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RESEARCH ARTICLE

Association between HIV-related knowledge and attitudes towards persons living with HIV in northern Kosovo: the quantile regression approach

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Abstract

Knowledge about HIV and level of HIV-related stigma have been considered the main indicators of the community's readiness to combat and bring the HIV epidemic to an end. Of all Serbia, the northern Kosovo province is especially vulnerable to the HIV spread because the infrastructure and the entire regulatory system had to be rebuilt after the ethnic conflict. The study objective was to examine the association between HIV-related knowledge level and attitudes towards people living with HIV (PLHIV) among university students from northern Kosovo using the quantile regression. A total of 1,017 students filled in an anonymous questionnaire. The questionnaire examined socio-demographic characteristics, HIV-related knowledge, attitudes towards PLHIV, sources of information about HIV, past experiences with PLHIV, and health behaviours. The dependent variable in the model was the attitude score (ATS) divided into quantiles (Q) in quantile regression analysis: Q0.10, Q0.25, Q0.50, Q0.75, and Q0.90. The independent variable was the knowledge score (KNS). The model was adjusted for relevant covariates. The majority of students had adequate HIV-related knowledge (89.6%) and 10.4% had lower knowledge. Most students also had a positive attitude (83.9%), while 16.1% were indecisive towards PLHIV. No students exhibiting wrong knowledge and negative attitudes were observed. The KNS and ATS significantly correlated with one another ($\rho = 0.383$; $p = 0.001$). The quantile regression model adjusted for variables associated with both KNS and ATS showed a negative association between KNS and ATS in the lowest quantile (Q0.10) of the ATS. In all other quantiles (Q0.25–Q0.90), a higher KNS was associated with having stronger positive attitudes towards PLHIV. This study confirmed that higher knowledge about HIV was associated with stronger positive attitudes towards HIV. Still, some students remain indecisive despite being knowledgeable about HIV. These students could benefit the most from continuing educational programmes to reduce the HIV-related stigma.

Keywords: HIV; knowledge; attitude; students; quantile regression

Introduction

Knowledge about HIV and level of HIV-related stigma has been considered the main indicators of the community's readiness to combat and bring the HIV epidemic to an end (National AIDS Trust, 2014; Burke, Fleming, & Guest, 2014; Plantin, Wallander, & Mannheimer, 2015). Thus far, it has been well-acknowledged that poor HIV-related knowledge gives way to the stigmatisation of people living with HIV (PLHIV) (National AIDS Trust, 2014; Shamu *et al.,* 2020; Genberg *et al.,* 2009; Gurmu & Etana, 2015). Contrary, higher knowledge level could motivate individuals to have positive attitudes and become more tolerant and supportive of people or peers in that community (Godin *et al.,* 2008; Godin & Kok, 1996; Fabrigar, Petty, Smith, & Crites, 2006; Baartman & de Bruijn, 2011). Studies examining the effectiveness of stigma reduction programmes aiming to increase the knowledge about HIV suggest that the transformation of attitudes towards PLHIV often develops along with the rise of HIV-related knowledge (Mak, Mo, Ma, & Lam, 2017; Sengupta *et al.* 2011). These findings support the Theory of Planned Behavior, according to which changes in attitudes are associated with changes in (health) behaviours (Godin, Belanger-Gravel, Eccles, & Grimshaw, 2008; Godin & Kok, 1996). Moreover, the effects of such programmes are far-reaching when coupled with other strategies, such as the inclusion of PLHIV in the communities (Mak *et al.,* 2017; Sengupta, Banks, Jonas, Miles, & Smith, 2011).

In addition to knowledge, previous studies found that factors associated with stronger positive attitudes towards PLHIV include older age, female gender, better social status, positive attitude, and tolerance towards key populations at increased risk of acquiring HIV (sex workers, injecting drug users, and gays and lesbians) and less frequent risky behaviours (Stephenson, 2009; Kingori, Nkansah, Haile, Darlington, & Basta, 2017; Korhonen, Kylma, Houtsonen, Valimaki, & Suominen, 2012; Adrien, Beaulieu, Leaune, Perron, & Dassa, 2013).

Of all countries in Southeastern Europe, Serbia still has the highest incidence of HIV (Cousins, 2018). Of all Serbia, the northern Kosovo province is especially vulnerable to HIV spread because the infrastructure and the entire regulatory system had to be rebuilt after the ethnic conflict between Serbs and Albanians. Due to the fact that the ethnic tensions are still ongoing, foreign military and non-governmental organisations continue to be present in this region. These circumstances favour migrations, unemployment, access to affordable psychoactive substances and alcohol, and the development of sex industry which enables the spread of HIV (Institute for Students' Health Care, 2020; Institute of Public Health of Serbia, 2017). Even though the available records suggest that the HIV epidemic is not that extensive in Kosovo, high-risk groups (men who have sex with men, sex workers, and injecting drug users) still acquire HIV 5 times more often than people in the general population (>5% vs. <1%) (Romanian Harm Reduction Network, 2006).

