



Smoking and Non-communicable diseases. Part II Cancer, Diabetes Mellitus, Kidney Diseases, Alzheimer's Disease, Arthritis

Shashi K. Agarwal, MD * 

¹2227 US Highway 1, #309 North
Brunswick, NJ 08902, USA



Abstract

Tobacco smoking is responsible for significant global morbidity and mortality. It has adverse effects on non-smokers exposed to second-hand and third-hand smoke. E-cigarettes are also harmful to human health. Smokeless tobacco also contains many toxic substances. Nicotine is the common addicting substance in all tobacco concoctions. Several well done studies confirm that no amount of tobacco exposure is safe. This second part of the manuscript discusses the deleterious effects of smoking on five non-communicable diseases, viz., cancer, diabetes mellitus, chronic kidney disease, Alzheimer's disease, and arthritis. Keywords: smoking, non-communicable diseases, cancer, diabetes mellitus, chronic kidney disease, Alzheimer's disease, arthritis

Copyright : © 2021 The Authors. Published by Medical Editor and Educational Research Publishers Ltd. This is an open access article under the CC BY-NC-ND license (<https://creativecommons.org/licenses/by-nc-nd/4.0/>).

1 | INTRODUCTION

It is estimated that over a billion people smoke globally¹. First-hand smoke is the smoke that enters the smoker's mouth directly and is also known as mainstream smoke². Side-stream cigarette smoke emanates from the burning ends of a cigarette. Environmental tobacco smoke or second-hand smoke is a combination of side-stream smoke (85%) and the exhaled main-stream smoke (15%)³. Third-hand smoke is the gas and particulate residue from tobacco products, including smoked cigarettes, that cling to surfaces such as skin, hair, clothing, and furniture⁴. These pollutants adhere strongly to

these surfaces, are difficult to remove with traditional cleaning methods, and may persist for minutes to months.

Supplementary information The online version of this article ([10.52845/CMI/2020-1-1-7](https://doi.org/10.52845/CMI/2020-1-1-7)) contains supplementary material, which is available to authorized users.

Corresponding Author: *Shashi K. Agarwal, MD*
Shashi K. Agarwal, MD 2227 US Highway 1, #309
North Brunswick, NJ 08902, USA
Email: usacardiologist@gmail.com

Smoked tobacco includes products like cigarettes, e-cigarettes and water pipes⁵. Smokeless tobacco products include loosely chewed tobacco leaves, tobacco paste and tobacco-based concoctions such as snus, naswar, gutka and snuffs⁶. Cigarette smoke has thousands of gaseous and particulate substances, with many being toxic and cancer provoking⁷. Water pipe smoking is immensely popular in the Middle East but has now become fashionable globally. Water pipe (also known as hookah, narghila, argileh, hubble bubble, goza, and sheesha in different countries) smoking contains many of the same toxicants as cigarette smoking⁸. Water pipe smoking may result in the inhalation of 50–100 times the smoke volume during a single smoking session, when compared to that inhaled from a single cigarette⁹. Electronic cigarettes (e-cigarettes) are battery-powered devices providing aerosol vapors for inhalation¹⁰. These vapors are usually produced by heating a liquid that has propylene glycol and/or vegetable glycerin, nicotine and flavoring. Though they are significantly lower in carcinogens and toxins, they still cause harm¹¹. Smokeless tobacco provides nicotine like cigarettes, with a slower absorption and still has more than 20 carcinogens¹².

Of all the known constituents, nicotine is the addictive substance in tobacco, smoked or taken in otherwise¹³. Toxic compounds in tobacco-derived smoke are nitrosamines and polycyclic aromatic hydrocarbons^{14,15}. Other toxic materials found in both tobacco cigarette/waterpipe smoke and e-cigarette vapor are volatile organic compounds and inorganic compounds such as metals and carbon monoxide. Carbon monoxide is toxic to humans, even at low concentrations¹⁶. E-cigarette liquid usually contains, propylene glycol, and glycerine, in addition to nicotine. The inhaled e-cigarette vapor contains toxic compounds derived from these three ingredients¹⁷. Smokeless tobacco also contain harmful substances like nitrosamines, polycyclic aromatic hydrocarbons, and aldehydes¹⁸. In general, no tobacco product is safe.

