RESEARCH PAPER

Perceptions of Human Papillomavirus (HPV) infection and acceptability of HPV vaccine among men attending a sexual health clinic differ according to sexual orientation

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ABSTRACT

Our aim was to gain a better understanding of the knowledge about Human Papillomavirus (HPV) infection and attitudes toward the HPV vaccine among men at risk for sexually transmitted infections (STI). A self-administered questionnaire was completed by attendees of the largest STI Center in Rome, Italy, from April to June 2013. Determinants of vaccine acceptability were investigated using a Structured Equation Model.

A total of 423 males participated in the survey: 296 (70.0%) men who have sex with men (MSM) and 127 (30.0%) men who have sex with women (MSW). Only one half of the participants knew that HPV is the cause of genital warts (56.9% of MSM vs. 49.5% of MSW, $p=0.28$). Even less were aware that HPV causes cancer in men (37.2% vs. 27.3%, $p=0.08$). MSW were more likely to indicate HPV as a cause of cervical cancer (80.8% vs. 69.3%, $p=0.03$) and to have heard about the vaccine (58.3 vs. 43.6%, $p=0.01$). Moreover, 72.1% of MSM and 70.3% of MSW were willing to be vaccinated. A rise of one-unit in the HPV awareness score increased the OR of vaccine acceptability among MSM by 25% (OR 1.25, 95%CI: 1.05–1.49; $p=0.013$). Differently, only attitudes had a relevant effect on willingness to be vaccinated among MSW (OR 3.32, 95%CI: 1.53–7.17; $p=0.002$).

Efforts should be made to maximize awareness of HPV, especially as a causative agent of genital warts and male cancers, and to reinforce positive attitudes toward vaccination among men visiting STI centers.

ARTICLE HISTORY

Received 23 July 2015
Revised 25 September 2015
Accepted 30 October 2015

KEYWORDS

acceptability; Human Papillomavirus (HPV); Men who have sex with men; Men who have sex with women; vaccine

Introduction

European men who have sex with men (MSM) suffer disproportionately more than men who have sex with women (MSW) from curable sexually transmitted infections (STI), such as syphilis and gonorrhea, because of their higher partner-change rates and their tendency to maintain a significant proportion of unsafe sexual practices throughout their lives.^{1–5} Moreover, since the year 2000, the MSM communities in the Western World have experienced increased incidences in viral STIs, such as HIV-1^{6–11} and HCV infections.^{12–14}

Compared to MSW, MSM also show higher rates of ano-genital infections caused by the Human Papillomavirus (HPV), together with an increased incidence rate of ano-genital and oropharyngeal cancers,^{15–16} particularly in cases where there is HIV-1 co-infection.^{17–18} In fact, receptive anal intercourse and oral sex, which are common sexual practices among MSM, are risk factors for the acquisition of high-risk HPV genotypes at ano-genital and oral level.^{19–21} Anal HPV infection has been evidenced in over 70% of MSM attending STI and outpatient clinics.^{22–23} Unfortunately, prevention programs promoting safe sexual behaviors through the adoption of persistent condom use and aimed at reducing the number of partners have been proven to be ineffective in the long term.²⁴

Anal HPV infection has also been evidenced in MSW, although its prevalence is usually lower than that found among MSM. In a community-based sample of MSW, anal HPV was evidenced in 12.2% of the individuals.²⁵ An even lower prevalence (1.2%) was observed in a small study of MSW attending a STI clinic,²⁶ while Piketty and collaborators found anal HPV in 46.0% of HIV-positive MSW.²⁷

For these reasons, the availability of a quadrivalent vaccine (qHPV) against both low-risk and high-risk HPVs, i.e., HPV 6, 11, 16 and 18 (Gardasil®, Merck & Co., Inc., Whitehouse Station, NJ, USA) might help reduce the burden of HPV-associated diseases in males attending STI clinics, including MSM. Indeed, HPV vaccination has been proven to be a cost-effective intervention for the prevention of genital warts and anal cancer among MSM in the USA.²⁸ This population, which shows a high prevalence of anal HPV infection throughout their entire sexual life,²⁹ will not be protected through the *herd immunity* effect which derives from the vaccination of girls.³⁰

In Italy, a national vaccination program for 11 year-old girls was introduced in 2007. It has reached a coverage of around 70% for the cohorts of adolescents that were initially targeted for vaccination. However, it was not until 2015 that 5 Italian regions have finally implemented a free vaccination program

for 11 year-old boys, but only one of these 5 regions included MSM and HIV-positive individuals.³¹

Therefore, it is important to investigate HPV awareness and attitudes toward the HPV vaccine among males at risk, included MSW attending STI clinics, since they are at higher risk for HPV infection than their heterosexual counterpart from the general population. Accurate data are particularly needed for the countries where a gender-neutral vaccination strategy has only been partially introduced.

To date, there has been a limited number of studies carried out in European males at risk, and these have varied widely in their design, outcome variables, and methodological approaches. In addition, the majority did not provide a conceptual framework to explain the inter-relationships between individual resources and expected behavioral outcomes.^{32,33} Most studies have regarded females, adolescents,³⁴⁻³⁶ adolescents' parents³⁷⁻⁴⁰ and the only large surveys of males at risk have been mainly conducted in USA and Australia.⁴¹⁻⁴⁵ These studies have shown a large variation in the proportion of gay/bisexual men who had heard of the HPV vaccine (26–73%) and who were willing to be vaccinated (36–74%).

Thus, we have developed a conceptual framework, based on the Theory of Planned Behavior, to investigate awareness regarding HPV infection and acceptability of the HPV vaccine among sexually active males attending a STI center. Determinants of vaccination acceptability were also investigated, as well as how this attitude changed according to male sexual orientation.

Results

Characteristics of the population

During the study period, 502 males who were able to read and understand the Italian language attended the STI Unit. For 423 (84.3%) of them, a valid questionnaire was collected. Forty-five males were unable to complete the questionnaire due to lack of time before consultation; 5 subjects did not leave their questionnaire in the dedicated box; 2 questionnaires which included nonsense answers to most questions and 27 predominantly incomplete questionnaires were excluded from the analysis.

The socio-demographic characteristics of the participants by sexual orientation are shown in Table 1. The median age of participants was 33 y (IQR: 27–41). Most of them were Caucasian (99.3%) and identified themselves as MSM (70.0%). Most of the participants reported a high school or university education. The majority of the individuals were not married. Less than one-third of the MSM had a steady sexual relationship, while 55.9% of the MSW had a stable partner. MSM tended to be younger and better educated, but they were also more likely to be unemployed. Overall, 51.4% of the participants had been previously diagnosed with an STI, and 27.9% declared, in the questionnaire, that they were HIV-positive.

