Childhood Leukemia and Electrical Appliances

To the Editor:

Hatch *et al.*[1] have presented data on the association between childhood acute lymphoblastic leukemia and the use of electrical appliances during pregnancy and childhood. A positive association was reported for video games connected to a television. The researchers were concerned with the effects of the alternating magnetic field, but I suggest that the direct electric field from the screens may be more important. Children using video games are likely to be close to the screen and Nielsen *et al.*[2] have estimated a field value of 244 kVm^{-1} on the tip of the nose of a person sitting 0.4 meters from a video display.

Henshaw *et al.*[3] have advanced the hypothesis that the enhanced deposition, by alternating electric fields, of radioactive radon daughters may account for the associations that have been reported between childhood leukemia and the proximity of power lines. Miles *et al.*[4] stated recently that measurements around a high voltage line do not support this hypothesis and in any case, the structure of a house will screen the inside from external electric fields. Henshaw's laboratory data, however, show that, for the same root mean square magnitudes, a direct current field is some 40 times more effective at depositing radon daughters than an alternating current one[5] and, in addition, the 244 kVm^{-1} estimated by Nielsen *et al.*[2] is considerably greater than the maximum field of 36 kVm^{-1} used in Henshaw *et al.*'s experiments.

Children sitting or standing close to television screens are in elevated direct current electric fields of a polarity that drives positively charged radon daughters and other pollutants toward the face. The UK National Radiological Protection Board[6] has concluded that radon progeny aerosols are unlikely to provoke skin reactions on users of visual display terminals, but I suggest that the data of Hatch *et al.* may repay further consideration in the light of the direct current electric field exposure.

David E. Jeffers
The National Grid Company plc
Brookmead
Guildford Business Park
Guildford
Surrey GU2 5XQ
United Kingdom
(address for correspondence)

References

1. Hatch EE, Linet MS, Kleinerman RA, Tarone RB, Severson RK, Hartsock CT, Haines C, Kaune WT, Friedman D, Robison LL, Wacholder S. Association between childhood acute lymphoblastic leukaemia and use of electrical appliances during pregnancy and childhood. Epidemiology 1998;9:234–245.
2. Nielson NF and Schneider T. Particle deposition onto a human head. Influence of electrostatic and wind fields. Bioelectromagnetics 1998;19:246–258.
3. Henshaw DI, Ross AN, Fews AP and Preece AW. Enhanced deposition of radon daughter nuclei in the vicinity of power frequency electromagnetic fields. Int J Radiat Biol 1996;69:25–38.
4. Miles JCH and Algar RA. Measurement of radon decay product concentration under power lines: Radiat Prot Dosim 1997;74:193–194.
5. Jeffers DE. High-voltage overhead lines and radon daughter deposition (Comment). Int J Radiat Biol 1998;73:5:579–582.
6. National Radiological Protection Board. Health Effects Related to the Use of Visual Display Units: Documents of the NRPB, Volume 4, No. 2. Chilton, UK: National Radiological Protection Board, 1994.

The Authors Reply:

We thank Jeffers for suggesting that static electric fields and their interaction with radon progeny may be responsible for the association we observed between the use of video games connected to television sets and childhood acute lymphoblastic leukemia (ALL).[1] Although we cannot entirely rule this out as a possible explanation for our results, we believe it to be unlikely. Like magnetic fields, the strength of a static electric field decreases very rapidly (by a factor of $1/r^2$ to $1/r^3$) with distance from the picture tube of a television set.[2] Seventy-five per cent of the mothers in our study reported that their children usually sat more than 4 feet (122 cm) away from the television screen while watching television or playing video games. In a recent study, we measured the distance between the screen and closest body part of 36 children using video games, and found that on average they sat 152 cm (range 90–229) from the television screen.[3] Thus, even if static electric fields from televisions are as high as the 244 kV/m value at 40 cm quoted by Jeffers, most children sit much farther than that from the television while playing video games and would thus be exposed to very low static fields.

We know of no published measurement of static electric fields produced by television sets, but Harvey[4] has published the results of such measurements for 54 video display terminals, which are similar to television sets in design and function. Harvey reported that the average electrostatic field 30 cm from the viewing screens of these units was 2.8 kV/m (range −3 kV/m to 15 kV/m). Interestingly, 19 of the 54 units had negative static electric fields, which would carry positively charged radon ions away from the faces of the users rather than to them, as suggested by Jeffers. These data, coupled with the strong decline of field strength that occurs as distance from the units increases, suggest that the static electric fields produced by television sets will be substantially lower than the 244 kV/m Jeffers quotes in his letter and probably indistinguishable from normal background levels.

