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An integrative behavior theory derived model to assess factors affecting HPV vaccine acceptance using structural equation modeling

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Abstract

The study examined factors that affect parental intention-to-vaccinate adolescent daughters with HPV vaccine in Mysore district, India. A cross-sectional study was conducted among 1,609 parents of adolescent girls attending schools in Mysore District between February 2010 and October 2011. A validated questionnaire was used to assess parental attitudes, beliefs related with HPV infection, cervical cancer, HPV vaccine and vaccination in general. Structural equation modeling was used to estimate parameters and assess whether a model based on the integrative behavior theory would fit the current data. More than two-thirds (78.0%) of parents would accept vaccinating their daughters with HPV vaccine. Intention to HPV vaccination significantly increased with increase in the perception of parents about the benefits (standardized regression

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Author contribution

PM, KK and VS conceived the project idea and designed the study; PM, KK and VS were responsible for the acquisition of the data; AD analyzed the data and drafted the manuscript; All authors read and contributed intellectually for the improvement and approval of the manuscript.

Conflict of interest

The authors reported no conflict of interest.

coefficient (β) = 0.39) or sources of information about HPV vaccine (β = 0.24), but intention decreased significantly with an increase in the perception about barriers to HPV vaccination β = −0.44). The effect of beliefs about severity of HPV infection or cervical cancer (β = 0.20), and beliefs about benefits (β = 0.20) or barriers (β = −0.25) to vaccination in general on intention to HPV vaccination were significantly mediated by parental attitudes and source of information about the vaccine. Geographical location significantly moderated the awareness about HPV on beliefs about severity of HPV infection or cervical cancer (β = 0.33), and the effect of religion on norms related to HPV vaccination (β = 0.19). Fit of the model to the data was acceptable. This study identified modifiable parental attitudes about HPV vaccine and beliefs related with HPV infection, cervical cancer and vaccination, which predicted parental intention-to-vaccinate their daughters with HPV vaccine in India. Health education interventions tailored to counter parental negative attitudes and beliefs about HPV vaccine and vaccination in general would be important for the community to promote HPV vaccination.

Keywords

HPV vaccine; Acceptance; Daughter; Parent; India

1. Introduction

About 67,477 women in India die every year due to cervical cancer [1]. Identifying and treating precancerous lesions would greatly reduce the incidence of invasive cervical cancer in the country [2,3]. However, due to shortage of infrastructure and trained experts, organized population-based cervical cancer screening programs are practically non-existent in India at present [1,4]. Primary prevention practices such as vaccination are important to effectively reduce the incidence of cervical cancer in the country.

The Indian government approved Human Papillomavirus (HPV) vaccination for females aged 10 to 12 years in 2008 [5]. However, HPV vaccination in India was suspended in 2010 due to the death of seven girls during a clinical trial in the country conducted from 2009 to 2011 by the Programme for Appropriate Technology in Health, the Indian Council of Medical Research and the state governments of Andhra Pradesh and Gujarat. The aim of the clinical trial was to study the appropriate delivery strategy and feasibility of HPV vaccine to prevent HPV infection among girls [6]. A few years later, the Indian government received $500 million in aid from Global Alliance for Vaccines and Immunization (India is no longer eligible for GAVI support), to roll out different vaccines, including HPV vaccine [7,8]. As a result, the Ministry of Health in the country ordered the National Technical Advisory Group on Immunization (NTAGI) to check the safety and efficacy of the HPV vaccine in order to determine whether to include the vaccine in the immunization programme, at least on a pilot basis [9]. In 2015, HPV vaccine (the bivalent Cervarix and quadrivalent Gardasil) was approved to be included in the National Immunization Programme by NTAGI [4,10]. In 2016, the states of Punjab and New Delhi included HPV vaccination in their immunization/public health programme [11]. To date, due to some controversies by the government officials [12], HPV vaccine was partially introduced in the Immunization Programme for eligible girls in India [13]. However, the vaccine is commercially available at a subsidized cost, for eligible girls in most regions of the country in two (if the first dose is taken before the age of 15) or three (if the first dose is taken at or after the age of 15 years or among immunocompromised girls) doses over a six to 12-month period [11,14].

When the HPV vaccine is fully included in the Immunization Program in India, uptake of the vaccine among eligible girls might be low due to misperceptions about HPV infection, cervical cancer and HPV vaccine, or vaccination in general [15–18]. Lower intention to HPV vaccination was associated with parental negative beliefs about HPV vaccine (e.g. side effects, high cost, less efficacious, promote sexual promiscuity) in India [16–18], Indonesia [19], Thailand [20], Japan [21] and Malaysia [22]. Studies also showed a decreased intention to vaccinate daughters with HPV vaccine among parents who had poor perception of susceptibility to HPV infection or cervical cancer, and severity of the disease in India [18], Indonesia [19], Japan [21] and Thailand [23,24].

Studies among parents in urban and rural regions in Mysore district, India also showed association of parental attitudes and beliefs about HPV infection, cervical cancer and HPV vaccine with the intention to vaccinate daughters with HPV vaccine [25–27]. However, of the three previously published articles on intention to HPV vaccination in Mysore district [25–27], one was qualitative [25], and two quantitative studies assessed factors associated with HPV vaccine acceptance among parents in urban [26] and rural [27] regions by examining items used to measure the constructs related to HPV infection, cervical cancer and HPV vaccine in the models independently, but not as a group. In addition, analysis of the factors associated with HPV vaccine acceptance in the previously published quantitative studies in Mysore district [26,27] was conducted using generalized estimated equations following the conceptual model proposed by Fernandez *et al*. (2010) [28].

Fernandez *et al*. (2010) [28] proposed that sociodemographic factors, attitudes, and beliefs related with HPV infection, cervical cancer and HPV vaccine are all immediate antecedents of HPV vaccine acceptance. However, the Integrated Behavior Theory (IBT) and theory of planned behavior suggests that attitudes, norms and self-efficacy affect intention to practice a behavior directly, but the effect of belief factors on intention to practice a behavior is indirect through attitudes and norms [29,30]. In turn, sociodemographic, knowledge, and personality traits indirectly influence attitudes, subjective norms, and self-efficacy by affecting belief factors. The IBT synthesizes the constructs knowledge, beliefs, attitudes, norms, self-efficacy, environmental constraints and intention from the theory of reasoned action, theory of planned behavior, social cognition theory and health belief theory to effectively explain factors that influence preventive health behavior particularly vaccination [29,30]. Due to the complex and overlapping nature of the factors that could affect preventive health behavior, models that follow an integrative approach will be more appropriate to examine determinants/antecedents to preventive health behavior. However, most studies in India examined factors associated with HPV vaccine acceptance after including sociodemographic factors, attitudes, and beliefs related with HPV infection, cervical cancer and HPV vaccine in a logistic regression model as direct predictors of HPV vaccine acceptance [16–18,26,27]. In addition, most of these studies were conducted in urban areas of India [16–18,26]. Thus, the current study analyzed data from urban [26] and rural regions [27] following an IBT-derived model using a more robust analytic technique (i.e. structural equation modeling) to better understand facilitators and barriers of parental HPV vaccine acceptance in Mysore, India.