The estimated economic cost associated with smoking is 1.8% of global gross domestic product. In 2012, the world's total medical expenditure for smoking-attributable diseases reached 467 billion US dollars, accounting for 5.7% of the global health

expenditure. Meanwhile, the total economic cost of smoking (including medical expenditures and productivity losses) in 2012 was 1852 billion US dollars, accounting for 1.8% of the global gross domestic product. Almost 40% of the economic cost occurs in low-income or middle-income countries.

2 | DISCUSSION

Noncommunicable diseases (NCDs) are the leading cause of mortality, killing more than 36 million people each year, globally¹⁹. They are responsible for 63% of all annual deaths. Developing countries bear the main brunt of this enormous mortality, with almost 80% of NCD deaths occurring in low and middle income countries²⁰. Modifiable behavioral health risk factors such as smoking tobacco, inadequate vegetable and fruit consumption, high alcohol consumption, physical inactivity and obesity increase the risk of NCD morbidity and mortality²¹. Tobacco smoking is a major player in this deleterious association. NCD diseases discussed in this manuscript include cancer, diabetes, chronic kidney diseases, Alzheimer's disease, and arthritis.

Cancer is the second leading cause of death (after cardiovascular disease) in 2017, accounting for 17% of all global deaths³¹. Cancer related mortality exceeds that caused by communicable diseases such as human immunodeficiency virus/acquired immunodeficiency syndrome, tuberculosis, and malaria., combined³¹. Cancer prevalence is rising and commonly involves the bladder, breast, colon, rectum, lung, cervix and head and neck²². In 2018, GLOBOCAN estimated that 18.1 million people had been diagnosed with cancer, with 9.6 million people dying from it, worldwide²³.

Diabetes is increasing in prevalence in several developed and in most developing countries^{45,46}. According to the International Diabetes Federation there are 451 million adults live with diabetes worldwide in 2017 and this number is projected to increase to 693 million by 2045⁴⁷. Type 2 diabetes accounts for 90–95% of diabetes cases and is caused by insulin resistance and progressive loss of β cell function and mass. Diabetes is associated with an increase in

mortality from several co-morbid conditions, such as CVDs, chronic kidney disease, cancer and liver diseases⁴⁸. It also increases the risk of infections with adverse outcomes. Diabetes is solely responsible for 1.5 million deaths worldwide. It also contributes to an additional 17.5 million deaths each year⁴⁹. Type 2 diabetes invariably leads to the development of several microvascular (retinopathy, nephropathy, and neuropathy) and macrovascular (coronary artery disease, stroke, peripheral artery disease) complications²⁴. Deaths from diabetes (DM) have increased by more than 60% since 2000 and now rank in the top 10 causes of death²⁵.

The worldwide prevalence of chronic kidney disease (CKD) is estimated to be 8–16%⁵⁸. CKD is associated with a reduction in the glomerular filtration rate (eGFR) <60 ml/min/1.73 m²⁵⁹. There are usually structural renal abnormalities also noted. Untreated CKD usually progresses to end-stage renal disease (GFR<15 ml/min), requiring dialysis or kidney transplant. CKD increases the risk of developing cardiovascular diseases, mineral and bone disorders, and anemia. Worldwide, a 31.7% increase of CKD mortality was observed over the last decade⁶⁰. Lifestyle factors, including smoking, alcohol, obesity, and physical inactivity have been implicated in the promotion of CKD.

Chronic kidney disease (CKD) affects over 10% of the population worldwide. It was ranked 16th among the leading causes of death in 2016 and is expected to become the 5th leading cause of death by 2040²⁶. Diabetic kidney disease is the leading cause of CKD²⁷.

Cognition is involved in attention, memory, language, orientation, performance, judgment and problem-solving skills. A decline occurs with age and is considered normal. Mild cognitive impairment is a pre-dementia stage. Alzheimer's disease (AD), a progressive disease, accounts for 50–70% of dementia cases⁶⁶. According to the WHO, 44 million had AD globally in 2016. This number is on the increase and is projected to reach 82 million by 2030 and 152 million by 2050⁶⁷.

