HIV prevalence in the Asia Pacific Region: an ecological approach to inequalities

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ABSTRACT: According to UNAIDS 2010, countries located in South and East Asia hold the second largest world population of PLWH. Structural and socioeconomic factors are important in HIV/AIDS epidemic. Despite country data are collected regularly, analytical comparisons for Asia-Pacific Region (APR) are scarce. We present an ecological approach to HIV/AIDS and its predictors in APR. Development and socioeconomic data for South-Asian, South East-Asian, East-Asian and Pacific countries were obtained from the World Bank data catalog (2009). Across countries comparisons were performed by linear regression models (for communication, health system, employment and equity factors) and correlations. Concentration index was also computed. Unemployment was significantly associated with HIV prevalence in the APR after controlling for confounders. Evidence for association with percentage of rural population, external health resources, telephones and women seats in the parliament was weaker (p 0.05 – 0.1). Concentration index was -0.28. We present current data on structural and socioeconomic determinants of HIV epidemics in the APR. Our data suggest that unemployment is an important predictor of HIV prevalence in APR and that other important structural factors might be related. Finally, although not associated with GNI, HIV prevalence showed a negative concentration index indicative of inequalities being present in the region.

Keywords: HIV prevalence, Asia Pacific Region

Introduction

Believed to have peaked in 1999 (UNAIDS, 2010), the HIV and AIDS epidemic continues to be an issue of global concern. The current estimate of WHO and UNAIDS (2010) states that there are 34 million people living with HIV(PLHIV) in the world (WHO, 2011, UNAIDS, 2011). A study done in 1996 mentioned that 22% of the then estimated 21.8 million PLHIV were from Asia and the Pacific (Dore *et al*, 1996).However, in 2010, only about 4.8 million people were estimated to live with HIV in Asia alone, a change brought about by a decreased transmission rate and increased access to ART (Antiretroviral Therapy) (UNAIDS, 2010, WHO, 2011).

It is important to mention that Asia and the Pacific is home to 55% of the world's population, mainly due to the massive populations of China, India and Indonesia, three of the world's four most populous countries (Kaldor, *et al*, 1994). The fact that populous countries are a part of the region also means that even if the overall prevalence of the region is low, the burden, in terms of absolute numbers of PLHIV is higher. In other words, even low prevalence rates would mean large population of PLHIV (UNAIDS, 2010) for this region. More than 90% of PLHIV in the region live in 10 countries- India, China, Thailand, Indonesia, Viet Nam, Myanmar and Malaysia, with India alone accounting for 49% of the total PLHIV in the region (WHO, 2011).However, the number of peopledying due to AIDS related causes displays a decreasing trend in South and South-East Asia since 2005-06. WHO Report 2011 mentions that the new lower infection and mortality rates in the region are a result of a combination of facts including behavioral interventions brought about by greater awareness amongst people, greater prevention efforts and increased coverage of ART (WHO, 2011). In fact, the introduction of ART has averted 300,000 deaths in the Asia and Pacific Region (APR) since 1995 (WHO, 2011).
HIV epidemics in APR are predominantly concentrated mainly among specific Most at Risk Populations (MARPs), except in Thailand, in which the adult prevalence has been estimated to

be at 1.3% (UNAIDS, 2010).While the epidemic in Asia is clearly concentrated (Lazarus *et al.*, 2010), with exception of Thailand, the epidemic in the Pacific region has also sometimes been termed as 'potentially mixed' (Wilson and Haperin, 2008). For some countries like China, HIV is concentrated in certain clusters within the country (UNAIDS, 2011), but has affected multiple population groups (Liu *et al*., 2005), practicing different risk behaviors and distinct geographical differences (UNAIDS, 2010) whereas in others, the type of epidemic varies according to the main drivers- unprotected paid sex, injecting drug, unprotected sex between men, unprotected sex, or a combination of 2 or more of these (WHO, 2011)

Different countries in this region face epidemic levels due to a broad range of underlying determinants including socio-cultural, economic, biological, cultural, ethnic, gender-based (Lin et al, 2007, Singa, 2009), and political (UNAIDS, 2007a). These factors often interact with other, creating multidimensional relationships, further making individual distinction more difficult (Greener, 2010). Thus, the factors affecting HIV in APR is a complex amalgamation. HIV and AIDS have moved from being a medical concern to a cross-cutting issue in the world. Even though prevalence in some of the countries is stabilizing, HIV is still a major threat to global health, and APR is no exception. Juxtaposition brought about by multiple factors acting at one or more levels affects the epidemic and cuts across geographical, gender or socio-economical divides. So, determining the relations between HIV prevalence and other structural factors is important. It can help to understand the epidemic better and deliver the interventions accordingly, the central theme of "Know your epidemic, know your response", led by UNAIDS (UNAIDS, 2007b). This can also help in optimizing the efficiency of the use of scarce resources (Hayes, 2010), an impending threat to effective response to HIV and AIDS in the region (UNAIDS, 2007a).

