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ECOLOGICAL STUDIES ON THE ASSOCIATION OF FOOD INSECURITY AND MALNUTRITION IN INDONESIA: A LITERATURE REVIEW

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Abstract. This review investigates the intricate relationship between food insecurity and malnutrition in Indonesia, emphasizing the utility of ecological studies in addressing these intertwined public health challenges. Food insecurity, characterized by unreliable access to affordable and nutritious food, is linked to various malnutrition outcomes, including stunting, micronutrient deficiencies, and the emerging double burden of malnutrition. By synthesizing findings from ecological research, this review explores how socio-economic, environmental, and policy-related factors influence food security and nutritional outcomes across diverse Indonesian regions. Key findings highlight significant regional disparities driven by income levels, educational attainment, and environmental conditions such as climate variability and land use changes. Moreover, governmental interventions, including food aid programs and nutritional policies, have shown promise in mitigating food insecurity but require enhanced integration and rural focus. This review underscores the importance of ecological methodologies, which analyze group-level data to uncover patterns and determinants of food insecurity and malnutrition. Recommendations for future research include region-specific ecological studies to inform multi-sectoral strategies targeting food security and nutrition. These insights are critical for policymakers aiming to achieve sustainable improvements in public health outcomes across Indonesia.

Keywords. Ecological Studies; Food Insecurity; Malnutrition; Public Health; Indonesia

INTRODUCTION

Food insecurity and malnutrition are interconnected public health challenges in Indonesia, shaped by socioeconomic, environmental, and cultural factors. Food insecurity, defined as limited or uncertain access to safe and adequate food, encompasses both food scarcity and social difficulties in acquiring food (Ashley, 2018). When persistent, it often leads to malnutrition, marked by nutrient imbalances in intake, as deficiencies or excesses (Beyene, 2023). In Indonesia, these issues are exacerbated by economic disparities, environmental risks, and the COVID-19 pandemic's effects on food availability and household incomes (Setyawati, 2022).

Malnutrition in Indonesia affects various age groups, particularly children, with consequences for growth, cognitive development, and long-term health. Limited access to nutrient-rich foods, especially in rural areas, contributes to a high prevalence of stunting among children under five (Mahmudiono et al., 2018). Heavy reliance on starchy foods, often lacking essential vitamins and minerals, such as vitamin A, iron, and zinc, further contributes to these deficiencies (Masitoh et al., 2023). Such nutritional inadequacies affect not only physical growth but also cognitive function and mental health, with food-insecure children often showing lower IQs and behavioral issues (Ke & Ford-Jones, 2015). Addressing malnutrition in Indonesia involves improving both food availability and dietary diversity. Food-insecure households tend to consume fewer nutrient-dense animal-based foods, vital for growth (Mahmudiono et al., 2018). Consequently, children in these households face higher risks of stunting and other malnutrition forms (Santa-Ramírez et al., 2023).

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The high prevalence of food insecurity and malnutrition calls for targeted interventions. Around 21,5% of Indonesian children under five are stunted, a slight improvement yet a significant public health issue (Kemenkes, 2023). Indonesia aims to reduce stunting rates to 14% by 2024, underscoring the need for continued interventions (Presiden RI, 2021). Additionally, Indonesia faces a "double burden" of malnutrition, with rising overweight and obesity rates alongside stunting. For instance, about 8.7% of children with cleft lip and/or palate experience both stunting and overweight, showing the complexity of Indonesia's nutritional issues (Rafisa, 2023).

Food insecurity remains significant in Indonesia. Indonesia's Global Food Security Index (GFSI) score reached 60.2 points in 2022, reflecting a 1.7% increase from the previous year. Based on this score, Indonesia's food security in 2022 falls within the medium category, which ranges from 55 to 69.9 points (Economist Impact, 2022). This issue has worsened due to COVID-19, which disrupted food supply chains and reduced household incomes, especially in rural areas with limited access to diverse foods (Marchianti et al., 2022; Masita, 2023). Socioeconomic constraints, which push families to cheaper but nutrient-poor foods, further contribute to both stunting and obesity (Fatmawati et al., 2020). Additionally, anemia—another form of malnutrition due to iron deficiency—affects around 47% of children under five (Setyawan et al., 2022).