Alzheimer's disease and other dementias afflict nearly 44 million people worldwide²⁸. The annual healthcare expenditure for AD patients, was \$277B

in 2018 and expected to go up to \$1100B annually by 2050.

The two main kinds are osteoarthritis and rheumatoid arthritis. Osteoarthritis (OA) is leading cause of pain and disability among adults all over the world. It affects almost 1 in 3 people over age 65⁷⁵. Osteo-arthritis exhibits cartilage loss while rheumatoid arthritis affects the synovial joints resulting in synovitis, joint erosion, and cartilage damage.

Arthritis is of over 100 types, the most common being rheumatoid arthritis, osteoarthritis, psoriatic arthritis and inflammatory arthritis²⁹. These diseases result in considerable functional disability in the sufferers, especially with increasing age.

All these diseases are not only non-communicable but usually chronic. CDC³⁰ defines chronic diseases as “conditions that last 1 year or more and require ongoing medical attention or limit activities of daily living or both.” Noncommunicable diseases are gradually replacing infectious diseases as the major health burden in the developing countries. Deaths from noncommunicable diseases are also on the rise, globally. As discussed in the previous part of this 2 part manuscript, smoking is one lifestyle that plays an important adverse role in the genesis and progression of these diseases.

Cancer

Smoking is strongly associated with cancer, accounting for 19% of all cancer cases³². Tobacco smoke is full of carcinogens³³. Active smoking has been associated with cancer of almost every organ of the human body. It is estimated that smoking accounts for 81.7% of lung cancers, 73.8% of larynx cancers, 50% of esophageal cancers, 46.9% of bladder cancers and 28.8% of all cancer deaths³². Other methods of smoking tobacco, such as water pipe smoking³⁴. Electronic Nicotine Delivery System (ENDS) smoking³⁵, and Heat-not-Burn (HNB) smoking³⁶ have also been implicated in increasing the cancer risk. Second-hand smoke also increases the risk of cancer³⁷. Smokeless tobacco also poses a risk, causing cancers of the oral cavity, esophagus, and pancreas³⁸. Smoking after the diagnosis of cancer demonstrate a poor treatment response and enhanced treatment-related toxic effects³⁹. They risk getting recurrences⁴⁰ and are more likely to

develop a primary second cancer⁴¹, compared to non-smokers. They are also subject to an increased mortality⁴². This mortality risk is reduced by 30% to 40% with smoking cessation⁴³. Overall, smoking cessation after cancer diagnosis may have benefits that equal or exceed those achieved by cancer treatments⁴⁴. Smoking cessation is difficult with almost 80% of smokers relapsing within the first month of abstinence, and only about 5% achieve long-term abstinence.

Diabetes Mellitus

Any kind of tobacco smoke exposure increase the risk of Type 2 diabetes⁵⁰. It is estimated that 11.7% of diabetes cases among men and 2.4% of diabetes cases among women are probably connected with active smoking⁵¹. This association appears to be dose-response related. In 2014, the Surgeon General reported that active smoking increases the risk of T2D by 30–40% in active smokers compared to non-smokers⁵². In a meta-analysis of 88 prospective studies of almost 6 million participants, Pan and group found that passive smoking was associated with a 22% increased risk of incident type 2 diabetes in never smokers compared to never smokers not exposed to passive smoke⁵¹. Alternate tobacco smoking methods and smokeless tobacco products also appear to impact diabetes development⁵³. Smoking during pregnancy increases the risk of gestational diabetes mellitus⁵⁴ and may also increase the risk of future diabetes in the offspring⁵⁵. Infants exposed to secondhand cigarette smoke also experience an increased risk for T2D development.

Active smoking has been associated with reduced appetite and weight loss. On the other hand, smoking cessation is often associated with weight gain. Several studies reported that diabetes risk was increased in individuals who had recently quit smoking, raising a concern about elevated diabetes risk with smoking cessation⁵⁶. This phenomenon occurs more frequently during the first 3 years post-cessation and appears to be related to an increase in body weight upon withdrawal of nicotine⁵⁶.

Smoking appears to acutely worsen glucose tolerance, alter peripheral insulin signaling and impair beta cell function⁵⁷.

