HIV/AIDS Epidemic in Malaysia: Vulnerability and Risk of Women

Md. Nazrul Islam Mondal[1, 3], Mahendran Shitan [1, 2]

[1]Laboratory of Computational Statistics and Operations Research
Institute for Mathematical Research
University Putra Malaysia
43400 UPM Serdang
Selangor; Darul Ehsan, Malaysia

[2]Department of Mathematics
Faculty of Science
University Putra Malaysia
43400 UPM Serdang
Selangor; Darul Ehsan, Malaysia

[3]Department of Population Science
and Human Resource Development
University of Rajshahi
Rajshahi- 6205, Bangladesh

ABSTRACT— ***Malaysia is no exception to the growing trend and severity in Human immunodeficiency Virus (HIV)/Acquired Immune Deficiency Syndrome (AIDS) cases where women are more vulnerable than men. Consequently, the incidence of HIV infections in females is steadily increasing. This study aimed to explore the HIV vulnerability of women and the inequity of HIV infections between males and females in Malaysia over time. Data and necessary information were obtained from the Ministry of Health, Malaysia. The analyses were done by polynomial curve fitting and discriminant function analysis. The fifth degree polynomials were found as useful fitting models for all the cases and almost all the curves explained more than 95% of the variation. The discriminant function analysis identified the discrimination among males and females HIV/AIDS prevalence and AIDS deaths. The current study identified the discrimination between males and females HIV and AIDS prevalence, and AIDS deaths over time and HIV infections among women are gradually rising. The findings suggested that the policies should be aimed at to reduce the major risk factors of HIV transmission, including injecting drug use, needle sharing, and unprotected sex.***

Keywords- HIV, AIDS, risk factors, women in Malaysia, discriminant function analysis

1. INTRODUCTION

Human Immunodeficiency Virus (HIV) causes Acquired Immune Deficiency Syndrome (AIDS) is a growing health problem both domestically and globally. The early cases of HIV/AIDS were reported in the USA in 1981. Since then, it has been steadily increasing and there are approximately 34 million people currently infected with HIV. Almost 30 million people have died of AIDS-related causes since the beginning of the epidemic. While the HIV cases have been reported all over the world, 97.00% of the infected persons reside in the low- and middle-income countries, particularly in sub-Saharan Africa [1]. Most people living with HIV or at risk of HIV do not have access to prevention, care or treatment, and update there is still no complete cure [2]. HIV primarily affects those in their most productive years (20-29 years); about half of new infections are among those under the age 25 years [1]. HIV not only affects the health of individuals, it impacts households, communities, and the development and economic growth of nations. New global efforts have been mounted to address the HIV/AIDS epidemic, particularly in the last decade.

Malaysia is a culturally diverse country with a population of 28 million and one of the fastest growing economies in Southeast Asia. However, Malaysia is facing an alarming increase in HIV/AIDS cases [3]. The first case of AIDS in Malaysia was reported in late 1986 [4] and since then the number of HIV infected individuals have increased. The World Health Organization identified Malaysia as a country with concentrated HIV epidemic [5]. This classification is based on the fact the infection rates are greater than 5.00% among the most-at-risk for populations. HIV/AIDS cases are most prevalent amongst injecting drug users (IDUs), sex workers (SWs), men who sex with men (MSM), and transgender (TG) population [6]. The states such as Sabah and Sarawak, located in East Malaysia, have reported 97.70%

and 83.60% of their HIV cases being transmitted through IDUs respectively in 2009 [7]. Since the first reported case of HIV in Malaysia 25 years ago, the cumulative figure of HIV infection and AIDS cases has been 94,841 and 17,686 respectively. Also 14,986 AIDS deaths had occurred within the same period. In 2011, as much as 19,804 people were screened for HIV status. The main risk factors were found to be IDUs (57.00%), followed by sexual transmission (32.00%). The national overall HIV prevalence rate was found to be around 0.40% [8].

