

Enhancing Sustainable Development Goal 3 (Health and Well-Being) through Timely HIV Case Presentation: A Study in Pulau Pinang, 2017–2021

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Abstract HIV remains a persistent public health challenge, with 81,000 cases in Malaysia in 2021. Late presentation (LP) of HIV cases is a significant barrier to achieving Sustainable Development Goal 3 of ending the AIDS epidemic by 2030. In 2021, 68% of new HIV cases in Malaysia presented late, emphasizing the urgency of addressing this issue. This study aimed to determine the trend and factors associated with LP of HIV cases in Pulau Pinang from 2017 to 2021, shedding light on the relationship between LP and the pursuit of SDG 3. A cross-sectional study was conducted utilizing secondary data from the National AIDS Registry and HIV/AIDS Registry Penang State Health Department. Data analysis was performed using descriptive analysis and logistic regression. Out of 1196 cases, 62.2% presented late. Late presenters included age above 50 years (80.4%), Chinese ethnicity (65.5%), unemployment (60.6%), intravenous drug users (68.2%), residing in the Timur Laut District (64.4%), and coinfected with Hepatitis C (72.5%) and Tuberculosis (81.4%). Over the study period, the late presentation rates increased from 57.6% to 64.4%. Factors associated with late presentation included age (30-49: AOR 1.91, 50 and above: AOR 4.0), ethnicity (Chinese: AOR 2.06; Malay: AOR 2.45), unemployment (AOR 1.40), and Tuberculosis coinfection (AOR 2.64). To advance SDG 3 and ensure inclusiveness in HIV care, addressing age, ethnicity, employment status, and Tuberculosis coinfection is essential. These findings call for targeted

strategies to improve timely HIV case presentation and ultimately contribute to the ending of HIV/AIDS epidemic by 2030.

Keywords HIV, AIDS, SDG 3, Late Presentation

1. Introduction

Human Immunodeficiency Virus (HIV) is a retrovirus that targets the immune system and causes a progressive decline in immune function. Without proper management, this condition can progress to Acquired Immunodeficiency Syndrome (AIDS), a severe immune deficiency state that increases susceptibility to life threatening opportunistic infections and certain type of cancer [1]. HIV infection continues to be a major public health issue. According to the World Health Organization, as of 2022, there were about 39.0 million people living with HIV globally, with 1.3 million new infections in the same year [2]. In Malaysia, approximately 82,000 individuals, both adults and children, are living with HIV representing about 0.25% of the population [3]. While the HIV prevalence in Malaysia is relatively lower than the global average, it remains a significant public health concern. For instance, in Sub-Saharan Africa, the prevalence of HIV among adults is around 3.8%, with some countries like Eswatini experiencing rates exceeding 25% [4]. In high-income

countries such as the United States, the prevalence is approximately 0.4% [5]. These comparisons highlight that, despite Malaysia's lower prevalence, the HIV epidemic poses a substantial public health challenge, particularly given the concentrated epidemic among key populations and the urbanized settings of states like Pulau Pinang.

Recognizing the urgent need to address this health crisis, the United Nations established Sustainable Development Goal 3 (SDG 3), part of a broader agenda aimed at ensuring healthy lives and promoting well-being for all ages. SDG 3 includes a specific target 3.3 to end the AIDS epidemic by 2030. The goal is known as 95-95-95; ensuring 95% of people with HIV are diagnosed, 95% of those diagnosed receive antiretroviral therapy (ART), and 95% of those on ART achieve viral suppression [6]. Malaysia, in line with global efforts, has committed to the goal as well. However, the trend of HIV cases in Malaysia remains plateau since 2010 with no significant reduction in incidence of new HIV cases every year [3]. Late presentation among new HIV cases is one of the hindrances that lead to failure of case reduction.

Late presentation of HIV cases is a significant concern that affects the healthcare sector globally and locally. Late presentation refers to the scenario where individuals are diagnosed with HIV at a late stage of the disease. This stage is typically marked by a significantly compromised immune system, often quantified as having a CD4 cell count below 350 cells/mm³ at the time of diagnosis or presenting with an AIDS-defining condition, regardless of the CD4 cell count [7]. Late presentation leads to delayed treatment, increased morbidity and mortality, and a higher risk of transmission [8,9]. This will consequently put strain on healthcare systems. Therefore, early detection and prompt initiation of effective antiretroviral therapy (ART) are crucial for managing the impact of HIV. Individuals who begin treatment early with higher CD4 counts are more likely to experience therapeutic success compared to those who start with lower CD4 levels [10].