Chronic Kidney Disease

In an analysis of 15 prospective cohort studies involving 65,064 incident CKD cases, Xia et al. found an increased risk of CKD in smokers vs nonsmoker⁶¹. Smoking enhances its progression⁶². It is also associated with a higher incidence of death from end-stage renal disease (ESRD) in both males and females⁶³. Smoking cessation reduces the risk of incident CKD⁶⁴.

Smoking is an independent risk factor for the development of CKD. Previous studies have demonstrated that nicotine causes tubule-interstitial injury and plays a central role in smoking-mediated renal dysfunction⁶⁵.

Alzheimer's Disease

Smoking has been linked to increased cognitive decline. Several studies reported that smokers were 1.9–4.3 times more likely to develop AD than non-smokers⁶⁸. Nicotine has short-term enhancing effects, and this may help explain the high rate of smoking in individuals with psychiatric disorders and the difficulty in quitting in this population⁶⁹. However, in the long run smoking harms cognitive function and may lead to the development of neurodegenerative disorders including AD⁷⁰. Second-hand smoke is also harmful to cognition with an increase in cognitive impairment of 24% noted in older adults with such an exposure⁷¹. Smoking during pregnancy can harm fetal brain development, while cigarette smoking at an earlier age is associated with future cognitive impairment⁷².

Smoking in AD patients is associated with oxidative stress, neuroinflammation, and impaired neuroprotection⁷³. Structural abnormalities such as a thinner anterior cingulum and prefrontal lobe have also been noted in these patients⁷⁴.

Arthritis

Smoking is a risk factor in knee and hip OA, causing an increased proliferation of chondrocytes⁷⁶. It increases pain and cartilage loss in these patients. However, a meta-analysis of 48 observational studies and data from the 5th KNHANES study of individuals over the age of 50 suggest the smoking and osteoarthritis may not be significantly associated⁷⁷.

Some studies have shown that CS intensity and duration are causally related to the risk of RA

development⁷⁸. This increased risk appears to persist even after CS cessation

3 | CONCLUSION

Tobacco use, especially cigarette smoking, is an important cause of global morbidity and mortality. Tobacco consumption in any form harms nearly every organ of the human body. It is adversely involved in the genesis and progression of all major non-communicable chronic diseases. Smoking remains the leading preventable cause of death in the world. No amount of exposure to tobacco is safe. Abstinence from smoking is therefore an important step in the prevention and management of the world's deadliest non-communicable diseases.

Acknowledgement: None

Funding: None

Conflict of interest: None

References

1. Eriksen M, Mackay J, Schluger N, Islami F, Drope J. The tobacco atlas. 5th ed American Cancer Society, 2015.; World Health Organization (WHO). WHO Report on the Global Tobacco Epidemic, 2017. World Health Organization. 2017. 1-263.
2. W.A Pryor, K Stone. Oxidants in cigarette smoke: Radicals, hydrogen peroxide, peroxy-nitrate, and peroxy-nitrite. *Ann NY Acad Sci*, 686 (1993), pp. 12-28.
3. A.E Taylor, D.C Johnson, H Kazemi. Environmental tobacco smoke and cardiovascular disease: A position paper from the Council on Cardiopulmonary and Critical Care, American Heart Association. *Circulation*, 86 (1992), pp. 699-702.
4. J.P. Winickoff, J. Friebely, S.E. Tanski, C. Sherrod, G.E. Matt, M.F. Hovell, et al. Beliefs about the health effects of "thirdhand" smoke and home smoking bans. *Pediatrics*, 123 (2009), pp. e74-e79.
5. Shihadeh A, Schubert J, Klaiany J, El Sabban M, Luch A, Saliba NA. Toxicant content, physical properties and biological activity of waterpipe tobacco smoke and its tobacco-free alternatives. *BMJ*. 2015;24(1):22–30.
6. Khan Z, Suliankatchi RA, Heise TL, Dreger S. Naswar (smokeless tobacco) use and the risk of oral cancer in Pakistan: a systematic review with meta-analysis. *NTR*. 2019;21(1):32–40.
7. <https://www.cancer.org/cancer/cancer-causes/tobacco-and-cancer/carcinogens-found-in-tobacco-products.html>.
8. Shihadeh A, Schubert J, Klaiany J, El Sabban M, Luch A, Saliba NA. Toxicant content, physical properties and biological activity of waterpipe tobacco smoke and its tobacco-free alternatives. *BMJ*. 2015;24(1):22–30.
9. Eissenberg T, Shihadeh A. Waterpipe tobacco and cigarette smoking: direct comparison of toxicant exposure. *Am J Prev Med*. 2009;37:518–523.
10. Grana R, Benowitz N, Glantz SA. E-cigarettes: a scientific review. *Circulation*. 2014;129(19):1972–86.
11. R. Grana, N. Benowitz, S.A. Glantz. E-cigarettes: a scientific review. *Circulation*, 129 (2014), pp. 1972-1986.
12. Warnakulasuriya S, Straif K. Carcinogenicity of smokeless tobacco: evidence from studies in humans & experimental animals. *IJMR*. 2018;148(6):681).
13. J.T Powell. Vascular damage from smoking: Disease mechanisms at the arterial wall. *Vasc Med*, 3 (1998), pp. 21-28.
14. Konstantinou E, Fotopoulou F, Drosos A, et al. Tobacco-specific nitrosamines: A literature review. *Food Chem Toxicol*. 2018 Aug;118:198-203. doi: 10.1016/j.fct.2018.05.008.

