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Health Service Accessibility and Risk in Cervical Cancer Prevention: Comparing Rural Versus Nonrural Residence in New Mexico

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Abstract

Purpose—Multiple intrapersonal and structural barriers, including geography, may prevent women from engaging in cervical cancer preventive care such as screening, diagnostic colposcopy, and excisional precancer treatment procedures. Geographic accessibility, stratified by rural and nonrural areas, to necessary services across the cervical cancer continuum of preventive care is largely unknown.

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Methods—Health care facility data for New Mexico (2010-2012) was provided by the New Mexico Human Papillomavirus Pap Registry (NMHPVPR), the first population-based statewide cervical cancer screening registry in the United States. Travel distance and time between the population-weighted census tract centroid to the nearest facility providing screening, diagnostic, and excisional treatment services were examined using proximity analysis by rural and nonrural census tracts. Mann-Whitney test ($P < .05$) was used to determine if differences were significant and Cohen's r to measure effect.

Findings—Across all cervical cancer preventive health care services and years, women who resided in rural areas had a significantly greater geographic accessibility burden when compared to nonrural areas (4.4 km vs 2.5 km and 4.9 minutes vs 3.0 minutes for screening; 9.9 km vs 4.2 km and 10.4 minutes vs 4.9 minutes for colposcopy; and 14.8 km vs 6.6 km and 14.4 minutes vs 7.4 minutes for precancer treatment services, all $P < .001$).

Conclusion—Improvements in cervical cancer prevention should address the potential benefits of providing the full spectrum of screening, diagnostic and precancer treatment services within individual facilities. Accessibility, assessments distinguishing rural and nonrural areas are essential when monitoring and recommending changes to service infrastructures (eg, mobile versus brick and mortar).

Keywords

cervical cancer; cervical cancer prevention; geographic accessibility; health care accessibility; health service delivery

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Despite our knowledge on how to prevent invasive cervical cancer, the American Cancer Society estimates that in the United States during 2016, there will be 12,990 cases of invasive cervical cancer and 4,120 deaths.[1] Invasive cervical cancer is mostly preventable because pre-cancer can be detected through cervical cancer screening (Papanicolaou [Pap] and/or human papillomavirus [HPV] testing), and treatment can excise precancerous lesions prior to invasion.[2] Screening is highly effective in reducing the incidence of invasive cervical cancer[3-5] but it is just one component of the full spectrum of cervical cancer preventive care. Cervical cancer preventive care, herein the continuum of preventive care, consists of a multi-step process moving across screening, diagnostic colposcopy, and excisional precancer treatment procedures.[6]

While there has been considerable research on non-spatial risk factors for cervical precancer and cancer outcomes (eg, sociodemographics and behavioral variables),[7-9] few studies have examined the association of spatial factors (eg, access to services) and the continuum of preventive care. Moreover, despite declines in cervical cancer incidence, rural and nonrural disparities persist.[10] Previous studies comparing the rural versus metropolitan cervical cancer incidence rate during 1998-2001 found a 14% higher rate in rural areas,[11] and a study of the 2000-2008 period reported a 15% higher rate in rural areas.[10] Although access to care is a complicated matrix of interacting variables,[12] there is consensus that access to screening and follow-up services is a potential driver for cervical cancer incidence.[10,11,13,14]

Geographic accessibility (generally characterized as travel distance or travel time) frequently represents the spatial dimensions of access[15-17] to health care services and it is commonly used as a predictor variable for health outcomes.[17-19] The prevention of cervical cancer could require travel to different health care facilities because not all providers and not all facilities can perform the services across the full continuum of preventive care.[6] For example, once a positive cervical screening test is detected, a diagnostic colposcopy would often be performed, and in some instances, an excisional treatment must be sought if precancer is detected—this could require travel to different health care facilities. Thus geographic accessibility has the potential to become a barrier to optimal health outcomes,[8,20] in particular as women with increasing risks for cervical precancer (eg, abnormal screening or diagnostic results) move through the continuum of preventive care.[19,21]

Even though clinical care delivery for cervical cancer screening, diagnostic, and precancer treatment is similar for all women, access to various specialty services may differ based upon rural and nonrural residence.[22,23] This disparity in access has not been specifically analyzed by service type across the continuum of preventive care. In rural areas limited medical infrastructures, including inadequate supply of providers ranging from primary care physicians and mid-level practitioners who most frequently recommend Pap tests, to gynecologic oncologists and medical oncologists who treat patients with cervical cancer,[21,24] and fewer on-site oncology services including radiation and chemotherapy are additional barriers that rural residents must navigate.[23] Population characteristics that place women at greater risk for incidence and mortality from cervical cancer, such as poverty, being elderly, and lack of or inadequate health insurance coverage are disproportionally concentrated in the less populated, rural areas of the United States.[8,23,25]

