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**BEHAVIORAL EFFECTS OF MICROWAVES:
RELATIONSHIP OF TOTAL DOSE AND DOSE RATE**

BY

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LIST OF ABBREVIATIONS AND SYMBOLS

ABBREVIATION

C	-Centigrade
CW	-Continuous Wave
F	-Fahrenheit
MHz	-Megahertz
mW/cm ²	-Milliwatts per centimeter squared
SA	-Specific absorption
SAR	-Specific absorption rate
W/kg	-Watts per kilogram

ABSTRACT

The goal of this research was to compare the relationship of wholebody averaged specific absorption rate (SAR) and specific absorption (SA) to determine if dose rate or dose was a better predictor of biological effects. Sperm positive Long-Evans female rats were exposed to approximately 10 W/kg for 1 or 3 hours to 2450 MHz CW microwave radiation. The maternal subjects were irradiated and then observed for natural delivery of their litters. The resultant pups made up the subject pool for the behavioral studies. Sensitivity to thermally induced seizures and huddling were studied. Analyses revealed that there were no statistically significant differences on the behavioral indices. The behavioral measures did not appear to be effected by prenatal exposure to microwave radiation at this level. The huddle sizes did become smaller as the pups aged and the two different huddle measurements employed differed in the proportion of variance accounted for by the age of the pups.

INTRODUCTION

The goal of this research was to compare the relationship of whole body averaged specific absorption rate (SAR) and specific absorption (SA) to see if dose rate or dose was a better predictor of behavioral effects. The research was conducted in two phases. The first phase was described in an earlier report. In the first phase female Long-Evans rats were exposed to 2450-MHz CW microwave radiation at calorimetrically determined whole body averaged specific absorption rates (SAR) of 2, 4, 6, and 8 W/kg for durations of 1, 2, 3, 4, 5, and 6 hours. Their colonic temperature changes at the end of exposure were compared to those of CF-1 mice following similar exposures. The mice were exposed at SARs calculated to be at 2, 4, and 8 W/kg for 1, 2, 3, 4, 5, and 6 hours. The colonic temperature change resulting from these exposures was different for the rat and the mouse. The post exposure colonic temperature of the rats was higher than their pre-exposure colonic temperature. For the mice, the post-exposure colonic temperature was nearly always lower than their pre-exposure colonic temperature, thus demonstrating the extensive difference in thermoregulatory efficiency for the two species of rodent. The dosimetric data collected during Phase I was used to establish the parameters to be used in Phase II.

In this second phase of the research sperm-positive Long-Evans female rats were to be exposed at SARs calculated at 4 and 6 W/kg for durations of 1 and 3 hours. The exposures occurred on gestational days 12 through 18. The maternal subjects were irradiated and then observed for natural delivery of their litters. The resultant pups made up the subject pool for behavioral studies. The behavioral tests included sensitivity to thermally induced seizures and huddle size. After completing the first series of exposures at the intended 6 W/kg level for 1 and 3 hours, some statistical analyses were performed. The averaged SARs actually approached 10 W/kg but there were no statistically significant differences on any of the behavioral indices. Since no effects were observed at the higher level of exposure, the 4 W/kg exposures were excluded from the protocol.

CONCLUSIONS

The colonic temperature measures indicated that there were some statistically significant differences between the groups. However, the analyses on the behavioral indices did not produce any statistically significant effects. The colonic temperature measures were taken on the exposed maternal subjects while the behavioral measures were taken on the pre-natally exposed pups.

Colonic Temperature Measures: Maternal Subjects

As expected, the average colonic temperatures of the maternal subjects increased during the microwave exposures. To determine temperature change, the pre-exposure colonic temperature was subtracted from the post-exposure colonic temperature. These temperature changes were also associated significantly with the duration and time of day of the exposure. Overall, the three hour exposure groups showed less

temperature increase than the groups exposed for one hour and the subjects exposed in the morning showed less of a change than the groups exposed in the afternoon.

The average colonic temperature at the end of the exposure session was higher in the microwave exposed groups than in the sham exposed groups and it was higher in subjects exposed for one hour versus three hours. The time of day during which the exposures occurred did not produce significant effects on post-exposure colonic temperature. The time of day during which the exposures occurred produced statistically significant effects on temperature change but not on post-exposure temperature. This is apparently due to the fact that the groups exposed in the morning had higher pre-exposure temperatures. Thus, the temperature changes were greater but the actual final temperature was not.

The body mass of the maternal subjects was significantly greater in the sham exposed than in the microwave exposed group. Cage control subjects were lower than the shams and greater than the microwave group but this was not statistically significant.

Behavioral Measures: Pre-natally Exposed Pups

Some of the pups were exposed to a highly thermalizing dose of microwave energy when they were two days of age. The exposures resulted in seizures. The rest of the litter was used to observe huddle size on days 5, 10, and 15 of age.

An analysis on litter size was performed for the pups in each of the behavioral tests. The microwave exposed pups used in the seizure study came from smaller litters. Since this litter size effect was only seen in the pups chosen for the seizure study, it would appear to be a statistical artifact that does not apply to the overall microwave exposed versus control groups.

No statistically significant differences were observed for any of the groups in latency to seizure.

The type of prenatal exposure also did not affect the size of the huddles observed at 5, 10, and 15 days of age. Two means of determining huddle size were employed. One assessment traced the outline of the pups as if they were enclosed in a rubberband while the second traced the outline of each individual pup including protruding tails and limbs. Using either measure it was clear that the age of the pups significantly effected huddle size. However, the analysis based on tracings of the individual pup outlines accounted for a much higher proportion of the variance than that based on the rubberband method.

RECOMMENDATIONS

The Phase I and II results did not indicate that post-natal measures of thermally induced seizure sensitivity or huddle size in pre-natally exposed rat pups were significantly effected by the relatively low-level microwave exposures.

However, some basic experimental principles were particularly obvious in the results. The first observation was in regard to the frequently cited issue of species differences. The Phase I studies indicated that the colonic temperature changes experienced during microwave exposure were dramatically different for rats and mice under similar, nearly identical, exposure conditions. Species differences frequently are cited and reported, but rarely is such a dramatic difference between relatively similar species reported for a seemingly straightforward measure such as colonic temperature change. This demonstration of such a frequently cited issue is particularly important in the research area generally referred to as bioelectromagnetics. Bioelectromagnetics research has focused considerable attention on the demonstration of thermal versus non-thermal effects. Colonic temperature changes are used frequently to distinguish between supposedly thermal versus non-thermal effects. Laboratory observations on animals are also very directly used to extrapolate to decisions regarding human exposure levels. These decisions are often made with only nominal regard for species differences that might underlie the results from laboratory studies on animals. The results from this research should be used as an exemplar of species differences underlying one of the most often used variables in laboratory observations in bioelectromagnetics research.

Another issue that is addressed by the results of this study is in regard to basic measurement principles. Behavioral research often can be used to demonstrate the importance of operational definitions in which variables and procedures are defined by the methods used to measure them. Two measurement procedures were used to determine huddle size. The proportion of variance accounted for was much greater for one of the two methods. When alternative procedures are available, it would seem that the most sensitive one should be chosen. In this case, sensitivity would be defined as the one that would account for the most variation.

MATERIALS AND METHODS

Microwave and Sham Exposure Facilities

The microwave exposure area was enclosed in an anechoic chamber measuring 3.0 x 3.0 x 2.4 meter. The anechoic chamber was a Lindgren 4-Shield RFR shielded room. The interior of the shielded room was rendered microwave anechoic by the absorber material lining the floor and walls of the chamber. The walls and floor perimeter were lined with CVCB-9 absorber material while the ceiling and door were covered with AN-77 absorber material. The central floor area in the direct illumination region was covered with high performance VHP- 26 pyramidal absorber. All of the absorber materials were Emerson and Cuming commercial products. The Lindgren anechoic chamber was purchased as surplus from LaBarge Electronics, a former private company in Tulsa, Oklahoma. Unless otherwise indicated all equipment used in this project was purchased direct from the manufacturer.

The sham chamber was adjacent to the microwave exposure facility. The chamber was constructed of 1/2 inch plywood and the inside

dimensions were 50 x 55 x 36 inches. The top of the chamber had entry ports for supply and return air plenums which were connected to the air conditioning and humidity control system. The floor of the chamber consisted of a caster mounted platform that slid out of the front of the enclosure to permit easy placement of the subjects. The inside of the chamber was lined with styrofoam that was painted black to resemble the inside of the microwave exposure chamber. A lightbulb located on the ceiling of the chamber provided illumination matching the illumination level inside the microwave chamber.

Microwave Power Source and System

The horn antenna mounted on the ceiling of the anechoic chamber was a modified Narda 644 horn antenna. The antenna was shortened to broaden the beam width of the antenna radiation pattern. A Narda 8601 Radiation Monitor with an 8621 omnidirection probe were used to measure field uniformity. Power densities uniform to 1.0 db maximum variation were produced over an area of 1.0 square meter. The Cober S1/V-F microwave power source provided continuous wave (CW) 2450-MHz microwave power at levels from 100 to slightly over 1000 watts. The power ripple was less than 50 watts peak to peak. The microwave output was coupled to the chamber through a directional coupler and WR-285 waveguide. A Narda 7000A microwave multimeter was used as a power meter to monitor and set the output power and as a reflectometer to measure antenna mismatch. A Racal-Dana 9921 microwave counter was used to verify the operating frequency. The waveguide ran to the antenna mounted on the top of the shielded enclosure. A Wavetek 2002 signal generator and the microwave multimeter were used to adjust the slide-screen tuner at the antenna feed point.

Temperature and Humidity Control

The temperature and humidity control system was fabricated by the University of Tulsa Physical Plant/Carpentry Shop. In addition to a Vista Scientific Environ-Aire E-1000 unit, the air conditioning system used a residential window type air conditioning-heat pump unit to control temperature and circulate the air. Residential type humidifiers and dehumidifiers and an electronic air filter/cleaner were mounted in air plenums. Thermostats and humidistats automatically controlled the environmental conditions. The conditioned air was divided and circulated to the anechoic and sham chamber. The temperature at the location of the animal differed by no more than 1° C between the anechoic and sham chambers.

Calorimetry System

The calorimetry system consisted of two twin-well calorimetry units, one two pen chart recorder (Houston Instruments, #D-5216-5), one immersion circulator (Fischer #73), one 17 lb capacity Corning Pyrex container (Fischer #11-823J) and one 140 BUT/hr refrigeration system and insulated enclosure. Each twin-well calorimeter consisted to two 25 x 10 cm aluminum cylinders surrounded by thermocouples attached to the

outer wall and connected in series so that the individual voltages were additive. The thermocouples of the right cylinder were connected to the thermocouples of the left cylinder so that the voltages were subtractive. Any temperature difference between the cylinders resulted in a net voltage output from the thermocouple arrays. The voltage output from each twin-well calorimeter was then fed to one channel of the two pen chart recorder. The twin wells were surrounded by an oval cylinder designed to maintain a constant temperature by circulating water through a series of coils. The unit was placed in a 13.5 x 17.5 cm container. The immersion circulator consisted of a continuously-variable heater coil with an output range of 100 to 1000 watts controlled by an immersed contact thermometer, a 15 liter per minute pump, and a thermometer to check the bath temperature. A refrigeration unit was constructed to enclose the Pyrex water bath container and maintain the bath temperature between 12 and 14 °C.

Animal Containers and Exposure Materials

Plexiglas cylindrical animal containers were placed on top of a bilayer styrofoam platform located on top of the high performance VHP-26 pyramidal absorber. The exposure containers were 10.16 cm diameter Plexiglas cylindrical holders that were 16.3 cm long and perforated with 0.95 cm holes to allow for air flow. The body of the cylindrical holder rested on a Plexiglas support and as a result the animal was approximately 2.5 cm above the platform. One end of the cylinder was removable for easy placement of the subjects in the container.

EXPERIMENTAL PROCEDURES

The maternal subjects were all exposed to 2450-MHz CW microwave radiation in an anechoic chamber. All exposures were from day 12 through 18 of gestation. After the day 18 exposure they were returned to their home cage where they delivered naturally and the pups served as subjects for the behavioral tests.

Calorimetry

The power settings for the estimated range of masses for the maternal subjects were determined from measurements of the temperature change of equal masses of Ringer's solution in plastic bags. Animal carcasses were then used to determine if the selected power levels did in fact produce equivalent SAR measurements.

The SAR's of phantom loads of Ringer's solution in plastic bags were measured for a range of masses. The SAR's were calculated from the difference in pre- and post-exposure temperature measured by a Bailey BAT-8 thermocouple probe. The SAR was then calculated as:

$$SAR = C_p T/t \text{ (specified as W/kg)}$$

Where: C_p is the specific heat capacity of the phantom Ringer's solution (4160.5 J kg/ °C)

T is the post- and pre-exposure temperature difference ($^{\circ}\text{C}$)

t is exposure time (sec)

Phantom masses ranged from 250 g to 450 g.

Subjects

Subjects were primiparous female Long-Evans rats between 90 and 180 days of age at the time of breeding. All rats were born in the animal colony at The University of Tulsa from original stock obtained from Charles Rivers Breeding Laboratory. The animal colony was maintained at 70°F with relative humidity of 60-75%. A 12/12 hour light/dark cycle was maintained automatically. The animals were caged in wire hanging cages. Laboratory rodent chow and tap water was available ad libitum throughout the breeding and exposure time except for the one or three hours they were in the microwave or sham chamber. After the final day of exposure the females were placed in plastic containers with wire tops. The floor of the plastic cages was covered with wood chips.

Procedure

A female was placed in the home cage of the male. The female was checked daily for the presence of a sperm plug. The day on which a plug was determined was termed Day 1 of gestation. At this time the female was weighed and assigned to one of the six treatment conditions (1 or 3 hour exposure in the sham, microwave, or cage control group). The females were placed in individual wire cages and monitored until Day 12 of gestation. During this period between Day 1 and Day 12 of gestation the females were not handled except for routine cage maintenance. On Day 12 of gestation the females were again weighed. Females who had not gained at least 6 to 10 g were euthanized and a caesarean section was performed to determine gravidity.

Beginning on Day 12 of gestation the female was weighed each morning and the colonic temperature was taken and recorded both immediately prior to and immediately following exposure. During the days on which exposure occurred they were housed individually in their home wire cages.

The exposure levels were determined using the table for the desired SAR of 10 W/kg and the mass of the dam. The table used for this determination of power level is included as Appendix B. The power level was changed each day according to the mass of the individual dam in order to provide a constant SAR throughout the exposure period.

All maternal subjects were exposed individually in plexiglas containers directly under the horn antenna in the anechoic chamber. A sham female was exposed concurrently. Two exposure sessions were given each day. There was a one hour exposure session and a three hour exposure session each day. Morning and afternoon exposure sessions were counterbalanced for exposure groups. An individual rat was always

exposed in the morning or afternoon time. Three hour exposures began at 9:00 and 1:00; one hour exposures began at 11:00 and 3:00. The morning exposures end at 12:00 and afternoon exposures end at 16:00.

On Day 18 of gestation the maternal subject was removed from the anechoic chamber and assigned a code number. She was then placed in the plastic maternity cage and monitored until the day of birth. On the day of birth the pups were counted and weighed. They were assigned to either the seizure or huddle study.

When the pups were two days of age the litters were culled to seven pups each. The pups in excess of seven were the subjects for the seizure experiments. When the pups were five days of age the litters were culled to six pups each. The huddling procedure was performed on days 5, 10, and 15.

Seizure Procedures

The seizures required two observers: one to observe the seizure and one to monitor the power level. On day two of age the pups were counted and all pups in a litter over seven were used in the study. The pups to be used were chosen randomly from the huddle. The sex of the pup was recorded and it was weighed.

The pre-exposure skin temperature of the pup was taken by placing the temperature probe at the base of the brain and laying it flat against the skin parallel to the spine. The pup was placed in a beaker and the beaker was placed in the outlined spot in the circularly polarized waveguide. The power was turned to a setting pre-determined to produce a seizure in a few minutes in pups of this age. The investigator monitoring the power verbally announced that it was on and the other investigator started the stopwatch for seizure latency at this time. The investigator watching the pup indicated when the seizure began and the stopwatch was turned off and the power was also terminated. The post-exposure temperature of the pup was taken as well as the temperature of the chamber. The condition of the pup was also recorded.

Huddle Procedures

The huddle sizes were measured on 5, 10, and 15 days of age. Huddles were photographed from directly overhead using a tripod-mounted 35 mm camera and color slide film. The camera was placed 1.05 meters from the huddle for all photographs (measured to the film plane of the camera). A total of four pictures of each huddle was taken on each observation day. Huddles were observed in the absence of the dam and at a mean ambient temperature of 21°C.

On each of the three days, six pups were removed from the home cage and placed in the observation section of the test cage measuring 28 x 16.5 cm. Bedding from the home cage was placed in the test cage. An identification tag was placed next to the huddle to identify the photograph. The pups were given 15 minutes to acclimate before the first photograph was taken. One photograph was taken every 15 minutes

until four photographs had been taken of each litter. The pups were removed from the observation container after the four photographs and returned to their home cages.

The slides of the huddles were developed and analysed. For all measurements the slide projector was placed 4.58 meters from the wall (measured to the plane of the slide) with the zoom lens in the furthest retracted position (minimum focal length) to project the smallest image. The slides were projected onto a chalkboard, the room lights were darkened, and the outer circumference of the litter huddles were traced with permanent ink onto a sheet of paper taped to the board. The following information was recorded on the paper: the dam's code number, the age of the pups, the date and time the photograph was taken, the ambient temperature -indicated by the Bailey thermometer, and the initials of the person tracing the photograph.

Two methods for measuring the size of the huddle were used. One method was termed rubberbandedness and the other is referred to as the individual pup measure. The paper was removed from the chalkboard and the perimeter of the huddle indicated with a contrasting color of permanent ink. The perimeter was drawn as if the pups were enclosed in a rubberband. The perimeter was measured as a convex polygon entirely enclosing all pups in the litter. The circumference (individual pup measure) of the clumps of pups, excluding extended tails and limbs, was traced with a hocometer and the length of the circumference recorded. The length of the perimeters was measured and recorded. An example of a huddle photograph and the two methods of huddle measurement are provided in Appendix C.

The average litter size of the four slides taken per session was calculated for each group and was used as the base for statistical analysis.