15. Boström CE, Gerde P, Hanberg A, et al. Cancer risk assessment, indicators, and guidelines for polycyclic aromatic hydrocarbons in the ambient air. *Environ Health Perspect*. 2002 Jun;110 Suppl 3(Suppl 3):451-88. doi: 10.1289/ehp.110-1241197.
16. Prockop LD, Chichkova RI. Carbon monoxide intoxication: an updated review. *J Neurol Sci*. 2007 Nov 15;262(1-2):122-30. doi: 10.1016/j.jns.2007.06.037. Epub 2007 Aug 27. PMID: 17720201.
17. Grana R, Benowitz N, Glantz SA. E-cigarettes: a scientific review. *Circulation*. 2014;129(19):1972–86.
18. Warnakulasuriya S, Straif K. Carcinogenicity of smokeless tobacco: evidence from studies in humans & experimental animals. *IJMR*. 2018;148(6):681.
19. https://www.who.int/features/factfiles/noncommunicable_diseases/en/
20. <https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases> - accessed January 18
21. Kvaavik E., Batty G.D., Ursin G., Huxley R., Gale C.R. Influence of individual and combined health behaviors on total and cause-specific mortality in men and women: The United Kingdom health and lifestyle survey. *Arch. Intern Med*. 2010;170:711–718. doi: 10.1001/archinternmed.2010.76.
22. Ferlay J, Ervik M, Lam F, et al. Global Cancer Observatory: Cancer Today. International Agency for Research on Cancer, 2018.
23. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin*. 2018; 68: 394- 424
24. Raghavan S, Vassy JL, Ho YL, et al. Diabetes mellitus-related all-cause and cardiovascular mortality in a national cohort of adults. *J Am Heart Assoc*. 2019;8:e011295. doi: 10.1161/JAHA.118.011295.
25. <https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death> - accessed January 15
26. Foreman KJ, Marquez N, Dolgert A, Fukutaki K, Fullman N, McGaughey M, et al. Forecasting life expectancy, years of life lost, and all-cause and cause-specific mortality for 250 causes of death: Reference and alternative scenarios for 2016–40 for 195 countries and territories. *Lancet*. 2018; 392 (10159): 2052–2090. 10.1016/S0140-6736(18)3169.
27. Alicic RZ, Rooney MT, Tuttle KR. Diabetic kidney disease. *Clin J Am Soc Nephrol*. 2017; 12 (12): 2032–2045.
28. Wu Y-T, Beiser AS, Breteler MMB. The changing prevalence and incidence of dementia over time—current evidence. *Nat Rev Neurol*. 2017;13:327.
29. <https://aanmc.org/featured-articles/arthritis/>
30. <https://www.cdc.gov/chronicdisease/about/index.htm>
31. Global Burden of Diseases 2017 Causes of Deaths Collaborators. Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*. 2018;392:1736-1788.
32. Islami, F., Goding Sauer, A., Miller, K.D., et al. (2018). Proportion and number of cancer cases and deaths attributable to potentially modifiable risk factors in the United States. *CA: A Cancer Journal for Clinicians*, 68, 31-54.
33. Cancer.org (2020) <https://www.cancer.org/cancer/cancer-causes/tobacco-and-cancer/carcinogens-found-in-tobacco-products.html>. – accessed December 1, 2020.