There is extant literature on geographic accessibility for preventive services to breast and colorectal cancer treatment facilities, and some studies have stratified differences by rural and nonrural residence. While findings have been inconsistent, studies have examined the association between geographic accessibility and breast cancer outcomes.[16,17,26,27] Using a multistate dataset, Henry and associates[17] found that longer travel time was not associated with a higher risk of late-stage breast cancer diagnosis and that accessibility to screening services was not correlated with rural/urban residence type. A study using the Surveillance, Epidemiology, and End Results (SEER) Program registry supported previous findings that women residing in rural areas, compared to women living in urban areas, had an increased likelihood of mastectomy.[28] Regardless of where one lives, studies have found that increased travel distance was a statistically significant predictor of mastectomy.[16,29] Colorectal cancer research has found that spatial access to an oncologist had a statistically significant association with survival amongst rural residents, while the finding did not exist for those living in urban areas.[30] In contrast, geographic accessibility to preventive services *across* the continuum of cervical cancer preventive care is understudied; previous studies have examined one component of the continuum rather than access to all of the necessary multistep preventive processes.[31]

This study aimed to describe geographic accessibility, defined as travel distance and travel time to health care facilities that perform cervical cancer screening (Pap and/or HPV testing), diagnostic testing (colposcopy), and excisional precancer treatment services (loop electrosurgical excision procedure or cone biopsy) in New Mexico, during the years 2010-2012. Results were stratified by rural and nonrural census tract to examine geographic accessibility by these dimensions, as Guidry and colleagues[19] identified this level of analysis as a gap in the literature. Drawing upon the call for the standardization of what constitutes rural and nonrural geography, we utilized definitions proposed by Meilleur and associates.[32] To our knowledge, this is the first study to measure geographic accessibility to health care facilities that performed actual services across the continuum of preventive care for cervical cancer prevention.

Methods

Study Area and Screening Population

The study area was New Mexico, a state with a female population of 1,042,716.[33] The most recent cervical cancer screening guidelines recommend initiating screening at age 21 years and stopping screening at age 65 years.[3,5,34] Approximately 57% of the New Mexico female population are within the age eligibility for this screening guideline.[33] Twenty-three percent of the overall female population lives in a rural area,[35] 20% are below the federal poverty level, and 16% have less than a high school education.[33]

Data Sources

The Office of Rural Health Policy, US Department of Health and Human Services,[36] provided Rural–Urban Commuting Area (RUCA) codes at the census-tract level. Socio-demographic data (eg, population, education, and poverty status) were obtained from the American Community Survey (ACS), 5-year estimates (2007-2011).[33] The New Mexico HPV Pap Registry (NMHPVPR) was the source for health care facility data for the years 2010-2012. Established in 2006, the NMHPVPR is the first population-based statewide cervical screening registry in the United States. The NMHPVPR includes address-level data on health care facilities that provided cervical screening (Pap and/or HPV testing), diagnostic testing (colposcopy), and excisional precancer treatment (loop electrosurgical excision procedure or cone biopsy). NMHPVPR acts as a designee of the New Mexico Department of Health that operates under NMAC 7.4.3, which specifies the list of Notifiable Diseases and Conditions for the state of New Mexico. The NMAC 7.4.3 specified that laboratories must report to the NMHPVPR all results for Pap and HPV tests, and cervical, vulvar and vaginal pathology performed on women residing in New Mexico.

Geographic Units

The geographic unit of analysis was the census tract (N = 499). To compute the mean population-weighted census tract centroid, we used census tract[33] and block group-level[37] population data retrieved from the ACS 5-year estimates (2007-2011 and 2009-2013). Census tracts are small, relatively permanent statistical subdivisions of counties, are relatively homogenous in population characteristics and organized to maintain an optimum population size of 4,000 (range between 1,200 and 8,000).[38] Block groups are statistical divisions of census tracts and range in population between 600 and 3,000.[39] We used ACS 5-year estimates (2007-2011) for the female age group most closely aligned with the cervical cancer screening guidelines (21-64 years old). The population-weighted centroid method used 498 census tracts; tract 9403 was deleted due to zero population count (located within the Los Alamos Laboratory area).