Many countries in the region have systems for routinely collecting data, either specifically or related to HIV and AIDS. Second generation surveillance is being carried out in majority of the countries in the region, ensuring rich information on HIV (Emmanuel *et al*., 2011). Surveys such as the Demographic Health Survey, on the other hand, include HIV and AIDS as a section in the nationally representative survey carried out every 3 to 5 years (MEASURE DHS, 2011). Routine data collection is a part of the health system in most of the countries as well, including behavioral surveillance and sentinel surveillance (UNAIDS, 2010). Small scale research and program data collection are also frequent. In this case, triangulation could be a different issue (Rutherford *et al.*, 2010), but data, of varying validity does exist in the national and regional level. However, studies addressing this issue at an ecological level are scarce. Although interest has been growing, there have relatively been fewer studies aiming to describe the situation of HIV and AIDS epidemic and the structural factors related to it in the region. This study aimed at presenting an ecological approach to HIV and AIDS and its predictors in the APR.

Methods

Data Collection and Study Variables

The World Bank Databank (http://data.worldbank.org/country) was accessed to download socioeconomic and development indicators for Asian countries. Countries analyzed belong to different income levels, as per World Bank definitions, ranging from low to lower middle income to higher middle income to high income level. Countries from South Asia and East Asia & Pacific regions were selected. Although Australia, New Zealand, Singapore, The Democratic Republic of Korea, Korea and Japan are not considered part of the East Asia & Pacific developing regions, these countries were included in the analysis as we consider it to be geographically pertinent. Additionally, data for China's two Special Administrative Regions, Hong Kong and Macao, were included as separate entities since the World Bank has independent data sets for these territories.

Moreover, even though China is classified as an upper middle income country within the East Asia & Pacific developing regions, both Hong Kong and Macao are not part of that region and are rather classified in the High Income level, non-OECD group(i.e. they are not member states of the Organization for Economic-Cooperation and Development). French Polynesia and New Caledonia are French Ultramar Territories that were not included in the analysis despite being located in the Pacific region because of limited data availability. Similarly, the US territories of American Samoa and Northern Mariana Islands, the Kingdom of Tonga and the independent countries of Samoa, Solomon and Marshall islands were not included in the analysis because of insufficient data. Finally, despite Hawaii is located in the pacific it was not included in this analysis as it is a member State of the American Union and there is not data available for this State in the World Bank Databank.

In order to analyze the impact that different social, economic and structural factors may have on HIV prevalence in the Asia Pacific Region we grouped the indicators (variables) selected into 5 major sets: 1) communication, 2) health system, 3) employment, 4) equity factors; and, 5) economic indicators. The most updated data for variables were used, for most of them this means 2009 registers but some of them are older. The variables included in the analysis are percentage of rural population, food production index, electrical power consumption, renewable internal water, improved water source, external resources on health (as a percentage of total expenditure on health), health expenditure per capita, internet users, telephone lines, mobile cellular subscriptions, quality of ports infrastructure, roads paved, employment in agriculture, unemployment (as a percentage of labor force), net migration, emigration rate of tertiary educated, military expenditure, cash surplus/deficit, proportions of seats held by women in national parliaments, life expectancy at birth, physicians per people, C02 emissions, income level, Gross National Income (GNI) per capita, Gross National Product (GDP) per capita.

GDP growth (annual %), primary school starting age (years), public spending on education, adult literacy rate, youth literacy rate, agricultural machinery (tractors per 100 sq Km of arable land), food production index, food exports, food imports, terrestrial protected areas, population density, combustible renewable and waste, agricultural land (% of land area), foreign direct investment, total reserves, use of IMF credit, household final consumption expenditure, automated teller machines (per 100,000 adults), listed domestic companies, inflation, immunization (DPT), improved sanitation facilities, hospital beds, out-of-pocket health expenditure, international tourism (receipts), armed forces personnel (as a percentage of total labor force), central government debt, subsidies and other transfers. Additionally, we got data on religion and religiosity. We collected information about the main religion/faith professed in any given country and it was defined as such if at least 50% or more of the population identified themselves with any religion.

For the purposes of our analysis all different Christian denominations were considered to be only one religion (i.e. Christianity). Similarly all different currents of Islam were considered to be one religion as were all variations of Buddhism and Hinduism. Religiosity data were collected from the Gallup World View data base (https://worldview.gallup.com/default.aspx).

Religiosity was defined both as a quantitative and as a qualitative variable. Quantitatively, religiosity was defined as the percentage of people answering "Yes" to the question: Is religion an important part of your daily life? We then divided countries in three groups of religiosity as follows: 1) Most religious countries, where 70% or more of the people answered "Yes"; 2) Average religious countries, where 40-70% of asked persons said religion was an important part of their daily life; and, 3) Least religious countries were those where less than 40% of people replied in the same way.

