Preventive Medicine 56 (2013) 35–40

Contents lists available at SciVerse ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Validation of a measure of knowledge about human papillomavirus (HPV) using item response theory and classical test theory

Jo Waller [a,*], Remo Ostini [b], Laura A.V. Marlow [a], Kirsten McCaffery [c], Gregory Zimet [d]

[a] Health Behaviour Research Centre, Department of Epidemiology and Public Health, UCL Gower Street, London WC1E 6BT, UK
[b] Healthy Communities Research Centre, Faculty of Health Sciences, The University of Queensland, Ipswich, QLD 4305, Australia
[c] Screening and Test Evaluation Program/Centre for Medical Psychology & Evidence-based Decision-making, School of Public Health, University of Sydney, NSW 2006, Australia
[d] Indiana University School of Medicine, Section of Adolescent Medicine, 410 West 10th Street, HS 1001, Indianapolis, IN 46202, USA

ARTICLE INFO

Available online 8 November 2012

Keywords:
IRT
HPV vaccination
Scale development
HPV knowledge

ABSTRACT

Objective. Public understanding of HPV is important to ensure informed participation in cervical cancer prevention programmes. While many studies have measured HPV knowledge, none has developed a validated measure for use across countries. We aimed to develop and validate such a measure.

Method. Items tapping knowledge of HPV, HPV testing and HPV vaccination were developed from previous literature and with expert consultation. The 29-item measure was administered via the internet to 2409 adults in the UK, US and Australia in 2011. Classical test theory and item response theory were used to establish the measure's psychometric properties.

Results. Total scale reliability was very good ($\alpha = 0.838$), as was internal consistency for a 16-item general HPV knowledge subset ($\alpha = 0.849$). Subsets of HPV testing and vaccination items showed reasonable test–retest reliability ($r_{test-retest} = 0.62$ and 0.69) but moderate internal consistency ($\alpha = 0.52$ and 0.56). Dimensionality analyses suggested that one item was not measuring the same construct as the remainder of the questionnaire. A 2-parameter logistic item response theory (IRT) model was fitted to the remaining 28 scale items.

Conclusions. A structurally coherent set of items covering a range of important HPV knowledge was developed. Responses indicated a reliable questionnaire, which allowed the fitting of an IRT model.

Introduction

High-risk human papillomavirus (HPV) is the primary cause of cervical cancer (Bosch and Munoz, 2002). HPV testing and vaccination are important elements for cervical cancer prevention. HPV DNA testing is increasingly used as part of cervical screening (Albrow et al., 2012; National Health and Medical Research Council Cervical Screening Guidelines Review Group, 2005; U.S.Preventive Services Task Force, 2012) and prophylactic vaccination programmes have been established in many countries (Arbyn et al., 2012).

Scientific progress in understanding HPV infection has been very rapid, but public knowledge about HPV and HPV vaccination has generally lagged behind (Dahlstrom et al., 2012; Klug et al., 2008; Li et al., 2009; Marlow et al., 2007; Samkange-Zeeb et al., 2011; Tiro et al., 2007). Low awareness and poor knowledge of HPV are concerning given the active role that people are increasingly expected to play in making decisions about their healthcare (Woolf et al., 2005). Studies have explored what women need to know about HPV from a clinical perspective (Tristram, 2006), and what women *want* to know about HPV (Anhang et al., 2004a; McCaffery and Irwig, 2005). In addition, there is evidence that particular information about HPV (e.g. its high prevalence and likelihood of non-progression to disease) may be important in minimising the anxiety that can be associated with a positive HPV test result (Klug et al., 2008; McCaffery et al., 2006; Waller et al., 2007).

Over the last 10 years, many studies have assessed HPV knowledge in a variety of different populations and settings, using both quantitative and qualitative methods (see Klug et al., 2008 for a systematic review). However, comparison across studies is difficult, in part due to the lack of measurement consistency. There has been a tendency for each study to develop a new measure of knowledge, with minimal psychometric evaluation.

With the widespread introduction of HPV testing and vaccination, monitoring public awareness and knowledge is important, particularly with validated measures that allow comparisons across time and between populations. Such measures will facilitate the testing of public information materials to ensure that they successfully increase HPV knowledge. To this end, we developed and validated a brief measure of HPV knowledge and tested its psychometric properties, using item response theory (IRT) to model data from the UK, the US and Australia, where HPV vaccination and testing have been introduced fairly recently.

* Corresponding author. Fax: +44 20 7679 8354.
E-mail address: j.waller@ucl.ac.uk (J. Waller).

0091-7435/$ – see front matter © 2012 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.ypmed.2012.10.028

Methods

Selection of items

Items were collected from published quantitative studies of HPV knowledge (56 studies, published 1992–2009). Evaluation of these items indicated seven thematic areas into which general HPV knowledge could be grouped: 1) health consequences of HPV; 2) HPV and cervical screening; 3) symptoms; 4) causes, risk factors and transmission; 5) prevention and treatment; 6) prevalence; and 7) testing/vaccination. We selected initial items to assess general HPV knowledge that covered the first six areas, as well as items on testing and vaccination, ensuring the inclusion of issues and pieces of information found to be important to women in previous studies (Anhang et al., 2004b; McCaffery and Irwig, 2005; McCaffery et al., 2006; Waller et al., 2007). Items were discussed in detail among the authors and assessed for accuracy and completeness by two clinical HPV experts in each of the three countries (the UK, US and Australia). These steps led to the rewording, deletion and addition of some items. The final set of items included in the survey is listed in the Supplementary material. We used a 'true/false' response format, with a 'don't know' option, coded as incorrect. We used a mixture of true and false items to minimise response bias.

