Buletin Kedokteran & Kesehatan Prima
Vol.4 No.2 (2025)
DOI: 10.34012/bkkp.v4i2.7812

ORIGINAL ARTICLE

Associations between lifestyle factors and acute respiratory infection incidence at Mayen Primary Health Clinic

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ABSTRACT

Background: Acute Respiratory Infections (ARI) remain a significant global health burden with high morbidity, particularly in developing nations. Modern lifestyle shifts—characterised by smoking habits, poor dietary patterns, physical inactivity, and compromised sleep quality—alongside environmental pollution, are hypothesised to contribute to susceptibility to these infections. Objective: This study aims to analyse the association between lifestyle factors (smoking, diet, physical activity, sleep quality) and environmental pollution exposure with the incidence of ARI among patients at the Mayen Primary Clinic in 2023–2024. Methods: This study employed an analytic observational design with a cross-sectional approach. The research was conducted at the Mayen Primary Clinic, Medan, involving 82 respondents selected via consecutive sampling. Data were collected using medical records and validated lifestyle questionnaires, followed by analysis using the Chi-Square test. Results: The findings revealed that the majority of respondents were suffering from ARI (85.4%). Bivariate analysis demonstrated significant correlations between ARI incidence and smoking habits ($p<0.001$), dietary patterns ($p=0.001$), sleep quality ($p<0.001$), and air pollution exposure ($p<0.001$). However, no significant association was observed between physical activity and ARI incidence ($p=0.601$). Conclusion: Unhealthy lifestyles and environmental pollution are primary determinants of ARI incidence in primary care settings, necessitating health interventions focused on behavioural modification and environmental control.

Keywords: ARI, lifestyle, smoking, air pollution, nutrition

Introduction

Acute Respiratory Infections (ARI) constitute one of the most persistent and prevalent public health challenges globally, affecting both developed and developing nations. These infections involve the upper or lower respiratory tract, with a duration typically lasting 14 days or less. Clinical manifestations vary widely, ranging from mild symptoms such as the common cold to life-threatening conditions like severe pneumonia. Globally, ARI contributes significantly to the burden of disease and mortality rates. According to recent data from the World Health Organization (WHO), respiratory infections cause approximately 7.5 million deaths annually worldwide, representing roughly 14% of total global mortality. This figure positions ARI as a leading cause of death that is largely preventable through appropriate risk factor management.[1,2]

In the national context, Indonesia faces similar challenges, where ARI consistently ranks among the top ten diseases with the highest morbidity rates. Vulnerability is not limited to toddlers with immature immune systems but also extends to the productive age population and the elderly. The epidemiological

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transition occurring in Indonesia further complicates the management of this disease. Beyond infectious agents such as viruses (Influenza, Rhinovirus, Respiratory Syncytial Virus) and bacteria (*Streptococcus pneumoniae*), host and environmental factors play crucial roles in determining individual susceptibility to infection. Modern lifestyles, which have evolved rapidly in recent decades, have brought significant changes in living patterns that potentially weaken the body's defence systems systemically.

These lifestyle shifts include an increased prevalence of smoking, a transition to nutrient-poor dietary patterns, a sedentary lifestyle or lack of physical activity, and circadian rhythm disruptions due to poor sleep quality. Smoking, whether active or passive, has long been identified as a major risk factor for respiratory disorders. Cigarette smoke contains thousands of hazardous chemical substances, including tar, carbon monoxide, and free radicals that are carcinogenic and irritative. Chronic exposure to cigarette smoke damages the respiratory epithelium, paralyses the cilia responsible for mucociliary clearance, and impairs alveolar macrophage function. Recent studies have even demonstrated a synergistic effect between smoking and air pollution, where the combination exacerbates airway inflammation beyond the individual effects of each factor. This creates a microenvironment highly conducive to pathogen colonisation.[3,4]