Moreover, over the past 2 decades, the incidence of newly diagnosed PLHIV has been rising among young adults aged 20–29 years (Institute for Students' Health Care, 2020; Institute of Public Health of Serbia, 2017). This age corresponds to the age of university student population, which suggests that people in this population group are not as aware of HIV in-depth as they should be. This renders the research about knowledge and attitudes towards PLHIV in university student population relevant in order to understand the problem and improve prevention and educational strategies for young adults.

While previous studies examined the association between HIV-related knowledge level and attitudes towards HIV (Kingori *et al.,* 2017; Korhonen *et al.,* 2012; Nubed & Akoachere, 2016; Thanavanh, Harun-Or-Rashid, Kasuya, & Sakamoto, 2013), there is a lack of studies which adopted less conventional analytical approaches. Quantile regression is generally rarely used in HIV research (Shim & Kim, 2020) and not once to assess the association between knowledge about HIV and attitudes towards PLHIV. Nevertheless, the application of quantile regression could allow for a more detailed investigation of the dynamics between these two aspects in HIV research and discriminate in which population group interventions could be more or less effective.

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The study objective was to examine the association between HIV-related knowledge level and attitudes towards PLHIV in a sample of university students from the northern Kosovo province using the quantile regression approach.

Methods

Setting

The study was carried out during the summer semester (February to June) of the academic year 2013–2014 at the University of Pristina temporarily seated in Kosovska Mitrovica, northern Kosovo province. The University of Pristina temporarily seated in Kosovska Mitrovica is the only educational institution in Kosovo that provides high education in Serbian language. The University encompasses 10 schools: health care (medicine, dentistry, and nursing), art, economy, law, natural sciences (biology, geography, mathematics, physics, and chemistry), technical sciences (technology, construction, and engineering), social sciences (philosophy, sociology, psychology, and languages), agriculture, sports, and pedagogy. University teaching activities and curricula correspond to those in the Republic of Serbia as the Serbian ethnic group (roughly 30,000) predominantly settles in the town of Kosovska Mitrovica. All ten schools that comprise the University with more than 5,000 undergraduate students were included in the study.

Participants

Students attending the first and fourth study year were invited to participate in the study. All 10 schools within the University were listed in alphabetical order and contacted by the researchers to arrange for the time of questionnaire distribution. Recruitment of students was carried out during mandatory lessons on two working days (Mondays and Thursdays) that were randomly chosen (picking papers with printed days of the week from a bag) to distribute the questionnaires. The time period in which the survey was organised was one week per school. All mandatory lectures scheduled for the survey day, within each school, were included. Participants were approached in all available classrooms as classrooms were considered optimal location to take the survey, because students were able to fill in the questionnaires privately on their own seat without being disturbed. The questionnaires were distributed after the compulsory classes had ended, while students were still in the classroom. Study authors provided a detailed explanation about the study and the questionnaire, highlighting that the survey was anonymous and voluntary. Students who did not want to participate in the study were free to leave the classrooms after the lecture had ended. At least one of the researchers was present in classrooms all the time in case students had any questions. After giving their informed consent to participate, the students completed the questionnaire anonymously. Because presence in the lessons was mandatory, researchers were able to include virtually all students from the respective classes.

A total of 1,225 students were invited to take part in the survey. A total of 82.02% responded and filled in the questionnaire. The study sample represented approximately 28.9% of all 3,524 first- and fourth-year students at the University. The informed consent for participation was obtained prior to taking the survey. Ethical approval was granted by the Ethics Committee of the School of Medicine, University of Pristina, temporally seated in Kosovska Mitrovica (Approval No. 09-1608-1, issued on October 29, 2013) (Milic *et al.,* 2021a; Milic *et al.,* 2021b).

Instrument

A questionnaire derived from the project 'Strengthening HIV Prevention and Care for the Groups Most Vulnerable to HIV/AIDS' (Grant no. SER-809-G04-H and SER-809-G05-H; project funder the Global Fund for the Fight against AIDS, Tuberculosis and Malaria) (UNAIDS, 2014; The Global Fund, 2019; Ministry of Health of Serbia, 2013) was used to collect relevant data. The

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questionnaire was adapted to suit the student population by adding several questions about the place of residence while attending university, going to nightclubs, and consumption of alcohol and use of illicit drugs.

Items were grouped according to clusters that logically related to one another. The first part was focused on students' socio-demographic data (six items). The second part examined specific sources of information that students had used to learn about HIV (six items).

The third part explored students' knowledge about HIV transmission. Possible answers to all 14 items were 'yes', 'no', and 'I do not know' and students were asked to circle only one answer per item. The answers about HIV-related knowledge were scored so as to obtain one summary score. One point was assigned to each incorrect answer, two points were assigned for being unsure and three points were assigned to each correct answer. The knowledge score (KNS) varied from a minimum of 14 to a maximum of 42, with higher scores indicating a better knowledge about HIV. KNS was categorised as wrong knowledge (all incorrect answers, KNS = 14), low knowledge (most unsure answers), and adequate knowledge (KNS≥28; most correct answers).

The following sections of the questionnaire examined different positions and experiences with HIV and PLHIV such as whether students had previously taken the HIV test, student's interest in being tested for HIV, and self-perceived risk for contracting HIV. Furthermore, the students were asked whether they previously had contact with PLHIV and whether they would change the level of contact after learning about one's HIV status. Additionally, students were asked about their opinion on high-risk groups for contracting HIV (persons who inject drugs, gays and lesbians, and sex workers).

