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10-1-2007

# The Relationship Between Nurse to Population Ratio and Population Density: A Pilot Study in a Rural/Frontier State

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## THE RELATIONSHIP BETWEEN NURSE TO POPULATION RATIO AND POPULATION DENSITY: A PILOT STUDY IN A RURAL/FRONTIER STATE

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**Key Words:** Rural, Frontier, Nurse-to-Population Ratio, Population Density

### ABSTRACT

The purpose of this study was to evaluate the relationship between nurse to population ratio and population density. A secondary analysis was conducted, correlating nurse to population data with county-based population density data. The sample consisted of all 17 counties in the state of Nevada (3 urban, 4 rural and 10 frontier). County nurse to population ratios ranged from 178 to 861 per 100,000 population and population density ranged from 0.3 to 173.9 people per square mile (mean of 39.3). Correlational analysis indicated a significant positive relationship between nurse to population ratio and population density ( $r = .65$  ( $p < .005$ )). Mean nurse to population ratios were found to be significantly different between frontier (356/100,000), rural (682/100,000), and urban (587/100,000) counties ( $F = 7.53$ ,  $p = .006$ ). Not surprisingly, the results indicated that the lowest nurse to population ratios occur in areas with the lowest population density. These findings provide rural and frontier nurses with support in advocating for aggressive strategies to address the nurse to population disparity affecting rural and frontier communities.

### INTRODUCTION

The current global nursing shortage represents one of the most serious challenges facing health care today. Since 2002, the nursing shortage has been identified as a “global crisis” (Oulton, 2006). Nursing shortages have been an ongoing challenge in rural and frontier communities, however limited research to date has explored the unique characteristics, consequences and implications of rural nursing shortages.

#### *Review of the Literature*

A predominant variable in nursing workforce research and policy discussions is nurse to population ratio. International research addressing nurse to population ratios has demonstrated a wide variance across countries. In 1993, the World Bank recommended a minimum recommended ratio of nurses to population at .2/1000 population (20/100,000). Robinson and Wharrad’s research (Wharrad & Robinson, 1999; Robinson & Wharrad, 2000) using a global data set derived from United Nations sources, including 147 countries, indicated that nurse to population ranged from a low of .03/1000 population in Chad and Rwanda to 16.4/1000 in Angola and Norway (US = 7/1000). Globally, 40% of the variance in the nurse to population ratio was explained by the GNP per capita and the distribution of nurses was strongly correlated with the distribution of physicians ( $r = .84$ ,  $p < .0001$ ). International studies such as these, however, are limited by the fact that there is no global standard definition of “registered” nurse (Robinson & Wharrad, 2000). The

international studies have also not addressed nurse to population ratio in relation population density or rural/urban differences.

Recent research, however, in Canada has addressed rural/urban considerations related to the Canadian nursing workforce. Pitblado (2005) and his associates report that 17.9% of Canadian nurses work in rural areas, but 21.7% of the total population are rural residents. The Canadian nurse to population ratio in 2000 in rural areas was 62.3 per 10,000 compared with the urban ratio of 78.0. Geographically, the Canadian nurse-to-population ratios decrease from east to west. This study also indicted that rural Canadian nurses had lower levels of education both at practice entry and throughout their careers as compared with their urban colleagues, which is consistent with studies in other countries (Kulig, 2005). They also found that rural Canadian nurses are more likely to have multiple employers and work in non-hospital settings than urban nurses.

