Published in final edited form as:

Policy Polit Nurs Pract. 2011 November ; 12(4): 215–223. doi:10.1177/1527154411431326.

Exploring the Links Between Macro-Level Contextual Factors and Their Influence on Nursing Workforce Composition

Allison Squires, PhD, RN¹ and Hiram Beltrán-Sánchez, PhD²

¹New York University, New York, NY, USA

²University of Southern California, Los Angeles, CA, USA

Abstract

Research that links macro-level socioeconomic development variables to healthcare human resources workforce composition is scarce at best. The purpose of this study was to explore the links between non-nursing factors and nursing workforce composition through a secondary, descriptive analysis of year 2000, publicly available national nursing human resources data from Mexico. Building on previous research, the authors conducted multiple robust regression analysis by federal typing of nursing human resources from 31 Mexican states against macro-level socioeconomic development variables. Average education in a state was significantly associated in predicting all types of formally educated nurses in Mexico. Other results suggest that macro level indicators have a different association with each type of nurse. Context may play a greater role in determining nursing workforce composition than previously thought. Further studies may help to explain differences both within and between countries.

Keywords

Healthcare human resources; nurses; nursing; Mexico; nurse-to-population ratio

Background

Outside of the exploration behind the international migration of health workers, research that links broad, macro-level socioeconomic development variables to healthcare human resources workforce composition is scarce at best. Some low and middle-income countries (LMIC) with similar development characteristics have better production and retention rates of health workers than others, but the reasons for these differences are not as simple as a lack of financing, poor health system management, or the presence of war and conflict. Often, they result from differences in infrastructure quality, i.e. the physical and financial quality of educational and healthcare systems.

For nursing human resources, macro-level socioeconomic development variables may help to explain part of the reason for variations in nursing workforce composition. The history of how a profession developed and formally organized offers the baseline explanation for differences in workforce composition, mostly explained by educational policy changes related to entry into practice. Outside of history, however, contextual factors can be social, economic, or political influences outside of the control of the profession that still have an impact upon it. The purpose of this paper is to explore how contextual variables related to socioeconomic development might affect the composition of the nursing workforce. Mexican nursing human resources serve as the case example.

A recent study in development economics suggested that the quality of institutional infrastructure, on which professions depend highly for training and service deployment,

affects the level of women's development in a country (Owen & You, 2009). The link between the quality of institutional infrastructure and women's overall development may have broad implications for the gender and class composition of the healthcare workforce, especially within the female-dominated profession of nursing in which the quality of internal professional institutions and related ones (like the educational system) vary significantly from country to country. Analyzing associations between socioeconomic variables and the composition of the nursing workforce may provide important insights for the understanding of some of the extra-professional factors affecting the production, recruitment and retention of nursing personnel. By identifying where links (or a lack thereof) between production, retention, and socioeconomic development occur, domestic and international policymakers can further refine nursing human resources and other healthcare worker policies. Similar studies could also produce further insight into health outcomes differences between countries or regions by examining the relationship between extra-professional factors and the role composition of the overall healthcare workforce.

In terms of nursing workforce composition, the prognostic challenges increase when a single category of healthcare worker, like nurses, can represent multiple types of jobs that require a variety of educational levels. It complicates research related to human resources for health and methods must adapt accordingly. For example, suppose that country X has 5 nurses for every 1,000 people and 80% of them work in hospitals. Furthermore, suppose the health system of this country is moderately resourced, does not have high levels of technological penetration, and it also has increasing rates of chronic diseases among its population, subsequently causing a rise in hospitalization rates. If 4 out of 5 healthcare personnel categorized as nurses only had training as nurse's aides, country X would have poor outcomes related to hospitalization because it lacks better educated nurses to care for increasingly complex patients. Patients would have prolonged hospitalizations and a greater likelihood of complications if there are fewer professionally prepared nurses, as many studies have demonstrated (Aiken et al., 2001a; Aiken et al., 2001b; Aiken et al., 2003; Dall et al., 2009). In that case, the prevalence of nurse's aides working in the acute care system would also suggest a lack of professional infrastructure within the nursing profession that can support the production of more professionally prepared personnel.