Statistical Analysis

Data were compiled into a single database and were analyzed using IBM SPSS Statistics 20 software. Descriptive statistics were calculated for quantitative variables (i.e. mean and standard deviation) such as HIV and religiosity and for qualitative variables (i.e. percentages) such as income level, geographical region, main religion and religiosity. Since ANOVA data assumptions were not met, a Kruskall-Wallis analysis was performed in order to assess whether HIV prevalence was related to income level, main professed religion and religiosity (as a qualitative variable). A Mann-Whitney test was used to study the difference in HIV prevalence according to geographical region. In order to assess whether religiosity (as a quantitative variable) was associated with HIV prevalence we obtained a scatter diagram and calculated Pearson's correlation between both variables. In order to investigate which indicators better predict HIV prevalence in these countries we used a two-step approach where an initial bivariate correlation analysis identified which variables (among those listed in the previous section) more strongly associated with HIV prevalence. These variables were then included into linear regression models which were run using a backward method with concomitant collinearity analysis. Finally, in order to assess whether inequalities help to understand the dynamics of HIV prevalence in the Asia Pacific Region we calculated the concentration index as previously described (Wagstaff *et a.l*, 1991).

Results

Income level in countries of the Asia Pacific Region

As shown in **Table 1**, countries in the Asia Pacific Region can be classified into two developing regions and two non-developing groups, as per World Bank definitions. The two developing regions are South Asia and East Asia

& Pacific whereas developed countries can either be part of the Organization for Economic-Cooperation and Development (high income OECD) or not (high income, non-OECD). For the purposes of this paper, high income countries (both OECD and non-OECD) were considered to be part of the Asia Pacific Region if they happen to be located in the appropriate geographical zone even though they are not grouped as such in the World Bank Databank. Some countries were not included in the analysis since data available were insufficient (see Methods).

Table 1: Asia Pacific countries (and territories) according to World Bank classification

World Bank Classification	Number of Countries (%)	Countries
High income OECD	4 (12.1%)	Australia, Japan, Korea, Republic of, New Zealand.
High income non-OECD	3 (9.1%)	Hong Kong (SAR)*, Macao (SAR)*, Singapore.
South Asia	8 (24.2%)	Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka.
East Asia & Pacific	18 (54.6%)	Cambodia, China (PR)*, Fiji, Indonesia, Kiribati, Korea (DR)*, Laos (PDR)*, Malaysia, Micronesia, (FS)*, Myanmar, Palau, Papua New Guinea, Philippines, Thailand, Timor-Leste, Tuvalu, Vanuatu, Vietnam
Total	33 (100%)	All

***Hong Kong (SAR):** Hong Kong Special Administrative Region China,**Macao (SAR):** Macao Special Administrative Region China,**China (PR):** People's Republic of China,**Korea (DR):** Democratic Republic of Korea,**Laos (PDR):** People's Democratic Republic of Laos,**Micronesia (FS):** Federates States of Micronesia

(Data source: World Bank Databank)

Income level varied across the different countries and territories in the Asia Pacific Region. Out of the 33 countries and territories studied, 15 belong to the lower middle income classification (45.5%), followed by 7 high income (21.2%), 6 low income (18.2%), and five upper middle income (15.2%) countries. Among the high income countries and territories four (12.1%) belonged to the OECD and three (9.1%) were not OECD members, **Figure 1**. None of the high income countries or territories is located in the South Asia region.

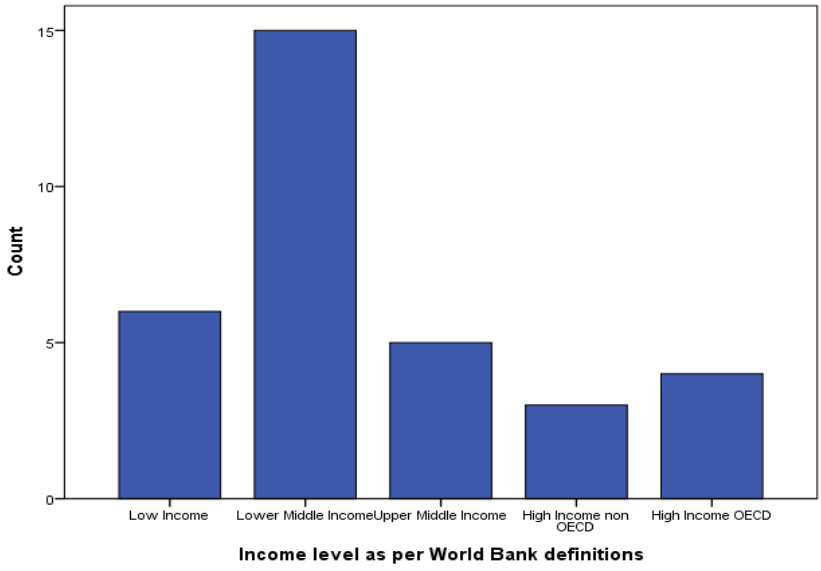

Figure 1: Distribution of countries in the Asia Pacific Region according to Income Level *(Data source: World Bank Databank)*

