Education

Knowledge of university students regarding the use of toxic substances, daily and eating habits with carcinogenic character

Conhecimento de estudantes universitários quanto ao uso de substâncias tóxicas, hábitos cotidianos e alimentares com caráter cancerígeno

Raphael da Silva Costa[I] , **Alexandre Azenha Alves de Rezende**[I] ,
Luciana Karen Calábria[I]

[I] Universidade Federal de Uberlândia, Campus Pontal, Ituiutaba, Minas Gerais, Brazil

ABSTRACT

The knowledge of university students regarding the use of toxic substances, daily and eating habits with a carcinogenic character was assessed by using a semi-structured questionnaire. In addition, a systematic review was carried out on an electronic basis on the subject. The results revealed that university students know little about the risks and association of high consumption of hyperglycemic foods, omega-6 and red meat, as well as the exposure to BPA and insecticides, despite the fact that most are aware of the harmful effects of excessive use of cell phones and its relation with cancer. Thus, we notice the importance of disseminating preventive information that promotes a change in living and eating habits with carcinogenic character, resulting in self-care and a better quality of life.

Keywords: industrialized food; balanced diet; cell phone; chemical exposure; carcinogenesis

RESUMO

O conhecimento de universitários sobre o uso de substâncias tóxicas e os hábitos cotidianos e alimentares com caráter carcinogênico foi avaliado por meio de um questionário semiestruturado. Além disso, uma revisão sistemática foi realizada em bases eletrônicas acerca do tema. Os resultados revelaram que os universitários pouco sabem sobre os riscos e associação do alto consumo de alimentos hiperglicêmico, de ômega-6 e carne vermelha, bem como da exposição ao BPA e inseticidas, apesar da maioria conhecer os malefícios do uso excessivo do celular e sua relação com o câncer. Percebe-se, assim, a importância da divulgação de informações preventivas que promovam a mudança de hábitos de vida e alimentares com caráter carcinogênico, resultando em autocuidado e melhor qualidade de vida.

1 INTRODUCTION

Cancer is a disease characterized by the presence of a malignant tumor with cells that have the ability to disorderly grow, which tend to invade tissues and neighboring organs (INCA, 2020a). It is also an important health problem and one of the biggest causes of morbidity and mortality in the world, affecting millions of people. In 2020, there were 9.9 million deaths of cancer, the equivalent to 16.1% of deaths globally, being the second leading cause of mortality worldwide (WHO, 2018; WHO, 2020). According to the National Cancer Institute (SANTOS, 2018), the SUS Computer Department (DATASUS, 2019) and the INCA (2019), there were more than 235 thousand deaths of cancer in Brazil in 2019, being estimated 625 thousand new cases in the next year. Prostate cancer in men and breast cancer in women were the ones with the highest incidence.

Carcinogenesis in a multicellular organism can result from either one or a combination of chemical, physical, biologic, and genetic insults to individual cells. Numerous toxic substances present in our environment have played an important role in the development of carcinogenesis, which is characterized by a series of genetic and cellular changes, including oncogene activation, that lead the cell to divide in an uncontrolled manner. This process is divided into three stages: initiation, promotion and progression (INCA, 2020a). The initiation phase occurs with the exposure to carcinogens - or potentially carcinogenic substances - and damage to DNA molecules. In the promotion phase, the so-called tumor promoters or active mitogens induce clonal cell expansion. Finally, in the progression phase, the modified cells develop irreversible changes, culminating in the uncontrolled proliferation of cancer cells (KLAUNIG; WANG, 2018). Depending on the mechanism of action of the chemical substance, three classes of chemical carcinogens can be recognized: 1) direct action or ultimate carcinogens - whose chemical structure

confers them the capacity to induce cancer without a previous metabolic activation; 2) co-carcinogens - chemical substances that cannot induce cancer when they are administered alone, but can enhance the carcinogenic effect of other substances and 3) procarcinogens – substances that become active after previous metabolic activation (BABA; CÂTOI, 2007).

