

Influence of Heavy Metals from the Flooded Areas of Tuzla Canton on the Growth of Stomach Adenocarcinoma

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Abstract: The aim of this study is to determine the relationship between food contaminated with heavy metals and growing number of stomach adenocarcinoma patients in Tuzla Canton after flooding of the river Spreča catchment area. The scope of work is retrospective and prospective five-year study (2010-2015) of 1,000 patients, who had stomach adenocarcinoma surgery in the department of surgery, University Clinical Centre Tuzla, and answered questions about diet. The patients were predominantly male, aged 60 to 70 (1.5: 1). The data on heavy metal contamination in farmlands in the river catchment area were provided by the Federal Department of Agropedology. The malignity was reported to the department of public health in Tuzla Canton. The results showed an increase in number of patients with stomach adenocarcinoma in the industrially developed municipalities who consumed vegetables contaminated with heavy metals after the floods. The smallest number of patients who underwent stomach adenocarcinoma surgery comes from the municipalities situated out of the flood plain, where farmland was not contaminated. It is concluded that most of the patients having stomach adenocarcinoma came from the municipalities with contaminated agricultural soil. The diet included vegetables, meat, and dairy products.

Key words: Stomach adenocarcinoma, diet, contaminated soil.

1. Introduction

Gastric cancer remains one of the deadliest diseases with a poor prognosis [1, 2]. Its main cause is the change in eating and life habits [3]. In the area of TK (Tuzla Canton), two studies were performed on patients operated for gastric adenocarcinoma. This cancer type comprises 95% of the total number of tumors of the stomach. From 2005 to 2010, 126 patients underwent the surgery, while in the period from 2010 to 2015, the number of surgical patients was 202. The percentage has increased by 100% as well as the recurrence of gastric cancer [4]. The Federal Department of Agropedology of Bosnia and Herzegovina has found soil contamination by heavy metals in more than 40 locations. Salčinović and his associates conducted a study of soil and plants in the

lower reaches of the river Spreča [5]. The increased values of heavy metals: mercury, range from 0.922 mg/kg to 3,653 mg/kg per sample, nickel, whose values range from 67.37 to 136.80 mg/kg, and chromium, ranging from 39.60 to 329.70 mg/kg. High concentrations of PAHs in the soil at the lower reaches of the river Spreča increased up to 30 times. PAH stands for compounds that arise and accumulate in the soil exclusively by industrial action. They have pronounced carcinogenic and genotoxic potential [6-8]. The permissible input value of Pb, Cd, Hg in the human organism with an average weight of 70 kg is: 3 mg of lead, 0.5 mg of cadmium, 0.3 mg of mercury. Maximum levels of metals and non-metals in food must comply with the requirements and regulations of the European Union, the World Health Organization and the Organization for Agriculture and Nutrition (Codex Alimentarius commission WHO/FAO) [9].

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2. Aim

The aim of the research was to: (1) determine the socio-demographic and sexual characteristics of the respondents and to determine the number of operated stomach adenocarcinoma patients in the Spreča river basin in Tuzla Canton; (2) prove a rise in the number of operated patients who have been consuming food from the areas contaminated by heavy metals after the floods; (3) determine the number of operated patients who consumed food from the uncontaminated Tuzla Canton suburban area.

3. Respondents and Methods

The retrospective-prospective five-year study covers cases of operated and unoperated patients with stomach cancer in the period from 01.01, 2010 to 31.12, 2015. One thousand respondents from Tuzla Canton were chosen to participate by means of random selection. The research was conducted on the basis of data from medical records and questionnaires in specialist-consultative outpatient clinics, operation data and postoperative course of the UKC Tuzla Clinic for surgery and from pathohistological lab findings for operated patients. The research was followed by reporting malignancies to the public health institute TK. Primary research was conducted using the method of

survey. The questionnaire contained an inquiry about the type of diet, consumption of vegetables, fruit, milk and meat. Data on soil contamination with heavy metals were used from the federal department of agropedology of Bosnia and Herzegovina.

Only subjects with pathohistologically verified gastric adenocarcinoma were included in the study, while subjects with leiomyosarcoma, lymphoma, carcinoid and squamous carcinomas were excluded.

4. Results

In the study, there were 202 operated patients from the group of 1,000 respondents. Adenocarcinoma of the stomach was more prevalent in men than women (1.5: 1). Moreover, most of the patients were aged 60-70 (Fig. 1).