Despite the global and national prevalence of late presentation in HIV cases, there is a lack of data on this trend in Pulau Pinang, an urbanized state in Malaysia. The incidence of new HIV cases was reported to be 13.3 per 100,000 people, among the highest comparing to other states in Malaysia in 2021. Thus, this study aimed to fill these knowledge gaps by identifying factors associated with late presentation of HIV patients in Pulau Pinang, with a focus on supporting SDG 3.3 to end HIV epidemic by 2030. The findings will provide valuable insights for policymakers in promoting inclusivity in HIV care, encouraging early diagnosis and treatment which are crucial aspects consistent with the pursuit of SDG 3.3.

2. Materials and Methods

2.1. Study Design and Area

This cross-sectional study was based on data extracted

from the National AIDS Registry (NAR) and Penang State Health Department HIV/AIDS Registry. The study aimed to describe late HIV presentation trends and factors associated with late diagnosis among newly diagnosed HIV patients in Pulau Pinang during the period from 2017 to 2021. The study was conducted within the Penang State, one of Malaysia's states located on the northwest coast of Peninsular Malaysia, covering an area of approximately 1,048 km² and having a population of approximately 1.77 million in 2020, as reported by the Department of Statistics Malaysia [11].

2.2. Study Population

The study population included all patients newly diagnosed with HIV/AIDS who registered in the NAR between January 2017 and December 2021, with their addresses at the time of diagnosis located in Pulau Pinang. The population consisted of individuals who underwent a confirmatory HIV test to validate their HIV status. Each diagnosed case was duly notified by medical officers to the respective District Health Office and subsequently registered into the NAR following a comprehensive investigation by a health inspector.

In Malaysia, HIV/AIDS screening and diagnostic services are provided through a network of public health facilities, private clinics, and non-governmental organizations. The initial screening is commonly performed using rapid HIV test kits, which are widely available and provide quick results. Individuals with a reactive result on the rapid test undergo a confirmatory test, typically using the PA (particle agglutination) antibody test, to validate the initial positive result. This confirmatory testing is conducted in certified laboratories to ensure accuracy and reliability. The Ministry of Health Malaysia oversees the national HIV/AIDS program, ensuring standardized protocols for testing, diagnosis, and notification are followed across the country. This system ensures comprehensive coverage and accurate diagnosis, which are crucial for effective HIV/AIDS management and control.

2.3. Sample Size and Sampling Method

To determine factors associated with late presentation among HIV cases in Pulau Pinang from 2017 to 2021, the sample size was calculated using two independent proportions using PS Software – Power and Sample Size Calculation version 3.1.2. A 10% addition to the sample size was incorporated to account for possible data entry errors, missing data, and outliers. Sample size calculations were based on studies that considered factors such as citizenship status, gender, HIV transmission route, and Tuberculosis coinfection, with power set at 80% and α at 0.05. The required sample size was 1007, and as the eligible population of 1196 HIV cases reported in Pulau

Pinang between 2017 and 2021 closely aligned with this number, all eligible cases were included using convenience sampling.

2.4. Data Acquisition

Data for this study were obtained from two major sources: the National AIDS Registry (NAR) and the Penang State Health Department HIV/AIDS Registry. For the NAR, it is operated under the Ministry of Health Malaysia and provides comprehensive national-level data on HIV/AIDS cases. This registry includes crucial information such as demographics, dates of HIV diagnosis, and clinical outcomes. The NAR serves as a broad epidemiological tool to understand HIV trends across Malaysia. For the Penang State Health Department HIV/AIDS Registry, it offers detailed, region-specific data relevant to Pulau Pinang. It includes additional clinical details such as CD4 counts and co-infections with Tuberculosis, Hepatitis B, Hepatitis C, and Syphilis. This information is vital for a more granular analysis of the health status and treatment needs of individuals within the state.

These data sources are complementary. While the NAR provides a broad national perspective, the Penang's registry provides in-depth local insights. The integration of these datasets ensures a robust and comprehensive understanding of HIV in Pulau Pinang. To prevent potential data overlap and ensure precise data consolidation, we utilized the NAR ID, a unique identifier assigned to each patient across both registries. This matching process ensured that each patient's information was accurately combined from both sources without duplication.

All data from these registries were anonymized using the NAR ID to protect patient privacy. During the data integration and analysis, anonymous identifiers were used to ensure non-identifiability of the data. Necessary permissions were obtained from the Director of the Penang State Health Department. Ethical approval was also secured from Universiti Sains Malaysia's ethics committees (reference number: USM/JEPeM/22110721) and the Medical Research and Ethics Committee (MREC) Ministry of Health Malaysia (reference number: NMRR-22-02914-OUA (IIR)).

2.5. Operational Definitions

HIV cases were defined based on the case definitions for infectious diseases in Malaysia, which states that a reportable case of HIV infection in individuals aged 18 months and older is established by reactive results on a screening test for HIV antibody followed by a positive result on a confirmatory test for HIV antibody [12]. The diagnostic process in this study began with an initial HIV screening using a rapid test kit. Individuals who tested

positive with the rapid test underwent a confirmatory test, specifically the particle agglutination (PA) antibody test. This two-step testing procedure ensures the accurate diagnosis of HIV infection.

