

COFFEE CONSUMPTION VS. CANCER RISK - A REVIEW OF SCIENTIFIC DATA

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ABSTRACT

Coffee and its impact on health continue to be the topic of much heated debate. Until recently, coffee consumption has been believed to be associated with adverse effects, mainly cardiovascular problems. However, the vast majority of contemporary sources not only emphasize a lack of detrimental effect, but also suggest a beneficial effect of coffee intake. According to the current state of knowledge, coffee consumption is not associated with the majority of cancers although the results of studies on bladder and lung cancer remain conflicting. In case of colorectal, liver and breast cancers, coffee drinking may even have a protective effect. Coffee contains numerous compounds, potentially beneficial as well as harmful. The former include polyphenols which inhibit harmful oxidation processes in the body, while the latter include acrylamide, whose high intake in daily diet may have carcinogenic action. The impact of coffee on the human body is associated also with other factors, e.g. the rate of metabolism and other individual features.

Key words: *coffee, cancer, health*

STRESZCZENIE

Od lat trwa dyskusja na temat wpływu picia kawy na zdrowie. Jeszcze do niedawna przeważały poglądy o jej negatywnych skutkach, w tym przede wszystkim w postaci zwiększonego ryzyka chorób sercowo-naczyniowych. W ostatnich latach większość publikacji naukowych podkreśla jednak brak szkodliwego wpływu picia kawy na zdrowie, a niektóre sugerują nawet jej działanie prozdrowotne. W świetle aktualnego stanu wiedzy obecność kawy w diecie nie ma związku z zachorowaniem na większość nowotworów. Niejednoznaczne są dane dotyczące nowotworów pęcherza moczowego i płuc, natomiast w przypadku jelita grubego, wątroby i piersi nie wyklucza się jej działania ochronnego. Kawa zawiera szereg składników, zarówno potencjalnie korzystnych, jak i szkodliwych. Do pierwszej grupy należą przede wszystkim polifenole, hamujące szkodliwe procesy utleniania w organizmie. Do drugiej należy zaliczyć akryloamid, którego duże spożycie może mieć działanie kancerogenne. Wpływ kawy na organizm człowieka może zależeć także od innych czynników, w tym szybkości jej metabolizmu i innych cech osobniczych.

Słowa kluczowe: *kawa, nowotwory, zdrowie*

INTRODUCTION

Notwithstanding the popularity of tea, coffee is the most favored beverage in the world. Taking into account the enormous demand for coffee, the effect of its consumption on health is an important public health issue. A great number of studies on coffee and health have been conducted over the last decades. Until recently, coffee consumption has been believed to be associated

with adverse effects, mainly cardiovascular problems. Contrary to earlier beliefs, the results of recent research emphasize that coffee drinking is not only not harmful but may in fact be a beneficial element of a diet. Titles such as “*Coffee can protect against diseases*” and “*Is it time to write a prescription for coffee?*” have started to appear in scientific journals [14, 44]. In light of current knowledge, habitual moderate coffee intake may help prevent several chronic diseases, including type 2 dia-

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betes mellitus, coronary heart disease, and *Parkinson's* disease [27].

Over the last four decades, the relationship between coffee consumption and cancer has generated great interest. While earlier studies suggested that coffee drinking might increase the actual the risk of cancer [6], current findings suggests that coffee is associated with a reduced risk of some malignancies [1]. Despite the accumulating body of evidence for its safety, coffee intake remains controversial. According to 36% of health care professionals, coffee consumption increases the risk of cancer [6].

This article presents recent evidence for the association between coffee consumption and the risk of some types of cancer, based on meta-analyses of studies from that area.

COLORECTAL CANCER

Colorectal cancer is currently one of the most common cancers worldwide. For decades, the relationship between coffee consumption and the risk for colorectal cancer has been extensively examined. Some studies published in the 80s reported an adverse association between coffee consumption and colon cancer among people consuming ≥ 2 cups of coffee a day [38], whereas others did not show any relationship or suggest a beneficial effect of coffee on colorectal cancer risk [33]. Nevertheless, all studies emphasized that more data are needed in order to determine the exact nature of the relationship, if any, between coffee consumption and cancer risk.