In Malaysia, the HIV/AIDS epidemic is quite heterogeneous in its dynamics and scope. A worrisome aspect of this epidemic is that HIV/AIDS affects the Malaysian in their prime productive years. HIV in Malaysia is predominantly male as they constitute 90.00% of cumulative HIV cases up to 2011 of whom majority are IDUs. However, the trend of ratio female: male has changed from 1:99 in 1990 to 1:10 in 2000 and to 1:40 in 2011. The rise in the number of women being infected with HIV is an indication that the disease has gone beyond affecting just drug users and SWs. In the earlier phase of the pandemic, IDUs were the main factor for HIV/AIDS cases. However, IDUs cases were uncommon amongst females. This trend has changed over time. For instance, in 1990 there was only one sexual transmission for every nine IDUs cases, but in 2010, there were five sexual transmission cases for every five IDUs cases. In 2011, sexual transmission had superseded IDUs as the main driving factor for the epidemic with a ratio of 6 sexual transmissions for every 4 IDUs reported [8].

From the year 2003, the HIV infection among males is showing a decline trend, but the infection among females is on the rise. Amongst men, 48.00% infection occurred via IDUs and 47.00% through sexual mode. Most HIV infections amongst women occurred mainly through heterosexual transmission (87.00%). In 2011, women and girls are increasingly getting HIV infection and they constitute around 21.00% of newly infected persons nationwide, compared to barely 5.00% ten years ago [8]. Importantly, the young women (20-29 years) are at greater risk of acquiring sexually transmitted diseases (STDs), particularly HIV, than other age groups.

The existent drastic situation of HIV/AIDS epidemic and its adverse effects were not clearly explained in the past studies [9-21]. Despite these limitations, recent epidemiological data did register some worrying trends. Firstly, it affected a relatively young age group [20-29] years); and secondly, there was a rising incidence among women. Understanding why women are at greater risk for STD/HIV infection and engage in unprotected sex, is an important aspect of developing and implementing prevention program in Malaysia. Probably the power differentials and social norms that favor males' significant contribution on health risks for females [22]. Other important aspect suggests the correlates such as negative attitudes towards condom use [23]. Moreover, physical and environmental barriers to using condoms [9], and lack of self-efficacy for negotiating condom use [24] had been found to be predictive of low use. Perception of risk was another important factor, particularly with respect to partner type. In addition, effective communication strategies within interpersonal relationships have been found to be a key factor in the ability of women to implement sexual protection. Worrisome aspect is that, in exploring attitudes and behaviors, few studies seek to look at the reasons for the lack of perception of risk, poor usage of condoms, and risky sexual behavior of adolescents. Furthermore, the attitudes and sexual practices among women remarkably differ from other regions, in view of a multiethnic and more conservative culture in Malaysia.

In Malaysia, research activities in this area have been limited mainly to descriptive studies [10-16]. Previous studies on HIV/AIDS issues were done based on purposive sampling of populations such as drug users, healthcare workers, and adolescents [14, 17, 25-26], and results cannot be generalized to the population as a whole. Few published studies are available on the knowledge, attitudes, and beliefs about HIV/AIDS among the general population in Malaysia [17-19]. But, no sound study has been concentrated on the women's HIV vulnerability in Malaysia. Therefore, the specific objectives of this study are to find out the trends of HIV and AIDS prevalence and AIDS deaths through polynomials of HIV and finally build up a discriminant function to show the discrimination in contributing HIV/AIDS epidemic by sexes over time. Hopefully, the findings could be an aid for the policymakers as well as the researchers in deciding how to combat HIV/AIDS epidemic in Malaysia.

2. DATA AND METHODS

Data on HIV and AIDS prevalence and AIDS related deaths by sexes from 1986 to 2011 were obtained from the Ministry of Health, Malaysia [8]. Based on the population demographics, data have been divided into male and female groups and examined the distribution of HIV and AIDS prevalence, and AIDS related deaths by years. In keeping mind the purpose of the study, the analysis was carried out to identify the factors that might have contributed in differentiating the two groups; the techniques of polynomial regression analysis and discriminant function analysis were used. The variables are: X_1 =HIV prevalence, X_2 =AIDS prevalence and X_3 = AIDS deaths on which the two groups (male and female) were expected to differ over time. A comparison between sexes was made using Microsoft Excel 2007 (Microsoft, Redmond, WA, USA). Polynomial regression analysis was used to determine the yearly trend in the number

of infected persons (HIV and AIDS) and deaths (AIDS). The underlying model corresponding to each variable was as follows:

$$X_i = \beta_0 + \beta_1 t_i + \beta_2 t_i^2 + \beta_3 t_i^3 + \ldots\ldots\ldots + \beta_p t_i^p + e_i \qquad (1)$$

where 't_i' is the year, 'X_i' is the number of infected persons of HIV or AIDS; and AIDS related deaths, and 'e_i' is the error terms. The forward selection procedure was applied to determine the appropriate order of the polynomial model.