Identifying factors that are related to HPV vaccine acceptance among parents in India will help guide the development of the contents and delivery mechanisms of health education programs to achieve maximum HPV vaccine coverage among the target population in Mysore. Results from this study could also be used to design evidence-based health education programs to increase HPV vaccine acceptance in other areas of India as well as other South Asian countries after modifying/adjusting to the context of culture, religion and sociodemographic status of the population in the country. The current study aimed to assess: i) direct and indirect predictors of HPV acceptance; ii) moderating effects of area of living on the relationship between socioeconomic status and indirect predictors HPV acceptance; and iii) appropriateness of a proposed model based on the IBT to fit the current data.

2. Methods

2.1. Study setting

A survey was conducted among parents in urban and rural areas in Mysore district, India. The survey in the urban area was done between February 2010 and January 2011 and the survey in the rural area was conducted between September and October 2011. In 2010, cervical cancer mortality rate was 16.5 per 100,000 in Karnataka [31]. Mysore district is the third (out of 30) most populous (3,001,127, density= 450/km2) administrative district located in the southern part of Karnataka [32]. Greater proportion of the inhabitants (1,755,714) in Mysore district live in rural areas [32].

2.2. Ethical consideration

This study was conducted after ethical approvals were obtained from Florida International University and Public Health Research Institute of India. Block Education officer and school administrators in the relevant villages also granted permission to conduct the study, and written informed consent was obtained from parents who participated in this study.

2.3. Study design and participants

This study was cross-sectional in design and the study participants were parents who had daughter(s) aged 11 to 15 years attending 7th through 10th grades. A total of 778 parents living in the urban area and 831 parents living in the rural areas of Mysore district participated in this study. Detailed description of the study procedures are available elsewhere [33]. In brief, 12 schools located in the urban area and 11 schools located in the rural area were selected based on probability proportionate-to-size sampling. Second, all eligible girls in the selected schools were given a program announcement that explained the study and invited parents to participate. Then 800 girls attending schools located in the urban area and 850 girls attending schools located in the rural area of the Mysore district were randomly selected and provided with a questionnaire and consent form to be completed by the parents. The questionnaire was completed by one parent in a family. Majority of the parents in both the urban (97.3%) and rural (97.8%) area returned the completed questionnaires and signed consent forms.

2.4. Measures

Health behavior theories appropriate for examining HPV vaccine acceptance and studies that reported factors related to HPV vaccine acceptance were referred to while developing the questionnaire used in this study [25, 29,30,34]. Validation of the questionnaire was done in *Kannada* (study area local language) and the items used to measure the construct 'susceptibility' and 'severity' were validated in a study [35]. In addition, the questionnaire was used in a previous study [34]. The reader is referred to citation [34] and [35] for information on the psychometrics of the questionnaire. The items in the questionnaire were grouped into eight constructs (beliefs about susceptibility to HPV infection or cervical cancer, beliefs about severity of HPV infection or cervical cancer, beliefs about benefits of vaccination, beliefs about barriers to vaccination, attitudes about benefits of HPV vaccination, attitudes about barriers to HPV vaccination, subjective norms about HPV vaccination, source of information about HPV vaccine) according to IBT. Details about the items used to measure the eight constructs are summarized in Table 1. In addition, there were eight items used to assess the socioeconomic, demographic, cultural and other relevant background factors of the study participants (age, gender, religion, marital status, occupation, educational status, awareness about HPV, knowing someone with cancer). In case some parents were not knowledgeable about HPV, cervical cancer and HPV vaccine, we had included basic information about HPV, cervical cancer and HPV vaccine, into the questionnaire. This basic information about HPV, cervical cancer and HPV vaccine would have helped parents to respond to the items used to measure attitudes and beliefs related to HPV, cervical cancer and HPV vaccine.

2.5. Data analysis

Data were first checked and cleaned using Stata software (Version 14, Texas, USA). As there were missing values for some of the items used to measure the constructs included in the SEM (benefits of HPV vaccination, barriers to HPV vaccination, subjective norms about HPV vaccine; missing range: 0.6% to 4.9%), a multiple imputation method (using chained equation) based on 20 iterations was used to estimate the missing values [36]. Then the cleaned data that included the estimated missing values were transferred to Mplus version 8 for confirmatory factor analysis (CFA) and SEM analysis [37]. CFA was performed by including each of the eight latent variables listed in Table 1 independently, and altogether simultaneously in the measurement model. CFA was used to assess the validity of the items employed to measure the latent variables/constructs and to check fit of the measurement model to the data. After determining appropriate measurement models for the latent factors using CFA (Fig 1), SEM was used to check if the proposed model (Fig 2) approximated/fit the data. SEM was also used to assess the parameters including the factor loadings, measurement errors, disturbances, covariance and path coefficients while examining factors that directly affect, mediate and moderate parental intention to vaccinate daughters with HPV vaccine. All the eight latent, background, and the outcome (intention to vaccinate daughter with HPV vaccine) variables were entered into the SEM model simultaneously (Fig 3). There was adequate participant to parameter ratio (i.e. acceptable power cut off value =7) for final full SEM model (1609/47=34) [38]. As the response variables were categorical in nature (multivariate normal distribution does not exist), the variance-covariance matrix with the Weighted Least Squares Estimation Method was used to assess the parameters [39].

Model fit statistics were assessed using Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI) and Tucker–Lewis Index (TLI). Models were assumed good/close fit when RMSEA <0.06, and TLI and CFI >0.95 [38]. Models were acceptable/fair fit if RMSEA was 0.06 to 0.08 and TLI and CFI was between 0.90 and 0.95 [40]. We re-specified miss-fitting models following the IBT soundness and modification indices outputs from Mplus [41].

3. Result

3.1. Characteristics of the study participants

We invited 1,650 parents to participate in the study. However, 22 parents from the urban area and 19 parents from the rural area did not return the completed questionnaire or had not signed the consent form, making the number of participants in this study to be 1609. Of the 1609 parents, 6.0% had formal education, 88.8% were Hindus, and 86.9% were employed. The mean age of the parents was 38.3±6.58 years (range=23 to 75 years) and 73.0% were females. More than two-thirds (78.0%) of the parents were willing to vaccinate daughter with HPV vaccine. Details of the study participant characteristics are described elsewhere [33].

3.2. Measurement model

The measurement model that included all the items used to measure the eight latent factors in Table 1 fit the data fairly well (RMSEA =0.032, 95% CI: 0.031, 0.034; CFI= 0.92, TLI=0.92). However, we further modified the measurement model by allowing some residual terms associated with similar items in the same construct to freely covary (Fig 1). Additionally, we modified the model by removing two items from the construct 'beliefs about benefits of vaccination' (D4 and D5) and one item from the construct 'subjective norms about HPV vaccination' (G1) with standardized factor loadings (β) ≤0.3. These modifications improved the model fit statistics of the measurement model (RMSEA =0.028, 95% CI: 0.026, 0.029; CFI= 0.95, TLI=0.95). Items used to measure the different constructs significantly loaded with β ≥ 0.4 with the exception of one item (D1: β =0.24).