Late presentation was defined as a CD4 count below 350 cells/mm³ at the time of HIV diagnosis, aligning with European consensus and the National Strategic Plan for Ending AIDS [9]. Although the European consensus also considers the presence of an AIDS-defining condition as part of the definition, this study specifically focused on the criterion of a CD4 count below 350 cells/mm³ at the time of diagnosis. The CD4 count is an essential indicator of the state of the immune system's well-being and is often used to evaluate the progress and severity of HIV infection. The CD4 count range for individuals who are in good health is typically between 500 and 1500 cells per cubic mm [13].

2.6. Statistical Analysis

Statistical analysis involved descriptive statistics to describe overall trends in late HIV presentation, sex-specific trend and transmission mode-specific trends. To identify factors associated with late HIV presentation, both simple and multiple logistic regression analyses were performed using IBM SPSS software version 27.

Simple logistic regression was initially used to explore the influence of each independent variable. Subsequent analyses employed multiple logistic regression, wherein variables were selected not solely based on a p-value of less than 0.25 during simple logistic regression but also on their clinical and epidemiological significance, as supported by prior research.

The multiple logistic regression process involved the creation of a preliminary main effect model, utilizing various model selection techniques. To ensure the absence of multicollinearity, factors such as variance inflation factor (VIF), standard error, and correlation matrices were examined. Possible two-way interactions between independent variables were explored, with any interaction effects subsequently excluded.

This resulted in a preliminary final model, whose fit was evaluated using the Hosmer and Lemeshow goodness-of-fit test, the receiver operating characteristic (ROC) curve, and a classification table. A p-value exceeding 0.05 in the Hosmer and Lemeshow goodness-of-fit test indicated a good model fit. Additionally, the model was considered appropriate as our study achieved an overall correctly classified percentage of more than 60.0% in the classification table, and the ROC curve displayed an area under the curve that is greater than 0.5. The results of the final model were presented with adjusted odds ratios (AOR), their corresponding 95% CI and relevant p-values. This two-step testing procedure ensures the accurate diagnosis of HIV infection.

3. Results

3.1. Characteristics of HIV Cases

Table 1 presents the characteristics of late presentation of HIV cases in Pulau Pinang from 2017 to 2021. Out of the 1196 cases, 744 (62.2%) were categorized as late presentations, while 452 (37.8%) were non-late presentations.

Table 1. Patients' Characteristics of Late Presentation of HIV cases in Pulau Pinang from 2017 – 2021 (n=1196)

Variables	Total n=744 n(%)	Late Presentation n=744		Non late presentation n=452		
		n	%	n	%	
Age group	18-29	515 (43.0)	269	52.2	246	47.8
	30-49	533 (44.6)	356	66.8	177	33.2
	50 and above	148 (12.4)	119	80.4	29	19.6
Sex	Female	133 (11.1)	83	62.4	50	37.6
	Male	1063 (88.9)	661	62.2	402	37.8
Ethnic	Indian	143 (12.0)	69	48.3	74	51.7
	Chinese	426 (35.6)	279	65.5	147	34.5
	Malay	597 (49.9)	378	63.3	219	36.7
	Non-citizen	30 (2.5)	18	60.0	12	40.0
District	Barat Daya	160 (13.4)	102	63.7	58	36.3
	Timur Laut	421 (35.2)	273	64.8	148	35.2
	Seberang Perai Utara	230 (19.2)	136	59.1	94	40.9
	Seberang Perai Tengah	277 (23.2)	170	61.4	107	38.6
	Seberang Perai Selatan	108 (9.0)	63	58.3	45	41.7
Citizenship	Non-citizen	30 (2.5)	18	60.0	12	40.0
	Citizen	1166 (97.5)	726	62.3	440	37.7
Marital status	Single/Widowed /divorced	989 (82.7)	618	62.5	371	37.5
	Married	207 (17.3)	126	60.9	81	39.1
Risk factors	PWID	22 (1.8)	15	68.2	7	31.8
	Homosexual	600 (50.2)	357	59.5	243	40.5
	Bisexual	145 (12.1)	86	59.3	59	40.7
	Heterosexual	429 (35.9)	286	66.7	143	33.3
Employment	Employed	960 (80.3)	582	60.6	378	68.6
	Unemployed	236 (19.7)	162	39.4	74	31.4
Education	Higher Education	430 (36.0)	258	60.0	172	40.0
	Lower Education	766 (64.0)	486	63.4	280	36.6
Syphilis coinfection	No	860 (71.9)	535	62.2	325	37.8
	Yes	336 (28.1)	209	62.2	127	37.8
Hepatitis Bcoinfection	No	1157 (96.7)	719	62.1	438	37.9
	Yes	39 (3.3)	25	64.1	14	35.9
Hepatitis C coinfection	No	1156 (96.7)	715	61.9	441	38.1
	Yes	40 (3.3)	29	72.5	11	27.5
Tuberculosis coinfection	No	1040(87.0)	617	59.3	423	40.7
	Yes	156(13.0)	127	81.4	29	18.6

3.2. Trend Analysis of Late Presentation

Figure 1 demonstrates the overall trend of HIV late presentation in Pulau Pinang from 2017 to 2021. The trend shows an overall increasing pattern. The fluctuation was less than 15%.