In addition to toxin exposure, nutritional aspects play a vital role in immunomodulation. Modern diets, often high in calories but poor in micronutrients, lead to the phenomenon of 'hidden hunger', where the body lacks essential vitamins and minerals such as Vitamin C, Vitamin D, and Zinc, which are necessary for antibody production and immune cell proliferation. This nutritional deficiency compromises the body's ability to respond adequately to pathogen invasion. Recent research highlights that high-quality dietary patterns can mitigate the risk of respiratory infections, even in individuals with other risk factors. Conversely, malnutrition or unbalanced diets weaken mucosal barriers and cellular immune responses.[5,8]

Another often overlooked aspect of lifestyle with significant impact is sleep quality. Sleep is not merely a resting phase but an active period during which the body undergoes cellular regeneration and immunological memory consolidation. During slow-wave sleep, the body releases pro-inflammatory cytokines necessary for responding to infection. Chronic sleep disruption or poor sleep quality can suppress the production of these cytokines and reduce the number of Natural Killer (NK) cells, which serve as the frontline defence against viruses. Coupled with environmental factors such as air pollution—which contributes significantly to pneumonia-related mortality—the risk of ARI becomes an accumulation of these various exposure factors. Particulate matter from air pollution can penetrate deep into the lung parenchyma, triggering systemic oxidative stress and persistent local inflammation.[9,10]

The Mayen Primary Clinic, a first-level health facility serving the community in Medan, recorded ARI as one of the diseases with the highest visit rates during the 2023–2024 period. This high incidence raises questions regarding specific determinants playing a role in this population. Although the theoretical relationship between lifestyle and ARI has been widely discussed, there has been no comprehensive study at this specific location mapping the specific risk profiles of patients. Understanding local risk factors is crucial because health interventions are often contextual and must be tailored to the demographic characteristics and behaviours of the local community. Based on this urgency, this study aims to analyse the relationship between lifestyle factors (smoking habits, diet, physical activity, sleep quality) and air pollution exposure with the incidence of ARI among patients at the Mayen Primary Clinic in 2023–2024.

Method

This study employed an analytic observational design with a cross-sectional approach. This design was selected to study the dynamics of the correlation between risk factors and effects through a point-time approach, meaning that the measurement of independent variables (lifestyle and environment) and the dependent variable (ARI incidence) was conducted simultaneously. The research was carried out at the Mayen Primary Clinic, Medan, with data collection covering the period from 2023 to 2024. This location was chosen based on preliminary data indicating a high prevalence of patient visits with respiratory complaints requiring further investigation into causal factors.

The population in this study comprised all patients visiting the Mayen Primary Clinic. The sampling technique used was consecutive sampling, a non-probability sampling technique where every patient meeting the inclusion criteria who arrived during the study period was included as a sample until the required sample size was met. A total of 82 respondents were successfully recruited for this study. Inclusion criteria included patients willing to be respondents, capable of communicating effectively, and domiciled within the clinic's

working area. Exclusion criteria were applied to patients unwilling to participate or those with emergency conditions that precluded the completion of research instruments.

The independent variables in this study consisted of five main parameters. First, smoking habits, measured based on smoking status and intensity. Second, dietary patterns, assessed based on the frequency and quality of daily nutritional intake. Third, physical activity, categorised into light, moderate, and vigorous based on the intensity of daily physical activities. Fourth, sleep quality, assessed based on duration and sleep satisfaction. Fifth, air pollution exposure, assessed based on environmental conditions at the respondent's residence or workplace that posed a high risk of smoke or dust exposure. The dependent variable was the incidence of ARI, established based on clinical diagnoses by physicians recorded in medical records, characterised by symptoms of acute infection in the respiratory tract. Data collection instruments used structured questionnaires for lifestyle variables that had been tested for validity, as well as secondary data from medical records for disease diagnosis. The collected data were then analysed univariately to observe the frequency distribution and bivariately using the Chi-Square test with a confidence level of 95% (α= 0.05) to determine the significance of relationships between variables.

