

## Original Research Article

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# Joint modelling of correlated binary outcomes regarding the misconceptions of HIV transmission: a study with reference to the tertiary and vocational education trainees in Sri Lanka

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## ABSTRACT

**Background:** Currently, people infected with HIV are largely discriminated and discredited. Misunderstanding about the mechanism of HIV transmission has been identified as one reason for discrimination. This study assessed the socio-demographic and behavioral risk factors of the two misconceptions about HIV transmission, namely HIV is transmitted by sharing cups and plates with an HIV infected person (Myth 1) and HIV is transmitted by mosquito bites (Myth 2) among the trainees who were selected to the Tertiary and Vocational Education Training (TVET) Centers in Sri Lanka.

**Methods:** This study applied stratified random sampling to select 955 respondents. A self-administered structured questionnaire was used to collect the data. Generalized linear mixed model (GLMM) approach was applied to find the associations between misconceptions about HIV and socio-demographic and behavioral risk factors of the trainees.

**Results:** Level of education of trainees, family relationship, knowledge on sexual and reproductive health (SRH), knowledge about the risk of getting HIV after sexual intercourse, whether the trainee had participated in seminar or workshop on sexually transmitted diseases were identified as the possible factors to detect the knowledge about the misconceptions of HIV transmission.

**Conclusions:** Even though the level of education among different social segments have not revealed remarkable differences in knowledge, the study convinced that the youth should be provided better awareness and education on STD and HIV through countrywide workshops and awareness programmes.

**Keywords:** Correlated binary outcomes, Generalized Linear Mixed model, Joint modeling, HIV/AIDS knowledge, Misconceptions of HIV

## INTRODUCTION

Sri Lanka is still classified as a low prevalent country for HIV in the global context but the number of HIV positive

cases have been slowly rising over the past few years.<sup>1</sup> The incidence of HIV in Sri Lanka gradually increased since 1987 where more males were affected than females. The estimated number of adults and children living with

HIV in Sri Lanka as of 2019 is 3631.<sup>2</sup> In 2019, new 439 HIV cases had been reported to the National STD/AIDS Control Program (NSACP) which is responsible for coordinating, planning and implementing the HIV National Strategic Plan and the AIDS policy in the country.<sup>2</sup> The new HIV infections among youths have shown an upward trend over the last five years. Earlier, it was young adults around 30 and 35 who were susceptible to HIV infection, but now the age has gone down to 20-25. According to the annual trends of reported HIV diagnoses, HIV among females has stabilized over last five years while HIV among males has been increasing. The trend amongst gay/bisexual men is increasing exponentially.<sup>1</sup>

Suffering from HIV in a culture like Sri Lanka generates a high level of stigma towards people living with HIV and many psychological and social effects.<sup>3</sup> The individual loses his social recognition, respect and acceptance. In this part of the globe everything rests in a dichotomy. Those whose characters are unblemished enjoy a high position in the society and the extreme opposite creates serious issues like social marginalization.<sup>4</sup> Saki, Kermanshahi, Mohammadi, Mohraz point out how the AIDS patients suffer from different dimensions of stigma, rejection, and insult that affect the individual him or herself, family, others and finally the society.<sup>5</sup>

Majority of people live with HIV in the African Continent than any other region in the world with so many misconceptions prevalent about HIV and AIDS.<sup>6</sup> Mostly social perceptions depend on numerous factors. When the people are unable to comprehend the scientific basis behind these, it is natural for them to formulate different ideas based on the norms, values, public opinion and speculation. All the Third World countries such as Nigeria, Pakistan, Iran, India have similar cultural characteristics.<sup>4-6</sup> Many rural, uneducated people and even the educated, urban younger generation who do not have an access to the latest knowledge of the sciences tend to live in their own traditional, unknown worlds. Such misconceptions include both genocidal beliefs; e.g. "HIV/AIDS was developed by White people in West to control Black African population" and belief linking to spirits or supernatural forces; e.g. "AIDS is caused by supernatural forces or witchcraft".<sup>6</sup> Further, some African men believe that condoms were infected with "AIDS worms"; and HIV was created by racist Whites and that HIV is put into the lubricant in condoms exported and distributed in Africa.<sup>7</sup> These HIV/AIDS misconceptions may obstruct HIV prevention efforts since they were associated with decreased condom use among African American men.<sup>8</sup>

Since ancient times Sri Lankans, irrespective of their ethnic background, have developed many cultural beliefs and thereby continuing many practices and rituals for the safety of patients. But the same Sri Lankans do not have cultural beliefs, such as illness representation about HIV.