Figure 2a shows that, over the years, the trends varied significantly among key populations. PWID (people who

injected drug) experienced a drastic decline, the most substantial decrease among all groups. Meanwhile, the homosexual and bisexual groups generally show an upward trend until 2020 before slightly dropping in 2021. The heterosexual group, despite an initial steady decrease, rebounded in 2020 and then decreased again in 2021. Figure 2b shows stabilized trends in males and females, with males witnessing a notable increase in 2020.

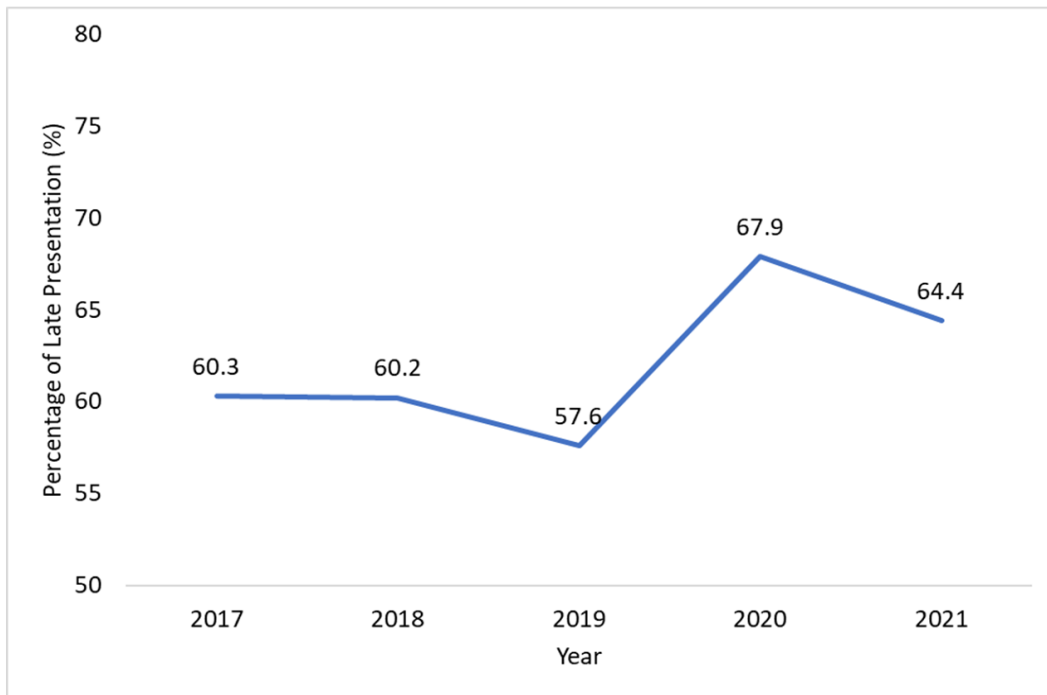


Figure 1. Trend of late presentation, 2017- 2021

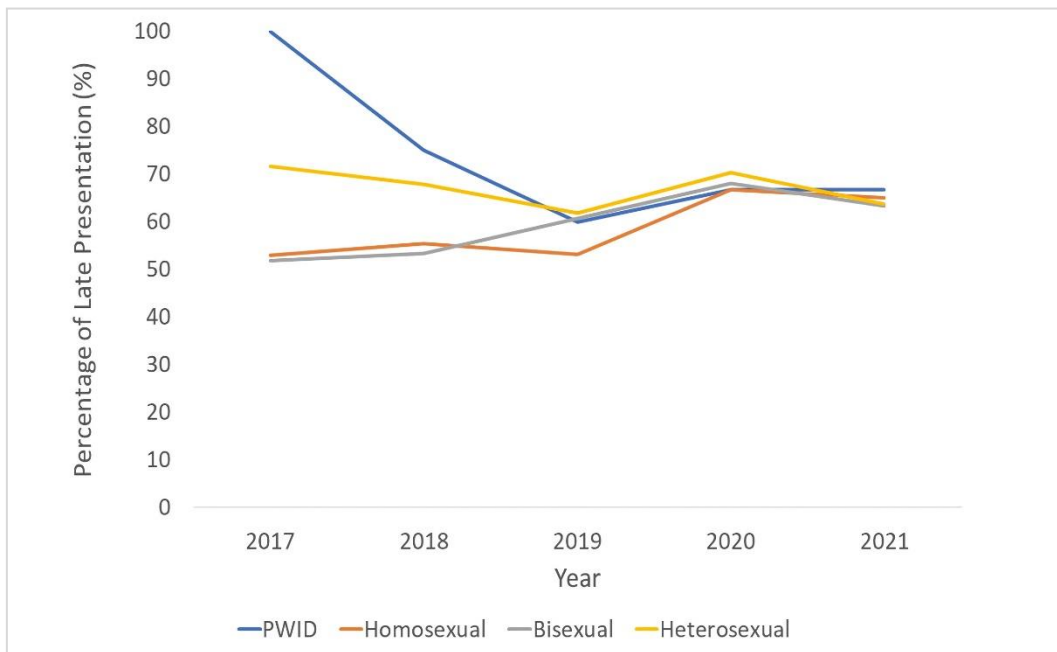


Figure 2a. Risk factor-specific trend of Late HIV Presentation

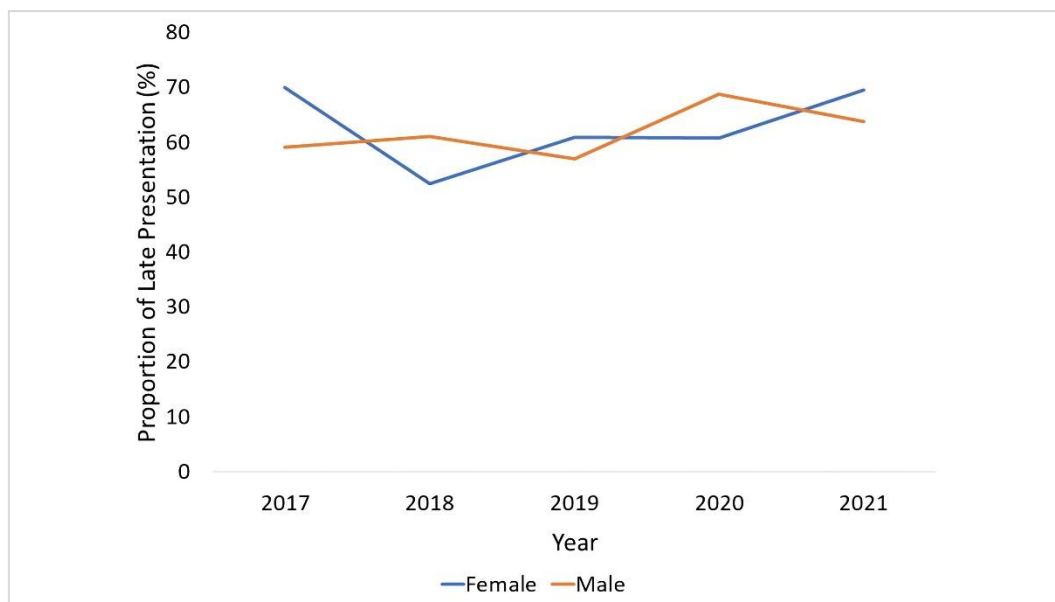


Figure 2b. Sex-specific trend of Late HIV Presentation

3.3. Factors Associated with Late Presentation

Multiple logistic regression analysis showed that age group, ethnicity, employment status, and Tuberculosis coinfection were significantly associated with the late presentation of HIV cases when other variables were adjusted.

Referring to Table 2, individuals in the age group of 30-49 years showed a higher likelihood of late presentation compared to the reference group of 18-29 years. The odds were 1.91 times greater (95% CI: 1.45, 2.51). This effect was even more pronounced in the age group