It is clear that cancers are more frequent nowadays compared to the first decades of the last century, and it is important to examine what has changed in the countries, especially after the Second World War in 1940. There are three crucial factors that have drastically changed our environment: the exacerbated increase of sugar consumption; the transformation of agriculture and animal husbandry, reflecting on our food; and the exposure to multiple chemicals (SERVAN-SCHREIBER, 2009; VERNIA *et al.*, 2021). Among them, the chemical exposure is the most reported in literature, as seen in Peres (2015), Ferguson and Solo-Gabriele (2016), Toledo and Nardocci (2016), Ferguson, Penney and Solo-Gabriele (2017), Perlroth and Castelo-Branco (2017), and Saggioro *et al.* (2019).

All studies corroborate, stating that organochlorine compounds (e.g. DDT and BHC), endocrine disrupters (e.g. bisphenol-A), aromatic amines and chlorinated hydrocarbons (mainly aromatic polycyclics) have a high carcinogenic potential. For example, the misuse of some utensils can bring the possibility of ingestion of undesirable compounds, such as bisphenol-A, as well as the high intake of phosphate-based preservatives that have a carcinogenic character (SERVAN-SCHREIBER, 2009). In food, a diet rich in omega-6 polyunsaturated fatty acids increases the incidence and decreases the latency of neoplasms, while a diet rich in omega-3 fatty acids reduces neoplastic development (CRUZ *et al.*, 2019).

Another non-chemical exposure that is also dangerous is found in the electromagnetic fields of cell phones, which if prolonged and continuous increases considerably the risks of acquiring brain cancer (SERVAN-SCHREIBER, 2009). However, there is still no consensus between exposure to radio frequency waves and cancer (BIELSA-FERNANDÉZ; RODRÍGUEZ-MARTÍN, 2018).

Given the risks and harms of chemical and non-chemical exposure to cancers, the objective of this study is to evaluate the knowledge of university students on the use of toxic substances, as well as daily and eating habits with carcinogenic character.

2 MATERIAL AND METHODS

The research had two stages, the first one was the application of an opinion survey questionnaire and the second one was the literature review. The semi-structured questionnaire was applied using the Google Forms® online platform, and was answered anonymously in May 2019 by 100 university students ranging from several undergraduate courses at the Federal University of Uberlândia, without age and biological sex restrictions. The opinion survey questionnaire allowed us to gather information that led us to the second stage of the research, the literature review, addressing the following topics: eating foods with a high glycemic index; imbalance in fatty acid levels (omega-3 and -6); high consumption of red meat; toxic substances present in household utensils; preservatives and contaminants in food and exposure to electromagnetic radiation from cell phones.

The data collected by the questionnaires were spreadsheet using Microsoft Office Excel® software and analyzed using descriptive statistics, considering absolute (n) and relative (%) frequencies.

After analyzing the survey, a review of the specialized literature was carried out between May 2019 and June 2021, consulting the electronic databases CAPES, PubMed, Google Scholar, Scielo and USP Repository, on the theme of cancer, using descriptors such as *câncer, carcinogênese, substâncias tóxicas* and *alimentação*, and its English correspondents, as well as the Boolean operator "AND" to compose the search strategy. We found articles, dissertations, theses, books and abstracts of scientific events related to the subject of this study.

Considering the objective of the research and the methodological conduct, this study was not registered or evaluated by the CEP/CONEP system because it meets items VI and VII of article 1st of resolution nº 510, of April 7th, 2016, which exempts from registration the surveys of research data with the objective of theoretical deepening without identifying the subjects involved, as well as a review of the literature based on scientific texts.

3 RESULTS AND DISCUSSION

The results obtained from the questionnaire answered by the university students were gathered in Table 1. It was possible to observe that only 48% of the respondents stated that they knew about the relationship between the high glycemic index and cell proliferation or the predisposition to cancer, including revealing a high daily consumption of white flour (white bread, pasta, white rice, cakes, refined and sweetened breakfast cereals), followed by sugary beverages, industrialized fruit juices and soft drinks, and of sugars (white or brown, honey, guarana syrup and dextrose) , corresponding to 89%, 66% and 60%, respectively.

