



## Discussion

## Rural areas are disproportionately impacted by smoking and lung cancer

Wiley D. Jenkins<sup>a,1</sup>, Alicia K. Matthews<sup>b</sup>, Angie Bailey<sup>c</sup>, Whitney E. Zahnd<sup>a</sup>, Karriem S. Watson<sup>d,e</sup>, Georgia Mueller-Luckey<sup>f</sup>, Yamile Molina<sup>d,e</sup>, David Crumly<sup>a,\*</sup>, Julie Patera<sup>c</sup>

<sup>a</sup> Office of Population Science and Policy, SIU School of Medicine, Springfield, IL 62794-9664, United States

<sup>b</sup> College of Nursing, University of Illinois at Chicago, Chicago, IL, United States

<sup>c</sup> Southern Illinois Healthcare, Carbondale, IL 62902, United States

<sup>d</sup> Community Engaged Research and Implementation Science, University of Illinois at Chicago, Chicago, IL, United States

<sup>e</sup> Division of Community Health Sciences, School of Public Health, University of Illinois at Chicago, Chicago, IL, United States

<sup>f</sup> Applied Health Department, Southern Illinois University, Edwardsville, IL, United States

## ARTICLE INFO

## Keywords:

Rural cancer disparities

Lung cancer

Screening

Low dose computed tomography

## ABSTRACT

Rural populations have higher rates of late stage lung cancer incidence and mortality compared to urban populations, making them important target populations for low dose computed tomography (LDCT) screening. LDCT screening has been shown to reduce lung cancer mortality and is recommended by the United States Preventive Services Task Force for individuals who meet certain risk criteria. However, rural populations may experience greater system, provider, and individual-level barriers to screening and related health-seeking behavior (e.g. smoking cessation). LDCT screening was first tested in urban, academic centers, so it is still unknown how readily it may be implemented in rural areas. Additionally, rural populations have limited access to both primary care physicians who may refer to LDCT screening and specialty physicians who may perform the screening. Further, rural populations may be less likely to seek screening due to lack of awareness and understanding or other unknown knowledge or psychosocial barriers. There are several strategies that may address these rural specific challenges. First, further research is needed to better understand the individual-level barriers that rural patients experience. Second, to reduce system-level barriers, additional efforts should be made to increase rural access to screening through improved referral processes. Third, creation of decision support materials to equip rural providers to engage their patients in a shared decision making process regarding screening may help reduce physician level barriers. Fourth, development of a holistic approach to smoking cessation may help reduce lung cancer risk in conjunction with LDCT screening.

## 1. Introduction

Lung cancer (LC) is the leading cause of cancer-related death for both men and women in the United States, with an annual mortality exceeding that for breast, prostate, colon, and pancreatic cancers combined (Howlader et al., 2014). The overall 5-year survival for LC is approximately 17% and has not changed significantly in 25 years despite advances in diagnosis, imaging, staging, and treatment (Howlader et al., 2014). The American Cancer Society estimates there will be ~222,500 new LC cases and ~155,870 deaths (~13% of all cancer cases and ~26% of deaths) in 2017 (American Cancer Society, 2017a). Further, these figures are not equitably distributed, with known disparities by race, socioeconomic status, geography, and gender (Ward et al., 2004; National Institutes of Health, 2008; Tabatabai et al., 2016).

Of particular concern is the rural-urban disparities in lung cancer incidence and mortality (2000–2006 data) (Atkins et al., 2017). However, recent advances may have significant impact, as the pivotal outcomes of the National Lung Cancer Screening Trial (NLST) demonstrated the benefit of screening using low dose computed tomography (LDCT) (Bach et al., 2012; National Lung Screening Trial Research Team et al., 2011).

However, the demographic engaged in the NLST was not reflective of the barriers seen in LC screening in rural communities (Bach et al., 2012; National Lung Screening Trial Research Team et al., 2011). A review of national, population-based cancer registries (2009–2013 data) indicates that lung and bronchus cancer incidence, distant stage incidence, and mortality rates are all elevated in rural areas (Table 1; not published elsewhere). Individuals who reside in rural areas

\* Corresponding author.

<sup>1</sup> Science Director, Office of Population Science and Policy; Associate Professor, Family and Community Medicine, SIU School of Medicine, 201 E. Madison Street, Springfield, Illinois 62794-9664, United States.