The next part explored students' attitudes towards PLHIV. Possible answers to all 17 items were 'I agree', 'I do not agree', and 'I am not sure'. Only one answer could be circled for each item. One point was assigned for expressing negative feelings, two points for not being sure what to think or feel, and three points were assigned for expressing positive attitude to PLHIV. By summing each point for the 17 items in this part of the questionnaire, the Attitude score (ATS) was obtained. The ATS values ranged from 17 to 51. Higher scores indicated a stronger positive attitude towards PLHIV. ATS was categorised as negative (all negative feelings, ATS = 17), indecisive (most unsure feelings), and positive (ATS≥35; most positive feelings).

The final part of the questionnaire examined whether the students engaged in health risk behaviours: going to nightclubs; consumption of alcohol; illicit drug/opioid use; number of sexual partner in the past 12 months; condom use at last sex; condom use with casual (non-committed) partner; and having sexually transmitted diseases in the past 12 months (Milic *et al.,* 2021a; Milic *et al.,* 2021b).

Statistical analysis

Data distribution was estimated using the Kolmogorov-Smirnov test. Variance analysis (ANOVA) and the Kruskal-Wallis-KW χ^2 test were used to test the differences between the continuous and the categorical descriptive variables. The correlation between the variables (questionnaire items) was tested by Spearman's correlation coefficient.

To examine the association of HIV knowledge (continuous knowledge score) with attitudes towards PLHIV (continuous attitude score), the quantile regression analysis was performed. The quantile regression provides a more comprehensive analysis of the independent variables at different points of the conditional distribution of the outcome variable. This means that several separate linear regressions are performed for each quantile of the distribution of the dependent variable. The dependent variable (outcome), ATS, was divided into the following quantiles (Q) in quantile regression analysis: Q0.10, Q0.25, Q0.50, Q0.75, and Q0.90. The independent variable (exposure) was the KNS.

First, the univariate, unadjusted model was tested to examine the association between KNS and ATS. Then, univariately all the covariates (i.e. items collected by the questionnaire) were tested.

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Each covariate presented an independent variable and dependent variables were ATS and KNS, respectively. Finally, models were adjusted for parameters that showed univariate association with both the exposure (KNS) and the outcome (ATS). All statistically significant ($p < 0.05$) or marginally significant ($p < 0.25$) variables were included in the final model (gender, age, field of study, having paid work during schooling, interest in taking the HIV test, previous contact with PLHIV, contact after knowing one's HIV status, self-perceived risk for HIV, and opinion about gays and lesbians). Quantile regression analysis was performed in Stata 14 software. All other analyses were done in SPSS, version 21.

Results

The study included 1,017 students, out of which 44.6% were male and 55.4% female, 30.3% studied health-related disciplines, and 62.3% were in the first faculty year. The mean ± standard deviation (SD) age of examined students was 21.3 ± 3.5 years. Description of the study population is presented in Tables 1 and 2.

Knowledge about HIV and attitudes towards PLHIV

The mean ± SD KNS of students was 32.8 ± 3.3. The majority of students (89.6%) had adequate knowledge, while only 10.4% demonstrated low HIV-related knowledge. In this study, there were no students who had wrong HIV-related knowledge. The mean ± SD ATS of students was 39.07 ± 4.45. The majority of students (83.9%) had a positive attitude, while 16.1% were indecisive towards PLHIV. In the study sample, none of the students had a negative attitude towards PLHIV.

The observed KNS and ATS significantly correlated with one another ($\rho = 0.383$; $p = 0.001$). Students who had positive attitude towards PLHIV also more often had adequate HIV-related knowledge.

Significant differences in ATS groups were registered for all items included in the KNS except for item regarding HIV transmission from mother to child (Table 3). On the other hand, there were no significant differences in five out of 17 items included in ATS according to KNS groups. Namely, among students with low and adequate knowledge, no significant difference was observed in the attitude regarding the need for better treatment of persons who were infected with HIV through transfusion, the need for free HIV medications, public disclosure of HIV status of family member, and paying for sex (Table 4). However, students with adequate HIV-related knowledge more often had a positive attitude towards PLHIV compared to those with lower HIV-related knowledge. Students with adequate HIV-related knowledge correctly disagreed with the statements that people infected with HIV deserved it, that people should not communicate with PLHIV, that HIV/AIDS is not a health problem in Serbia, and that only injecting drug users, gays and lesbians, and sex workers have HIV. They also did not support the attitudes that children should be separated from HIV-positive parents, that PLHIV should be isolated at work and children in schools, that HIV testing should be mandatory by law, that all employees have the right to know whether their colleague has HIV, and that employers have the right to fire PLHIV. On the other hand, students with adequate HIV-related knowledge compared to those with lower knowledge were more likely to agree with the attitude that PLHIV should have the same rights as healthy people and that they would care for a family member with HIV, but they were indecisive about the statement that they would not worry about their health if a colleague had HIV (Table 4).