Workforce composition also becomes important when examining broader health outcomes research in the community and in hospitals. Research in many countries has started to look at the links between socioeconomically sensitive health outcomes and personnel composition. One recent study demonstrated a link between the overall Nurse-to-Population Ratio per 1,000 people (NPOP) and a selected group of socioeconomic and professional infrastructure variables in Mexico (Squires & Beltrán Sánchez, 2009). That study showed that average education levels and types of work opportunities (public vs. private) explained 70% of the variance in the NPOP between Mexican States ($r^2 = .7$, $p = .0000$). It did not, however, differentiate between the different categories for nurses in Mexico in the analysis.

Other studies have explored the impact of workforce composition on mortality indicators while controlling for extraprofessional factors. One of the first studies investigating the impact of the nurse-to-population ratio on infant and under-5 mortality, while controlling for external factors like GNP per capita and female literacy, found that the inclusion of different external variables in the analysis caused healthcare personnel effects to disappear, suggesting unclear relationships or the need for analytic methods better capable of managing inter-country variability (Robinson & Wharrad, 2000). Other research showed that countries with more physicians had better maternal-child health outcomes while countries with more nurses had better childhood immunization rates (Anand & Bärnighausen, 2004, 2007). Those studies controlled for factors like national income, female adult literacy, and other variables in relation to the patients, but not in relation to the internal composition of the

healthcare workers themselves other than a categorical representation of physician and nurse.

With regard to the three studies described above, one factor that none of them included was the fact that nurses as a healthcare worker category may range from a nurse's aide to a masters degree or higher prepared nurse in both developed and developing countries. Country specific regulation also creates a variation, unknown in its scope, in what nurses are allowed to do in their roles. Therefore, to truly capture actual health outcomes sensitive to the nursing workforce, health services and policy researchers need to improve their understanding of the relationship between the local context and its impact on nursing workforce composition. Furthermore, without a better understanding of the impact of context on workforce composition, policymakers will fail to adequately understand issues related to the production of nursing personnel and the development of the profession, especially in low-resource settings. This paper attempts to enhance the understanding of those relationships.

Contextual Background – The Mexican Health System and Nursing

Mexico serves as the case example for this research because it is an upper middle income country with well-documented, publicly available nursing human resources data. Mexico ranks in the top twenty economies of the world and is a member of the Organization for Economic Cooperation and Development (OECD). The country is also economically diverse, with some of the world's richest and poorest people living there. Its healthcare system is a mix of public and private facilities. Epidemiologically, it is transitioning from an infectious disease profile to a chronic disease one (Arrendondo et al., 2005; Martínez & Leal, 2003). In terms of nurse migration, it is a "pre-migration" country where wide-scale emigration is not yet a problem (Squires, 2010).

In terms of workforce composition, Mexican nursing resembles its northern counterpart of the United States (U.S.) in that there are multiple levels of entry into the profession and multiple categories of nurses working in hospitals. Overall, there are approximately 200,000 nurses in Mexico with 8% having a bachelor's degrees and only 1% having graduate degrees (SIARHE, 2009). Most nurses come from families of low or middle socioeconomic status and are often the first in their families to receive a formal education beyond the eighth grade level (Squires, 2007). All nursing graduates, regardless of their type of program, must complete a year of social service in an acute care or community setting in order to receive their diploma and nursing license. The social service experience is similar, in many respects, to the growing numbers of post-baccalaureate nurse internship programs found in some large university medical centers in the U.S.