RESULTS AND DISCUSSION

The results of the first phase of research were reported in the Phase I report. The results presented and discussed in this section were based on the statistical analyses listed in Appendix A. All treatment variables associated with the characteristics of the maternal subjects and their exposure as well as the variables associated with the litter characteristics and behavioral measures were analysed using a three factor analysis of variance ($3 \times 2 \times 2$: exposure condition \times duration of exposure \times time of day of exposure or a $2 \times 2 \times 2$ on maternal colonic temperatures since the cage control subjects did not have pre- and post-exposure temperature measures). Post hoc tests (Tukey HSD) were performed only when a significant main effect was followed by a significant interaction.

The major behavioral indices of seizure latency and huddle size did not differ as a function of microwave exposure. The analyses that did produce statistically significant effects will be presented in this section. Figures are included for all of the variables that were analysed. Some, but not all of the non-significant differences will be

discussed. The averages for each of the measures along with standard deviations and group size are presented in tabular form in Appendix D.

The average for the whole body average SAR was 10.45 W/kg (+ 1.07 SD). The highest SAR value was 12.6 W/kg and the lowest was 8.5 W/kg. Data from 59 gravid dams were used in the analyses; 18 cage control, 21 sham exposed and 20 microwave exposed.

Parental Characteristics: Age and Mass

Figure 1 presents the age of the dam on Day 1 of gestation (p 's > 0.05) and Figure 2 presents the age of the male mate on gestational day 1, which represents the day on which the sperm plug was detected (p 's > 0.05). The mass of the dams in the different treatment groups was not statistically different on Day 1, Day 12, or Day 18 of gestation (Figures 4, 5, and 6). However, there was a statistically significant difference in the mass gained from Day 1 through Day 18 (Figure 7). The treatment groups were different ($F = 5.87$, $p < 0.01$) and this difference was due to the sham exposed groups gaining more than the microwave exposed groups (Tukey HSD $p < 0.05$). Time of day and duration of exposure were not significant. The average gain in mass was 72.8 g for the sham exposed group and 55.0 g for the microwave exposed group. The cage control groups average gain of 66.61 g was not statistically different from the other two treatment groups.

Colonic Temperature Measures: Maternal Subjects

As expected, the microwave exposed groups experienced an increase in colonic temperature during exposure. Temperature change was calculated as the difference between the pre-exposure and the post-exposure colonic temperature. There was a significant difference in temperature change associated with all three of the major variables: exposure condition ($F = 289.98$, $p < 0.00^{\circ}$), duration of exposure ($F = 11.8$, $p 0.002$), and time of day of exposure ($F = 4.21$, $p < 0.05$). The microwave groups had an average temperature increase of 2.04 °C. All of the sham exposed groups experienced a decrease in colonic temperature and the average was -0.51 °C. The one hour groups increased more than the 3 hour groups while the morning exposure groups increased less than the afternoon groups. There were no significant interactions.

Pre-exposure colonic temperatures also differed by treatment group ($F = 5.04$, $p < 0.03$) and time of day of exposure ($F = 21.51$, $p < 0.0002$). The average for the sham exposure groups was 38.2 °C and the microwave exposure groups averaged 38.04 °C. The groups exposed in the morning averaged 38.29 °C while the ones exposed in the afternoon averaged 37.96 °C. There was also a significant treatment group by duration of exposure interaction ($F = 4.75$, $p = .034$). The sham exposed group had lower pre-exposure temperatures before the one hour sessions and the microwave exposed group had lower pre-exposure temperatures before the three hour sessions.

The sham exposed group had a post-exposure colonic temperature of 37.7° C while the microwave exposed colonic temperatures averaged 40.09 °C ($F = 281.35$). The groups exposed for one hour had average

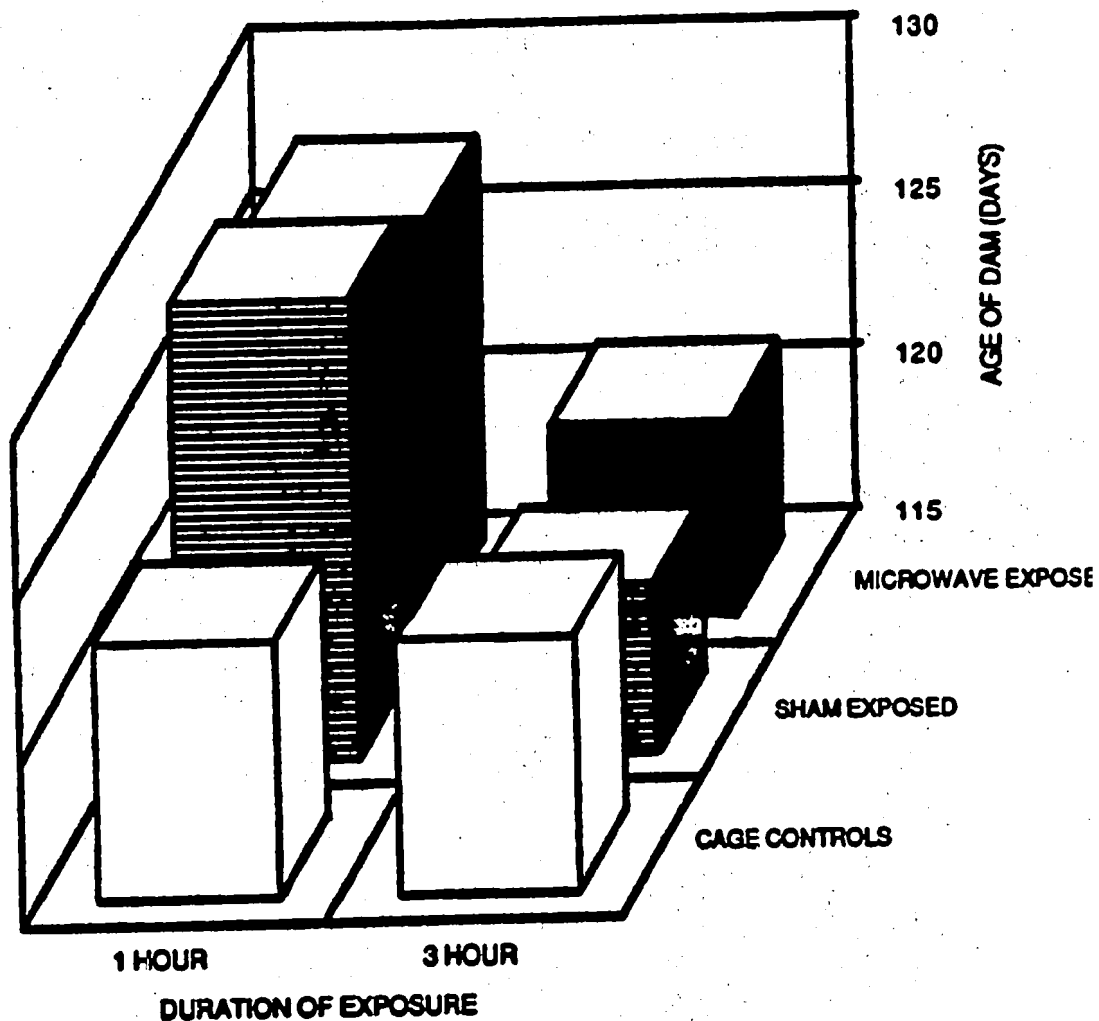


Figure 1: Age (in days) of gravid Long-Evans rats on day 1 of gestation.

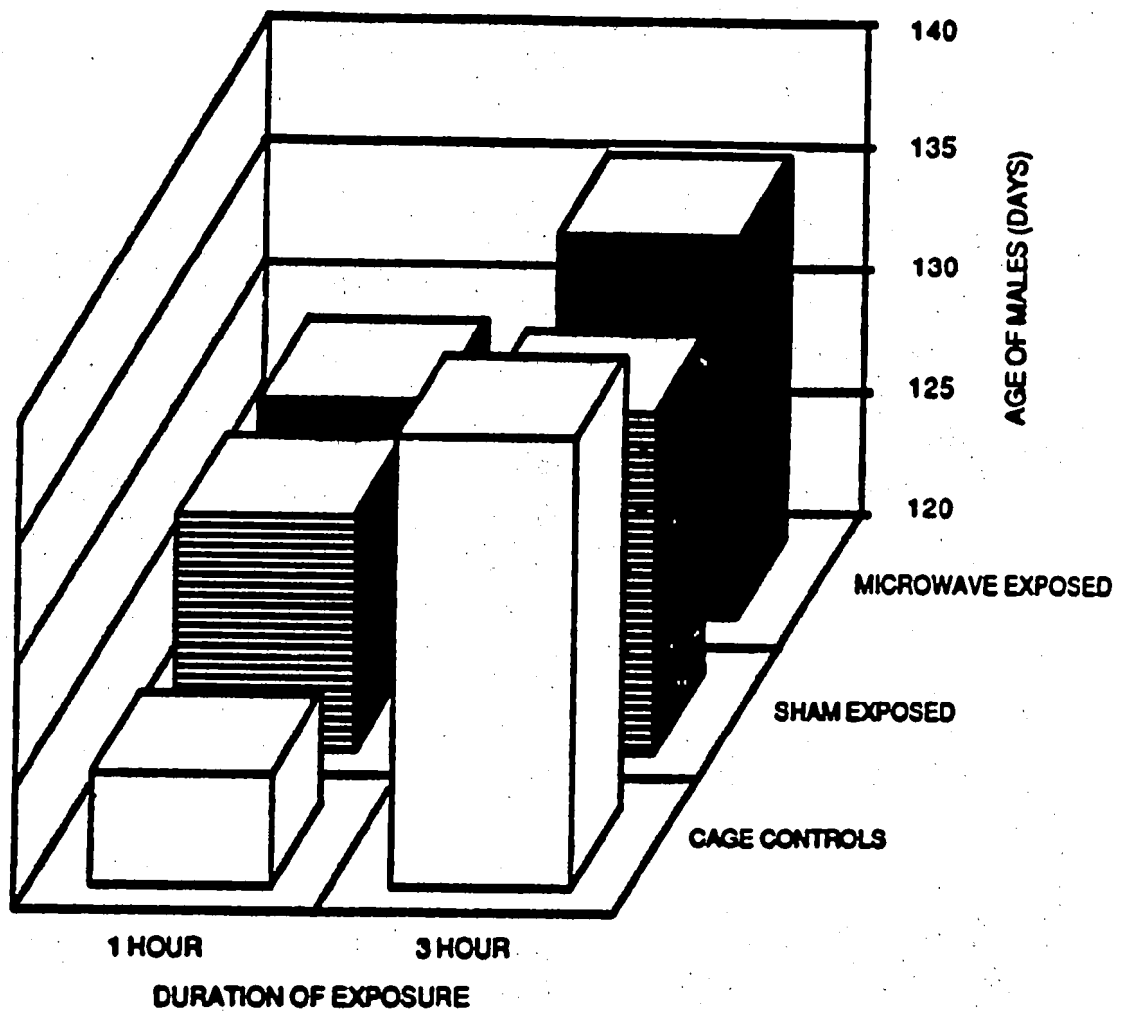


Figure 2: Age of mates (male Long-Evans rats) on day when sperm plug was discovered (day 1 of gestation).

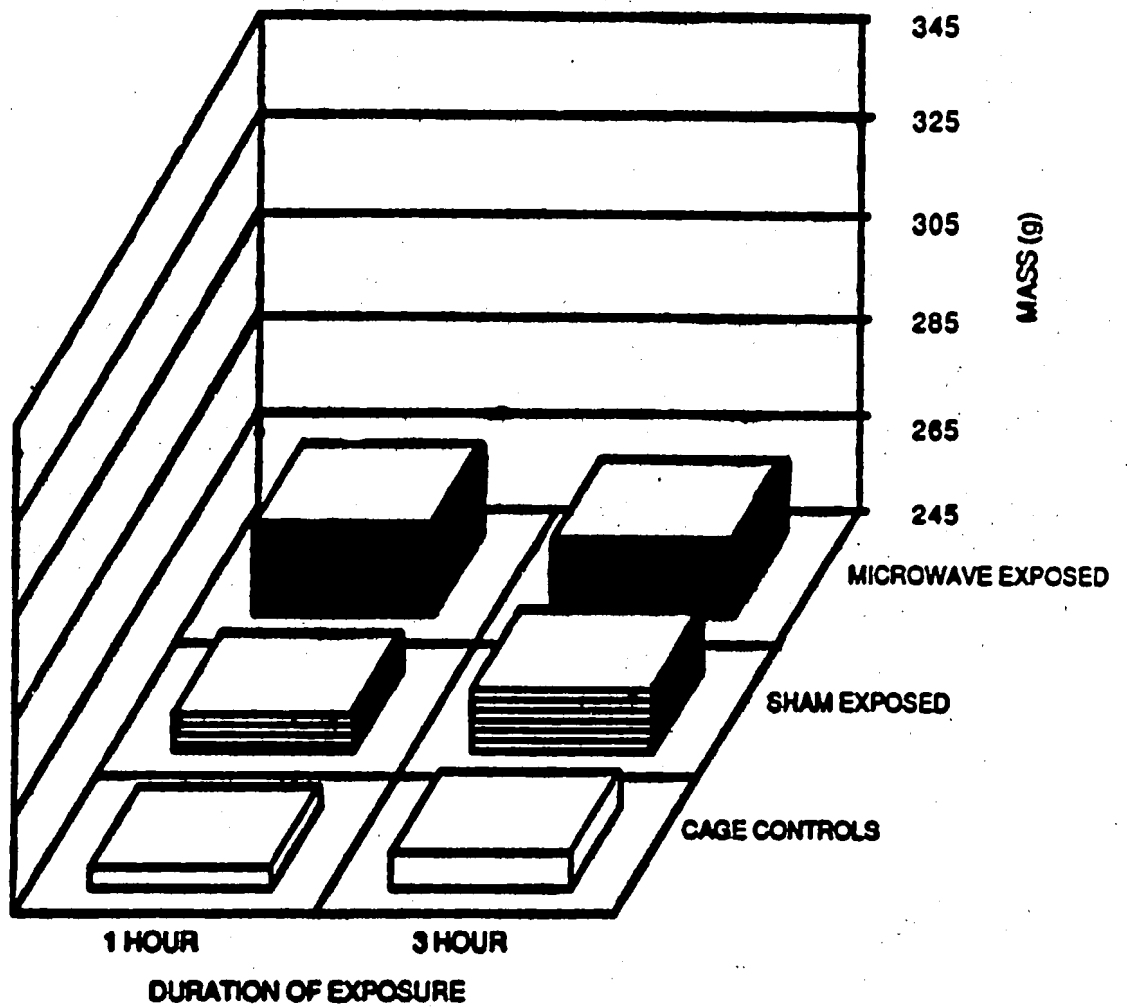


Figure 3: Mass of gravid Long-Evans rats on day 1 of gestation.

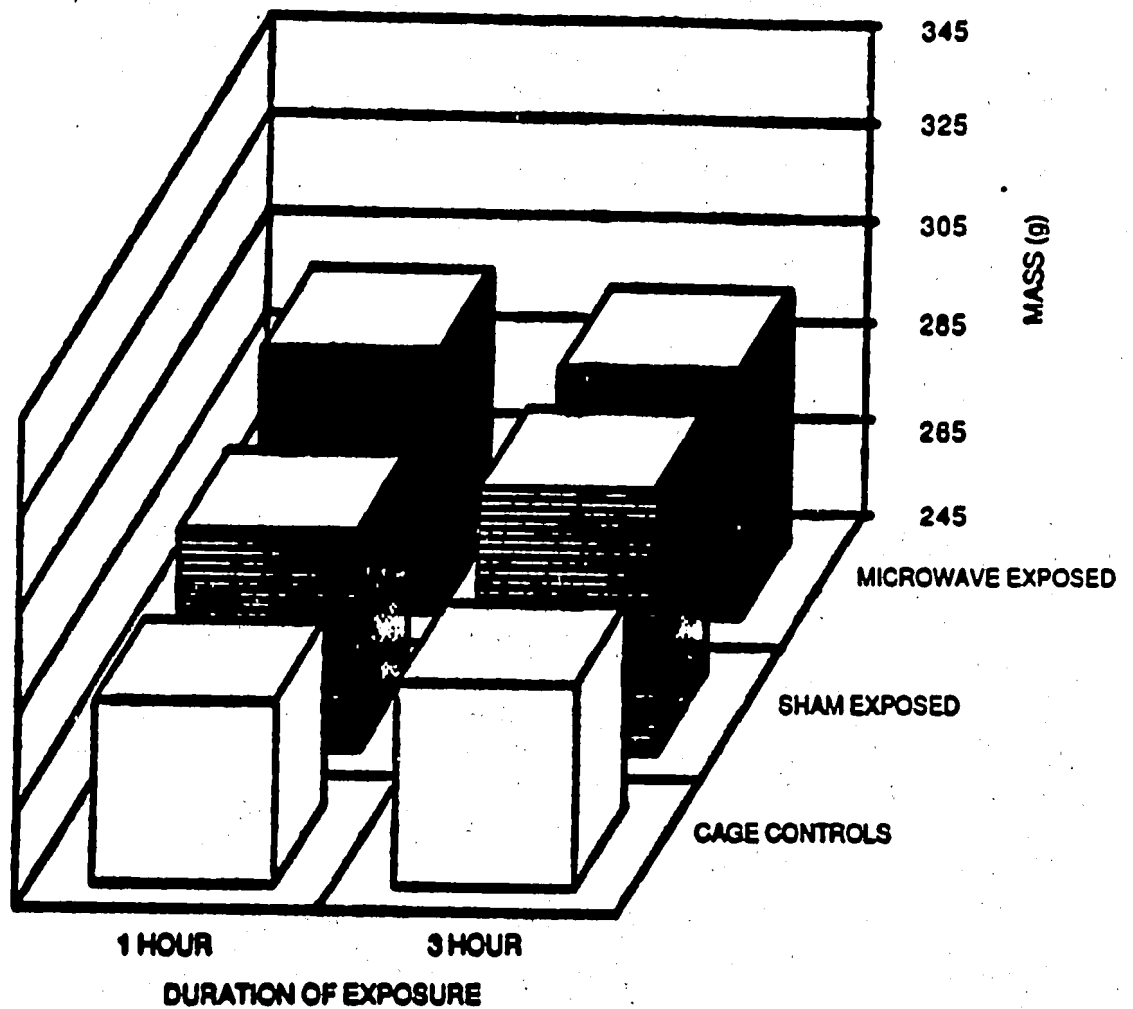


Figure 4: Mass of gravid Long-Evans rats on day 12 of gestation.