HIV Prevalence in the Asia Pacific Region

The 2009 prevalence of HIV among individuals aged between 15 and 49 years old ranged from 0.10% to 1.30% in the different countries and territories of the Asia Pacific Region. Most of the countries reported a low HIV prevalence in this age group with 12 countries and territories (39.4%) reporting a prevalence of 0.10%, HIV prevalence was reported to be 0.20% by 3 countries (Bhutan, Indonesia and Laos), two countries reported prevalence rates of 0.40% (Nepal and Vietnam) whereas other two countries reported 0.50% (Cambodia and Malaysia). A prevalence rate of 0.30%, 0.60%, 090% and 1.30% was reported by only one country. (See **Table 2**) Finally, 10 countries (30.3%) did not report any data on this variable; these countries were excluded from all subsequent statistical analyses. (Table 2) Although the mean (SD) 2009 HIV prevalence for Asia Pacific was 0.29%(0.31%), the reported prevalence rates for South Asia and East Asia & Pacific development regions in the same year were 0.30% and 0.2%, respectively (World Bank Databank).

Table 2: Asia Pacific countries and territories by 2009 HIV prevalence as a percentage of population aged between 15 and 49 years old

HIV Prevalence (% of population ages 15-49)	**Countries**
0.10	Australia, Bangladesh, China, Fiji, Japan, Korea (Rep), Maldives, New Zealand, Pakistan, Philippines, Singapore, Sri Lanka,
0.20	Bhutan, Indonesia, Laos (PDR)
0.30	India
0.40	Nepal, Vietnam
0.50	Cambodia, Malaysia
0.60	Myanmar,
0.90	Papua New Guinea,
1.30	Thailand
No data reported	Afghanistan, Hong Kong (SAR China), Kiribati, Korea (Dem. Rep.), Macao (SAR China), Micronesia (Fed. Sts.), Palau, Timor-Leste, Tuvalu

Data source: World Bank Databank

Regarding income level and ist association with HIV prevalence, mean HIV prevalence was found to be highest among upper middle income countries and lowest in high income countries ($p > 0.05$). (Figure 2) All high income countries reported a prevalence of 0.10%, regardless of whether they were part of the OECD or not, whereas the prevalence reported by countries in the other income levels ranged from 0.10% to 1.30%. (**Figure 2**) Since Papua New Guinea was an outlier, a new Kruskall-Wallis analysis was computed, excluding Papua New Guinea, also finding a non-significant association ($p > 0.05$).

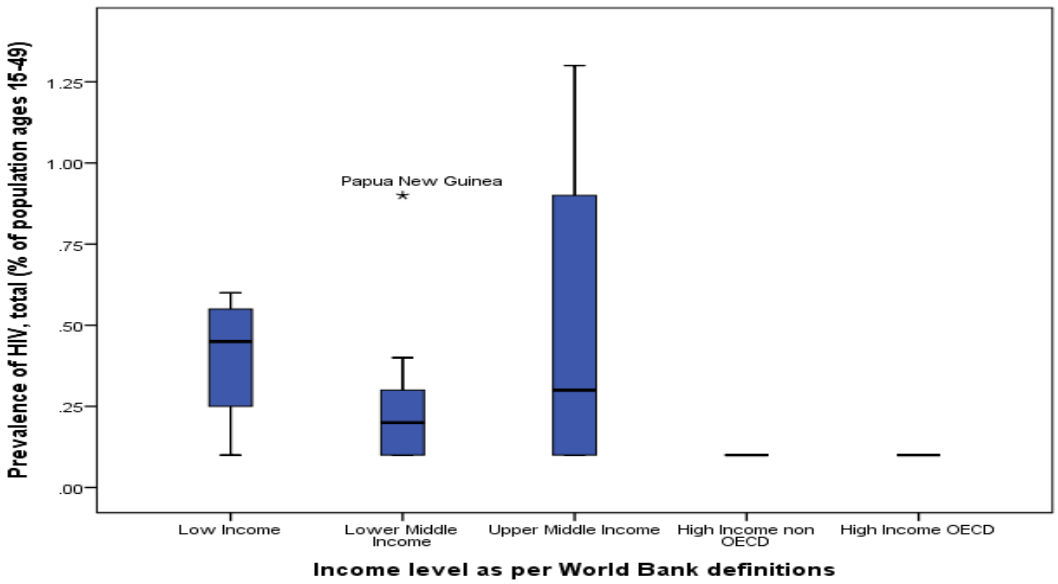

Figure 2: HIV prevalence by income level.

When considering the geographical regions,it was observed that all countries in South Asia reported prevalence rates of 0.40% or below whereas the prevalence reported by countries in the East Asia & Pacific region was more varied. In general terms, HIV prevalence varied more among East Asia & Pacific countries whereas mean HIV prevalence was lower in South Asia but this difference was not statistically significant ($p > 0.05$, Mann-Whitney test)(**Figure 3**). It is important to mention that Thailand was an outlier, as shown in Figure 3. A new Mann-Whitney test analysis excluding Thailand resulted in statistically non-significant differences ($p > 0.05$).