The measurement model for each construct independently showed a good fit between the proposed model and the data; perceived benefits of HPV vaccination (RMSEA =0.03, CFI= 0.99, TLI= 0.98, factor loading range (β)=0.42 to 0.88), perceived barriers to HPV vaccination (RMSEA =0.05, CFI= 0.98, TLI= 0.96, β= 0.46 to 0.80), beliefs about severity of HPV infection or cervical cancer (RMSEA =0.00, CFI= 1.0 , TLI= 1.0, β=0.69 to 0.91), beliefs about susceptibility to HPV infection or cervical cancer (RMSEA =0.06, CFI= 1.0, TLI= 0.99, β=0.69 to 0.91), beliefs about benefits of vaccination (RMSEA = 0.00, CFI= 1.00, TLI= 1.00, β=0.41 to 0.85), beliefs about barriers to vaccination (RMSEA = 0.00, CFI= 1.00, TLI= 1.00, β=0.50 to 0.69), subjective norms about HPV vaccine (RMSEA = 0.11, CFI= 0.99, TLI= 0.98, β=0.61 to 0.85).

3.3. Structural model

The final full structural model based on IBT was identified; total parameter estimated (n=184=number of factor loadings (39) + variances (65) + covariance (25) + structural paths

(55)} was less than the number of unique (co)variances of measured variables {n=1653=57 × (57+1)/2, where 57 is the total number of measured variables} (Fig 3). The RMSEA statistics showed close fit of the proposed model to the observed data covariance matrix (RMSEA: 0.025, 95% CI=0.024, 0.026). The CFI (=0.92) and TLI (=0.91) values also indicated that the proposed model fit the data acceptably. Furthermore, the ratio of the model chi-square statistic (χ^2=4580.45) to the degrees of freedom (df=1616) (χ^2/df=2.83) was less than the recommended threshold for good model fit (=5) [42,43]. However, the chi-square statistics comparing the covariance matrix by the proposed model and the observed data was significant (χ^2 =3120, df=1616, p<0.01).

3.4. Factors directly affecting intention to HPV vaccination

Intention to vaccinate daughters with HPV vaccine was significantly greater among parents who perceived that HPV vaccine had greater benefits (unstandardized regression coefficient (B) = 0.51, standardized regression coefficient (β) = 0.39, p <0.001 for both) and among those who received information about HPV vaccine from several sources (B = 0.32, β = 0.240, p <0.001 for both). On the other hand, lower intention to vaccinate daughters was observed among parents expressing greater perceived barriers to vaccinating daughters with HPV vaccine (B = −0,92, β = −0.44, p <0.001 for both). However, subjective norms related with HPV vaccine did not affect parental intention to vaccinate their daughters with the vaccine (B =0.05, p=0.412, β = −0.44, p=0.411) (Table 2 and Fig 3).

3.5. Factors indirectly affecting intention to HPV vaccination

Parental beliefs about benefits (B =0.39, β =0.20) or barriers (B = −1.04, β = −0.25) to vaccination, and that HPV infection and cervical cancer are severe (B =0.26, β = 0.20), significantly and indirectly affected their intention to vaccinate daughters with HPV vaccine (p <0.001 for all) (Table 2 and Fig 3). The effect of parental beliefs about benefits of vaccination on their intention to vaccinate daughters with HPV vaccine was significantly mediated by their perceptions about the benefits (B = 0.40, β =0.20, p <0.001 for both) or barriers (B = −0.14, p =0.013; β =−0.08, p=0.004) to HPV vaccination, and parental sources of information about HPV vaccine (B =0.13; β =0.07, p<0.001 for both). The effect of the parental beliefs about barriers to vaccination on their intention to vaccinate daughters with HPV vaccine was also significantly ((p <0.001 for all) mediated by their perception about the benefits (B = 0.70; β = 0.17) or barriers (B = −1.80; β =−0.43) to HPV vaccination. Similarly, the effect of parental beliefs that HPV infection or cervical cancer are severe on their intention to vaccinate daughters with HPV vaccine was significantly mediated by their perception about the benefits (B = 0.24; β =0.18, p<0.001 for both) or barriers (B = −0.07, p =0.022; β = −0.05, p=0.02) to HPV vaccination, and sources of information about HPV vaccine (B = 0.09; β =0.07, p<0.001 for both).

Belief that daughters are susceptible to HPV infection or cervical cancer, that HPV infection or cervical cancer are severe, and beliefs about benefits or barriers to vaccination were significantly (p<0.01 for all) positively related to parental perceived benefits, and barriers to HPV vaccination, as well as sources of information about the vaccine (Table 3).

3.6. Effect of background factors on beliefs about HPV infection, cervical cancer, and vaccination

Muslims were more likely to perceive that their daughters were susceptible to HPV infection or cervical cancer ($B = 0.38$, $p = 0.001$; $\beta = 0.50$, $p = 0.001$), and were less likely to have negative beliefs about vaccination ($B = -0.13$, $p = 0.027$; $\beta = -0.51$, $p = 0.019$), but were also less likely to expect that other people will recommend HPV vaccination for their daughters ($B = -0.40$, $p = 0.027$; $\beta = -0.64$, $p < 0.001$) as compared to non-Muslims (Hindus and Christians). Parents who were aware of HPV were more likely to believe that their daughters were susceptible to HPV infection or cervical cancer ($B = 0.29$, $p = 0.008$; $\beta = 0.38$, $p = 0.007$). An increase in the educational status of the parents was also associated with an increase in parental beliefs that HPV infection and cervical cancer are severe ($B = 0.17$, $p = 0.008$; $\beta = 0.22$, $p = 0.007$).

There was significant interaction between the area where the participants lived and awareness about HPV in predicting parental beliefs about severity of HPV infection or cervical cancer ($B = 0.25$, p $= 0.035$; $\beta = 0.33$, $p = 0.034$) (Table 5). Similarly, there was significant interaction between the area where participants lived and awareness about someone with cancer in predicting parental beliefs about susceptibility of their daughters to HPV infection or cervical cancer ($B = 0.33$, $p = 0.037$; $\beta = 0.14$, $p = 0.023$), and parental beliefs about barriers to vaccination ($B = -0.14$, $p = 0.026$; $\beta = -0.18$, $p = 0.017$). There was also significant interaction between the area of residence and religion in predicting norms related to vaccinating of daughters with HPV vaccine ($B = 0.43$, $p = 0.001$; $\beta = 0.19$, $p = 0.001$).

4. Discussion

In this cross-sectional survey of parents of adolescent girls in Mysore district, India, parental perception about the benefits of HPV vaccination and sources of information about HPV vaccine were the strongest direct positive predictors of parental intention to vaccinate daughters with HPV vaccine. Parental beliefs about severity of HPV infection or cervical cancer, and beliefs about benefits of vaccination in general were indirect positive predictors of intention to vaccinate. Studies among parents in another region of India [18], China [44], Indonesia [19], and Thailand [20,23,24] also showed a positive relationship between attitudes about benefits of HPV vaccine (e.g. effective, prevent HPV infection and cervical cancer, affordable) and parents' intention to vaccinate with HPV vaccine . Acceptance of HPV vaccination among the Indonesian [19] and Japanese parents [21] was also positively related with their beliefs about severity of cervical cancer.