SMOKING AND NON-COMMUNICABLE DISEASES. PART II CANCER, DIABETES MELLITUS, KIDNEY DISEASES, ALZHEIMER'S DISEASE, ARTHRITIS

34. WHO (2005). Study Group on Tobacco Regulation. Waterpipe Tobacco Smoking: Health Effects, Research Needs and Recommended Actions by Regulators. Geneva, Switzerland: World Health Organization.
35. Goniewicz M.L., Knysak J., Gawron M., et al. (2014). Levels of selected carcinogens and toxicants in vapour from electronic cigarettes. *Tob Control*, 23, 133- 139.
36. Auer R, Concha-Lozano N., Jacot-Sadowski I., Cornuz J., Berthet A. (2017) Heat-not-burn tobacco cigarettes: smoke by any other name. *JAMA Intern Med*, 177, 1050-1052.
37. Oberg M., Jaakkola M.S., Woodward A., Peruga A., Prüss-Ustün A. (2011). Worldwide burden of disease from exposure to second-hand smoke: a retrospective analysis of data from 192 countries. *Lancet*, 8, 377(9760):139-46. [https://doi: 10.1016/S0140-6736\(10\)61388-8](https://doi.org/10.1016/S0140-6736(10)61388-8). PMID: 21112082.
38. IARC (2012). IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Personal habits and indoor combustions. Volume 100 E. A review of human carcinogens. IARC Monogr Eval Carcinog Risks Hum, 100(pt E):1–538.
39. NCCDPHP, (2014). National Center for Chronic Disease Prevention and Health Promotion. Office on Smoking and Health. The Health Consequences of Smoking: 50 Years of Progress: A Report of the Surgeon General. Atlanta, GA: Centers for Disease Control and Prevention.
40. Warren G.W., Cartmell K.B., Garrett-Mayer E., Salloum R.G., Cummings K.M. (2019). Attributable Failure of First-line Cancer Treatment and Incremental Costs Associated with Smoking by Patients With Cancer. *JAMA Netw Open*, 2, e191703. [https://doi: 10.1001/jamanetworkopen.2019.1703](https://doi.org/10.1001/jamanetworkopen.2019.1703).
41. Do K.A., Johnson M.M., Lee J.J., et al. (2004). Longitudinal study of smoking patterns in relation to the development of smoking-related secondary primary tumors in patients with upper aerodigestive tract malignancies. *Cancer*, 101, 2837–42.
42. Sitas F., Weber M.F., Egger S., et al. (2014). Smoking cessation after cancer. *J Clin Oncol*, 32 (32), 3593–5. [https://doi: 10.1200/JCO.2014.55.9666](https://doi.org/10.1200/JCO.2014.55.9666).
43. Gritz E.R., Toll B.A., Warren G.W. (2014). Tobacco use in the oncology setting: advancing clinical practice and research. *Cancer Epidemiol Biomarkers Prev*, 23(1), 3-9.
44. Toll B.A., Brandon T.H., Gritz E.R., Warren G.W., Herbst R.S; (2013). AACR Subcommittee on Tobacco and Cancer. Assessing tobacco use by cancer patients and facilitating cessation: an American Association for Cancer Research policy statement. *Clin Cancer Res*, 19(8), 1941-1948.
45. Patterson CC, et al. Trends and cyclical variation in the incidence of childhood type 1 diabetes in 26 European centres in the 25 year period 1989–2013: a multicentre prospective registration study. *Diabetologia*. 2019;62:408–417. doi: 10.1007/s00125-018-4763-3.
46. Wang L, et al. Prevalence and ethnic pattern of diabetes and prediabetes in China in 2013. *JAMA*. 2017;317:2515–2523. doi: 10.1001/jama.2017.7596.
47. Cho NH, et al. IDF Diabetes atlas: global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes Res. Clin. Pract.* 2018;138:271–281. doi: 10.1016/j.diabres.2018.02.023.
48. Bragg F, et al. Association between diabetes and cause-specific mortality in rural and urban areas of China. *JAMA*. 2017;317:280–289. doi: 10.1001/jama.2016.19720.
49. World Health Organization. [Accessed February 2017];