Rural and Nonrural Geography

There is not a single established definition for "rural" in US research or policy studies. Most recently, the Office of Rural Health Policy (ORHP)[40] definition was proposed as a standard, in order for cancer researchers to adopt one standard that can be used to define rural, and thereby utilize a common analytical approach.[32] The multiple definitions for rural and nonrural reflect the multidimensional nature of these concepts, often leading to confusion and unwanted mismatches in program eligibility.[40] Cancer research studies evaluating outcomes and patterns of care have used various definitions of rural, resulting in difficulty when comparing studies and making generalizations.[32] Because the purpose of our study was to determine if there was a significant difference in access to health services across the continuum of preventive care comparing rural to nonrural census tracts, we opted to utilize the ORHP definition as discussed in Meilleur and associates.[32] Moreover, while the ORHP does not require agencies to adopt its definition of rural, and recognizes that alternate definitions may be better suited for the purpose of specific program requirements, the ORHP definition is used to determine geographic eligibility to apply for rural health grants.[36]

Geographic Spatial Analytical Approaches

Two types of locations were used in this analysis: (1) the origin (ie, population-weighted centroid of the census tracts for the state of New Mexico) and (2) the destination (ie, geographic coordinates [latitude and longitude] of the facilities). We used two measures of geographic accessibility to conduct proximity analysis to the nearest destination from the point of origin by year for each type of service provided across the continuum of preventive care. First, we measured travel distance (hereafter referred to as distance) via roads *from* the road nearest to the population-weighted census tract centroid *to* the nearest facility providing specific service within the continuum of preventive care. Second, we measured the shortest travel time (hereafter referred to as time) *from* the road nearest to the population-weighted census tract centroid *to* the nearest facility providing specific service within the continuum of preventive care.

The Texas A&M University Geoservices Online Geocoding service, version 4.01, was used to geocode the New Mexico health care facility data by type of service provided across the continuum of preventive care.[41] All health care facilities could be geocoded; however, to improve quality we used the Geocode Correction tool within the Texas A&M University Geocoder as described by Goldberg and associates.[41,42] The mean population-weighted centroid function within ArcGIS 10.1 was used to compute the centroids of the census tracts.[43] The population-weighted centroid is a summary single reference point, which represents how the population is spatially distributed and grouped at the census tract-level.[44] Due to the common data limitation of not having patient-level addresses, geographic accessibility studies address this limitation by assigning a single point location to represent the location of a population. The travel time computation based upon this single point is assumed representative of the travel time realized by population members.[45] This assumption can mask significant variability, which is revealed in the range, but is necessary because of the uncertainty of potential factors that influence travel when conducting population-based studies.[46] Census tracts were weighted based upon screen eligible population to remove effects based upon varying population. The ACS 5-year estimates (2007-2011) of the female population (21-64 years old) were used to represent the screen eligible population, as this age group is most closely aligned with current cervical cancer screening guidelines of women aged 21-65 years old. As a first step in data processing, we used Python™ programming language (version 2.7.5)[47] to automate the enumeration of census tracts by their screen eligible population. This allowed for the calculation of a weight of each census tract to be based upon the screen eligible population. We then used these weights to adjust for effects based upon varying population; the source code is available from the authors by request.

Distances and times were calculated using the Shortest Path calculator developed for the North American Association of Central Cancer Registries, which is maintained at the Texas A&M University GeoInnovation Service Center.[48] The shortest path and fastest route methodology was computed as described by Henry and colleagues.[17]

Distance was grouped into seven categories (in kilometers): <15; 15 to < 30; 30 to < 45; 45 < 60; 60 to <75; 75 to <100; and 100+. These categories were established based on breast cancer research of geographic proximity analysis of surgical and treatment facilities.[16] Time was grouped into seven categories (in minutes): <10; 10 to < 20; 20 to < 30; 30 to < 40; 40 to < 50; 50 to <60; and >60. Similarly, these categories were established based on breast cancer treatment geographic proximity to diagnosing facility and nearest mammography facility research.[17]

The Mann-Whitney test (2 independent samples, $P < .05$, 2-tailed) was used to determine if differences in distance and time were statistically significant for rural census tracts versus nonrural census tracts. Cohen's r was calculated to determine effect size.[49] A small effect is 0.1, a medium effect is 0.3, and a large effect is 0.5.[49,50]

Travel time by aforementioned categories were mapped by rural and nonrural areas to display spatial representation of geographic accessibility, which aided in visually identifying gaps in the location of services.[51] To map density of cervical screening, diagnostic, and excisional precancer treatment facilities by screening population, we used the screen eligible population by census tract.

This study was reviewed and approved by the University of New Mexico Human Research Review Committee and by the Texas A&M University Institutional Review Board.