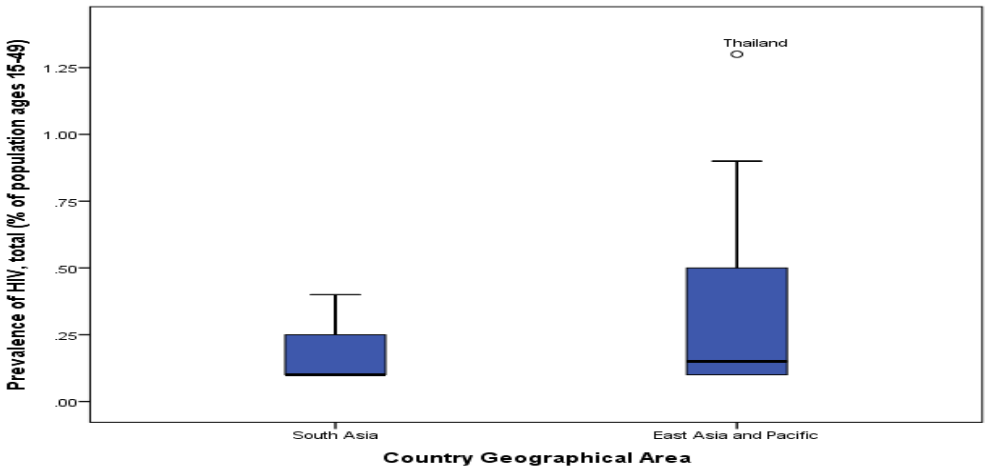

Figure 3: HIV prevalence by geographical region

There was a clear association between HIV and behavior and it is well known that religion and religiosity may highly influence behavior. All countries where Christianity was the most professed faith reported an HIV prevalence rate of 0.10% with the sole exception of Papua New Guinea which reported a prevalence rate of 0.90%. Sixty percent (3 out of 5)of the countries where Islam was the main religion reported a prevalence of 0.10% with only two countries (Malaysia and Indonesia reporting prevalence rates greater than 0.10%, at 0.50% and 0.20%, respectively). The prevalence rate reported by countries where Buddhism was the main religion was more varied with a mean of 0.39% (SD 0.42%). The only two countries where Hinduism was the most professed religion, India and Nepal, reported a prevalence of 0.30% and 0.40%, respectively. Finally, only three countries had no major religion and two of them (Republic of Korea and Singapore) reported an HIV prevalence of 0.10% whereas Vietnam had a prevalence of 0.40%. The differences in prevalence reported among these different groups were, however, statistically non-significant ($p > 0.05$, Kruskall-Wallis test). A new Kruskall-Wallis Analysis excluding the outliers (Papua New Guinea, Malaysia and Thailand) also showed that the differences were statistically non-significant (**Figure 4).**