of 50 years and older, who demonstrated a 4-fold increase in the odds of late presentation (95% CI: 2.44, 6.55). When considering ethnicity, both Chinese and Malay patients showed higher odds of late presentation compared to the reference group of Indian patients. Specifically, the odds were 2.06 times higher in Chinese patients (95% CI: 1.35, 3.13), and 2.45 times higher in Malay patients (95% CI: 1.64, 3.65). For employment status, unemployed individuals had a higher likelihood of late presentation when compared to those who were employed. The odds ratio for unemployed individuals was 1.40 (95% CI: 1.00, 1.95). Regarding coinfection, individuals with Tuberculosis coinfection had a higher likelihood of late presentation of 2.64 (95% CI: 1.69, 4.14).

Table 2. Multivariable analysis of factors associated with late presentation of HIV cases in Pulau Pinang (n=1196)

Variables		AOR (95% CI)	p-value
Age group	18-29	1	
	30-49	1.91 (1.45, 2.51)	<0.001
	50 and above	4.00 (2.44, 6.55)	<0.001
Ethnicity	Indian	1	
	Chinese	2.06 (1.35, 3.13)	0.001
	Malay	2.45 (1.64, 3.65)	<0.001
	Non-Citizen	2.17 (0.88, 5.36)	0.092
Employed status	Yes	1	
	No	1.40 (1.00, 1.95)	0.049
TB coinfection	No	1	
	Yes	2.64 (1.69, 4.14)	<0.001

Constant=-1.217

Enter method was applied. No multicollinearity and interaction

Hosmer Lemeshow test. P-value 0.798

Classification table 64.3% correctly classified.