Table 2 shows how answers to the questions concerning HPV infection were distributed for each group. Three quarters of the participants (74.9%) had heard of HPV infection, with a slightly higher proportion for MSW compared to MSM (78.0% vs. 73.6%). Among the HPV-aware group, 91.5% knew that

Table 1. Selected socio-demographic, and behavioral characteristics of the 423 study participants enrolled at the largest STI center in Rome (Italy) from April to June 2013.

	MSM n=296	MSW n=127	Total N=423
Age median, years (IQR)	32.5 (26–40)	36 (29–46)	33 (27–41)
Education			
middle school or less	16 (5.4)	17 (13.4)	33 (7.8)
high school	136 (45.9)	63 (49.6)	199 (47.0)
university	135 (45.6)	43 (33.9)	178 (42.1)
undetermined	9 (3.1)	4 (3.1)	13 (3.1)
Occupation			
unemployed	66 (22.3)	14 (11.0)	80 (18.9)
employed	230 (77.7)	113 (89.0)	343 (81.1)
Marital status			
unmarried	267 (90.2)	63 (49.6)	330 (78.8)
married	3 (1.0)	34 (26.8)	37 (8.7)
divorced/widower	6 (2.0)	14 (11.0)	20 (4.7)
undetermined	20 (6.8)	16 (12.6)	36 (8.6)
Type of partnership			
no stable partner	174 (58.7)	23 (18.1)	197 (46.6)
stable partner	88 (29.8)	71 (55.9)	159 (37.6)
undetermined	34 (11.5)	33 (26.0)	67 (15.8)
Duration of relationship ^a median, months (IQR)	14.5 (6–48)	24 (12–60)	18 (9–60)
Age at first sexual intercourse median, years (IQR)	18 (16–20)	17 (16–18)	18 (16–19)
History of STI ^b			
no	139 (47.3)	64 (51.6)	203 (48.6)
yes	155 (52.7)	60 (48.4)	215 (51.4)
Self-reported HIV positivity ^c	54 (34.8)	6 (10.0)	60 (27.9)

^aFor the participants who declared they had a stable partner

^bboth current and previous STIs were considered; data were missing for 5 participants

^camong those reporting history of STI

Note. MSM, men who have sex with men; MSW, men who have sex with women; STI, sexually transmitted infections; IQR, interquartile range

HPV is sexually transmitted. Most participants (72.9%) correctly identified HPV as a cause of cervical cancer. Compared to MSM, MSW were significantly more likely to indicate HPV as a cause of cervical cancer (80.8% vs. 69.3%, $p < 0.05$), and as an easily acquired infection (80.8% vs. 66.5%, $p < 0.01$). Compared to the proportion of participants who knew that HPV may cause cervical cancer, there was a dramatic decrease in the proportion of those who indicated HPV as a cause of genital warts (56.9% in MSM and 49.5% in MSW, $p = 0.28$) and cancer in men (41.3% among MSM and 32.3% among MSW, $p = 0.13$).

Most of the participants, regardless of sexual orientation, correctly identified HPV as a common/very common infection, which affects both men and women. No significant differences in the proportion of those who provided the correct answers to the questions concerning risk-reduction and transmission of HPV infection were observed between the 2 groups of participants. Median scores for awareness were 3 (IQR: 0–4) for MSM and 4 (IQR: 1–5) for MSW (median test, continuity corrected $p = 0.083$). Only among MSW, did the median awareness score tend to increase according to the educational level (not shown).

The distribution of answers to questions regarding HPV vaccine knowledge and acceptability is provided in Table 3. None of the participants reported that they had previously received the HPV vaccine. MSW were more likely to have heard about the vaccine (58.3% vs. 43.6%, $p = 0.01$).

Table 2. Distribution of answers to the questions regarding HPV knowledge among the 423 study participants enrolled at the largest STI center in Rome (Italy) from April to June 2013.

	MSM n=296	MSW n=127	p-value
Have heard of HPV			0.35
no	78 (26.4)	28 (22.0)	
yes	218 (73.6)	99 (78.0)	
HPV: ^a			0.39
is rare/don't know	47 (21.6)	17 (17.1)	
is common/very common (true)	171 (78.4)	82 (81.8)	
can infect both men and women			0.83
false	14 (6.4)	7 (7.0)	
true (true)	204 (93.6)	92 (93.0)	
is easy to contract			0.01
no/don't know	73 (33.5)	19 (19.2)	
yes (true)	145 (66.5)	80 (80.8)	
is sexually transmitted			0.85
false	19 (8.7)	8 (8.1)	
true (true)	199 (91.3)	91 (91.9)	
can cause ano-genital warts			0.22
false	94 (43.1)	50 (50.5)	
true (true)	124 (56.9)	49 (49.5)	
can cause cervical cancer			0.03
false	67 (30.7)	19 (19.2)	
true (true)	151 (69.3)	80 (80.8)	
can cause sterility in women			0.02
false (true)	186 (85.3)	94 (94.9)	
true	32 (14.7)	5 (5.1)	
can cause impotence in men			0.42
false (true)	207 (95.0)	96 (97.0)	
true/don't know	11 (5.0)	3 (3.0)	
is mainly asymptomatic			0.41
false/don't know	117 (53.2)	48 (48.5)	
true (true)	102 (46.8)	51 (51.5)	
can be transmitted in the absence of symptoms			0.65
false/don't know	49 (22.5)	20 (20.2)	
true (true)	169 (77.5)	79 (79.8)	
increases with the number of partners			0.31
false/don't know	36 (16.5)	12 (12.1)	
true (true)	182 (84.5)	87 (87.9)	
risk of HPV infection may be lowered			0.72
no/don't know/other	64 (29.4)	31 (31.3)	
yes, using condoms (true)	154 (70.6)	68 (68.7)	
can be associated with cancer in men			0.13
false/don't know	128 (58.7)	67 (67.7)	
true (true)	90 (41.3)	32 (32.3)	

^aFor the respondents who had heard of HPV

Note. MSM, men who have sex with men; MSW, men who have sex with women

Considering the whole study population, only 35.1% were willing to receive the vaccine and willingness was higher among MSW, although not significantly (40.9% vs. 31.4%, $p=0.07$).

