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Carcinogenicity of Radio-Frequency Radiation: Similarities and Differences Between Outcomes of Two Studies

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Abstract

We discuss the similarities and the differences between two papers published on the carcinogenicity of radio frequency radiation in the military setting with some overlap of the patients' groups. The first paper reported statistically significant increases of cancer cases while the second did not. We show that the two papers presented similar and non-conflicting characteristics of the reported cancers, mainly high hematolymphoid cancers percentage frequencies and earlier onset of cancers in the exposed group. We think that the conclusion of not identifying carcinogenicity, which is explained in the second paper by not reaching statistical significance, is due to much smaller size of the patients' group in that paper.

Keywords: Radio frequency radiation; Non-ionizing radiation; Radar; Electromagnetic fields; Human carcinogen; Hematolymphoid cancers; Hematopoietic malignancies; Sarcoma.

Introduction

On 21 Oct 2022 we published our work [1]. Our findings were consistent with a cause-effect relationship between occupational exposure to Radio Frequency Radiation (RFR) and Hematolymphoid (HL) and other cancers in soldiers in the military setting. The findings were similar to those in five other previously reported groups in Poland, Belgium, and Israel. On 3 February 2023 Shapira et. al published [2] with the conclusion "Our study did not find an increased short-term risk for cancer in young adults exposed to Non-Ionizing Radiation (NIR)". A subset of the patients was common to both the studies. The different conclusions merit a comment.

We think the research such as reported in [2] is important. Investigations of the carcinogenicity of RFR in the military and occupational setting should be performed and reported on all the personnel exposed, as done in [2] on the one specific cohort.

Both studies found similar characteristics of the cancers such as similar increase in Percentage Frequency (PF) of HL cancers, but [2] was based on much smaller number of patients and therefore the analysis didn't reach statistical significance. Our work [1] had many more cases because it collected patients over more years and included cases not just from Iron Dome units but also from other units with RFR exposure. In the case of the [2] study, we have to recognize that absence of significance is not absence of effect. We present the details in the next section.

Discussion of aspects of the two papers

The patients groups

The two papers studied groups of patients with some overlap. We did not exchange patient lists to preserve the patient's privacy as also dictated by the ethics committee. The authors of [2] performed a historical cohort study including all Israel De-

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fense Forces (IDF) service members who have served in aerial defense units with RFR exposures since the establishment of these units in 2009 and diagnoses up to 2018. The paper [1] is a case series study. The series comprised cancer patients who were enrolled in the study and who had been exposed to significant levels of RFR during their IDF service in units, including, but not limited to air defense. We included patients diagnosed from 2002 till 2021. The authors of [2] have vastly better access to important information such as patients lists, sizes of units the patients served in, service durations, quantitative data on exposure to RFR and more. These data should be available to all those who are concerned with the exposure-effect relationship and with what needs to be done to protect the soldiers.

The paper [2] reported 13 cancer cases diagnosed from 2009 to 2018 among all air defense units. We [1] found 46 patients diagnosed from 2002 to 2021. Twenty patients were from Iron Dome units, 9 patients were from other air defense units and additional 17 patients were from other units operating radio frequency transmitting equipment.

Hematolymphoid cancers

HL cancers were the focus of [1]. The HL percentage frequency (PF), which is the percentage of HL patients among all the cancer patients, was found about twice the expected value and statistically significant. The study [2] reports Odds Ratio (OR) of HL cancers as 2.76 and OR of all cancers as 1.4 resulting in HL PF larger by a ratio of 1.97 relative to the control group. The HL PF results in [2], while remarkably similar to those in [1], do not achieve statistical significance. The reason for not achieving statistical significance in [2] is insufficient size of the patients group because the width of the confidence interval and the p-value, given the similar magnitude of the HL PF estimate, depend mainly on the numbers of cases.

Other cancer characteristics

All cancer incidence: Here CI denotes confidence interval and p denotes p-value. The work [2] reports OR=1.4 (CI 95%: 0.73-2.71) while [1] reports Risk Ratio (RR) of 8, (CI 95%: 2.9-17.0), $p<0.002$ but, while statistically significant, it is based on a small subgroup of cases with exposure possibly higher than the average of the patients group.

