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Research Paper

Living Conditions and Respiratory Health: A Study on ARI Determinants in a Wetland Urban Settlement in South Sumatra

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Abstract
Introduction: Acute respiratory infection (ARI) remains a significant public health concern in Indonesia, particularly among populations living in substandard housing conditions. In South Sumatra Province, ARI cases have shown a sharp increase over recent years, with 32,336 cases reported in 2021, 519,167 cases in 2022, and 539,327 cases in 2023. Urban wetland settlements, such as Ilir Timur II Subdistrict in Palembang City, are especially vulnerable due to poor environmental and socioeconomic conditions. This study aimed to analyze the association between physical housing conditions and household behaviors with the incidence of ARI in a wetland urban settlement. Methods: A cross-sectional study was conducted in 2024 involving 100 residents of Ilir Timur II, Palembang, selected through purposive sampling. Data were collected using structured interviews and analyzed using bivariate tests (Chi-square) and multivariate logistic regression. Results: A total of 66% of households reported at least one ARI case in the past six months. Among the variables examined, only the presence of a ceiling (plafon) was significantly associated with ARI incidence (p = 0.038; OR = 2.60; 95% CI: 1.05–6.41). Other variables such as education level, housing density, roofing, walls, floor condition, smoking behavior, and physical activity showed no significant association. Disscussion: Poor indoor environmental conditions—especially the absence of a ceiling—are associated with an increased risk of ARI in wetland settlements. Improving housing structures and promoting healthy living environments in such areas are essential strategies to reduce the burden of respiratory infections.

Keywords
acute respiratory infection, housing conditions, indoor environment, urban wetlands

1. INTRODUCTION

Acute respiratory infection (ARI) is an infectious disease affecting the respiratory tract from the nose to the lungs. It is caused by viruses and bacteria that spread easily and can affect individuals of all ages. ARI remains one of the leading causes of mortality in children under five worldwide, especially in developing countries or low-income populations. Families with lower socioeconomic status often reside in substandard housing environments, increasing their risk of exposure to ARI due to multiple contributing factors. These include poor housing conditions, exposure to cigarette smoke, malnutrition, low immunity, and pathogenic microorganisms responsible for respiratory infections (Suluh et al., 2024).

According to the World Health Organization (WHO), ARI accounts for approximately 4.25 million deaths annually. In Indonesia, the Ministry of Health reported 705,659 ARI cases in 2020, accounting for 39.2% of the disease burden (Hariningsih et al., 2023). In South Sumatra, ARI remains a major health issue, with a total of 274,502 reported cases from January to June 2019. Palembang City recorded the highest number, with 80,162 cases during that period. More alarmingly, ARI cases have steadily increased in South Sumatra, with 32,336 cases reported in 2021, 519,167 in 2022, and 539,327 in 2023 (BPS, 2024).

Palembang is a city characterized by a high proportion of wetland areas—approximately 70% of its land consists of wetlands (Oktarini, 2018). Ilir Timur II Subdistrict, situated along a riverbank, is one such urban wetland area. Environmental factors play a vital role in public health, and in wetland regions, the physical conditions of homes are a major contributor to the risk of ARI. Housing structures that do not meet health standards—such as inadequate roofing, poor-quality walls and floors, high indoor humidity, overcrowding, and elevated temperatures—can increase

the likelihood of respiratory infections (Lubis and Ferusgel, 2019).

Recent studies in various regions of Indonesia have highlighted the importance of indoor environmental quality in the transmission of ARI, particularly among vulnerable populations such as children and the elderly. Several studies have found associations between inadequate ventilation, the absence of ceilings, overcrowding, and use of poor building materials with higher incidence of respiratory infections. However, most of these studies were conducted in dryland or urban fringe areas, with limited evidence focusing on wetland urban settlements—regions that are distinct in terms of humidity, infrastructure, and exposure to both environmental and behavioral risks. Therefore, further research is needed to understand how these specific conditions in wetland areas affect ARI occurrence and to inform targeted interventions.

2. METHOD

This study employed a quantitative approach using a cross-sectional design. quantitative research primarily applies a post-positivist paradigm, emphasizing causal relationships, reduction to variables, specific hypotheses and questions, statistical data collection, and theory testing (Ardiawan et al., 2022). A cross-sectional approach involves measuring both exposure and outcome variables simultaneously, without follow-up over time (Abduh et al., 2023).