Results

All health care facilities were successfully geocoded. Based upon geocode quality codes,[42] approximately 81% of health care facilities were geocoded at the building centroid, 6% at the exact parcel centroid, 10% by address range interpolation, 2% at the street centroid, and less than 1% at the US Postal Service Zip Code area centroid and city centroid level. Table 1 shows the address-level health care facilities that provided services across the continuum of preventive care in New Mexico for the years 2010 through 2012. In terms of the percentage of services across the study years, facilities in rural areas provided the majority of total services in the form of screening (75%-79%) compared to 68%-69% of facilities in nonrural areas. The percentage of screening and diagnostic services was consistently higher in nonrural areas compared to rural areas; there was a slight increase for both areas during 2011. However, rural areas in 2012 dropped back to 2010 levels while nonrural areas retained the majority of the increase. The percentage of facilities that provided all services (screening, diagnostic and precancer treatment) in nonrural areas was consistently higher compared to facilities in rural areas year-to-year, but the differential was reduced from 45% in 2010 to 37% in 2012.

Across all cervical cancer preventive health care services and years, women who resided in rural areas had a significantly greater geographic accessibility burden when compared to nonrural areas (4.4 km vs 2.5 km and 4.9 minutes vs 3.0 minutes for screening; 9.9 km vs 4.2 km and 10.4 minutes vs 4.9 minutes for colposcopy; and 14.8 km vs 6.6 km and 14.4 minutes vs 7.4 minutes for precancer treatment services, all $P < .001$). Distance and time increase as one must seek advanced care to prevent cervical cancer; however, the finding was less pronounced for nonrural census tracts. Tables 3 and 4 show 2010-2012 time and distance measurements from the population-weighted census tract centroid to the nearest health care facility that provided cervical cancer preventive service care by nonrural and rural census tracts.

The Mann-Whitney U test was used to evaluate the distance and time differences from the population-weighted centroid to the nearest facility providing cervical screening services by nonrural and rural census tracts (Table 2). Reporting results from 2012, which are representative of the findings during the study period, we found a significant small effect for time (Median (*Mdn*) unit of measurement expressed as minutes) to screening services comparing rural (*Mdn* = 5.40) and nonrural (*Mdn* = 3.00) census tract groups, $P < .001$, and $r = .198$. For time to diagnostic services, we found a significant medium effect comparing rural (*Mdn* = 10.20) and nonrural census (*Mdn* = 5.40) tract groups, $P < .001$, and $r = .327$. Similarly, there was a medium effect for travel time to nearest health care facility that provided excisional service comparing rural (*Mdn* = 16.20) and nonrural (*Mdn* = 7.80) census tract groups, $P < .001$, and $r = .300$. We found a significant small effect for distance to screening services comparing rural (*Mdn* = 4.41) and nonrural (*Mdn* = 2.57) census tract groups, $P < .001$, and $r = .210$. For distance to diagnostic services, we found a significant medium effect comparing rural (*Mdn* = 9.72) and nonrural census (*Mdn* = 4.39) tract groups, $P < .001$, and $r = .309$. Similarly, there was a small effect for time to nearest health care facility that provided excisional service comparing rural (*Mdn* = 17.25) and nonrural (*Mdn* = 6.63) census tract groups, $P < .001$, and $r = .284$.

Visual representation of female (21-64 years old) population density in New Mexico revealed vast areas that have extremely low population density dominating the state. Differences in female population density range from .033 to 1231 (mean 225 and standard deviation of 268). There was an observed relationship with densely population areas and the presence of health care facilities that provided services across the continuum of preventive care. As posited, densely populated areas, ie, nonrural census tracts, had a large number of facilities that provided services across all components of the continuum of preventive care. Travel time and travel distance from the population-weighted census tract centroid to the nearest health care facility comparing rural to nonrural census tracts varied significantly. The disparity is most pronounced in the northeastern portion of the state, which is rural and where the female population density is low. In this area, travel time to cervical cancer diagnostic colposcopy and excisional precancer treatment services is predominantly 60+ minutes. In the southwestern portion of the state, which has low population density and is mainly rural, there is a cluster of nonrural census tracts present, which has similar travel times and distances to diagnostic and treatment services, as compared to the rural census tracts in the same area.