Bones, connective tissues, and sarcoma: The supplementary material of [2], table S1, reports bones and connective tissues cancers with OR 2.76, p=0.274, while [1] reports sarcomas with PF = 15.2%, 95%CI (6.3%–28.9%), p=0.04, nearly twice the 7.0% PF expected. The elevated cancer risk by about a factor of two is similar in both the papers, however the cancer category in the two papers is related but not identical: bones and connective tissues versus sarcoma.

Latencies: The study [2] reports shorter latencies in the exposed group, average age at diagnosis 23.1 years, versus 25.2 in the control group with typical age of recruitment of 18 years. This is stated in [2, table 1] and shows up also in [2, figure 2] and even more in figure S1 in the supplementary material. Similarly, [1] states, qualitatively, that the latencies were short in the studied group and in the other five groups of similarly exposed patients reported previously elsewhere.

Time dependency of probability to be diagnosed with cancer: Figure 3 in [1] presents cumulative number of cancer cases in a small group of personnel as a function of time from beginning of RFR exposure. The curve of the exposed group rises much faster than the expected, cancer registry based, curve. Figure S1, the Kaplan-Meier curve for survival probability in the supplementary data of [2], presents probability of cancer-free survival. Note that the curves in [1, figure 3] are proportional to the probability of being diagnosed with cancer over a period of time while figure S1 of [2] is the probability of not to be diagnosed with cancer over the same period. So, the curves in [1, figure 3] could be expected to be similar to the decrease of the curves in [2], supplementary material, figure S1 relative to unity. By inspection, figure S1 presents probabilities behaving similarly to those in [1, figure 3]. In general, figure S1 indicates earlier cancer onset of the exposed group. It indicates that the probability of being diagnosed with cancer in the first 4 or 5 years after recruitment is estimated roughly as 3 times greater for the exposed group and becomes similar to the control group after 8 years. However, the data after 8 years become unreliable since the number of soldiers in each group drops from 3732 to 420 due to end of follow up, as presented by the numbers at the lower part of figure S1. Analysis with a larger but less matching control group in [2, figure 2] shows the same but weaker tendency. The work [2] did not find this statistically significant; this would be reasonable if it were an isolated finding, but it is not, it is just one out of more similarities with our findings which are statistically significant. Furthermore, after military service ends, we can expect risks from exposure to RFR to decline over time. This situation is similar to the reversal of risks after the cessation of smoking and the cessation of exposure to asbestos.

Additional remarks

Comparison groups: The comparison groups in [2] are military units and may have other hazardous exposure including, possibly, carcinogens. Therefore, it would be helpful to see a comparison also with the Israeli cancer registry and not just to other military groups.

Different exposure levels within the exposed groups: The paper [2] states that the exposure was unit level exposure as opposed to individual exposure. This means that there is a possibility that some individuals within the 3825 members of the exposed group could have been exposed to lower levels of RFR. Also, participants serving in the exposed group for 90 days or a little more were less exposed than those with full term of service and the exposure in the years 2009 and 2010 in which the air defense units were established might have been less severe than in the years after. Similar possibility of different exposure levels is discussed in [1] too. As explained in our paper [1], such an occurrence of including some not-exposed people into the exposed group would bias the findings towards the null hypothesis of no relationship between exposure and cancer.

Discussion

The two papers report mostly similar and non-conflicting qualitative and quantitative characteristics of cancers in the RFR exposed groups. The results in [1] reached statistical significance, [2] did not, the reason of the difference is the larger number of patients in [1].

A lot of additional research is needed to reveal the dependence of cancer risks on RFR levels, exposure duration, peak to average ratio of radar pulses, modulation, and frequencies. Till

then the maximal RFR exposure levels in the military and occupational settings should be set not higher than the current actual exposure level of a typical citizen such as presented in [1]. This can be achieved by applying protective measures such as shielding as suggested in [1]. As stated in [1], the more reasonable solution is a worldwide peace.

Declarations

Conflict of interest: Mora Deitch is the founder and Chief Executive Officer of Zoar, a volunteer Non-Government Organization assisting cancer patients.

Elihu D Richter: The Unit of Occupational and Environmental Medicine in the Hebrew University-Hadassah School of Public Health and Community Medicine provided medical opinions to previous cancer patients. The fees went directly into the Unit research budget in the University.

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