The objective of this study was to assess the relationship between physical housing conditions and behavioral factors with the incidence of ARI in Ilir Timur II Subdistrict, Palembang City, in 2024. The study focused on two types of variables: the dependent variable (ARI incidence) and independent variables including education level, housing density, type of roofing, presence of a ceiling, type of wall and flooring, physical activity, and smoking behavior among household members.

The population of the study comprised all residents of Ilir Timur II Subdistrict. Participants were selected through purposive sampling. This non-random sampling method allows researchers to choose participants based on specific criteria relevant to the study objective (Lenaini, 2021). A total of 100 respondents were selected from 1 Ilir, 3 Ilir, and Lawang Kidul subdistricts within Ilir Timur II. Inclusion criteria included residents aged 17 years and older who were willing to participate by signing an informed consent form, and who were capable of providing accurate data. Exclusion criteria included individuals unwilling to participate.

Data were collected through structured interviews using a standardized questionnaire. The variables were analyzed through bivariate tests (Chi-square) to identify potential associations, and then subjected to multivariate analysis using backward logistic regression. Variables with p-values <0.25 in the bivariate analysis were included in the multivariate model to determine the most significant predictors of ARI incidence, with a 95% confidence interval.

Ethical approval for this study was obtained from Health Research Ethics Committee, Faculty of Public Health Sriwijaya University, with approval number: 351/UN9.FKM/TU.KKE/2024, and written informed consent was obtained from all participants prior to data collection.

3. RESULTS

A total of 100 respondents participated in this study. Analysis of ARI incidence within the past six months showed that 66% of households had at least one member who experienced symptoms of ARI, such as cough, cold, fever, or shortness of breath, while 34% reported no such incidence.

Bivariate analysis was performed using the Chi-square test to assess the relationship between each independent variable and ARI incidence. Among the variables analyzed, only the presence of a ceiling (plafon) showed a statistically significant association with ARI (p = 0.035). Other variables—such as education level (p = 0.886), housing density (p = 0.140), roof type (p = 0.712), wall type (p = 0.299), floor condition (p = 0.223), physical activity (p = 0.387), and the presence of smokers in the household (p = 0.335)—were not significantly associated with ARI incidence. (Table 1)

Variables with p-values <0.25 in the bivariate analysis (housing density, ceiling, and floor condition) were included in the multivariate logistic regression model using the backward stepwise method. The initial model indicated that all three variables had potential contributions, with the presence of ceiling showing the strongest association (p = 0.030; OR = 2.788; 95% CI: 1.101–7.060), followed by floor condition (p = 0.218) and housing density (p = 0.122). (Table 2)

In the final model, after applying the backward elimination method, only the variable presence of ceiling remained statistically significant. Households without ceilings were found to be 2.6 times more likely to experience ARI compared to those with ceilings (p = 0.038; OR = 2.600; 95% CI: 1.054–6.412). This suggests that inadequate home insulation and ventilation linked to ceiling absence may contribute to increased susceptibility to respiratory infections. (Table 3)

4. DISCUSSION

4.1 Educational Level and ARI Incidence

Based on Table 1, 66.7% of respondents with lower education levels reported having household members with ARI symptoms in the past six months, compared to 65.3% in the higher education group. Statistical analysis showed no significant association between the respondent's last level of education and the incidence of ARI in Ilir Timur II Subdistrict, Palembang City in 2024 ($p = 0.886$; $p > \alpha = 0.05$). This finding is consistent with a previous study conducted in the working area of Semerap Health Center, Kerinci District, Jambi, which also reported no significant relationship