Illness representation, which assign meaning to and explain causes of health outcomes, vary along the dimension of perceived control over an illness – that is, the role of external entities (e.g. spiritual, supernatural) versus internal characteristics (e.g. personal effort, genetics) in controlling health events.<sup>9</sup> The common misconceptions about HIV transmission are HIV infection can be acquired by swimming, sharing meals, shaking hands, casual touch, speaking face-to-face with an infected person and transmission through mosquito bites.<sup>4,10,11</sup>

Knowledge of HIV prevention and misconceptions about HIV transmission among young adults are two important research questions to be addressed. Many studies can be found in Sri Lanka about the knowledge of HIV prevention among the young adults but not much sufficiently addressed the misconceptions of HIV transmission.<sup>3,11-13</sup> Correct knowledge of HIV/AIDS not only requires a person to know about the methods of prevention, but also to know which commonly held beliefs are false. Misconceptions about the risk of HIV transmission through casual social contacts was the strongest predictor of discriminatory attitudes toward person with HIV/AIDS, whereas knowledge about the true main methods of HIV transmission was not associated with these attitudes.<sup>4</sup> Further, perceptions of "immorality" of behaviors related to HIV infection has been reported as another reason for discrimination.<sup>15</sup>

This study considers the young adult school leavers who entered the Technical and Vocational Education and Training (TVET) Centers as trainees. In Sri Lanka, generally students who could not complete formal education up to the general certificate of education: ordinary level (GCE O/L), or could not pass general certificate of education: advanced level (GCE A/L) enter TVET Centers to acquire skills of a certain vocation. Hence, comparatively they have less educational qualifications. Two binary questions related to misconceptions about HIV transmission are considered: whether HIV is transmitted by sharing cups and plates with a person who has HIV/AIDS (myth1) or through mosquito bites (myth2). The objective of the present study is to identify how socio-demographic factors, knowledge based biological/medical factors, intimate relationships among the family members affect the myth 1 and myth 2. We applied generalized linear mixed model (GLMM) approach to model these bivariate responses, myth1 and myth 2, in assessing the socio-demographic and behavioral risk factors of the misconceptions about HIV transmission.<sup>16</sup> Such approach allows for the flexible incorporation of the various correlations in the data and the resulting methodology can be readily implemented using standard statistical packages and software.

It is obvious that the two responses observed from the same respondent are likely to be correlated. Failure to account for such correlations by treating responses from the same respondents as independent may consequently

yield incorrect inferences. Standard errors calculated by incorrectly assuming correlated observations to be independent tend to underestimate the true sampling variability, consequently yielding type I error of significance tests.<sup>17</sup> Hence, joint modelling of two outcomes provides better control over type I error rates in multiple tests and gains in efficiency in the parameter estimates.

## METHODS

This study used the data collected by Tertiary and Vocational Education Commission (TVEC) from the trainees of the TVET sectors. Nine training centers were considered. More than 50,000 trainees enter the TVET sectors annually. Therefore it was decided to conduct the survey for the sample size of 1,000 TVET trainees. The sampling frame was the young adult school leavers who entered the TVET Centers as trainees during the period of 2018 January to 2018 December. Stratified random sampling method was applied to select the sample from the three sectors of Estate, Rural and Urban. Number of respondents in the sample from each sector was decided proportionately according to trainees enrolled in the training programmes at TVEC sectors in year 2018. Hence, 20%, 40% and 40% respondents from the sectors of Estate, Rural and Urban, respectively were selected for the sample.

### **Inclusion criteria**

The study included the trainees of the TVET sectors who were registered in year 2018 and formally consented to take part in the survey.

### **Exclusion criteria**

Exclusion criteria of the study were the trainees of the TVET sectors those who were registered in year 2018 and those who did not formally consent to take part in the survey.

After the formal consent was obtained from the study participants, a self-administered structured questionnaire was used to collect data regarding demographic characteristics, intimate relationship with family members, knowledge on STDs, and knowledge on misconceptions about HIV transmission on respondents. There were personal and sensitive questions in the survey. Therefore, respondent's identification details were not collected. After cleaning the data and excluding the uncompleted questionnaires with respect to the response variables and predictors, 955 questionnaires were considered into the analysis.