Fisher's linear Discriminant Function Analysis (DFA) was employed to investigate differences between groups (male and female) on the basis of the HIV and AIDS prevalence and AIDS death cases, indicating which attributes contribute most to group separation. DFA is an optimal dimensionally reduction technique in terms of maximizing the separability of these cases. It determines a set of projection vectors that maximize the scatter between the classes while minimizing the scatter within each class. In DFA, dependent variables may have more than two conditions at a categorical level and independent variables are scale data [27]. Moreover, FDA is a classification method that projects high-dimensional data onto a line and performs classification in this one-dimensional space. The projection maximizes the distance between the means of the classes while minimizing the variance within each class.

Stacking the training data for all classes into the matrix $X \in \Re^{n \times m}$ and representing the *i*-th row of *X* with the column vector X_i, the total-scatter matrix is [28-29]

$$S_t = \sum_{i=1}^{n} (X_i - \overline{X})(X_i - \overline{X})^T \qquad (2)$$

where $\overline{X}$ is the total mean vector whose elements correspondent to the means of the columns of *X*. Let the matrix X_i contain the rows of *X* corresponding to class *i*, then

$$S_i = \sum_{x_i \in X_i}^{n} (X_i - \overline{X}_i)(X_i - \overline{X}_i)^T \qquad (3)$$

is the within-scatter matrix, for class *i* where $\overline{X}_i$ is the mean vector for class *i*. Let *c* be the number of classes, then

$$S_w = \sum_{i=1}^{c} S_i \ . \qquad (4)$$

Is the within-class-scatter matrix, and

$$S_b = \sum_{i=1}^{c} n_i (\overline{X}_i - \overline{X})(\overline{X}_i - \overline{X})^T . \qquad (5)$$

Is the between-class-scatter matrix, where n_i is the number of observations in class *i*. The total scatter matrix is equal to the sum of the between-scatter matrix and the within-scatter matrix [29],

$$S_t = S_b + S_w . \qquad (6)$$

Assuming invertible S_w, then the DFA vectors are determined by computing the singularities of the optimization problem

$$J(V) = \max_{V \neq 0} \; magnitude\left(\frac{V^T S_b V}{V^T S_w V} \right) \qquad (7)$$

where V is the unit vector of the projected line.

For maximization $J(V)$, let $\frac{dJ(V)}{dV} = 0,$

implies that, $$S_b V = \lambda S_w V, \qquad (8)$$

where the eigenvectors $\lambda = \frac{V^T V_b V}{V^T S_w V}$ indicate the degree of overall separability among the classes. Because the direction and not the magnitude of V is important, the norm is usually chosen to be $\|V\| = 1.$

DFA involves a linear equation that will predict which group the case belongs to. The discriminant function in the form [30] is as follows:

$$Z = l_1 X_1 + l_2 X_2 + l_3 X_3 + ... + l_k X_k, \qquad (9)$$

where, Z = discriminate function,

l_k = the discriminant coefficient or weight for the *k*-th variable, and

X_k = respondent's score for the *k*-th variable.

The coefficients l_k will be obtained using Mahalanobis D^2 technique where

$$D^2 = \sum_k l_k d_k, \qquad (10)$$

and $d_i = \mu_{1i} - \mu_{2i}$; μ_{1i} and μ_{2i} being the mean values of the *i*-th variable under the two populations.