Among those aware of the vaccine, 72.1% of the MSM and 70.3% of the MSW were willing to be vaccinated, despite the fact that 47.3% of the MSM and 50.0% of the MSW were uncertain about its safety and the fact that over one third had heard conflicting opinions about it (38.0% and 37.8%, respectively). The proportion of MSM willing to be vaccinated tended to increase when the HPV vaccine was presented as a tool to prevent both genital warts and cancer compared to when it was presented as a tool to prevent only genital warts or cancer. Participants who had heard of the HPV vaccine were also prone to recommend the vaccine to friends and/or sexual partners (MSM: 84.5%, MSW: 81.1%).

Among the participants that were willing to be vaccinated, 89.2% of the MSM and 71.2% of the MSW were ready to

Table 3. Awareness and acceptability of the HPV vaccine among the 423 study participants enrolled at the largest STI center in Rome (Italy) from April to June 2013.

	MSM n=296	MSW n=127	p-value
Have heard about the HPV vaccine			0.01
No	167 (56.4)	53 (41.7)	
Yes	129 (43.6)	74 (58.3)	
HPV vaccine is safe ^a			0.25
No	7 (5.4)	8 (10.8)	
don't know	61 (47.3)	37 (50.0)	
Yes	61 (47.3)	29 (39.2)	
Have heard divergent opinions on the vaccine ^a			0.98
no/don't know	80 (62.0)	46 (62.2)	
Yes	49 (38.0)	28 (37.8)	
Willing to be vaccinated ^a			0.97
No	12 (9.3)	7 (9.5)	
don't know	24 (18.6)	15 (20.2)	
Yes	93 (72.1)	52 (70.3)	
Would you be willing to be vaccinated ^a if the vaccine prevented ano-genital warts			0.84
No	4 (3.1)	3 (4.0)	
don't know	14 (10.8)	9 (12.2)	
Yes	111 (86.0)	62 (83.8)	
if the vaccine also prevented cancer			0.26
No	3 (2.3)	2 (2.7)	
don't know	11 (8.6)	12 (16.2)	
Yes	115 (89.1)	60 (81.1)	
if the vaccine prevented only cancer			0.96
No	7 (5.5)	3 (4.1)	
don't know	15 (11.6)	8 (10.8)	
Yes	107 (82.9)	63 (85.1)	
Would you advise your partner/friend to be vaccinated ^a			0.53
No	20 (15.5)	14 (19.0)	
Yes	109 (84.5)	60 (81.1)	
Willing to receive a 3-dose schedule ^b			<0.01
No	10 (10.8)	15 (28.8)	
Yes	83 (89.2)	37 (71.2)	
Willing to pay for the vaccine ^b			0.75
No	6 (6.5)	5 (9.6)	
don't know	19 (20.4)	7 (3.5)	
Yes	68 (73.1)	40 (76.9)	
How much would you pay for the vaccine ^b			0.63
up to 50 €	29 (31.2)	10 (19.2)	
up to 100 €	24 (25.8)	15 (28.8)	
up to 150 €	11 (11.8)	4 (7.7)	
up to 300 €	8 (8.6)	6 (11.5)	
more than 300 €	12 (12.9)	10 (19.2)	
no answer	9 (13.2)	7 (13.5)	

^aamong the respondents who had heard about HPV vaccine^bamong the respondents willing to be vaccinated

receive up to 3 doses ($p<0.01$). Moreover, 73.1% of the MSM and 76.9% of the MSW were willing to pay to be vaccinated.

Perception-attitude-behavior relationships

A path diagram of the structural model of the different constructs that influence the acceptability of the vaccination in this population is shown in Fig. 1. The results of the model are reported in Table 4. Overall, perceived benefits were directly related to awareness of HPV infection (coeff 0.30; 95%CI: 0.17 to 0.43; $p<0.001$) and attitudes (coeff 0.07; 95%CI: 0.00 to 0.14; $p=0.049$) whereas perceived severity influenced awareness of HPV infection (coeff 0.54; 95%CI: 0.36 to 0.73; $p<0.001$) but

Figure 1. Path analysis illustrating relationships between exogenous variables, endogenous mediators and endogenous outcome in the structural model of HPV vaccine acceptability.

not attitudes. The effect of perceived severity on awareness almost doubled that of perceived benefits (i.e., for every unit increase in severity and in benefits, awareness was 0.54 and 0.30 units higher, respectively). The ORs of vaccination acceptability increased by 21% (OR 1.21, 95%CI: 1.05–1.39) and by 47% (OR 1.47, 95%CI: 1.08–1.99), respectively, for a one-unit increase in awareness and in attitude score.

Factors influencing awareness and attitudes differed for MSW and MSM. Among MSW, perceived benefits were directly related to both awareness ($p=0.047$) and attitudes ($p=0.041$) whereas perceived severity was only related to awareness ($p=0.019$), as was observed for the whole population. Among the MSM, perceived benefits ($p<0.001$) and perceived severity ($p<0.001$) were both directly related to awareness but neither of them was related to attitudes.

Regarding behavioral intentions, for the MSW, the ORs were about 3 times higher for attitudes (OR 3.32, 95%CI: 1.53–7.17; $p=0.002$) than for awareness (OR 1.16, 95%CI: 0.90–1.50; $p=0.252$). The awareness was not significantly related to vaccination acceptability among MSW.

Among the MSM, an increase of one-unit in awareness score increased the OR of vaccination acceptability by 25% (OR 1.25, 95%CI: 1.05–1.49; $p=0.013$), whereas the attitudes had no significant effect on vaccine acceptability.

Discussion

To the best of our knowledge, this represents the first Italian survey which aims to investigate HPV awareness and attitudes toward vaccination in males attending an STI center. The study also identified specific predictors of vaccination behavior in MSM and MSW.

Little is known about the influence of beliefs and awareness on the dynamics of vaccination behavior for infectious diseases. In MSM, greater awareness regarding HPV infection and positive attitudes toward preventative behavior are significantly associated with higher rates of willingness toward vaccination³³ but it is still unknown how these relationships vary according to sexual orientation.

Notably, despite the fact the participants were attendees of an STI center and that over half of them reported a history of STI, 25.1% had never heard of HPV infection. Moreover, among the participants who had heard about HPV, those aware of its association with genital warts and male cancer totaled only 54.6% and 38.5%, respectively.

In our study, the proportion of MSM who were aware of HPV infection (73.6%) is lower than that found among MSM recruited in a sexual health clinic in New York,⁴⁶ but consistent with that of Australian (74.0%)⁴⁵ and American MSM (79.0%).^{42,47} Our proportion is higher than that of an Italian study conducted on MSM and bisexual men recruited at cruising-points (54.6%).⁴⁸

Similarly, a wide variation in the proportion of the HPV-aware MSW can be observed. In this study, 78.0% of the MSW were HPV-aware, which is close to what was observed in heterosexuals recruited in New York (81.0%),⁴⁹ but higher than what was found among MSW attending an STI center in Puerto Rico (45%).⁵⁰

MSW were more likely than MSM to recognize that HPV is easily transmitted, may cause cervical cancer but does not cause infertility in women. MSW tended to know more about the effects of HPV on women's health probably due to an additional educative effect originating from the relationship with female partners and their health-related knowledge, concerns and/or attitudes.

