Factsheet

Sex and Gender Differences in Onkology

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Cancer Incidence and mortality


In addition to the incidence of cancer in sexual organs such as prostate and ovary, sex and gender differences in cancers such as colon, lung, and liver have been reported. [Dorak MT, Karpuzoglu E. Gender differences in cancer susceptibility: an inadequately addressed issue. Front Genet. 2012;3:268; Torre LA, Siegel RL, Ward EM, Jemal A. Global cancer incidence and mortality rates and trends--an update. Cancer Epidemiol Biomarkers Prev. 2016;25:16–27.]


Furthermore, bladder cancer and leukemia have been predominantly diagnosed in men. [Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. JAMA Oncol. 2017;3:524–548.]

1.1 Cancer Mortality


Women’s cancers such as breast, ovarian and uterine corpus cancer result in relatively high mortality. Men-specific cancers such as prostate cancer also represent prominent causes for cancer death. Mortality associated with esophagus, liver, and bladder cancer is higher in men than in women. Men had a 34% higher risk of death due to melanoma compared with women. [UROCARE-5 Working Group Survival of patients with skin melanoma in Europe increases further: results of the EUROCARE-5 study. Eur J Cancer. 2015;51:2179–2190.]

Therefore, mortality from various cancer types shows gender disparity.

Lung Cancer

Lung cancer is a major cause of premature and avoidable mortality around the world, and although in more developed countries mortality rates are beginning to decrease, especially in men, the number of deaths from lung cancer in less developed countries is steadily increasing. While historically more men than women have died from lung cancer as a result of higher levels of smoking, the male:female mortality ratio is now showing signs of narrowing. Both sex- and gender-linked factors are important in the etiology of lung cancer. For example, lung cancer is highly associated with tobacco consumption, but also occurs in those who have never smoked. This implies that external factors, such as environmental tobacco smoke (ETS),
need consideration; in addition, research has suggested that exposure to domestic pollution (e.g. emissions from cooking fuels) and to environmental pollution may also have an impact on lung cancer incidence rates. Of high importance is the incidence of lung cancer in never smokers that is significantly higher in China than in the United States; this is particularly notable in women. These data suggest inclusion of ambient air pollution exposure and gender into lung cancer risk prognostic models to better capture high-risk individuals, especially for non-smoking women. [D. Yang, Cancer Volume 468, 1 January 2020, Pages 82-87: Epidemiology of lung cancer and lung cancer screening programs in China and the United States.]

Colon Cancer


Again and again, unfavourable nutrition is cited as a cause of colon cancer. Especially the predominant consumption of foods made from refined flour but also of red meat seems to promote colon cancer. It is undisputed that alcohol contributes to the development of colorectal cancer. New forms of drug and surgical therapy [Brenner, H., M. Kloor, and C. P. Pox, Colorectal cancer. Lancet, 2014. 383 (9927): p. 1490-1502.] have contributed significantly to improving the five-year survival rate which is now quite good, with an average of 40 to 60 percent, but depends crucially on the stage of the disease at which the colorectal cancer is discovered. Therefore, starting from the age of 50 in men and 55 in women in Germany, the cost of a colonoscopy by which pre-stage and early forms can be discovered, is covered by the health insurance funds. [Teoh, D., et al., Excess Cost of Cervical Cancer Screening Beyond Recommended Screening Ages or After Hysterectomy in a Single Institution. J Low Genit Tract Dis, 2018. 22 (3): p. 184-188.]


Genetic and Hormonal Factors


This is probably related to genetic polymorphism of SULT1A1. Moreover, genetic polymorphism, which is linked to drug metabolizing enzymes, influences the risk of carcinogenesis [Bolufer P, Collado M, Barragán E, Cervera J, Calasanz MJ, Colomer D, Roman-Gómez J, Sanz MA. The potential effect of gender in combination with common genetic polymorphisms of drug-metabolizing enzymes on the risk of developing acute leukaemia. Haematologica. 2007;92:308–314.]

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Furthermore, sex hormones may contribute to differences in the incidence of cancer between men and women. [Dorak MT, Karpuzoglu E. Gender differences in cancer susceptibility: an inadequately addressed issue. Front Genet. 2012;3:268; Do TN, Ucisik-Akayya E, Davis CF, Morrison BA, Dorak MT.]