3. RESULTS

When the polynomial regression of degree *'p'* for the different values (p = 1, 2, 3, 4, and 5) were fitted on the numbers of HIV and AIDS cases and AIDS death cases by years, it was found that the polynomials of degree five gave the best fit as a model for both the male and female populations (Figs. 1-4). These figures also show that 93.00% (R^2 = 0.93) for male HIV cases, 97% (R^2 = 0.97) for female HIV cases, 90% (R^2 = 0.90) for male AIDS cases, 94.00% (R^2 = 0.94) for female AIDS cases, 96.00% (R^2 = 0.96) for male AIDS death cases, 96.00% (R^2 = 0.95) for female AIDS death cases, 94.00% (R^2 = 0.94) for total HIV cases, 91.00% (R^2 = 0.91) for total AIDS cases, and 96.00% (R^2 = 0.96) for total AIDS deaths, could explain the yearly variation when the fifth-degree polynomial model was applied. All the parameters of the fitted models were statistically significant ($p < 0.05$).

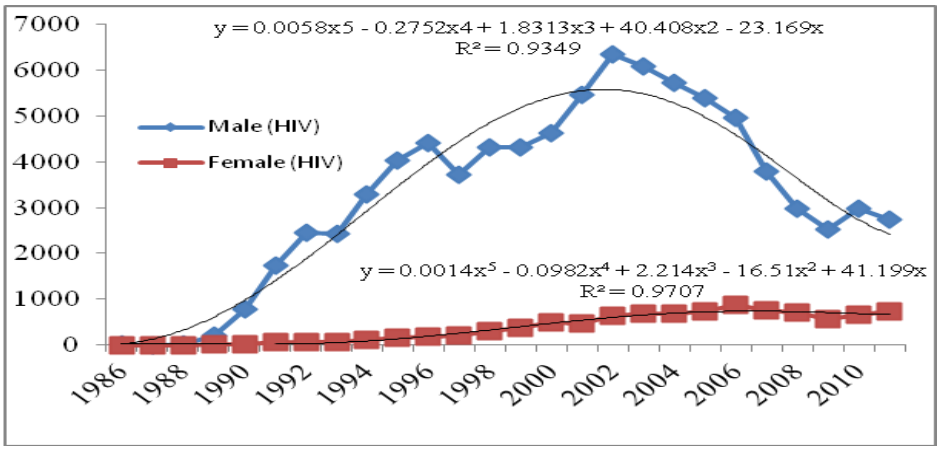

Fig. 1. HIV prevalence of males and females from 1986 to 2011 in Malaysia

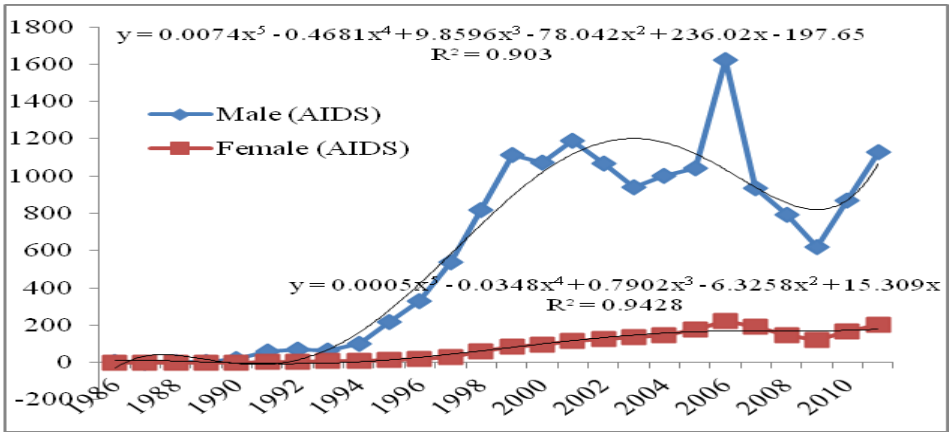

Fig. 2. AIDS prevalence of males and females from 1986 to 2011 in Malaysia

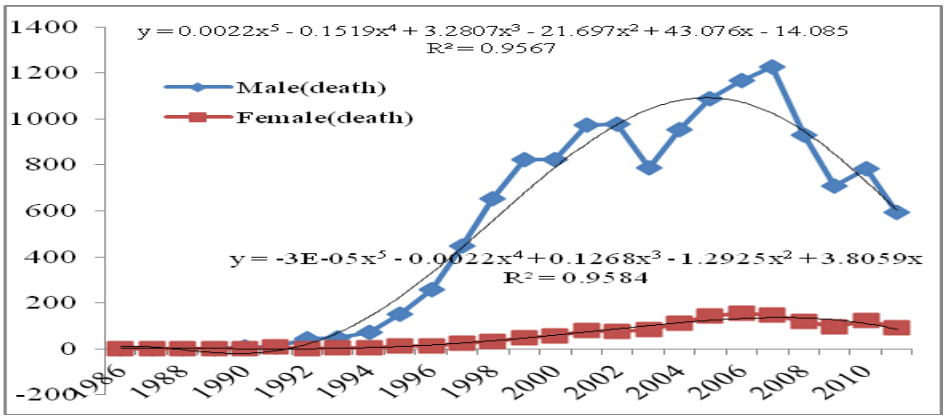

Fig. 3. Deaths due to AIDS of males and females from 1986 to 2011 in Malaysia

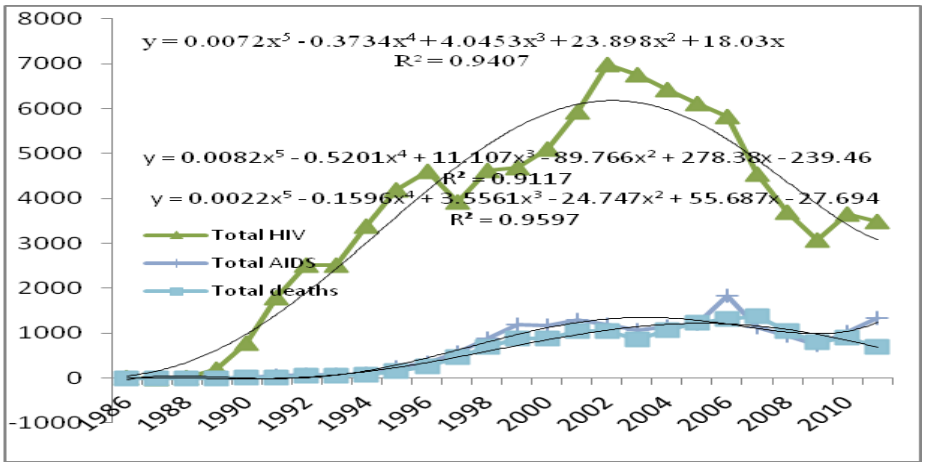

Fig. 4. Total HIV, AIDS and AIDS death cases from 1986 to 2011 in Malaysia