The excessive intake of refined carbohydrates and especially high dietary energy has the potential to increase the risk of cancer, including breast cancer (MULLIE *et al*., 2016), raising levels of insulin and insulin-like growth factor-1 (IGF-1) (ENGIN, 2017; WU *et al*., 2021). Even resulting in mitogenic and anti-apoptotic effects, with a promoter effect on the carcinogenesis of various types of cancers (ZIELINSKA *et al*., 2015). Some cancers, such as prostate and breast cancer are called hormone-dependent, as they depend on androgens for their development and progression. Testosterone, for example, is naturally regulated by SHBG (Sex Hormone Binding Globulin), insulin and IGF-1. Therefore, insulin can increase the risk of these cancers by suppressing SHBG levels (AUGUSTIN *et al*., 2015).

Regarding the excessive consumption of omega-6 fatty acids, only 34% of respondents said they were aware of its relationship with the risk of developing

cancer. On the other hand, the majority reported daily consumption of vegetable oils (62%), such as soybean, sunflower and/or canola, and products rich in trans fat, such as stuffed cookies, ready-made pies and chips (54%). The omega-3 and omega-6 fatty acids participate in physiological processes in reverse, enabling physiological balance. While omega-3 fatty acids regulate inflammation and cell growth, as well as promote blood flow, omega-6 fatty acids stimulate inflammation, blood clotting and cell growth (SERVAN-SCHREIBER, 2009).

In addition, diets high in fat are generally low in dietary fiber, a fact that increases the time of intestinal transit, favoring the proliferation of bacteria and consequently the degradation of bile acids, producing potential carcinogenic agents, which have greater interaction with the intestinal mucosa. The main harmful agents are bile salts, metabolites of short chain fatty acids, resulting from the increase in intraluminal pH and which are formed at the end of the metabolism of fats and animal protein, determining changes in the epithelium and culminating, therefore, in the development of cancer (VERNIA *et al*., 2021).

Table 1 – Knowledge of university students regarding the use of toxic substances, daily and eating habits with carcinogenic character, Ituiutaba, MG, 2019

Evaluated issues	%
Consumption of food with a high glycemic index	
White flour: white bread, overcooked pasta, white rice, cakes, refined and sweetened breakfast cereals	89.0
Sugary beverages, industrialized fruit juices and soft drinks	66.0
Sugar: white or brown, honey, guarana syrup and dextrose	60.0
Potato, mainly mashed potato (except the potato variety Nicola)	50.0
Jams and fruits in syrup	9.0
Relationship between the glycemic index and proliferation of cancer cells	48.0
Consumption of food rich in omega-6 fatty acids	
Vegetable oils (soybean, sunflower and/or canola)	62.0
Stuffed cookies, ready-made pies and chips that contain trans fat	54.0
Margarine	46.0
Health risks (cancer) due to excessive consumption of omega-6 fatty acids	34.0
Weekly consumption of red meat	
Low (up to three times a week)	34.0
Regular (at least four times a week)	30.0

Table 1 – Conclusion

Evaluated issues	
Weekly consumption of red meat	
High (everyday)	35.0
Relationship between high consumption of red meat and breast cancer	23.0
Utensils used incorrectly	
Soda and food cans	42.0
Microwave bowls	36.0
Cup	21.0
Electric kettle	3.0
Baby bottle	2.0
Toxic substances released by utensils when heated or in contact with hot food	44.0
Frequent consumption of foods preserved in phosphate-based substances	
Soft drinks (including sugary and fizzy drinks)	60.0
Processed sweets	53.0
Meat or processed products derived from pork (with preservatives)	47.0
Processed ice cream	40.0
Ready-made industrialized foods (frozen pizza, frozen fish sticks, etc.)	37.0
Cheese paste	13.0
Fruit syrups	3.0
Knowledge regarding substances such as dioxin, polychlorinated biphenyls and certain pesticides, such as DDT	13.0
Preventive measures in the risk of cancer generated by the excessive use of cell phone	
Avoid keeping the cell phone close to your body, at night do not leave it less than 2 meters away and prefer airplane mode or switched *off*	64.0
Restrict the use to short calls, preferring text messages	54.0
When using, change the ear side regularly and before bringing the cell phone to your ear, wait for the other person to answer.	45.0
During calls, keep distance from the cell phone (prefer to use speakerphone or a headset).	45.0
Knowledge regarding the risks of excessive use of cell phone	73.0