Table 1. Bivariate Analysis Between Independent Variables and ARI Incidencea

Variable	ARI Incidence				*p*-value
	ARI	%	No ARI	%	
Education Level					
Low	34	66.7	17	33.3	0.886
High	32	65.3	17	34.7	
Housing Density					
Does not meet standard	23	76.7	7	23.3	0.140
Meets standard	43	61.4	27	38.6	
Roof Type					
Zinc	47	67.1	23	32.9	0.712
Others	19	63.3	11	36.7	
Ceiling					
Absent	14	50.0	14	50.0	0.035
Present	52	72.2	20	27.8	
Wall Type					
Wood	15	57.7	11	42.3	0.299
Brick	51	68.9	23	31.1	
Floor Condition					
Poor	14	56.0	11	44.0	0.223
Good	52	69.3	23	30.7	
Physical Activity					
Poor	16	59.3	11	40.7	0.387
Good	50	68.5	23	31.5	
Smoking Household Members					
Yes	54	68.4	25	31.6	0.335
No	12	57.1	9	42.9	

between maternal education and ARI among children under five ($p = 0.618$; $p > \alpha = 0.05$) (Wisudariani et al., 2022). However, this result differs from other studies which found a significant relationship between maternal education and ARI incidence in the working area of 7 Ulu Health Center, Palembang City, with a p-value of 0.004 ($p < \alpha = 0.05$) (Febrianti, 2020). Similarly, another study also showed a significant association, with a p-value of 0.001 ($p < \alpha = 0.05$) (Cinta, 2018). The type of education referred to in this study is formal education, which takes place in structured institutions with a clear hierarchy from basic to higher education levels (Syaadah et al., 2022). ormal education is expected to improve individuals' capacity to receive, process, and apply health-related information more effectively. Although this study did not demonstrate a statistically significant relationship between educational level and ARI, education remains an essential determinant of health behavior. Individuals with higher educational backgrounds are more likely to adopt preventive health measures and seek timely care. While education was not found to be a significant factor in this study, its role in shaping health literacy and decision-making should not be underestimated in efforts to reduce the burden of ARI.

4.2 Housing Density and ARI Incidence

According to Table 1, 76.7% of respondents living in overcrowded housing conditions—defined as not meeting recommended residential space standards—reported ARI cases in their households within the past six months. However, statistical analysis indicated no significant association between housing density and ARI incidence in Ilir Timur II Subdistrict, Palembang City, in 2024 ($p = 0.140$; $p > \alpha = 0.05$). This result is consistent with the findings of Rahma Dani et al. (2022), who found no statistically significant relationship between bedroom occupancy density and ARI incidence among children under five ($p = 0.12$; $p > \alpha = 0.05$) (Dani et al., 2022). On the other hand, these findings contrast with the study conducted by Suswani and Aszrul (2018), which reported a significant association between household crowding and ARI incidence in the working area of Ulugalung Health Center, Eremerasa District, Bantaeng Regency, where the p-value was 0.000

Table 2. Initial Model of Multivariate Logistic Regression on ARI Incidence

Variable	P-Value	Exp(B)	95% CI
Housing Density	0.122	0.450	0.164 - 1.239
Ceiling	0.300	2.788	1.101 - 7.060
Floor Condition	0.218	1.831	0.699 - 4.794

Table 3. Final Model of Multivariate Logistic Regression on ARI Incidence

Variable	P-Value	Exp(B)	95% CI
Ceiling	0.038	2.600	1.054 - 6.412

($p < \alpha = 0.05$) (Suswani and Aszrul, 2018) Although not statistically significant in this study, the implications of housing density should not be overlooked. High household density facilitates the rapid transmission of respiratory infections due to close physical proximity and limited airflow (Putri, 2019) (Putri and Mantu, 2019)Furthermore, overcrowded conditions can elevate indoor temperature and humidity levels while reducing oxygen concentration, all of which are known to weaken immune defenses and increase susceptibility to ARI (Waliyyuddin et al., 2024) Even in the absence of a significant statistical relationship, housing density remains a critical environmental determinant of ARI that warrants attention in public health planning, especially in vulnerable urban communities.