Results

Based on data collection conducted on 82 respondents at the Mayen Primary Clinic, the characteristics of respondents and the analysis of relationships between variables were obtained. Univariate analysis showed the frequency distribution of each variable studied, while bivariate analysis illustrated the significance of the relationship between risk factors and ARI incidence. The data summary is presented in the following tables, which have been reconstructed to facilitate interpretation.

Table 1. Distribution of respondent characteristics and research variables

Variable	Frequency (n=82)	Percentage (%)
ARI Incidence		
Yes (Diagnosed)	70	85.4
No	12	14.6
Smoking Habit		
Heavy/Moderate	50	61
Light/Non-smoker	32	39
Dietary Pattern		
Poor	59	72
Good	23	28
Physical Activity		
Light	14	17.1
Moderate	55	67.1
Vigorous	13	15.8
Sleep Quality		
Poor	56	68.3
Good	26	31.7
Air Pollution		
Poor	56	68.3
Good	26	31.7

Table 1 shows that the majority of respondents in this study suffered from ARI, totalling 70 individuals (85.4%). Regarding risk factors, most respondents exhibited unhealthy lifestyle profiles. This is evident from the high proportion of respondents with poor dietary patterns (72.0%), poor sleep quality (68.3%), and exposure to poor air quality (68.3%). regarding physical activity, the majority of respondents fell into the moderate activity category (67.1%). These data provide an initial overview that the patient population at the Mayen Primary Clinic carries a considerable burden of risk factors.

The analysis results in Table 2 indicate significant findings for almost all variables, with the exception of physical activity. For the smoking habit variable, a p-value of <0.001 was obtained, indicating a highly significant relationship. Respondents with heavy/moderate smoking habits dominated the ARI cases compared to non-smokers or light smokers. Dietary patterns also showed a strong correlation with ARI incidence (p=0.001). Approximately 67% of total ARI cases occurred in individuals with poor dietary patterns, whereas the number of individuals with good dietary patterns suffering from ARI was significantly lower.

Table 2. Relationship between lifestyle/environmental factors and ARI incidence

Variable	ARI Incidence (n=70)	No ARI (n=12)	p-value
Smoking Habit			
Heavy/Moderate	46 (56.0%)	4 (4.9%)	<0.001
Light/Non-smoker	24 (29.4%)	8 (9.7%)	
Dietary Pattern			
Poor	55 (67.0%)	4 (4.9%)	0.001
Good	15 (18.2%)	8 (9.7%)	
Physical Activity			
Moderate	47 (57.3%)	8 (9.7%)	0.601
Low/High	23 (28.0%)	4 (4.9%)	
Sleep Quality			
Poor	50 (60.9%)	6 (7.3%)	<0.001
Good	20 (24.3%)	6 (7.3%)	
Air Pollution Exposure			
Poor	53 (64.6%)	3 (3.6%)	<0.001
Good	17 (20.7%)	9 (10.9%)	

Highly significant relationships were also found in the variables of sleep quality ($p<0.001$) and air pollution exposure ($p<0.001$). Patients with poor sleep quality had a much greater tendency to suffer from ARI compared to those who slept well. Similarly, respondents living or working in environments with poor air quality accounted for the largest proportion of ARI cases (64.6%). Conversely, the physical activity variable did not show a statistically significant relationship with ARI incidence in this population, as indicated by a p-value of 0.601 (>0.05). The distribution of ARI cases was relatively evenly spread across various physical activity categories, although the highest frequency was found in moderate activity.

Discussion

The results of this study underscore the critical role of lifestyle and environmental determinants in susceptibility to respiratory infections at the primary care level. The main findings confirm that smoking, dietary patterns, sleep quality, and air pollution are strong predictors of ARI incidence, while physical activity showed no direct significant correlation in this study population.