Discussion

This study set out with the aim of describing geographic accessibility to health care facilities providing services across the continuum of cervical cancer preventive care, stratified by rural and nonrural census tracts in New Mexico during the years 2010 to 2012. Our findings confirm that women in rural areas, as opposed to those residing in nonrural areas, are significantly burdened with longer travel distances and times to obtain preventive cervical cancer health care services. Women living in rural areas may be less inclined to seek or may delay follow-up care, which could result in treatment of invasive cervical cancer rather than of pre-invasive cancer. There are fewer facilities providing all services across the continuum of preventive care in rural census tracts, as compared to nonrural census tracts. Visual inspection of spatial maps illustrates that predominant clusters of facilities, regardless of type of service provided, are located in the most densely populated, nonrural areas of the state. These findings support previous research that rural areas have limited medical infrastructure.[21,24] While rural census tracts have a comparable percentage of facilities that provided only cervical screening services, as compared to nonrural census tracts, this finding does not preclude a contribution to failures in the continuum of cervical cancer preventive care at this level. Previous studies have reported that physicians in rural clinics are less likely to recommend and/or perform cervical cancer screening.[22,23,52] Thus, the service that is most accessible to women in rural areas (ie, cervical screening) may not be adequately recommended.

Since our study is the first to describe distance and time to all services across the continuum of cervical cancer preventive care, we do not have comparative measures. The most similar cervical cancer research study to our work examined travel distance and travel time to the nearest general practitioner and the nearest cancer center.[53] Our data are in agreement with Brewer and colleagues[53] who reported a median distance to the nearest cancer center facility, which would be equipped to perform diagnostic and excisional precancer treatment services for cervical cancer prevention, as 21 km compared to less than 1 km for a general practice facility that would predominantly provide cervical cancer screening services. We found that the median distance to excisional precancer treatment services (14.77 km for rural vs 6.56 km for nonrural census tracts) was farther than to cervical screening services (4.37 km for rural vs 2.48 km for nonrural census tracts); our travel time findings also align.

There were fewer health care facilities that provided diagnostic and excisional precancer treatment services, as compared to cervical screening services, which is to be expected. All women aged 21-65 years need access to a facility that provides cervical cancer screening services, whereas the need for diagnostic or excisional precancer treatment procedures during 2010 through 2012 was approximately 10- and 100-fold less, respectively, when compared to cervical screening.[54]

This study was limited by the absence of individual-level usage of services; it measures population-based access rather than realized individual access. Being limited to address-level health care facilities that provided services across the continuum of preventive care for New Mexico only, we did not integrate geographic accessibility for areas adjacent to state boundaries. However, state-level data records report that less than 3% of services across the continuum of preventive care were provided outside of New Mexico.[54] Due to data limitations, these findings do not consider that distance to care could be longer for individual women who participate in systems of care that would then require bypassing the nearest facility[16] to receive care as a system member. Furthermore, distances and travel times to care for individual women who do not have health insurance might be longer still, potentially exacerbating poor health outcomes associated with lack of health insurance.[56,57]

The geographical accessibility findings in this study were strengthened by the use of actual health care facility locations that provided services across the continuum of preventive care. The use of actual health care facility locations rather than a default of a primary care physician location is a more accurate measure of geographic accessibility.[24] Stratification by rural and nonrural census tracts extends our knowledge of differences in geographical accessibility. Our use of the ORHP rural definition supports the call for it to be a research standard; we further this initiative by highlighting its use for determining geographic eligibility to apply for health grants. Findings based upon the use of the ORPH rural definition can be used in public policy settings to support the need for resources. Finally, we used the Shortest Path method to compute distance and time because in mountainous areas of the Western United States, such as our study area, it is recommended for improved accuracy versus Euclidean distance measurement.[58]

Conclusion

This study has demonstrated that those at greatest risk for cervical cancer (ie, those who require excisional treatment for cervical precancer) are burdened with the greatest distance and longest time to obtain required specialty health care, as compared to those accessing cervical screening and diagnostic services, irrespective of where one resides. Women who live in rural census tracts are disproportionality burdened, as compared to those living in nonrural census tracts. Recent research found that universal compliance to the recommended screening guideline for all screen-eligible women (ie, 3-year cytology), along with 100% compliance to colposcopy/biopsy referrals, resulted in the greatest reduction in lifetime cervical cancer incidence (72.2%) as compared to current screening practice (48.5%).[59] We found that health care facilities providing both screening and colposcopy/biopsy services or the full spectrum of screening, colposcopy/biopsy, and excisional precancer treatment services were limited at 12% and 8% for rural, and 17% and 13% for nonrural census tracts, respectively. These findings illustrate the challenges that women with cytologic or histologic abnormalities will often be referred for follow-up at different facilities simply because few facilities offer colposcopy and excisional services. Furthermore, the need to access multiple different facilities as the risk of invasive cervical cancer increases presents additional barriers for at-risk women.