Fig. 2 shows the number of operated patients in Tuzla Canton municipalities. The largest number of patients who underwent adenocarcinoma surgery comes from municipalities in the industrial zone located alongside the Spreča river basin. By looking at municipalities, the largest number of treated patients comes from: Tuzla 55, Živinice 28, Lukavac 18, Kalesija 13, Gračanica 16. A minimum number of treated patients come from suburban areas, Sapna 3, Teočak 4, Čelić 6.

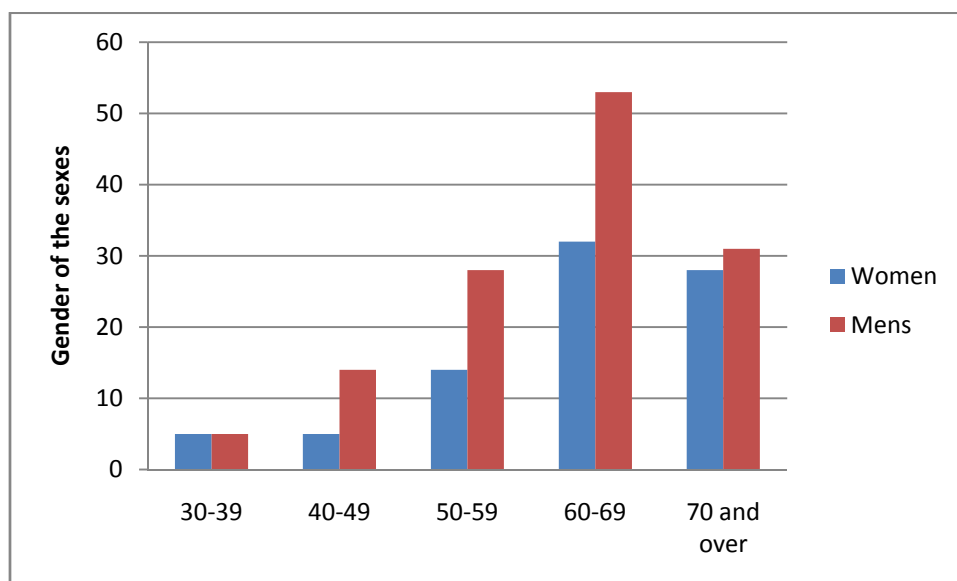


Fig. 1 The distribution of patients by age and sex.

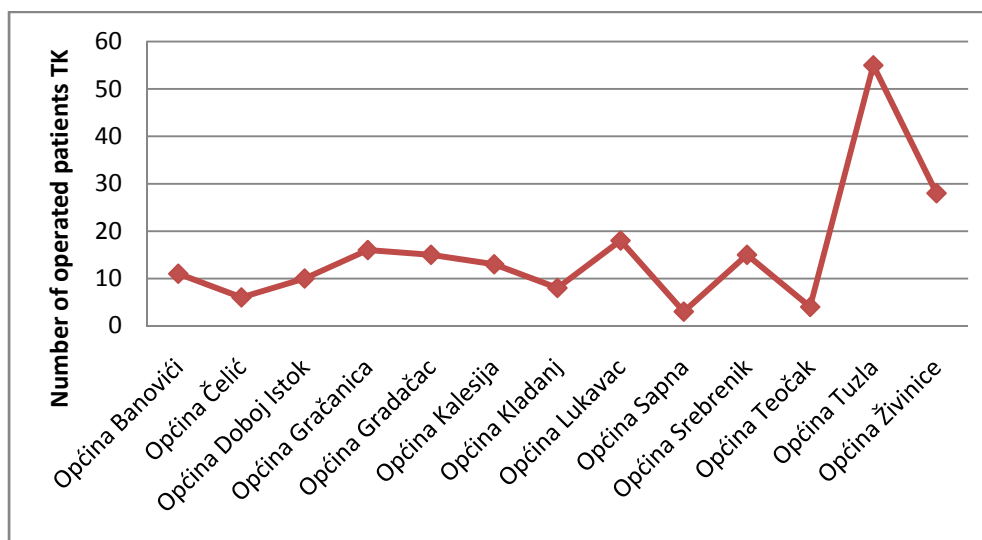


Fig. 2 Number of operated patients in Tuzla Canton municipalities.