An important contextual note about the Mexican nursing workforce that is relevant to this study is that the Mexican government's salary commission, the entity that sets minimum wage levels for all workers in the country, formally recognizes nurses with a bachelor's degree or higher as "professionally prepared" (Boletín de Prensa, 2004). While administrators should recognize this through higher salaries for nurses with this level of preparation, it does not often happen in reality. There is rampant underemployment for bachelor's prepared Mexican nurses due to systemic problems with hiring procedures and other issues and as a result, nurses with this high level of education often work in jobs categorized as auxiliary nurses (nurse's aide) if that is the only job available (Nigenda et al., 2006). Neoliberal health system reforms from the last thirty years contributed to chronic underfinancing, thus the high levels of underemployment among BSN prepared nurses, and many of the other problems healthcare workers face in the country (Homedes & Ugalde, 2005; Malvárez & Castrillon, 2005; Segura et al., 2002). In addition, since all healthcare

workers in the public sector belong to a healthcare workers union specific to the division of the public system where they work, union policies have also contributed to complications in hiring policies in the public sector that have not necessarily benefitted the profession (Squires, 2007). The private sector, on the other hand, has erratic management practices when it comes to nursing personnel that contribute to low retention rates and offers fewer career advancement opportunities than the public sector (Squires, 2007).

In terms of workforce data categorization, for the national nurse-to-population ratio it is common for policymakers and analysts around the world to group all types of nurses, including aides, into a single nursing category or differentiate only between nurses and nurses aides (see WHO definitions: <http://apps.who.int/globalatlas/docs/HRH/HTML/Dfn.htm>). Within hospital administrative practices, however, the categorization of Mexican nursing personnel is only loosely based on education level and comprises the following types: auxiliary, generalist, technical, and specialist. Auxiliary nurses (nurse's aides) have minimal to no formal education in nursing and typically find work in hospitals. They are also widely used in primary care roles in both urban and rural Mexican communities. Generalist category nurses have a basic preparation ranging from the equivalent of licensed practical nurse preparation in the U.S. (with most receiving this training in a vocational high school) to a bachelor's degree. Technical nurses (minimum of associate's degree equivalent to U.S. nursing education but may have bachelor's degree) tend to work mostly in hospitals but can find employment opportunities in the private sector and in public health centers. Specialist nurses receive a certificate for pursuing four months to a year of additional training in areas like the operating room, intensive care unit, pediatrics, and obstetrics. Nurses with graduate degrees tend to work in administrative or educational roles in hospitals or universities.

The problems with nursing workforce categorization in Mexico present several challenges for producing not only accurate patient outcomes research, but also for workforce policy development. For example, it would be difficult to accurately capture the effect that a nurse's education has on patient outcomes if there are underemployed, formally educated nurses spending the majority of their time with patients. Short staffing situations have often placed auxiliary nurses with these levels of education in positions where they may practice outside their formal job description. In addition, with generalist nurses ranging in education from a graduate of vocational nursing high school in the 1980s to recent bachelor's degree graduates will also complicate the analysis. Therefore, prior to analyzing the institutional situation, capturing the effect of context on nursing composition can help to explain and possibly predict the nurse-to-population ratio specific to each type of nurse.

Methods

The analysis for this study followed a similar methodology as Squires and Beltrán-Sánchez (2009). Nursing workforce data, including type of nurse by role, at the state level from the year 2000 were drawn from the Secretaría de Salud y Asistencia's (SSA) website that has a publicly available database of Nursing Human Resources (NHR) for Mexico (SIARHE, 2009). The dataset used for this study had the most recent and complete breakdown of nursing workforce composition of anything that was publicly available in Mexico, with a few limitations. Of note, data was not available about number and types of nursing education programs in each state, only the total number of nursing schools for each state, some of which are university based and others are affiliated with vocational (high school level) or technical (post-high school) programs. The private sector releases nursing personnel data on a limited basis and therefore, data from that sector in this analysis may be incomplete but it is not enough to affect the results since the public sector is the largest employer of nurses (SIARHE 2009).

Nonetheless, for analytic purposes, the available data allowed the researchers to conduct a two phase analysis. The first phase analyzes each type of nursing job category and the second stage groups nurses into two categories representing formally educated nurses and auxiliary nurses. The selected variables, therefore, are tested for their associations with the Auxiliary-nurse-to-population ratio (auxiliary ratio), Generalist-nurse-to-population ratio (generalist ratio), Specialist-nurse-to-population ratio (specialist ratio), and with Other-nurse-to-population ratio (other ratio). The “Other” nurses are hospital administrators and “pasantes” –nurses who are in the process of completing their final year of training by working full time in hospitals or communities but have not yet received their diplomas. For the second phase, the groups divide into the auxiliary group while the other three categories merge into a single category of the formally educated nurse-to-population ratio (formally educated ratio).