Participants

Participants were recruited through an online survey research company, *Survey Sampling International* (SSI), which maintains large respondent panels in multiple countries (e.g. over 1 million respondents in the US, over 200,000 in the UK, and over 80,000 in Australia). SSI sends e-mail invitations to a random subset of panel members who meet the study's entry criteria. We commissioned SSI to recruit 400 men and 400 women between the ages of 18 and 70 living in each of the three countries (USA, Australia and the UK) and to re-contact 50 male and 50 female participants who had heard of HPV from each country to complete the survey again 2-weeks later.

Procedure

From January to March 2011 potential participants were sent an invitation email with a link to the online study. Those who clicked on the link were directed to our web-survey and asked to enter their age, sex and country of residence. We set quotas to ensure we would not get more than the commissioned number of participants in each category. The online questionnaire was programmed and hosted by the Health Behaviour Research Centre, UCL and was approved by research ethics committees at UCL, University of Sydney and Indiana University.

Measures

Participants were asked 'Before today, had you ever heard of human papillomavirus (HPV)?' Those responding 'yes' were asked to complete 16 items assessing knowledge of HPV. They were then asked i) if they had heard of HPV testing, and if so, answered 6 items about HPV testing, and ii) if they had heard of HPV vaccination, and if so, answered 7 items about the vaccination. Participants also provided demographic information. The survey was completed online so there were no missing data.

Analysis

IRT was used to assess the psychometric properties of the HPV knowledge measure at the item level and to provide scale scores for respondents. In addition, classical reliability statistics and factor analyses were used to investigate test functioning and scale structure. All analyses were conducted separately on data from each country. Given very similar values for extracted factors, and reliability estimates that differed only at the second decimal place, analyses were conducted on combined data from the three countries.

Classical reliability statistics and factor analyses

We evaluated test–retest reliability and used Cronbach's alpha to assess internal consistency reliability. A high alpha also indicates the unidimensionality of the responses, and speaks to the construct validity of the test. To further evaluate dimensionality, exploratory principal axis factor analysis (EFA) and confirmatory factor analysis (CFA) were applied to item responses from each potential subscale (general HPV knowledge, HPV testing knowledge, and HPV vaccination knowledge) and from all 29 knowledge items together.

Item response theory (IRT)

IRT is a modern test theory that provides a means of evaluating and scoring response data by simultaneously modelling item and respondent characteristics, and has measurement advantages over classical methods of measurement (Ostini and Nering, 2006). The mathematical foundation of IRT is a function that relates the probability of a specific item response (e.g. a correct response to a knowledge question) to the respondent's trait level (e.g. amount of HPV knowledge) on the trait that the item is measuring (Ostini and Nering, 2006). IRT makes the following assumptions about the data produced by tests: item response data should be of known dimensionality, usually unidimensional; data must be locally independent which is usually the case if a test is unidimensional (Hambleton and Swaminathan, 1985); and finally, the latent variable is monotonically related to item response probability. Assumptions can be evaluated graphically or using item fit statistics.

A 1-parameter (Rasch-type) dichotomous IRT model (1PL) and a 2-parameter logistic IRT model (2PL) were fit to the response data using Parscale software (Muraki and Bock, 2003). The relative appropriateness of the two models for our data was evaluated by examining item fit statistics, item parameter estimate standard errors, item response function slopes, and levels of item information. Respondent knowledge scores were then estimated for each subset of items separately. Descriptive characteristics (mean and s.d.) for the three knowledge score distributions were calculated.

Finally, two additional analyses were conducted to provide validity information on the survey's functioning. First, respondent IRT scaled scores on each subset of items were correlated as a measure of overlap in the content of the three item subsets. Correlations were also calculated between responses on each subset of items and a single item survey question asking people to indicate how much they knew about HPV.

Results

Responses were obtained from 2409 participants of whom 1473 completed the general HPV knowledge items, 742 completed the HPV testing items and 1165 completed the HPV vaccination items (see Fig. 1). Sample characteristics are provided in Table 1.

Reliability analyses

Cronbach's alpha and test–retest reliability values for all 29 HPV knowledge items and for each potential subscale are provided in Table 2. Internal consistency and test–retest reliability for the 29-items were very good. The 16 general HPV knowledge items also had good internal consistency and test–retest reliability. Test–retest reliabilities for the six HPV testing items and the seven HPV vaccination items were good and fair respectively. The internal consistency of these two subscales was lower, suggesting some heterogeneity of item content.

Dimensionality analyses

The internal consistency analyses support interpreting the 16 items measuring general HPV knowledge and the full set of 29 items as conceptually coherent constructs.

Summary results from EFA investigating the unidimensionality hypothesis are shown in Table 3 and indicate good support for treating the 16 general HPV knowledge items as a single dimension. Based on the four criteria reported in Table 3, support for the unidimensionality hypothesis is the weakest for the whole 29 HPV knowledge item set. Follow-up EFA showed that removing items that did not load strongly did little to improve unidimensionality.

CFA results are presented in Table 4 and show that, for each item set, the fit of a 1-factor model is not supported from the Chi-square test and has weak support from the CFI and NFI statistics. The RMSEA and SRMR statistics provide stronger support for the unidimensionality assumption, including for the full 29 item set in the case of SRMR.