We found little relation between average radon levels in the home and the risk of ALL in our study (OR = 1.30, 95% CI = 0.9–1.8; OR = 0.91, 95% CI = 0.6–1.3; and OR = 1.44, 95% CI = 0.9–2.3 for 37–73 Bqm^{-3}, 74–147 Bqm^{-3}, and ≥148 Bqm^{-3} compared with the reference level of <37 Bqm^{-3}).[5] Because Jeffers suggested that radon levels are higher close to television sets, we reanalyzed our data on the reported use of video games and televisions, and distance from the television within levels of radon measured in the home. We find no evidence that the associations between ALL and video game use, time spent watching television, or distance from the television can be explained by radon exposure (Tables 1 and 2). For distance from the television, the strongest trend is found among those children living in homes with the lowest

TABLE 1. Odds Ratios* and 95% CI by Patterns of Television and Video Game Use during the Reference Year by Categories of Time-Weighted Radon Concentration

	Radon Concentration, Bqm^{-3}							
	<37		37–73		74–147		≥148	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Video games connected to television†								
Never used	1.00		1.00		1.00		1.00	
<Weekly or <10 min/d	1.98	1.03–3.83	1.26	0.60–2.62	0.82	0.31–2.12	1.30	0.39–4.37
10–59 min/d	0.82	0.37–1.81	1.49	0.67–3.28	0.58	0.18–1.81		
60 min/d	1.65	0.83–3.30	1.43	0.60–3.41	1.95	0.53–7.17	3.68	0.66–20.4
Television: time spent watching during reference year‡								
<2 hours/d	1.00		1.00		1.00		1.00	
2 and <4 hours/d	1.13	0.54–2.34	0.90	0.40–2.06	0.87	0.34–2.23	0.84	0.26–2.71
4 and <6 hours/d	1.52	0.71–3.23	1.04	0.44–2.49	1.29	0.48–3.51	5.21	0.83–32.7
6 hours/d	2.91	1.32–6.42	2.36	0.90–6.22	1.49	0.51–4.33	8.07	1.34–48.8
Distance from television§								
>6 feet	1.00		1.00		1.00		1.00	
4 and 6 feet	1.29	0.74–2.24	1.65	0.78–3.49	2.31	0.80–6.66	1.17	0.42–3.26
<4 feet	1.72	0.92–3.21	1.29	0.55–3.03	2.23	0.70–7.15	1.76	0.48–6.42

* Odds ratios adjusted for sex and age at reference date.
† Subjects 3 years of age and older at the reference date.
‡ Adjusted for distance from the television.
§ Adjusted for time spent watching television.

levels of radon, which is the opposite of what would be expected under Jeffers' hypothesis.

Additional evidence against a causal association between television, video games, and ALL is the lack of change in incidence rates for childhood leukemia since the Second National Cancer Survey in 1947–1950,[6] despite the explosive growth in both the use of video games and in the amount of time children spend watching television. Given the dramatic change in the prevalence of exposure over time, one would have to argue that a strong protective factor had increased in prevalence during the same time period for there to be no effect of television watching or video game use on ALL incidence rates.

We believe that differential misclassification from report bias is a more likely explanation for the association of video games and televisions with ALL. Mothers had difficulty recalling their children's activity patterns before the diagnosis. A case's mother, whose child has been affected by a life-threatening illness, may exaggerate the child's television or video game exposure as part of a search for an explanation of the family's misfortune, while a control's mother may answer without having thought much about it. It is likely that children with ALL become more sedentary after diagnosis, and case mothers' reports of activities such as watching television and playing video games before diagnosis reflect to some extent current habits rather than behavior before diagnosis. We are currently planning a methodologic study to examine changes over time in maternal recall after a diagnosis of ALL and other childhood cancers to shed some light on this question.