50. Willi C, Bodenmann P, Ghali WA, Faris PD, Cornuz J. Active smoking and the risk of type 2 diabetes: a systematic review and meta-analysis. *JAMA*. 2007;298:2654–64.
51. Pan A, Wang Y, Talaei M, Hu FB, Wu T. Relation of active, passive, and quitting smoking with incident type 2 diabetes: a systematic review and meta-analysis. *Lancet Diabetes Endocrinol*. 2015;3(12):958-967. doi:10.1016/S2213-8587(15)00316-2.
52. The Health Consequences of Smoking-50 Years of Progress: A Report of the Surgeon General. Atlanta (GA): 2014.
53. Ostenson CG, Hilding A, Grill V, Efendic S. High consumption of smokeless tobacco (“snus”) predicts increased risk of type 2 diabetes in a 10-year prospective study of middle-aged Swedish men. *Scand J Public Health*. 2012;40:730–7.)
54. England LJ, Levine RJ, Qian C, Soule LM, Schisterman EF, Yu KF, et al. Glucose tolerance and risk of gestational diabetes mellitus in nulliparous women who smoke during pregnancy. *Am J Epidemiol*. 2004;160:1205–13
55. Jaddoe VW, de Jonge LL, van Dam RM, Willett WC, Harris H, Stampfer MJ, et al. Fetal exposure to parental smoking and the risk of type 2 diabetes in adult women. *Diabetes care*. 2014;37:2966–73.
56. Yeh HC, Duncan BB, Schmidt MI, Wang NY, Brancati FL. Smoking, smoking cessation, and risk for type 2 diabetes mellitus: a cohort study. *Ann Intern Med*. 2010;152:10–7.
57. Morimoto A, Tatsumi Y, Deura K, Mizuno S, Ohno Y, Watanabe S. Impact of cigarette smoking on impaired insulin secretion and insulin resistance in Japanese men: The Saku Study. *Journal of diabetes investigation*. 2013;4:274–80.
58. Jha V., Garcia-Garcia G., Iseki K., et al. Chronic kidney disease: global dimension and perspectives. *The Lancet*. 2013;382(9888):260–272. doi: 10.1016/s0140-6736(13)60687-x.
59. National Kidney Foundation. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. *Am J Kidney Dis*. 2002;39: S1–266. Available:
60. GBD 2015 Mortality and Causes of Death Collaborators. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet Lond Engl*. 2016;388(10053):1459–544.
61. Xia J, Wang L, Ma Z, Zhong L, Wang Y, Gao Y, He L, Su X. Cigarette smoking and chronic kidney disease in the general population: a systematic review and meta-analysis of prospective cohort studies. *Nephrol Dial Transplant*. 2017 Mar 1;32(3):475-487. doi: 10.1093/ndt/gfw452.
62. Orth S.R., Hallan S.I. Smoking: A risk factor for progression of chronic kidney disease and for cardiovascular morbidity and mortality in renal patients—absence of evidence or evidence of absence? *Clin. J. Am. Soc. Nephrol*. 2008;3:226–236. doi: 10.2215/CJN.03740907.
63. Ishani A., Grandits G.A., Grimm R.H., Svendsen K.H., Collins A.J., Prineas R.J., Neaton J.D. Association of single measurements of dipstick proteinuria, estimated glomerular filtration rate, and hematocrit with 25-year incidence of end-stage renal disease in the multiple risk factor intervention trial. *J. Am. Soc. Nephrol*. 2006;17:1444–1452. doi: 10.1681/ASN.2005091012.
64. Jo W, Lee S, Joo YS, Nam KH, Yun H-R, Chang TI, et al. (2020) Association of smoking with incident CKD risk in the general population: A community-based cohort study. *PLoS ONE* 15(8): e0238111.
65. Zheng CM, Lee YH, Chiu IJ, et al. Nicotine Causes Nephrotoxicity through the Induction of NLRP6 Inflammasome and Alpha7 Nicotinic Acetylcholine Receptor. *Toxics*. 2020;8(4):92. Published 2020 Oct 26. doi:10.3390/toxics8040092.