Despite their very low awareness score, MSM tended to know a little more than MSW about HPV infection as a cause of genital warts and cancer in men. However, this knowledge was counteracted by the tendency to underestimate or ignore

Table 4. Coefficients (coeff), 95%CI and p values for the causal paths of the willingness towards HPV vaccination in MSW and MSM adjusted according to age and educational level.

	All men N=203			MSW N=74			MSM N=129		
	coeff.	95%CI	p value	coeff.	95%CI	p value	coeff.	95%CI	p value
Awareness									
Benefits	0.30	(0.17to 0.43)	< 0.001	0.24	(0.00to 0.47)	0.047	0.33	(0.17to 0.50)	<0.001
Severity	0.54	(0.36to 0.73)	< 0.001	0.44	(0.07to 0.81)	0.019	0.65	(0.43to 0.87)	<0.001
Attitudes									
Benefits	0.07	(0.00to 0.14)	0.049	0.12	(0.00to 0.24)	0.041	0.02	(−0.06 to 0.11)	0.584
Severity	−0.01	(−0.10to 0.08)	0.822	0.04	(−0.14to 0.22)	0.635	−0.03	(−0.15to 0.08)	0.566
Vaccination acceptability	O.R.	95%CI	p value	O.R.	95%CI	p value	O.R.	95%CI	p value
Awareness	1.21	(1.05to 1.39)	0.007	1.16	(0.90to 1.50)	0.252	1.25	(1.05to 1.49)	0.013
Attitudes	1.47	(1.08to 1.99)	0.014	3.32	(1.53to 7.17)	0.002	1.11	(0.76to 1.60)	0.591

the risk of acquiring the infection. A similar situation has also been observed among MSM in New York.⁴²

Although the vaccines against HPV have been available for several years, less than half of the people interviewed knew of their existence. In particular, MSM were significantly less aware than MSW of the HPV vaccine (43.6% vs. 58.3%). The proportion of MSM aware of HPV vaccines was similar to that observed in another Italian survey⁴⁷ and higher than that of other Australian⁴⁵ and American studies.⁴² Among the MSW, the proportion of vaccine-aware individuals (58.3%) was similar to that observed in a sample of MSW interviewed in New York (63.0%).⁴⁹

Importantly, almost 3 quarters of the HPV vaccine-aware participants were willing to be vaccinated, with no significant difference between the 2 groups. However, considering the whole study population, only 35.1% were willing to accept vaccination. Willingness to receive the vaccine was higher among MSW (40.9% vs. 31.4%, $p=0.07$).

The proportion of MSM aware of the HPV vaccine who expressed their intentions to be vaccinated (72.1%) was comparable to that observed in another Italian study,⁴⁸ and in a Canadian survey (67%),⁵¹ although slightly lower than that of an investigation conducted in New York (75.0%).⁵² Cost was a critical factor only for 6.5% of our MSM, whereas 27.9% of the MSM in New York refused HPV vaccination for financial reasons.⁵³

Not all those aware of the HPV vaccine and willing to accept vaccination were convinced about vaccine safety. Notably, approximately 50.0% of the participants were willing to accept vaccination despite being concerned about vaccine safety.

Some studies have highlighted that knowledge alone does not predict health behavior⁵⁴ and nor does it play a direct role in subsequent HPV vaccination behavior⁴⁰ in the general population and among adolescents. It is possible that attitudes exert an even more important role than awareness level. For these reasons, we specified a causal pathway based on the Health Belief Model (HBM) approach, which takes 4 psychological constructs into account. Importantly, our study described how HPV awareness, self-perceptions and attitudes are associated in a causal pathway with vaccination behavior. The results showed that factors influencing vaccination behavior differed between MSM and MSW.

We did not find any direct relationship between awareness and vaccination behavior for MSW. Among MSW, willingness toward vaccination seemed to be primarily dictated by their attitudes that had developed through their personal experiences with vaccinations against other infectious diseases during adulthood. The study indicated that MSW were more likely to develop a positive attitude toward HPV vaccination if they perceived a greater benefit from it. Thus, we suppose that normative beliefs may be more influential than knowledge and awareness levels among MSW. Differently, the more MSM were aware of HPV infection, the more likely they were to accept vaccination. The evidence that HPV awareness is positively related to vaccine acceptability among MSM has been highlighted in studies mainly conducted in USA.^{35,42,49,52} We also attempted to measure the causal pathway from awareness to vaccine acceptability. Among MSM, a greater perception of the severity of HPV-related diseases and benefits of vaccination influenced HPV awareness positively. Moreover, the effect of

perceived severity on awareness almost doubled that of perceived benefits of vaccine, and “severity” was perceived particularly in terms of capacity of HPV to cause cancer also in men.

Some limitations of the study should be mentioned. The participants were attendees of an STI center, thus they are at risk for HPV infection. Therefore, our results cannot be generalized. Moreover, a self-administered questionnaire facilitated data collection but may have sacrificed the investigation of additional aspects, which could have been better collected through face-to-face interviews. Finally, because the willingness to be vaccinated was investigated primarily as “intention to,” our findings may not be representative of the actual acceptance and adherence to a real vaccination protocol.

Importantly, we developed a conceptual framework to explain the interrelationships between individual resources and expected behavioral outcomes and we used structural equation modeling (SEM) to identify predictors of HPV vaccination acceptability in men at risk with different sexual orientations.

In conclusion, HPV awareness among at-risk males does not seem to reach adequate levels, and there is an excessively low proportion that is aware of the availability of an effective and safe vaccine. Additionally, few men were willing to accept vaccination in the whole study population. This fact stresses the need to increase awareness regarding HPV infection and concerning the availability of a protective vaccine in all males that attend STI clinics.

Among MSM, we envisage that enhancing the availability of information about the severity of infection, the relationship between HPV infection and male cancers, and about the benefits of the vaccine, will have a relevant and direct effect on willingness toward vaccination in a neutral-gender or risk-based immunization program. Differently, among at-risk MSW, vaccination behavior may be successfully promoted by targeting their attitudes toward the benefits of the HPV vaccine, like those associated with other useful vaccines in adulthood. Considering our limited study sample, further studies are needed to investigate more thoroughly differences in HPV knowledge between MSM and MSW attending STI clinics. Moreover, there is a need to shed more light on the possible direct role of normative beliefs in the promotion of vaccination behavior.