Future research should examine the relationship between geographic accessibility (stratified by rural and nonrural areas) to health care services by race/ethnicity groups given the documented cervical cancer disparities among racial/ethnic minorities.[8] Further, efforts to investigate how geographic accessibility to health care facilities may influence failures of 3-year interval cervical screening and failures in recommended follow-up for diagnosis and treatment of cervical abnormalities should be undertaken. Our use of the proposed ORHP definition[32] to define rural and nonrural census tracts has a practical application. If unequal access is found and the ORHP definition is used, health practitioners would have met the geographic eligibility requirement to apply for a rural health grant and have evidence-based findings to support the need for resources. Other factors related to geographic accessibility, including direct costs (eg, cost for gas), indirect costs (eg, ability to take time off work), and availability of public transportation[60] should also be considered in future studies. Continued efforts are needed to ensure that all women have comparable access to services across the continuum of cervical cancer preventive care.

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Table 1

Health Care Facilities Performing Various Cervical Cancer Preventive Services by Year, in Rural and Nonrural Census Tracts in New Mexico, 2010-2012

	2010				2011				2012			
	Nonrural		Rural		Nonrural		Rural		Nonrural		Rural	
Services Provided[a]	N	%	N	%	N	%	N	%	N	%	N	%
Screening Only[b]	228	69.3%	241	78.8%	240	67.8%	230	75.7%	234	68.0%	232	79.2%
Diagnostic Only[c]	3	0.8%	2	0.7%	3	0.9%	2	0.6%	4	1.2%	1	0.3%
Excisional Treatment Only[d]	0	0.0%	1	0.3%	0	0.0%	0	0.0%	1	0.3%	0	0.0%
Screening and Diagnostic Only	51	15.6%	38	12.4%	67	18.9%	49	16.1%	60	17.4%	36	12.3%
All Services[e]	47	14.3%	24	7.8%	44	12.4%	23	7.6%	45	13.1%	24	8.2%

[a]No facilities were identified that only provided screening and excisional treatment services or diagnostic and exicisional treatment services.

[b]Screening services include Pap smear and/or HPV testing.

[c]Diagnostic service is colposcopy.

[d]Excisional treatment services includes cone and loop electrosurgical excision procedure.

[e]Screening, diagnostic, and excisional treatment.

Table 2

Travel Time (minutes) From Population-Weighted Census Tract Centroid to Nearest Health Care Facility That Provided Cervical Cancer Screening, Diagnostic, and Excisional Treatment Services for Nonrural Census Tracts and Rural Census Tracts in New Mexico, 2010–2012

Screening[a]	2010	2011	2012	Diagnostic[b]	2010	2011	2012	Treatment[c]	2010	2011	2012
Nonrural (301) Time (minutes)											
<10	89.82%	88.03%	87.18%	<10	77.16%	77.96%	76.02%	<10	66.86%	65.58%	64.42%
10-< 20	6.84%	8.62%	9.48%	10-< 20	16.57%	15.88%	16.99%	10-< 20	22.86%	19.39%	20.72%
20-< 30	0.92%	1.03%	1.03%	20-< 30	3.02%	2.90%	2.85%	20-< 30	3.75%	5.33%	5.16%
30-< 40	1.07%	1.07%	1.07%	30-< 40	1.47%	1.47%	2.35%	30-< 40	3.89%	6.76%	6.71%
40-< 50	0.73%	0.63%	0.63%	40-< 50	1.17%	1.17%	1.17%	40-< 50	2.03%	2.03%	2.08%
50-< 60	0.00%	0.00%	0.00%	50-< 60	0.00%	0.00%	0.00%	50-< 60	0.00%	0.29%	0.29%
60+	0.62%	0.62%	0.62%	60+	0.62%	0.62%	0.62%	60+	0.62%	0.62%	0.62%
Mean	5.28	5.50	5.59	Mean	7.63	7.69	8.11	Mean	10.26	11.29	11.41
Median	3.00	3.00	3.00	Median	4.80	4.80	5.40	Median	7.20	7.20	7.80
IQR[d]	1.80–6.00	1.80–6.30	1.80–6.30	IQR[d]	2.40–9.60	3.00–9.60	3.00–10.50	IQR[d]	4.20–12.60	4.20–13.80	4.20–13.80
Min	0.01	0.01	0.01	Min	0.60	0.60	0.60	Min	0.60	0.60	0.60
Max	76.80	76.80	111.00	Max	84.60	84.60	84.60	Max	96.00	96.00	96.00
Rural (197)											
<10	68.89%	67.64%	68.06%	<10	49.12%	47.19%	47.70%	<10	41.43%	42.01%	37.51%
10-< 20	12.92%	14.43%	14.01%	10-< 20	18.60%	18.81%	19.06%	10-< 20	15.84%	16.31%	19.49%
20-< 30	8.75%	9.07%	9.07%	20-< 30	9.54%	10.35%	9.68%	20-< 30	7.71%	7.71%	9.56%
30-< 40	3.27%	2.29%	2.29%	30-< 40	6.05%	7.95%	7.67%	30-< 40	7.62%	7.62%	7.23%
40-< 50	1.29%	1.29%	1.29%	40-< 50	4.81%	5.20%	2.66%	40-< 50	6.06%	5.77%	5.94%
50-< 60	0.50%	1.48%	1.48%	50-< 60	1.66%	1.98%	1.77%	50-< 60	4.70%	4.70%	5.87%
60+	4.38%	3.80%	3.80%	60+	10.20%	8.51%	11.46%	60+	16.64%	15.88%	14.41%
Mean	11.79	11.84	11.89	Median	20.97	21.02	21.81	Median	29.19	27.86	28.53
Median	4.80	4.80	5.40	IQR[d]	10.20	10.80	10.20	IQR[d]	14.40	12.60	16.20
IQR[d]	1.80–16.50	2.10–16.80	2.10–17.10	IQR	5.10–31.50	4.80–32.70	5.40–33.30	IQR	5.70–48.00	5.70–46.80	6.30–48.30
Min	0.01	0.01	0.01	Min	0.60	0.60	0.60	Min	0.60	0.60	0.60
Max	188.40	188.40	186.00	Max	194.40	194.40	194.40	Max	195.60	195.60	195.60