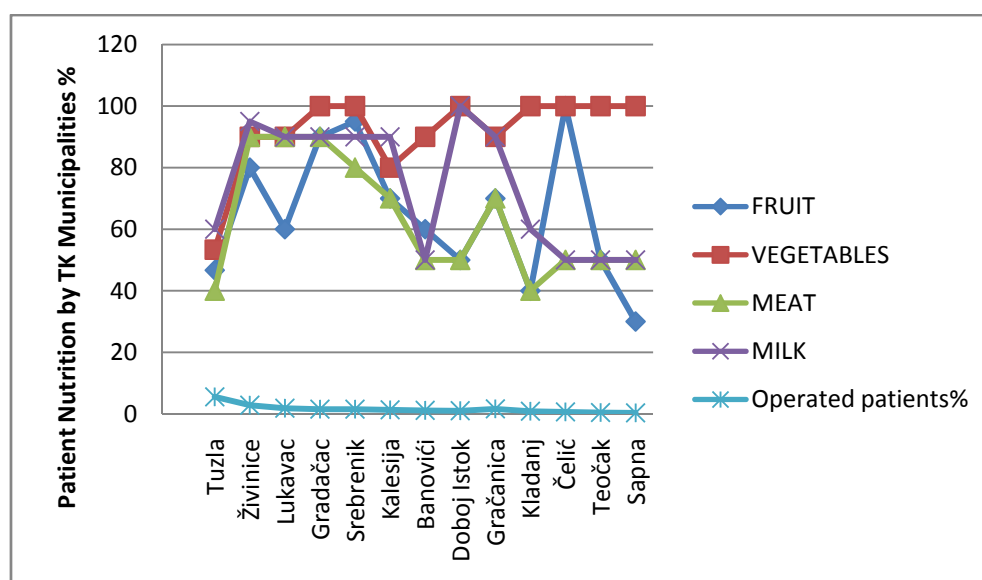


Fig. 3 Diets by municipalities TK in relation to the 1,000 respondents.

Table 1 Heavy metals content in soil.

Heavy metals content in soil mg/kg by Mark Ehwaldu	Soil samples limit values	Soil samples part of the surface	Soil samples, the deep part
Cadmium (Cd)	0.5	1.47	0.67
Cobalt (Co)	45	47	
Chrome (Cr)	50	56.77	64.87
Nickel (Ni)	30.00-45.00	295.67	559
Mercury (Hg)	0.5	0.5	2

Fig. 3 is a representation of the number of surgical patients per municipality based on 1,000 respondents from Tuzla Canton whose diet consisted of fruit, vegetables, meat, and milk. The number of respondents is expressed in percentages. The largest presence of

uncontaminated vegetables and fruit was found in the diet of patients coming from unflooded municipalities of Sapna, Teočak and Čelić. The most common food consumed by respondents in municipalities with the highest number of operated patients, Tuzla, Živinice,

Kalesija and Lukavac, was meat and milk.

Table 1 shows the amount of heavy metals present in agricultural land in the Spreča river basin after the floods in 2014. Cadmium, cobalt, chromium, nickel and mercury are most prevalent. Especially after tillage, deeper layers of soil contained a larger amount of heavy metals. In the Spreča river basin area, industrial municipalities had an increase in patients operated for stomach adenocarcinoma.

5. Discussion

The results of our study showed an increase in gastric cancer diagnoses in Tuzla Canton in the flooded territory of the Spreča river basin. In the last decade, the number of patients suffering from gastric carcinoma has increased [1, 10]. Male population has a higher rate of cancer diagnosis, as well as the elderly, results obtained by other authors in their studies as well. [1, 11]

Numerous studies have described the effects of heavy metals on the occurrence of gastric cancer [2, 7, 12]. Studies of other authors confirmed our study too, which shows that vegetables and fruit grown in soil contaminated with heavy metals can cause stomach carcinoma [12, 13]. Our study has found an increase in the number of patients operated for gastric adenocarcinoma in industrial municipalities of Tuzla, Živinice, Lukavac and Gračanica. All four of these municipalities belong to the Spreča river basin area. The surrounding farmland was flooded in the period from 2012 to 2014. Contamination of vegetables and fruit by industrial waters, heavy metals (cadmium, cobalt, nickel, chromium, mercury) was 30 times greater. There was an increase in the number of operated patients compared to the total number of respondents who mostly consumed vegetables from the areas contaminated by the floods. Other studies have also confirmed the effects of heavy metals on the occurrence of stomach carcinoma [13, 14].

Our study also confirmed that a reduced intake of meat and milk resulted in a smaller number of patients

operated for gastric carcinoma. There were a smaller number of diagnosed subjects whose diet consisted more of vegetables and fruit in municipalities where there was no contamination of vegetables and fruit by heavy metals, Doboj Istok, Sapna, Teočak, Kladanj [5]. In these municipalities, there were fewer cases of operated patients. Many studies have showed that red and processed meat may increase the risk of colon, esophagus, stomach, and lung cancer [10, 13].