E-mail addresses: [wjenkins@siumed.edu](mailto:wjenkins@siumed.edu) (W.D. Jenkins), [aliciak@uic.edu](mailto:aliciak@uic.edu) (A.K. Matthews), [dcrumly22@siumed.edu](mailto:dcrumly22@siumed.edu) (D. Crumly).

<https://doi.org/10.1016/j.pmedr.2018.03.011>

Received 20 October 2017; Received in revised form 14 March 2018; Accepted 21 March 2018

Available online 24 March 2018

2211-3355/ © 2018 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

**Table 1**  
Rural-urban rate ratios lung cancer incidence and mortality; 2009–2013.

	All rate ratio (95% CI)	Male rate ratio (95% CI)	Female rate ratio (95% CI)
Incidence rate ratio <sup>a</sup>	1.14 (1.14–1.15)	1.20 (1.19–1.20)	1.08 (1.07–1.09)
Distant stage incidence rate ratio <sup>a</sup>	1.15 (1.15–1.16)	1.18 (1.17–1.20)	1.10 (1.09–1.11)
Mortality rate ratio <sup>b</sup>	1.20 (1.19–1.21)	1.24 (1.24–1.25)	1.13 (1.12–1.14)

Urban is the reference group.

<sup>a</sup> Data from the NAACCR public use dataset (Lichter, 2012).

<sup>b</sup> Data from the NCHS mortality data embedded in SEER\*Stat (Caldwell et al., 2016).

traditionally have worst health outcomes, lower educational levels, and travel longer distances to receive care in comparison to individuals who reside in urban areas (Stamm et al., 2007; McCord et al., 2012; Murimi and Harpel, 2010). These influential patient-level factors mold physicians' healthcare practices, including the provision of preventive care services (Brems et al., 2006). Ultimately, the approximately 19.3% of the US population residing in rural areas face a host of challenges and barriers to lung cancer prevention, detection, and care (United States Census Bureau, 2017). While much of the observed LC disparities may be attributed to higher smoking rates, the data indicate a need to aggressively pursue multiple means to examine and subsequently reduce lung cancer in disproportionately impacted rural areas.

## 2. Low dose computed tomography (LDCT)

LDCT scans have been shown to benefit individuals at increased LC risk by both literature review and the results of the National Lung Cancer Screening Trial (NLST) (Bach et al., 2012; National Lung Screening Trial Research Team et al., 2011). The NLST compared chest X-ray and low dose computed tomography (LDCT) to detect lung cancer in high risk individuals (individuals aged 55–74 years with a 30 pack-year smoking history; including current or former smokers who had quit in the past 15 years). The relative reduction in LC mortality was 20.0% and absolute reduction in mortality was 0.33% for LDCT compared to chest X-ray; avoiding 87 deaths over 26,722 screened participants. Further, LDCT scans detected more early stage LC (Kramer et al., 2011). These findings have led to multiple medical organizations (e.g. United States Preventative Services Task Force [USPSTF]; American Lung Association; American Cancer Society) to endorse LDCT lung cancer screening for high risk patients (U.S. Preventive Services Task Force, 2015; American Lung Association, 2015; American Cancer Society, 2017b).

### 2.1. System barriers

Multiple system level barriers to implementing LDCT screening have emerged. The NLST study did not assess LDCT screening in rural centers, and barriers and facilitators to delivering LDCT screening there may vary from urban centers. According to qualitative findings on providers' perspective of LDCT screening in New Mexico (consisting of providers from four rural settings), providers expressed concern about access to LDCT equipment and potential financial burdens among rural populations (Hoffman et al., 2015). While USPSTF recommendations guide insurance coverage guidelines for preventive screening through Medicare and private insurance, coverage issues remain an implementation barrier (Eberth et al., 2014). Further, a study of Lung Cancer Alliance Screening Centers of Excellence noted logistic barriers to implementation, including financial issues of cost associated with screening implementation and overall operations (Qiu et al., 2016).

