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Effects of Grounding on Body Voltage and Current in the Presence of Electromagnetic Fields

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Abstract

Objectives: The aim of this study was to determine if grounding in the presence of electromagnetic fields (EMFs) encountered in a normal housing environment produces harmful currents in the human body.
Design: This study had a test–retest design, with duration of 5–15 min per participant.
Participants: There were 50 participants, of whom 23 were males aged 12–77 years ($M_{age} \pm$ standard deviation $= 50.5 \pm 19.5$ years) and 27 were females aged 13–79 years ($M_{age} \pm$ standard deviation $= 45.9 \pm 19.0$ years).
Intervention: Each participant was instructed to touch a lamp on a desk with his or her left hand, then to move the hand away from the lamp (first one foot away and then three feet) while his/her body voltage was measured. Each participant was then grounded and instructed to repeat the same hand movements. Current was also measured during the grounded retest.
Outcome measures: The measured parameters were alternating current (AC) body voltage and current generated from contact or proximity to a lamp and other appliances situated on top of a desk.
Results: AC body voltage was reduced by an average of 58-fold when participants were grounded compared with when they were not grounded. AC currents generated during grounding were several orders of magnitude lower than the accepted minimum level of perception.
Conclusion: Normal levels of EMFs existing in houses are too low to produce harmful currents when a person is grounded.

Introduction

Multiple studies have shown that grounding the human body to Earth (also called earthing) produces health benefits. Among benefits reported are reductions in inflammation and pain, improvement in sleep and energy, a decrease in stress, a reduction in the indicators of osteoporosis, and improvements in peripheral blood flow and glucose regulation.[1–3] The impetus for doing this research project was the claim found on a number of Web sites that grounding while exposed to electromagnetic fields (EMFs) in a normal household environment may produce enough alternating current (AC) through the body to be harmful, and thus it is advisable to ground oneself only after shutting off power and/or eliminating all EMFs present in the environment.[4,5] The author could not find any research proving or disproving this claim. To test this claim, an experiment was set up to measure simultaneously the AC voltage and AC current induced in the body in a typical home-office environment in the presence of multiple electrical equipment while a person is grounded.

Materials and Methods

Participants

Fifty participants (23 male) recruited from friends and acquaintances of the author, took part in this project. All participants were Caucasians, except for two Hispanics (one male and one female). The male age range was 12–77 years ($M_{age} \pm$ standard deviation [SD] $= 50.5 \pm 19.5$ years). The average weight was 77 ± 15 kg, and the average height was 179 ± 10 cm. The average body mass index (BMI) was 23.8 ± 3.8 kg/m^2. The female age range was 13–79 years ($M_{ag}e \pm SD = 45.9 \pm 19.0$ years). The average weight was 62 ± 9 kg, and the average height was 168 ± 9 cm. The average BMI was 21.9 ± 3.3 kg/m^2. Institutional Review Board supervision was provided by the Western Institutional Review Board (WIRB; www.wirb.com).

Materials

The setup for the experiment is presented in Figure 1. On the left, a printer and scanner can be seen on a desk.

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FIG. 1. Experiment setup with from left to right: printer, scanner, cordless phone, lamp, computer monitor, and keyboard. The multimeter is the red instrument in front of the phone and lamp.

Immediately to the right of the scanner is a cordless phone, and next to it the lamp. A monitor is situated at the far right. All equipment was switched on during the testing.

The AC voltages and currents induced in the body by the EMFs generated by these pieces of equipment were measured using a commercially available multimeter (UNI-T, model UT60E). This is the red instrument with leads attached to it in the middle of the desktop (Fig. 1).

Readers should note that there is no single multimeter model. Multimeters come in a variety of measuring options. All have a socket (receptacle) called the common (usually marked COM) for the ground connection probe. The meter used for this study was equipped with three sockets (receptacles): (1) COM, (2) voltage (V), and (3) current (μAmA). Other meters may have only a COM socket, and others may allow measurement of voltage and current. During this experiment, the meter was grounded via a ground probe (black wire in Fig. 1) inserted in the COM port on one end and connected to a nearby ground port (third hole) of a wall electrical outlet on the other end.

To ground participants, a common medical electrode patch (www.axelgaard.com/Technology/UltraStim/) was used and connected via a cord to the ground port (third hole) of a nearby wall outlet.

The ground port was checked and confirmed to be working properly. This was done using a commercially available ground outlet checker (Outlet Checker USA: www.earthing.com/accessories/testers-checkers.html?___SID=U).