DFA was performed and the results were summarized in Tables: 1-5. The results of background statistics are presented in Table 1; and tests of equality of group means and pooled with group means are presented in Table 2. The analysis has tried to predict a group membership and examined whether there are any significant differences between the groups (male and female) on each of the independent variables (HIV and AIDS cases, and AIDS death cases) using group means and analysis of variance (ANOVA) results. There significant group differences were found. Table 2 provides strong statistical evidence of significant differences between means of male and female groups for all independent variables producing very high value F's.

Table 1. Background statistics of dependent and independent variables

Sex	Attributes	Mean	SD	Maximum	Minimum
Male	HIV	3283	1943.31	6349	2
	AIDS	601	499.17	1620	0
	AIDS Deaths	521	440.43	1227	0
Female	HIV	365	304.83	875	0
	AIDS	80	76.82	222	0
	AIDS Deaths	56	54.11	154	0
Total	HIV	1824	2016.51	6978	2
	AIDS	340	440.64	1842	0
	AIDS Deaths	288	389.53	1374	0

Table 2. Tests of equality of group means and pooled within-groups matrices

Test of Equality of Group Means			**Pooled groups matrices**			
	Wilk's Lambda	**F**	**Attributes**	**HIV**	**AIDS**	**AIDS Deaths**
HIV	.47	57.19***	HIV	1.00	0.78	0.785
AIDS	.64	27.64***	AIDS	0.78	1.00	0.94
AIDS Deaths	.64	28.60***	AIDS Deaths	0.77	0.94	1.00
Box' M Test = 270.69						