### **Measures**

Socio-demographic factors (gender, age in years, education), knowledge based biological/medical factors (knowledge about sexually transmitted diseases (STDs)),

intimate relationships, and whether the respondent has attended seminars or workshops on STDs in the school were considered as covariates in our analysis. The level of Education of the trainee was categorized into four groups: (1) below GCE (O/L) or not passed GCE(O/L) (2) passed GCE (O/L) (3) not passed GCE (A/L) (4) passed GCE (A/L) or above qualification. Respondent's knowledge about the STDs were measured using two binary questions: (1) There is a risk of acquiring STDs even after single sexual intercourse with a person who has STDs (correct/incorrect) and (2) Genital ulcers can be a symptom of STDs (correct/incorrect). Intimate relationship between parents and siblings were measured via two questions: (1) Have you ever discussed sexual health with your parents (never/occasionally/often), and (2) Have you ever discussed sexual health with your siblings (never/occasionally/often). Further, respondents were asked whether he or she has ever attended seminars/workshops on STDs in the school (yes/no).

### **Statistical Model**

Consider the bivariate response, myth1 and myth2 and denote the response vector for the  $i$ th ( $i=1,2,\dots,n$ ) subject by  $Y_i = (Y_{i1}, Y_{i2})^T$  with the responses  $Y_{i1}$  for myth1 and  $Y_{i2}$  for myth2.  $Y_{ij}$  ( $j=1,2$ ) is a binary random variable taking the values 0 or 1 depending on whether response occurs or not, respectively. Let  $X_{i1}$  and  $X_{i2}$  be the vectors of covariates associated with myth1 and myth2, respectively,  $\beta_1$  and  $\beta_2$  are the corresponding vectors of regression coefficients. We assume a set of latent, random effects  $b_i$  are shared by two myths of the same individual. This shared random intercept captures the unobserved factors specific to each individual which may influence the responses and tends account the correlation between the two myths of the same individual. The random intercepts are assumed to vary independently from one individual to another and be normally distributed with zero mean and variance  $\sigma_b^2$ . With the logit transformation, the joint model is given by

$$Y_{i1}|b_i \sim \text{Bernoulli}(\mu_{i1}|b_i), \text{ and } Y_{i2}|b_i \sim \text{Bernoulli}(\mu_{i2}|b_i),$$

$$\mu_{i1}|b_i = \frac{\exp(X_{i1}^T \beta_1 + b_i)}{1 + \exp(X_{i1}^T \beta_1 + b_i)}, \quad \mu_{i2}|b_i = \frac{\exp(X_{i2}^T \beta_2 + b_i)}{1 + \exp(X_{i2}^T \beta_2 + b_i)},$$

$$\text{and } b_i \sim N(0, \sigma^2).$$

The joint responses of an individual are assumed to be independent given the shared random intercept. Significance of parameters were tested using the Wald test statistic. The one limitation associated with the parameter estimates of the above fitted model is, they do not have marginal (population averaged) interpretation. That is, parameters in the joint model have to be interpreted conditional on the random intercept. Following Ghebremichael<sup>16</sup> the logit of the marginal mean can be approximated by

$$\text{logit}(\mu_{ij}) \approx \frac{\mathbf{X}_{ij}^T \boldsymbol{\beta}_j}{\sqrt{1 + c^2 \sigma_b^2}}$$

$$\text{Where, } c = \frac{16\sqrt{3}}{15\pi}$$

and hence the marginal interpretation of the regression parameters can be obtained. Standard errors of the population - averaged parameters can then be obtained using the Delta method. This model is fitted using PROC NLINMIXED in SAS.