These statistics reveal a complex crisis of food insecurity and malnutrition in Indonesia, with high rates of stunting, a double burden of malnutrition, and widespread food insecurity. Addressing these challenges requires coordinated action across government, community organizations, and health sectors to increase nutritious food access, promote healthy eating habits, and address underlying socioeconomic inequalities.

Ecological research provides a valuable approach to studying food insecurity and malnutrition, especially in Indonesia, where these issues intersect with socioeconomic and environmental factors. Ecological studies analyze group-level data, enabling researchers to identify broader patterns and correlations that may be undetectable in individual-level studies (Newman, 2023). This approach is critical in Indonesia, where factors like household income, food prices, and rural-urban disparities shape food insecurity (Mamahit, 2023). By examining these factors at a population level, researchers can better understand how systemic issues contribute to food insecurity and malnutrition, facilitating more targeted interventions. Ecological studies also highlight connections between food insecurity and malnutrition across demographic groups, such as children and older adults. For example, studies indicate that food insecurity can worsen malnutrition among older adults, creating a double burden for this vulnerable group (Gkiouras et al., 2020). During the COVID-19 pandemic, ecological studies have proven valuable in quantifying economic disruptions' impacts on household food security across regions and social classes (Amrullah et al., 2023; Purnasari et al., 2020).

Additionally, ecological research provides insights into social determinants of food insecurity and malnutrition. For example, Smith et al., (2017) found that social capital, such as trust and community networks, significantly impacts household food security. Recognizing these dynamics at the community level helps policymakers design interventions that leverage social networks to alleviate food insecurity. Moreover, Masitoh et al., (2023) highlight low dietary diversity among food-insecure households in rural Indonesia, where diets are often starchy and nutrient-poor. By analyzing dietary trends across communities, ecological studies provide insights into nutritional gaps that inform public health strategies aimed at improving diet quality. In summary, ecological research is crucial for understanding

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Page : 129-139
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food insecurity and malnutrition in Indonesia. By studying these issues at the group level, researchers can identify vulnerable populations, assess the impacts of social and environmental factors, and develop comprehensive strategies addressing food insecurity and malnutrition's root causes.

Ecological studies are observational research designs that analyze data at the group level, providing insights into how environmental, social, and economic factors affect population health outcomes. In public health research, ecological studies are particularly valuable for exploring complex issues, such as food insecurity and malnutrition, which are influenced by broader contextual factors. By examining population-level data, these studies help researchers understand how community characteristics relate to health outcomes, offering insights that individual-level studies may not provide.

A major strength of ecological studies is their ability to identify patterns and associations within population-level data, guiding public health policy and interventions. Coutts et al., (2014) stressed the importance of understanding the natural environment's impact on health, which is crucial for public health research. This approach is particularly relevant given climate change, as ecological studies help identify vulnerable populations and evaluate potential health impacts of environmental changes (Hathaway & Maibach, 2018; Woodhall et al., 2019). Ecological studies are also effective for exploring health disparities and inequalities. By analyzing data across communities, researchers can uncover how socioeconomic factors, resource access, and social networks affect health outcomes, particularly related to food insecurity and malnutrition (Roser-Renouf et al., 2016). This approach is essential for addressing the double burden of malnutrition, as it provides a nuanced understanding of how undernutrition and obesity coexist within specific populations (Batal et al., 2023; Walls et al., 2021). However, ecological studies have limitations, particularly with ecological fallacy, where group data leads to incorrect assumptions about individual behaviors. While these studies provide a broad view of health determinants at the community level, researchers should interpret findings cautiously and supplement them with individual-level research.