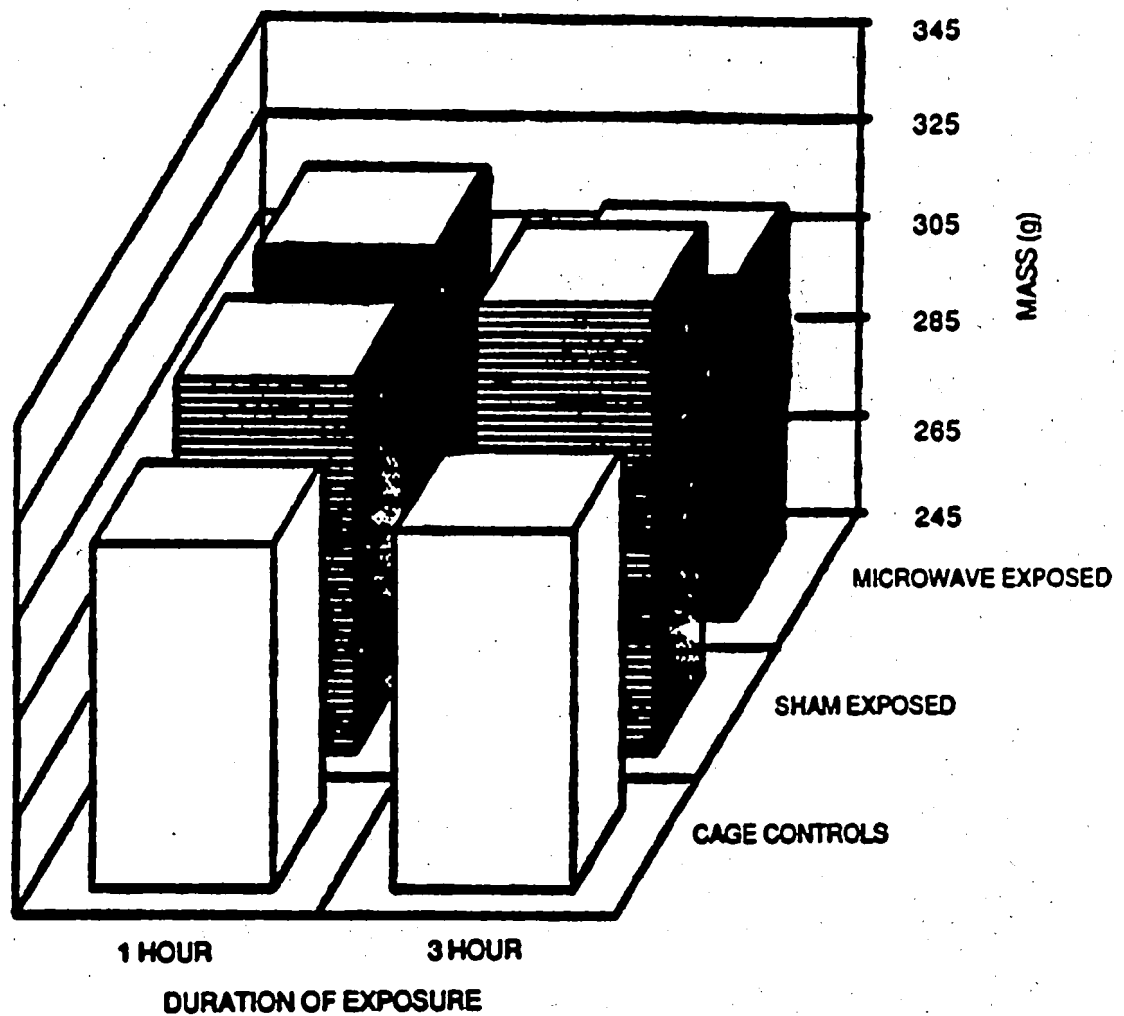


Figure 5: Mass of gravid Long-Evans rats on day 18 of gestation.

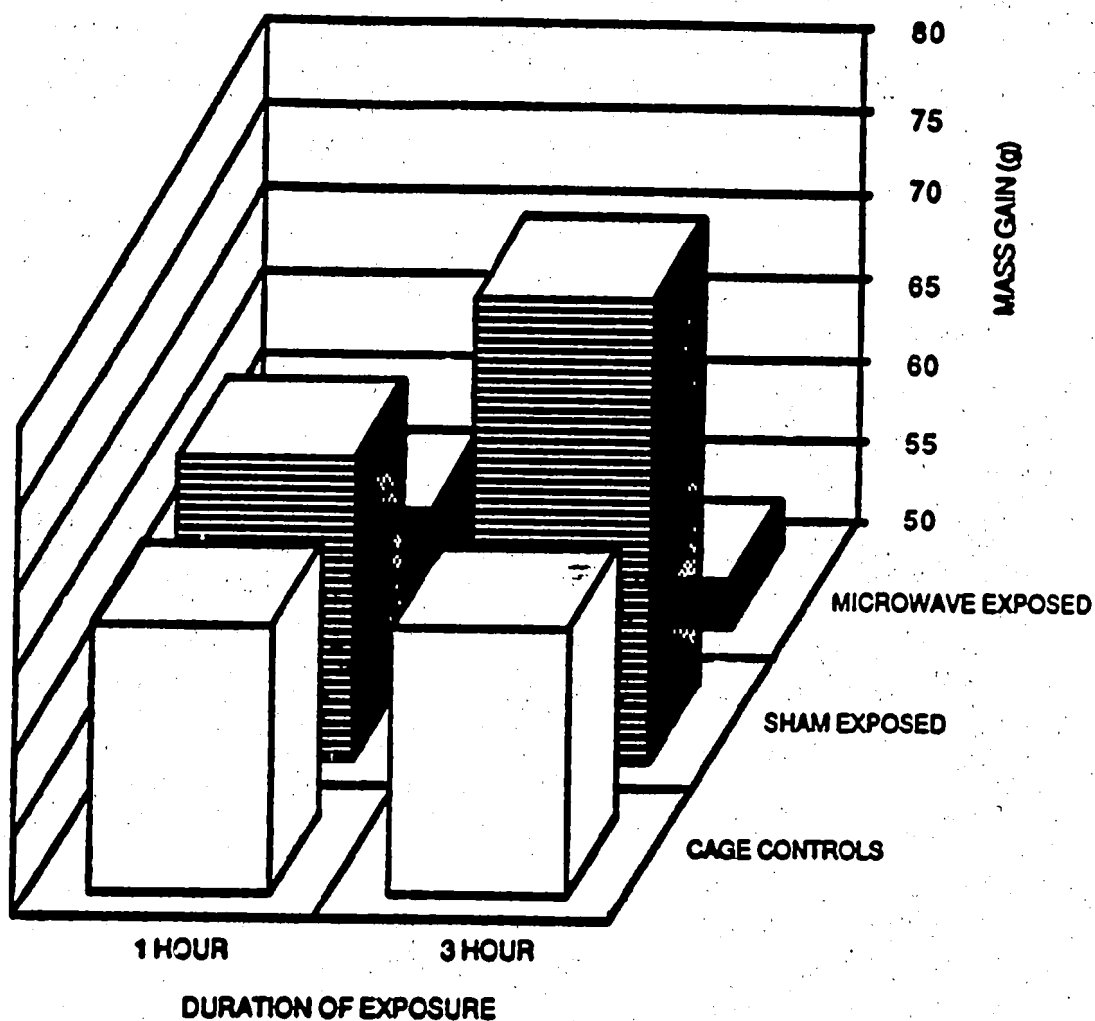


Figure 6: Mass gain (g) of gravid Long-Evans rats from day 1 through day 18 of gestation. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

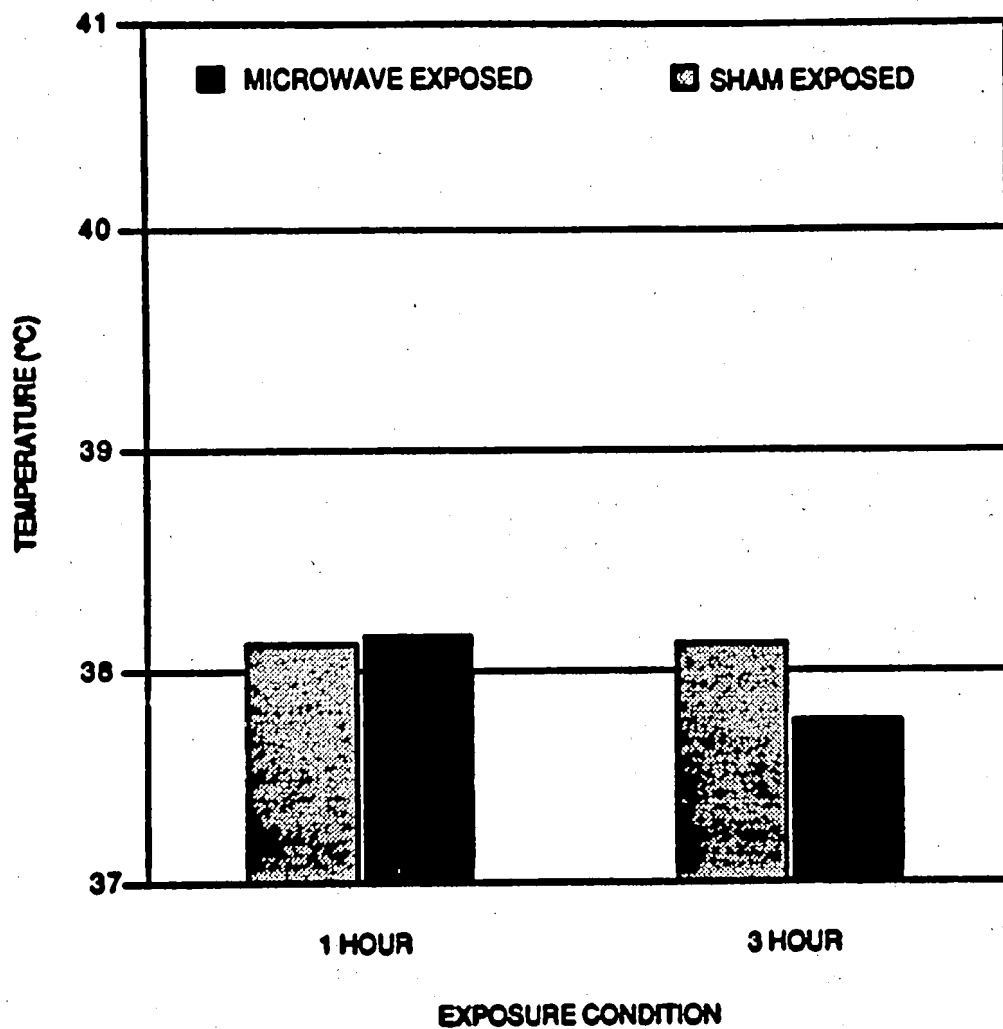


Figure 7: Colonic Temperature (°C) of gravid Long-Evans rats before exposure to 2450 MHz CW microwave radiation at an SAR of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation.

post-exposure temperatures of 39.12 °C compared to 38.52 °C for the three hour groups ($F = 21.51$, $p = .00016$). The treatment group by duration and time of exposure interaction was also statistically significant ($F = 4.70$, $p = .035$). The sham group exposed for one hour in the morning had the highest post-exposure temperature while the microwave group exposed for one hour in the afternoon was the highest. The pre- and post-exposure temperatures as well as the temperature difference are depicted in Figures 8, 9, and 10. Figure 11 shows the gestation period for the dams in all treatment conditions.

Post-Natal Pup Measures

Litter sizes for the pups at birth were not significantly different with average sizes of 11.22, 11.76, and 10.60 pups for the cage control, sham exposed and microwave exposed groups. This is depicted in Figure 12. The average mass of the pups on the day of birth is presented in Figure 13. The duration of exposure and the time of day of exposure did not produce any significant effects on litter size or average mass.

Pups from each litter were selected for the seizure study when they were 2 days of age. There were no statistically significant differences for the mass of the pups, the pre- and post-treatment skin temperature, the difference between the post- and pre-treatment skin temperature, or the average latency to seizure. These measures are illustrated in Figures 14 through 18.

As indicated in the section on Experimental Procedures, the huddle sizes were measured on days 5, 10, and 15 of age. Two measurement techniques were used. Individual measures was the term used to describe the procedure in which the outline of every pup was drawn and measured. The term perimeter measures was used to describe the procedure in which the outline of all of the pups was drawn as if a rubberband was placed around all of the pups. Using either of the two measures there was a statistically significant effect for the age of the pups. Older pups form smaller and smaller huddles (perimeter measure; $F = 3.51$, $p < 0.05$; individual measure; $F = 40.42$, $p < 0.001$).

Figure 19 shows the huddle chamber temperature on day 5 and Figures 20 and 21 depict the huddle size using individual or perimeter measures. Figures 22, 23, and 24 depict the same measures for huddle data on day 10 while Figures 25, 26, and 27 refer to day 15. Using the perimeter measure the average huddle size on days 5, 10, and 15 was 38.08, 34.14, and 32.44 cm respectively. The individual measurement procedure resulted in huddle sizes of 49.07 (5 day), 39.19 (10 day), and 35.69 (15 day) cm.

The proportion of variance accounted for by the two measurement techniques was calculated using the η^2 method suggested by Lindman (1974). The perimeter measure accounted for 8% of the variance in huddle size across the three age groups while the individual measure accounted for 5%.

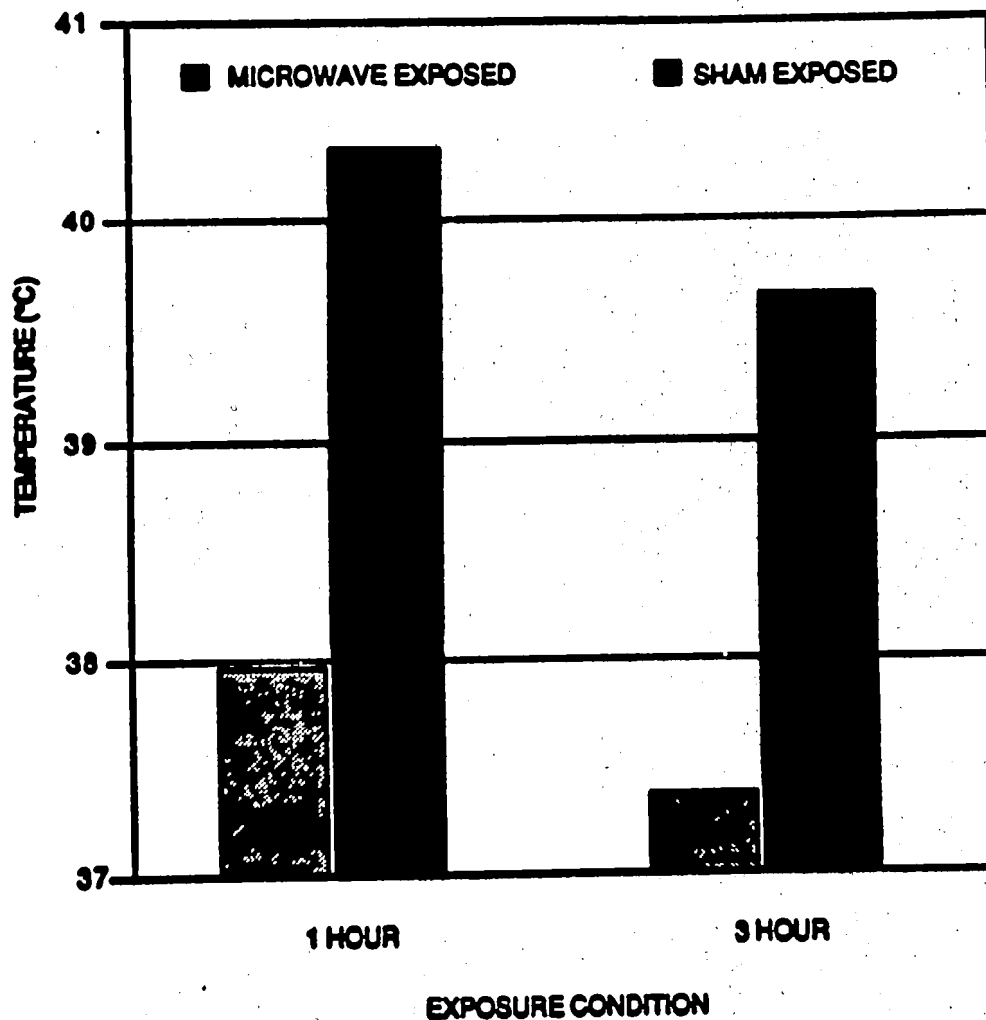


Figure 8: Colonic temperature (°C) of gravid Long-Evans rats after exposure to 2450 MHz CW microwave radiation at an SAR of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation.

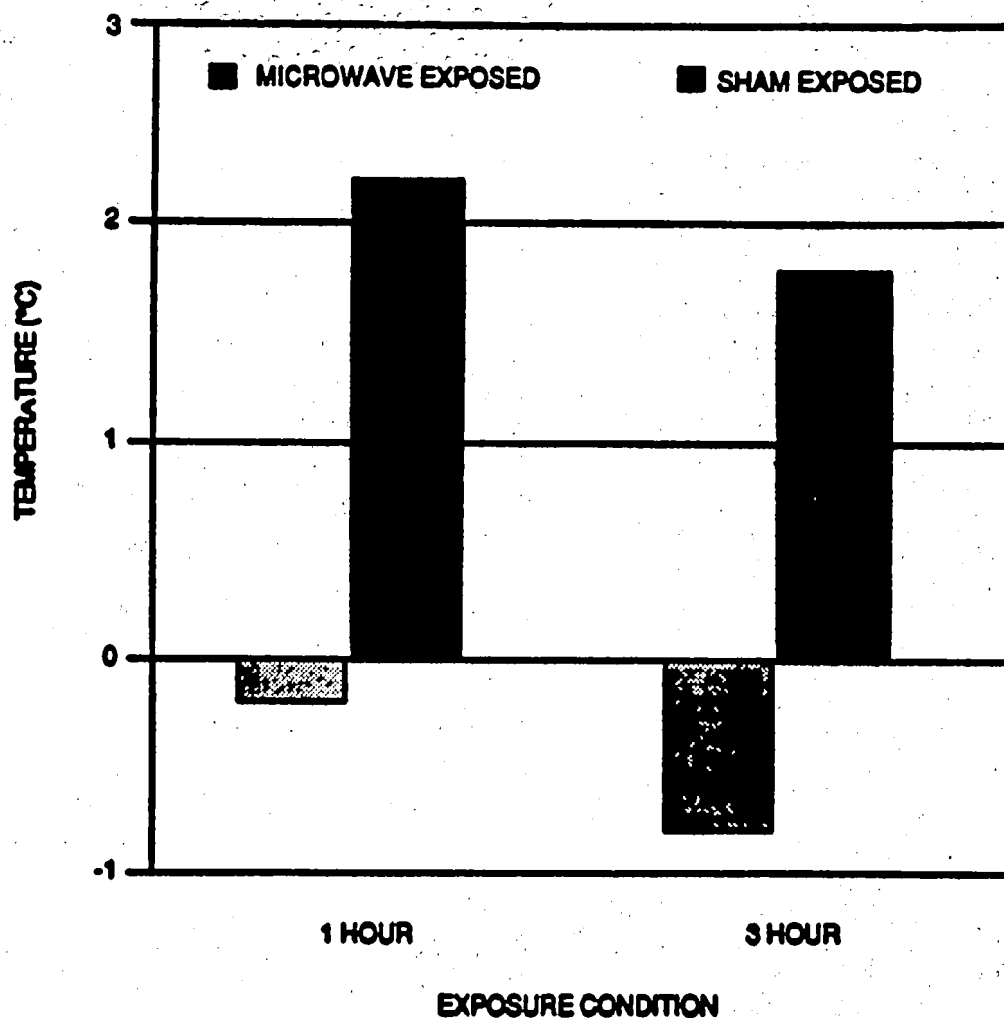


Figure 9: Post - pre exposure colonic temperature (°C) difference of gravid Long-Evans rats exposed to 2450 MHz CW microwave radiation at an SAR of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation.