## RESULTS

Sixty-two percent of the trainees in the sample were males. They were between 15 to 25 years and the average age was 22 years. Around 12% had studied up to GCE (O/L), 25% had passed GCE (O/L) examination, 52% had sat for the GCE (A/L) examination but not got through and the rest (11%) had passed GCE (A/L) examination or higher educational qualification. Sixty-seven percent of trainees had participated in seminar or workshop on STDs conducted at school. Fifty-one percent of trainees never discussed any matters related to sexual health with their siblings, 41% had occasionally discussed and 8% had discussed with siblings. Similar scores were observed for the trainees regarding whether they discussed matters related to sexual health with their parents. Regarding the awareness of STDs, 25% of males and 39% of females were not aware about the fact that STDs could be acquired even after single sexual intercourse with a

person who has STDs. Further, 37% of males and 51% of females did not believe that genital ulcers could be a symptom of STDs. This implies that males were more aware about above facts of STDs than females (for both facts p value < 0.001). Regarding the misconceptions of HIV transmission, 21% of males and 16% of females endorsed myth1 (a 95% confidence interval for the difference between these two proportions is [-0.005, 0.101]); 29% of males and 26% of females endorsed myth2 (a 95% confidence interval for the difference between these two proportions is (-0.03, 0.09)).

Potential determinants of myth1 and myth2 were identified using the chi-square analysis and all the variables that were found to be significantly associated with myth1 and myth2 at 0.10 levels were included to the joint model: Level of education (Edu), relationship with siblings (Relation\_sibs), knowledge that STDs could be acquired even after single sexual intercourse with a person who has STDs (knowl), and whether the trainee had participated in workshop or seminar on STDs conducted in the school (workshop). For the convenience of model representation, an ANOVA type model representation of conditional mean is given below.<sup>18</sup>

$$(\text{logit}(\mu_{i1}|b_i)) = (\lambda_{01} + \lambda_{i1}^{\text{Edu}} + \lambda_{i1}^{\text{Relation\_sibs}} + \lambda_{i1}^{\text{Knowl}} + \lambda_{i1}^{\text{Workshop}}) + b_i$$

$$(\text{logit}(\mu_{i2}|b_i)) = (\lambda_{02} + \lambda_{i2}^{\text{Edu}} + \lambda_{i2}^{\text{Relation\_sibs}} + \lambda_{i2}^{\text{Knowl}} + \lambda_{i2}^{\text{Workshop}}) + b_i$$

The above model provides parameter estimates conditional on the shared random effect,  $b_i$ . Following Ghebremichael the marginal interpretation of the regression parameters was obtained.<sup>16</sup>

**Table 1: Influencing factors for myth1 and myth2 based on the above model among trainees at TVET sector. parameter estimates are conditional on random intercept while the odds ratios are based on marginal parameter estimates.**

Covariate	Myth 1		Myth 2		Reference category
	Parameter estimate (SE)	OR (95% CI)	Parameter estimate (SE)	OR (95% CI)	
<b>Intercept</b>	-3.002 (0.539)	-	-2.469 (0.441)	-	
<b>Education</b>					
Below GCE (O/L) or not passed GCE (O/L)	1.559 (1.012)	3.348 (0.721, 5.542)	1.226 (0.916)	2.586 (0.645, 10.367)	Passed GCE (A/L) or achieved higher level education
Passed GCE (O/L)	1.605 (0.491)**	3.469 (1.656, 7.266)	0.679 (0.338)*	1.693 (0.942, 3.044)	
Passed GCE (A/L)	0.940 (0.465)**	2.072 (1.024, 4.193)	0.618 (0.354)*	1.615 (0.944, 2.761)	
<b>Relationship with siblings</b>					
Often	-0.794 (0.413)*	0.541 (0.289, 1.011)	-0.075 (0.407)	0.943 (0.508, 1.750)	
Occasionally	-0.097 (0.245)	0.928 (0.639, 1.347)	0.039 (0.216)	1.031 (0.743, 1.432)	Never
<b>Knowledge</b>					
Agree	-0.127 (0.250)	0.906 (0.619, 1.325)	0.473 (0.223)**	0.693 (0.487, 0.986)	Disagree
<b>Participated in workshop or seminar on STDs</b>					
Yes	-0.062 (0.247)	0.953 (0.656, 1.386)	-0.400 (0.226)*	0.733 (0.521, 1.033)	No
Sigma ( $\sigma$ )	1.387 (0.174)**	-			

\*\* significant at 0.05 level, \* significant at 0.10 level

Table 1 shows the results of the above model. The parameter estimates (conditional on the random effect) and odds ratios (OR) along with a 95% confidence interval based on the marginal parameter estimates are reported. The odds of believing myth1 for the trainees who studied up to GCE (O/L) was 3.348 times higher than those trainees who passed GCE (A/L) or above qualification. The odds of believing myth2 for the trainees who studied up to GCE (O/L) was 2.586 times higher than those trainees who passed GCE (A/L) or above qualification. Trainees who often discussed matters related to sexual health with their siblings were less likely to believe myth 1 (OR=0.541) and myth 2 (OR=0.943) than the ones who hardly discussed those matters with siblings. Trainees who are knowledgeable about the way how STDs could be passed from an individual who were affected by STDs to a healthy individual are less likely to believe myth1 (OR=0.906) and myth2 (OR=0.693) than the trainees who did not have sufficient knowledge about how STDs could pass from one individual to another. Trainees who participated in seminars or workshops on STDs in the school lower rates of myth 1 (OR=0.953) and myth 2 (OR=0.733).