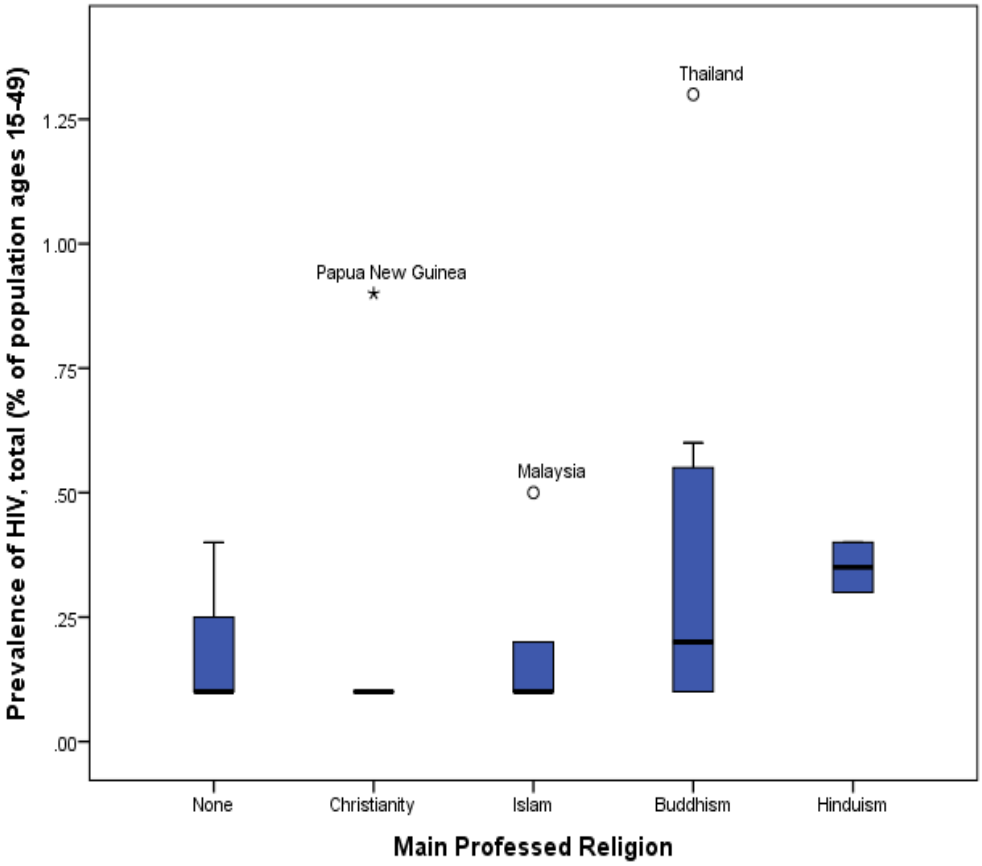

Figure 4: HIV prevalence by main religion in the country

Afterwards, an analysis of whether income level might be distorting the observed distribution between religion and HIV prevalence was done. As shown in **Figure 5,** different income levels were represented in countries with different main professed religion and this distribution was statistically non-significant ($p > 0.05$, chi square test).

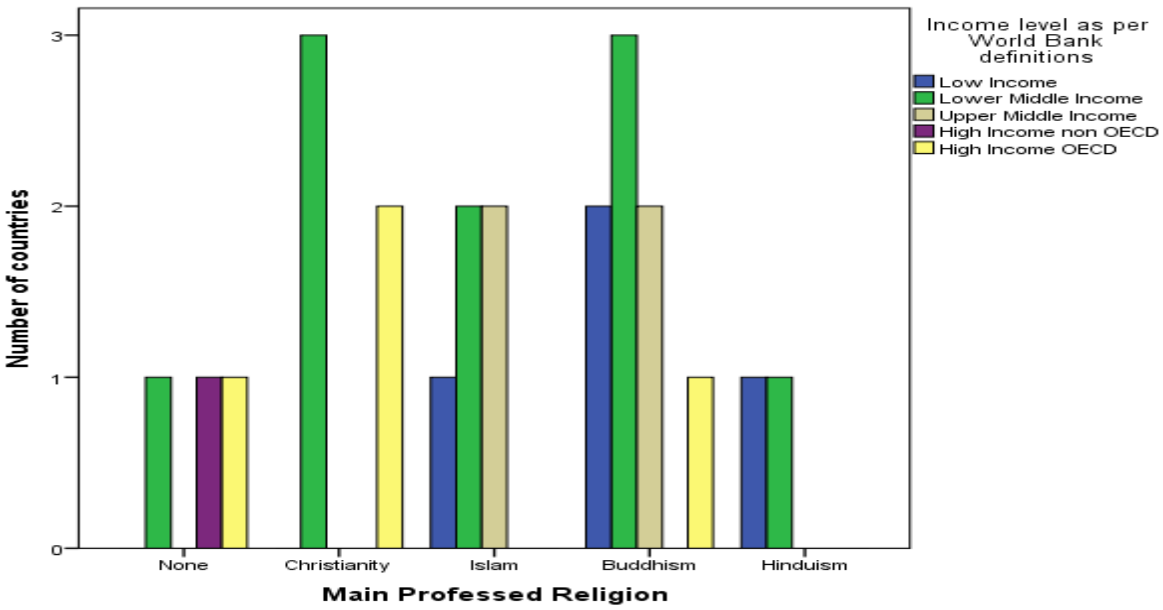

Figure 5: Asia Pacific Countries by Religion and Income Level.

Finally, since the degree of religious commitment may widely vary among people, whether religiosity was associated with HIV prevalence in the Asia Pacific region was tested. As shown in **Figure 6**, as with increase in religiosity there was a slight increase in HIV prevalence; however, the association is not statistically significant ($p > 0.05$, Pearson's Correlation). We then analyzed whether income level might be distorting this likely association. As shown in **Figure 7**, income level was unevenly distributed in the different religiosity groups ($p = 0.002$, chi square test).