Area under ROC was 65.7%

4. Discussion

Our study demonstrated an overall increasing trend in late HIV presentations in Pulau Pinang from 2017 to 2021, peaking in 2020 at 67.9%, which is similar to national trend. Sex-specific trends from 2017 to 2021 revealed a persistently high rate of late HIV diagnosis for both males and females, with males witnessing a notable increase in 2020. The risk factors presented diverse trends across different groups, with initially the highest late presenters in PWID groups ultimately converging in 2021 with late presentation rates aligning within a narrow band for all groups but remaining above 50%. In terms of patient's characteristics, our study found that late presentation was more prevalent among older age groups. Certain districts reported higher percentages of late presentations, with Timur Laut topping the list. Among the risk factors considered, people who inject drugs (PWID) have highest proportion of presenting late, closely followed by heterosexual individuals. A higher rate of late presentation was also found among individuals having coinfection with Tuberculosis and Hepatitis C.

In this study, the trend observed in the proportion of late presentations each year within the study period indicates a concerning pattern ranging from 57.6% to 67.9%. Despite some minor fluctuations, the overall trend suggests a persistent high prevalence of late presentations. The rising pattern of late HIV presentation in Pulau Pinang aligns with the national trend observed across Malaysia [3]. This indicates that efforts to reduce the frequency of late diagnoses and promote timely HIV detection and care have not been effectively implemented or successful during this time period.

These individuals who presented late missed opportunities to stop the future transmission of HIV and lost the chance to start medication early. In comparison to other developed countries, our study results in Pulau Pinang highlight that we are still lagging behind in addressing the issue of late presentations in HIV infection by showing an increasing trend of HIV late presenters like Turkey [14] and the East of England [15] who have shown decreasing trends among late presenters in recent years. While the trends in late presentation of HIV infection have remained relatively stagnant in region like Panama and Australia [16, 17].

Stigma and discrimination are still widespread in Malaysia, although very much improving including among healthcare workers [18]. Moreover, despite the efforts to expand HIV testing services, there are still segments of the population that face barriers to accessing testing, including marginalized communities, key populations (such as men who have sex with men, sex workers, and people who inject drugs), and individuals who may be hesitant to seek testing due to fear of social repercussions. Other than that, limited knowledge about the modes of transmission, prevention methods, and available testing services can result in individuals being

unaware of their risk and the need for regular testing. This lack of awareness may lead to delayed diagnosis and only present at a later stage of infection when symptoms become apparent [19].

The findings of this study affirm the existing literature's consistent association between age and late presentation for HIV diagnosis. Individuals aged 30-49 and those aged 50 and above were more likely to present late compared to the 18-29 age group. This aligns with previous studies that consistently found that older age, especially above 50, was a risk factor for delayed presentation for diagnosis [20-23]. Several interconnected factors are responsible for the growing trend of late HIV diagnosis among elderly individuals. First, global life expectancy is rising, resulting in a larger elderly population, including in Malaysia. This demographic shift indicates that there could be an increasing number of older people sustaining an active sexual lifestyle, including both intra and intergenerational sexual relationships. Men in South Africa, for instance, have reported continuing sexual relations with both their spouses and younger unmarried women, thereby increasing the likelihood of HIV transmission at advanced ages [24, 25].

Older individuals may also be concerned about privacy protection, which may discourage them from pursuing testing or presenting themselves at testing facilities, causing a delay in diagnosis [26]. The problem was exacerbated by the double stigma that elder sexual minorities face due to their age and sexual minority status. The discomfort associated with discussing risky sexual behaviours was heightened among elder sexual minorities [27]. In addition, it has been observed that some providers do not consider HIV testing among senior patients a priority, deeming it unnecessary and funny [28]. This misconception originates from the mistaken assumption that older patients are predominantly monogamous and thus a low-risk population. However, many older adults are actually open to a discussion about their sexual health with their providers, but they prefer that the provider initiates the discussion [29].

Other than that, higher odds of late presentation among older age groups are due to the presence of generational disparities in HIV awareness and knowledge compared to youngsters [30]. Furthermore, older individuals often face unique challenges that contribute to delayed HIV testing and diagnosis, such as comorbidities. Their chronic illnesses can divert attention from HIV risk or symptoms. A systematic review and meta-analysis in Ethiopia found that people with chronic illness have 3 times odds of presenting late [31].