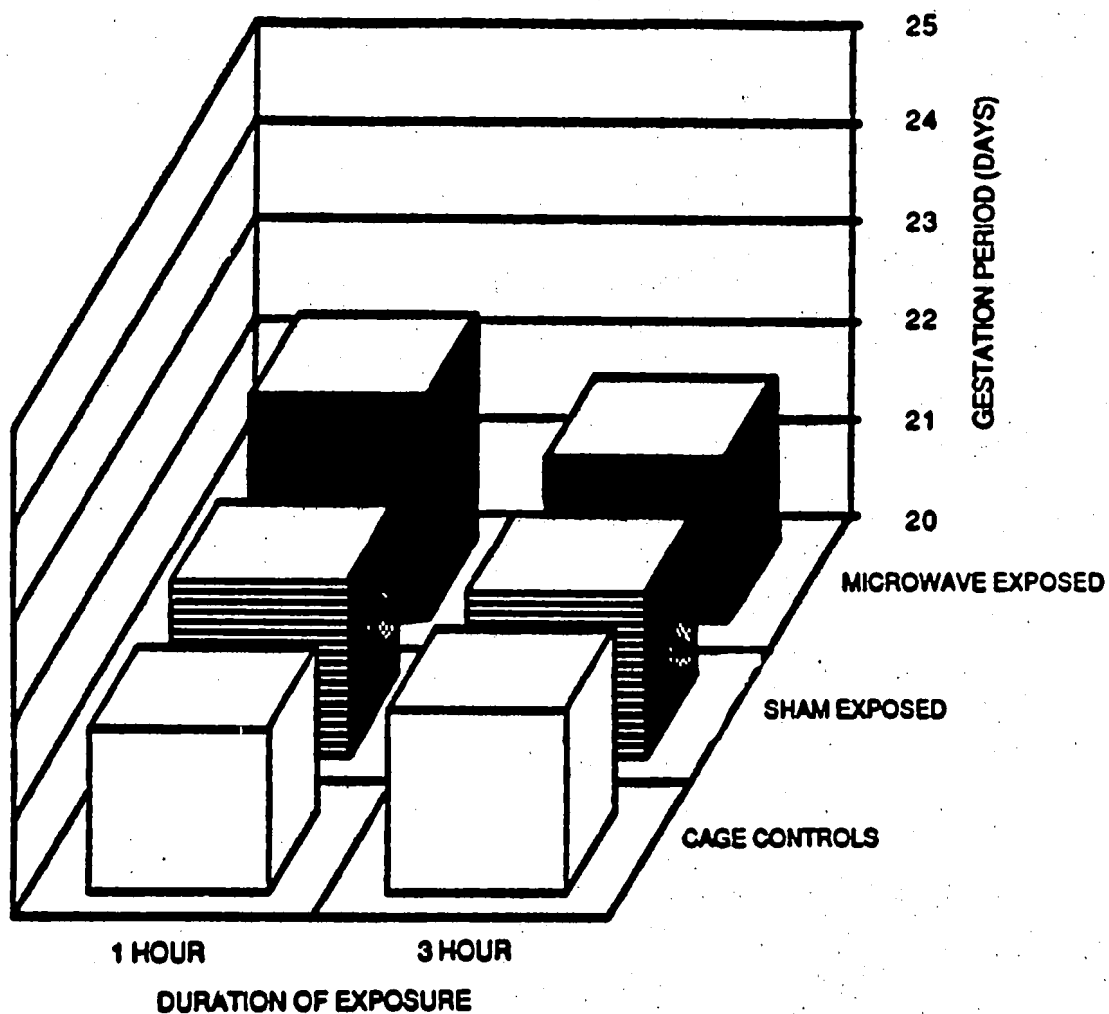


Figure 10: Gestation period (in days) of Long-Evans rats. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

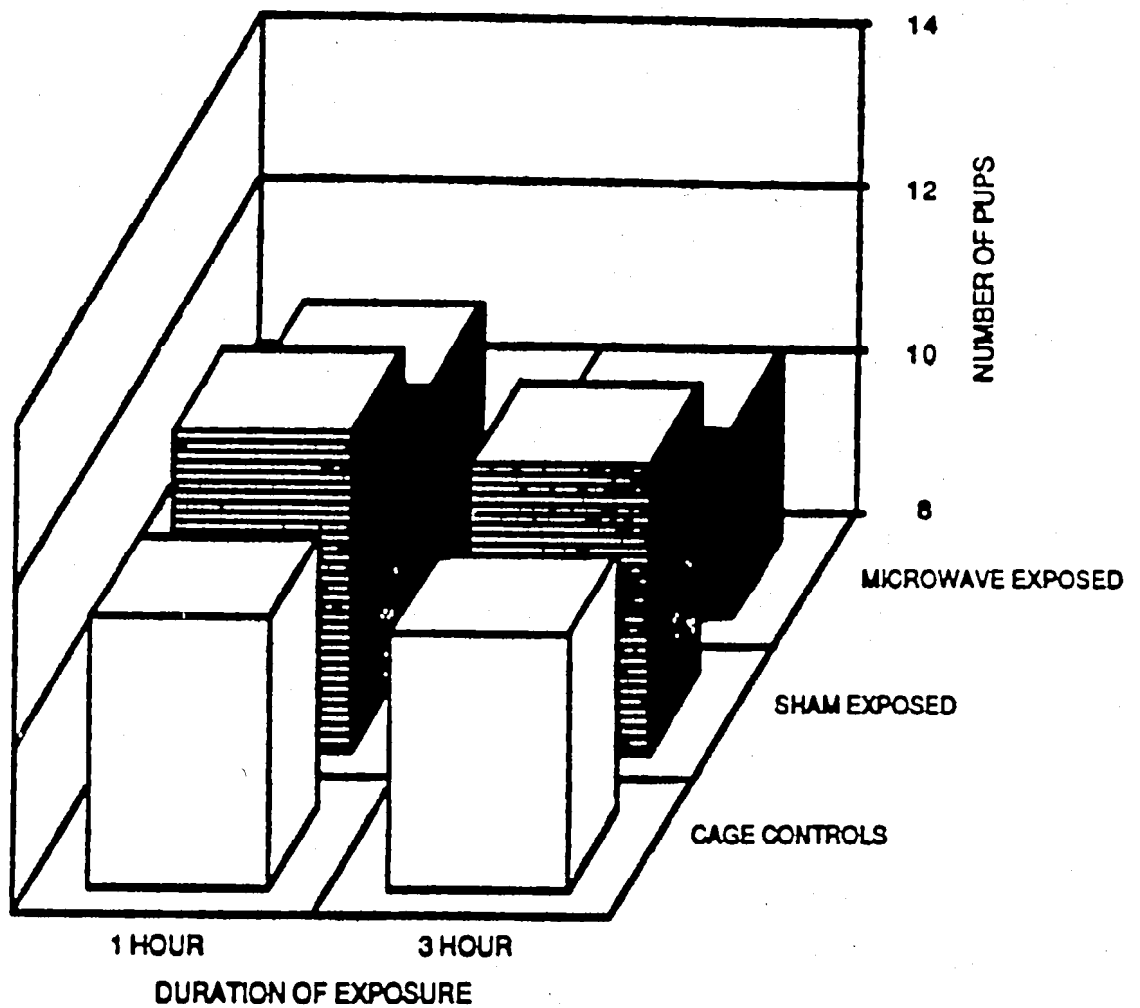


Figure 11: Average litter size after prenatal treatment. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

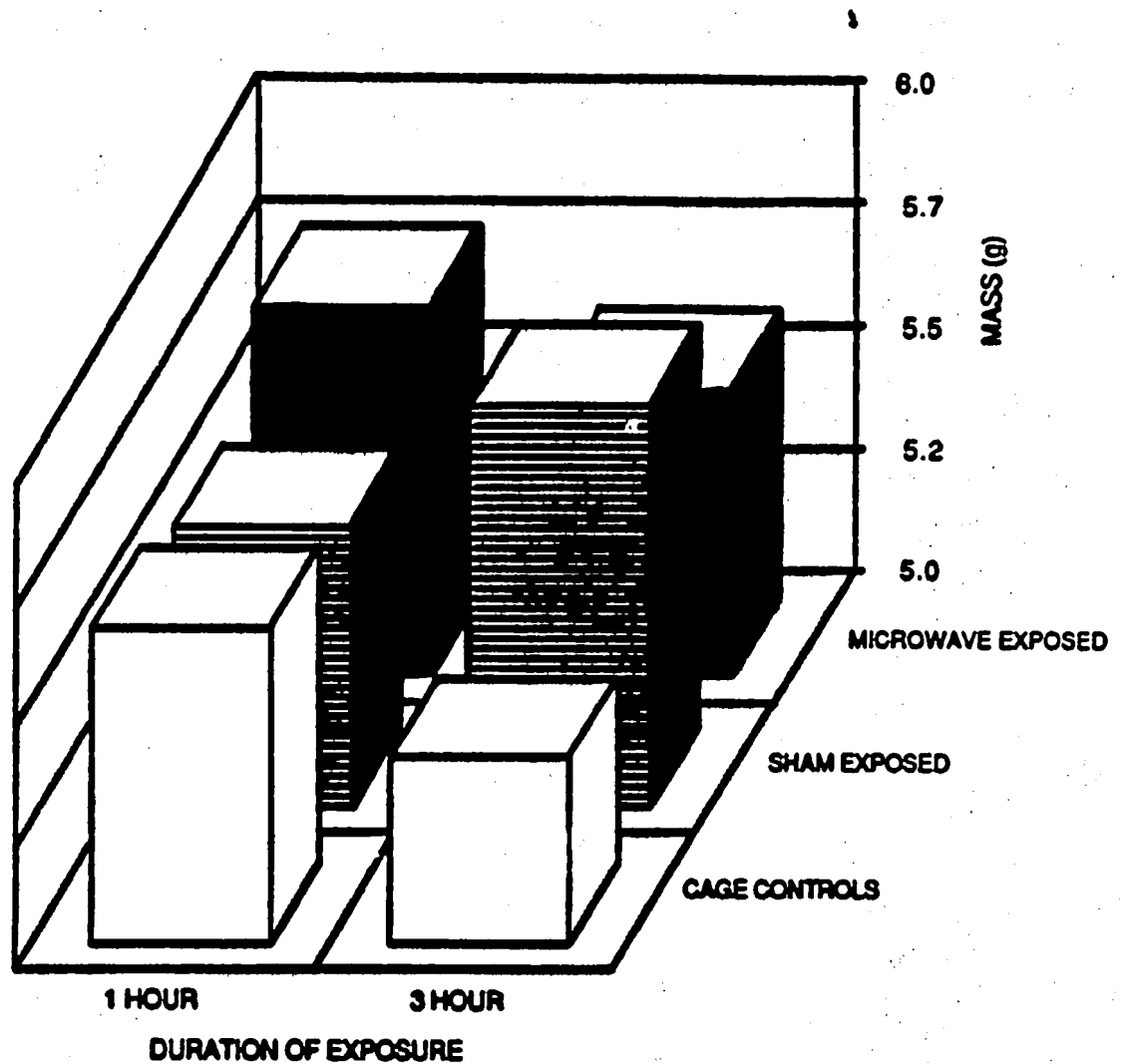


Figure 12: Mass of Long-Evans rat pups on day of birth. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

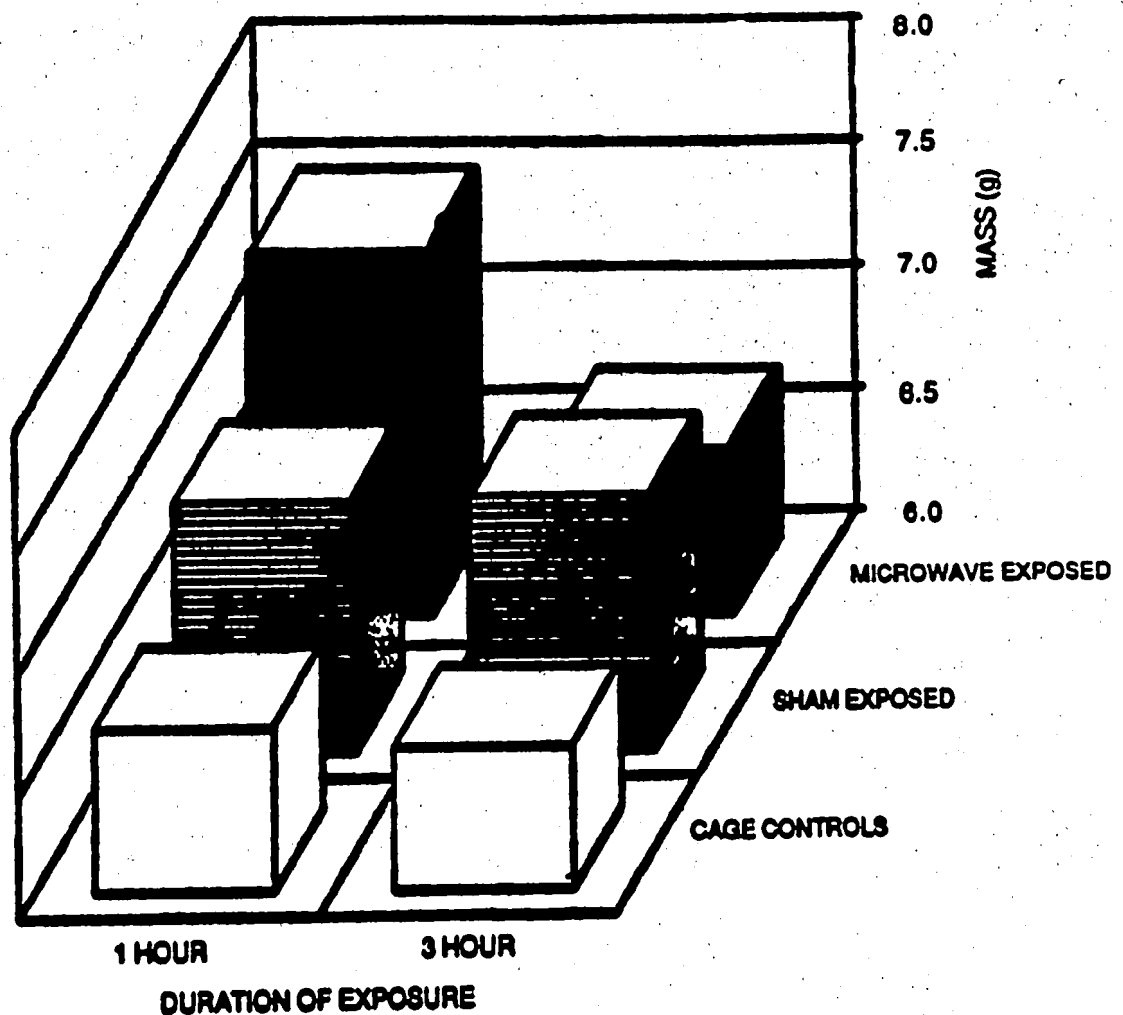


Figure 13: Mass of 2 day old Long-Evans rat pups used in seizure study. Exposure groups refer to prenatal exposure. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls. Raw data points used for these calculations were litter means.

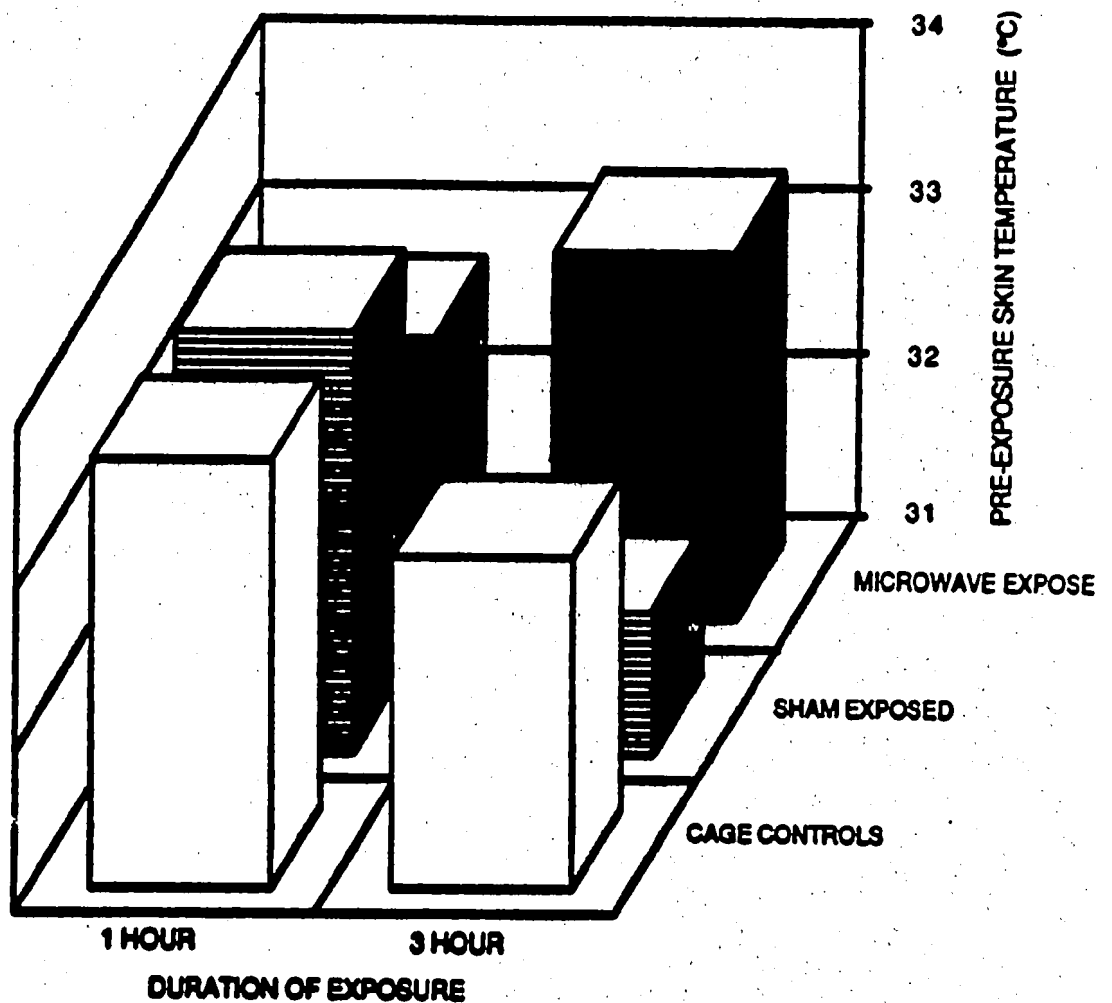


Figure 14: Skin temperature (°C) of 2 day old Long-Evans rat pups immediately before being placed in the seizure chamber. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls. Raw data points used for these calculations were litter means.