Census tracts weighted based upon screen eligible population.

[a]Screening services include Pap smear and/or HPV testing.

[b]Diagnostic service is colposcopy.

[c]Excisional treatment services include cone and loop electrosurgical excision procedure.

[d]IQR indicates Interquartile Range (Q1-Q3).

Table 3

Travel Distance (kilometers) From Population-Weighted Census Tract Centroid to Nearest Health Care Facility That Provided Cervical Cancer Screening, Diagnostic, and Excisional Treatment Services for Nonrural Census Tracts and Rural Census Tracts in New Mexico, 2010-2012

Screening[a]	2010	2011	2012	Diagnostic[b]	2010	2011	2012	Treatment[c]	2010	2011	2012
Nonrural (301) Distance (km)											
<15	94.93%	94.84%	94.09%	<15	85.40%	85.70%	84.47%	<15	80.03%	76.59%	76.24%
15-< 30	3.72%	3.91%	4.49%	15-< 30	11.94%	11.30%	12.00%	15-< 30	12.01%	10.61%	10.96%
30-< 45	0.86%	0.75%	0.93%	30-< 45	1.73%	2.08%	1.72%	30-< 45	3.91%	6.73%	6.73%
45-< 60	0.50%	0.50%	0.50%	45-< 60	0.92%	0.92%	1.81%	45-< 60	2.26%	3.67%	3.67%
60-< 75	0.00%	0.00%	0.00%	60-< 75	0.00%	0.00%	0.00%	60-< 75	1.17%	1.68%	1.68%
75-< 100	0.00%	0.00%	0.00%	75-< 100	0.00%	0.00%	0.00%	75-< 100	0.11%	0.22%	0.22%
100+	0.00%	0.00%	0.00%	100+	0.00%	0.00%	0.00%	100+	0.50%	0.50%	0.50%
Mean	4.49	4.67	4.76	Mean	7.27	7.30	7.87	Mean	10.91	12.66	12.88
Median	2.29	2.57	2.57	Median	4.12	4.18	4.39	Median	6.50	6.55	6.63
IQR[d]	1.80–6.00	1.80–6.30	1.80–6.30	IQR[d]	2.40–9.60	3.00–9.60	3.00–10.50	IQR[d]	4.20–12.60	4.20–13.80	4.20–13.80
Min	0.03	0.03	0.03	Min	0.21	0.21	0.21	Min	0.21	0.45	0.45
Max	52.69	55.68	55.65	Max	56.71	56.71	56.71	Max	110.58	110.58	110.58
Rural (197)											
<15	75.68%	75.68%	76.10%	<15	60.42%	57.46%	58.47%	<15	51.21%	52.26%	47.12%
15-< 30	14.15%	13.99%	13.57%	15-< 30	13.60%	15.22%	13.04%	15-< 30	10.27%	10.27%	15.20%
30-< 45	4.78%	4.14%	4.14%	30-< 45	7.39%	6.37%	9.76%	30-< 45	5.36%	5.36%	6.25%
45-< 60	2.65%	3.51%	3.51%	45-< 60	7.83%	11.32%	5.85%	45-< 60	10.16%	9.12%	10.69%
60-< 75	2.74%	2.67%	2.67%	60-< 75	2.74%	4.12%	4.29%	60-< 75	5.26%	5.67%	3.67%
75-< 100	0.00%	0.00%	0.00%	75-< 100	4.44%	2.78%	4.38%	75-< 100	6.65%	7.81%	6.18%
100+	0.00%	0.00%	0.00%	100+	3.57%	2.72%	4.21%	100+	11.09%	9.50%	10.88%
Mean	10.87	11.08	11.13	Mean	23.36	23.33	24.65	Mean	37.28	34.91	36.35
Median	4.35	4.35	4.41	Median	9.72	10.35	9.72	Median	14.32	12.73	17.25
IQR[d]	1.80–16.50	2.10–16.80	2.10–17.10	IQR[d]	5.10–31.50	4.80–32.70	5.40–33.30	IQR[d]	5.70–48.00	5.70–46.80	6.30–48.30
Min	0.03	0.03	0.03	Min	0.32	0.32	0.43	Min	0.32	0.76	0.76