Results of the quantile regression

Through the use of quantile regression, it was observed that the exposure to a higher KNS modifies and reshapes the distribution of ATS, i.e. whether exposure effects are consistent across quantiles. In this way, deeper and extended quantitative evidence on the association of KNS and ATS was

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Table 1. Characteristics of Investigated Students

Parameters		Number	Percent	*p* between categories
Sex	Male	454	44.6	0.001
	Female	563	55.4	
School groups	Health-related	308	30.3	0.001
	Others	709	69.7	
Study year	First I	634	62.3	0.001
	Fourth IV	383	37.7	
Additional activities	Works and studies	59	5.8	0.001
	Just student	958	94.2	
Relationship status	Single	470	46.2	0.001
	In a relationship	477	46.9	
	Living with partner	9	0.9	
	Married	61	6.0	
Relationship category	Single	470	46.2	0.016
	Coupled	547	53.8	
Accommodation during schooling	Student dormitory	283	27.8	0.001
	Rented apartment	311	30.6	
	In his/her own home	130	12.8	
	With parents	293	28.8	
Receiving special education on HIV	Yes	297	29.2	0.001
	No	720	70.8	
Has been tested for HIV before	Yes	55	5.4	0.001
	No	962	94.6	
Testing attitude	Knows where to test	375	36.9	0.001
	Knows where to ask	346	34.0	
	Cannot be done here	30	2.9	
	Not interested	266	26.2	
Self-assessment of risk for HIV infection	Very high	35	3.4	0.001
	High	51	5.0	
	Do not know	194	19.1	
	Low	251	24.7	
	Very low	486	47.8	
Previous contact with an HIV+	Had contact	37	3.6	0.001
	No verified contact	980	96.4	
Interactions with HIV+ persons	Not sure what to do	208	20.5	0.001
	Stop the contact	98	9.6	
	Less contact	277	27.2	
	Same contact	434	42.7	

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Table 2. Opinion about HIV High-Risk Groups and Risky Behaviours of Students

Parameters		Number	Percent	*p*
Opinion about persons who use drugs	Positive	232	22.8	0.001
	Negative	651	64.0	
	Indifferent	134	13.2	
Opinion about gays and lesbians	Positive	319	31.4	0.001
	Negative	508	50.0	
	Indifferent	190	18.7	
Opinion about sex workers	Positive	335	32.9	0.001
	Negative	431	42.4	
	Indifferent	251	24.7	
Clubbing	Every night	35	3.4	0.001
	Couple of times/week	164	16.1	
	During weekends	600	59.0	
	Does not go clubbing	218	21.4	
Alcohol	Drinks until drunk	65	6.4	0.001
	Drinks moderately	663	65.2	
	Does not drink	289	28.4	
Opioids (drugs)	Use	47	4.6	0.001
	No use	970	95.4	
Number of sex partners last year	More than one	265	26.1	0.001
	One or less	752	73.9	
Condom use with a casual partner	Always	395	38.8	0.001
	Sometimes	180	17.7	
	Only with new partner	67	6.6	
	Never	53	5.2	
	Does not have sex	322	31.7	
Condom use at last sex	Yes	380	54.8	0.012
	No	314	45.2	
	Does not have sex	322	31.7	
STDs last year	Yes – had	32	3.2	0.001
	No – did not have	985	96.9	

obtained and compared to the conventional analysis based on mean values that may miss, underestimate, or overestimate the effect of input factors on the tail of the distribution. In this way, it was determined which groups of students can benefit the most from health promotion interventions. In the unadjusted quantile regression model, a positive association between KNS and ATS was observed across all quantiles (Q0.10–Q0.90) (Table 5). However, in the adjusted quantile regression model, a negative association between KNS and ATS was observed in the lowest quantile (Q0.10) of the ATS. This may suggest that students who had a higher level of knowledge about HIV also felt paradoxically indecisive towards PLHIV. In all other quantiles

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Table 3. Differences in Items Comprising Knowledge Score in Regards to Attitude Score

		Attitude score groups					
		Indecisive		Positive			
Parameters		Number	%	Number	%	χ^2	p
Transmission via hand shaking	Correct	10	6.1	17	2.0	46.049	0.001
	Do not know	34	20.7	55	6.4		
	Not correct	120	73.2	781	91.6		
Transmission via sexual intercourse	Correct	4	2.4	6	0.7	9.071	0.011
	Do not know	6	3.7	11	1.3		
	Not correct	154	93.9	836	98.0		
Transmission via sharing personal hygiene products	Correct	100	61.0	510	59.8	6.977	0.031
	Do not know	37	22.6	137	16.1		
	Not correct	27	16.5	206	24.2		
Transmission via sharing cutlery	Correct	61	37.2	160	18.8	31.732	0.001
	Do not know	41	25.0	200	23.4		
	Not correct	62	37.8	493	57.8		
Transmission via intravenous drugs equipment	Correct	136	82.9	793	93.0	18.673	0.001
	Do not know	22	13.4	42	4.9		
	Not correct	6	3.7	18	2.1		
Transmission via insect bites	Correct	40	24.4	204	23.9	10.128	0.006
	Do not know	72	43.9	276	32.4		
	Not correct	52	31.7	373	43.7		
Transmission via swimming in pools, sea, or rivers	Correct	14	8.5	22	2.6	39.043	0.001
	Do not know	56	34.1	156	18.3		
	Not correct	94	57.3	675	79.1		
Transmission via sharing room	Correct	15	9.1	12	1.4	57.297	0.001
	Do not know	36	22.0	79	9.3		
	Not correct	113	68.9	762	89.3		
HIV vaccination exists	Correct	35	21.3	98	11.5	24.187	0.001
	Do not know	57	34.8	212	24.9		
	Not correct	72	43.9	543	63.7		
HIV+ person is easy to recognise	Correct	25	15.2	60	7.0	20.855	0.001
	Do not know	52	31.7	198	23.2		
	Not correct	87	53.0	595	69.8		
Just one healthy partner equals no risk	Correct	35	21.3	233	27.3	12.581	0.002
	Do not know	47	28.7	145	17.0		
	Not correct	82	50.0	475	55.7		