In terms of ethnicity, this study found that Chinese and Malay individuals were more likely to present late compared to Indian individuals. This is consistent with a study conducted in Ontario, Canada, which showed that Black/African Caribbean individuals presented later compared to their white counterparts [32]. These findings underscore the role of ethnicity in late presentation

patterns and suggest that these patterns may vary significantly depending on the specific cultural and regional context. In Malaysia, it is not appropriate to attribute the disparities in late presentation of HIV among different ethnic groups to inequalities, as there are equal rights and access to healthcare facilities for all Malays, Indians and Chinese without any evident of ethnic based disparities or discrimination. However, it is important to recognize that these differences are more likely influenced by cultural, religious beliefs, and community understandings that vary among different ethnic groups. It is essential to acknowledge the presence of distinct norms, beliefs, and understandings within each ethnic group which can contribute to variations in late HIV diagnosis [33]. These contextual factors have contributed to the observed differences in late presentation patterns among different ethnic groups. It is crucial to consider the specific cultural and regional context when interpreting these findings and designing targeted interventions. For example, a study conducted in Penang on health seeking behaviour, found that cultural beliefs can have a profound impact on an individual's self-care and health behaviour, including their propensity to seek treatment [34].

The findings of this study also highlight the significant influence of employment status on the likelihood of individuals presenting late for HIV treatment, consistent with the research conducted by Agaba, et al. [35]. Unemployed individuals were more likely to be present late, emphasizing the role of socioeconomic factors in healthcare access and behaviour. These findings are further supported by the study conducted in South Africa, which also revealed a positive association between employment status and various aspects of HIV care, including testing, linkage to care, retention, and medication adherence [36]. Unemployed individuals often face various challenges that discourage their timely access to healthcare services. In Malaysia, the financial issue of testing and treatment is not an issue for those who have financial constraints because the government provides it for free. However, indirect expenses such as regular transportation to healthcare facilities will pose significant burdens to those without a source of income. These economic obstacles can discourage unemployed individuals from seeking medical care promptly, leading to diagnosis delays [37]. Moreover, being unemployed may also shift an individual's focus towards immediate needs such as job-seeking activities and attending interviews. Based on Maslow's hierarchy of needs, people tend to fulfil their basic necessities, like securing a source of income, before attending to less immediate needs like health check-ups or disease prevention, including HIV testing. This diversion of priorities could further contribute to delays in testing among the unemployed [38].

The impact of unemployment on late presentations should also be considered in the context of psychological

and emotional well-being. Unemployment has proven to cause increased stress, anxiety, and depression, which can further delay healthcare seeking. The psychological burden of unemployment can overshadow individuals' recognition of early symptoms or their motivation to seek medical attention promptly [39]. In addition, unemployment may coincide with less knowledge about health-related issues. Without proper information or education, misconceptions about the disease can worsen, potentially increasing the fear and stigma associated with HIV and thus deterring testing and treatment. Therefore, the status of employment plays a remarkable role in determining an individual's engagement with healthcare services, particularly in the context of HIV testing. Unemployment tends to have a set of challenges, such as economic and psychological aspects that discourage timely medical attention. Socioeconomic factors, along with psychological stresses linked to unemployment, can act as barriers, leading to late HIV diagnosis. Furthermore, a lack of proper information or education about HIV can exacerbate misconceptions and stigma, further hindering the testing process.

Our study also points out the significant association between Tuberculosis (TB) coinfection and late presentation (LP) in HIV patients, which was consistent with findings from other studies conducted in regions such as southwest Ethiopia and Iran [40, 41]. This finding can be attributed to the patient's perception of the risk and consequences of HIV as a significant factor in the late presentation [42]. Their risk perception towards HIV has driven them not to get tested, even though they are aware of the risk of having HIV until prominent symptoms emerge after being infected with Tuberculosis. According to the Health Belief Model, an individual's perceived susceptibility or risk perception towards a disease plays a crucial role in shaping their health-seeking behaviours, which include their willingness to take preventative measures, seek medical advice, undergo tests, or follow treatment protocols. In essence, how vulnerable or susceptible they perceive themselves to be to a certain illness significantly influences the actions they take regarding their health [43]. In the context of HIV, it is unfortunately often the case that individuals who perceive their susceptibility to be low, despite acknowledging the presence of risk factors, are less likely to actively seek out testing. Individuals often don't seek help or testing until only they notice prominent symptoms such as prolonged coughing, fever, night sweats, and weight loss, which are indicative of Tuberculosis. To exacerbate the situation, even though patients are already worried about their health condition, with prominent symptoms of Tuberculosis, sometimes their decision to see traditional healer without going to hospital or clinic will further delay the diagnosis of HIV. This has been demonstrated in a study in Ethiopia, where using traditional treatment was among the reasons for HIV late diagnosis [42].

