT IN INDONESIA: A LITERATURE REVIEW OF ENVIRONMENTAL DETERMINANTS OF OBESITY

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Abstract

Background: Obesity is a complex public health issue influenced by multiple determinants, including environmental factors that promote excessive calorie intake and physical inactivity, known as obesogenic environments. **Objective**: This literature review is to broaden understanding the environmental determinants of obesity in Indonesia. **Method:** A narrative literature review was conducted focusing on studies published between 1999 and 2024. Sources were retrieved from databases including PubMed, WHO Global Health Observatory, and national health surveys such as Riskesdas. The ecological framework by Swinburn et al. (1999) was used to analyse environmental influences on obesity. **Results:** Findings indicate that built and food environments play significant roles in shaping obesity patterns in many places. Studies show increasing obesity prevalence in both urban and rural Indonesia, with environment-related factors such as food availability, urbanization, and reduced physical activity opportunities contributing to this trend. **Conclusion:** Food environment, land use and physical infrastructure were identified as potential proxies for obesogenic environments in Indonesia. Further studies are needed to evaluate and validate these proxies to support the development of environments conducive to healthy lifestyles and to reduce obesity prevalence.

Keywords: Obesity, Obesogenic Environment, Indonesia

Introduction

The rising prevalence of overweight and obesity worldwide, has made obesity prevention as global public health prority.[1] In 2022, 2.5 billion adults—43% of the global population aged 18 years and over—were overweight, including 890 million were obese.[2] Not mentioning the growing number of childhood obesity which leads to higher prevalence of adulthood obesity and degenerative diseases later.[3] Overweight and obesity was as become significant risk factor for mortality and morbidity from cardiovascular diseases, diabetes, cancer and muscoletal disorder.[4] The prevalence of overweight varies across regions, with the WHO South-East Asia Region reporting a prevalence of 31% in 2022.[2] According to Indonesia's Basic Health Research (Riskesdas), adult obesity prevalence increased from 15.4% in 2013 to 21.8% in 2018[5,6] reflecting a growing public health concern linked to lifestyle and environmental changes. Nowadays, there is an increasing interest of multi-sector approach to obesity prevention.[7] An environmental approach is one of a potential effective strategy to encourage healthy living. [8,9,10,1] There are movements to address aspects of the obesogenic environment using multidicipline approach of urban design, nutrition and geography[11]. However, despite the acknowledgement of the role of environment to obesity, the use of environmental strategy to prevent obesity is not yet fully explored[12] especially in developing country like Indonesia.

Results and Discussion

A. Etiology of Overweight and Obesity

The pandemic of obesity already driven many reseachers to find out what possible

factors contributing to the pandemic. WHO consultation on obesity report explore that the etiology of obesity involve many factors and complex interaction among genetic, hormones, different social and environmental factors such as unhealthy dietary habits and less physical activities lifestyle.[13] Factors are associated with generating overweight and obesity in the population based on studies is present below:

Biologic Factor

In some population, obesity occurance is close related to genetically susceptibility to obesity. Neel proposes an idea of "thrifty genotype" that makes some population more susceptible to obesity.[14] Thrifty genotype is defined by Neel as the characteristic of body that is very efficient in the intake and/or utilization of food.[14] Therefore, Ulijaszek explains that body function is actually under control of genetic, meanwhile the human genome is likely to do selection for traits that promote energy intake and storage and that minimize energy expediture.[15] Nevertheless, in the population level obesity is associated with both mono and polygenes expressing obesity in environment that give predisposition to obesity, with genetic variation that influencing metabolism.[15]

Nutrition Factor

Energy from food is used to manage essential work in the body so that it determines body total energy expenditure. Total energy expenditure itself represents the sum of three factors; the Basal Metabolic Rate (BMR), Thermic Effect of Food (TEF) and physical activities (PA), it accounts for two thirds (60%) of daily energy expenditure.[9] Eventhough BMR takes the biggest proportion in energy expenditure, the role of BMR causing weight gain itself is not easy to change. The balance between energy intake and energy expenditure, however,

determines how much energy will be available to be stored in the period of excees energy as well as to be released in period of energy shortage.[16] Meanwhile, weight gain starts when the energy intake exceeds total daily energy expenditure and stay in the body for a prolonged period.[16] It may reflect that there is imbalance energy used in the body. In addition, past nutritional status (childhood obesity status) also influences the occurrence of obesity later in life. Study found that children and teenager with obesity have approximately a fivefold increased risk of remaining obese as adult compared to their non obese peers.[17]

Social Factor

Socioeconomic inequities in some other country make the access to food is limited due to economic insecurity.[18] Energy-dense and nutrient-poor foods become the best choices by the poor groups to provide daily calories at an affordable cost, however nutrient-rich foods and high-quality diets not only cost more but also are consumed by more affluent groups[19]