### ***Nurse to Population Ratio in the U.S.***

In the United States, according to the most recent National Sample Survey of Registered Nurses, conducted in March 2004, there were an estimated 2.9 million registered nurses. The national ratio of employed nurses per 100,000 population (the nurse to population ratio) as of March 2004 was 825, increased from 782 in 2000. Historically, the nurse to population ratio in the US has increased from 436/100,000 in the 1970's to 638 in the 1980's and 720 between 1990 and 1996 (Shih, 1999). New England and the Middle Atlantic regions consistently have the highest nurse to population ratios, while the Pacific, West North Central, and South Atlantic regions have historically had the lowest nurse to population ratios (Shih, 1999). According to the National Center for Health Workforce Analysis (2004), in 2000 the national supply of full time equivalent registered nurses was estimated at 1.89 million while the demand was estimated at 2 million, a shortage of 110,800 (6%). By 2010 that shortage is estimated to reach 17%, 27% by 2015, and an alarming 36% by 2020.

In rural and frontier areas of the U.S., the current nursing shortage is particularly acute, because it has just exacerbated long standing nursing shortages that have plagued those communities for decades (LaSala, 2000; Stratton, Dunkin, & Juhl, 1995). Movassaghi and his associates (Movassaghi, Kindig, Juhl, & Geller, 1992) examined the 1988 National Sample Survey of Registered Nurses and found the nurse to population ratio (using work location) to be 726/100,000 in metropolitan areas, compared to 385 in rural areas. When rural areas were examined in more depth, the nurse to population ratio was found to be 448 in counties with populations of 25,000 to 50,000, 319 in counties with 10,000 to 25,000 and 349 in counties with less than 10,000. Thus, the nurse to population ratio in the most rural areas (counties with less than 25,000 residents) was less than half of the ratio in metropolitan areas. This stratification of rural areas failed to take into account the geographic size of counties, thus did not truly reflect population density, only population size. Additional findings from this study indicated that rural nurses had lower educational levels than urban nurses and a higher percentage of rural nurses worked outside of hospitals, especially public health and nursing homes.

More recently, Skillman, Palazzo, Keepnews and Hart's (2006) research using the 2000 National Sample Survey of Registered Nurses found that 20.8% of RNs in the US lived in rural areas, including 9.2% in large rural, 6.7% in small rural, and 4.9% in

isolated rural areas, which approximated the general population distribution. The nurse to population ratios in urban and large rural areas (by residence) were similar (830 and 794/100,000), but declined significantly in small rural and isolated small rural areas (723 and 719/100,000), similar to Movassaghi's earlier findings. These disparities in nurse to population ratios based on population size were found to be even more pronounced when location of employment rather than location of residence was considered. The nurse to population ratio per 100,000 population (by location of employment) was 836 in large rural, 679 in small rural and 411 in isolated small rural areas as compared with 839 in urban areas. These findings indicated that a significant proportion of nurses living particularly in the most rural areas commute to jobs in urban areas. The average age for rural nurses was 43.1 years, which was similar to urban nurses (43.4 years), however the average age increased slightly as rurality increased. This study also indicated that rural nurses had significantly lower levels of education, with 32.2% of rural nurses holding a baccalaureate or higher degree versus 46.6% of urban nurses. The more rural the nurses were, the lower their educational levels. This study also found that rural nurses earned 14 to 18% less than urban nurses, with salary declining with increasing rurality. Rural nurses were also more likely to work full-time and in non-hospital settings, particularly public/community health settings, a trend again that increased with increasing rurality. Unlike previous studies, this study used zip code (RUCA) coding in designating rurality, rather than the more traditional county-based designations. This method is advantageous in that it provides more precise differentiation of rural areas, especially in counties with a mixture of rural and urban areas. The use of the National Sample Survey data has the advantage of providing nationwide data that can be compared with previous Survey results. However the data are based on sample data, and underrepresentation of nurses located in very rural areas may occur (Bigbee & Lind, 2007). The variable of population density again was not addressed directly in this study, but was somewhat reflected in the RUCA coding of rurality.