However, perceived barriers to HPV vaccination, which was measured by assessing parental negative attitudes about HPV vaccine – side effects, high cost, low family support, low risk of HPV infection/cervical cancer, not enough information about HPV vaccine, negatively predicted intention to vaccinate with HPV vaccine. The more parents' attitudes were negative towards the HPV vaccine, the less they accepted it. In addition, parents who had negative beliefs about vaccination in general were less interested in recommending HPV vaccine for their daughters. Studies among parents in Mysore city [25] and Andhra Pradesh, India [16] also showed reduced acceptance of HPV vaccine among parents who had negative attitudes about HPV vaccine. Another study among Indonesian parents reported negative parental attitudes about HPV vaccine and vaccination in general as reasons for decreased acceptance of the vaccine [19]. Thai and Japanese women also reported negative attitudes about HPV vaccine – high cost, side effects, low efficacy as reasons for not accepting HPV vaccine for their daughters [20,21]. A study among Malaysian mothers also showed cost as a main reason for a low intent to vaccinate children with HPV vaccine [22]

Additionally, the current study showed that area of residence significantly moderated the effect of background factors – particularly religion, awareness about HPV and someone with cancer, on parental beliefs about vaccination, HPV infection and cervical cancer. The level of access to medical services, medical professionals, health information, as well as educational level, and cultural characteristics of populations, which can influence parental awareness about HPV or cervical cancer and religious practices related to beliefs about vaccination, might be different in urban and rural areas in India [45,46]. As a result, the effect of awareness about HPV and someone with cancer, as well as religion on parental beliefs about susceptibility and severity of HPV infection or cervical cancer, and beliefs about vaccination may not be similar in urban and rural areas in India.

There was relatively high intention to get daughters vaccinated with HPV vaccine (78.0%) in the current study population. This intention to vaccinate with HPV vaccine was greater when compared to the rate reported among parents in other regions in India (46.0% - 74.0%) [17,18], Malaysia (65.7%) [22] and China (26.5%) [47], but lower than the rate reported in Indonesia (96.1%) [19], Japan (93.0%) [21], and Thailand (84%-85%) [20,24]. Even in Mysore district, the intention to HPV vaccination rate was greater among parents who were living in the rural (79.9%) [27] than those living in the urban (71.1%) area [26]. This difference in the intention to HPV vaccination rate among parents in different regions of Mysore district in India or South Asian countries could be attributed to differences in the level of parental awareness/knowledge and beliefs/attitudes related to the risk and severity of HPV infection and cervical cancer as well as HPV vaccination. Indeed, intention to vaccination of daughters with HPV vaccine among Indian parents increased from 24% to 74% after parents read fact sheet about the relationship between HPV infection and cervical cancer as well as availability of effective and safe vaccine to protect cervical cancer [17].

These findings have possible implications both for practice and research. Health education programs aimed at reducing negative attitudes of parents about HPV vaccine (e.g. side effects, low efficacy) and vaccination in general (e.g. too many vaccines, get the disease and protected naturally), in addition to teaching facts about the vaccine, as well as creating awareness about HPV infection and cervical cancer are important in India, particularly to those living in Mysore district, to improve their intention to vaccinate their daughters with HPV vaccine. The health education program would be more beneficial (influential) if it targeted rural communities where the level of awareness about HPV and cervical cancer might be low, and religious practices/cultures that do not encourage HPV vaccination may prevail. Furthermore, the current study suggests that the IBT can be appropriate to guide future studies that examine factors affecting HPV vaccine acceptance among the Indian communities.

This cross-sectional study involved a probability sample and reasonably large sample size with a high response rate. The analysis was done following a robust theory-based technique. Despite the above strengths, findings in this study should be interpreted in light of the following limitations. Although the RMSEA, CFI, and TLI values suggested that the proposed model based on the IBT fits with the current data, the chi-square statistics indicated significant difference in the covariance matrix by the proposed model and the observed data. However, as the chi-square test is an approximation and sensitive to sample size, the current model is still reasonable to assume to be valid to explain the data. With the value of χ^2/df= (4580.45/1616) being less than five, some scholars consider it a good fit [42,43]. In addition, due to the cross-sectional nature of the study and lack of actual HPV vaccine uptake data, we are unable to establish cause and effect relationship between the variables and fully test the IBT. Moreover, interpretation of mediating effects must be done in the context of a cross-sectional study. Furthermore, only parents of school going adolescent girls participated in this study. This may affect generalizability of the current findings to parents who do not have daughters attending schools. Moreover, the data were self-reported. Thus, there could be some level of social desirability and information bias in responses. Furthermore, suspension of HPV vaccination in India in 2010 might have affected the beliefs and attitudes of parents about HPV infection, cervical cancer and HPV vaccine. Finally, the data for this study were collected between February 2010 and October 2011. There may have been changes in the parental opinion/views regarding cervical cancer, HPV infection and vaccine, and vaccination in general in the past years. This delay in the time for reporting the results after the data were collected may affect policy measures designed to change misperceptions of parents related to HPV infection, cervical cancer and HPV vaccine in order to improve HPV vaccine acceptance among parents in Mysore, India.

5. Conclusions

The current study identified parental perception about the benefits of HPV vaccination, and sources of information about HPV vaccine as the strongest direct positive predictors of intention-to-vaccinate girls with HPV vaccine, and parental beliefs about severity of HPV infection or cervical cancer, and beliefs about benefits of vaccination in general as indirect positive predictors of intention to HPV vaccination. Perceived barriers to HPV vaccination negatively predicted parental intention to vaccinate daughters with HPV vaccine. The study also confirmed complementary relationships of the socioeconomic factors and constructs related to beliefs and attitudes suggested by the IBT. However, further longitudinal studies that measure HPV vaccine uptake status is important to examine the causal influence of constructs of IBT on one another, and to fully verify whether IBT can be applied to appropriately guide studies that examine factors affecting HPV vaccination in the Indian population.