4.1. Strength

This study was based on a robust cross-sectional study design, analyzing 1196 records which exceed the required 1007 samples for broad and representative findings. The application of statistical methods, including simple and multiple logistic regression, enhances the internal validity and credibility of our results. Our study covers a comprehensive set of sociodemographic factors (age, ethnicity, sex, marital status, employment status, education level, citizenship and district of origin), modes of transmission (PWID, homosexuals, heterosexuals, bisexuals), and coinfections (Syphilis, Hepatitis B, Hepatitis C and Tuberculosis), providing a detailed understanding of the determinants of late HIV presentation. The robustness of our data analysis, reflected in the Hosmer Lemeshow test and ROC values, strengthens internal validity. The absence of missing data across all variables adds to the reliability of our findings. With a large sample size and broad variables, our study's generalizability is supported. Multivariate analyses were conducted to assess the independent association between each independent variable, such as age group, ethnicity, marital status, employment status, education level, risk factors, and coinfection status, and the timing of HIV presentation while adjusting for other relevant factors.

4.2. Limitation

Our study has a few limitations. Firstly, the generalizability of our findings is limited as the study was conducted in a single state, however the sample in this study can be considered representative as it specifically targeted Pulau Pinang, which is the second highest in terms of HIV incidence rate in Malaysia in 2021. Secondly, the omission of potential risk factors such as stigma, alcohol or drug dependence may have influenced the results, because the study is dependent on the availability of variables and data in the secondary registry. Incorporating these variables in future studies would provide a more comprehensive understanding of the determinants of late HIV presentation. Furthermore, considering qualitative methodologies alongside quantitative analyses can offer deeper insights into the experiences and perspectives of individuals affected by late presentation of HIV. Next, this study applied a cross-sectional design, which makes it challenging to establish causal relationships between the identified factors and late HIV presentations.

CD4 count is used as a marker for determining the timing of HIV progression. However, the limitations of using CD4 count alone to categorize individuals as presenting late or non-late is that approximately 5% of HIV infected individuals are classified as rapid progressors as they progress to AIDS within a relatively short period, typically within three years after infection [44]. These individuals may exhibit a low CD4 count, leading to the assumption that they are presenting late. While it is

commonly understood that in the absence of antiretroviral therapy (ART), the median time to develop AIDS is around 10-11 years [45].

5. Conclusions

In conclusion, our study has identified the factors contributing to late HIV presentation among cases in Pulau Pinang from 2017 to 2021. An analysis of 1196 cases revealed that 62.2% were categorized as late presentations, signifying a significant public health concern. The data showed an upward trend in the proportion of late presentations each year, despite minor fluctuations. Alarming, this trend peaked in 2020, with 67.9% of cases presenting late, a figure that highlights the severity of this issue. Through our multivariable analysis, we identified age group, ethnicity, employment status and Tuberculosis coinfection as significant determinants of late presentation. Specifically, individuals aged 30-49 and 50 and above, those from the Chinese and Malay ethnicities, unemployed individuals and HIV/Tuberculosis coinfection who exhibited a markedly higher likelihood of late presentation.

Furthermore, it is important to acknowledge that the non-significant variables, such as sex, district of origin, marital status, education level, Hepatitis B coinfection, Syphilis coinfection, and citizenship, did not show a significant association with late HIV presentation in our final model. While these variables did not emerge as significant determinants in our analysis, it is worth noting that their potential impact on late presentation should not be disregarded. The complexity of HIV diagnosis and the diverse factors influencing it may require further investigation to fully understand their role in late HIV diagnosis. Exploring the potential associations of these variables with late presentation can contribute to a more comprehensive understanding of the factors at play and inform future research and interventions aimed at reducing late HIV diagnosis aligning with the broader global health agenda outlined in SDG 3.3 to end HIV/AIDS epidemic by 2030.

Our recommendation includes emphasizing the importance of tailored approaches to reach the at-risk populations of presenting late, strengthening HIV education campaigns, expanding accessibility to testing and linkage to care, promoting regular testing, addressing socioeconomic factors, enhancing healthcare provider training, fostering collaborations, and conducting further research to gain a deeper understanding of the underlying factors contributing to late HIV presentations. Specifically, additional investigation is needed to explore the reasons for the upward trend observed in the proportion of late presentations over the study period. This could involve qualitative studies or in-depth interviews with affected individuals to identify barriers and facilitators to timely HIV testing and care-seeking behaviours. Furthermore, research can explore additional factors that may contribute

to late presentation, such as stigma, lack of awareness, healthcare system factors, or individual level behavioural factors. Those studies would provide valuable insights for designing targeted interventions and tailored strategies to effectively address the specific challenges faced in Pulau Pinang. These recommendations will collectively contribute to achieving the targets set forth by SDG 3.3, reinforcing our commitment to ending the HIV/AIDS epidemic by 2030.

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Conflict of Interest

All authors declare that there is no competing interest associated with this research.

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