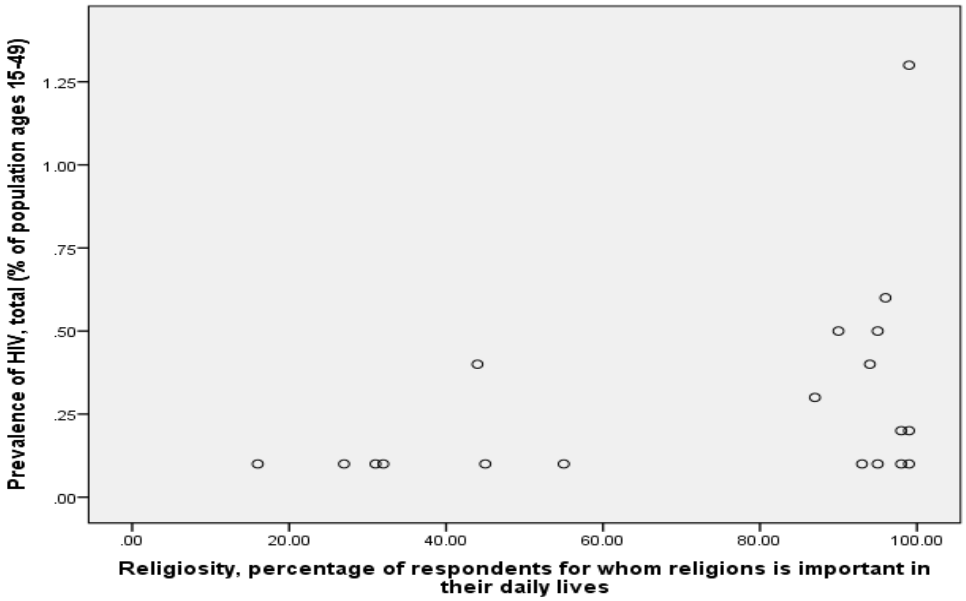

Figure 6: HIV prevalence and Religiosity in Asia Pacific

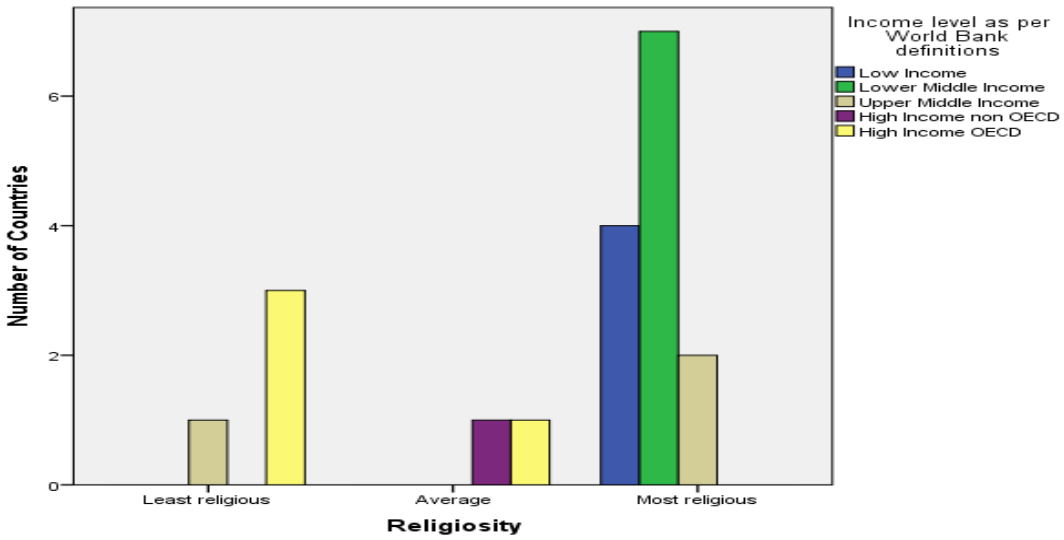

Figure 7: Asia Pacific Countries by Religiosity and Income Level

Correlates of HIV prevalence in Asia Pacific

In order to define what the correlates of HIV prevalence in Asia Pacific were, a two-step approach was followed, including a first attempt to identify strongly correlated variables using Spearman's correlation followed by a multivariate linear regression to account for possible confounder effects of those variables found to be associated with HIV prevalence. Variables from all groups (communications, health system, employment, equity factors and economic indicators) were tested one by one. The only variables that were strongly correlated with HIV prevalence were unemployment ($p = 0.013$) and life expectancy at birth ($p = 0.033$). Additionally, some other variables were more weakly associated with HIV prevalence, namely rural population as a percentage of total population ($p = 0.054$), external resources for health as a percentage of total expenditure on health ($p = 0.065$), proportion of seats held by women in national parliaments ($p = 0.089$) and telephone lines per 100 people ($p = 0.097$).

A linear regression using the two variables strongly associated with HIV prevalence in Asia Pacific region showed that although both variables remained associated with HIV prevalence, unemployment showed a stronger correlation after controlling for life expectancy at birth (**Table 3**).

Table 3: Linear Regression Models of the association between HIV prevalence and its predictors in the Asia Pacific Region.

Variables	Initial Model				Final Model			
	Coefficient	95% CI		P value	Coefficient	95% CI		P value
		Lower	Upper			Lower	Upper	
Unemployment	-0.181	-0.302	-0.060	0.018	-0.145	-0.202	-0.087	<0.001
Religiosity	0.010	0.001	0.019	0.035	0.006	0.003	0.010	0.003
Life expectancy	0.058	-0.072	0.188	0.251	--	--	--	--
Rural population	0.009	-0.004	0.023	0.119	--	--	--	--
Women parliament*	0.034	-0.009	0.077	0.086	--	--	--	--
Telephone Lines	-0.014	-0.058	0.030	0.388	--	--	--	--
External resources for health	-0.047	-0.281	0.186	0.566	--	--	--	--

* Proportion of seats held by women in national parliaments.