The primary aim of this review is to explore ecological studies on the relationship between food insecurity and malnutrition in Indonesia. By focusing on population-level data, this review seeks to identify patterns and determinants contributing to food insecurity and malnutrition, particularly among vulnerable communities. Through this analysis, the review aims to offer insights into effective public health strategies for improving nutritional outcomes in Indonesia. This review is structured as follows: it begins with a methodological framework for ecological studies and then discusses an ecological perspective of food insecurity and malnutrition in Indonesia. The review then examines factors influencing the association between food insecurity and malnutrition. Finally, it offers concluding remarks on the implications of ecological research for public health policy and future research directions. By synthesizing available ecological studies, this review aims to contribute to a comprehensive understanding of food insecurity and malnutrition in Indonesia, offering evidence-based recommendations for policymakers and public health practitioners to improve food security and nutrition across the country

METHOD

This study is a literature review aimed at synthesizing available research on the association between food insecurity and malnutrition in Indonesia, with a focus on ecological perspectives. A comprehensive search of published literature was conducted in major

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electronic databases, including PubMed, ScienceDirect, Google Scholar, and Scopus. The search used keywords such as: food insecurity, malnutrition, Indonesia, ecological studies. Boolean operators like AND/OR were applied to combine the terms. The findings were synthesized descriptively to highlight trends, gaps, and key insights into how food insecurity is linked to malnutrition at a community or population level in Indonesia. Emerging themes were categorized and presented to provide a coherent narrative.

RESULTS AND DISCUSSION

Methodological Framework for Ecological Studies

Ecological studies offer a unique approach to understanding the complex interactions between populations and their environments, making them an essential tool in public health research. Ecological studies focus on groups or populations as units of analysis, rather than individuals, which allows for the investigation of population-level trends and patterns. These studies are particularly useful in examining large-scale issues like food insecurity and malnutrition, where the factors involved are often deeply embedded in community, environmental, and socio-economic contexts. The general principles of ecological studies are rooted in the analysis of population-level data. Unlike individual-level epidemiological studies that examine personal exposures and outcomes, ecological studies aggregate data at the group level, often across geographic regions or demographic groups (Newman, 2023). This approach allows researchers to explore the relationships between variables, such as food security and malnutrition, across diverse populations. For example, a study may examine the average levels of food insecurity in different regions of a country and correlate them with the prevalence of malnutrition among children. The focus is not on individuals, but rather on how the mean values of exposures and outcomes behave across populations (Loney & Nagelkerke, 2014).

This group-based approach differs from individual-level epidemiological studies in several key ways. Individual-level studies, such as cohort or case-control designs, often collect detailed data on personal risk factors and outcomes, allowing for more precise control over confounding variables. Ecological studies, by contrast, use aggregated data, which makes it difficult to account for individual-level differences. However, ecological studies have advantages in their ability to cover large populations, offering insights into public health trends that might be impractical or too costly to study on an individual basis (Dufault & Klar, 2011). For instance, studies that look at food security and malnutrition at a national level provide a broad understanding of the issues but may miss specific, individual-level nuances.

Ecological studies used in food security research can be categorized into several types: exploratory, analytical, and hypothesis-generating studies. Exploratory ecological studies are often the first step in understanding complex issues like food insecurity. These studies do not begin with a specific hypothesis but instead aim to identify general patterns and trends. For example, Shannon et al., (2015) explored the relationship between urban environments and food security among older populations in Georgia. This exploratory approach revealed significant associations between food deserts and increased food insecurity, helping to identify potential areas for further investigation.

Analytical ecological studies, on the other hand, are designed to test specific hypotheses about the relationships between population-level exposures and outcomes. These studies often employ rigorous statistical methods to analyze how one variable may affect another. A good example of an analytical ecological study is the work by Johnson &

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Page : 129-139
ISSN:2828-4925
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Markowitz, (2017), which tested the hypothesis that food insecurity during early childhood negatively impacts social outcomes in kindergarten. The study demonstrated a significant association between food insecurity and reduced social skills, providing valuable evidence for the long-term effects of food insecurity on child development.

Hypothesis-generating ecological studies serve to identify potential causal relationships that can be explored in future research. These studies help generate new theories and guide the design of more focused investigations. For instance, Howard, (2011) conducted a study on the transitions between food insecurity and food security, and how these shifts influenced children's social skill development. The study not only described the observed phenomena but also suggested potential hypotheses regarding the impact of food security on childhood development, offering a foundation for future research.