Source: Authors (2020)

Still, 77% are unaware of the correlation between high consumption of red meat and increased rates of breast cancer, with prevalence in the frequency of weekly consumption, considered as low (34%), regular (30%) and high (35%). The red meat presents a risk factor for the development of cancer when subjected to high temperatures, resulting in the formation of nitrous components, heterocyclic amines and polycyclic aromatic hydrocarbons that are carcinogenic agents. Nitrous compounds, for example, are alkaline agents that can react with DNA, acting on target tissues, changing their bases and, consequently, initiating carcinogenesis (DEMEYER *et al*., 2016). Also, the consumption of 120 grams/day of red meat,

compared to no consumption, indicates the estimated risk between 1.24-1.28, reinforcing the adoption of a balanced diet with low intake of this food (ZANDONAI; SONOBE; SAWADA, 2012).

Furthermore, it is in the process of preparing and cooking meat that the release of carcinogenic factors, including nitrates and nitrites, is estimated to occur. N-nitro compounds and nitrate when transformed into nitrite induce tumor formation, resulting in increased cellular damage and production of free radicals. Nitrite can also be formed in cured meats preserved with sodium nitrate and sausages, as well as by the action of saliva that transforms it into nitrite. Besides that, meat prepared at high temperature may have their proteins denatured and result in the formation of heterocyclic amines, which are chemical carcinogens (CASCELLA *et al*., 2018).

Worldwide, there is a direct relationship between the frequency of cancers and the consumption of meat, cold cuts and dairy products, and an indirect relationship with the consumption of vegetables and legume, and it is recommended to reduce the consumption of red meat to a maximum of 500 grams per week (INCA, 2020b).

Considering the release of toxic substances, such as bisphenol-A, 56% of the individuals stated that they did not know its relationship with the heating of utensils used in our daily lives, being the soda and food cans (42%) and the microwave bowls (36%) the most wrongly used.

Bisphenol-A (BPA) is a synthetic organic compound widely used in the manufacture of polymers, such as polycarbonates, epoxy resins, in addition to a variety of plastics. Such materials are present in thermal papers, sunglasses, medical and dental materials, as well as food packaging, among others. The bioaccumulative character of BPA can lead to DNA degradation and increased cell proliferation, migration, invasion and apoptosis, resulting in tumor progression (GAO *et al*., 2015).

BPA, considered as an endocrine disruptor and xenoestrogen, has a powerful chemical toxicity, being one of the components of polyvinyl chloride (PVC) or hard plastic, generally found in the internal lining of several containers in the kitchen and snack bars. This toxic substance is released when the food is heated, having a carcinogenic effect (HU *et al*., 2012; PAULOSE *et al*., 2015; WEI *et al*., 2016). According to Naidu *et al*. (2021), human health can suffer harmful damage if exposed to endocrine disruptors, which have the ability to disable and modify functions of the endocrine system of various animals, including humans, affecting growth and reproduction, as well as the evolution of cancer.

Regarding the consumption of foods preserved in phosphate-based substances (calcium phosphate, disodium phosphate, phosphoric acid, sodium triphosphate, etc.), the most frequently mentioned were soft drinks, including sugary and fizzy drinks (60%), followed by processed sweets (53%).

Servan-Schreiber (2009) points out studies that reveal greater growth of tumors in animals fed a diet rich in phosphate additives, at levels that correspond to those that humans are exposed to when consuming a western diet with industrialized foods and soft drinks. This raises the hypothesis that the excessive amount of phosphate genetically activates the development of cancers. On the other hand, studies on this matter are still scarce and inconclusive.

The consumption of red meat and large fish, as well as milk derivatives, constitutes 90% of human exposure to contaminants, including substances such as dioxin, polychlorinated biphenyls and certain pesticides such as atrazine. Based on this, 87% of respondents said they were unaware of these substances.