**Therapy**


Certain cancer therapeutics have stronger side effects in women. [Ozdemir, Csajka et al. 2018] Available data clearly demonstrate that women are more susceptible to the toxicity of different types of drugs. [Nicolson, Mellor et al. 2010, Soldin, Chung et al. 2011] with an increased risk of acute hematologic and/or nonhematologic toxicity, such as mucositis, nausea and emesis, and alopecia. This has been shown for colorectal, (Chua, Kho et al. 2011) small-cell, (Singh, Parulekar et al. 2005) and non–small-cell lung cancers (Wakelee, Wang et al. 2006); Hodgkin lymphoma (Klimm, Reineke et al. 2005); glioblastoma (Lombardi, Rumiotto et al. 2015); Ewing sarcoma (van den Berg, Paulussen et al. 2015); and osteosarcoma. (Ferrari, Palmerini et al. 2009) Higher rates of toxicity in the female population are also found in children treated for acute lymphoblastic leukemia. (Meeske, Ji et al. 2015) Women are also more vulnerable to late cardiotoxicity after anthracycline treatment in childhood. (Lipshtultz, Lipsitz et al. 1995) Men have a higher elimination capacity of various anticancer drugs, including paclitaxel, (Joerger, Huitema et al. 2006) fluorouracil, [Gusella, M., et al., Pharmacokinetic and demographic markers of 5-fluorouracil toxicity in 181 patients on adjuvant therapy for colorectal cancer. Ann Oncol, 2006. 17(11): p. 1656-60.], doxorubicin, (Doobs, Twelves et al. 1995) imatinib, (Gotta, Bouchet et al. 2014) sunitinib, (Houk, Bello et al. 2009) bevacizumab, (Lu, Bruno et al. 2008) and rituximab. (Pfreundschuh, Poeschel et al. 2014) Given the binding of drugs to erythrocytes, sex differences in hematocrit might also affect drug metabolism. (Schrijvers 2003) As a result, for many drugs, higher plasma levels are reached in women. Additionally, differences in expression levels of drug metabolizing enzymes resulting from genetic polymorphisms (e.g., cytochrome P450 isoforms; pharmacogenetics) may also play a role. (Maliepaard, Nofziger et al. 2013) For example, CYP3A, which accounts for the metabolism of approximately 50% of commercially available drugs, has been reported to have a higher activity in women. (Hunt, Westerkan et al. 1992) In contrast, the expression levels of the drug efflux pump P-glycoprotein encoded by the MDRI gene are higher in men (Meibohm, Beierle et al. 2002).

A number of studies with various chemotherapy regimens have described a positive correlation between female sex, higher response rates, and longer survival (Elsaleh, Joseph et al. 2000, Klimm, Reineke et al. 2005, Wheatley-Price, Blackhall et al. 2010). Recommended chemotherapy doses should have the most favorable balance between efficacy and toxicity for the majority of patients. However, these recommended doses are
usually established in phase I and II trials with a predominantly male population, that do not consider the potential impact of sex on optimal dosage, and are not designed to identify potentially different optimal doses for both men and women.

In fact, the maximum tolerated dose (MTD) for some drugs might actually be lower in women, and administration of standard doses could lead to increased blood drug concentrations and toxicity. In contrast, the lower rates of toxicity in men might be interpreted as a sign of relative underdosing, which could contribute to their poorer prognosis. [Radkiewicz, C., et al., Sex differences in cancer risk and survival: A Swedish cohort study. Eur J Cancer, 2017. 84: p. 130-140.] For chemotherapy, it is generally accepted that a lower dose-intensity has a negative impact on survival, and unintentional underdosing might result in a 10% to 20% relative reduction in survival. (Lyman 2009)

Concerning Immunotherapies, the difference in gender plays an important role. The most commonly used immunotherapies are used to activate the immune system from a dormant or suppressed status. Such therapies are called immune-checkpoint inhibitors. As sex plays an important role in immune responses [S. Klein, Nat Rev Immunol 2016], differences have been also detected in patients undergoing immune-checkpoint inhibitors in terms of efficacy and side effects.
Literaturverzeichnis


Lombardi, G., E. Rumiato, R. Bertorelle, D. Saggioro, P. Farina, A. Della Puppa, F.