Patients and methods

Study population

A cross-sectional investigation was carried out among males attending the STI Unit of the San Gallicano Dermatological Institute in Rome, Italy. From April to June 2013, consecutive male attendees of ≥ 18 y of age were asked to participate in the survey through the compilation of a self-administered anonymous questionnaire. Those who were not able to read and understand the Italian language were excluded. Before medical consultation, male attendees were invited by the nurses to fill in the questionnaire in the waiting room of the clinic and to leave it in a ballot box. The study was approved by the Ethics Committee of the Istituti Fisioterapici Ospitalieri (IFO) of Rome, Italy (Prot. CE/454/14) and was performed in accordance with the ethical standards established in the 1964 Declaration of Helsinki and its later amendments.

The questionnaire

The questionnaire included 39 items, and was designed according to other tools utilized in similar investigations. A brief explanation of the aims of the study and the instructions to compile the questionnaire were included in the first page. Nor HPV vaccine availability or its cost were disclosed. All the items which were considered to be relevant by a panel of 5 clinicians and researchers who were expert in HPV infection were included. Language, procedures, contents and general acceptability of the first version were analyzed by a *focus group* composed of 4 MSM and 4 MSW. The questionnaire obtained a high internal consistency (Cronbach's coefficient $\alpha = 0.83$). In the final version, the items measured: demographic data ($n=6$); sexual habits ($n=4$); knowledge of HPV infection and its characteristics (transmission, symptoms, diffusion, risk factors and associated diseases) ($n=14$); awareness and attitudes toward the HPV vaccine concerning safety issues, perceived benefits and barriers, willingness to accept HPV vaccination in different scenarios (i.e., to prevent genital warts and/or cancer, willingness to accept different numbers of doses and costs), and participation in other vaccination programs ($n=15$). The items required "True"/"Yes," "False"/"No" or "Don't know" answers. Some were multiple-choice questions. Ten minutes were required to complete the questionnaire. Each questionnaire was assigned a unique 4-digit identifier.

Conceptual framework

The theory of *planned behavior* was used to model participants' willingness to accept vaccination and possible related factors. This theory claims that *attitudes* are significant predictors of human behavior, which are determined by beliefs about specific topics and objects and organized according to specific psychological dimensions.⁵⁵ In this study, the specific topic and object are represented by HPV infection and HPV vaccine, respectively. The psychological dimensions of human behavior were defined according to the HBM. This model is based on the assumption that an individual facing a particular disease or threat evaluates his/her susceptibility to the problem and its severity, and then bases his/her decision to take action on the perceived benefits and perceived barriers of different actions.⁵⁶⁻⁵⁷

We proposed a causal modeling approach, which considers perceptions, awareness and attitudes, in order to evaluate HPV vaccination acceptability in a population of males at risk for HPV infection. The model can be represented as follows: PERCEPTIONS → HPV AWARENESS AND ATTITUDE → HPV VACCINATION

We hypothesized that perception of infection severity, and vaccination benefits and barriers would influence individuals' awareness and attitude, and that awareness and attitude would influence acceptability of the HPV vaccine. In other words, attitudes and awareness may play a mediating role between individuals' perceptions and their behavior toward vaccine acceptance.

Regarding HPV, perceived severity refers to an individual's understanding of infection severity and its possible sequelae, such as genital warts, other related diseases and cancer.

Perceived benefits refer to perceived health benefits of HPV vaccination, and perceived barriers were identified as self-imposed obstacles and other factors that can limit pro-active strategies or actions toward vaccination. HPV awareness was defined as the level of knowledge reached by study participants and measured using a quantitative score obtained in the 14 items of the HPV knowledge section. Finally, perceived susceptibility refers to individuals' feelings of being affected by HPV. Differently from severity, barriers and benefits, susceptibility was not fully investigated in our questionnaire, so this dimension was not included in the final casual model.

Statistical analyses

For the categorical variables, we utilized proportions, while for continuous variables, medians and interquartile ranges (IQR) were calculated. Wilcoxon Signed Rank tests were used to evaluate differences in age and HPV awareness between MSM and MSW. Proportions of correct answers about HPV knowledge were calculated by sexual orientation and only for participants who stated they had heard of HPV. For the purpose of this analysis, missing data were coded as wrong answers. Chi-square tests were used to assess differences in demographical characteristics, HPV knowledge and willingness to accept vaccination. Factor analysis with tetrachoric correlation of the observed variables eliciting subjects' perceptions, beliefs, and behaviors was conducted to extract items with high loadings on each construct. Factors eliciting the underlying constructs of *awareness, severity, benefits and attitudes* were identified. Items with factor loadings above 0.40 were retained and summative scores were generated for each construct. Scores for awareness and severity were obtained only for subjects answering "yes" to the question "Have you ever heard of HPV infection?." Vaccination acceptability was the dependent variable in the current study, with 3 possible outcomes: not willing = 0, willing = 1, not sure = 2. We recoded "not sure" as zero. We specified a logistic regression model and carried out a recursive path analysis.⁵⁸ This method is employed to determine whether a set of data in a multiple system fits well with a priori causal model.⁵⁹ Path coefficients for the full model are derived from a series of "layered" multiple regression analyses which can be carried out simultaneously by structural equation modeling (SEM).⁶⁰ A multiple regression analysis was performed for each endogenous variable. These variables were predicted from all the other variables which had a direct effect on them.

In our case, both awareness and attitudes have direct effects upon vaccination acceptability and are directly affected by benefits and severity. The exogenous variables were benefits and severity, while the endogenous mediators were awareness and attitudes. The endogenous outcome was HPV vaccination acceptability. The analyses were adjusted for age and educational level, and carried out for the whole population and separately for MSW and MSM. Analyses were conducted using Stata 13.0. Further details about the contents of the different constructs are reported in the supplemental note.

Abbreviations

STI Sexually Transmitted Infection

HPV	Human Papillomavirus
qHPV	quadrivalent HPV vaccine
MSM	men who have sex with men
MSW	men who have sex with women
SEM	Structured Equation Model
HBM	Health Belief Model
OR	Odds ratio
CI	confidence interval
IQR	interquartile range

Disclosure of potential conflicts of interest

The authors declare that they have no conflict of interest.

Acknowledgment

The authors acknowledge Dr. Michael Kenyon for his review of the English language.