Chemical substances such as those used in organochlorine insecticides and industrial by-products (DDT, atrazine, dioxin, hexachlorobenzene and aldrin) are typical persistent and bioaccumulative organic pollutants. Although some of these substances have been removed from the market years ago, they are still detectable in agricultural land and in industrial areas where they were present. It is noteworthy that women during pregnancy can mobilize organochlorine residues

present in body fat, incorporating them into breast milk (VAN-DEN-BERG *et al.*, 2017). In addition, animal experiments have demonstrated the carcinogenic, teratogenic, immunotoxic and endocrine interfering effect of these residues (JAYARAJ; MEGHA; SREEDEV, 2016).

Since visceral fat is the main target of accumulation of most carcinogenic compounds, it is evident that breast, ovaries, prostate, colon and lymphatic system cancers are the types with the highest incidence in the West, since these tissues are formed or surrounded by fat (SERVAN-SCHREIBER, 2009). Besides its fat-soluble characteristic, we must consider that the metabolism by-products of many agrochemicals are often more toxic and carcinogenic than the initial molecule itself and can act in a systemic way.

Another important aspect evaluated in this study was the risk of excessive use of the cell phone. From the total investigated, 73% declared to know the risks, and the main preventive measures were "avoid keeping the cell phone close to your body; at night do not leave it less than 2 meters away and prefer airplane mode or switched off" (64%) and "restrict the use to short calls, preferring text messages" (54%).

Electromagnetic fields were determined by the International Cancer Research Agency (IARC) as group 2B "possible human carcinogens" (IARC, 2002; 2011; LEACH; WELLER; REDMAYNE, 2018) and the increased risk of glioblastoma multiforme was revealed after exposure to this magnetic field and associated with the use of cell phones (HARDELL; CARLBERB, 2015; VORNOLI *et al.*, 2019), as well as the increase in glucose metabolism in the brain after 50-minute exposure (VOLKOW *et al.*, 2011). Despite this, Karipidis (2018) did not obtain significant results that could support the association between cell phone use and brain tumor, although he also does not rule out the possibility of a small risk. This divergence of results reinforces the need of studies in the area and that covers a longer latency period.

4 CONCLUSION

The data collected revealed that the university students investigated know little about the risks and association of high consumption of food with a high glycemic index, excessive intake of omega-6 and red meat, as well as the exposure to bioaccumulative contaminants, such as BPA and insecticides with carcinogenic effects, despite the fact that most students are aware of the harmful effects of excessive use of cell phone and its relation to cancer.

In addition to the little knowledge diagnosis, it was also possible to identify the high consumption of white flour, sugary beverages, refined sugar and vegetable oils, which can be proved to stimulate the body to carcinogenesis, resulting in mitogenic and anti-apoptotic effects, as well as leading to inflammatory responses. However, the investigated population revealed low (or adequate) consumption of red meat, little misuse of utensils that have BPA and adherence to protective measures for the safe use of cell phones.

Therefore, it is noticed the importance of disseminating preventive information which promotes individual reflection about their living and eating habits that have a carcinogenic character, resulting in self-care and better quality of life.

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Authorship contributions

1 - Raphael da Silva Costa
Graduated in Biological Sciences
http://orcid.org/0000-0003-1953-294X - dasilvacosta.rafael@gmail.com
Contributions: Formal Analysis, Investigation, Methodology, Visualization, Writing – original draft.

2- Alexandre Azenha Alves de Rezende
PhD in Genetics (Emphasis on Mutagenesis)
http://orcid.org/0000-0003-1751-9194 - azenha@ufu.br
Contributions: Investigation, Visualization, Writing – review & editing.

3 - Luciana Karen Calábria
PhD in Biochemistry (Emphasis on Clinical Biochemistry)
http://orcid.org/0000-0002-0500-0232 - lkcalabria@ufu.br
Contributions: Formal Analysis, Investigation, Methodology, Resources, Visualization, Writing original draft, Writing review & editing.

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