4.3 Roof Type and ARI Incidence

As presented in Table 1, 67.1% of respondents living in houses with zinc roofs reported ARI cases in their households over the past six months, compared to 63.3% among those with other roof materials. Despite this difference, the statistical analysis showed no significant association between roof type and ARI incidence in Ilir Timur II Subdistrict, Palembang City, in 2024 ($p = 0.712$; $p > \alpha = 0.05$). This result is not consistent with the findings of Murniati et al. (2023), who reported that non-standard roof materials significantly contributed to ARI incidence in the working areas of Lhonknga and Simpang Tiga Health Centers in Aceh Besar (Murniati et al., 2023). That study also noted that the majority of the observed houses used zinc as roofing material. In contrast, the current finding is in line with the study by Rafaditya et al. (2021), which reported no significant association between roof type and ARI ($p = 0.583$; $p > \alpha = 0.05$) (Rafaditya et al., 2022). While zinc and asbestos are among the most commonly used roofing materials in low-income areas, both have known drawbacks in terms of environmental health. Asbestos contains silica-based mineral fibers that can release airborne particles and irritate the respiratory tract when inhaled.19 Meanwhile, zinc roofing has poor thermal insulation properties, contributing to higher indoor temperatures (Ardillah and Ningrum, 2021). Furthermore, poorly constructed roofs may allow rainwater and dust infiltration, both of which can affect indoor air quality and overall respiratory health of occupants (Syam and Ronny, 2016). Although no statistical significance was found, the choice of roofing material remains an important consideration in healthy housing design, as poor-quality roofs may indirectly contribute to respiratory risk through suboptimal thermal regulation and increased indoor pollution.

4.4 Ceiling Presence and ARI Incidence

According to Table 1, 72.2% of respondents who had ceilings in their homes reported ARI symptoms within the past six months. Bivariate analysis indicated a statistically significant association between the presence of a ceiling and ARI incidence ($p = 0.035$; $p < 0.05$). Furthermore, the multivariate logistic regression presented in Table 3 confirmed that ceiling presence was the only significant predictor in the final model ($p = 0.038$), with an odds ratio (OR) of 2.600 and a 95% confidence interval (CI) of 1.054–6.412. This suggests that the absence of a ceiling more than doubles the risk of ARI in the household.

This finding highlights the importance of ceiling design and material in influencing indoor air quality and, consequently, respiratory health. Inadequate ceilings may lead to poor air circulation, increased humidity, and accumulation of indoor pollutants, which collectively create a conducive environment for respiratory infections such as ARI (Rafaditya et al., 2022) Conversely, well-constructed ceilings that incorporate ventilation features and eco-friendly materials can help regulate temperature and humidity, thereby reducing the risk of respiratory problems (Ardillah and Ningrum, 2021). Supporting this, a study by Atmawati, Jumakil, and Kohali also found a strong association between the presence of ceilings and ARI incidence among young children, particularly in houses that failed to meet healthy housing standards (Atmawati et al., 2021) Factors such as poor ventilation, overcrowding, unsealed roofing, wooden walls, dusty floors, and indoor smoking were collectively identified as major contributors to the increased risk of ARI. These interconnected environmental deficiencies, especially in households with vulnerable populations such as

children, highlight the critical role of ceiling installation as part of a holistic approach to improving residential health conditions. The presence of a ceiling is a key structural component associated with reduced ARI risk. Integrating ceiling installation into public health housing interventions could substantially improve indoor air quality and lower respiratory disease burden, particularly in disadvantaged urban environments.

4.5 Wall Type and ARI Incidence

According to Table 1, 68.9% of respondents living in houses with brick walls reported ARI symptoms within the past six months. However, bivariate analysis revealed no statistically significant association between wall type and ARI incidence ($p = 0.299$; $p > \alpha = 0.05$). Kurnia and Audia previously reported that non-permanent wall materials—such as wood—have the potential to contribute to the development of acute respiratory infections (ARI) among household members (AZ and Audia, 2021). Wooden walls are often porous and contain gaps that can allow the entry of airborne bacteria or viruses into indoor spaces. In contrast, permanent, non-porous walls that are easy to clean may serve as a protective barrier, helping prevent the accumulation and spread of infectious agents. Although the descriptive data in this study suggested a potential trend related to wall material, the statistical analysis did not confirm a significant relationship between wall type and ARI incidence in the study area. This result differs from previous findings involving pediatric populations in other regions, where wall material was identified as one of several significant environmental risk factors. The divergence in results may reflect the multifactorial nature of ARI, in which wall type plays only a partial role. While no significant association was found between wall type and ARI in this study, improving building materials to meet healthy housing standards remains an important preventive strategy in reducing environmental risks for respiratory illness.