References

- [1] Fenton KA, Lowndes CM. Recent trends in the epidemiology of sexually transmitted infections in the European Union. *Sex Transm Infect* 2004; 80:255–63; PMID:15295121; <http://dx.doi.org/10.1136/sti.2004.009415>
- [2] Dougan S, Evans BG, Elford J. Sexually transmitted infections in Western Europe among HIV-positive men who have sex with men. *Sex Transm Dis* 2007; 34:783–90
- [3] Stolte IG, Dukers NH, de Wit JB, Fennema JS, Coutinho RA. Increase in sexually transmitted infections among homosexual men in Amsterdam in relation to cART. *Sex Transm Infect* 2001; 77:184–86; PMID:11402225; <http://dx.doi.org/10.1136/sti.77.3.184>
- [4] Giuliani M, Palamara G, Latini A, Maini A, Di Carlo A. Evidence of an outbreak of syphilis among men who have sex with men in Rome. *Arch Dermatol* 2004; 141:100–1
- [5] Marcus U, Kollan C, Bremer V, Hamouda O. Relation between the HIV and the re-emerging syphilis epidemic among MSM in Germany: an analysis based on anonymous surveillance data. *Sex Transm Infect* 2005; 81:456–57; PMID:16326845; <http://dx.doi.org/10.1136/sti.2005.014555>
- [6] Sullivan P, Hamouda O, Delpech V, Geduld JE, Prejean J, Semaille C, Kaldor J, Folch C, Op de Coul E, Marcus U, et al. Reemergence of the HIV epidemic among men who have sex with men in North America, Western Europe, and Australia, 1996–2005. *Ann Epidemiol* 2009; 19:423–31; PMID:19460672; <http://dx.doi.org/10.1016/j.jannepidem.2009.03.004>
- [7] Giuliani M, Vescio M F, Latini A, Palamara G, Palamara G, Pimpinelli F, Donà MG, Stivali F, Carduccelli F, Ensoli F, et al. Continuous increase in HIV-1 incidence after the year 2000 among men who have sex with men in Rome: insights from a 25-year retrospective cohort study. *Euro Surveill* 2014; 19:20969; PMID:25443035; <http://dx.doi.org/10.2807/1560-7917.ES2014.19.47.20969>
- [8] Jansen I AV, Geskus RB, Davidovich U, Jurrans S, Coutinho R A, Prins M, Stolte IG. Ongoing HIV-1 transmission among men who have sex with men in Amsterdam: a 25-year prospective cohort study. *AIDS* 2011; 25:493–501; PMID:21192230; <http://dx.doi.org/10.1097/QAD.0b013e328342f6e9>
- [9] Ackers ML, Greenberg AE, Lin CY, Bartholow BN, Goodman H, Longhi M, Gurwith M. High and persistent HIV seroincidence in men who have sex with men across 47 US cities. *PLoS ONE* 2012; 7: e34972. Epub 2012 Apr 18; PMID:22529964
- [10] Fisher M, Pao D, Murphy G, Dean G, McElborough D, Homer G, Parry JV. Serological testing algorithm shows rising HIV incidence in a UK cohort of men who have sex with men: 10 years application. *AIDS* 2007; 21:2309–14; PMID:18090279; <http://dx.doi.org/10.1097/QAD.0b013e3282ef9fed>
- [11] Phillips AN, Cambiano V, Nakagawa F, Brown AE, Lampe F, Rodger A, Miners A, Elford J, Hart G, Johnson AM, et al. Increased HIV incidence in men who have sex with men despite high levels of ART-induced viral suppression: analysis of an extensively documented epidemic. *PLoS ONE* 2013; 8:e55312; PMID:23457467; <http://dx.doi.org/10.1371/journal.pone.0055312>
- [12] Browne R, Asboe D, Gilleece Y, Atkins M, Mandalia S, Gazzard B, Nelson M. Increased numbers of acute hepatitis C infections in HIV positive homosexual men; is sexual transmission feeding the increase? *Sex Transm Infect* 2004; 80:326–7; PMID:15295139; <http://dx.doi.org/10.1136/sti.2003.008532>
- [13] Rauch A, Rickenbach M, Weber R, Hirschel B, Tarr PE, Bucher HC, Vernazza P, Bernasconi E, Zinkernagel AS, Evison J, et al. Unsafe sex and increased incidence of hepatitis C virus infection among HIV-infected men who have sex with men: the Swiss HIV Cohort Study. *Clin Infect Dis* 2005; 1:395–402; <http://dx.doi.org/10.1086/431486>
- [14] Richardson D, Fisher M, Sabin CA. Sexual transmission of hepatitis C in MSM may not be confined to those with HIV infection. *J Infect Dis* 2008; 197:1213–4; PMID:18462168; <http://dx.doi.org/10.1086/533454>
- [15] Hartwig S, Syrjänen S, Dominiak-Felden G, Brotons M, Castellsagué X. Estimation of the epidemiological burden of human papillomavirus-related cancers and non-malignant diseases in men in Europe: a review. *BMC Cancer* 2012; 12:30; PMID:22260541; <http://dx.doi.org/10.1186/1471-2407-12-30>
- [16] Chaturvedi AK. Beyond Cervical Cancer: Burden of Other HPV-Related Cancers Among Men and Women. *J Adolesc Health* 2010; 46: S20–6.16; PMID:20307840; <http://dx.doi.org/10.1016/j.jadohealth.2010.01.016>
- [17] Palefsky JM, Holly EA, Efirdc JT, Da Costa M, Jay N, Berry JM, Daragh TM. Anal intraepithelial neoplasia in the highly active antiretroviral therapy era among HIV-positive men who have sex with men. *AIDS* 2005; 19:1407–17; PMID:16103772; <http://dx.doi.org/10.1097/01.aids.0000181012.62385.4a>
- [18] Machalek DA, Poynten M, Jin F, Fairley CK, Farnsworth A, Garland SM, Hillman RJ, Petoumenos K, Roberts J, Tabrizi SN, et al. Anal human papillomavirus infection and associated neoplastic lesions in men who have sex with men: a systematic review and meta-analysis. *Lancet Oncol* 2012; 13:487–500; PMID:22445259; [http://dx.doi.org/10.1016/S1470-2045\(12\)70080-3](http://dx.doi.org/10.1016/S1470-2045(12)70080-3)
- [19] Nielson CM, Harris RB, Dunne EF, Abrahamsen M, Papenfuss MR, Flores R, Markowitz LE, Giuliano AR. Risk factors for anogenital human papillomavirus infection in men. *J Infect Dis* 2007; 196:1137–45; PMID:17955431; <http://dx.doi.org/10.1086/521632>
- [20] Dietz CA, Nyberg CR. Genital, oral, and anal human papillomavirus infection in men who have sex with men. *J Am Osteopath Assoc* 2011; 111:S19–25; PMID:21415374
- [21] Heck JE, Berthiller J, Vaccarella S, Winn DM, Smith EM, Shan'gina O, Schwartz SM, Purdue MP, Pilarska A, Eluf-Neto J, et al. Sexual behaviours and the risk of head and neck cancers: a pooled analysis in the International Head and Neck Cancer Epidemiology (INHANCE) consortium. *Int J Epidemiol* 2010; 39:166–81; PMID:20022926; <http://dx.doi.org/10.1093/ije/dyp350>
- [22] Dona' MG, Palamara G, Di Carlo A, Latini A, Vocaturo A, Benevolo M, Pimpinelli F, Giglio A, Moretto D, Impara G, et al. Prevalence, genotype diversity and determinants of anal HPV infection in HIV uninfected men having sex with men. *J Clin Virol* 2012; 54:185–9
- [23] de Pokomandy A, Rouleau D, Ghattas G, Vézina S, Coté P, Macleod J, Allaire G, Franco EL, Coutlée F, the HIPVIRG study group. Prevalence, clearance, and incidence of anal human papillomavirus infection in HIV-infected men: the HIPVIRG cohort study. *J Infect Dis* 2009; 199:965–73; PMID:19239366; <http://dx.doi.org/10.1086/597207>
- [24] Wilson DP. Interpreting sexually transmissible infection prevention trials by adjusting for the magnitude of exposure. *Clin Trials* 2010; 7:36–43; PMID:20007407; <http://dx.doi.org/10.1177/1740774509355177>
- [25] Nyitray AG, da Silva RJ, Baggio ML, Lu B, Smith D, Abrahamsen M, Papenfuss M, Quiterio M, Villa LL, Giuliano AR. The prevalence of genital HPV and factors associated with oncogenic HPV among men having sex with men and men having sex with women and men: the