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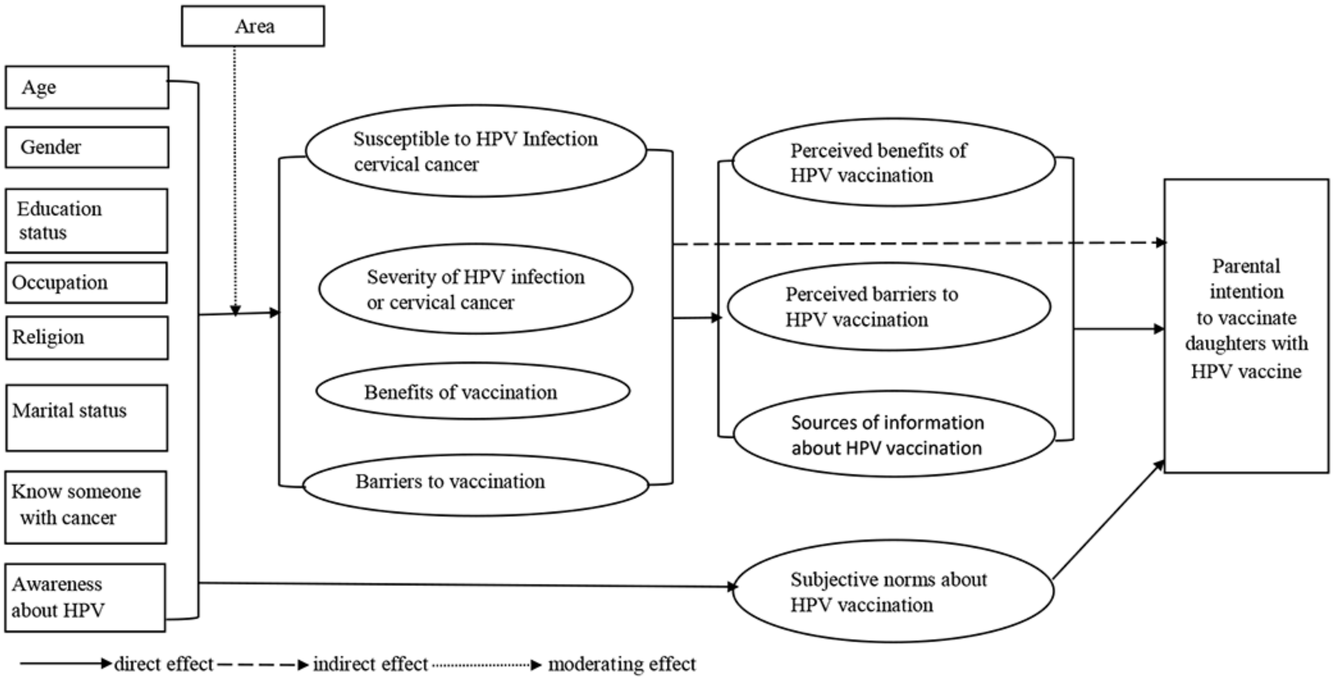

Fig 1.

Proposed integrative behavior theory derived model for understanding factors predicting parental intention to vaccinate daughters with HPV vaccine

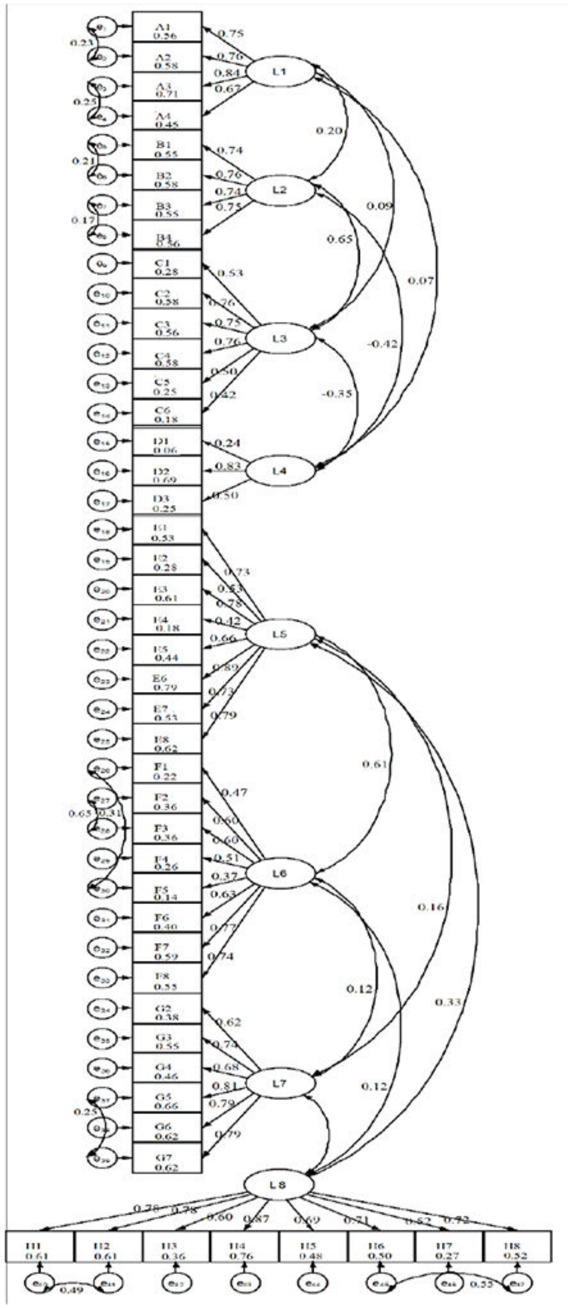

Fig 2.

Measurement model of latent factors predicting parental intention to vaccinate daughters with HPV vaccine in Mysore, India 2010/2011