## DISCUSSION

Study suggests that (1) trainees who studied up to GCE (O/L), or up to GCE (A/L) but not passed GCE (A/L) were more likely to endorse myth 1 and myth 2 than the trainees who passed GCE (A/L) or higher level education, (2) trainees who discussed matters related to sexual health with their siblings are less likely to believe myth 1 and myth2 than the trainees who never discussed such matters with their siblings, (3) trainees who participated in seminars or workshops on STDs in the school were less likely to endorse myth 1 and myth 2 than those who participated in seminars or workshops on STDs, and (4) trainees who believed that STDs could be acquired even after single sexual intercourse with a person who has STDs are less likely to endorse myth 1 and myth 2 than those trainees who did not believe. Majority of trainees believed myth2 than myth1 (28% and 19%, respectively). Myth2 says HIV can be transmitted through mosquito bites. However, the biological reason why HIV cannot be transmitted through a mosquito bite is, HIV cannot replicate inside the mosquito due to lack of T4 antigen on cell surface.<sup>19</sup> However, people are aware that there is a high concentration of HIV is in the blood stream of the HIV/AIDS infected individual. Hence, they have a misconception that when mosquitos bite there may be a high chance to transmit HIV to the body of another person.

According to our results, the aspects such as gender, ethnic group, and religion of the trainees were not significantly related with myth1 and myth2. Most of the studies showed that age of the respondent is significantly associated with the misconceptions of HIV transmission.<sup>12,14</sup> However, in our study, age of the trainee was not a significant factor to believe

misconceptions about HIV transmission since more or less all the trainees were in the same age group. Even though we classified the respondents under Estate, rural and urban those divisions did not provide different results since all the sectors have an equal access to the fair amount of educational background through which they have obtained the basic ideas of awareness regarding HIV.

In this study, we proposed a joint response model to identify the influencing factors for the misconceptions about HIV transmission among the trainees in TVET sectors. Modelling responses jointly is more appropriate than separate fitting of models that ignore the dependence between myth1 and myth2. The Pearson Chi-square test of independence between myth1 and myth2 was highly significant thereby indicating that the trainees who believed myth 1 were likely to believe myth 2 as well (Chi-square value=42.83, p value <0.0001). This was also concluded by our model since the variance of the random intercept was different from zero ( $\sigma^2=1.387$ , p value <0.0001).

The study has several strengths compared to previous studies. First, the correlation between two misconceptions about HIV was taken into consideration in our analytic approach thereby yielding unbiased estimates. Second, although the joint model parameters have conditional interpretation on random effects, following Ghebremichael we obtained marginal parameters estimates and hence marginal odds ratios.<sup>16</sup> Third, the method we proposed can easily be extended to more than two responses. Fourth, our study covered a large population based-study, enhancing its generalizability to all the trainees in TVET sectors in Sri Lanka. Similar study is conducted under the demographic and health survey, Sri Lanka in 2016, but it was limited to ever-married women aged 15 to 49.<sup>11</sup>

Though, our study includes the trainees within the age range of 15 to 25 years youth, our results cannot be generalized for all the youth in Sri Lanka in this age group, since we collected the information only from the youth who were in TVET sectors. This is one of main limitations in the study.

## CONCLUSION

The following conclusions have been derived from the results of the study: (1) it concludes that the level of education is a crucial factor in believing misconceptions of HIV, (2) it deduces the fact that the sharing of experiences and open and comfort discussions especially among the closest peers and colleagues have a pivotal impact on not believing the myths of HIV, (3) it is highlighted that the insight created through accumulated awareness by participating in public awareness programs on STDs diminish the credulity of HIV misconceptions and (4) modelling the responses jointly is more

appropriate than separate fitting of models that ignore the dependence between the two myths.

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