Two approaches structured the analysis at the State level. First, bivariate techniques in the form of correlation coefficients and scatterplots tested for the association between each selected predictor and each kind of nurse-to-population ratio. A multivariate technique then fitted multiple linear regression models where auxiliary ratio, generalist ratio, specialist ratio, other ratio and formally trained ratio are the dependent variables, respectively. The independent variables, at the State level, include socioeconomic indicators, nursing preparation, and nursing workplace. Socioeconomic indicators include median household income (in 1,000 pesos in the year 2000), average education (average years of schooling), and average children per family. Nursing preparation is assessed through the total number of nursing school in each State. Finally, nursing workplace is represented by the ratio of the number of private to public health facilities. These linear models were estimated by implementing an iteratively re-weighted least squares robust regression method that allowed the researchers to dampen the effect of influential observations (Cleveland, 1979; Neter, Kutner, Nachtsheim, & Wasserman, 1996). Mexico City was eliminated from this analysis given that, with one quarter of the overall population of Mexico living there (~26 million people), it concentrates disproportionately large numbers on every covariate. Thus, the final analysis corresponds to 31 State-level observations.

Results

The largest average nurse-to-population ratio per 1,000 people in the country corresponds to the Generalist nurses followed by Auxiliary, while Specialists comprise the smallest ratio (Table 1). In terms of the explanatory variables used in this analysis, all States have similar average level of education and average number of children per family; but there are important differences in income, nursing schools and health care facilities across States.

The analysis showed that different factors predict the ratios of the two types of nursing groups that dominate the Mexican nursing workforce. Regression models showed that socioeconomic indicators and the nursing workplace work in opposite direction in their association with the nurse-to-population ratio. For example, States with higher average number of years of schooling in the population are associated with a significantly higher formally educated ratio, whereas a higher number of private facilities, relative to public facilities, is linked with a reduction in the formally educated ratio.

Analysis by Type of Nurse: Bivariate Results

Correlation coefficients show significant associations between some predictors and the nurse-to-population ratios (Figure 1). Increases in median household income are weakly associated with an increase in generalist ratio only, although positive links are observed between median household income and the rest of the nurse-to-population ratios. Thus, there

seems to be more demand for health services that require attention provided by Generalist nurses as median household income increases.

Average years of schooling is positively and significantly associated with an increase in every type of nurse-to-population ratio, more so among Generalist ($r=.67$, $p<.0000$) and Specialist ($r=.65$, $p=.0001$). Since nursing candidates are mostly women in Mexico, this result may illustrate the consequences of greater access to resources (financial, institutional, etc.) that promote educational and career advancement as state education level and per capita income are highly correlated.

Additionally, increases in the average number of children per family are significantly associated with declines in the specialist ratio only ($r=-.40$, $p=.02$). This finding implies that States with a high average number of children per family tend to have lower numbers of Specialist nurses. This evidence coincides with previous findings that sociocultural factors, particularly those related to childcare and family dynamics, could be associated with a reduced number of nurses (Specialists in this case) as childcare issues and other family demands will inhibit a nurse's ability to advance professionally until the children reach a mature age.

For Auxiliary and Generalist ratios, there is a significant negative association with the total number of nursing schools. While the finding for auxiliary ratio is not surprising, the generalist ratio finding is and may be explained by the types of nursing schools present in the state. If a state has more technical and university-based programs, then there will be fewer auxiliary nurses. Finally, the ratio of private-to-public facilities does not seem to be significantly associated with any type of specific nurse-to-population ratio in this bivariate analysis. Previous results show that the ratio of private-to-public facilities significantly associates with the overall nurse-to-population ratio (Squires & Beltrán-Sánchez 2009). Those results, however, come from multivariate analysis that control for other factors. These same data do provide evidence that suggest that increases in the number of private facilities, relative to public ones, inevitably reduce the overall nurse-to-population ratio in a Mexican state.