### ***Purpose and Conceptual Framework***

Thus, no research to date has specifically addressed nurse to population ratio in relation to the specific variable of population density. It may be argued that comparing rural/urban differences indirectly addresses population density, however, this is a relatively rough measure at a categorical level that fails to capture the unique challenges of populations living in very sparsely populated areas. Thus, the purpose of this study was to evaluate the relationship between nurse to population ratio and population density using counties as the unit of analysis. The concept of "Nurse Dose" served as the theoretical framework for the study. Brooten and Youngblut (2006) recently proposed this concept, which includes three components: dose, nurse, and host response. They define "dose" as the number of nurses or amount of care given by nurses; "nurse" as the education, expertise, and experience of the nurse; and "host response" as the response of the patient or organization to the nurse's care. Current research, most of which is hospital-based, has demonstrated that "differing nurse doses have been associated with both increases and decreases in patient mortality, morbidity, and health costs" (p.94). Brooten and Youngblut contend that in the macro view, nurse to population ratios related to geographic areas are consistent with their conceptual model. (In the macro view,

“dose” is the number of nurses per capita, and “host” could be a community, a hospital, or another health care organization.) However, community-oriented population-based studies addressing the concept of nurse dose are extremely limited and no studies have specifically addressed the nurse dose concept in relation to rurality. Two research questions were addressed in this pilot study:

1. What is the relationship between nurse to population ratio and county population density?
2. Are there significant differences in nurse to population ratios between urban, rural and frontier counties?

## METHODOLOGY

A correlational secondary analysis was conducted, examining nurse to population data in relation to county-based population density in the state of Nevada, which is an ideal setting to study nurse to population ratios, particularly in relation to rural and frontier areas. Between 1990 and 2000 the population of the state increased 69% to approximately 2 million, and the explosive growth has continued since then, making it one of the fastest growing states in the nation. Not surprisingly, Nevada is currently experiencing one of the most critical nursing shortages in the U.S. According to the 2000 National Sample Survey of Registered Nurses, there were an estimated 12,940 registered nurses in Nevada in 2000 (increasing to 16,206 in 2004). As a result, Nevada held the dubious distinction of having the worst nurse-to-population ratio in the nation, 520/100,000, as compared with the national average of 782 in 2000. Nevada’s nurse to population ratio increased to 604/100,000, compared with the national ratio of 825/100,000 in 2004, which made it second worst in the nation above California at 590/100,000. The National Center for Health Workforce Analysis (2004) predicted a Nevada nursing shortage of 12% in 2000, 23% in 2005, 31% in 2010, 41% in 2015, and 50% in 2020.

The sample consisted of all 17 counties in the state of Nevada, including three urban, four rural and ten frontier counties. Rural counties were defined as counties with no Metropolitan Statistical Area, and frontier counties were defined as those counties with population densities of less than seven persons/square mile. Nevada ranks second only to Alaska among U.S. states for having the highest percentage of frontier counties. The nurse-to-population ratios by county were drawn from The Nursing Workforce and Nursing Education in Nevada report (Packham, 2003) based on 1999 data from the Nevada State Board of Nursing and population estimates from the Nevada State Demographer's Office. Thus the complete dataset (not a sample) of Nevada nurses was used, ensuring a more accurate count particularly of nurses in rural and frontier areas. The location of the nurses was classified by residence only (not location of employment). The county population density data were calculated using county land area data and population estimates from the same time period obtained from the Nevada State Demographer’s Office.

## RESULTS

Descriptive analysis revealed that county-level nurse to population ratios ranged from 178 to 861 per 100,000 population with a mean of 473. Fifteen of the state's 17 counties (89%) had nurse to population ratios below the national average of 782 per 100,000 population. Looking specifically at the 14 rural and frontier counties, the nurse to population ratio was below the national average in all but one county. All of the frontier counties were also below the overall state average. County population density ranged from 0.3 to 173.9 persons/square mile with a mean of 39.3 and a median of 1.8 persons/square mile. This skewed distribution is consistent with the predominance of rural and frontier counties in the state.