Note: The covariance matrix has 50 degrees of freedom, Tests null hypothesis of equal population covariance matrices, and ***p<0.00

The Box's M is 270.69 with F = 42.17 which is significant at p<0.00 (Table 2). Eigenvalue provides information on each of the discriminate function produced. Two groups were used, namely 'male' and 'female', so only one function is displayed. A canonical correlation of 0.73 suggests the model explains 53.58% of the variation in the grouping variable, i.e. whether a respondent male or female. Wilk's lambda indicates the significance of the discriminant function. A highly significant function (p<0.00) and provides the proportion of total variability not explained (46.20%) (Table 3).

Table 3. Eigenvalue and Wilk's lambda

Eigenvalues	**Function**	**Eigenvalue**		**Canonical Correlation**
	1	1.17		0.73
Wilks' Lambda	Test of Function(s)	Wilks' Lambda	Chi-square	
	1	0.46	37.47***	

Note: The covariance matrix has 50 degrees of freedom, Tests null hypothesis of equal population covariance matrices, and ***p<0.00

Table 4 provides an index of the importance of each predictor like the standardized regression coefficients $(\beta's)$ in multiple regression where the sign indicates the direction of the relationship. HIV prevalence was the strongest predictor while AIDS deaths were next in importance as a predictor. These two variables with large coefficients stand out as those that strongly predict allocation to the male or female group. AIDS prevalence was less successful as predictor. Based on these, the equation of discriminant function:

$$Z = (1.139 \times X_1) + (-0.322 \times X_2) + (0.133 \times X_3). \qquad (11)$$

In Eq. 11, given the numbers of HIV and AIDS prevalence, and AIDS deaths, the score of male or female can be calculated. The discriminant function coefficients indicate the partial contribution of each variable to the discriminate function controlling for all other variables in the equation. The coefficients can be used to assess each independent variable's unique contribution to the discriminate function. It provides information on the relative importance of each variable. The structure matrix table (Table 5) shows the correlations of each variable in discriminate function. These Pearson coefficients are structure coefficients or discriminant loadings. Thus, the HIV prevalence and AIDS deaths suggest the higher label of HIV transmission AIDS deaths and the function (Eq. 11) discriminates between males and females.

Table 5. Standardized canonical discriminant function coefficients, and structure matrix

	Attributes	Function
Standardized Canonical Discriminant Function Coefficients	HIV	1.14
	AIDS	-0.32
	AIDS Deaths	0.13
Structure Matrix	HIV	0.99
	AIDS Deaths	0.70
	AIDS	0.69

The numbers of HIV and AIDS cases and death cases related to AIDS by sexes over time from 1986 to 2011 put into the discriminant function (Eq. 11) and the corresponding figure is presented in Fig. 5. The figure of discriminant function predicts that the discrimination among males and females in contributing to HIV and AIDS infection and deaths due to AIDS taken together are gradually diminished.