4.6 Floor Condition and ARI Incidence

According to Table 1, 56.0% of respondents with poor floor conditions in their homes reported ARI symptoms within the past six months. However, bivariate analysis showed no statistically significant association between floor condition and ARI incidence ($p = 0.223$; $p > \alpha = 0.05$). In contrast, a study conducted in Kotagajah Village found a significant relationship between floor type and ARI incidence.24 he analysis revealed that respondents living in houses with substandard floors, such as earthen surfaces, were more likely to suffer from ARI compared to those living in houses with floors meeting minimum health standards. Poor-quality flooring that is not water-resistant may increase indoor humidity, thereby promoting the growth of microorganisms responsible for respiratory infections (Pangaribuan, 2017). Although this study did not find a statistically significant association, the condition of household floors remains an important environmental factor in respiratory health. Damp and unsealed floors may act as reservoirs for pathogens and allergens, especially in wetland regions where humidity levels are naturally high. Improving floor conditions is a practical and cost-effective intervention that can contribute to reducing ARI risk, particularly in underserved communities with inadequate housing infrastructure.

4.7 Physical Activity and ARI Incidence

Based on Table 1, 68.5% of respondents who reported engaging in daily physical activity experienced ARI symptoms in their household within the past six months. In comparison, 59.3% of those with poor physical activity levels also reported ARI. Despite this difference, bivariate analysis revealed no statistically significant association between physical activity and ARI incidence ($p = 0.387$; $p > \alpha = 0.05$). Physical activity plays an important role in reducing the risk of respiratory diseases. Engaging in regular physical exercise is known to improve overall health, particularly by enhancing respiratory function and reducing vulnerability to infections (Firmansyah et al., 2023). In general, the benefits of physical activity far outweigh any potential negative impacts. Exercise is widely recognized as a strategy to strengthen the immune system, making the body more capable of defending against viral and bacterial pathogens. Additionally, consistent physical activity supports effective blood circulation, including improved oxygen and nutrient delivery to the brain during exertion (Tomatala et al., 2019). The findings of this study are consistent with previous evidence, indicating no significant relationship between physical activity and ARI incidence in Ilir Timur II Subdistrict, Palembang, in 2024. One plausible explanation is that most residents in the study area maintain a relatively consistent level of daily physical activity, which may result in limited variability in exposure levels, thereby reducing its observable impact on ARI outcomes. Although physical activity is essential for maintaining immune and respiratory health, its protective effect against ARI may not be directly observable in communities where activity levels are uniformly high across the population.

4.8 Household Smoking and ARI Incidence

The results of this study showed no statistically significant association between the presence of household smokers and ARI incidence in Ilir Timur II Subdistrict, Palembang City, in 2024 ($p = 0.335$; $p > \alpha = 0.05$). Although 68.4% of respondents who had at least one family member who smoked also reported ARI symptoms in their household during the past six months, the data suggest that smoking did not have a direct influence on ARI occurrence in this population.

According to Reychell's theory, indoor smoking is a known risk factor for ARI, and passive smokers—particularly children—face a higher risk of respiratory illness due to

consistent exposure to cigarette smoke (Mirino et al., 2022). However, the lack of a significant relationship in this study may be explained by other contributing factors, such as environmental conditions. Ilir Timur II is located near an industrial zone, which may contribute to elevated levels of ambient air pollution, serving as a potential confounder in the observed ARI cases.

Additionally, adequate household ventilation in many of the surveyed homes may have facilitated sufficient air exchange, thereby diluting the concentration of tobacco smoke indoors. Healthy lifestyle practices adopted by some respondents may have also mitigated the harmful effects of smoking exposure.

The findings of Mulyadi and Nugroho support this result, indicating no significant relationship between household smoking and ARI incidence among children under five ($p = 1.000$; $p > \alpha = 0.05$) (Mulyadi and Nugroho, 2018) Despite this, the theoretical basis for smoking as a respiratory health hazard remains robust. Cigarette smoke contains particulate matter and toxic gases that, when inhaled regularly, can compromise respiratory function and trigger infections, including ARI (Ruhban et al., 2023). Although smoking was not statistically associated with ARI in this study, it remains an important risk factor in respiratory health. Continued public education is essential to raise awareness about the dangers of indoor smoking and to promote healthy living behaviors that support respiratory well-being.