- HIM study. *Sex Transm Dis* 2011; 38:932–40; PMID:21934568; <http://dx.doi.org/10.1097/OLQ.0b013e31822154f9>
- [26] Van Doornum GJ, Prins M, Juffermans LH, Hooykaas C, van den Hoek JA, Coutinho RA, Quint WG. Regional distribution and incidence of human papillomavirus infections among heterosexual men and women with multiple sexual partners: a prospective study. *Genitourin Med* 1994; 70:240–6; PMID:7959707
- [27] Piketty C, Darragh TM, Da Costa M, Bruneval P, Heard I, Kazatchkine MD, Palefsky JM. High prevalence of anal human papillomavirus infection and anal cancer precursors among HIV-infected persons in the absence of anal intercourse. *Ann Intern Med* 2003; 138:453–9; PMID:12639077; <http://dx.doi.org/10.7326/0003-4819-138-6-200303180-00008>
- [28] Kim JJ. Targeted human papillomavirus vaccination of men who have sex with men in the USA: a cost-effectiveness modelling analysis. *Lancet Infect Dis* 2010; 10:845–52; PMID:21051295; [http://dx.doi.org/10.1016/S1473-3099\(10\)70219-X](http://dx.doi.org/10.1016/S1473-3099(10)70219-X)
- [29] Dona' MG, Latini A, Benevolo M, Moretto D, Cristaudo A, Giuliani M. Anal Human Papillomavirus infection prevalence in men who have sex with men is age-independent: a role for recent sexual behavior? *Future Microbiol* 2014; 9:837–44; PMID:25156373; <http://dx.doi.org/10.2217/fmb.14.44>
- [30] Ali H, Donovan B, Wand H, Read TR, Regan DG, Grulich AE, Fairley CK, Guy RJ. Genital warts in young Australians five years into national human papillomavirus vaccination programme: national surveillance data. *BMJ* 2013; 346:f2032; PMID:23599298; <http://dx.doi.org/10.1136/bmj.f2032>
- [31] Giambi C. Stato di avanzamento della campagna vaccinale per l'HPV: dati di copertura vaccinale al 31/12/2014. Rapporto semestrale (23 September 2015). [Internet]. Rome: Istituto Superiore di Sanità; 2015 Apr 30 [cited 2015 Sept 29]. 14 p. Available from: <http://www.epicentro.iss.it/problemi/hpv/aggiornamenti.asp>.
- [32] Allen JD, Coronado GC, Williams RS, Glenn B, Escoffery C, Fernandez M, Tuff RA, Wilson KM, Mullen PD. A systematic review of measures used in studies of human papillomavirus (HPV) vaccine acceptability. *Vaccine* 2010;28:4027–37; PMID:20412875; <http://dx.doi.org/10.1016/j.vaccine.2010.03.063>
- [33] Nadarzynski T, Smith H, Richardson D, Jones CJ, Llewellyn CD. Human papillomavirus and vaccine-related perceptions among men who have sex with men: a systematic review. *Sex Transm Infect* 2014; 90:515–23; PMID:24787367; <http://dx.doi.org/10.1136/sextrans-2013-051357>
- [34] Di Giuseppe G, Abbate R, Liguori G, Albano L, Angelillo IF. Human papillomavirus and vaccination: knowledge, attitudes, and behavioural intention in adolescents and young women in Italy. *Br J Cancer* 2008; 99:225–9; PMID:18628763; <http://dx.doi.org/10.1038/sj.bjc.6604454>
- [35] Marek E, Dergez T, Rebek-Nagy G, Kricskovics A, Kovacs K, Bozsa S, Kiss I, Ember I, Gocze P. Adolescents' awareness of HPV infections and attitudes towards HPV vaccination 3 years following the introduction of the HPV vaccine in Hungary. *Vaccine* 2011; 29:8591–8; PMID:21939711; <http://dx.doi.org/10.1016/j.vaccine.2011.09.018>
- [36] Tisi G, Salinaro F, Apostoli P, Bassani R, Bellicini A, Groppi L, Donarini P, Pecorelli S. HPV vaccination acceptability in young boys. *Ann Ist Super Sanità* 2013; 49:286–91
- [37] Lenselink CH, Gerrits MM, Melchers WJ, Massuger LF, van Hamont D, Bekkers RL. Parental acceptance of Human Papillomavirus vaccines. *Eur J Obstet Gynecol Reprod Biol* 2008; 137:103–7; PMID:17368910; <http://dx.doi.org/10.1016/j.ejogrb.2007.02.012>
- [38] Sam IC, Wong LP, Rampal S, Leong YH, Pang CF, Tai YT, Tee HC, Kahar-Bador M. Maternal acceptance of human papillomavirus vaccine in Malaysia. *J Adolesc Health* 2009; 44:610–12; PMID:19465327; <http://dx.doi.org/10.1016/j.jadohealth.2008.11.014>
- [39] Jaspers L, Budiningsih S, Wolterbeek R, Henderson FC, Peters AA. Parental acceptance of human papillomavirus (HPV) vaccination in Indonesia: a cross-sectional study. *Vaccine* 2011; 29:7785–93; PMID:21821079; <http://dx.doi.org/10.1016/j.vaccine.2011.07.107>
- [40] Fishman J, Taylor L, Kooker P, Frank I. Parent and adolescent knowledge of HPV and subsequent vaccination. *Pediatrics* 2014; 134:e1049–e1056; PMID:25225141; <http://dx.doi.org/10.1542/peds.2013-3454>
- [41] Wheldon CW, Daley EM, Buhi ER, Nyitray AG, Giuliano AR. Health beliefs and attitudes associated with HPV vaccine intention among young gay and bisexual men in the southeastern United States. *Vaccine* 2011; 29:8060–5; PMID:21864615; <http://dx.doi.org/10.1016/j.vaccine.2011.08.045>