Another key recommendation from the USPSTF on LDCT screening involves the use of shared decision making (SDM). SDM is a Centers for

Medicare and Medicaid Services requirement for coverage and reimbursement to ensure the provider engages with the patient about the risks and benefits of LDCT for lung cancer screening and that the provider documents the SDM discussion in the medical record (Centers for Medicare and Medicaid Services, 2015; Watson et al., 2016). While, SDM does ensure that the patient is engaged in the screening decision making process, it can also serve as another barrier related to provider knowledge and can be impacted by patients' health literacy (Cardarelli et al., 2017). Still, one-on-one conversations with their physicians regarding screening details and the provision of decision support materials and desired by patients (Mishra et al., 2016; Kanodra et al., 2016).

### 2.2. Provider barriers

Rural health providers may face particular challenges in implementing screening. Rural areas often face the implementation barrier of reduced radiologist capacity relative to the number of those at risk, potentially limiting LDCT screening of eligible patients (Smieliauskas et al., 2014). Survey and focus group research on provider perspectives has indicated that primary care providers are inadequately aware of the recommended guidelines and order chest X-rays for screening purposes more often than LDCT (Hoffman et al., 2015; Lewis et al., 2015). Moreover, primary care providers are apprehensive about LDCT false positive rates, the potential complications of follow-up biopsies, and the feasibility of implementing LDCT screening in their health care settings. LDCT referrals are low among both primary care (only 41% made a referral in the past year) and pulmonologists (only 52.4% made guideline-concordant screening decisions) (Ersek et al., 2016; Iaccarino et al., 2015). Studies assessing other screening modalities have found that rural providers in general have lower rates of adhering to guidelines, which may be associated with characteristics of rural populations (Kulczycki et al., 2016; Luman et al., 2006; Beydoun and Beydoun, 2008). These barriers exist within the context of a general shortage of primary care providers, of which there are numerous documented disparities in rural areas (Laditka et al., 2009).

### 2.3. Individual barriers

Screening implementation in rural areas is not solely limited by provider-based limitations, but also involves a number of well-characterized socio-demographic and access barriers (Finney Rutten et al., 2004). Patient-level barriers to the receipt of LDCT screening include a lack awareness and understanding of LDCT screening, with patients often confusing chest X-rays and biopsy with LDCT screening (Cardarelli et al., 2017). Patients also perceive that screening adherence precludes them from the need to quit smoking, and those who have received LDCT screening may not appropriately understand their LC risk, especially in relation to their recent smoking history.

## 3. Other aspects of screening uptake and risk reduction

### 3.1. Smoking cessation counseling

A baseline clinical intervention may be the Five Major Steps to Intervention (The "5 A's"; ask, advise, assess, assist, and arrange) (Agency for Healthcare Research and Quality, 2014). Though this motivational intervention is brief and simple, some studies indicate that only a minority of primary care providers are familiar with them (generally), and/or fully utilize them for smoking cessation (specifically) (Addo et al., 2011; Balls et al., 2010; Tong et al., 2010). Further strategies include pharmacotherapeutic tools including nicotine replacement therapies and non-nicotine therapies (Anczak and Nogler, 2003). Additionally, tobacco cessation programs administered via telephone based programs (quitlines) have documented success in improving tobacco cessation in high risk populations. Yet, there is a

documented decrease in effectiveness of quitlines in rural communities compared to urban populations (Griffin et al., 2015). As a result, there is growing dialogue for the need to consider the “rural culture” and how it impacts rural population behaviors and norms within the context of tobacco cessation and lung cancer screening (Hartley, 2004). Additionally, many of the practice-based evidence (PBE) and research-based evidence (RBE) projects have not examined the implementation of evidence based tobacco cessation and navigation in rural communities (Vaidya et al., 2017).

### 3.2. Social supports

Overall, little is known about eligible adults' barriers to receiving LDCT screening, or how social support can be used to overcome them, especially in rural populations. The literature is replete with findings that demonstrate the significant role of social support on the receipt of preventive care (Kirby, 2008; Honda and Kagawa-Singer, 2006; Ertel et al., 2009). For example, family encouragement to seek screening can contribute to screening adherence for colorectal cancer screening and mammography (Wang et al., 2014; Allen et al., 2008). Study has also indicated that cancer screening information circulated through social support systems and families affect patient attitudes towards cancer screening (Shaw et al., 2012). Therefore, social support may serve as a contributing factor to addressing patient barriers and examine uptake and screening compliance. Health care navigation services have been shown to be efficacious in overcoming patient barriers to cancer screening in vulnerable patient populations and may prove beneficial in reducing similar barriers to LDCT in rural communities (Robinson-White et al., 2010; Freund et al., 2008). Furthering the knowledge on the role of social support and improving uptake of LDCT screening may also be informed by examining the social networks in rural communities (Wheeler and Basch, 2017).