(*Continued*)

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Table 3. (*Continued*)

Parameters		Attitude score groups				χ^2	p
		Indecisive		Positive			
		Number	%	Number	%		
HIV+ mother can have an HIV– child	Correct	40	24.4	250	29.3	5.201	0.074
	Do not know	74	45.1	305	35.8		
	Not correct	50	30.5	298	34.9		
Current therapy significantly extends life	Correct	32	19.5	81	9.5	36.854	0.001
	Do not know	73	44.5	253	29.7		
	Not correct	59	36.0	519	60.8		
Washing hands reduces risk of HIV infection	Correct	49	29.9	195	22.9	34.249	0.001
	Do not know	72	43.9	227	26.6		
	Not correct	43	26.2	431	50.5		
Knowledge score group	Low knowledge	48	29.3	58	7.1	74.379	0.001
	Adequate know	116	70.7	795	92.9		

(Q0.25–Q0.90), a higher KNS was associated with having stronger positive attitudes towards PLHIV with the strongest association in Q25 and Q50. Not being interested in HIV testing or not knowing that testing is possible in Kosovo was associated with less supportive attitudes towards PLHIV, and the magnitudes of these associations were higher at lower quantiles compared to higher ones. One's position to stop the contact after learning one's HIV-positive status was associated with less supportive attitudes towards PLHIV across all quantiles (Q0.10–Q0.90). As the students' position changed from stopping contact after knowing one's HIV status to reducing contact and then maintaining the same level of contact, in the same way, the coefficient B gradually changed from a negative (smaller magnitudes of association) to a positive one, significantly in the Q25 and Q50 quantiles (Table 6).

Discussion

The quantile regression approach applied in this study has not previously been used to examine the influence of HIV-related knowledge on attitudes towards PLHIV. The quantile regression is commonly considered a versatile method to inform researchers about complex relationships between various factors (Lachos *et al.,* 2015). It is especially useful in studies where outliers may arise, because it is resistant to their influence. Quantile regression can provide a deeper insight into rather weak or nonlinear associations as it models the entire conditional distribution. For this reason, the results of this study add novelties to the body of evidence about this relationship, particularly regarding the lowest and highest quantiles of the attitude score.

Evidence suggests that the increasing level of knowledge about HIV leads to the development of positive attitudes towards PLHIV as well as reduction of HIV-related stigma and discrimination (Nubed & Akoachere, 2016; Thanavanh *et al.,* 2013; James & Ryan, 2018; Mahajan *et al.,* 2008; Herek, Capitanio, & Widaman, 2002). The observed quantile regression model surprisingly showed that having higher knowledge about HIV was associated with indecisiveness, i.e. hesitant attitudes towards PLHIV in the lowest quantile of the ATS distribution. Increasing level of HIV-related knowledge, however, was associated with stronger positive attitudes in all other quantiles, especially in the Q25 and Q50. Based on these findings, it can be anticipated that the introduction

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Table 4. Differences in Items Comprising Attitude Score in Regards to Knowledge Score

		Knowledge score groups					
		Low knowledge		Adequate knowledge			
Parameters		Number	%	Number	%	χ^2	p
People with HIV are infected because they deserved it	Agree	6	5.7	47	5.2	15.066	0.001
	Disagree	70	66.0	736	80.8		
	Not sure	30	28.3	128	14.1		
Children should be removed from HIV + parents	Agree	58	54.7	189	20.7	68.527	0.001
	Disagree	19	17.9	480	52.7		
	Not sure	29	27.4	242	26.6		
People with HIV have same rights	Agree	86	81.1	830	91.1	10.681	0.005
	Disagree	8	7.5	35	3.8		
	Not sure	12	11.3	46	5.0		
Persons infected by transfusion deserve better treatment	Agree	34	32.1	321	35.2	5.238	0.073
	Disagree	39	36.8	395	43.4		
	Not sure	33	31.1	195	21.4		
Only injecting drug users, gays and lesbians, and sex workers have HIV	Agree	29	27.4	124	13.6	24.994	0.001
	Disagree	49	46.2	636	69.8		
	Not sure	28	26.4	151	16.6		
Employers have right to fire HIV + persons	Agree	41	38.7	125	13.7	60.107	0.001
	Disagree	27	25.5	550	60.4		
	Not sure	38	35.8	236	25.9		
All medications for HIV should be free	Agree	64	60.4	587	64.4	1.436	0.488
	Disagree	21	19.8	140	15.4		
	Not sure	21	19.8	184	20.2		
Testing for HIV should be mandatory by law	Agree	76	71.7	562	61.7	6.591	0.037
	Disagree	10	9.4	176	19.3		
	Not sure	20	18.9	173	19.0		
HIV + should not go to the same school with HIV− children	Agree	54	50.9	171	18.8	67.042	0.001
	Disagree	21	19.8	496	54.4		
	Not sure	31	29.2	244	26.8		
I would not worry for my health if colleague had HIV	Agree	25	23.6	344	37.8	11.267	0.004
	Disagree	48	45.3	282	31.0		
	Not sure	33	31.1	285	31.3		
All employs have right to know if their colleague has HIV	Agree	82	77.4	612	67.2	4.593	0.101
	Disagree	12	11.3	141	15.5		
	Not sure	12	11.3	158	17.3		