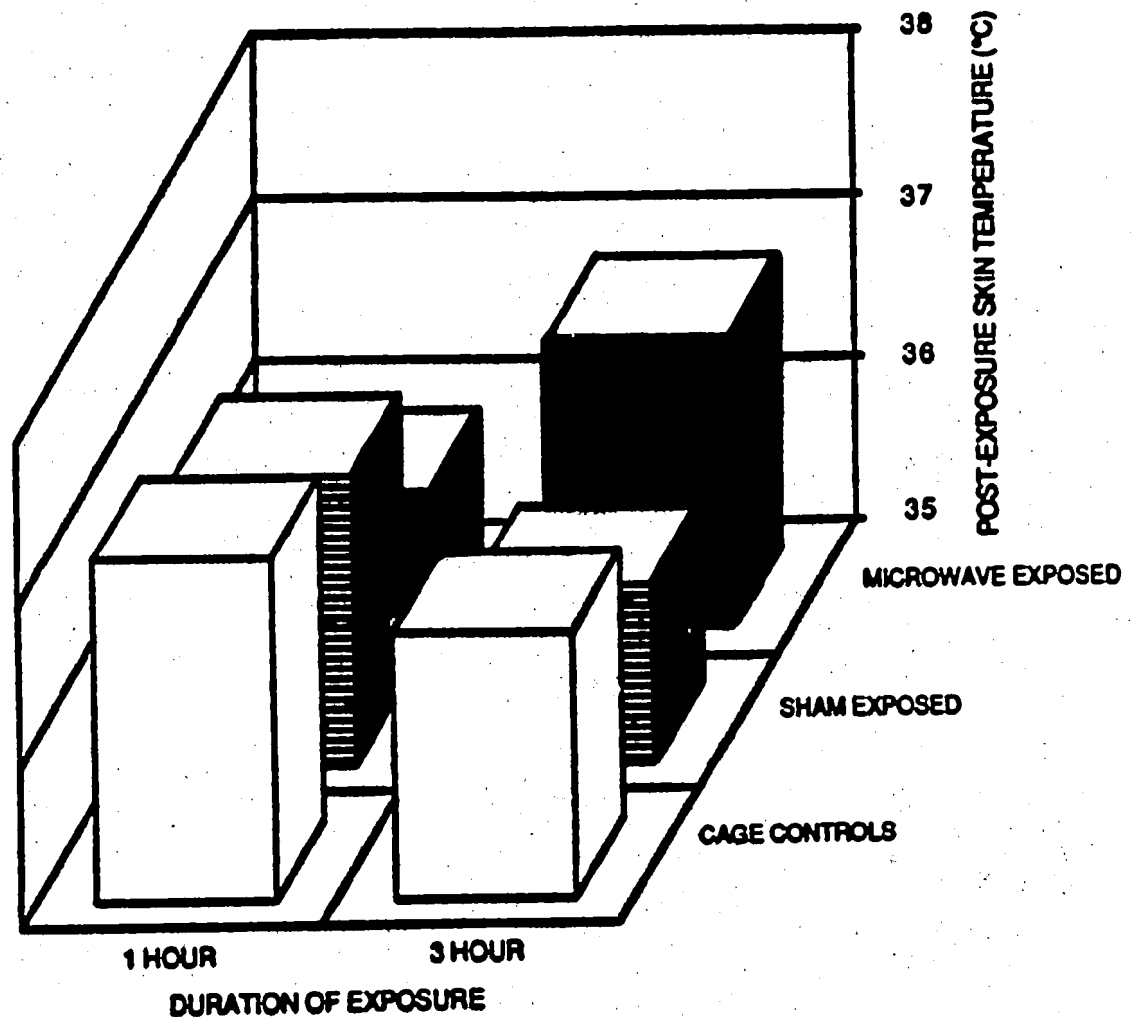


Figure 15: Skin temperature (°C) of 2 day old Long-Evans rat pups immediately after removal from seizure chamber after onset of seizure. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls. Raw data points for these calculations were litter means.

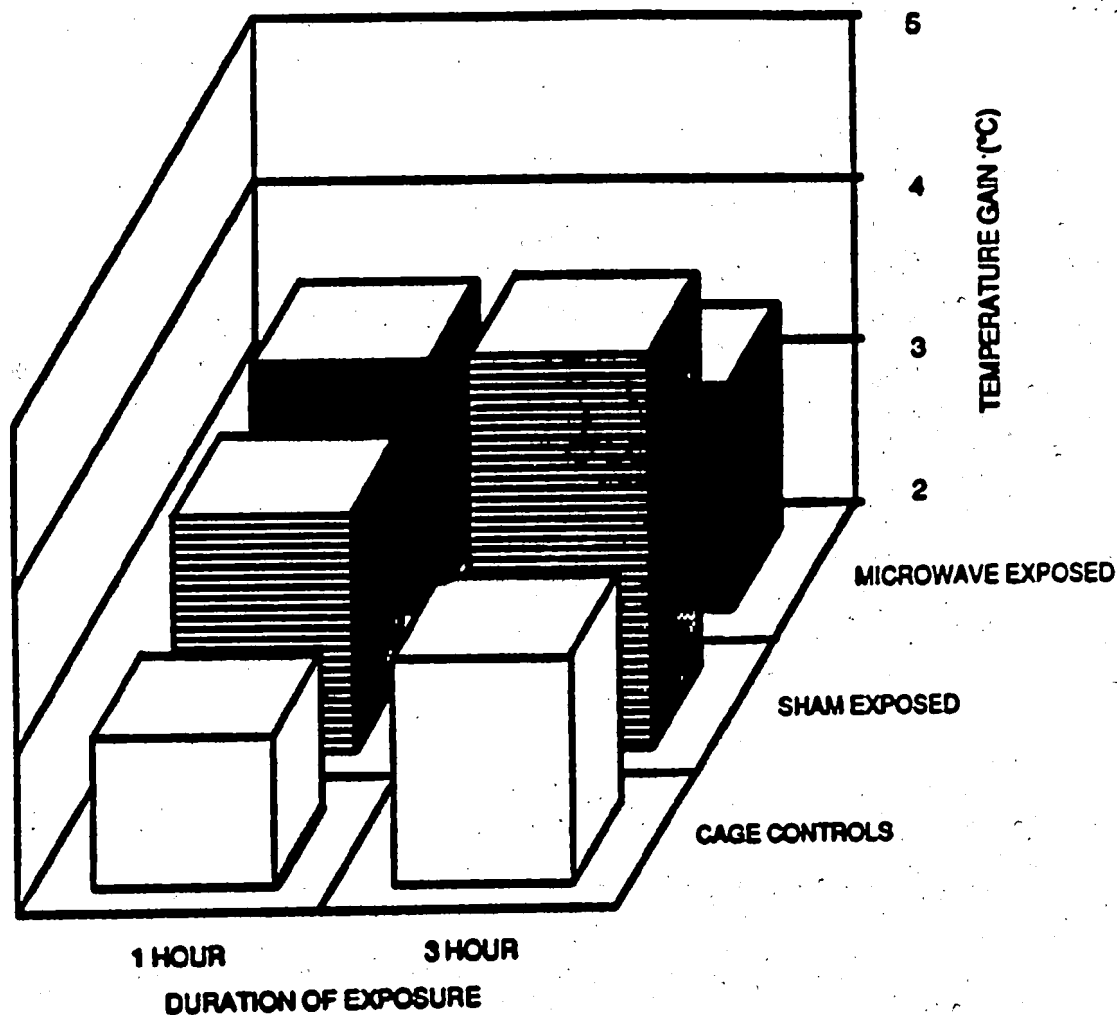


Figure 16: Temperature rise (post - pre exposure) of 2 day old Long-Evans rat pups during exposure to 2450 MHz circularly polarized microwave radiation until onset of seizures. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls. Raw data points used for these calculations were litter means.

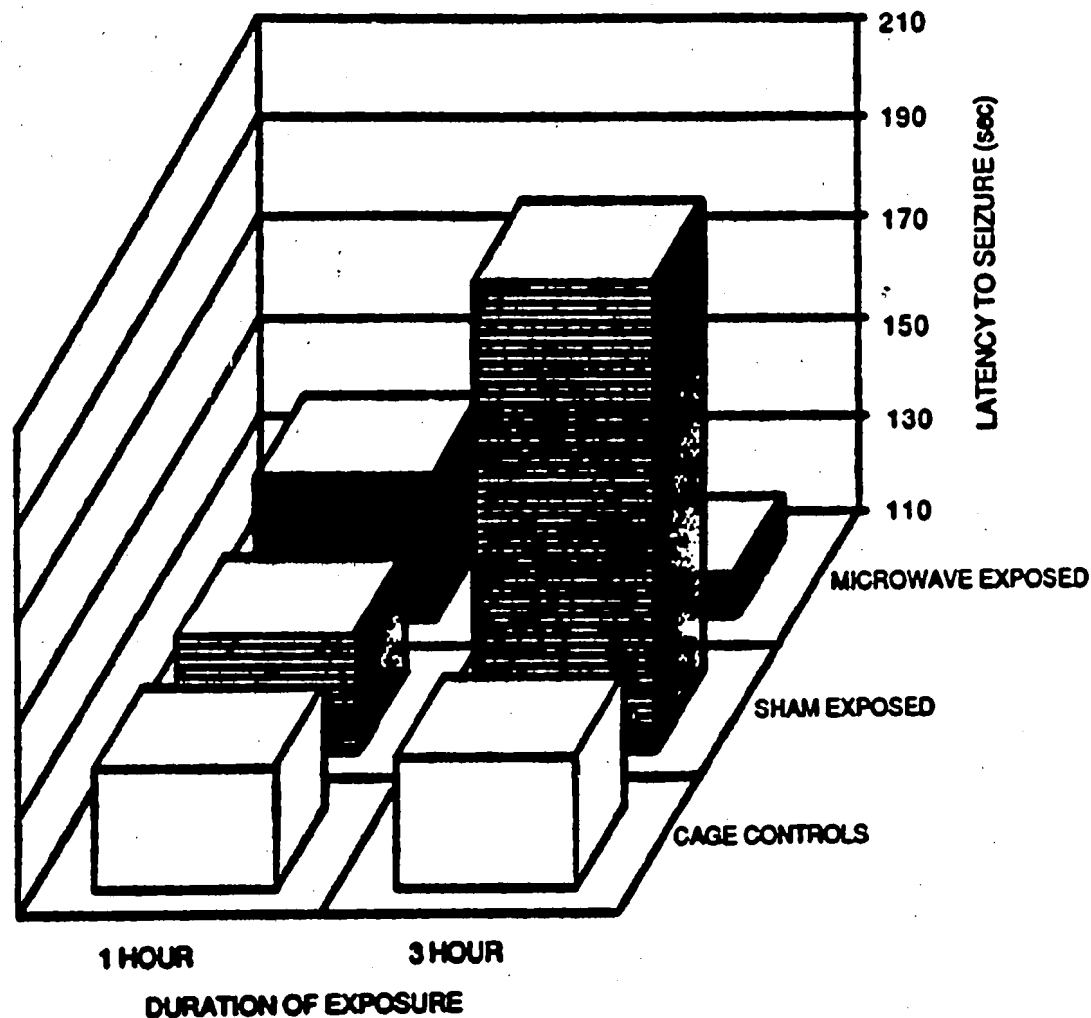


Figure 17: Latency to seizure of 2 day old Long-Evans rat pups. Seizures were induced by 2450 MHz circularly polarized microwave radiation. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls. Raw data points used for these calculations were litter means.

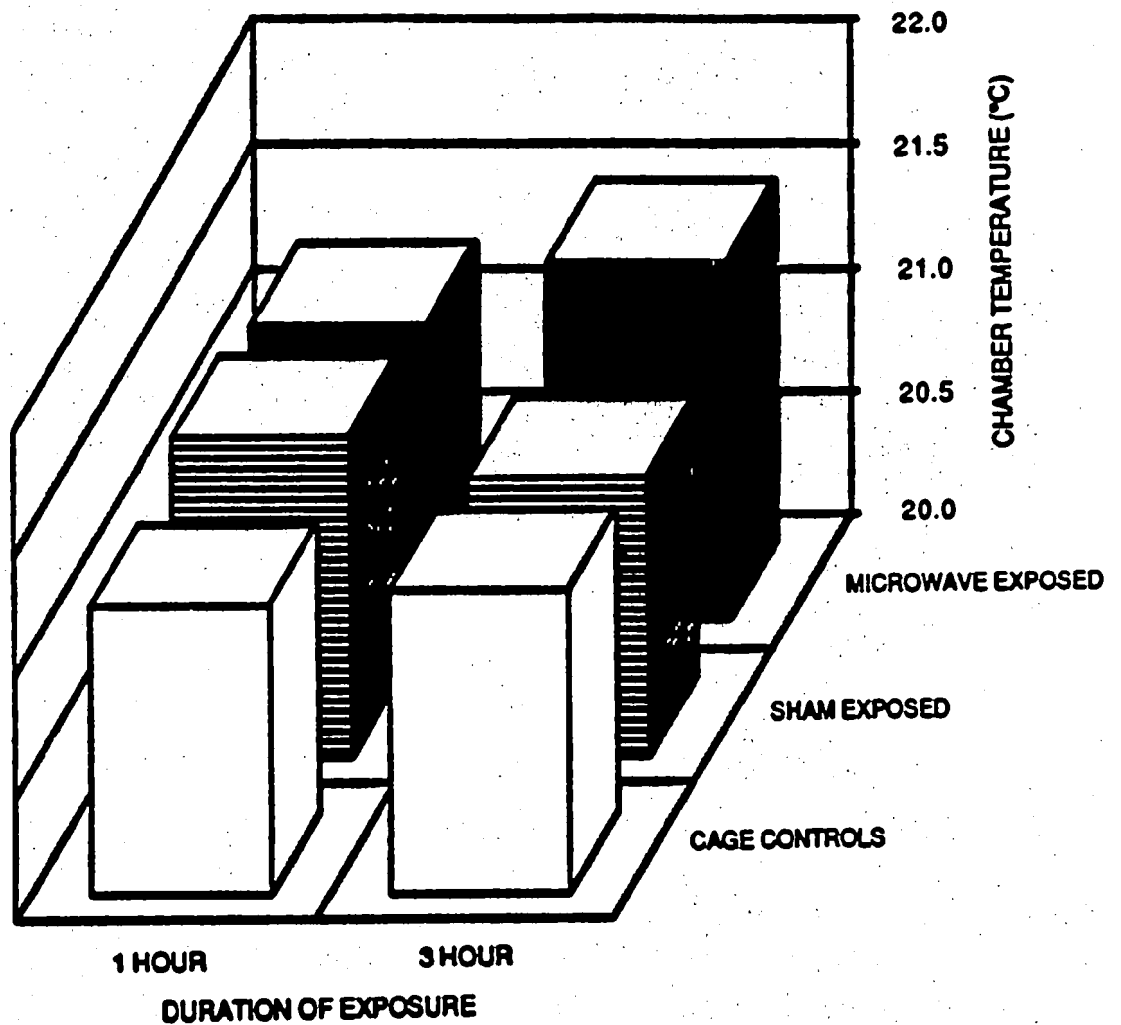


Figure 18: Mean chamber temperature over the course of photography sessions in huddle chamber for 5 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