For statistical considerations, namely too few data points (i.e. too few countries) another analysis was run with only unemployment and life expectancy. Both variables remained statistically associated to HIV prevalence when included in the same model (data not shown).In that analysis unemployment showed a negative coefficient whereas life expectancy had a positive one. Finally, the concentration index calculated was -0.28.

Discussion

Although HIV epidemics and their driving forces have been thoroughly studied in the Asia Pacific Region, ecological studies aimed at showing differences across countries are scarce. In this study we tried to identify the correlates/predictors of HIV prevalence rates in the countries located in the APR. It is well known that HIV epidemics are shaped by a diversity of interacting factors including social, economic and political forces. (19) These important structural factors should be considered if effective strategies to prevent death and disease burden are to be implemented and succeed. An attempt was made on this paper to better understand what important structural factors might be related to the current state of HIV epidemics in this region of the world.

As described by Wilson and Halperin (Wilson and Halperin, 2008)most of the Asian countries are in a state of concentrated epidemics, with the exception of Thailand, whereas countries in the Pacific region may show concentrated, low-graded generalized or mixed epidemics. Accordingly, we found that out of all countries analyzed only Thailand had a prevalence rate greater than 1% and the second country with highest prevalence rate, Papua New Guinea with 0.90%, is located in the Pacific Region. It has been proposed that HIV epidemics may not only be affected by but also affect economic development. (20) Thus, we tried to identify associations between income level and HIV prevalence rates. It was found that although high income countries had lower prevalence rates and low income countries showed the highest mean prevalence rate, the differences found were not statistically significant.

It is important to notice the great variation in prevalence rates reported in lower and higher middle income countries where Papua New Guinea and Thailand, respectively, had prevalence rates much higher than their counterparts. Nonetheless, differences remained non-significant even when outliers were not considered. It seems very likely that other forces that fall out of the scope of this study, and not only HIV, are responsible for the economic performance of the different countries. These results suggest that income level might have an influence on HIV epidemics but that other important factors are also responsible and should be considered.

The importance of religion in HIV epidemics have also been pointed out by some other authors. (21) It has been proposed that religion and openness of society are important determinants of HIV epidemics, at least in the men who have sex with men subpopulation. (21) We observed that mean prevalence rates were higher in Hindus and Buddhist countries as opposed to those where most people identified themselves as Muslims or Christians ($p > 0.05$).Since the degree of commitment to a particular religious lifestyle may vary among individuals, we then tried to see whether religiosity was associated with HIV epidemics. We found that there seems to be a positive relationship between religiosity and HIV prevalence; i.e. increased prevalence rate with increased religiosity. These results might reflect the fact that more religious communities may have less access to scientific knowledge and data interpretation. However, these results might be distorted by income level as high income countries were in general terms less religious whereas low and middle income were more religious.

Conclusion

Finally, an assessment of how different socioeconomic forces help to shape the current state of HIV epidemics in APR was done which led to the identification of seven factors that were moderately and strongly correlated with HIV prevalence rates; namely, unemployment, religiosity, life expectancy, percentage of rural population, proportion of seats held by women in national parliaments, telephone lines and external resources on health. After controlling for the effects of the other indicators, only unemployment and religiosity remained associated with HIV prevalence. Our results suggest that increasing unemployment figures predict lower HIV prevalence rates (i.e. an inverse association) whereas increasing religiosity would predict increased HIV prevalence rates. The latter has already been discussed. As far as unemployment is concerned the interpretation is much more difficult but one plausible explanation could be that employment in these countries is associated with migration from rural areas to urban slums, where mostly young males live and engage more frequently in risky sexual behavior. Thus, increased employment would be related with increased HIV prevalence and therefore increased unemployment would predict lower prevalence rates.

The present study is, to the best of our knowledge, the first one to investigate the driving forces of the HIV epidemics in the Asia Pacific Region from an across countries perspective

using an ecological study design. The results presented help understand these forces and should ignite further investigation to better comprehend how they are influencing the current state of HIV epidemics. It is worth mentioning that although other important factors such as current efforts to mitigate HIV burden might also affect HIV prevalence rates (i.e. programs, activities, interventions, among others) might as well strongly affect the current epidemic status, there was no data available for these variables on the dataset used for this study. Nonetheless, other direct and indirect indicators of health care access and public/foreign efforts as well as of important structural factors could be used in this analysis. Very importantly, the role of employment/unemployment in the dynamics of HIV epidemics in Asia Pacific should be studied further and with more detail as well as the true role that religion/religiosity plays. In order to do that we need to make use of more powerful study designs like case control or cohort studies. The present study has some limitations inherent to study design (i.e. small number of countries analyzed which in turn limit the robustness of the linear regression models used) and the results should be interpreted in that context, especially one should consider the concept of ecological fallacy.

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