Spatial and Spatio-temporal Epidemiology 19 (2016) 78–90

Contents lists available at ScienceDirect

Spatial and Spatio-temporal Epidemiology

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

Original Research

Spatial variations in cervical cancer prevention in Colombia: Geographical differences and associated socio-demographic factors

Silvia Bermedo-Carrasco[a], Cheryl Waldner[b,*], Juan Nicolás Peña-Sánchez[c], Michael Szafron[d]

[a] School of Public Health, University of Saskatchewan, 104 Clinic Place, Saskatoon SK S7N 5E5, Canada
[b] Western College of Veterinary Medicine and School of Public Health, University of Saskatchewan, 52 Campus Drive Saskatoon SK S7N 5B4, Canada
[c] College of Medicine, University of Saskatchewan, 103 Hospital Drive, Saskatoon SK S7N 0W8, Canada
[d] School of Public Health, University of Saskatchewan, 104 Clinic Place, Saskatoon SK S7N 5E5, Canada

ARTICLE INFO

Article history:
Received 23 February 2016
Revised 8 May 2016
Accepted 28 July 2016
Available online 3 August 2016

Keywords:
Spatial analysis
Cervical cancer prevention
Papillomavirus vaccines
Pap test
Bayesian analysis
Colombia

ABSTRACT

We examined spatial variations in the frequencies of women who had not heard of human papillomavirus vaccination (NHrd-Vac) and who had not had Pap testing (NHd-Pap) among Colombian administrative divisions (departments), before and after considering differences in socio-demographic factors. Following global and local tests for clustering, Bayesian Poisson hierarchical models identified department factors associated with NHrd-Vac and NHd-Pap, as well as the extent of the spatially structured and unstructured heterogeneity. Models of spatial variations for both outcomes included the department percentage of women with subsidised health insurance. The relative risks of NHrd-Vac and NHd-Pap were highest in several departments adjacent to the Colombian border. Our finding that the risk of not having adequate access to cervical cancer (CC) prevention programmes in Colombia was location-dependent, could be used to focus resources for CC prevention programmes.

1. Introduction

Worldwide, 528,000 women were diagnosed with cervical cancer (CC) and 266,000 CC related deaths were reported in 2012 (Ferlay et al., 2013). Cervical cancer is a preventable disease (Singhrao et al., 2013) that inequitably impacts less developed regions of the world (Ferlay et al., 2013). Thousands of young women in developing nations continue to be diagnosed and die due to CC (Tsu and Levin, 2008). In Latin America, nearly 69,000 new CC cases were estimated in 2012. The 2012 age-standardised incidence rate of CC in Colombia was 18.7 per 100,000, which is higher than the rates for Costa Rica, Chile, and Brazil, but lower than those for Bolivia, Nicaragua, and Paraguay (Ferlay et al., 2013). Limited access by women to CC prevention programmes (Piñeros et al., 2007), socio-cultural and economic barriers, and organisational challenges to CC prevention programmes have been described as obstacles to decreasing the burden of CC in Latin America (PAHO, 2010).

A combination of primary and secondary strategies is recommended for preventing CC (PAHO, 2010; Grce, 2009). While primary prevention aims to reduce the

Abbreviations: CC, cervical cancer; Cr. I, credible interval; DANE, National Administrative Department of Statistics; GLMM, Generalised linear mixed models; HPV, human papillomavirus; NDHS, National Demographic and Health Survey; NHrd-Vac, have not heard of HPV vaccination; NHd-Pap, have not had Pap testing; RR, relative risk; RRR, relative risk ratio; RRR_M, median relative risk ratio.

* Corresponding author.
E-mail addresses: silvia.bermedo@usask.ca (S. Bermedo-Carrasco), cheryl.waldner@usask.ca (C. Waldner), juan.nicolas.ps@usask.ca (J.N. Peña-Sánchez), michael.szafron@usask.ca (M. Szafron).

http://dx.doi.org/10.1016/j.sste.2016.07.002
1877-5845/

occurrence of disease among susceptible individuals (e.g. through disease education, vaccination, health promotion), secondary prevention seeks to reduce the burden of illness and improve outcomes by case-finding early in the disease process (e.g. through screening) (Oleckno, 2008). Although education has been described as a key factor for the success of CC prevention programmes (Abiodun et al., 2014), Colombian studies have shown limited knowledge and awareness of the human papillomavirus (HPV) and its role in the development of CC (Hanisch et al., 2008), as well as the importance of HPV vaccination (Piñeros et al., 2013; Bermedo-Carrasco et al., 2015a). While in one study 77% of Colombian women reported participating in CC screening programmes (i.e. Pap testing) in the previous three years, there are still many women with limited access to Pap testing in Colombia (Piñeros et al., 2007).