Numerous case-control and cohort studies have been published since the 80s. In 1991, a Working Group of the International Agency for Research on Cancer reviewed the existing data and concluded that there is some evidence of an inverse relation between coffee drinking and cancer of the large bowel in man [10]. This suggestion was later confirmed in a meta-analysis of case-control studies based on data published up to 1997 [12]. Numerous meta-analyses have been undertaken recently and their results are also optimistic. A meta-analysis of prospective cohort studies in 2009 showed no significant effect of coffee consumption on colorectal cancer risk [16], whereas a meta-analysis of case-control studies in 2010 suggested a moderately favorable effect (17% lower risk of cancer) [10]. A beneficial effect of coffee on the risk of colorectal cancer was also confirmed by a meta-analysis of cohort studies in 2011 [52]. As many as three analyses and a review of data were published in 2013. One of them, including case-control studies, stated that the risk of colorectal cancer is reduced by 15% for heavy coffee drinkers as compared to low or non-drinkers, and that the risk of

colon cancer is reduced by 21% [23]. *Tian et al.*, in their analysis of observational studies, detected a significant association between coffee intake and decreased risk of colorectal and colon cancer among subjects consuming ≥ 4 cups of coffee a day [43], while a review of epidemiological evidence by *Bøhn et al.*, indicated that coffee may protect against colorectal cancer [6].

BREAST CANCER

In 1990, a Norwegian cohort study including over 14 000 women demonstrated that lean women who drank ≥ 5 cups of coffee a day were at a 50% lower risk of breast cancer as compared to their peers who drank ≤ 2 cups a day [47]. These optimistic findings were later confirmed by a Swedish study, where coffee intake was associated with a modest (20%) decrease in estrogen receptor (ER)-negative breast cancer among postmenopausal women drinking ≥ 5 cups coffee a day [24]. An 11-year French cohort study [9], and a 22-year follow-up American study [11] reported lack of relationship between coffee and breast cancer risk. Also, recently published meta-analyses of studies found no significant association between breast cancer risk and coffee consumption [18], either inverse [52], or only a borderline significant beneficial relationship between high coffee intake and the risk of breast cancer [41].

According to some authors, the effect of coffee intake on breast cancer risk can depend on caffeine metabolism, with cytochrome P450 CYP1A2 playing the essential role. Metabolites of caffeine are regarded as the best markers of the activity of this cytochrome in humans. CYP1A2 is also involved in the metabolism of estrogen and, therefore, is the key enzyme in the etiology of breast cancer [2, 4, 13, 21, 28]. Some data imply that the relation between coffee consumption and cancer risk can be modified by the *CYP1A2*1F* genotype. One study conducted in Sweden suggested that moderate to excessive consumption of coffee by patients with the *CYP1A2*1F* AA genotype may slow the growth of estrogen receptor-positive tumors [4]. Conflicting results were reported in another study from this country including healthy postmenopausal non-hormone users. According to that study, consumption ≥ 3 cups of coffee a day protects against breast cancer only in C genotype carriers [17]. However, a study by *Lowcock et al.*, has shown a significant reduction (29%) of breast cancer risk in heavy coffee drinkers (≥ 5 cups a day), independently of the CYP1A2 genotype [28]. The protective effect of coffee on women with the C genotype (AC or CC) but not the AA genotype was also observed in carriers of the BRCA1 mutation who are at high-risk of breast cancer [20]. Premenopausal women with the *BRCA1* or *BRCA2* mutation who ha-

bitually drank ≥ 6 cups of coffee a day experienced a statistically significant reduction (by 70%) in breast cancer risk also according to another study [32]. Finally, a meta-analysis of 37 studies by Jiang et al., published in 2013 demonstrated an inverse association of coffee/caffeine intake with breast cancer risk in carriers of the BRCA1 mutation [18].