Procedure

Prior to the study the author explained to potential participants the nature of the experiment and the procedure, and obtained consent from those interested in being involved. They were then scheduled for individual testing. Upon arrival at the author's home, age, weight, and height were documented. For the first set of measurements, participants were not grounded.

Each participant was asked to stand in front of the home-office desk having various radiating devices on it, as shown in Figure 1. Participants could not be grounded through the floor, as the floor was made of wood that was covered with a carpet made of insulating material. The multimeter was turned on and set to measure AC voltage. One end of the voltage probe (red wire in Fig. 1) was inserted into the multimeter voltage socket. The other end was connected to a copper cylinder (on the right of the multimeter in Fig. 1).

Each participant was asked to grasp the copper cylinder with the right hand so that a body voltage measurement could be made. The person was then asked to grasp the lit lamp on the metal part above the on/off knob with the left hand and hold that position until a stable reading was attained on the multimeter. This reading consistently took 10–12 sec to stabilize. Each participant was then instructed to move the left hand a distance of one foot from the lamp and then three feet from the lamp. At each position, body voltage was measured.

Next, each participant was grounded with an electrode patch in order to measure the induced body voltage while being grounded. The patch was placed on the left palm. One end of the grounding cord was snapped onto the patch. The other end was inserted into the ground port (third hole) of the wall outlet. The measurements were taken as described above.

The current was measured using the following procedure. The current probe wire was inserted into the current-measuring socket of the multimeter. This is the white wire attached to the left socket of the multimeter in Figure 1. The other end to the wire was attached to the patch. This allowed the participant to be grounded through the multimeter while simultaneously having his/her body current measured. The multimeter was turned on, and the dial was moved to μA. The participant then placed the left hand on the lamp, and moved it one foot away and then three feet away while current measurements were taken.

Results

Averages (Avg) and *SD* of AC voltage and current measurements are presented in Table 1 for when each participant's left hand was touching the lamp, at one foot from the lamp, and at three feet from the lamp. Body resistance was calculated by

Table 1. Voltage and Current Measurements

	Voltage measurements (V)						*Current measurements (μA)*			*Resistance Calculations (kΩ)*		
	Ungrounded			*Grounded*								
	T	*1′*	*3′*	*T*	*1′*	*3′*	*T*	*1′*	*3′*	*T*	*1′*	*3′*
Avg	6.87	1.22	1.01	0.151	0.019	0.016	2.62	0.78	0.54	76.07	27.10	30.88
SD	1.68	0.22	0.19	0.044	0.006	0.006	1.48	0.20	0.12	33.21	9.26	11.18

T, touching the lamp; 1′, one foot from the lamp; 3′, three feet from the lamp; Avg, average; *SD*, standard deviation.

TABLE 2. RATIO OF UNGROUNDED TO GROUNDED VOLTAGES

Voltage (V) ungrounded/grounded		
T	*1′*	*3′*
45.5	62.8	64.8

dividing voltage measurements by current measurements for grounded participants according to Ohm's law.

Because the voltage values used to calculate each of the averages (Avg row) presented in the ''Voltage Measurements'' section of Table 1 did not follow a normal distribution, Wilcoxon's signed-rank test was used to determine the statistical significance of the difference in voltage averages between grounded and ungrounded conditions for each distance from the lamp.

Discussion

As can be seen from Table 1, the average body voltage dropped dramatically when participants were grounded. These voltage drops were statistically significant ($p < 0.001$). Table 2 presents the ratio of ungrounded to grounded voltages for the three cases: touching the lamp, one foot from the lamp, and three feet from the lamp. The voltages decreased by a factor of 58 on average. These results are comparable to the results obtained by Applewhite.[6]

The average current measured from grounded participants was the largest when the participants touched the lamp, as expected. Even when touching the lamp, the measured average current was very low: 2.62 μA. The Electrical Safety manual of the United States National Institute for Occupational Safety and Health states that a current <1 mA is generally not perceptible.[7] The minimum accepted current level for perception is thus 382 times bigger than the current generated when touching the lamp and 1852 times bigger than the current measured at three feet from the lamp. These results imply that the possibility of a person being harmed by these induced AC currents is virtually zero.

It is to be noted that the resistances obtained by dividing the voltage by the current when participants are grounded give resistance values within the expected range of normal dry skin resistances (1000–100,000 Ω),[8] giving further validity to the presented measurement values.

Conclusion

This study indicates clearly that normal levels of electromagnetic fields existing in a home-office setting are too low to produce harmful currents when a person is grounded.

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Author Disclosure Statement

R. Brown was an independent contractor hired by Earth FX for this project. Earth FX and earthing.com played no role in the study design, data analysis, interpretation, or writing of the manuscript. The author reports no other conflicts of interest.

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