Despite the valuable insights that ecological studies can provide, they have both strengths and limitations. One of the major strengths of ecological studies is their ability to analyze large populations. This broad scope makes them well-suited to identifying trends that may not be visible in smaller studies. For example, ecological studies on food insecurity can assess patterns across entire regions, helping policymakers understand which areas are most at risk and enabling the development of targeted interventions (Huang, 2023). In addition, ecological studies are often more cost-effective than individual-level studies because they typically use existing data sources such as national surveys or health records. This makes ecological studies a practical option for researchers working with limited resources (Jacquet et al., 2016).

However, ecological studies also have significant limitations, particularly the risk of ecological fallacy. This occurs when inferences about individual behavior or health outcomes are drawn from group-level data, which can lead to misleading conclusions. For instance, while an ecological study might find that regions with higher food insecurity also have higher rates of obesity, this does not necessarily mean that all individuals in those regions who are food insecure are obese. The relationships observed at the population level may not hold true for individuals within that population, making it difficult to apply findings from ecological studies to specific individuals (Tarkang et al., 2022).

Food Insecurity and Malnutrition in Indonesia: An Ecological Perspective

In Indonesia, food insecurity and malnutrition are pressing public health issues, impacting a significant portion of the population across various regions. These issues are inherently complex, influenced by socio-economic disparities, environmental challenges, and differences in agricultural practices. Given that ecological studies analyze data at a group level, they offer a unique perspective on how these variables collectively impact food security and nutritional outcomes. By examining food insecurity and malnutrition from a population-level view, ecological studies help illuminate the broader trends and underlying factors that shape these public health challenges in Indonesia (Rozaki, 2021).

Regional disparities in food insecurity and malnutrition across Indonesia highlight the inequalities that exist between urban and rural areas, as well as among different provinces. Eastern Indonesia, particularly areas such as East Nusa Tenggara, West Papua, and Maluku, faces some of the highest rates of food insecurity and malnutrition, while regions with more developed infrastructures, such as Jakarta and Bali, experience lower rates (Amrullah et al., 2019). These disparities are influenced by multiple socio-economic factors, including limited employment opportunities, lower education levels, and restricted access to healthcare facilities. As noted by Akbar et al., (2023), the COVID-19 pandemic exacerbated these

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Vol. 3 No. 1 (2024)
Page : 129-139
ISSN:2828-4925
DOI: 10.47841/icorad.v3i1.193

disparities, with rural households more severely affected by reduced income and restricted market access, which significantly hindered food availability and affordability.

Socio-economic factors play a critical role in shaping food security outcomes. Households in rural regions are more likely to rely on subsistence agriculture, which leaves them vulnerable to environmental disruptions and seasonal variations in food production (Isaura et al., 2022). Additionally, these areas often lack adequate infrastructure, further complicating the transportation and distribution of food supplies. Urban populations, on the other hand, may have better access to diverse food sources but are also more susceptible to economic instability due to the high cost of living. This distinction underscores how food security in Indonesia is closely tied to both geographical location and socio-economic status (Hasanah et al., 2017).

Ecological studies have provided significant insights into the relationship between food insecurity and malnutrition in Indonesia. For instance, Amrullah et al., (2023) conducted a study examining the effects of the COVID-19 pandemic on food insecurity, finding that urban households experienced greater resilience due to better access to food markets, while rural areas faced heightened challenges in maintaining food security. The study used regional data to compare food insecurity trends before and after the pandemic, highlighting how external economic shocks can exacerbate existing vulnerabilities in less economically robust regions.

Another important ecological study conducted by Hasanah et al., (2017) explored the relationship between labor migration and food expenditure in Eastern Indonesia. The study revealed that households with family members working in urban centers experienced increased food security, as remittances allowed for more stable food purchases. This finding demonstrates the impact of economic migration on rural food security, illustrating how income diversification can mitigate food insecurity. Additionally, Isaura et al., (2019) examined the association between food insecurity and depressive symptoms among Indonesian adults. The study found that food insecurity contributed to poor mental health, which, in turn, affected dietary choices and nutritional outcomes. By focusing on the interconnections between mental health and food security, the study highlights a multidimensional perspective on malnutrition and food insecurity in Indonesia.