### 3.3. Special populations in rural areas

Rural areas are far from homogenous with geographical and cultural norms associated with smoking highly varied across the U.S. Further, there are existing and emerging racial/ethnic variations in rural areas that also has implication for serving the needs of rural based smokers (Crowley et al., 2015). For example, Hispanics made up more than one-half of the people added to the U.S. rural population through both migration and births between 2000 and 2010 (Lichter, 2012). In addition to the barriers noted above for persons living in urban areas, immigrant and/or racial/ethnic minorities living in rural areas may have additional barriers to care related to accessing LDCT lung cancer screening and tobacco cessation services including language and cultural barriers (Caldwell et al., 2016). These trends have implications for education, outreach and the provision of appropriate lung health care.

## 4. Strategy going forward

Just as the problem is multifaceted, so too should be the response, and the introduction of LDCT as a screening tool may be a new impetus for coordinated action. LDCT is approved by the USPSTF for screening purposes, is endorsed by multiple organizations, and is a covered patient service under CMS. Its expanded implementation into rural areas (especially) may be utilized as the lynchpin for new and coordinated smoking interventions. From a system perspective, efforts need to be made to increase LDCT accessibility in rural areas (frequently also low resource). While it may be infeasible to outright place LDCT equipment and personnel in rural areas, there are networks of federally-funded cancer centers and healthcare organizations to which patients may be referred. From a provider perspective, physicians, especially in rural areas, should be educated regarding LDCT utility and encouraged to promote its appropriate use. Purposeful work in this regard may also serve to increase screening promotion in general among rural providers

– impacting other cancers as well. Finally and from the patient perspective, purposeful attention should be paid to patient needs, especially those specific to LDCT screening such as provider discussions and decision support materials. Physicians and patients are receptive to LDCT screening, but time constraints limit conversations and the use of decision aids. Healthcare and managed care organizations should explore options for either reimbursing clinicians for extended visit time, or alternative methods of patient engagement (e.g. with nurse practitioners).

There exist multiple smoking interventions shown to be effective. Rural areas are less likely to fully utilize some services (e.g. Quitline) and many lack resources to achieve eligible population saturation. We suggest that uncoordinated and ad hoc screening promotion and risk reduction interventions (e.g. separate interventions targeting individual aspects) may be of substantially less effectiveness in a rural culture where multiple aspects are interdependent. A more holistic approach simultaneously targeting aspects of: smoking initiation; social acceptability; tobacco access; purposeful smoking assessment and referral to cessation resources; and enhanced access to and utilization of clinical care may be needed. Increasing awareness and uptake of LDCT screening among patients and providers may provide a new and additional impetus to addressing the tobacco control needs in these communities. This should be purposefully pursued in rural communities, as health care advancements such as improved methods for cancer early detection and treatment can actually exacerbate observed disparities if appropriate outreach and diffusion is not conducted (Chang and Lauderdale, 2009; Levine et al., 2010).

## 5. Conclusions

The current data that demonstrates evidence based practices for improving lung cancer outcomes in high risk populations has been largely limited to urban areas and little research has been done to discuss generalizability and scalability of that data in rural populations. Rural residents are less likely to see a physician regularly, have less access to smoking cessation programs, and ultimately experience worse outcomes for cancer diagnosis (Hutcheson et al., 2008; Williams and Thompson, 2016; Singh and Siahpush, 2014). As such, additional research is needed to identify and address barriers to LDCT uptake and adoption relating to patient, provider, and system-level factors with an intentional focus upon screening and prevention within the context of rural communities. This in turn may instigate additional supportive activities associated with risk reduction and health promotion.

### Disclosures

None of the authors have any disclosures.

### Funding

There was no funding associated with this work.

### Acknowledgements

Jenkins acknowledges funding from 1P20 CA192987-01A1; Matthews acknowledges funding from U54 CA202997-01 and P20 CA202908-01; Watson acknowledges funding from U54 CA202997-01 and P20 CA202908-01; Molina acknowledges funding from K01CA193918.