Analysis by Type of Nurse: Multivariate Results

The main covariate associated with the production of nurses is the average education level in a State, followed by weak associations with the ratio of private-to-public facilities and with average children per family (Table 2, Panel A). Except for auxiliary nurses, a one year increase in average education is significantly associated with average increases in nurse-to-population ratios, controlling for the rest of the covariates. This result is particularly important for Generalist nurses for which one year increase in education leads to an average of about 3 more nurses per 10,000 people.

Analysis for Formally Educated Nurses - Bivariate Results

Grouping Generalist, Specialist, and Other into formally educated nurse-to-population ratio (formally trained ratio) shows that average education level is the only covariate that is significantly and positively associated with this ratio (Figure 2). Contrary to this result, there are two weak negative associations between average children per family and total number of nursing schools with the formally trained ratio, respectively. As previously described, these negative links may imply that sociocultural factors could be associated with a reduced number of nurses or serve as an inhibitor to professional advancement. In terms of professional infrastructure, more nursing schools may not necessarily produce more nurses if there are large numbers of programs in a state that are of poor quality, not formally

accredited, or if the programs are not for professional preparation at the post-high school education level.

Analysis for Formally Educated Nurses - Multivariate Results

Consistent with the bivariate results, the average education level in a State is positively and significantly associated with the production of formally educated nurses, controlling for other factors (Table 2, Panel B). The magnitude of this association implies an average increase of about 4 formally educated nurses per 10,000 people for every one year increase in average education. On the other hand, there is weak evidence suggesting that increases in the number of private facilities, relative to public ones, invariably leads to a reduction in the formally trained ratio, controlling for other covariates. This result is consistent with previous qualitative findings where nurses described the private sector as, with few exceptions, hiring only the lowest educationally prepared nurses (Squires 2007).

Discussion

The findings from this study show that both socioeconomic development indicators and professional infrastructure can affect the types and numbers of nurses available to respond to the health needs of a country, thus nursing workforce composition. This study's results further expand on the work by Squires and Beltrán-Sánchez (2009), but more clearly defines where the effect between development, professional infrastructure, and nursing workforce composition occurs. The striking difference between the results for the formally educated ratio and the auxiliary ratio shows that for countries seeking to develop their nursing workforce, investments in education at all levels for women and men needs to be a central part of any nursing workforce development plan.

A few limitations did emerge while conducting the analysis and many are ones other researchers should be mindful of if they seek to replicate the study. First, the analytic methods used, data quality, and data age all impose their own limits on the results. Due to the small sample size ($n=31$), there is still the possibility that variables that are not statistically significant in this study may provide important insights in predicting nurse-to-population ratios at the state level. Countries with fewer states will have to have their analyses adapted to reduce the likelihood for error. There is also some concern about the accuracy of the data given that Mexico is a country that consistently ranks high on international corruption indices. The analytic process attempted to compensate for these factors by conducting a large number of statistical tests to comply with the assumptions of a linear model, and we believe the results of this study are robust and account for data inadequacies. With regard to the data's age, the data we used was the most complete, publicly available one that also included complete data for all the other contextual variables included in the analysis. Since finding complete datasets about nursing personnel in developing countries is often a challenge, the data serves as a way to establish the methods for this type of analysis. Further replication of the analysis with more recent data will help confirm the rigor, reliability, and validity of this analytic approach.

In addition, the methods and results presented here may not replicate well in other developing countries, especially if the quality of available nursing workforce data is limited. Cultural similarities in health services delivery between Mexico and other countries in Latin America may make the findings more closely applicable to nursing workforce issues in that region, but would require individual country analyses to confirm this assumption. Other factors that might influence the results include international migration rates and HIV/AIDS infection rates in the population as the disease is a known driver of nurse migration and contributes to healthcare personnel shortages in all categories. In countries where those two

issues are problems, researchers may need to factor them into the analysis to determine if they have significant effects.