L1=Susceptibility to HPV/cervical cancer

L2=Severity of HPV/cervical cancer

L3=Benefits of vaccination

L4=Barriers to vaccination

L5=Benefits of HPV vaccination

L6=Barriers to HPV vaccination

L7=Subjective norms about HPV vaccination

L8=Source of information about HPV vaccine

* details of names of items measuring each latent factor is provided in table 1

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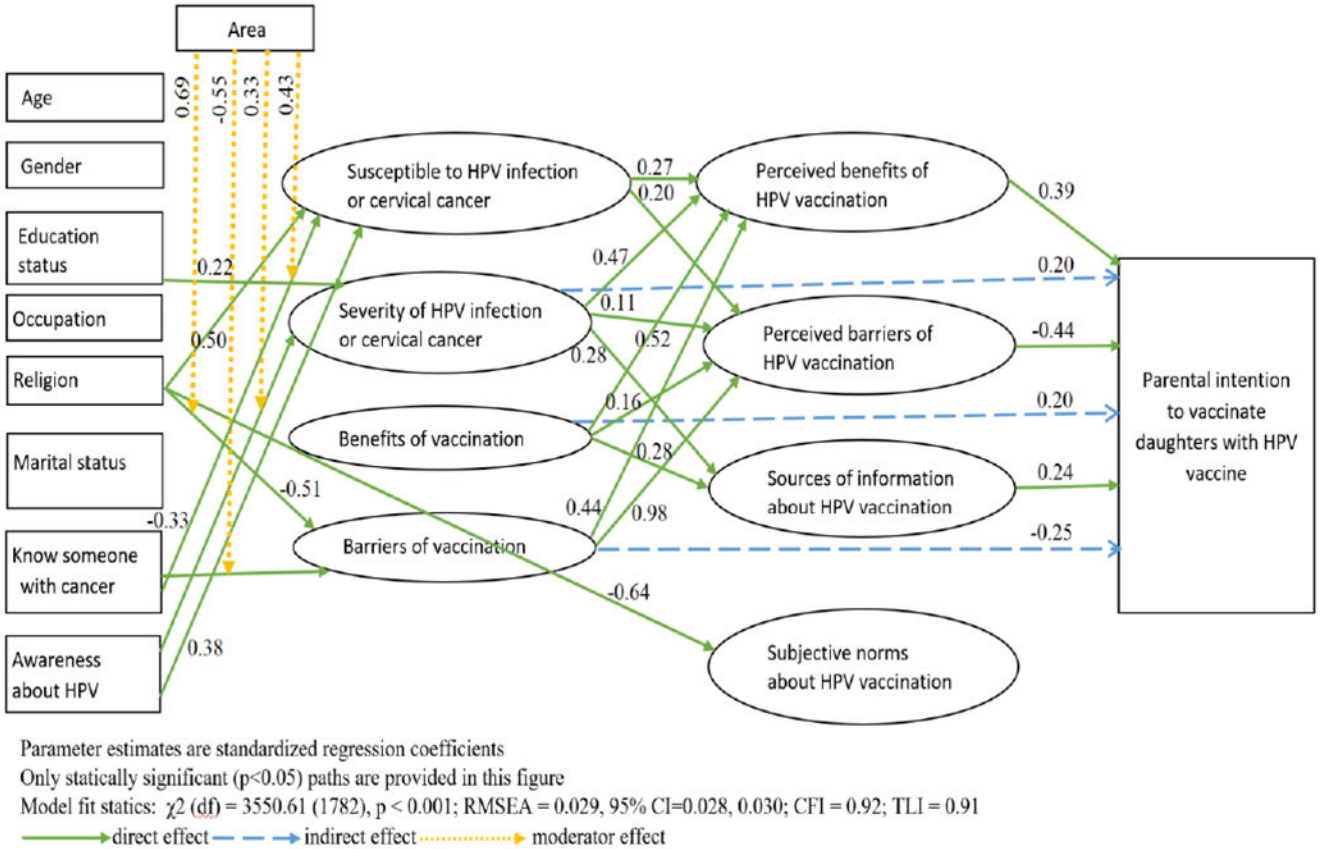

Fig 3.

Structural equation model explaining factors predicting parental intention to vaccinate daughters with HPV vaccine in Mysore, India 2010/2011

Table 1

Latent variables/constructs and the corresponding measuring items along with their responses/scores

Constructs	Item label	Item	Responses/Scores
Susceptibility to HPV/cervical cancer (L1)	A1	It is possible that my daughter will get cervical cancer in the future.	1=disagree, 2=do not know, 3=agree
	A2	It is likely that my daughter may get cervical cancer someday.	
	A3	It is likely that my daughter may get HPV infection in the future.	
	A4	My daughter may be at risk of getting HPV infection	
Severity of HPV/ cervical cancer (L2)	B1	I believe that cervical cancer is a serious disease	1=disagree, 2=do not know, 3=agree
	B2	I believe that cervical cancer can be extremely harmful	
	B3	I believe that HPV infection can be extremely harmful	
	B4	I believe that HPV infection can cause serious health problem	
Benefits of vaccination (L3)	C1	Vaccines are effective in preventing disease	1=no, 2=not sure, 3=yes
	C2	It is very important that my children receive all their vaccination	
	C3	Vaccine is one way that parents can ensure their child health	
	C4	I have a responsibility, to have my children vaccinated for the protection of all children.	
	C5	The government does a good job providing vaccination & health services	
	C6	I would feel resp, if anything bad happened I did not have my child	
Barriers to vaccination (L4)	D1	I am concerned about vaccine side effects	1=no, 2=not sure, 3=yes
	D2	I am afraid of vaccination my children	
	D3	It is better to get the disease and get protected naturally vaccine	
	D4	I would feel resp, if anything bad happened I had my child vaccinated	
	D5	There are too many vaccine already included childhood vaccine schedule	
Benefits of HPV vaccination (L5)	E1	Recommendation from doctor or nurse	1= not important all, 2=important 3=very important
	E2	Worry about daughter getting cervical cancer	
	E3	Belief that vaccine will be safe	
	E4	Worry that daughter may become sexually active	
	E5	Support from family members to vaccinate your daughter	
	E6	Learning more about the relationship of HPV to cervical cancer	
	E7	Government approval of vaccine safety and effectiveness	
	E8	Belief that vaccine will prevent cervical cancer	
Barriers to HPV vaccination (L6)	F1	High cost of HPV vaccination	1= not important all, 2=important 3=very important
	F2	Low risk that daughter will be infected with HPV	
	F3	Low risk that daughter will get cervical cancer	
	F4	Family will disapprove of getting daughter	

Constructs	Item label	Item	Responses/Scores
	F5	Injection may cause pain to my daughter	
	F6	Not enough information available about HPV vaccine	
	F7	Worried about safety of the HPV vaccine	
	F8	Vaccination may not be effective	
Subjective norms about HPV vaccination (L7)	G1	Do you think your doctor want to vaccinate your daughter?	l=no, 2=don’t know, 3=yes
	G2	Do you think your spouse want to you vaccinate?	
	G3	Do you think your friends want you to vaccinate?	
	G4	do you think your father and mother want you to vaccinate?	
	G5	Do you think other relatives want you to vaccinate?	
	G6	Do you think your In-laws want to vaccinate?	
	G7	Do you think your neighbors want you to vaccinate your daughter?	
Source of information about HPV vaccine (L8)	HI	I get my information from Television	0=no, 1=yes
	H2	I get my information about from newspaper	
	H3	I get my information about from internet	
	H4	I get my information about vaccine from doctor	
	H5	I get my information from Anganwadi teacher or worker	
	H6	I get my information from friends	
	H7	I get my information from daughter at school	
	H8	I get my information from family member/relative	

Table 2

Unstandardized (*B*) and standardized (*β*) effects of factors affecting intention to HPV vaccination for the structural model

Factors		Intention to HPV vaccination	
		B **(95% CI)**	***β*** **(95% CI)**
Direct			
Benefits of HPV vaccination		0.51 (0.29, 0.74)	0.39 (0.23, 0.55)
Barriers to HPV vaccination		−0.92 (−1.24, −0.59)	−0.44 (−0.59, −0.30)
Information about HPV		0.32 (0.19, 0.44)	0.24 (0.15, 0.34)
vaccination			
Norms about HPV vaccination		0.05 (−0.07, 0.17)	−0.44 (−0.04, 0.10)
Indirect	Mediators		
Beliefs about benefits of	Benefits of HPV vaccination	0.40 (0.19, 0.60)	0.20 (0.11, 0.29)
Vaccination	Barriers to HPV vaccination	−0.14 (−0.25, −0.03)	−0.07 (−0.12, −0.02)
	Information about HPV vaccination	0.13 (0.06, 0.21)	0.07 (0.03, 0.10)
	Sum of indirect effect	0.39 (0.22, 0.56)	0.20 (0.13, 0.27)
Beliefs about barriers to	Benefits of HPV vaccination	0.70 (0.28, 1.12)	0.17 (0.09, 0.25)
Vaccination	Barriers to HPV vaccination	−1.80 (−2.58, −1.01)	−0.43 (−0.57, −0.30)
	Information about HPV vaccination	0.06 (−0.03, 0.14)	0.01 (−0.01, 0.03)
	Sum of indirect effect	−1.04 (−1.51, −0.57)	−0.25 (−0.34, −0.16)
Beliefs about susceptibility	Benefits of HPV vaccination	0.14 (0.07, 0.21)	0.10 (0.06, 0.15)
to HPV and cervical cancer	Barriers to HPV vaccination	−0.12 (−0.18, −0.05)	−0.09 (−0.13, −0.04)
	Information about HPV vaccination	−0.01 (−0.03, 0.02)	−0.01 (−0.02, 0.01)
	Sum of indirect effect	0.02 (−0.05, 0.08)	0.01 (−0.03, 0.06)
Beliefs about severity of	Benefits of HPV vaccination	0.24 (0.13, 0.35)	0.18 (0.10, 0.26)
HPV and cervical cancer	Barriers to HPV vaccination	−0.07 (−0.13, −0.01)	−0.05 (−0.09, −0.01)
	Information about HPV vaccination	0.09 (0.05, 0.14)	0.07 (0.04, 0.100)
	Sum of indirect effect	0.26 (0.17, 0.36)	0.20 (0.13, 0.26)