### References

- Ado, S.F., Maiden, K., Ehrenthal, D.B., 2011. Awareness of the 5 A's and motivational interviewing among community primary care providers. *Del. Med. J.* 83, 17–21.
- Agency for Healthcare Research and Quality, 2014. Five major steps to intervention (the “5 A's”). <https://www.ahrq.gov/professionals/clinicians-providers/guidelines/>

- recommendations/tobacco/5steps.html, Accessed date: 8 March 2017.
- Allen, J.D., Stoddard, A.M., Sorensen, G., 2008. Do social network characteristics predict mammography screening practices? *Health Educ. Behav.* 35, 763–776.
- American Cancer Society, 2017a. *Cancer facts & figures 2017*. <https://www.cancer.org/research/cancer-facts-statistics/all-cancer-facts-figures/cancer-facts-figures-2017.html>, Accessed date: 9 May 2017.
- American Cancer Society, 2017b. *Lung cancer screening guidelines*. <https://www.cancer.org/health-care-professionals/american-cancer-society-prevention-early-detection-guidelines/lung-cancer-screening-guidelines.html>, Accessed date: 9 May 2017.
- American Lung Association, 2015. *Providing guidance on lung cancer screening to patients and physicians*. [www.lung.org/assets/documents/lung-cancer/lung-cancer-screening-report.pdf](http://www.lung.org/assets/documents/lung-cancer/lung-cancer-screening-report.pdf), Accessed date: 9 May 2017.
- Anczak, J.D., Nogler, R.A., 2003. Tobacco cessation in primary care: maximizing intervention strategies. *Clin. Med. Res.* 1, 201–216.
- Atkins, G.T., Kim, T., Munson, J., 2017. Residence in rural areas of the United States and lung cancer mortality. Disease incidence, treatment disparities, and stage-specific survival. *Ann. Am. Thorac. Soc.* 14, 403–411.
- Bach, P.B., Mirkin, J.N., Oliver, T.K., et al., 2012. Benefits and harms of CT screening for lung cancer: a systematic review. *JAMA* 307, 2418–2429.
- Balls, J.E., Price, J.H., Dake, J.A., et al., 2010. African American primary care physicians' perceptions and practices regarding smoking cessation therapy. *J. Natl. Med. Assoc.* 102, 579–589.
- Beydoun, H.A., Beydoun, M.A., 2008. Predictors of colorectal cancer screening behaviors among average-risk older adults in the United States. *Cancer Causes Control* 19, 339–359.
- Brems, C., Johnson, M.E., Warner, T.D., et al., 2006. Barriers to healthcare as reported by rural and urban interprofessional providers. *J. Interprof. Care* 20, 105–118.
- Caldwell, J.T., Ford, C.L., Wallace, S.P., Wang, M.C., Takahashi, L.M., 2016. Intersection of living in a rural versus urban area and race/ethnicity in explaining access to health care in the United States. *Am. J. Public Health* 106 (8), 1463–1469.
- Cardarelli, R., Roper, K.L., Cardarelli, K., et al., 2017. Identifying community perspectives for a lung cancer screening awareness campaign in Appalachia Kentucky: the Terminate Lung Cancer (TLC) study. *J. Cancer Educ.* 32, 125–134.
- Centers for Medicare and Medicaid Services, 2015. *Decision memo for screening for lung cancer with Low Dose Computed Tomography (LDCT) (CAG-00439N)*. <https://www.cms.gov/medicare-coverage-database/details/nca-decision-memo.aspx?NCAId=274>, Accessed date: 9 May 2017.
- Chang, V.W., Lauderdale, D.S., 2009. Fundamental cause theory, technological innovation, and health disparities: the case of cholesterol in the era of statins. *J. Health Soc. Behav.* 50, 245–260.
- Crowley, M., Lichter, D.T., Turner, R.N., 2015. Diverging fortunes? Economic well-being of Latinos and African Americans in new rural destinations. *Soc. Sci. Res.* 51, 77–92.
- Eberth, J.M., Qiu, R., Adams, S.A., et al., 2014. Lung cancer screening using low-dose CT: the current national landscape. *Lung Cancer* 85, 379–384.
- Ersek, J.L., Eberth, J.M., McDonnell, K.K., et al., 2016. Knowledge of, attitudes toward, and use of low-dose computed tomography for lung cancer screening among family physicians. *Cancer* 122, 2324–2331.