4.9 Interpretation of Key Findings

The study's primary finding reveals that the absence of ceiling (plafon) is significantly associated with increased ARI incidence in wetland urban settlements (p = 0.038; OR = 2.600; 95% CI: 1.054-6.412), with households lacking ceilings being 2.6 times more likely to experience respiratory infections. This suggests that ceiling structures play a crucial role in regulating indoor air quality by preventing dust accumulation, controlling humidity levels, and facilitating proper ventilation—all essential factors in respiratory health protection. The absence of statistically significant associations between other housing variables (roof type, wall material, floor condition) and ARI incidence, despite their documented importance in previous research, indicates that ceiling presence may be particularly critical in wetland environments where humidity tends to be persistently high. Based on these findings, we recommend that local health authorities prioritize ceiling installation programs in wetland settlements as a cost-effective intervention to reduce ARI burden. Community health centers should integrate ceiling assessment into their environmental health screenings, while local governments should consider implementing subsidized ceiling improvement initiatives for low-income households in wetland areas.

4.10 Comparison with Previous Studies

Our findings both align with and diverge from previous research in important ways. The significant association between ceiling absence and ARI incidence corroborates results from similar studies, such as those reporting children in houses without ceilings having a 28.8% higher risk of ARI compared to those in properly constructed homes. However, unlike multiple studies that have established strong links between smoking behavior and respiratory infections, our research found no significant relationship between household smoking and ARI incidence (p = 0.335). This divergence may be attributed to confounding factors specific to wetland settlements, such as ambient air pollution from nearby industrial zones and coal transport routes along the Musi River, which could potentially mask the effects of indoor smoking. Similarly, while considerable literature identifies overcrowding as a major risk factor for respiratory infections, with odds ratios ranging from 1.23 to 9.1 depending on population and setting, our study found no statistically significant association between housing density and ARI (p = 0.140). This contrasts with systematic reviews that consistently link residential crowding to increased risk of severe respiratory infections, suggesting that the unique environmental characteristics of wetland settlements may alter the typical risk factor profile for respiratory diseases found in other contexts.

4.11 Limitations and Cautions

This study has several limitations that should be acknowledged to contextualize its findings. First, the use of a cross-sectional design prevents causal inference, as the temporal relationship between housing conditions and ARI incidence could not be established. Second, the data were collected through structured self-reported interviews, which may introduce recall bias, especially in reporting recent respiratory symptoms or household environmental features. Additionally, environmental exposures such as indoor humidity, mold presence, and ambient air pollution—particularly from coal transportation along the nearby Musi River—were not directly measured, although these factors may influence ARI risk. This study focused only on selected housing and behavioral variables. Other potentially influential factors—such as ventilation systems, occupational exposures, access to health services, and nutritional status—were not included in the analysis. These limitations do not undermine the internal consistency of the study but highlight areas for refinement in future research, including longitudinal designs, objective environmental assessments, and expanded geographic sampling to enhance external validity.

4.12 Recommendations for Future Research

It is important to note that this study was conducted in a wetland settlement located near the Musi River, which serves as a major coal transport route. Airborne particulate

matter generated from barge traffic and coal dust could contribute significantly to local air pollution and ARI risk. Unfortunately, this factor was not directly measured in the study. The potential confounding effect of outdoor air pollution—particularly PM2.5 and PM10—should be addressed in future research using environmental monitoring tools and geospatial analysis.

5. CONCLUSION

This study found that 66% of households in Ilir Timur II Subdistrict, Palembang, reported at least one case of acute respiratory infection (ARI) within the past six months. Among the housing and behavioral variables analyzed, only the presence of a ceiling (plafon) showed a statistically significant association with ARI incidence. Households without ceilings were 2.6 times more likely to report ARI compared to those with ceilings ($p = 0.038$; OR = 2.600; 95% CI: 1.054–6.412). Other factors—including education level, housing density, roofing material, wall and floor type, physical activity, and smoking behavior—did not demonstrate statistically significant associations. These findings emphasize the critical role of housing infrastructure, particularly ceiling installation, in mitigating ARI risk in wetland urban environments. Public health interventions in similar settings should prioritize structural housing improvements to enhance indoor air quality and reduce respiratory health burdens. Future research incorporating environmental monitoring and

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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