(*Continued*)

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Table 4. (*Continued*)

Parameters		Knowledge score groups: Low knowledge Number	Low knowledge %	Adequate knowledge Number	Adequate knowledge %	χ^2	p
HIV + people should be isolated	Agree	44	41.5	115	12.6	71.658	0.001
	Disagree	30	28.3	577	63.3		
	Not sure	32	30.2	219	24.0		
I would take care of a family member with HIV	Agree	70	66.0	714	78.4	8.516	0.014
	Disagree	16	15.1	79	8.7		
	Not sure	20	18.9	118	13.0		
I don't want people to know if my family member had HIV	Agree	49	46.2	350	38.4	3.664	0.161
	Disagree	24	22.6	282	31.0		
	Not sure	33	31.1	279	30.6		
I do not want to communicate or contact people living with HIV	Agree	33	31.1	123	13.5	29.442	0.001
	Disagree	40	37.7	558	61.3		
	Not sure	33	31.1	230	25.2		
Paying for sex is acceptable	Agree	30	28.3	172	18.9	5.662	0.059
	Disagree	58	54.7	587	64.4		
	Not sure	18	17.0	152	16.7		
HIV/AIDS is not a health problem in this country	Agree	19	17.9	145	15.9	8.158	0.017
	Disagree	44	41.5	505	55.4		
	Not sure	43	40.6	261	28.6		

Table 5. Quantile Regression Model: Association between Knowledge Score about HIV and Attitude Score Towards People Living with HIV-Unadjusted Model

Attitude score	$Q_{0.10}$ *B*	$Q_{0.10}$ 95%CI	$Q_{0.25}$ *B*	$Q_{0.25}$ 95%CI	$Q_{0.50}$ *B*	$Q_{0.50}$ 95%CI	$Q_{0.75}$ *B*	$Q_{0.75}$ 95%CI	$Q_{0.90}$ *B*	$Q_{0.90}$ 95%CI
Knowledge score	**0.56****	0.40, 0.71	**0.59****	0.46. 0.72	**0.60****	0.50, 0.70	**0.57****	0.47, 067	**0.40****	0.27, 0.53
Constant	15.44	10.34, 20.55	**17.24****	13.07, 21.40	19.80	16.52, 23.08	23.29	19.90, 26.67	**31.00****	26.80, 35.20

of specialised educational programmes about HIV could have the greatest effect among people who have indecisive attitude (those distributed around the middle quantiles of the ATS) as well as among people who already had positive attitudes towards PLHIV. In efforts to reduce the HIV-related stigma, knowledge about HIV seems to be the most important contributor, although the direction and the strength of the association between these two factors may be strongly influenced by social factors (Stephenson, 2009; UNAIDS, 2014; Earnshaw *et al.,* 2012). The most successful interventions aiming to reduce the HIV-related stigma included both individual (changes of knowledge and behaviour) and community-level activities (supporting women's role in a society) (Thapa *et al.,* 2018). Therefore, the role of university students who could be actively involved in the activities that promote tolerance and inclusion of PLHIV as well as prevention of HIV should be emphasised.

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Table 6. Quantile Regression Model: Association between Knowledge Score about HIV and Attitude Score Towards People Living with HIV-Adjusted Model