SMOKING AND NON-COMMUNICABLE DISEASES. PART II CANCER, DIABETES MELLITUS, KIDNEY DISEASES, ALZHEIMER'S DISEASE, ARTHRITIS

66. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders, 5th ed.; American Psychiatric Association: Washington, DC, USA, 2013.
67. WHO (2020) Towards a dementia plan: a WHO guide WHO. Available online at: http://www.who.int/mental_health/neurology/dementia/policy_guidance/en/ (accessed August 4, 2020).
68. Anstey K. J., von Sanden C., Salim A., O'Kearney R. (2007). Smoking as a risk factor for dementia and cognitive decline: a meta-analysis of prospective studies. *Am. J. Epidemiol.* 166 367–378. 10.1093/aje/kwm116.
69. Newhouse P.A., Potter A., Singh A. Effects of nicotinic stimulation on cognitive performance. *Curr. Opin. Pharmacol.* 2004;4:36–46. doi: 10.1016/j.coph.2003.11.001.
70. Hill R.D., Nilsson L.G., Nyberg L., Backman L. Cigarette smoking and cognitive performance in healthy Swedish adults. *Age Ageing.* 2003;32:548–550. doi: 10.1093/ageing/afg067.
71. He F, Li T, Lin J, Li F, Zhai Y, Zhang T, Gu X, Zhao G. Passive Smoking Exposure in Living Environments Reduces Cognitive Function: A Prospective Cohort Study in Older Adults. *Int J Environ Res Public Health.* 2020 Feb 21;17(4):1402. doi: 10.3390/ijerph17041402.
72. United States Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Center for Behavioral Health Statistics and Quality (2012). National survey on drug use and health, 2012 [Data set]. National survey on drug use and health (NSDUH) series. ICPSR—Interuniversity Consortium for Political and Social Research. 10.3886/ICPSR34933.v3.
73. Liu Y, Li H, Wang J, et al. Association of Cigarette Smoking With Cerebrospinal Fluid Biomarkers of Neurodegeneration, Neuroinflammation, and Oxidation. *JAMA Netw Open.* 2020 Oct 1;3(10):e2018777. doi: 10.1001/jamanetworkopen.2020.18777.
74. Karama S., Ducharme S., Corley J., Chouinard-Decorte F., Starr J. M., Wardlaw J. M., et al. (2015). Cigarette smoking and thinning of the brain's cortex. *Mol. Psychiatry* 20 778–785. 10.1038/mp.2014.187.
75. Arthritis Alliance of Canada. The Impact of Arthritis in Canada: Today and Over the Next 30 Years. Toronto: Arthritis Alliance of Canada; 2011.
76. Cooper C, Inskip H, Croft P et al. . Individual risk factors for hip osteoarthritis: obesity, hip injury, and physical activity. *Am J Epidemiol* 1998;147:516–22. 10.1093/oxfordjournals.aje.a009482.
77. Kang K, Shin JS, Lee J, et al. Association between direct and indirect smoking and osteoarthritis prevalence in Koreans: a cross-sectional study. *BMJ Open.* 2016;6(2):e010062. Published 2016 Feb 18. doi:10.1136/bmjopen-2015-010062.
78. Hedström A.K., Stawiarz L., Klareskog L., Alfredsson L. Smoking and susceptibility to rheumatoid arthritis in a Swedish population-based case-control study. *Eur. J. Epidemiol.* 2018;33:415–423. doi: 10.1007/s10654-018-0360-5.

How to cite this article: Agarwal S.K, MD **Smoking and Non-communicable diseases. Part II Cancer, Diabetes Mellitus, Kidney Diseases, Alzheimer's Disease, Arthritis.** *Clinical Medicine Insights.* 2020; 34–42. <https://doi.org/10.5284/5/CMI/2020-1-1-7>