Table 3

Unstandardized (B) and standardized effects (β) of parental beliefs about HPV, cervical cancer and vaccination on parental attitudes and source of information related to HPV vaccination for the structural model

Belief (exposure)	Attitude/information (outcome)	*B* (95% CI)	*β* (95% CI)
Benefits of vaccination	Perceived benefits of HPV vaccination	0.79 (0.55, 1.01)	0.52 (0.44, 0.61)
	Perceived barriers to HPV vaccination	0.15 (0.05, 0.26)	0.16 (0.06, 0.26)
	Sources of information about HPV vaccination	0.42 (0.25, 0.59)	0.28 (0.19, 0.37)
Barriers to vaccination	Perceived benefits of HPV vaccination	1.37 (0.83, 1.90)	0.44 (0.36, 0.52)
	Perceived barriers to HPV vaccination	1.96 (1.32, 2.60)	0.98 (0.96, 0.99)
	Sources of information about HPV vaccination	0.17 (−0.08, 0.43)	0.06 (−0.02, 0.13)
Susceptibility to HPV infection or cervical cancer	Perceived benefits of HPV vaccination	0.28 (0.20, 0.35)	0.27 (0.20, 0.34)
	Perceived barriers to HPV vaccination	0.13 (0.08, 0.18)	0.20 (0.12, 0.27)
	Sources of information about HPV vaccination	−0.03 (−0.10, 0.05)	−0.03 (−0.10, 0.05)
Severity of HPV infection or cervical cancer	Perceived benefits of HPV vaccination	0.47 (0.36, 0.57)	0.47 (0.39, 0.54)
	Perceived barriers to HPV vaccination	0.07 (0.02, 0.13)	0.11 (0.03, 0.20)
	Sources of information about HPV vaccination	0.29 (0.20, 0.37)	0.28 (0.21, 0.36)

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Table 4

Unstandardized (B) and standardized (β) effects of background factors on parental beliefs about HPV, cervical cancer and vaccination for the Structural Model

Background (exposure)	**beliefs/norm (outcome)**	***B* (95% CI)**	***β* (95% CI)**
Age	Susceptibility to HPV/cervical cancer	−0.02 (−0.03, 0.001)	−0.02 (−0.04, 0.002)
	Severity of HPV/cervical cancer	0.02 (−0.001, 0.03)	0.020 (−0.002, 0.041)
	Benefits of vaccination	0.08 (−0.003, 0.02)	0.02 (−0.01, 0.04)
	Barriers to vaccination	−0.002 (−0.01, 0.004)	−0.01 (−0.03, 0.02)
	Subjective norms about HPV vaccination	−0.004 (−0.02,0.01)	−0.01 (−0.03, 0.01)
Gender	Susceptibility to HPV/cervical cancer	−0.08 (−0.36, 0.20)	−0.11 (−0.48, 0.26)
	Severity of HPV/cervical cancer	0.023 (−0.23, 0.28)	0.03 (−0.30, 0.361)
	Benefits of vaccination	−0.006 (−0.19, 0.18)	−0.01 (−0.36, 0.34)
	Barriers to vaccination	−0.001 (−0.09, 0.09)	−0.004 (−0.38, 0.37)
	Subjective norms about HPV vaccination	0.01 (−0.18, 0.20)	0.02 (−0.29, 0.32)
Education	Susceptibility to HPV/cervical cancer	−0.05 (−0.18, 0.08)	−0.07 (−0.24, 0.11)
	Severity of HPV/cervical cancer	0.17 (0.04, 0.29)	0.22 (0.06, 0.38)
	Benefits of vaccination	0.09 (−0.004, 0.19)	0.18 (−0.003, 0.36)
	Barriers to vaccination	−0.04 (−0.08, 0.01)	−0.15 (−0.32, 0.03)
	Subjective norms about HPV vaccination	0.03 (−0.07, 0.12)	0.05 (−0.10, 0.20)
Occupation	Susceptibility to HPV/cervical cancer	−0.09 (−0.28, 0.11)	−0.11 (−0.37, 0.15)
	Severity of HPV/cervical cancer	−0.09 (−0.28, 0.11)	−0.11 (−0.36, 0.14)
	Benefits of vaccination	−0.140 (−0.28, 0.00)	−0.27 (−0.54, −0.01)
	Barriers to vaccination	−0.01 (−0.09, 0.06)	−0.06 (−0.36, 0.24)
	Subjective norms about HPV vaccination	0.03 (−0.13, 0.19)	0.05 (−0.20, 0.30)
Religion	Susceptibility to HPV/cervical cancer	0.38 (0.15, 0.61)	0.50 (0.20, 0.80)
	Severity of HPV/cervical cancer	0.12 (−0.13, 0.37)	0.16 (−0.17, 0.48)
	Benefits of vaccination	−0.14 (−0.33, 0.06)	−0.26 (−0.64, 0.12)
	Barriers to vaccination	−0.13 (−0.24, −0.01)	−0.51 (−0.93, −0.09)
	Subjective norms about HPV vaccination	−0.40 (−0.61, −0.19)	−0.64 (−0.97, −0.31)
Marital status	Susceptibility to HPV/cervical cancer	−0.16 (−0.49, 0.17)	−0.21 (−0.64, 0.23)
	Severity of HPV/cervical cancer	−0.20 (−0.50, 0.10)	−0.27 (−0.66, 0.12)
	Benefits of vaccinationT)	0.09 (−0.12, 0.30)	0.18 (−0.23, 0.58)
	Barriers to vaccination	0.04 (−0.07, 0.15)	0.17 (−0.28, 0.62)
	Subjective norms about HPV vaccination	−0.01 (−0.26, 0.23)	−0.02 (−0.42, 0.37)
Region	Susceptibility to HPV/cervical cancer	−0.53 (−1.53, 0.48)	−0.69 (−2.01, 0.62)
	Severity of HPV/cervical cancer	0.41 (−0.53, 1.34)	0.53 (−0.69, 1.74)
	Benefits of vaccination	−0.03 (−0.71, 0.65)	−0.05 (−1.37, 1.26)
	Barriers to vaccination	0.15 (−0.20, 0.50)	0.62 (−0.78, 2.02)
	Subjective norms about HPV vaccination	−0.30 (−1.03, 0.43)	−0.48 (−1.65, 0.69)
Knowing someone with cancer	Susceptibility to HPV/cervical cancer	−0.25 (−0.50, 0.00)	−0.33 (−0.66, −0.003)