Among Colombian women, different factors have been associated with the lack of Pap testing and not having heard of HPV vaccination. Having a limited education (Hanisch et al., 2008), living in rural areas (Bermedo-Carrasco et al., 2015a), and having subsidised health insurance (Bermedo-Carrasco et al., 2015a) have been associated with limited access to CC prevention programmes. Population density might also be an indicator of whether women participate in CC prevention initiatives, because of the association between population density and access to health care (Hanlon et al., 2012).

While spatial variations in CC mortality have been described (Piñeros-Petersen et al., 2010) across the 33 Colombian administrative divisions, called departments (32 departments and the Capital District, Bogotá, D.C.), spatial analyses of primary and secondary CC prevention have not been reported to date. The spatial analysis of primary and secondary CC prevention data could improve our understanding of geographical variations in risk (Elliott and Wartenberg, 2004) and identify any spatial patterns and disease clusters (Pfeiffer et al., 2008).

The overall goal of this study was to identify spatial variations in both the department frequencies of young women who have never heard of HPV vaccination and the department frequencies of young women in Colombia who have never had Pap testing. The first objective of this study was to use global and local tests for clustering to describe spatial patterns in the department frequencies of women aged 13–49 years who had not heard of HPV vaccination (NHrd-Vac) and the department frequencies of women aged 18–49 years who had not had Pap testing (NHd-Pap). The second objective was to examine whether the identified spatial patterns could be explained by department-level differences in socio-demographic attributes among women, including a lack of formal education, having subsidised health insurance, and living in rural areas, as well as differences in department population density.

2. Methods

2.1. Data sources

Data aggregated by Colombian departments (Appendix A) were used for this ecological study. The data were obtained from the 2010 Colombian National Demographic and Health Survey (NDHS) and the Colombian National Administrative Department of Statistics (*Departamento Administrativo Nacional de Estadística*–DANE). The 2010 NDHS was a representative nationwide survey comprising health information reported by 53,521 women aged 13–49 years (Ojeda et al., 2010). The 2010 department total population estimates used in this study were made available by DANE (DANE, n.d.).

Two CC prevention outcomes were summarised for each department from the 2010 NDHS: 1) the relative frequency of NHrd-Vac in women aged 13–49 years; and 2) the relative frequency of NHd-Pap in women aged 18–49 years. To compute the relative frequency of NHrd-Vac women in a given department, the numerator was the department number of women aged 13–49 who never heard of HPV vaccination (those who had not heard of HPV and a vaccine to prevent CC), and the denominator was the total department number of women aged 13–49 years surveyed in the 2010 NDHS. To compute the relative frequency of NHd-Pap women by department, the numerator was the department number of women aged 18–49 years who reported never having had Pap testing, and the denominator was the department total number of eligible women aged 18–49 years surveyed about CC prevention in the 2010 NDHS. According to the NDHS, women eligible to answer CC questions were those 18 years or older, who had experienced intercourse, and did not have a hysterectomy (Ojeda et al., 2010).

To describe socio-demographic risk factors, department percentages of women with no education (hereinafter called no education), having subsidised health insurance (hereinafter called subsidised insurance), and living in rural areas (hereinafter called rurality) were calculated for women aged 13–49 and 18–49 years. These percentages were used as potential risk factors for NHrd-Vac and NHd-Pap. Furthermore, the 2010 population density (hereinafter called density) was calculated per department as the total department population divided by the area of the department (in km^2). The five geographic regions established in the 2010 NDHS were used to summarise results across departments (Appendix A).

2.2. Spatial clustering

For both outcome variables (frequencies of NHrd-Vac and NHd-Pap women), global and local clustering tests were used to identify aggregations of cases (Lawson, 2006). To determine if global clustering was present, a global Moran's I for each study outcome was calculated using the empirical Bayes index proposed by Assunção and Reis (1999) and Bivand et al. (2008) via Monte Carlo simulation through the *spdep* package in the R software (R Core Team, 2013). This index used either the age-specific number of NHrd-Vac women or the number of NHd-Pap women as the numerator and the total department age-specific number of women as the denominator to account for the underlying population at risk (Assunção and Reis, 1999). Neighbouring departments were defined using a first-order Queen argument, accounting for the spatial relationships