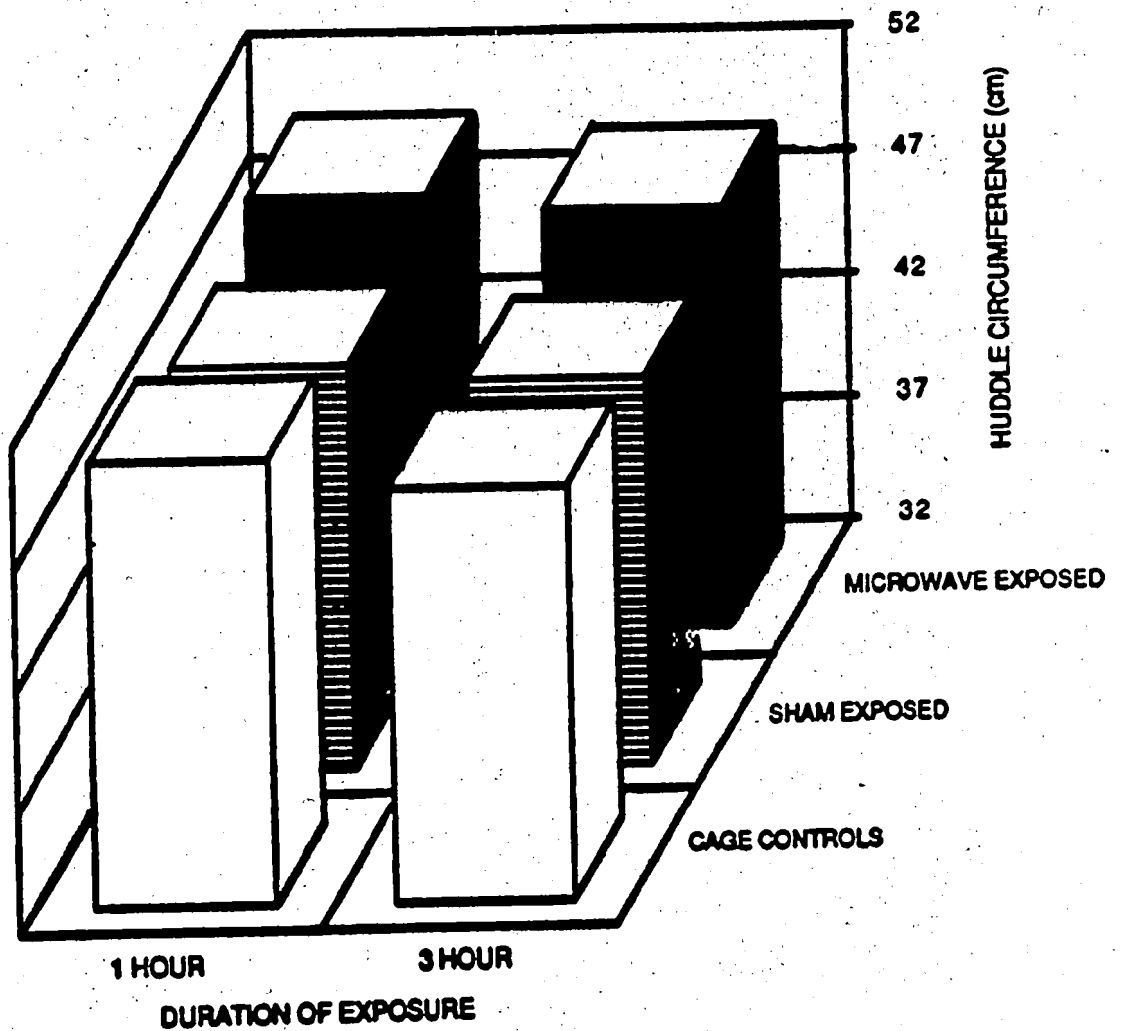


Figure 19: Mean huddle circumference for 5 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

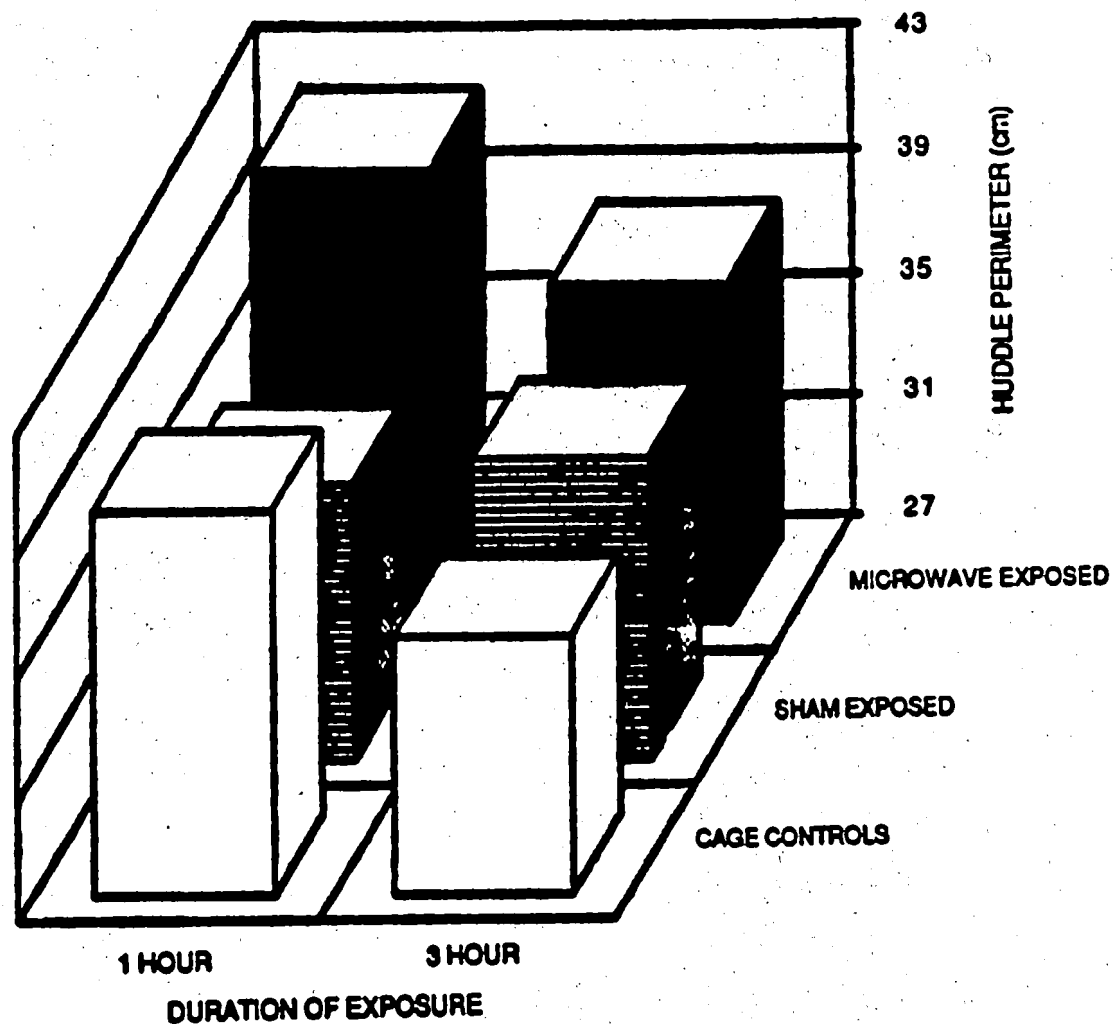


Figure 20: Mean general perimeter (rubberband) huddle measures for 5 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

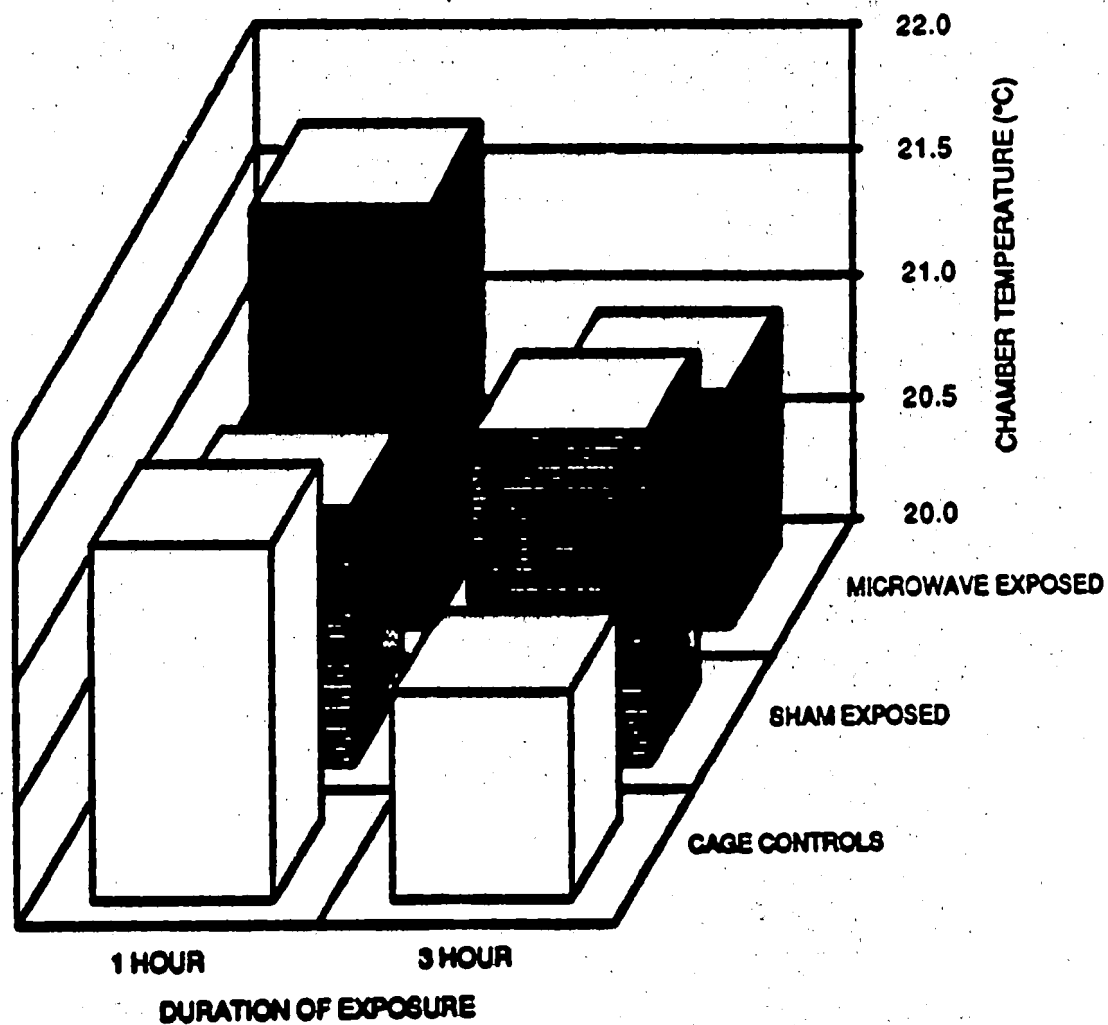


Figure 21: Mean chamber temperature over the course of photography sessions in huddle chamber for 10 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

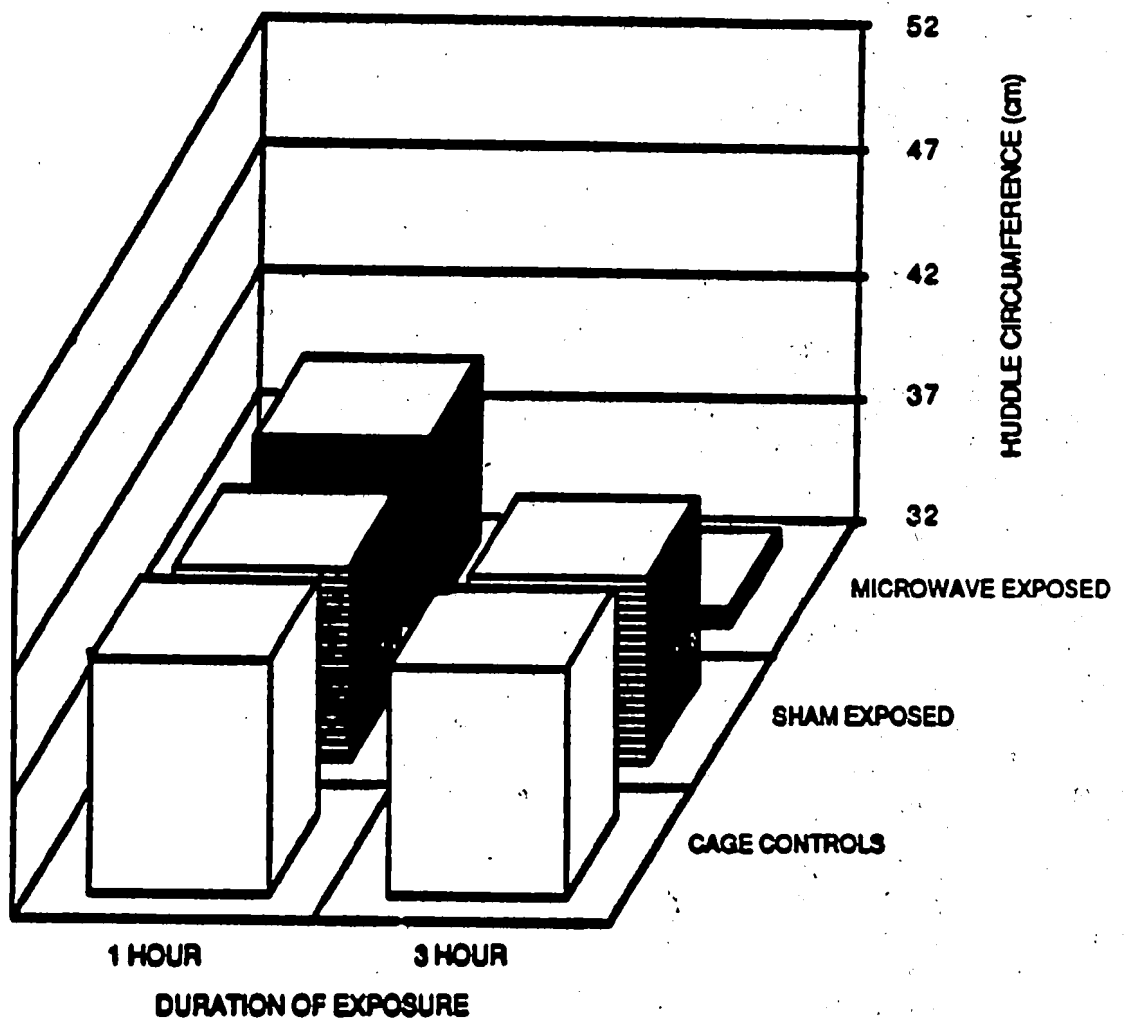


Figure 22: Mean huddle circumference for 10 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

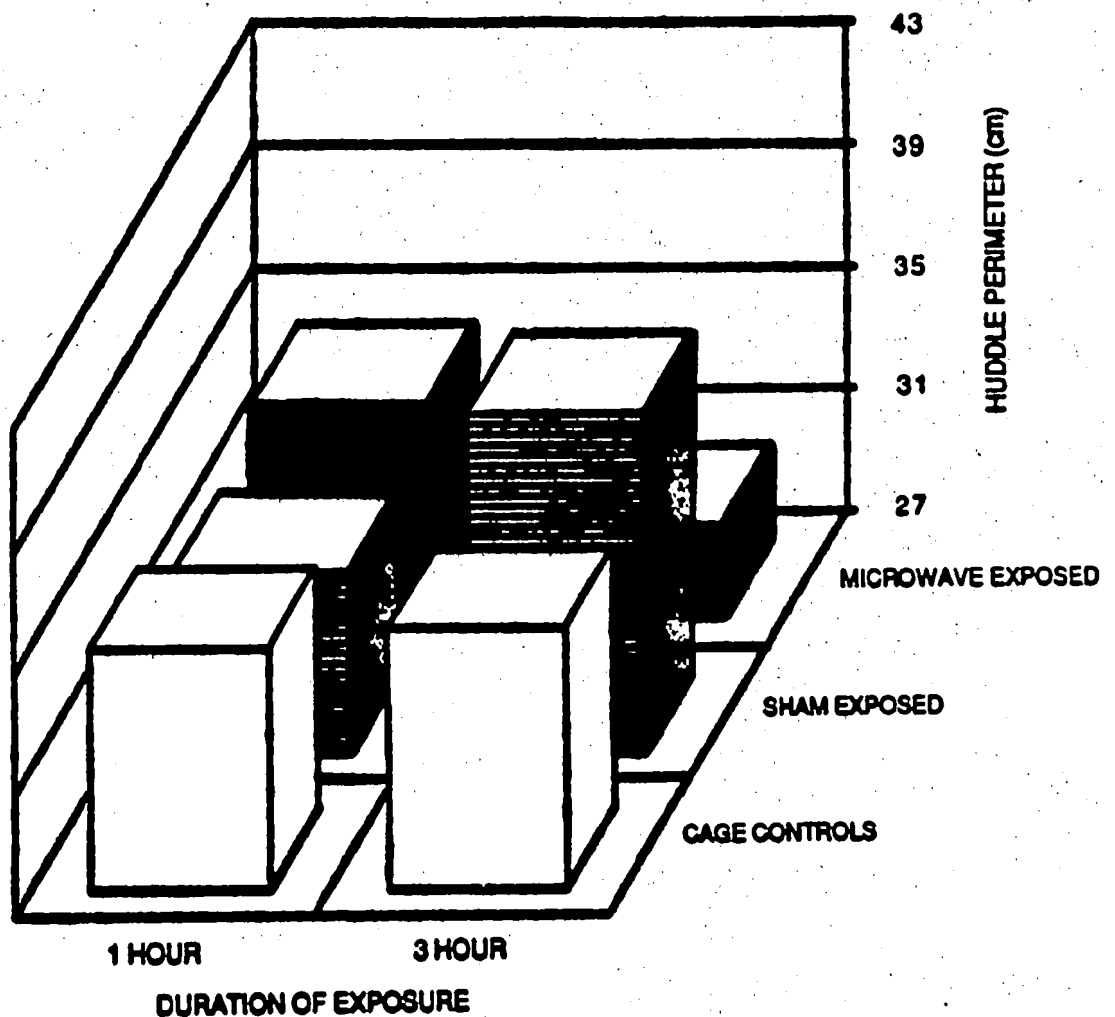


Figure 23: Mean general perimeter (rubberband) huddle measures for 10 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