Overall, however, the results presented here also demonstrate how measuring nursing human resources through just a total nurse-to-population ratio is not an adequate measure of the response capacity of a health system for providing nursing services nor will it produce an accurate picture of health outcomes without distinguishing between different nursing workforce categories. Another important aspect of these findings relates to the result illustrating the association between the ratio of private-to-public health facilities and the type of nurse. Private hospitals, in the case of Mexico, may prove to be a deterrent to a more educated workforce in that context because they pay the least, tend to have poor working environments from a management perspective, and these hospitals hire the least educated nursing staff possible so their profit margins are higher. This likely explains why states with a higher proportion of private hospitals, relative to public ones, also had higher numbers of auxiliary nurses. The facilities in private hospitals may look aesthetically more pleasing to an outsider, but if they hire the least educated nurses their outcomes are likely no better than a less aesthetically pleasing, government-managed facility. For Mexico, it is a simple equation: Public hospitals pay better and have better benefits, thus attracting more educated nurses to work in them even when they are not fully funded by the government to hire all the positions they need. The current opportunities the public sector presents for nurses for hiring requirements and career advancement actually promotes a better educated nursing population.

Generally, this finding in particular suggests that the collective package of opportunities, salaries, and benefits nurses can gain from working for an organization (public or private) may have more influence on workforce composition than who owns and manages the healthcare facility. The plethora of research that demonstrates how organizational characteristics can influence the nursing workforce, in particular how the hiring patterns of those institutions will influence workforce composition and personnel retention, also receives additional support from the results of this research. Therefore, by examining variables external to the workplace that affect workforce composition, the study illustrates how these relationships might influence the internal nursing workforce composition of a healthcare organization and, consequently, the quality of health worker relationships within institutions –a consistent issue in the quality of work environments.

Future research about the nursing workforce in countries with diverse categories of nursing personnel should also account for these different job categories when attempting to quantify or qualify the effect of nursing care on patient outcomes. Education does not always correlate with job category in many countries, so contextual experts would need to participate in the analytic team in order to produce the correct interpretation of the results. Simultaneously, capturing the effect of poor retention rates on outcomes would also be important because if a hospital has a constant stream of inexperienced or poorly educated nurses caring for patients, outcomes will differ even, perhaps, with adequate supplies to care for them.

Another important aspect of this study is that the findings laid a conceptual foundation to explore the relationship between the nursing work environment and personnel issues from a macro-level perspective. The findings from this study suggest that methods used to study nursing workforce issues, like the work environment, may also apply to low and middle income countries with some adjustments for context. Replication of these methods in other countries will also be a useful exercise to determine regional differences and similarities. Quantifying the effect of HIV/AIDS infection rates and migration (international and domestic) will help determine the extent to which these variables influence NPOP rates and

the types of nursing human resources that exist in the country. In other words, how exactly context affects these variables and nursing workforce composition will require further research in individual countries to determine the similar and distinct contextual variables.

Highlighting the effects of context on nursing workforce composition also becomes important as epidemiologic profiles of middle-income countries shift towards non-communicable disease ones. The acuity and complexity of chronically ill patients will increase with these epidemiologic shifts, even if health system resources lag behind. Hospitalization risk, in particular, will also increase and contribute to rising health system costs. As nurses caring for these types of patients in many countries already know, hospitalized, chronically ill patients require more nursing services and nurses that are better educated to handle the complexity of pathophysiologic conditions that come with chronically ill patients. The health system costs of caring for chronically ill patients and their complications will far outweigh the costs of additional nursing personnel working in the system (Dall et al, 2009). Even prevention efforts to keep chronically ill patients out of the acute care setting require more nurses in new roles with better education and most importantly, experience caring for chronically ill patients in a variety of settings.

To some, many of these findings may seem obvious, like a better educated population will have better educated nurses. In the case of Mexico, however, that logic does not always hold true, especially when considering the negative effect that private facilities have on nursing workforce composition --one that discourages more formally educated nurses. To date, however, research had not quantified the influence of external contextual factors on the nursing workforce or its composition, especially in developing countries. Above all else, this study helps lay the foundation for showing where the links exist between healthcare human resources, socioeconomic development, and professional infrastructure.