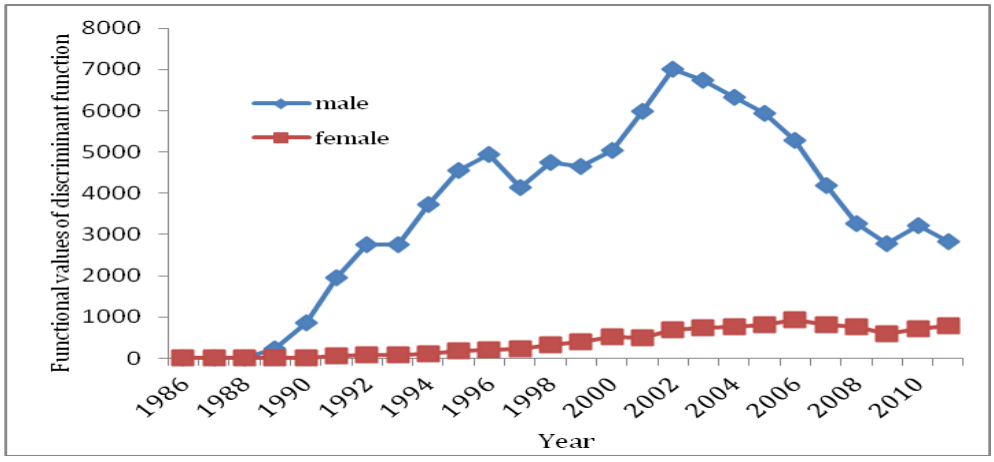

Fig. 5. Discrimination functions plotted and discrimination gradually decreases

4. DISCUSSION

Women have been affected by HIV/AIDS since the beginning of the epidemic, an impact that has grown over time [31]. Women of color, particularly black women have been especially hard hit and represent the majority of new HIV infections. Many women with HIV are low-income and most have important family responsibilities, potentially complicating the management of their illness. Women and girls are confronting HIV/AIDS epidemic in Malaysia where the women are one of the fastest growing populations being infected with HIV. While the proportion of women and girls reported to have been infected with HIV remains less than 10.00% as of December 2007, the past five years have seen

dramatic increase in the number of new cases documented amongst women. Because of most HIV infection cases among women and girls in Malaysia have occurred through heterosexual sex [19]. Moreover, a large number of housewives are in the cause of concern of women's vulnerability [22]. The newly infected women and girls contracted the disease from their husbands or boyfriends. Even some women are aware of the risks, but they do not have the power of negotiation to insist their partners to use condoms. Women are most likely to be infected through heterosexual sex, followed by IDUs. This pattern is consistent across racial and ethnic groups, although heterosexual transmission accounts for a greater share of new HIV infections. HIV interacts with women's reproductive health on many levels. Women with HIV are at increased risk for contracting a range of conditions, including human papillomavirus, which can lead to cervical cancer, and severe pelvic inflammatory disease. Most new infections are transmitted heterosexually, although risk factors vary. In Malaysia, MSM, IDUs, and SWs are at significant risk, are directly linked with women's HIV infections.

In Malaysia, HIV surveillance system is based on notification of newly diagnosed HIV infection and screening in sub-populations only. It is estimated that there are about 170,000 IDUs in Malaysia [8]. At the beginning of the epidemic, IDUs were the main driver with 70-80% of all new reported cases in 1990s being attributed to the IDUs. Recent studies [20-21] noted that high drug users were found to be injecting buprenorphine. Importantly, the IDU patients are not provided drug counseling or other psychosocial services[21] which fuel to the rise the number of IDUs. High prevalence of unprotected sex with their wives and girl friends (55.00%) and commercial SWs (31.00%) were reported among IDUs [26], making the actual mode of transmission among the IDUs unclear. The drastic situations like heterosexual behaviors of male IDUs, were found among female IDUs, which increased the more risk of their HIV infection and transmission. The rising trend of infection has started to decline constantly in 2004, and had reached 39.00% in 2011; signaling a rise in the proportion of sexually transmitted HIV. Overlapping of the main risk behaviors, namely IDUs and SWs are also being observed. Clearly, the men who were infected through drug use and unprotected sexual intercourse with SWs would infect more women in the future.

Female SWs are frequently thought of as being at a higher risk of HIV exposure as they are often not in a position to insist that their customers wear condoms. Alarmingly it has been reported that men will still pay more money for unprotected sex with SWs. This means that SWs are not only at risk of becoming infected with HIV, but that if they are already infected, they can pass the virus on to their clients. In Malaysia, a nationwide study among SWs conducted by UNFPA and FRHAM in 2008-2009 revealed that 16.00% of SWs were drug users; while 13.00% were ex-drug users; close to 29.00% of them were IDUs and about a third shared needles with their friends and husband [32]. It is estimated that the population of SWs in Malaysia to be 60,000 comprised of 40,000 female SWs and 20,000 TG. The SWs account for approximately 0.60% of total reported cases or 611 of the 94,841 cases reported thus far [8]. In comparison to the large proportion of IDUs reported to be infected with HIV, the number of HIV cases reported among SWs is quite small. However, this is taken as a gross underreporting of this population as SWs will not necessarily identify themselves as such and may also not come forward for treatment.