In addressing the first research question regarding the relationship between county-based nurse to population ratio and population density, a two-tailed Pearson's correlational analysis was conducted. The results indicated a significant positive relationship between nurse to population ratio and population density ( $r = .65, p < .005$ ). In light of the international data that has demonstrated a strong link between nurse and physician distribution, a follow-up correlational analysis including physician to population ratio was performed. These results indicated that neither the relationship between population density and physician to population ratio ( $r = .33, p > .05$ ), nor the relationship between nurse to population ratio and physician to population ratio ( $r = .33, p > .05$ ), were statistically significant, which is in contrast to some previous international findings.

To compare the nurse to population ratios in the urban, rural and frontier counties (research question two), an analysis of variance was conducted. The results revealed significant differences in the mean nurse to population ratios between the frontier (356/100,000), rural (682/100,000), and urban (587/100,000) ( $F = 7.53, p = .006$ ) counties. The slightly higher rural ratio can be explained by the relatively few rural counties included (4) and the recent rapid growth of the state's urban counties. In light of the small number of counties and the unequal distribution between the urban, rural, and frontier categories, a non-parametric Kruskal Wallis test of difference was conducted and the results again indicated a significant difference between the three groups ( $\chi^2 7.043, p = .030$ ).

## DISCUSSION

In light of the current global nursing shortage the results of this pilot study are highly relevant in assessing the distribution of nursing professionals, particularly in rural and frontier areas. The findings indicate that nurse to population ratio is positively related to population density and that frontier counties have significantly lower nurse to population ratios than rural or urban counties, which is not surprising given the chronic nursing shortages that plague many rural and frontier areas. These findings, based on a relatively small state population, suggest that the nursing shortage is most acute in those areas with the lowest population densities. These results provide additional evidence related to the chronic rural nursing shortage which can be used in advocacy efforts addressing nurse recruitment and retention efforts, particularly in areas with the lowest population density.

### ***Limitations and Research Implications***

This study was limited by the small sample of counties drawn from only one unique state. In addition, nurse to population ratios in counties with very small populations must be interpreted cautiously due to the effect of small numbers. For example, if 10 nurses live in a rural county with a population of 3,000, the nurse to population ratio is 333/100,000. If only three additional nurses move into this county, the nurse to population ratio jumps to 433/100,000. Calculating the nurse to population ratio based on 1000 population rather than 100,000 is arguably more appropriate in this setting but limits the comparability with national data. The fact that data related to nurses' location of employment was not included also represents a significant limitation. Further research is indicated using more current data with larger samples, addressing both location of nurse residence and employment, to elucidate the relationship between nurse to population ratio and population density in greater depth. It is essential, however, that the variable of nurse to population ratio be viewed within the larger context. This perspective is emphasized by the Canadian nursing workforce researchers who stress that geographic factors, such as distance and isolation, as well as unique practice patterns must also be considered when assessing the rural nursing workforce (Pitblado, 2005). Further international research is also indicated, examining nurse to population ratios in relation to population density and rural/urban differences, within and between developed and developing nations.

The results of this pilot study also support the "Nurse Dose" concept as a useful theoretical approach for the study of nurse to population ratios and nursing workforce dynamics in general. This study primarily addressed the "dose" aspect of the concept. Further research addressing the entire concept, including the "nurse" and "host response" aspects, in relation to nurse to population ratio is indicated to fully assess the theoretical utility of the concept at the macro level. Specifically assessing community health outcomes as related to nurse to population ratios would be particularly relevant to building the empirical basis for this newly developed conceptual approach.

### ***Practice, Education and Policy Implications***

Implications for rural practice and policy include the need for increased emphasis on nurse recruitment and retention in rural and frontier areas. Aggressive strategies to address the chronic disparities in nurse to population ratios affecting frontier and some rural communities are particularly needed, including creative incentives to attract and retain professional nurses to live and work in the most remote communities. Greater emphasis on creative approaches to educating nurses specifically for rural and frontier practice is also indicated. It is critical that these strategies be shared among the international nursing community to address the rural nursing shortage from a truly global perspective.

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