	$Q_{0.10}$		$Q_{0.25}$		$Q_{0.50}$		$Q_{0.75}$		$Q_{0.90}$	
Attitude score	*B*	95%CI	*B*	95%CI	*B*	95%CI	B	95%CI	*B*	95%CI
Knowledge score	**−0.39****	0.23, 0.55	**0.36****	0.24. 0.47	**0.34****	0.25. 0.42	**0.30****	0.21. 0.39	**0.27****	0.15. 0.38
Gender Female vs. male	0.54	−0.60, 1.67	**1.00****	0.18. 1.81	0.30	−0.31, 0.90	−0.48	−1.12, 0.17	**−1.02****	1.83, −0.20
Age	0.11	−0.10, 0.31	0.06	−0.09, 0.21	**0.11***	0.00, 0.22	**0.16****	0.05, 0.28	0.02	−0.13, 0.17
Field of study Other vs. healthcare	−0.93	−16.54, 14.68	−2.35	−13.52, 8.83	−5.32	−0.83. 0.56	−7.05	−15.95. 1.86	**−12.68***	−23.98, −1.39
Paid work No vs. yes	0.40	−1.97, 2.78	0.25	−1.45, 1.96	0.73	−13.65, 3.01	**1.39***	0.04, 2.75	−0.63	−2.35, 1.09
Interest in taking the test for HIV										
Knows where to take it Reference										
Knows whom to ask	0.11	−1.07, 1.28	−0.13	−0.97, 0.71	−0.59	−1.21, 0.04	−0.31	−0.98, 0.36	−0.17	−1.01, 0.68
Test not available	**−5.46****	−8.36, −2.55	**−4.00****	−6.09, −1.92	**−2.28****	−3.83, −.73	**1.92***	−3.58, −0.26	**−3.48****	−5.58, −1.37
Not interested	**−1.53****	−2.81, −0.24	**−1.69****	−2.61, −0.77	**−1.26****	−2.54, −1.17	**−1.34****	−2.08, −0.61	−0.50	−1.43. 0.44
Previous contact with persons living with HIV										
No vs. yes	0.39	−2.27, 3.05	0.64	−1.26, 2.55	−9.65	−1.42, 1.42	0.59	−2.11, 0.93	0.44	−1.49, 2.36
Self-perceived risk for HIV										
Very high Reference										
High	−0.27	−3.67, 3.13	−0.26	−2.69, 2.17	0.10	−1.71, 1.92	0.23	−1.71, 2.17	0.17	−2.29, 2.63
Do not know	0.96	−1.90, 3.81	−0.99	−1.06, 3.03	0.49	−1.03, 2.01	0.13	−1.49, 1.76	1.01	−1.05, 3.08
Low	1.80	−1.04, 4.64	1.93	−0.10, 3.96	1.25	−0.27, 2.76	0.86	−0.76, 2.48	1.18	−0.88, 3.23
Very low	0.96	−1.79, 3.71	1.19	−0.77, 3.16	0.97	−0.50, 2.43	0.91	−0.66, 2.47	0.99	−1.00, 2.98

(*Continued*)

Table 6. (*Continued*)

	$Q_{0.10}$		$Q_{0.25}$		$Q_{0.50}$		$Q_{0.75}$		$Q_{0.90}$	
Attitude score	*B*	95%CI	*B*	95%CI	*B*	95%CI	B	95%CI	*B*	95%CI
Contact after knowing one's HIV status										
Not sure Reference										
Stop the contact	**−4.29****	−6.21, −2.36	**−3.52****	−4.90, −2.14	**−3.74****	−4.77, −2.72	**−2.91****	−4.01, −1.81	**−3.98*****	−5.3, −2.59
Reduce the contact	−1.23	−2.63, 0.18	**−1.08***	−2.09, −0.07	**−1.67****	−2.42, −0.91	**−1.92****	−2.72, −1.11	**−1.67****	−2.68, −0.65
Same level of contact	1.02	−0.18, 2.32	**1.41****	0.48, 2.34	**0.77****	0.07, 1.46	0.31	−0.43, 1.05	0.21	−0.73, 1.15
Opinion about gays and lesbians										
Their right Reference										
Avoid them	−1.13	−2.41, 0.14	−0.47	−1.38, 0.44	−0.48	−1.16, 0.20	−0.51	−1.24, 0.22	−0.88	−1.80, 0.05
Need protection	−0.76	−2.21, 0.69	−0.64	−1.68, 0.40	−0.33	−1.11, 0.44	−0.27	−1.10, 0.55	0.00	−1.05, 1.05
Do not think of them	−1.13	−2.57, 0.31	−0.67	−1.70, 0.36	**−0.83***	−1.60, −0.06	−0.64	−1.47, 0.17	**−1.14***	−2.19, −0.11

Legend: Bold values denote statistical significance (**$p < 0.01$; *$p < 0.05$); *B* – unstandardised coefficient, CI – confidence interval. Relationship status and sources of information (internet, university lecturers, friend) were not associated with the Attitude score.

Previous studies found that raising knowledge about HIV is overall effective, but not sufficient to tackle the HIV-related stigma (Stephenson, 2009; Earnshaw, Smith, Chaudoir, Lee, & Copenhaver, 2012; Turan *et al.,* 2017; Visser, Makin, Vandormael, Sikkema, & Forsyth, 2009). The findings in this study suggest that persons who had lower ATS or expressed greater level of stigma may not benefit from specialised programs aimed at raising HIV awareness and education. In fact, these might even be counteractive. Persons who, overall, have negative attitudes towards PLHIV could perceive HIV-related education as coercion and, therefore, increase their level of stigmatisation because PLHIV are in focus. Several studies did not confirm the association between higher HIV knowledge and lower level of HIV-related stigma (Serlo, 2008; Nyblade *et al.,* 2003). It is suggested that social factors like gender, race/ethnicity, sexual orientation, and academic status may be observed as the association mediators that might have a more significant role in shaping specific attitudes than basic knowledge (Kingori *et al.,* 2017). The change in social, cultural, and religious norms requires support from the entire community at large (Stephenson, 2009; Earnshaw *et al.,* 2012; Turan *et al.,* 2017; Visser *et al.,* 2009). In these circumstances, it might be more effective to influence the change in environmental factors, such as implementation of anti-discrimination laws, supporting women and their role in the communities, transformation of taboos associated with HIV and high-risk groups for contracting HIV, foundation of support groups, and inclusion of key populations in the mainstream culture (Schweitzer *et al.,* 2023; Galli, Borderi, & Viale, 2020).