Environment Factor

Swinburn et al describe environment factors to obesity using an ecological model.[8] By using ecological model, it describes environment influence on individual's or population's status of obesity as the result of multiple influences, which later impacts on fat mass through mediator of energy intake and energy expenditure from physical activities.[8] Enhance to that, physiological adjustment in response to weight loss or weight gain, such as metabolic rate and nutrition partitioning, may moderate the impact of energy imbalance on changes in fat mass. As the result, biological and behavioral factors become central of attention in obesity treatment and prevention. However, the driving force of environmental to obesity have not been well explored.[8]

Figure 1 describes the environmental influence on obesity proposed by Swinburn et al.[8] Swinburn divided environmental influence into two different size; microenvironments (such as home, workplaces, school, community place, food retailers), macroenvironments (such as media, transport system, urban/rural development, food production) and type (physical, economical, political and sociocultural) in relation with food and physical activity.[8] Based on Swinburn study, it was concluded that the individual food and physical activity exposure to obesogenic environments varied within any population and is mediated economically, politically and socially.[15] Moreover, physical environment is one important determinant to influence opportunity to calorie intake and calorie expenditure.[1] In conclusion, a person's obesity status is associated with the neighborhood and the larger environment around.

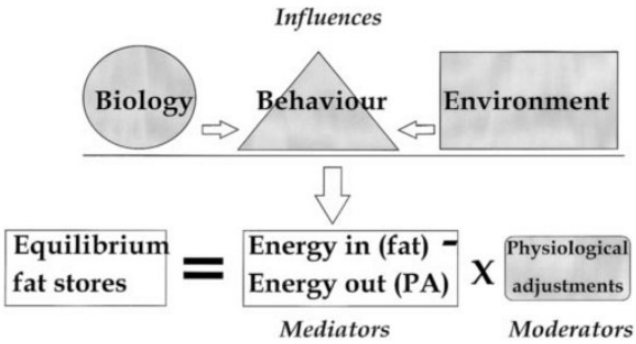

Figure 1. Ecological Model for Understanding Obesity [8]

B. Obesogenic Environment

From Oxford advance dictionary, environment is define as "*The conditions that affect the behavior and the development of somebody/something; the physical conditions that somebody/someting exists in; the setting or condition which a particular activity is carried*

on."[20] In the context of obesity, this refers to the *obesogenic environment*, it is a settings that promote weight gain and do little to support weight loss.[21] Powell et al[22] similarly define it as environments that facilitate or reinforce obesity. The term also reflects broader global economic and cultural changes that shape food choices and physical activity patterns.[16] Swinburn et al describe obesogenicity as "the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations."[8,21]

The relationship between obesity and the environment has been recognized in developed countries for decades. In the UK, obesity was predicted to be environmentally driven over 25 years ago.[9] Environmental factors promote energy-dense food consumption, reduce physical activity, and limit energy expenditure, thereby contributing to the obesity epidemic.[23,24] Swinburn et al distinguish two key environmental domains: the built environment, which influences active living, and the food environment, which is shaped by access to food outlets such as restaurants and supermarkets.[21] Environmental interventions have been identified as the most cost-effective strategies in obesity prevention.[21,25] Urbanization further amplifies these challenges. Rural areas increasingly adopt urban lifestyles or transition into urban spaces. In the U.S., urbanicity correlates with obesity risk across race, ethnicity, and gender[26], a trend similarly observed in Southeast Asia, where urban areas report higher obesity prevalence across age and gender groups.[27] While data from developing Asian countries are limited, a study in urban South Africa links poor infrastructure, high density, and unsafe neighbourhoods to reduced physical activity and increased obesity risk.[28] Similar associations are found in U.S. urban settings with poor walkability and fast-food density.[26]

In relation to food, the obesogenic environment encompasses the production,

distribution, availability, and affordability of foods that increase the risk of obesity.[15] Over the past decades, the global food environment has shifted significantly. Portion sizes have increased, in part due to economic pressures on the food industry, which drive companies to expand markets through aggressive advertising and marketing strategies.[29] These pressures have led to widespread availability of energy-dense, nutrient-poor foods, often marketed more effectively than balanced nutrition messaging.[29] A WHO report highlights that global trade and food marketing contribute to the nutrition transition, characterized by increased intake of foods high in sugar, salt, and saturated fats.[30] These dietary trends promote excessive visceral fat accumulation, which the human body is poorly adapted to counteract under conditions of energy surplus.[31]

Intervention strategies such as taxation of unhealthy foods, front-of-pack labelling systems, and restrictions on marketing to children have been proposed to improve the food environment.[32] Yet, identifying the most influential environmental factors remains a challenge, as many of these determinants are geographically specific and socially embedded.

