Final results regarding Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission: report regarding mean body weight and heart and brain tumor incidence

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Abstract
The Ramazzini Institute (RI) performed a life-span carcinogenic study on Sprague-Dawley rats to evaluate the carcinogenic effects of RFR in the situation of far field, reproducing the environmental exposure to RFR generated by 1.8 GHz GSM antenna of the radio base stations of mobile phone. Animals were exposed from prenatal life until natural death to a 1.8 GHz GSM far field of 0, 5, 25, 50 V/m with a whole-body exposure for 19 h/day. In 2018, we reported the final results regarding brain and heart tumors. A statistically significant increase in the incidence of heart Schwannomas was observed in treated male rats at the highest dose (50 V/m). Furthermore, an increase in the incidence of malignant glial tumors was observed in treated female rats at the highest dose (50 V/m), although not statistically significant. Furthermore, here we show for the first time the impact of the treatment on mean body weight of the F1 rats; results indicate a statistically significant decrease in group treated at 50 V/m during lactation period. Together with the recent NTP releases, findings from this study provide sufficient evidence to call for the reevaluation of IARC conclusions regarding the carcinogenic potential of RFR in humans.
Keywords: radiofrequency radiation, radio base antennas, Sprague-Dawley rat,

1. Introduction

Experimental studies defining the potential carcinogenic effects of exposure to RFR have been largely inadequate because of the exposure conditions applied, because of the limited number of animals used in each experimental group and because of the short duration of the experiments. The International Agency for Research on Cancer (IARC) in its Monograph on RFR concluded that RFR are possible carcinogens for humans (IARC, 2013).
In 2005, the Ramazzini Institute (RI) started a life-span carcinogenic study on Sprague-Dawley rats to evaluate the carcinogenic effects of RFR in the situation of far field, reproducing the environmental exposure to RFR generated by an 1.8 GHz GSM antenna of the radio base stations of mobile phone. This is the largest long-term study ever performed in rats on the health effects of RFR, including 2,448 animals. Here, we reported the final results regarding brain and heart tumors, as well as mean body weights of F1 rats during lactation.

2. Materials and Methods

For material and methods section, please refer to "Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission" by Falcioni et al. (2018). Plan of the experiment is reported in table 1.

3. Results and Discussion

The biophase parameters for control and treated groups are presented in our publication Falcioni et al. (2018): no differences were observed in mean body weight either in male or in female rats throughout the exposure period, from weaning to spontaneous death. Nevertheless, RFR treatment significantly impaired the mean body weight of the F1 offspring. Litter mean body weight in group IV was significantly decreased compared to those of the unexposed controls, on PND 1 and throughout the lactation period, particularly from postnatal day (PND) 9 to 13 (table 2). The lack of further decreases in body weight over the course of the lifespan carcinogenicity study suggests that the RFR-mediated effects on body weight in the F1 offspring may be specific to the perinatal period. The same effect on pup weight limited to lactation period was observed in the study by NTP (NTP TR 595), further confirming this hypothesis.
NTP doses were established to mimic the localized exposure on body tissues from a cell phone placed near the body and were therefore particularly higher than those used by the RI. In fact, RI doses were similar to those found in our living and working environment to mimic the full-body human exposure generated by radio base antennas. Despite these differences, both studies found statistically significant increases in the development of the same type of very rare glial malignant tumors (NTP TR-595, 2018; Falcioni et al., 2018). In particular, a

statistically significant increase in the incidence of heart Schwannomas was observed in treated male rats at the highest dose (50 V/m). Furthermore, although not statistically significant, we observed an increase in the incidence of heart Schwann cells hyperplasia in treated male and female rats at the highest dose, and an increase in the incidence of malignant glial tumors in treated female rats at 50 V/m.

The RI findings are consistent with those of NTP on near field exposure, as both reported an increase in the incidence of brain and heart tumors of the same histotype of those observed in some epidemiological studies on cell phone users.

The results from the perinatal portions of our study indicate that RFR at these exposures could impact normal development. However, the occurrence of slowed pup weight gain with RFR exposure compared to untreated controls could be secondary to effects on the dams. For example, changes in maternal behavior or capacity to properly nourish their pups may have contributed to this effect as the magnitude of the lower pup body weights appeared to be limited to early lactation and then decrease as the pups aged and required less maternal care, until they did no more require at weaning. Unfortunately, behavioral abnormalities could not be directly observed in the current studies because the design of the chambers prohibited observation during the 19-hour daily RFR exposure periods. Further research would be required to elucidate the mechanism by which RFR induces these effects in pups.

Table 1. Long-term bioassay on 1.8 GHz base station RFR, administered at different doses to Sprague-Dawley rats, from prenatal life to spontaneous death: plan of the experiment (Experiment BT 1CEMRF)

Group	**Treatment**	**Animals**	
No.	**GSM-RFR 1.8GHz (V/m) [a]**	**Sex**	**No.**
I	0	M	412
		F	405
		M+F	817
II	5	M	401
		F	410
		M+F	811
III	25	M	209
		F	202
		M+F	411
IV	50	M	207
		F	202
		M+F	409
Total			**2,448**

Table 2. Mean body weights of F1 rats during lactation. **: statistically significant decreased, $p \leq .01$ using linear regression models (one for each value of PND) that take into account the dimensions of the litter.

Group	Treatment	PND 9	PND 10	PND 11	PND 12	PND 13
No.	GSM-RFR 1.8GHz (V/m) [a]	Mean BW SD	Mean BW SD	Mean BW SD	Mean BW SD	Mean BW SD
I	0	16.5 ± 1.7	16.7 ± 1.8	18.4 ± 2.3	20.9 ± 1.2	20.5 ± 2.8
II	5	16.2 ± 1.9	17.1 ± 1.9	18.7 ± 1.9	20.4 ± 2.3	20.4 ± 2.7
III	25	16.7 ± 1.6	17.9 ± 2.1	18.9 ± 2.4	20.1 ± 1.3	19.8 ± 2.4
IV	50	13.4 ± 1.8**	15.2 ± 1.7**	16.5 ± 2.3**	18.4 ± 2.0**	17.8 ± 2.2**

References

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