People living in regions with high HIV prevalence tend to be more knowledgeable about HIV transmission, which was found to reduce the levels of HIV-related stigma (Du, Chi, & Li, 2018). Association of higher knowledge with stronger positive attitudes across higher quantiles in this study was expected, as Kosovo province is regarded as a high-risk area for HIV transmission (Milic *et al.,* 2021a; Milic *et al.,* 2021b). Nevertheless, it was observed that the strength of this association becomes weaker with having stronger positive attitudes, suggesting that when individuals have higher knowledge levels, its impact on attitudes is positive, but not as strong. Possible explanation might come from a potential oversaturation in person's interest and receptiveness for further knowledge on the matter. Consequently, it seems that when people already have a high knowledge they should only occasionally receive updates. Nevertheless, continuous education is always preferable and crucial for hesitant individuals who have indecisive attitudes. Exposure to periodical education campaigns could be useful to transform their indecisive attitudes into positive ones. Moreover, perhaps somewhat weaker association in the top quantiles may also reflect higher openness and acceptance of individuals irrespective of knowledge about HIV and not just loss of concern for repetitive information. This should be explored in more detail in further research.

In addition to knowledge, lack of interest in HIV testing and one's position to stop the contact after learning a person's HIV-positive status were observed as factors associated with less supportive attitudes towards PLHIV. The negative association was particularly strong in the lower quantiles of ATS distribution, suggesting that those students who were not interested in issues surrounding HIV were more likely to stop contact with a newly diagnosed PLHIV. Interest in HIV-related issues depends on the perception of HIV risk, which is related to having information about the problem (Zizza, *et al.,* 2021). Students' HIV testing history and stigma appear to be largely mediated by HIV knowledge (James & Ryan, 2018). Not having previous contact with PLHIV was previously shown to be associated with greater HIV-related stigma. Thus, the results of this study support the evidence from literature (Tesic, Kolaric, & Begovac, 2006; Lau & Tsui, 2005; Brown, Macintyre, & Trujillo, 2003). In a study conducted among young Korean men, it was observed that in the 25th quantile the attitude score towards HIV infection was the most negative and that those who had no experience with people living with HIV had more stigmatising attitudes (Shim & Kim, 2020). In a population where the likelihood of contact with an HIV-positive person is low, social media and the mainstream can spread stories such as basketball player Earvin 'Magic'Johnson's statement that he was infected with HIV through heterosexual intercourse to reduce the stigma associated with homosexuality and show that anyone can become infected with HIV (Casey, *et al.,* 2003).

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A prior study from the Balkan region suggested that having previous contact with PLHIV and lower levels of homophobia were associated with stronger positive attitudes towards PLHIV (Dunjic-Kostic *et al.*, 2012). It was found that the association between not having interest and opinion regarding gays and lesbians and weaker positive attitude towards PLHIV was across the middle quantiles of the ATS distribution. Overall, it seems that students who had indecisive attitude towards PLHIV could be the most likely to change their attitudes as opposed to individuals who had already formed strong negative attitudes and are, therefore, more resistant to change. Academic setting has been deemed as the most appropriate environment in which interventions to reduce HIV-related stigma are also the most effective. This is likely due to the social climate among the students and building new social circles among the university students (Haffejee, Maughan-Brown, Buthelezi, & Kharsany, 2018). Workshops organised at the University could be the most suitable way to introduce individuals from the high-risk groups in order to reduce the HIV stereotypes.

This study has several limitations. Self-reported data, particularly those about sensitive topics, are open to information bias. Moreover, another limitation could be the fact that this research was conducted in the university student population which may affect generalisability. Obtained results should be confirmed on the general population in further studies. Potential limitation of this study may also be a delay in data reporting. This study is an integral part of a larger investigation about the knowledge, attitudes, and behaviours of university students in North Kosovo about HIV. Because the doctoral dissertation of the first authors is based on this large investigation, the publication of data had to be postponed until the entire investigation was completed and all the results were analysed and evaluated. However, because social and political circumstances in northern Kosovo have not noticeably changed in recent decades (sex education is not included in school curricula), findings from this study likely reflect the present circumstances. The associations observed in this study were based on a cross-sectional study design; therefore, inference about causality remains limited. As observed associations could be more complex, further qualitative studies should be performed to better understand the subtle motives for attitudes towards PLHIV.

To conclude, this study was the first to apply the quantile regression to identify complex association between HIV-related knowledge and attitudes towards PLHIV. Association of higher HIV-related knowledge with stronger positive attitudes towards PLHIV was confirmed in almost all the quantiles. Still, some students remain indecisive despite being knowledgeable about HIV. This phenomenon should be explored in qualitative studies to understand their feelings and beliefs. Only after this research it is possible to better understand the reasons behind students' indecisiveness and be able to address them through public health interventions.

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