Ecological studies also reveal how food insecurity disproportionately affects specific population groups in Indonesia. For children, food insecurity often results in undernutrition, leading to long-term health consequences such as stunting and impaired cognitive development. Franklin et al., (2012) emphasized that food insecurity can influence dietary behaviors in children, limiting their intake of diverse and nutrient-rich foods. This finding aligns with studies in Indonesia, where malnourished children in food-insecure households face heightened risks of developmental delays and poor educational outcomes.

Pregnant women in Indonesia are another population group particularly affected by food insecurity. Insufficient access to nutritious food during pregnancy not only affects maternal health but also has serious implications for infant health, potentially leading to low birth weights and maternal anemia. Franklin et al., (2012) pointed out that economic constraints often force pregnant women in low-income households to make nutritional sacrifices, which impacts both maternal and child health outcomes. This finding is significant in rural Indonesia, where limited access to healthcare services further exacerbates the effects of food insecurity on maternal and infant health.

Furthermore, ecological data reveal distinct patterns of food insecurity between rural and urban populations in Indonesia. While urban residents may experience greater market

Proceeding of 3rd International Conference on Research and Development (ICORAD)
Vol. 3 No. 1 (2024)
Page : 129-139
ISSN:2828-4925
DOI: 10.47841/icorad.v3i1.193

access, the high cost of living often leads to economic food insecurity, where households struggle to afford nutritious food despite its availability. Rural populations, however, face physical barriers to food access due to underdeveloped infrastructure and dependence on local agricultural yields. The study by Amrullah et al., (2023) noted that during the COVID-19 pandemic, rural households were disproportionately affected due to logistical barriers that restricted food supply chains. Environmental challenges, such as droughts and floods, further destabilize food security in these areas, as rural households are heavily dependent on seasonal agriculture (Belachew et al., 2013).

Factors Influencing the Association Between Food Insecurity and Malnutrition

The association between food insecurity and malnutrition is complex and influenced by various socioeconomic, agricultural, environmental, and policy-related factors. Each of these factors plays a crucial role in shaping the food security landscape in Indonesia, often affecting vulnerable populations disproportionately. Ecological studies, which observe variables at the group level, provide a holistic perspective on how these broader factors impact food security and nutritional outcomes across different communities in Indonesia (Rozaki, 2021).

Socioeconomic determinants are among the primary influences on food insecurity and malnutrition, with income, education, employment, and poverty significantly shaping access to adequate and nutritious food. Higher income levels generally improve food security by enabling households to purchase a variety of foods, while education, particularly among mothers, is closely linked to improved dietary practices and nutritional outcomes for children (Ali et al., 2019). In Indonesia, poverty exacerbates food insecurity, as low-income families often have limited access to nutritious foods, leading to higher malnutrition rates, particularly among children. Lukwa et al., (2020) examined how socioeconomic inequalities drive malnutrition among children under five, noting that low-income families in rural areas are more likely to experience food insecurity due to limited resources. This finding resonates with research conducted by Cahyono & Tokuda, (2024), who noted that lower education levels and unemployment contribute to food insecurity, suggesting that targeted interventions to improve education and employment could mitigate malnutrition risks.

Ecological studies also highlight how employment status influences food security. Households with stable employment are better equipped to manage food expenses, while those facing job insecurity or unemployment are more vulnerable to fluctuations in food access, especially during economic downturns. Studies conducted by (Atoloye et al., 2015) in Nigeria emphasize the spatial patterns of food insecurity, finding that households with inconsistent income sources tend to have less dietary diversity, increasing malnutrition risk. Similarly, in Indonesia, employment stability is critical in ensuring consistent food access, underscoring the importance of employment-focused policies to address food insecurity.