LIVER CANCER

Data on potentially beneficial effects of coffee on liver function and liver diseases have accrued over the last two decades. Since 2007, all published data in this area indicate that coffee consumption can protect against liver cancer. A meta-analysis of cohort and case-control studies by Larsson and Wolk [22] reported an inverse association between coffee consumption and liver cancer among individuals with and without a history of liver disease. Their conclusion was also confirmed by a meta-analysis of cohort studies by Yu et al., who suggested a significant inverse relation between coffee intake and hepatocellular cancer [52]. Two independent meta-analyses were published in 2013. One of them stated the risk of liver cancer for high coffee drinkers was 50% lower than for no/almost never drinkers both, in European and in Asian studies [37]. The second reported that the risk of hepatocellular carcinoma for coffee consumption vs. no consumption was lower by 40% [5].

On the basis of epidemiological evidence it seems safe to conclude that coffee drinking not only does not increase the risk of liver cancer but may in fact protect from it. According to some experts, moderate daily intake of unsweetened coffee is a responsible addition to the main therapy for non-alcoholic fatty liver disease patients [44].

BLADDER CANCER

Bladder cancer is the most common cancer of the urinary tract, of unknown etiology. Since the early 1970s, coffee consumption has been considered to be related with an increased risk of bladder cancer [51]. Despite a large number of studies published since then, the relation between coffee and bladder cancer remains highly controversial [42]. A meta-analysis of cohort studies in 2011 found coffee to be inversely associated with bladder cancer in men, whereas that trend was not observed in women [52]. A meta-analysis of case-control studies, published a year later, provides opposite data, suggesting a linear increase in the risk of bladder cancer along with the amount of coffee intake (15-29% increase for 2-4 cups of coffee a day, respectively).

On the other hand, a meta-analysis of cohort studies in that publication failed to confirm such a correlation [53]. However, the results of the latest meta-analysis of observational studies in 2015 postulate an increased risk between coffee consumption and bladder cancer, especially among male coffee drinkers and non-smoking coffee drinkers [51].

PROSTATE CANCER

The results of studies relating to coffee consumption and prostate cancer remain inconsistent, despite numerous meta-analyses undertaken recently. A meta-analysis of case-control studies in 2010 reported a harmful association between coffee consumption and prostate cancer risk, whereas cohort studies failed to confirm it [34]. The meta-analyses of cohort studies in 2014 and 2015, which support the hypothesis that coffee consumption may even decrease the risk of prostate cancer, provided more optimistic conclusions [7, 26].

OTHER CANCERS

Regardless of the findings of the meta-analysis from 2011 that coffee consumption may reduce the total cancer incidence [52], data about lung cancer are less optimistic. In one study, an elevated lung cancer risk was observed for drinkers of ≥ 2 cups of coffee a day [3]. In another report, a linear relationship was found between coffee consumption and increased risk of lung cancer, especially for consumers of ≥ 3 cups coffee a day [48]. A meta-analysis on this topic indicated that high coffee consumption may increase the risk of lung cancer but, according to the authors, these results should be interpreted with caution due to other confounding factors, e.g. smoking [40]. As far as pancreatic cancer is concerned, two meta-analyses were published recently. The first suggests the existence of an inverse relationship between coffee drinking and the risk of pancreatic cancer [8], whereas according to the second coffee consumption is not appreciably related to pancreatic cancer, even at high intakes [46].

SUGGESTED ACTION OF COFFEE ON CANCER RISK

Despite a great number of studies on the relationship between coffee consumption and health, the protective mechanism of coffee against cancer remains elusive. Coffee can potentially impact the etiology of cancer by multiple pathways. One of them is connected with polyphenols which are abundant in coffee. Polyphenols

have strong antioxidant properties and can inhibit oxidative stress and oxidative DNA damage [6, 54]. In such countries as Finland and Norway, where that drink is extremely popular, coffee provides more than 50% of the total dietary antioxidants [6, 45]. The chlorogenic acid, which may slow intestinal glucose absorption and support insulin sensitivity in the body, is the most known among coffee polyphenols. Chronic hyperinsulinemia and insulin resistance are confirmed markers of high risk for some cancer sites [52].