6. Conclusions

The study revealed that there is an increase in surgical patients in the municipalities along the Spreča river. After the flooding in the industrial zone, the agricultural land was proven to contain heavy metals. Surveyed respondents mostly consumed vegetables from the contaminated areas. The lowest number of operated patients comes from municipalities where no flooding and no contamination of land occurred. Increase the screening of populations of flooded areas in the prevention of gastric adenocarcinoma. Control the degree of soil contamination with heavy metals of agricultural land. Prohibit the use of agricultural products from contaminated soil.

Conflict of Interest

The authors declare that there is no conflict of interest about considering or publishing the Manuscript.

References

- [1] Siegel, R. L., Miller, K. D., and Jemal, A. 2016. "Cancer Statistics." *CA Cancer J Clin.* 66 (1): 7.
- [2] Abnet, C. C. 2007. "Carcinogenic Food Contaminants. *Cancer Invest.*" 25 (3): 189-96.
- [3] Cabebe E., and Espat N. 2017. "Gastric Cancer Clinical Presentation." Accessed Jan 4, 2017. <http://emedicine.medscape.com/article/278744-clinical#b5>.
- [4] Mehmedagić, I., Hasukić, Š., and Kadrić, N. 2016. "Influence of Clinical Pathological Characteristics of Adenocarcinoma of the Stomach on Survival Time." *IESRJ* 2: 16-20.
- [5] Salčinović, A., Tomić, M., Filipović, H., Bukalo, E., and Behlulović, D. 2015. "The Effects of Floods on

Contamination of Soil and Plant Material within Monitoring in the Low Flow of the Spreča River." Flood Risk Management and Mitigation of Damage Consequences Symposium, 219-27.

- [6] Jasic, M., and Begic, L. 2007 "Biohemija Hrane." *Printcom Tuzla*, Univerzitet U Tuzli, Accessed Jan 4, 2017. http://www.untz.ba/uploads/file/nastava/studijski_prog_II_ciklusa/2014-15/Studijski_program_II_ciklusa_TF_Nutricionizam.pdf.
- [7] Järup, L. 2003. "Hazards of Heavy Metal Contamination." *Br Med Bull* 68 (1): 167-82.
- [8] Luqueño, F. F., Valdez, F. L., Melo, P. G., Suárez, S. L., González, E. N. A., Martínez, A. I., et al. 2013. "Review Heavy Metal Pollution in Drinking Water—A Global Risk for Human Health." *AJEST African Journal of Environmental Science* 7 (7): 567-84.
- [9] Joint FAO/WHO Standard Programme Codex Alimentarius Commission. 2013. "Proposals for the Elaboration of New Standards and Related Texts and for the Discontinuation of Work." Codex Alimentarius Commission (36th Session), FAO Headquarters. Accessed July 1-5, 2013 ftp://ftp.fao.org/codex/Meetings/CAC/cac36/cac36_09e.pdf.
- [10] González, C. A., Jakszyn, P., Pera, G., Agudo, A., Bingham, S., Palli, D., et al. 2006. "Meat Intake and Risk of Stomach and Esophageal Adenocarcinoma within the EPIC (European Prospective Investigation into Cancer and Nutrition)." *J Natl Cancer Inst* 1-98 (5): 345-54.
- [11] Chen, Y., Liu, L., Wang, X., Wang, J., Yan, Z., Cheng, J., et al. 2013. "Body Mass Index and Risk of Gastric Cancer: A Meta-analysis of a Population with More than Ten Million from 24 Prospective Studies." *Cancer Epidemiol Biomarkers Prev.* 22 (8): 1395-408.
- [12] Zhao, Q. H., Wang, Y., Cao, Y., Chen, A. G., Ren M., Ge Y. S., et al. 2014. "Potential Health Risks of Heavy Metals in Cultivated Topsoil and Grain, Including Correlations with Human Primary Liver, Lung and Gastric Cancer, in Anhui Province, Eastern China." *Science of the Total Environment* 470 (1): 340-7.
- [13] Yuan, W. Z., Yang, N., and Li, X. K. 2016. "Advances in Understanding How Heavy Metal Pollution Triggers Gastric Cancer." *BioMed Research International*, 1-10.
- [14] Mohammad, M. A., Afagh, K., Omid, E., Majid, G., Ali, F., and Mohammad, R. Z. 2015. "Geographical Distribution of Stomach Cancer Related to Heavy Metals in Kurdistan, Iran." *Int J Env Health Eng* 4: 12.