In Indonesia, urban dietary patterns have begun to influence rural communities. According to the National Basic Health Survey, several rural provinces, including North Sulawesi, East and West Papua, East Kalimantan, North Maluku, the Riau Archipelago, and Gorontalo, have adult obesity rates exceeding the national average.[33] However, research on obesogenic environments in these areas is limited. Built and food environments are often interlinked. For example, studies by Burgoine et al[34] and Frank et al[35] have shown that factors like street connectivity, land-use mix, and proximity to supermarkets or fast-food restaurants influence BMI and dietary quality. Moreover, Nelson et al[12] found that the built environment

shapes health behaviors and outcomes, often varying by gender and urbanicity. In the Indonesian context, dietary patterns remain heavily carbohydrate-based, with rice being the predominant staple at approximately 1.57 kg per week, far exceeding the consumption of other carbohydrate sources such as wheat, corn, or cassava.[36] This imbalance reflects a nutritional environment that may contribute to the development of obesogenic conditions, as excessive reliance on refined carbohydrates with low protein intake can promote positive energy balance and poor satiety regulation. See Table 1 for further information.

Table 1. Review of Studies that Explored the Relationship Between Obesity and Variables Obesogenic Environment in the Community

Author (Year)	Overall Purpose	Sample: Number & Location	Outcome variable	Built Environment Variable: Unit of Measurement & Data Source(s)	Other Variables (Source)	Findings for association of obesity and the obesogenic environment	Limitations
Bugoine et al 2011 [34]	To link physical environment with individuals and ti subsequently scruitinise the relationship	893 individuals aged 16+ North East England	BMI percentile and food vegetable consumption	Unit of Measurement: • Foodscape location all over North East England • Calculating residential density • Calculating street connectivity • Calculating land use mix Data Source: • Location of food retail and restaurants- North East England Yellow Pages (phonebook, postcode, internet and geocode)	• Individual and demographics (BMI category, Socioeconomic status, Supermarket accessibility, Problem of vandalism, Urban or rural category, Sex, Ethnicity, Fruit and vegetable consumption, age) • Walkability index	• Varying elements of both walkability and food availability are significantly associated with BMI and fruit and vegetable intake	• Variying spatial resolution of data recording • Analysis was occasionally limited by the categorical nature of data restricted direction of causation • Cross-sectional design • More accurate method in assessing foodscape is needed
Nelson NM and Woods SB, 2009 [12]	Examined neighborhood feature related to physical activities among adolescent	Adolescent N=4587 age 15-17 years, 51.4% male	BMI (Self-report physical activity)	*Unit of Measurement:* • Facility for walking and cycling • Pedestrian/traffic safety • Personal safety • Neighborhood surrounding • Street connectivity • Land use mix • Proximity to stores and facilities *Data Sources:* • NEWS data • Proximity of food location • School type, gender and location	• Socio-demographics • Physical activity	• Neighborhood perception predicted overweight and obesity • Adolescent who reported physical activity were 2% less likely to be overweight/obese and 5% less likely to be obese	• The study was few early investigation into obesogenic environment relevant to young people • Cross sectional data • The NEWS was design for urban American setting that likely to have different variations • Neighborhood environment data are likely inter-related
Xu and Wang, 2015 [26]	To find possible different impact of built environment	328,156 adults United	Physical inactivity (no leisure time or	*Unit of Measurement:* • Rates of physical inactivity and obesity for various socio-demographic groups	• Demographics* • Neighborhood variable • Street connectivity	• Some obesity is geographically specific and vary between men and women • Built environment influencing	• Cross-sectional design • Limited detail provided about data; both physical activity and obesity rely on BRFSS data