- Ertel, K.A., Glymour, M.M., Berkman, L.F., 2009. Social networks and health: a life course perspective integrating observational and experimental evidence. *J. Soc. Pers. Relat.* 26, 73–92.
- Finney Rutten, L.J., Nelson, D.E., Meissner, H.I., 2004. Examination of population-wide trends in barriers to cancer screening from a diffusion of innovation perspective (1987–2000). *Prev. Med.* 38, 258–268.
- Freund, K.M., Battaglia, T.A., Calhoun, E., et al., 2008. National Cancer Institute Patient Navigation Research Program: methods, protocol, and measures. *Cancer* 113, 3391–3399.
- Griffin, E., Moon, G., Barnet, R., 2015. Examining the significance of urban-rural context in tobacco quitline use: does rurality matter? *Int. J. Public Health* 60, 327–333.
- Hartley, D., 2004. Rural health disparities, population health, and rural culture. *Am. J. Public Health* 94, 1675–1678.
- Hoffman, R.M., Sussman, A.L., Getrich, C.M., et al., 2015. Attitudes and beliefs of primary care providers in New Mexico about lung cancer screening using low-dose computed tomography. *Prev. Chronic Dis.* 12, E108.
- Honda, K., Kagawa-Singer, M., 2006. Cognitive mediators linking social support networks to colorectal cancer screening adherence. *J. Behav. Med.* 29, 449–460.
- Howlander, N., Noone, A.M., Krapcho, M. (Eds.), 2014. *SEER Cancer Statistics Review, 1975–2011*. National Cancer Institute, Bethesda, MD (December, report).
- Hutcheson, T.D., Greiner, K.A., Ellerbeck, E.F., et al., 2008. Understanding smoking cessation in rural communities. *J. Rural. Health* 24, 116–124.
- Iaccarino, J.M., Clark, J., Bolton, R., et al., 2015. A national survey of pulmonologists' views on low-dose computed tomography screening for lung cancer. *Ann. Am. Thorac. Soc.* 12, 1667–1675.
- Kanodra, N.M., Pope, C., Halbert, C.H., Silvestri, G.A., Rice, L.J., Tanner, N.T., 2016. Primary care provider and patient perspectives on lung cancer screening. A qualitative study. *Ann. Am. Thorac. Soc.* 13 (11), 1977–1982 (Nov).
- Kirby, J.B., 2008. Poor people, poor places and access to health care in the United States. *Soc. Forces* 87, 325–355.
- Kramer, B.S., Berg, C.D., Aberle, D.R., et al., 2011. Lung cancer screening with low-dose helical CT: results from the National Lung Screening Trial (NLST). *J. Med. Screen.* 18, 109–111.
- Kulczycki, A., Qu, H., Shewchuk, R., 2016. Primary care physicians' adherence to guidelines and their likelihood to prescribe the human papillomavirus vaccine for 11- and 12-year-old girls. *Womens Health Issues* 26, 34–39.
- Laditka, J.N., Laditka, S.B., Probst, J.C., 2009. Health care access in rural areas: evidence that hospitalization for ambulatory care-sensitive conditions in the United States may increase with the level of rurality. *Health Place* 15, 731–740.
- Levine, R.S., Rust, G.S., Pisu, M., et al., 2010. Increased Black-White disparities in mortality after the introduction of lifesaving innovations: a possible consequence of US federal laws. *Am. J. Public Health* 100, 2176–2184.
- Lewis, J.A., Petty, W.J., Tooze, J.A., et al., 2015. Low-dose CT lung cancer screening practices and attitudes among primary care providers at an academic medical center. *Cancer Epidemiol. Biomark. Prev.* 24, 664–670.
- Lichter, D.T., 2012. Immigration and the new racial diversity in rural America. *Rural. Sociol.* 77 (1), 3–35. <http://dx.doi.org/10.1111/j.1549-0831.2012.00070.x>.
- Luman, E.T., Ching, P.L., Jumaan, A.O., et al., 2006. Uptake of varicella vaccination among young children in the United States: a success story in eliminating racial and ethnic disparities. *Pediatrics* 117, 999–1008.
- McCord CE, Elliott TR, Brossart DF, et al. *Mental health issues in rural areas. Rural populations and health: determinants, disparities, and solutions 2012: 323–339.*