References

- Aiken LH, Clarke SP, Sloane DM, Sochalski JA. An international perspective on hospital nurses' work environments: the case for reform. *Policy, Politics, & Nursing Practice*. 2001a; 2(4):255–63.
- Aiken LH, Clarke SP, Sloane DM, et al. Nurses' reports on hospital care in five countries. *Health Affairs*. 2001b; 20:43–53. [PubMed: 11585181]
- Aiken LH, Clarke SP, Cheung RB, Sloane DM, Silber JH. Educational levels of hospital nurses and surgical patient mortality. *Journal of the American Medical Association*. 2003; 290(12):1617–23. [PubMed: 14506121]
- Anand S, Bärnighausen T. Human resources and health outcomes: cross-country econometric study. *Lancet*. 2004; 364:1603–09. [PubMed: 15519630]
- Anand S, Bärnighausen T. Health workers and vaccination coverage in developing countries: an econometric analysis. *Lancet*. 2007; 369:1277–85. [PubMed: 17434403]
- Arredondo A, Parada I, Orozco E, Garcia E. Impact of decentralization on health financing in Mexico. *Revista de Salud Pública*. 2004; 38(1):121–29.
- Arredondo A, Zúñiga A, Parada I. Health care costs and financial consequences of epidemiological changes in chronic diseases in Latin America: evidence from Mexico. *Public Health*. 2005; 119(8): 711–20. [PubMed: 15885723]
- Boletín de prensa; 16 de diciembre 2004; Mexico D.F: Comisión Nacional de Salarios Mínimos; 2004.
- Cleveland WS. Robust locally weighted regression and smoothing scatterplots. *Journal of the American Statistical Association*. 1979; 74(368):829–836.
- Dall M, Chen YJ, Seifert RF, Maddox PJ, Hogan PF. The economic value of professional nursing. *Medical Care*. 2009; 47(1):97–104. [PubMed: 19106737]
- Homedes N, Ugalde A. Neoliberal reforms in health services in Latin America: a critical view from two case studies. *Revista Pan Americana de Salud Pública/ Pan American Journal of Public Health*. 2005; 17(3):210–220.

- Lake ET. The nursing practice environment: measurement and evidence. *Medical Care Research and Review*. 2007; 64(2 Supplement):104S–22S. [PubMed: 17406014]
- Laurell AC. Health system reform in Mexico: a critical review. *International Journal of Health Services*. 2007; 37(3):515–35. [PubMed: 17844932]
- Malvárez, S.; Castrillón, C. Series Human Resources Development. Washington, DC: Human Resource Development Unit. Strategic Health Development Area. Pan American Health Organization; 2005. Overview of the Nursing Workforce in Latin America.
- Martinez SC, Leal FG. Epidemiological transition: model or illusion? A look at the problem of health in Mexico. *Social Science & Medicine*. 2003; 57(3):539–50. [PubMed: 12791495]
- Navarro Salazar, M.; Cárdenas Becerril, L.; Vázquez Domínguez, AT. Colegio Nacional de Enfermeras, AC: 55 Años de Vida. 2. Mexico, D.F: Colegio Nacional de Enfermeras; 2002.
- Neter, JH.; Kutner, MH.; Nachtsheim, CJ.; Wasserman, W. *Applied Linear Statistical Models*. Chicago: Irwin; 1996.
- Nigenda G, Ruiz JA, Rosales Y, Bejarano R. Enfermeras con licenciatura en México: estimación de los niveles de deserción escolar y desperdicio laboral [Bachelor's prepared nurses in Mexico: An estimation of attrition and labor wastage]. *Salud Pública de México*. 2006; 28(1):22–29. [PubMed: 16555531]
- Owen AL, You R. Growth, attitudes toward women, and women's welfare. *Review of Development Economics*. 2009; 13(1):134–150.
- Robinson J, Wharrad H. Invisible nursing: exploring health outcomes at a global level. Relationships between infant and under-5 mortality rates and the distribution of health professionals, GNP Per Capita, and female literacy. *Journal of Advanced Nursing*. 2000; 32(1):28–40. [PubMed: 10886432]
- Salas Segura, S.; Zárate, Grajales R.; Rubio, Domínguez S. Aportaciones de la Enfermería en el Sistema de Salud: Estudio De Caso [The Contributions of Nursing to the Health System: A Case Study]. Mexico, D.F: Instituto Nacional de Salud Pública; 2002.
- Secretaría de Salud y Asistencia. Estadísticas anuarias archivos. Secretaría de Salud y Asistencia; <http://sinais.salud.gob.mx/publicaciones/publicaciones.htm>
- Sistema de Recursos Humanos en Enfermería (SIARHE). [access 20 June 2009] Consulta: Personal de enfermería. <http://www.salud.gob.mx/unidades/cie/siarhe/>
- Squires A. NAFTA and Mexican Nursing. *Health Policy & Planning*. 2011; 26:124–32. [PubMed: 20595330]
- Squires, AP. Unpublished Doctoral Dissertation. New Haven: Yale University; 2007. A Case Study of the Professionalization of Mexican Nursing: 1980–2005.
- Squires A, Beltrán-Sánchez H. Predicting nursing human resources: An exploratory study. *Policy, Politics, and Nursing Practice*. 2009; 10(2):101–109.