Author (Year)	Overall Purpose	Sample: Number & Location	Outcome variable	Built Environment Variable: Unit of Measurement & Data Source(s)	Other Variables (Source)	Findings for association of obesity and the obesogenic environment	Limitations
	factors in area at various urbanicity levels and between gender in adult	States	noexercise in last month) Obesity status (Measured height and weight)	• NCHS urban-rural classification scheme for countries *Data Sources:* • BRFSS data • U.S cencus 2010	• Walkability • Food environment • Intersecion density	people's health behaviour and outcome	• Finer geographic resolution to improve define built environment • Limited data availability and time
Frank et al 2012 [37]	Examined the development of GIS-based multicomponent physical activity and nutrition environment indicators of child obesogenic environments	1000 children aged 6-11 years per each type of neighborhood (exact number in sample not identified) San Diego and Seattle regions	BMI change over 1 and 3 yrs (Measured height and weight)	*Unit of Measurement:* • Cencus block data of walkability level • Park proximity • Park quality • Fast-food proximity • Supermarket proximity *Data Sources:* • Cencus block data • Park availbility data • GIS shapefile • Food outlets data	• Demographics*	• To identify sufficient numbers of childrenaged6–11 years, highphysical activity environment block groups had at least one high-quality park within 0.25 miles and were above median walkability • Low physical activity environment groups had no parks and were below median walkability • High nutrition environment block groups had a supermarket within 0.5 miles, and fewer fast-food restaurants within 0.5miles • Low nutrition environments had either no supermarket, or a supermarket and more than fast-food restaurants within 0.5miles	• Incongruent categorization of exposures (BMI was measured as change over time, but food environment variable was measured at one point.) • Use of secondary aggregate data • Types of stores not differentiated (Small grocery store indistinguishable from supermarkets) • Limited sample size in subpopulations • Did not measure or control for dietary intake.

*Demographics include various population characteristics such as age, sex, race, ethnicity, education level, employment status, income level, marital status, or other social attribute varied by study.

BMI – Body Mass Index
GIS – Geographic Informational Systems
NEWS– Neighborhood Environment Walkability Scale
BRFSS– Behavioral Risk Factor Surveillance System
NCHS – National Center for Health Statistic

C. Environmental Determinant of Obesity

The individual factors that caracterize certain population can show varied result in obesity prevalence. Interaction between individual factors and environmental factors may come up with different obesity pattern. In addition, there was variation between studies to decribing obesogenicity of environment. From Mackenbach et al[1] review, it is found that only two environmental correlates show consistent association with weight status: indicators of urban sprawl (usually based on population density and its positively associated with obesity) and measures of land use mix (negatively associated with obesity). Those variables included in environmental factor analysis always appear as the important marker to obesogenic environment. Even so, actually there are many proxies and variables of environment, however, the finding was still diverse and not yet showing consistent result. This can be caused by different context or geographic and the heterogenity in method and measures used[1], so that research in this field needs to be developed. Worsening air quality, including in Indonesia, may contribute to obesogenic environments by promoting systemic inflammation, a biological mechanism linked to obesity and other chronic diseases.[38] In term of health facility, one of the key challenges in addressing obesogenic environments is ensuring that adult-focused health promotion is delivered early through Primary Health Care, so that positive lifestyle behaviors can be established before older age to prevent obesity and support healthy aging.[39] Variables used to oprationalize obesogenic environment analysis in prior studies are summarized below **(Table 2)**:

Table 2. Summarize of Variables Associated with Obesogenic Environment from Prior Studies

Individual variables	Environmental variables	Other
1. BMI category 2. Socioeconomic status 3. Supermarket accessibility 4. Problem of vandalism 5. Urban or rural living area 6. Gender 7. Ethnicity 8.Fruit and vegetable consumption 9. Age category 10. Physical activity (time for do exercise) 11. Employment status 12. Marital status 13. Smoking status 14. Education 15. Income	1.Availability of food to consume 2.Residential density 3. Street connectivity 4.Land use mix 5. Pedestrian 6. Facilities for walking and cycling 7. Neighborhood aesthetics 8. Proximilty to stores and facilitites 9.Convinient facilities 10.Distance to food, retail, education, recreaction, and entertainment 12. Food environment: fast-food restaurant per capita 13. Food environment: convinience store, fast-food restaurants, sit-down restaurants, specialty food stores,multipurpose stores	**Neighborhood variables:** poverty rateand race heterogenity **Urbanicity:** urban population in urban areas over total population in the country **Playability index**: public park quality **Nutrition environment:** combination of fast food concentration and supermarket proximity within and immediate surrounding of block group

Conclusion

The rising prevalence of overweight and obesity in Indonesia reflects the significant impact of environmental factors, particularly those related to food systems, urban development, and physical activity opportunities. Fundamentally, obesity was caused by excess energy intake compare to energy expenditure. Both factors are very much linked to the environment setting. Environment that promote high energy intake at the same time promote less physical activity known as obesogenic environment. This review highlights how obesogenic environments shaped by the availability of unhealthy food options, limited

walkability, and urban infrastructure and contribute to unhealthy lifestyles. The ecological model provides a comprehensive framework for understanding these influences at both micro- and macro-environmental levels.

The variable found from previous study such as food environment characteristics, land use patterns, and physical infrastructure can be useful key proxies indicators in mapping obesogenic environments. However, the measurement and standardization of these proxies in the Indonesian context remain limited. Future research is needed to develop context-specific indices and validate them across diverse settings to support effective public health interventions and policies targeting obesity prevention.

Conflict of Interest

There is no conflict interest of this publication.

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