Agricultural productivity and environmental conditions also play a significant role in determining food availability and security in Indonesia. Rural areas heavily reliant on agriculture are often vulnerable to seasonal variations and environmental factors such as climate change, which can disrupt food production and supply. In the context of Indonesia's diverse agricultural landscape, fluctuating weather patterns, droughts, and flooding have profound impacts on food security. For instance, McQuade et al., (2019) found that in Tanzania, seasonal food insecurity due to agricultural dependency led to low birth weights and increased acute malnutrition, illustrating how environmental factors can exacerbate nutritional deficiencies. These findings are relevant to Indonesia, where seasonal challenges

Proceeding of 3rd International Conference on Research and Development (ICORAD)
Vol. 3 No. 1 (2024)
Page : 129-139
ISSN:2828-4925
DOI: 10.47841/icorad.v3i1.193

and climate events can limit food access for rural populations, leading to higher rates of food insecurity and malnutrition.

Land use practices also significantly affect agricultural productivity and, consequently, food security. In Indonesia, small-scale farmers are often constrained by limited land access, making it difficult to produce sufficient food for household consumption and local markets. Land fragmentation and inadequate agricultural policies further compound these challenges. Cahyono & Tokuda, (2024) highlights the need for more efficient land use policies to support sustainable agricultural productivity, which would help stabilize food supply and availability, particularly in regions prone to climate shocks. Additionally, ecological studies indicate that the depletion of arable land due to urban expansion and industrial activities compromises food security, as it reduces the land available for local food production (McQuade et al., 2019).

Climate change has an increasingly significant impact on food security in Indonesia, affecting crop yields, altering growing seasons, and increasing the frequency of extreme weather events. These changes threaten local food supplies and can drive up food prices, making it difficult for low-income families to access affordable, nutritious food. The study by Dafursa & Gebremedhin, (2019) in Ethiopia illustrated how climate variability led to decreased dietary diversity, especially among children in agrarian communities. In Indonesia, similar patterns are observed, where climate-related disruptions in food production reduce dietary diversity, impacting nutritional outcomes for vulnerable groups such as children and pregnant women. Addressing these agricultural and environmental factors is essential to enhance resilience against food insecurity, particularly in climate-sensitive regions.

Government policies and interventions play a crucial role in reducing food insecurity and malnutrition. Effective policies that address food production, distribution, and access are essential for improving food security across Indonesia. Food aid programs and nutrition education initiatives, particularly for low-income and rural communities, have been shown to improve food security and dietary outcomes. For example, an intervention program highlighted by McKay et al., (2022) focused on nutrition education and medical care for poor pregnant women, which helped increase dietary protein intake, highlighting the positive impact of targeted health interventions on food security. Similar initiatives in Indonesia could support vulnerable groups, particularly in areas where malnutrition is prevalent.

Ecological studies also demonstrate the effectiveness of government programs in mitigating food insecurity. Ali et al., (2019) examined food security interventions in Bangladesh and found that comprehensive programs addressing both economic and nutritional needs helped improve dietary diversity among children. These findings suggest that a multifaceted approach to food security, combining direct food assistance with education and income support, could benefit Indonesian populations. However, Cahyono & Tokuda, (2024) notes that policy interventions in Indonesia need better integration and implementation to be more effective, particularly in rural areas where logistical challenges and limited infrastructure often hinder program reach.

Moreover, policies aimed at improving agricultural practices and infrastructure can positively impact food security by stabilizing local food systems. In regions with significant agricultural activity, investments in irrigation, crop diversification, and sustainable farming practices can enhance food availability, reducing dependence on external food sources. Government support for small-scale farmers, especially in remote areas, could help build resilience against food insecurity by improving local food production capabilities (McQuade

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Vol. 3 No. 1 (2024)
Page : 129-139
ISSN:2828-4925
DOI: 10.47841/icorad.v3i1.193

et al., 2019). Additionally, policies that address climate change by promoting adaptive agricultural techniques can mitigate some of the environmental challenges that threaten food security.

CONCLUSION

Food insecurity and malnutrition in Indonesia present complex challenges that require multi-dimensional solutions, informed by ecological research. This review underscores the importance of understanding the broader socio-economic, agricultural, environmental, and policy-related factors that shape food security across diverse regions and populations. Ecological studies provide a valuable framework for examining these issues, offering insights that can guide policymakers and public health professionals in formulating effective interventions. However, addressing food insecurity and malnutrition in Indonesia requires a collaborative approach that integrates economic policies, educational programs, agricultural resilience, and targeted health interventions.

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