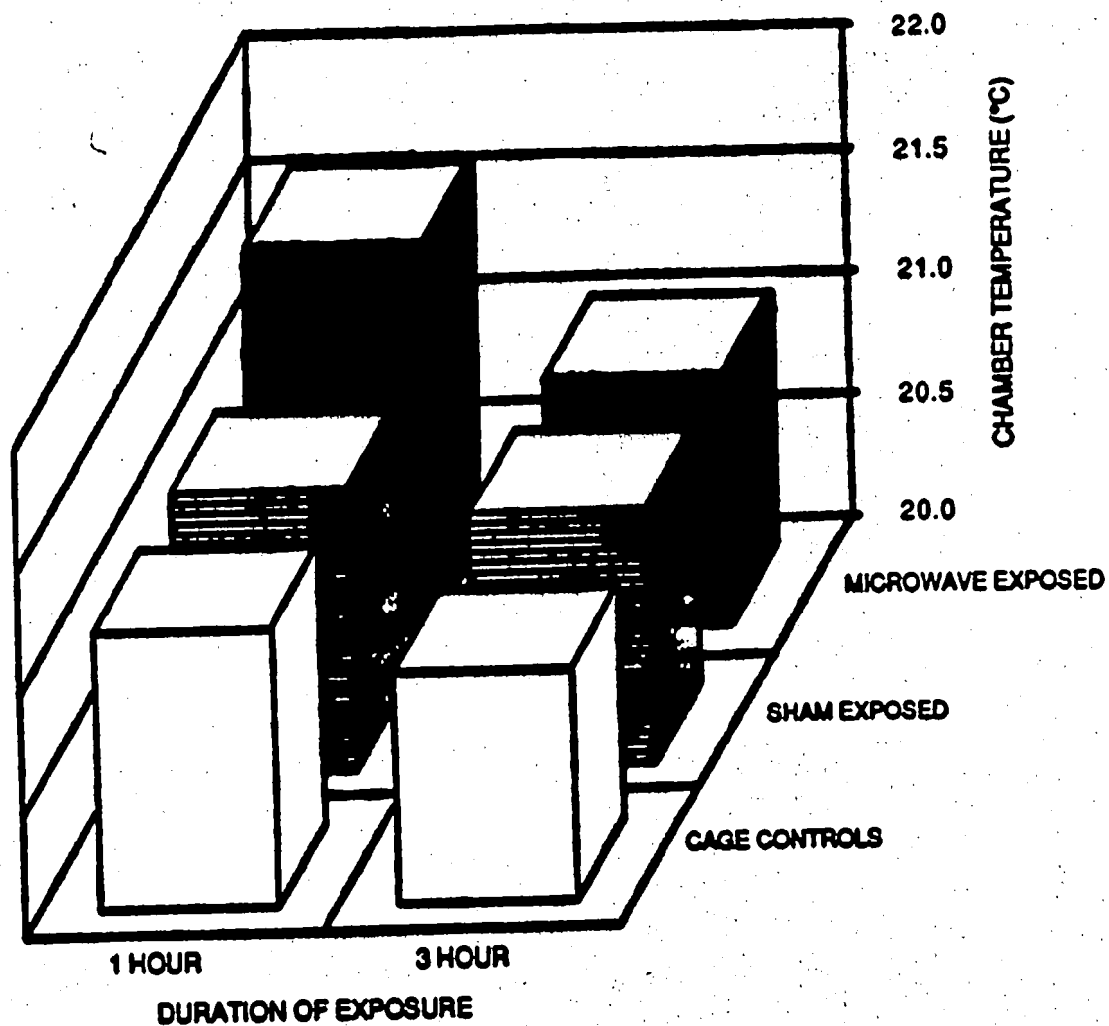


Figure 24: Mean chamber temperature over the course of photography sessions in huddle chamber for 15 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

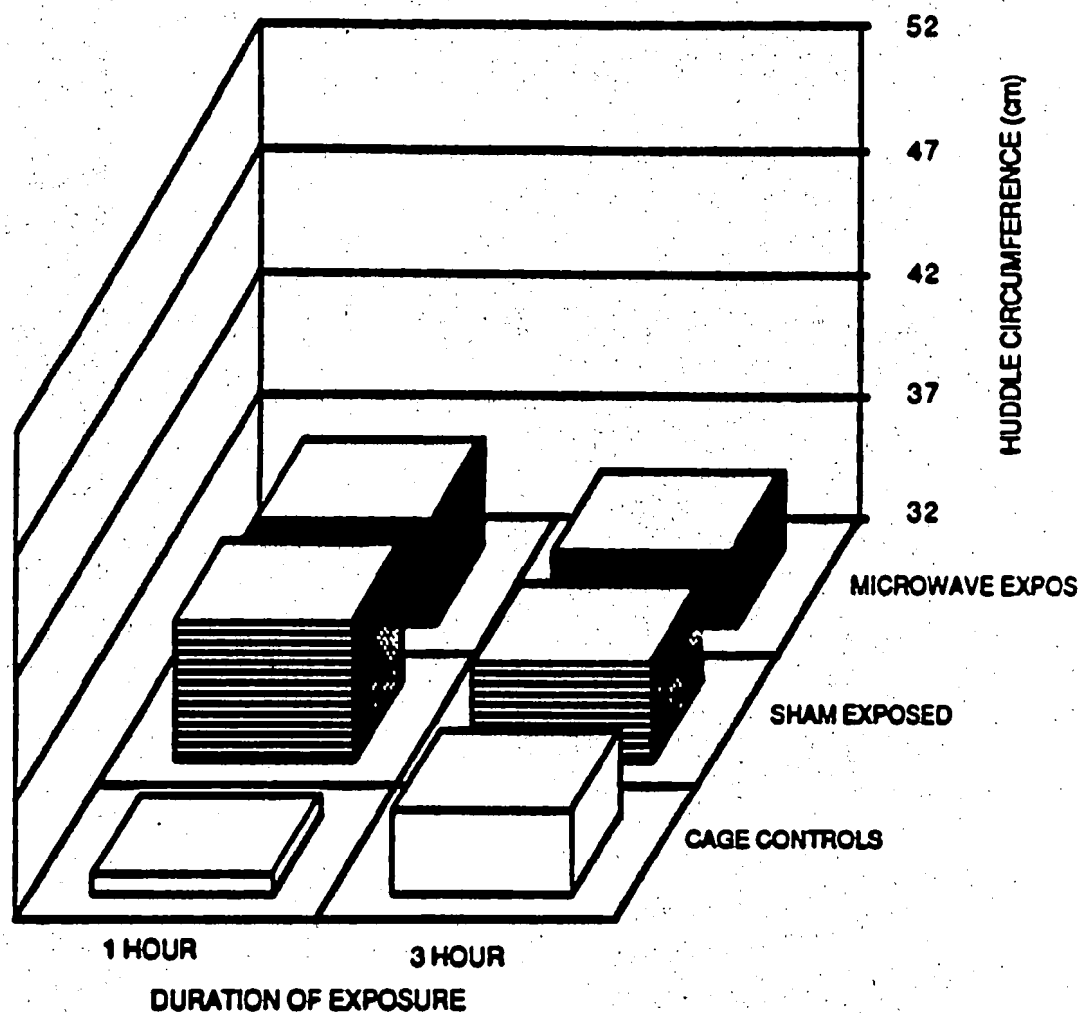


Figure 25: Mean huddle circumference for 15 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

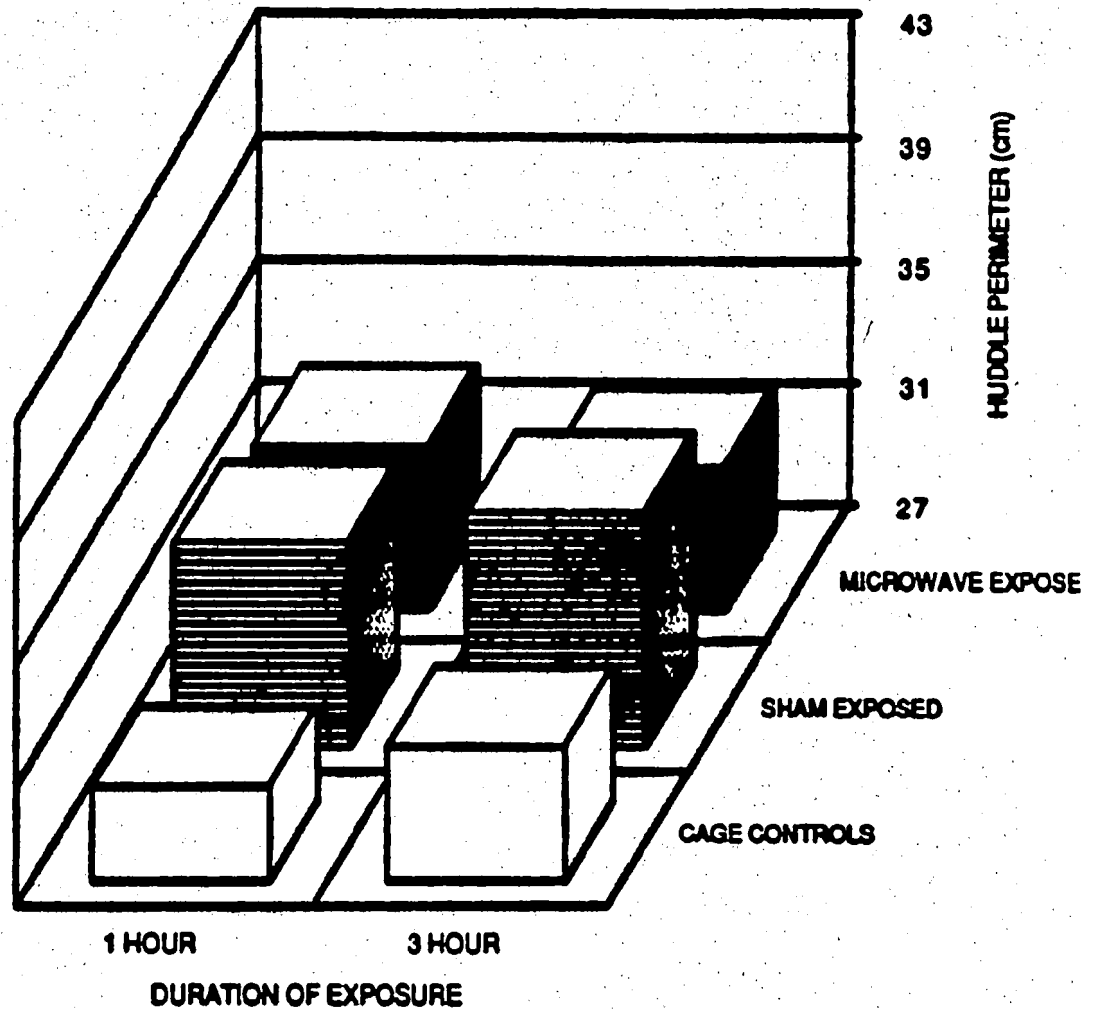


Figure 26: Mean general perimeter (rubberband) huddle measures for 15 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

In conclusion, the behavioral measures that were the main focus of this study did not appear to be effected by pre-natal exposure to 2450 MHz CW microwave radiation at an average whole body SAR of approximately 10 W/kg for 1 or 3 hours. The huddle sizes became smaller as the pups aged and the huddle measurement techniques were different in the proportion of variance in huddle size that was accounted for by the age of the pups.

Lindman, H.R. (1974). Analysis of Variance in Complex Experimental Designs. San Francisco, CA, W.H. Freeman & Co., p 53.

APPENDIX A

LIST OF STATISTICAL ANALYSES PERFORMED

Statistical analyses included a three factor ($3 \times 2 \times 2$) analysis of variance for exposure condition (cage control, sham exposed, microwave exposed), duration of exposure (1 hour, 3 hour), and time of day of exposure (morning, afternoon). Basic descriptive statistics such as the mean, standard error, standard deviation, etc... were also generated on the following variables:

- Age of mate on day 1 of gestation
- Age of dam on day 1 of gestation
- Litter size on day of birth
- Mean pup mass on day of birth
- Gestation period
- Mass of dam on day 1 of gestation
- Mass of dam on day 12 of gestation
- Mass of dam on day 18 of gestation
- Mass difference of dams (day 18 - day 1)
- Pre-exposure colonic temperature of dams
- Post-exposure colonic temperature of dams
- Colonic temperature difference of dams (post - pre)

The following using individual pups as raw data points:

- Mass of pups seised on day 2
- Pre-exposure temperature of pups seised
- Post-exposure temperature of pups seised
- Latency to seizure
- Temperature difference of pups seised
- Number of pups used from each litter for seizures

The following using litter means as raw data points:

- Mass of pups seised on day 2
- Pre-exposure temperature of pups seised
- Post-exposure temperature of pups seised
- Latency to seizure
- Temperature difference of pups seised
- Number of pups used from each litter for seizures

$4 \times 2 \times 2$ (age of pups (5 days, 10 days 15 days) exposure condition (cage control, sham exposed, microwave exposed) \times duration of exposure (1 hour, 3 hour) \times time of day of exposure (morning, afternoon)) ANOVA and basic descriptive statistics (mean, standard error, standard deviation, etc...) on the following variables:

- Perimeter of individual pups
- Convex polygon perimeter
- Mean temperature of huddle chamber

Tukey's HSD test between the sham exposed group and the microwave exposed group on the difference in dam mass (day 18 - day 1).

APPENDIX B

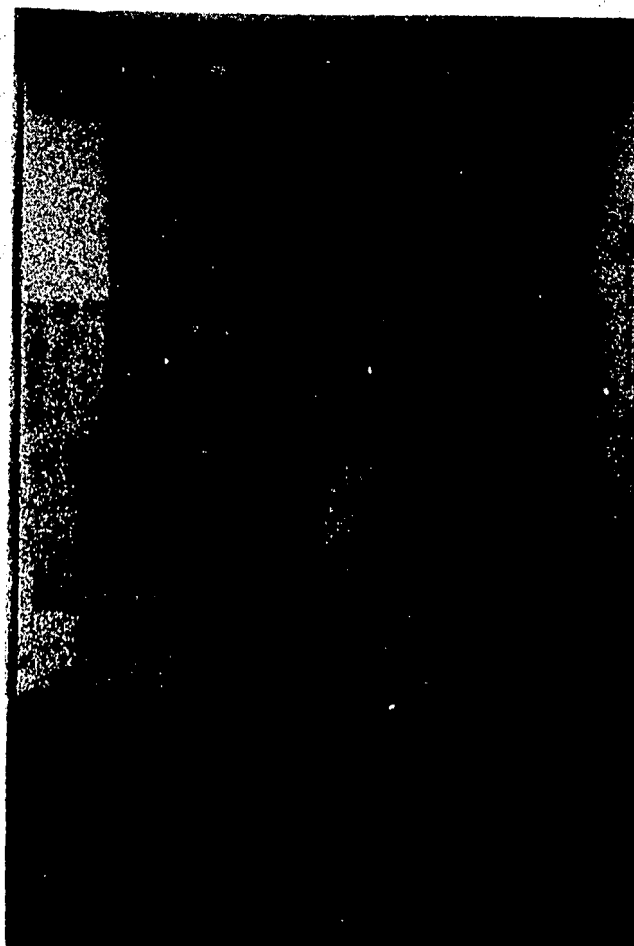
TABLE FOR DETERMINING POWER SETTINGS

TABLE FOR DETERMINING POWER TO GET SAR = 10
FOR VARYING MASSES

<u>MASS(g)</u>	<u>POWER(W)</u>
250	605.7
255	614.4
260	623.1
265	631.8
270	640.5
275	649.2
280	657.9
285	666.6
290	675.3
295	684.0
300	692.7
305	701.4
310	710.1
315	718.8
320	727.5
325	736.2
330	744.9
335	753.6
340	762.3
345	771.0
350	779.7
355	788.4
360	797.1
365	805.8
370	814.5
375	823.2
380	831.9
385	840.6
390	849.3
395	858.0
400	866.7
405	875.4
410	884.1
415	892.8
420	901.5
425	910.2
430	918.9
435	927.6
440	936.3
445	945.0
450	953.7

APPENDIX C

HUDDLE PHOTOGRAPH AND HUDDLE MEASUREMENT EXAMPLE



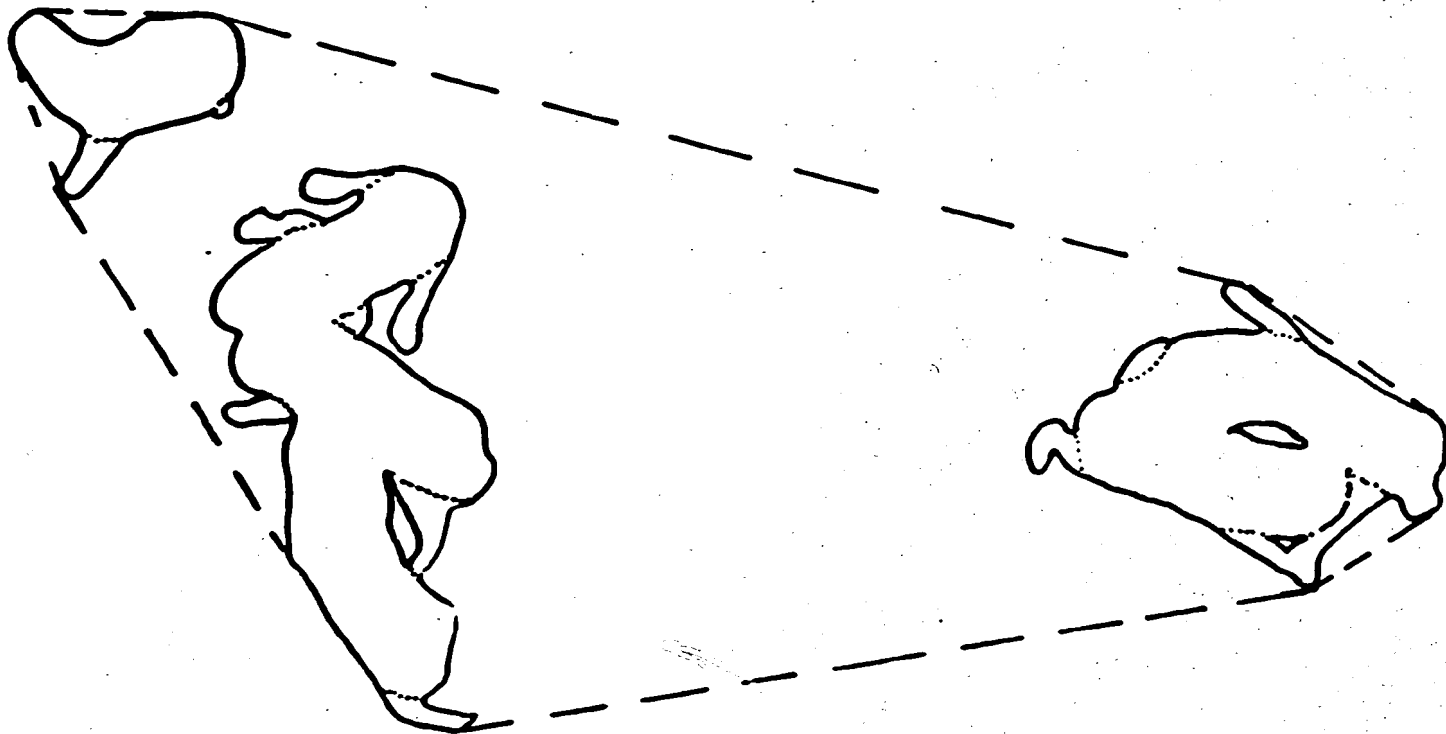
Reproduced from
best available copy.

6

Litter 123
Day 5 10-23-86
Photo 1 10:23
6 pups 21.9 C
DAL

Solid line - perimeter measure referred to as
individual pup.