- Mishra, S.I., Sussman, A.L., Murrietta, A.M., et al., 2016. Patient perspectives on low-dose computed tomography for lung cancer screening, New Mexico, 2014. *Prev. Chronic Dis.* 13, E108. <http://dx.doi.org/10.5888/pcd13.160093>. (Aug 18).
- Murimi, M.W., Harpel, T., 2010. Practicing preventive health: the underlying culture among low-income rural populations. *J. Rural. Health* 26, 273–282.
- National Institutes of Health, 2008. *Cancer health disparities*. National Cancer Institute <https://www.cancer.gov/about-nci/organization/crchr/cancer-health-disparities-fact-sheet#q11>, Accessed date: 7 March 2017.
- National Lung Screening Trial Research Team, Aberle, D.R., Adams, A.M., et al., 2011. Reduced lung-cancer mortality with low-dose computed tomographic screening. *N. Engl. J. Med.* 365, 395–409.
- Qiu, R., Copeland, A., Sercy, E., et al., 2016. Planning and implementation of low-dose computed tomography lung cancer screening programs in the United States. *Int. J. Oncol. Nurs.* 20, 52–58.
- Robinson-White, S., Conroy, B., Slavish, K.H., et al., 2010. Patient navigation in breast cancer: a systematic review. *Cancer Nurs.* 33, 127–140.
- Shaw, S.J., Vivian, J., Orzech, K.M., et al., 2012. Consistency in attitudes across cancer screenings in medically underserved minority populations. *J. Cancer Educ.* 27, 165–171.
- Singh, G.K., Siahpush, M., 2014. Widening rural-urban disparities in all-cause mortality and mortality from major causes of death in the USA, 1969–2009. *J. Urban Health* 91, 272–292.
- Smieliauskas, F., MacMahon, H., Salgia, R., et al., 2014. Geographic variation in radiologist capacity and widespread implementation of lung cancer CT screening. *J. Med. Screen.* 21, 207–215.
- Stamm, B.H., Lambert, D., Piland, N.F., et al., 2007. A rural perspective on health care for the whole person. *Prof. Psychol. Res. Pract.* 38, 298.
- Tabatabai, M.A., Kengwoung-Keumo, J.J., Oates, G.R., et al., 2016. Racial and gender disparities in incidence of lung and bronchus cancer in the United States: a longitudinal analysis. *PLoS One* 11 (9), e0162949. <http://dx.doi.org/10.1371/journal.pone.0162949>. (Sep 29).
- Tong, E.K., Strouse, R., Hall, J., et al., 2010. National survey of U.S. health professionals' smoking prevalence, cessation practices, and beliefs. *Nicotine Tob. Res.* 12, 724–733.
- U.S. Preventive Services Task Force, 2015. *Final update summary: lung cancer: screening*. <http://www.uspreventiveservicestaskforce.org/Page/Document/UpdateSummaryFinal/lung-cancerscreening>, Accessed date: 9 December 2015.
- United States Census Bureau, 2017. *2010 census urban and rural classification and urban area criteria*. <https://www.census.gov/geo/reference/ua/urban-rural-2010.html>, Accessed date: 9 March 2017.
- Vaidya, Namita, et al., 2017. Practice-based evidence in community guide systematic reviews. *Am. J. Public Health* 107 (3), 413–420. <http://dx.doi.org/10.2105/AJPH.2016.303583>. (March 1).
- Wang, H.L., Christy, S.M., Skinner, C.S., et al., 2014. Predictors of stage of adoption for colorectal cancer screening among African American primary care patients. *Cancer Nurs.* 37, 241–251.
- Ward, E., Jemal, A., Cokkinides, V., et al., 2004. Cancer disparities by race/ethnicity and socioeconomic status. *CA Cancer J. Clin.* 54, 78–93.
- Watson, K.S., Blok, A.C., Buscemi, J., et al., 2016. Society of Behavioral Medicine supports implementation of high quality lung cancer screening in high-risk populations. *Transl. Behav. Med.* 6, 669–671.
- Wheeler, S.B., Basch, E., 2017. Translating cancer surveillance data into effective public health interventions. *JAMA* 317 (4), 365–367. <http://dx.doi.org/10.1001/jama.2016.20326>.
- Williams, F., Thompson, E., 2016. Disparity in breast cancer late stage at diagnosis in Missouri: does rural versus urban residence matter? *J. Racial Ethn. Health Disparities* 3, 233–239.