Background (exposure)	beliefs/norm (outcome)	*B* (95% CI)	*β* (95% CI)
	Severity of HPV/cervical cancer	0.12 (−0.17, 0.40)	0.15 (−0.22 , 0.52)
	Benefits of vaccination	0.11 (−0.10, 0.31)	0.20 (−0.18, 0.60)
	Barriers to vaccination	0.07 (−0.03, 0.17)	0.28 (−0.12, 0.69)
	Subjective norms about HPV vaccination	−0.05 (−0.26, 0.17)	−0.07 (−0.41, 0.27)
Heard about HPV	Susceptibility to HPV/cervical cancer	0.29 (0.08,0.50)	0.38 (0.10, 0.66)
	Severity of HPV/cervical cancer	−0.03 (−0.24, 0.17)	−0.04 (−0.31, 0.22)
	Benefits of vaccination	−0.001 (−0.15, 0.15)	−0.002 (−0.29, 0.29)
	Barriers to vaccination	−0.03 (−0.11, 0.06)	−0.10 (−0.42, 0.22)
	Subjective norms about HPV vaccination	0.04 (−0.13, 0.20)	0.06 (−0.21, 0.33)

Table 5.

Unstandardized and standardized effects of interaction between area and background factors in predicting parental beliefs about HPV, cervical cancer and vaccination for the structural model

Background factors × Area (exposure)	Beliefs and norm factors (outcome)	*B* (95% CI)	*β* (95% CI) p-value
Age	Susceptibility to HPV/cervical cancer	0.011 (−0.01, 0.03)	0.25 (−0.16, 0.67)
	Severity of HPV/cervical cancer	−0.01 (−0.03, 0.01)	−0.17 (−0.58, 0.24)
	Benefits of vaccination	0.004 (−0.02, 0.02)	0.13 (−0.31, 0.57)
	Barriers to vaccination	−0.002 (−0.01, 0.01)	−0.15 (−0.61, 0.31)
	Subjective norms about HPV vaccination	0.01 (−0.01, 0.02)	0.14 (−0.26, 0.54)
Gender	Belief about susceptibility to HPV infection and cervical cancer	0.12 (−0.20, 0.43)	0.08 (−0.13, 0.28)
	Belief about severity of HPV infection and cervical cancer	0.04 (−0.26, 0.33)	0.02 (−0.17, 0.21)
	Belief about benefits of vaccination	0.10 (−0.12, 0.32)	0.10 (−0.11, 0.31)
	Belief about barriers to vaccination	−0.02 (−0.12, 0.09)	−0.04 (−0.25, 0.17)
	Subjective norms about HPV vaccination	0.05 (−0.17, 0.27)	0.04 (−0.13, 0.22)
Education	Susceptibility to HPV/cervical cancer	0.03 (−0.12, 0.18)	0.03 (−0.11, 0.17)
	Severity of HPV/cervical cancer	0.09 (−0.06, 0.23)	0.08 (−0.05, 0.22)
	Benefits of vaccination	0.09 (−0.03, 0.20)	0.12 (−0.04, 0.27)
	Barriers to vaccination	0.001 (−0.05, 0.05)	0.002 (−0.15, 0.15)
	Subjective norms about HPV vaccination	−0.01 (−0.12, 0.11)	0.10 (−0.11, 0.12)
Occupation	Susceptibility to HPV/cervical cancer	0.06 (−0.17, 0.28)	0.04 (−0.11, 0.18)
	Severity of HPV/cervical cancer	0.06 (−0.16, 0.28)	0.04 (−0.11, 0.18)
	Benefits of vaccination	0.13 (−0.03, 0.30)	0.12 (−0.04, 0.27)
	Barriers to vaccination	0.00 (−0.08, 0.08)	0.00 (−0.17, 0.17)
	Subjective norms about HPV vaccination	−0.04 (−0.22, 0.14)	−0.03 (−0.17, 0.11)
Religion	Belief about susceptibility to HPV infection and cervical cancer	0.02 (−0.26, 0.30)	0.01 (−0.09, 0.11)
	Belief about severity of HPV infection and cervical cancer	−0.06 (−0.37, 0.26)	−0.02 (−0.13, 0.09)
	Belief about benefits of vaccination	−0.02 (−0.27, 0.22)	−0.01 (−0.14, 0.11)
	Belief about barriers to vaccination	0.08 (−0.04, 0.20)	0.09 (−0.04, 0.22)
	Subjective norms about HPV vaccination	0.43 (0.18, 0.68)	0.19 (0.08, 0.29)
Marital status	Susceptibility to HPV/cervical cancer	0.15 (−0.25, 0.54)	0.09 (−0.15, 0.32)
	Severity of HPV/cervical cancer	0.22 (−0.15, 0.58)	0.13 (−0.09, 0.34)
	Benefits of vaccination	0.05 (−0.21, 0.32)	0.05 (−0.18, 0.27)
	Barriers to vaccination	−0.08 (−0.21, 0.06)	−0.14 (−0.38, 0.09)
	Subjective norms about HPV vaccination	0.13 (−0.16, 0.42)	0.09 (−0.12, 0.30)
Knowing someone with cancer	Susceptibility to HPV/cervical cancer	0.33 (0.04, 0.61)	0.14 (0.02, 0.25)
	Severity of HPV/cervical cancer	0.14 (−0.18, 0.46)	0.06 (−0.07, 0.19)
	Benefits of vaccination	−0.003 (−0.24, 0.23)	−0.002 (−0.15, 0.14)
	Barriers to vaccination	−0.14 (−0.26, −0.02)	−0.18 (−0.32, −0.03)
	Subjective norms about HPV vaccination	0.08 (−0.16, 0.32)	0.04 (−0.08, 0.16)

Background factors × Area (exposure)	Beliefs and norm factors (outcome)	*B* (95% CI)	*β* (95% CI) p-value
Heard about HPV	Susceptibility to HPV/cervical cancer	−0.19 (−0.43, 0.05)	−0.10 (−0.23, 0.03)
	Severity of HPV/cervical cancer	0.25 (0.02, 0.48)	0.13 (0.01, 0.26)
	Benefits of vaccination	0.13 (−0.05, 0.31)	0.10 (−0.04, 0.24)
	Barriers to vaccination	0.01 (−0.08, 0.10)	0.02 (−0.13, 0.17)
	Subjective norms about HPV vaccination	−0.05 (−0.24, 0.14)	−0.03 (−0.16, 0.09)