Screening[a]	2010	2011	2012	Diagnostic[b]	2010	2011	2012	Treatment[c]	2010	2011	2012
Max	74.85	73.50	73.85	Max	199.75	193.51	161.30	Max	252.73	215.30	214.04

Census tracts weighted based upon screen eligible population.

[a]Screening services include Pap smear and/or HPV testing.

[b]Diagnostic service is colposcopy.

[c]Excisional treatment services include cone and loop electrosurgical excision procedure.

[d]IQR indicates Interquartile Range (Q1-Q3).

Table 4

Differences in Travel Distance (kilometers) and Travel Time (minutes) by Nonrural Census Tracts Versus Rural Census Tracts[a]

Distance (km)	Mdn Diff.[b]	IQR[c]	U[d]	P[e]	r[f]	Time (minutes)	Mdn Diff.[b]	IQR[c]	U[d]	P[e]	r[f]
Screening[g]											
2010	2.060	1.288-7.081	$2.9*10^9$	<.001	.210*	2010	1.800	1.800-7.800	$2.9*10^9$	<.001	.210*
2011	1.770	1.304-7.339	$2.9*10^9$	<.001	.205*	2011	1.800	1.800-8.400	$3.0*10^9$	<.001	.198*
2012	1.835	1.304-7.483	$2.9*10^9$	<.001	.210*	2012	2.400	1.800-9.000	$3.0*10^9$	<.001	.198*
Diagnostic[h]											
2010	5.601	2.478-14.307	$2.5*10^9$	<.001	.303* *	2010	5.400	3.000-12.000	$2.4*10^9$	<.001	.320* *
2011	6.164	2.768-14.774	$2.5*10^9$	<.001	.311* *	2011	6.000	3.600-12.600	$2.4*10^9$	<.001	.326* *
2012	5.327	2.800-14.500	$2.5*10^9$	<.001	.309* *	2012	4.800	3.600-13.200	$2.4*10^9$	<.001	.327* *
Excisional Treatment[i]											
2010	7.821	3.734-19.441	$2.6*10^9$	<.001	.273*	2010	7.200	4.200-18.000	$2.5*10^9$	<.001	.292*
2011	6.180	3.862-23.529	$2.8*10^9$	<.001	.243*	2011	5.400	4.800-19.800	$2.7*10^9$	<.001	.264*
2012	10.622	4.136-25.476	$2.6*10^9$	<.001	.284*	2012	8.400	4.800-19.800	$2.5*10^9$	<.001	.300* *

[a] Analysis included nonrural (n=301) and rural (n=197) census tracts weighted by target screening population.

[b] Difference in Medians (Rural - Nonrural).

[c] IQR indicates Interquartlie Range (Q1-Q3).

[d] Indicates Mann Whitney U score.

[e] Mann Whitney Test (2 Independent Samples, $P < .05$, 2-tailed).

[f] Cohen's *r* indicates effect size of Mann-Whitney U test, .1 is a small effect(*), .3 is a medium effect(**), and .5 is a large effect (*).

[g] Screening services include Pap smear and/or HPV testing.

[h] Diagnostic service is colposcopy.

[i] Excisional treatment services includes cone and loop electrosurgical excision procedure.