The highly significant relationship between smoking habits and ARI incidence ($p<0.001$) is consistent with extensive medical literature. Cigarette smoke is a chemical irritant that directly damages the physical defence mechanisms of the lungs. Exposure to cigarette smoke causes ciliary paralysis in the bronchial epithelium, thereby disrupting mucociliary clearance mechanisms. Consequently, mucus accumulates and becomes a growth medium for bacteria such as *Streptococcus pneumoniae* and *Haemophilus influenzae*. Furthermore, oxidants in cigarettes inhibit the phagocytic function of alveolar macrophages, which are the first line of cellular defence in the lungs. These findings support studies by Hilmawan et al. (2020) and Smith, Garcia, & Brown (2024), which concluded that smokers have a multiplied risk of respiratory infections due to local and systemic immune suppression. In the context of patients at the Mayen Primary Clinic, the high number of moderate-to-heavy smokers signals the need for more aggressive smoking cessation programmes.[3,11]

The dietary pattern variable was also proven to be significantly related to ARI ($p=0.001$). This validates the concept of immunonutrition, where nutritional status affects immune system competence. Respondents with poor dietary patterns are likely to experience subclinical micronutrient deficiencies. Vitamins A, C, D, E, as well as minerals like Zinc and Selenium, are vital for T-cell proliferation and antibody production. Deficiency in any of these components can weaken the adaptive immune response. A study by Gonzales et al. (2024) emphasised that adequate nutrition can reduce the duration and severity of viral respiratory infections. In this study, the majority of ARI patients had dietary patterns categorised as poor, indicating that nutritional intervention must be an integral part of ARI management, not just pharmacotherapy.[8]

Poor sleep quality was identified as another dominant risk factor ($p<0.001$). The underlying biological mechanism involves cytokine regulation. During sleep, the body produces pro-inflammatory cytokines (such as IL-1, IL-6, TNF-α) that aid the immune response. Sleep deprivation disrupts this production and increases levels of stress hormones like cortisol and adrenaline, which are immunosuppressive. Walker & Bryant (2024), in their systematic review, stated that individuals with short sleep duration (<6 hours) or low sleep efficiency are more susceptible to rhinovirus exposure. This finding is highly relevant to the modern urban lifestyle, which tends to sacrifice sleep time, thereby increasing vulnerability to community infections.[9]

Environmental factors in the form of air pollution showed a very strong correlation ($p<0.001$). This is unsurprising given the study location in an urban area likely to have high levels of vehicular or industrial pollution. Air pollutants, particularly Particulate Matter (PM) 2.5 and PM 10, can penetrate the airway barrier and trigger chronic inflammation. Pollution exposure increases the expression of receptors on epithelial cells used by viruses for viral entry, such as the ACE2 receptor in the case of coronaviruses or the ICAM-1 receptor in rhinoviruses. Chauhan & Johnston (2023) noted that air pollution not only increases the incidence of new infections but also exacerbates symptoms in those already infected.[10]

An interesting finding in this study is the lack of a significant relationship between physical activity and ARI incidence ($p=0.601$). This result differs from the general J-shaped curve theory, which states that moderate physical activity enhances immunity, while inactivity or extreme activity suppresses it. This insignificance may be due to sample homogeneity, where the majority of respondents (67.1%) were in the 'moderate activity' category, resulting in insufficient data variation to produce a statistically meaningful difference. Another possibility is the presence of more dominant confounding factors, such as high smoking prevalence or pollution, which 'masked' the protective effect of light exercise. This aligns with some literature suggesting that the benefits of exercise can be negated if performed in highly polluted environments.

Conclusion

Based on data analysis and discussion, it can be concluded that the incidence of Acute Respiratory Infections (ARI) at the Mayen Primary Clinic in 2023–2024 has a highly significant relationship with lifestyle and environmental factors. Smoking habits, poor dietary patterns, low sleep quality, and high exposure to air pollution were proven to be major determinants of increased ARI cases. Conversely, physical activity did not show a statistically meaningful relationship in this study population. The clinical implications of these findings suggest that ARI management in primary care must shift from a purely curative approach to a holistic preventive approach. Physicians and healthcare workers need to actively educate patients on the importance of smoking cessation, balanced nutrition, and sleep hygiene as part of the prescription for recovery. Furthermore, environmental health advocacy to reduce pollution exposure is essential in lowering the disease burden in the community.

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