- [42] Reiter PL, Brewer NT, McRee AL, Gilbert P, Smith JS. Acceptability of HPV vaccine among a national sample of gay and bisexual men. *Sex Transm Dis* 2010; 37:197–203; PMID:20118831; <http://dx.doi.org/10.1097/OLQ.0b013e3181bf542c>
- [43] Gerend MA, Barley J. Human Papillomavirus Vaccine acceptability among Young Adult men. *Sex Transm Dis* 2009; 36:58–62; PMID:18830138; <http://dx.doi.org/10.1097/OLQ.0b013e31818606fc>
- [44] Pitts MK, Fox C, Willis J, Anderson J. What do gay men know about human papillomavirus? Australian gay men's knowledge and experience of anal cancer screening and human papillomavirus. *Sex Transm Dis* 2007; 34:170–3; PMID:16837830; <http://dx.doi.org/10.1097/01.olq.0000230436.83029.ce>
- [45] Simatherai D, Bradshaw CS, Fairley CK, Bush M, Heley S. What men who have sex with men think about the human papillomavirus vaccine. *Sex Transm Infect* 2009; 85:148–9; PMID:19153110; <http://dx.doi.org/10.1136/sti.2008.032581>
- [46] Sanchez DM, Pathela P, Niccolai LM, Schillinger JA. Knowledge of human papillomavirus and anal cancer among men who have sex with men attending a New York City sexually transmitted diseases clinic. *Int J STD AIDS* 2012; 23:41–3; PMID:22362686; <http://dx.doi.org/10.1258/ijsa.2011.011163>
- [47] Brewer NT, NG TW, McRee AL, Reiter PL. Men's beliefs about HPV-related disease. *J Behav Med* 2010; 33:274–81; PMID:20162346; <http://dx.doi.org/10.1007/s10865-010-9251-2>
- [48] Pelullo CP, Di Giuseppe G, Angelillo IF. Human Papillomavirus Infection: Knowledge, attitudes, and behaviors among lesbian, gay men, and bisexual in Italy. *PloS ONE* 2012; 7 (8):e42856; PMID:22905178; <http://dx.doi.org/10.1371/journal.pone.0042856>
- [49] Reiter PL, Brewer NT, Smith JS. Human papillomavirus knowledge and vaccine acceptability among a national sample of heterosexual men. *Sex Transm Infect* 2010; 86:241–6; PMID:19951936; <http://dx.doi.org/10.1136/sti.2009.039065>
- [50] Colon-López VC, Ortiz AP, Del Toro-Mejías ML, García H, Clatts MC, Palefsky J. Awareness and knowledge of Human Papillomavirus (HPV) infection among high-risk men of Hispanic origin attending a Sexually Transmitted Infection (STI) clinic. *BMC Infect Dis* 2012; 12:246; <http://dx.doi.org/10.1186/1471-2334-12-246>
- [51] Rank C, Gilbert M, Ogilvie G, Jayaraman GC, Marchand R, Trussler T, Hogg RS, Gustafson R, Wong T, ManCount Study Team. Acceptability of human papillomavirus vaccination and sexual experience prior to disclosure to health care providers among men who have sex with men in Vancouver, Canada: implications for targeted vaccination programs. *Vaccine* 2012; 30:5755–60; PMID:22796376; <http://dx.doi.org/10.1016/j.vaccine.2012.07.001>
- [52] Hernandez BY, Wilkens LR, Thompson PJ, Shvetsov YB, Goodman MT, Ning L, Kaopua L. Acceptability of prophylactic human papillomavirus vaccination among adult men. *Human Vaccin* 2010; 6:467–75; <http://dx.doi.org/10.4161/hv.6.6.11279>
- [53] Thomas EA, Goldstone SE. Should I or shouldn't I: decision making, knowledge and behavioral effects of quadrivalent HPV vaccination in men who have sex with men. *Vaccine* 2011; 29:570–6; PMID:20950728; <http://dx.doi.org/10.1016/j.vaccine.2010.09.101>
- [54] Ajzen I, Joyce N, Sheikh S, Cote NG. Knowledge and the prediction of behavior: the role of information accuracy in the theory of planned behavior. *Basic Appl Soc Psych* 2011; 33:101–17; <http://dx.doi.org/10.1080/01973533.2011.568834>
- [55] Ajzen I. The theory of planned behaviour. *Organizational behaviour and Human Decision Process* 1991; 50:179–211; [http://dx.doi.org/10.1016/0749-5978\(91\)90020-T](http://dx.doi.org/10.1016/0749-5978(91)90020-T)
- [56] Dabbs JM, Leventhal H. Effects of varying the recommendations in a fear arousing communication. *J of Personal Soc Psych* 1996; 4:525–31.56; <http://dx.doi.org/10.1037/h0021190>

- [57] Simon K, Das A. An Application of the Health Belief Model toward educational diagnosis for VD education. *Health Educ Quarterly* 1984; 4:403–18; <http://dx.doi.org/10.1177/109019818401100402>
- [58] Sewall Wright. Correlation and Causation. *J Agricultural research* 1921; Vol XX (7) pp. 557–585
- [59] Sewall Wright. The Method of Path Coefficients. *Annals of Mathematical Statistics* 1934;5:161–215; <http://dx.doi.org/10.1214/aoms/1177732676>
- [60] Rabe-Hesketh S, Skrondal A, Pickles A. Generalized multilevel structural equation modeling. *Psychometrik* 2004; a69:167–90; <http://dx.doi.org/10.1007/BF02295939>