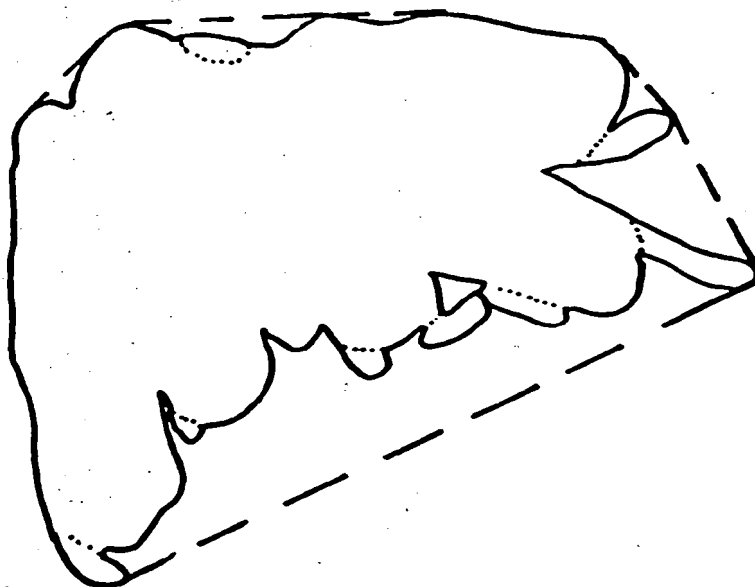
Broken line - circumference measure referred to
as rubberbandedness.



Litter 123
Day 10 11-23-86
Photo 3 10:15
6 pups 21.2 C
DAL

Solid line - perimeter measure referred to as
individual pup.

Broken line - circumference measure referred
to as rubberbandedness.



APPENDIX D

TABLES CONTAINING AVERAGE SCORES WITH STANDARD ERRORS AND GROUP SIZES

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION		DURATION		COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	131.60 9.87 5	117.83 4.90 6	111.75 4.82 4	133.00 10.97 3	122.78 6.56 9	122.89 5.15 9
SHAM	129.80 9.11 5	114.00 7.42 5	128.57 8.11 7	127.75 10.20 4	129.08 5.79 12	120.11 6.20 9
EXPOSED	133.25 10.76 4	115.60 6.75 5	124.00 9.38 7	127.50 9.26 4	127.36 6.94 11	120.89 5.60 9

Table 1: Age (in days) of gravid Long-Evans rats on day 1 of gestation.

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION		DURATION		COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	122.20 8.93 5	143.00 12.21 6	127.75 21.87 4	129.33 11.32 3	124.67 10.14 9	138.44 8.83 9
SHAM	127.40 9.80 5	140.80 18.78 5	131.14 11.92 7	125.50 7.26 4	129.58 7.75 12	134.00 10.76 9
EXPOSED	126.75 12.42 4	143.80 15.75 5	129.86 11.60 7	125.25 7.61 4	128.73 8.27 11	135.55 9.44 9

Table 2: Age (in days) of mates (male Long-Evans rats) on day when sperm plug was discovered (day 1 of gestation).

GROUP	TIME OF DAY					
	MORNING		AFTERNOON		COMBINED DURATION	
	DURATION					
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	257.60 18.63 5	253.50 13.29 6	238.75 11.19 4	250.67 18.67 3	249.22 11.32 9	252.55 10.15 9
SHAM	250.20 15.25 5	255.20 12.12 5	254.43 17.44 7	261.00 10.35 4	252.67 11.51 12	257.78 7.73 9
EXPOSED	269.50 13.51 4	250.00 7.64 6	260.28 11.80 7	281.33 14.95 3	263.63 8.66 11	260.44 8.38 9

Table 3: Mass of gravid Long-Evans rats on day 1 of gestation.

GROUP	TIME OF DAY					
	MORNING		AFTERNOON		COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	291.00 19.27 5	293.17 10.93 6	271.75 11.40 4	274.33 16.49 3	282.44 11.67 9	286.89 9.07 9
SHAM	285.40 12.38 5	295.20 11.60 5	292.86 18.76 7	303.75 7.56 4	289.75 11.68 12	299.00 7.01 9
EXPOSED	302.25 16.15 4	283.17 4.44 6	297.71 7.59 7	320.67 24.34 3	299.36 7.13 11	295.67 9.83 9

Table 4: Mass of gravid Long-Evans rats on day 12 of gestation.

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION		DURATION		COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	329.60 21.92 5	323.00 8.51 6	298.50 11.79 4	311.67 21.76 3	315.78 13.65 9	319.22 8.55 9
SHAM	315.60 16.74 5	332.40 13.47 5	325.00 19.47 7	341.25 8.28 4	321.08 12.84 12	336.33 8.01 9
EXPOSED	325.00 16.67 4	299.33 3.83 6	317.86 7.93 7	341.00 26.63 3	320.45 7.45 11	313.22 10.65 9

Table 5: Mass of gravid Long-Evans rats on day 18 of gestation. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION		DURATION		COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	72.00 5.70 5	69.50 7.96 6	59.75 3.09 4	61.00 8.39 3	66.55 3.90 9	66.67 5.85 9
SHAM _a	65.40 6.12 5	77.20 5.61 5	70.57 3.52 7	80.25 8.59 4	68.42 3.20 12	78.55 4.62 9
EXPOSED _a	55.50 4.33 4	49.33 8.59 6	57.57 7.85 7	59.67 14.17 3	56.82 5.06 11	52.78 7.10 9

Table 6: Mass gain (g) of gravid Long-Evans rats from day 1 through day 18 of gestation. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls. Cells with subscripts are significantly different from one another. (a: $F=5.87$, $p=0.0055$; Tukey's HSD $p=.05$)

GROUP	TIME OF DAY					
	MORNING a			AFTERNOON a		
	DURATION		DURATION		COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	-	-	-	-	-	-
SHAM b	38.45 0.25 5	38.40 0.08 5	37.92 0.09 7	38.12 0.09 4	38.14 0.13 12	38.28 0.08 9
EXPOSED b	38.29 0.19 4	38.07 0.11 6	38.07 0.06 7	37.62 0.10 3	38.15 0.08 11	37.92 0.10 9

Table 7: Colonic temperature (C) of gravid Long-Evans rats before exposure to 2450 MHz CW microwave radiation at an SAR of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation. Cells with similar subscripts are significantly different from one another. (a: $F=15.22$, $p=0.02984$; b: $F=5.04$, $p=0.00071$; Group X Duration interaction: $F=4.75$, $p=0.03444$)

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION		DURATION		COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR a	3 HR a
CAGE	-	-	-	-	-	-
SHAM b	38.31 0.26 5	37.32 0.08 5	37.69 0.15 7	37.38 0.06 4	37.95 0.16 12	37.35 0.05 9
EXPOSED b	40.13 0.21 4	39.75 0.21 6	40.54 0.19 7	39.64 0.17 3	40.39 0.15 11	39.71 0.15 9

Table 8: Colonic temperature (C) of gravid Long-Evans rats after exposure to 2450 MHz CW microwave radiation at an SAR of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation. Cells with similar subscripts are significantly different from one another. (a: $F=21.51$, $p=0.00016$; b: $F=281.35$, $p=0.00000$; Group X Duration X Time interaction: $F=4.70$, $p=0.03531$)

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION			COMBINED DURATION		
	1 HR	3 HR	1 HR	3 HR	1 HR b	3 HR b
CAGE	-	-	-	-	-	-
SHAM c	-0.14 0.12 5	-1.08 0.12 5	-0.23 0.20 7	-0.73 0.07 4	-0.19 0.12 12	-0.93 0.09 9
EXPOSED c	1.84 0.20 4	1.68 0.23 6	2.47 0.24 7	2.02 0.22 3	2.24 0.18 11	1.80 0.17 9

Table 9: Post - pre exposure colonic temperature (C) difference of gravid Long-Evans rats exposed to 2450 MHz CW microwave radiation at an SAR of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation. Cells with similar subscripts are significantly different from one another. (a: F=4.21, p=0.04560; b: F=11.83, p=0.00193; c: F=289.98, p=0.00000)

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION			COMBINED DURATION		
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	21.60 0.24 5	22.00 0.26 6	21.75 0.25 4	21.67 0.33 3	21.67 0.17 9	21.89 0.20 9
SHAM	21.80 0.37 5	21.60 0.24 5	21.71 0.18 7	21.75 0.25 4	21.75 0.18 12	21.67 0.17 9
EXPOSED	22.25 0.25 4	21.80 0.20 5	22.29 0.18 7	21.50 0.50 4	22.27 0.14 11	21.67 0.24 9

Table 10: Gestation period (in days) of Long-Evans rats. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION		DURATION		COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	11.20 2.08 5	10.67 1.74 6	11.50 1.19 4	12.00 0.58 3	11.33 1.20 9	11.11 1.16 9
SHAM	11.00 2.26 5	11.20 0.80 5	12.57 1.38 7	12.00 0.58 4	11.92 1.20 12	11.56 0.50 9
EXPOSED	10.50 1.71 4	10.40 2.04 5	11.00 1.80 7	10.25 1.25 4	10.82 1.25 11	10.33 1.19 9

Table 11: Average litter size after prenatal treatment. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION		DURATION		COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	5.73 0.33 5	5.42 0.32 5	5.59 0.14 4	5.34 0.27 3	5.66 0.18 9	5.39 0.21 8
SHAM	5.60 0.20 5	5.70 0.30 5	5.57 0.19 7	5.99 0.29 4	5.58 0.14 12	5.83 0.20 9
EXPOSED	5.76 0.20 4	5.61 0.17 5	5.74 0.27 7	5.54 0.09 4	5.75 0.17 11	5.58 0.10 9

Table 12: Mass of Long-Evans rat pups on day of birth. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION				COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	6.71 0.88 4	6.51 0.64 4	6.63 0.63 4	6.69 0.82 3	6.67 0.50 8	6.59 0.46 7
SHAM	7.08 0.69 4	6.43 0.82 4	7.03 0.32 6	7.55 0.44 4	7.03 0.31 10	7.49 0.50 8
EXPOSED	4.75 0.63 4	6.50 0.22 5	7.55 0.39 7	7.03 0.23 3	7.49 0.25 11	6.69 0.18 8

Table 13: Mass of 2 day old Long-Evans rat pups used in seizure study. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls. Raw data points used for these calculations were litter means.

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION				COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	32.95 1.64 4	32.88 1.53 4	34.36 0.84 4	33.28 0.81 3	33.65 0.89 8	33.05 0.88 7
SHAM	33.58 0.54 4	30.61 2.64 4	33.57 0.58 6	33.16 0.51 4	33.58 0.39 10	31.89 1.33 8
EXPOSED	33.01 0.31 4	33.13 1.14 5	32.56 0.91 7	33.46 0.52 3	32.72 0.58 11	33.25 0.70 8

Table 14: Skin temperature (C) of 2 day old Long-Evans rat pups immediately before being placed in the seizure chamber. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls. Raw data points used for these calculations were litter means.

GROUP	TIME OF DAY					
	MORNING		AFTERNOON		COMBINED DURATION	
	DURATION					
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	37.05 1.25 4	35.24 1.58 4	36.13 0.72 4	38.12 0.56 3	36.59 0.69 8	36.47 1.05 7
SHAM	37.19 0.75 4	34.45 1.26 4	36.62 0.74 6	37.85 0.83 4	36.85 0.51 10	36.15 0.95 8
EXPOSED	36.95 0.54 4	36.08 0.79 5	35.88 0.84 7	37.52 0.47 3	36.27 0.57 11	36.62 0.56 8

Table 15: Skin temperature (C) of 2 day old Long-Evans rat pups immediately removal from the seizure chamber after onset of seizure. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls. Raw data points used for these calculations were litter means.

GROUP	TIME OF DAY					
	MORNING		AFTERNOON		COMBINED DURATION	
	DURATION					
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	4.09	2.37	1.77	4.83	2.93	3.42
	0.98	0.22	0.45	1.23	0.67	0.69
	4	4	4	3	8	7
SHAM	3.77	3.83	3.20	4.98	3.43	4.41
	0.57	1.47	0.49	1.42	0.36	0.97
	4	4	6	4	10	8
EXPOSED	3.94	2.95	3.32	4.07	3.54	3.37
	0.60	0.59	0.40	0.48	0.33	0.43
	4	5	7	3	11	8

Table 16: Temperature rise (post - pre exposure) of 2 day old Long-Evans rat pups during exposure to 2450 MHz circularly polarized microwave radiation until onset of seizures. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls. Raw data points used for these calculations were litter means.

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION		DURATION		COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	163.26 46.97 4	102.90 9.10 4	106.48 14.68 4	182.83 26.67 3	134.87 25.18 8	137.16 19.65 7
SHAM	165.11 44.58 4	124.93 20.75 4	113.63 11.51 6	289.04 98.22 4	134.22 19.49 10	206.99 55.87 8
EXPOSED	149.99 20.58 4	109.44 13.80 5	132.33 7.20 7	132.05 17.50 3	138.75 8.56 11	117.92 10.86 8

Table 17: Latency to seizure of 2 day old Long-Evans rat pups. Seizures were induced by 2450 MHz circularly polarized microwave radiation. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls. Raw data points used for these calculations were litter means.

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION		DURATION		COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	21.20 0.23 3	21.03 0.43 4	21.18 0.12 4	21.52 0.54 3	21.19 0.11 7	21.24 0.32 7
SHAM	21.10 0.14 5	20.93 0.28 3	21.59 0.19 4	21.30 0.46 4	21.32 0.14 9	21.14 0.28 7
EXPOSED	21.15 0.19 3	21.35 0.25 5	21.22 0.15 6	21.66 0.15 3	21.20 0.11 9	21.46 0.17 8

Table 18: Mean chamber temperature over the course of photography sessions in huddle chamber for 5 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

GROUP	TIME OF DAY					
	MORNING		AFTERNOON		COMBINED DURATION	
	DURATION					
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	48.58	48.09	51.50	50.29	50.25	49.03
	1.86	1.65	1.24	2.25	1.13	1.30
	3	4	4	3	7	7
SHAM	47.45	48.00	49.50	47.81	48.36	47.89
	2.64	2.67	0.23	3.15	1.44	1.96
	5	3	4	4	9	7
EXPOSED	52.58	48.37	48.29	50.50	49.72	49.17
	1.79	1.18	1.74	1.09	1.43	0.88
	3	5	6	3	9	8

Table 19: Mean huddle circumference for 5 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

GROUP	TIME OF DAY					
	MORNING		AFTERNOON		COMBINED DURATION	
	DURATION					
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	37.50 3.27 3	36.83 3.94 4	41.24 3.02 4	33.89 3.13 3	39.64 2.17 7	35.57 2.49 7
SHAM	36.60 4.59 5	36.11 3.39 3	35.08 1.98 4	37.37 3.66 4	35.92 2.56 9	36.83 2.35 7
EXPOSED	42.66 1.50 3	38.29 2.35 5	41.44 2.30 6	38.11 2.67 3	41.85 1.56 9	38.22 1.65 7

Table 20: Mean general perimeter (rubberband) huddle measures for 5 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION				COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	21.80 0.31 4	20.60 0.10 4	20.97 0.39 3	21.18 0.23 3	21.45 0.28 7	20.85 0.15 7
SHAM	21.28 0.40 5	20.80 - 1	20.83 0.19 5	21.48 0.61 4	21.05 0.22 10	21.35 0.49 5
EXPOSED	21.68 0.89 3	20.93 0.38 3	21.71 0.44 5	20.97 0.10 3	21.70 0.39 8	20.95 0.18 6

Table 21: Mean chamber temperature over the course of photography sessions in huddle chamber for 10 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION				COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	43.62 2.23 4	42.19 4.18 4	39.37 2.89 4	40.50 3.33 3	41.50 1.87 8	41.46 2.59 7
SHAM	38.50 1.88 5	44.62 6.12 2	41.12 3.04 5	36.97 1.71 4	39.81 1.74 10	39.52 2.50 6
EXPOSED	37.03 1.85 3	34.50 1.73 4	40.73 4.00 6	30.33 3.76 3	39.50 2.71 9	32.71 1.89 7

Table 22: Mean huddle circumference for 10 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION		DURATION		COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	36.66 1.82 4	38.00 4.74 4	33.21 2.82 4	32.66 1.92 3	34.93 1.68 8	35.71 2.85 7
SHAM	33.13 0.76 5	39.66 6.66 2	33.00 2.43 5	37.50 3.44 4	33.06 1.20 10	38.22 2.81 6
EXPOSED	33.72 2.14 3	30.79 1.37 4	34.02 3.79 6	28.89 4.56 3	33.92 2.52 9	29.97 1.91 7

Table 23: Mean general perimeter (rubberband) huddle measures for 10 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

GROUP	TIME OF DAY					
	MORNING			AFTERNOON		
	DURATION		DURATION		COMBINED DURATION	
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	21.28 0.78 2	20.79 0.56 3	21.07 0.46 4	21.11 0.17 3	21.14 0.35 6	20.95 0.27 6
SHAM	21.07 0.35 4	21.55 0.05 2	21.19 0.51 5	20.80 0.25 4	21.14 0.30 9	21.05 0.22 6
EXPOSED	21.34 0.27 2	21.10 0.45 3	21.68 0.33 5	20.91 0.49 2	21.59 0.24 7	21.03 0.29 5

Table 24: Mean chamber temperature over the course of photography sessions in huddle chamber for 15 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

GROUP	TIME OF DAY					
	MORNING		AFTERNOON		COMBINED DURATION	
	DURATION		DURATION			
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	34.66 3.33 2	37.42 1.71 3	31.94 1.31 4	33.75 1.28 3	32.85 1.32 6	35.58 1.26 6
SHAM	37.10 3.90 4	34.08 6.08 2	37.99 4.05 5	36.97 1.28 4	37.59 2.67 9	36.00 1.87 6
EXPOSED	32.37 3.37 2	33.25 2.63 3	37.57 2.33 5	37.37 0.12 2	36.08 2.01 7	34.90 1.76 5

Table 25: Mean huddle circumference for 15 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.

GROUP	TIME OF DAY					
	MORNING		AFTERNOON		COMBINED DURATION	
	DURATION					
	1 HR	3 HR	1 HR	3 HR	1 HR	3 HR
CAGE	33.41 1.08 2	33.77 3.37 3	28.58 1.30 4	29.27 1.76 3	30.19 1.34 6	31.52 1.97 6
SHAM	32.29 2.75 4	33.50 7.50 2	34.63 3.43 5	35.20 1.71 4	33.59 2.17 9	34.64 2.25 6
EXPOSED	29.33 2.00 2	29.79 1.67 3	33.53 2.19 5	34.49 2.16 2	32.33 1.75 7	31.67 1.62 5

Table 26: Mean general perimeter (rubberband) huddle measures for 15 day old Long-Evans rat pups. Exposure groups refer to prenatal exposures. Dams were exposed to 2450 MHz CW microwave radiation at SAR's of 0 or 10 W/kg for 1 or 3 hours daily from day 12 through day 18 of gestation or were cage controls.