Figure 1.
Bivariate Associations between Each Nurse-to-Population Ratio per 1,000 people and Each Explanatory Variable: Mexico, 2000

Figure 2.
Bivariate associations between formally educated nurse-to-population ratio per 1,000 people (FENPOP) and each explanatory variable.

Table 1

Descriptive Values of Selected Variables: Mexico, 2000

Variables	Mean	Std. Dev.	Min	Max	Source
Nurse-to-population ratio					
Auxiliary	0.77	0.25	0.39	1.19	(1)
Generalist	0.87	0.28	0.38	1.57	(1)
Specialist	0.18	0.10	0.05	0.47	(1)
Other	0.24	0.09	0.10	0.45	(1)
Formally trained	1.29	0.39	0.54	2.05	(1)
Socioeconomic indicators					
Median Income ^a	91.99	20.91	52.63	140.68	(2)
Average Education ^b	7.17	0.80	5.30	8.50	(2)
CPF	2.87	0.23	2.60	3.50	(2)
Nursing preparation					
Nursing Schools	11.19	9.03	2.00	36.00	(1)
Nursing workplace					
Private Facilities	63.65	70.58	8.00	390.00	(1)
Public Facilities	545.74	382.40	115.00	1528.00	(1)
RPr-P	0.13	0.11	0.03	0.56	(3)

Note: CPF stands for the average number of children under 18 per family, and RPr-P corresponds to the ratio of Private to Public facilities.

^aIn 1,000 Mexican pesos^bEducation is measured in single years of schooling

Sources: (1) SSA, (2) INEGI, (3) Own computation based on SSA data.

Table 2

Robust Regression Estimates for Each Type of Nurse-to-Population-Ratio: Mexico, 2000

Variables	Panel A			Panel B	
	Auxiliary ratio (A)	Generalist ratio (G)	Specialist ratio (S)	Other ratio (O)	Formally trained ratio (G)+(S)+(O)
Socioeconomic indicators					
Median income	0.003 (0.217)	-0.001 (0.488)	0.001 (0.520)	0.000 (0.619)	-0.001 (0.639)
Average education	0.088 (0.269)	0.279 (0.000)	0.049 (0.041)	0.084 (0.000)	0.438 (0.000)
Children per family	-0.129 (0.607)	0.215 (0.218)	-0.068 (0.355)	0.116 (0.092)	0.172 (0.509)
Nursing preparation					
Total nursing schools	-0.007 (0.203)	-0.005 (0.188)	0.000 (0.845)	0.001 (0.428)	-0.004 (0.504)
Nursing workplace					
Ratio Private to Public Fac.	-0.880 (0.087)	-0.349 (0.316)	-0.131 (0.370)	-0.217 (0.112)	-0.932 (0.081)

Note: p-values are shown in parenthesis.

Source: Own estimates based on Table 1.