Coffee is also a source of diterpenes – cafestol and kahweol, which can modulate multiple enzymes involved in carcinogenic detoxification, especially in the process of hepatic detoxification [19, 22, 44, 51]. Drinking coffee has been associated with a reduced risk of hepatic injury and cirrhosis and, via that pathway, coffee can protect against liver carcinogenesis [5, 22, 29]. With reference to colon cancer, specific possible mechanism include reduction of synthesis and secretion of bile acids, known promoters of colon cancer [10, 23], whereas in case of breast cancer the anti-carcinogenic properties of coffee can result from altered estrogen metabolism [4].

It is important to note that coffee is a primary source of caffeine. Based on the current evidence, it is suggested that moderate caffeine intake by healthy adults at a dose level of 400 mg a day is not associated with adverse effects, including incidence of cancer. Composition of coffee is determined by strength of the brew and brewing methods. Stronger brews have higher levels of caffeine, but also lots of beneficial polyphenols [15, 31, 49].

Considering the influence of coffee on health it is important to take into consideration various genetic factors, mainly determined by the CYP1A2 genotype, which play a role in metabolism of caffeine [2].

ACRYLAMIDE IN COFFEE

Acrylamide is an industrial monomer which has been manufactured for over 50 years and used in many fields of industry. This substance is also formed during the process of cooking, principally by the *Maillard* reaction between the amino acid asparagine and reducing sugars [30, 35]. Acrylamide is produced during roasting of coffee beans in high temperatures [6, 30]. Numerous studies have shown coffee to be a significant dietary source of acrylamide. In adult diet, coffee may deliver up to 39% of the total daily intake of this substance [19, 30]. A study by *Mojška* et al., found that one cup of coffee contained on average 0.45 µg of acrylamide [30].

A lot of animal studies have shown that acrylamide is carcinogenic [30, 36]. In 1986, an American study revealed a report on the mortality rate among 371 em-

ployees who had had potential exposure to acrylamide during monomer production and polymerization operations at an industrial facility [39]. Finally, in 1994 acrylamide was evaluated by the International Agency for Research on Cancer as “probably carcinogenic to humans” (IARC Group 2A) [30, 36]. Nevertheless, epidemiological studies and retrospective re-analyses of data published so far failed to provide sufficient evidence that dietary acrylamide increases the risk of any type of cancer in humans, including kidney, large bowel, bladder, oral cavity, breast, and ovarian cancer [25, 36, 50].

SUMMARY

Results of recently published studies on the effect of coffee on health are surprisingly positive for coffee consumers. An accumulated body of scientific evidence confirmed a lack of correlation between coffee intake and development of cancer. Furthermore, some authors suggest that coffee may in fact have pro-health properties. However, bearing in mind many factors affecting the risk of cancer in humans, the assumption that habitual coffee drinking can prevent carcinogenesis should be interpreted with caution.

Also, it is important to note that the impact of coffee on health may depend on the type and strength of the brew, and serving size. Most studies failed to provide accurate information on that matter. Therefore, the question whether every kind of coffee has the same impact on human body and which coffee is potentially the best remains unanswered. In Poland, it is very popular to pour hot water directly over the ground coffee in a cup. However, to the best of our knowledge, the Polish literature offers no data on the effect of such method of brewing on human health. In Western countries, where most scientific data come from, coffee is often prepared using paper filter. On the other hand, optimistic scientific findings come from various regions of the world, including America, Japan, and Europe, what may be proof that coffee is not harmful and support the hypothesis that coffee may be recommended in the future as an element of a pro-health diet.

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