As it is, the situations with male SWs are currently largely unknown as they are often hard to identify. As such, they are left out of existing outreach and intervention programs. Female SWs and TG are the highest infected risk populations with national rates estimated at 12.00% in 2011 [8]. The Integrated Bio-Behavioral Surveillance (IBBS) 2009 conducted with SWs indicated that 10.50% of respondents were with HIV; about 61.00% reported the use of a condom with their most recent client while 38.60% correctly identified ways to prevent sexual transmission of HIV [33]. The IBBS also reported 6% had IDUs in the past year and 20% of them had sexual partners who are IDUs. Needles and syringes are commonly shared between SWs and their clients who pay for sexual services with drugs while condom use was found to be generally low and infrequent. The Behavioral Surveillance Survey (BSS) 2004 reported 79.00% of respondents amongst female SWs had used condom with their recent client and 20% had used drugs in one form or another [32]. Due to many uncertainties around the SWs and clients population sizes, HIV spread and SWs may be more that estimated.

Under the existing classification in the HIV surveillance system, MSM are considered to be in the homosexual/bisexual category, and as of December 2011, there were 2,406 (2.50%) out of 94,841 cumulative number of HIV reported cases were among this category [8]. In 2009, a venue-day-time-sampling (VDTS) study was carried out among 517 respondents in Kuala Lumpur out of which 3.90% were found to be with HIV. One in four reported having more than five male partners in the past six months. About 45.00% of those who had unprotected sex with a casual partner were almost 3 times more likely to be with HIV compared to those who did not engage in that activity. Approximately 16.10% had had sex with a female partner in the past six months. Due to social pressures, cultural context and the fear of facing stigma, MSM are more likely bisexual (i.e. having wives and girlfriends). There is an estimated 173,000 MSM in Malaysia [8]. Given many uncertainties around the MSM, HIV spread in MSM may reach higher prevalence in a short period.

Gender inequalities, differential access to services, and sexual violence increase women's vulnerability to HIV, and women, especially younger women, are biologically more susceptible to HIV. The women with HIV/AIDS may encounter barriers to treatment and do not receive optimal levels of care compared to men. The women with HIV were less likely to receive combination therapy and fared more poorly on other access measures than men. The women with HIV face limited access to care and experience disparities in access, relative to men. Women also experience different clinical symptoms and complications. They were also more likely to postpone care because they lacked transportation or were too sick to go to the doctor than men.

5. CONCLUSION

The polynomial models of HIV and AIDS, and AIDS deaths by sexes in years show the gaps, but the gaps gradually reduced, which means HIV prevalence and AIDS related deaths of females are gradually increasing compared with males. The discriminant analysis was conducted to predict whether males or females having the higher contribution of HIV and AIDS infections and AIDS deaths over time. Predictor variables were the numbers of HIV and AIDS cases, and death cases of AIDS by sexes over time. Significant mean differences were observed for all the predictors on sex. The results identified that Malaysian HIV/AIDS epidemic has slowly shifted from almost entirely male to having a higher proportion of female cases with strongly linked to women and heterosexual transmission. With no specific cure for HIV/AIDS, prevention measures based on information remain vital for tackling HIV/AIDS epidemic and its associated problems. The results have some policy implications for the most at risk groups of populations, especially for women. Communication and intervention strategies could play important roles in educating the public, especially for the women on prevention and control the HIV transmission. The rising prevalence of HIV infection of females in Malaysia supports the importance of interventions to reduce the major risk factors of HIV, including IDUs, needle sharing, and unprotected sex. Moreover, the exact efforts are also needed to empower the women to fight against extramarital sex, promote education and encourage condom utilization. Further research is needed to identify the determinant factors for which the women are more HIV infected.

Acknowledgements: The authors are very grateful to the Institute for Mathematical Research (INSPEM), University Putra Malaysia (UPM); Malaysia for granting a Visiting Scientist Fellowship to complete this study. Thanks are also to the editor and the referees for their comments and criticism, which lead to greatly improved version of this paper.

Competing interest: The authors declare that they have no competing interests.

Contribution of Authors: All authors have contributed to the conceptualization, conduct, and analysis of this research, and all authors have participated in the manuscript drafting, editing, and revising. All authors have approved the final version of this manuscript.

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