TABLE 2. Distribution* of Cases and Controls by Time-Weighted Radon (Rn) Concentration and Patterns of Television and Video Game Use during the Reference Year

	Radon Concentration, Bqm^{-3}									
	<37		37–73		74–147		≥148		Total	
	Cases	Controls	Cases	Controls	Cases	Controls	Cases	Controls	Cases	Controls
Video games connected to television										
Never used	64	70	55	47	32	30	18	16	169	163
<Weekly or <10 min/d	34	21	24	19	11	14	10	7	79	61
10–59 min/d	14	20	23	15	6	10	9	0	52	45
60 min/d	29	20	21	13	8	4	8	2	66	39
Total	141	131	123	94	57	58	45	25	366	308
Television: Time spent watching during reference year										
<2 hours/d	19	32	23	16	12	14	8	7	62	69
2 and <4 hours/d	65	76	57	49	29	38	23	27	174	190
4 and <6 hours/d	54	48	40	31	24	21	11	2	129	102
6 hours/d	61	27	39	13	18	14	16	2	134	56
Total	199	183	159	109	83	87	58	38	499	417
Distance from television										
>6 feet	32	40	18	18	7	13	12	10	69	81
4 and 6 feet	101	94	103	62	54	52	31	22	289	230
<4 feet	63	40	33	26	22	21	15	6	133	93
Total	196	174	154	106	83	86	58	38	491	404

* Numbers of cases and controls vary owing to missing values.

Elizabeth E. Hatch
Jay H. Lubin
Robert E. Tarone
Sholom Wacholder
Ruth A. Kleinerman
Martha S. Linet

Division of Cancer Epidemiology and Genetics
National Cancer Institute
6130 Executive Boulevard EPN 408
Rockville, MD 20892-7362
(address correspondence to: Elizabeth E. Hatch)

William T. Kaune

EM Factors
640 Jadwin Avenue, Suite F
Richland, WA 99352

References

1. Hatch EE, Linet MS, Kleinerman RA, Tarone RE, Severson RK, Hartsock CT, Haines C, Kaune WT, Friedman D, Robison LL, Wacholder S. Association between childhood acute lymphoblastic leukemia and use of electrical appliances during pregnancy and childhood. Epidemiology 1998;9:234–245.
2. Harvey SM. Electric field exposure of persons using video display terminals. Bioelectromagnetics 1984;5:1–12.
3. Kaune WT, Miller MC, Linet MS, Hatch EE, Kleinerman RA, Wacholder S, Mohr AH, Tarone RE. Children's exposure to magnetic fields produced by television sets used for viewing programs and playing video games. (Submitted).
4. Harvey SM. Survey of electric and magnetic fields at Ontario Hydro V06 work station. Report No. 84–74-K, Ontario Hydro Research Division, Pickering, Ontario, Canada.
5. Lubin JH, Linet MS, Boice JD, Buckley J, Conrath SM, Hatch EE, Kleinerman RA, Tarone RE, Wacholder S, Robison LL. Case-control study of childhood acute lymphoblastic leukemia and residential radon exposure. J Natl Cancer Inst 1998;90:294–300.
6. Linet MS, Devesa SS. Descriptive epidemiology of childhood leukemia. Br J Cancer 1991;63:424–429.

Adjustment for Age at First Birth in Etiologic Studies of Breast Cancer Involving Exposures That May Affect Age at First Birth

To the Editor:

In a recent letter, Sharpe[1] argues that in our study of the association between induced abortion and breast cancer risk,[2] we should not have adjusted for age at first birth in certain situations. Here we show that without adjustment for age at first birth, we would get a confounded result.

Sharpe suggests that women with a history of induced abortion on average might have a first birth at a later age. Therefore, he claims, age at first birth is an intermediate variable in the analysis of the association between induced abortion and breast cancer risk in women with an induced abortion before the first birth. Nevertheless, the scientific question in our analysis was whether there is a direct *biological* relation between having an induced abortion and development of breast cancer. For age at first birth to be an intermediate variable in such an analysis, it should be related to a step in the potential causal biological pathway between induced abortion and breast cancer. That women with a history of induced abortion tend to have a first birth at a later age can hardly constitute such a biological effect. Instead it reflects different social behavior among these women. Similarly, an association between, for example, higher education and breast cancer risk would reflect a behavioral association between education and having a late age at first birth and not a direct biological causal pathway from education to breast cancer. In other words, lack of adjustment for age at first birth would introduce a spurious effect that would reflect the well-known biological effect of late age at first birth rather than a potential biological effect of induced abortion.

Nevertheless, we can assure Sharpe that adjustment for age at first birth was of no importance for the conclusion in our analysis. Overall we find no effect of induced abortion 1.00 (0.94–1.06) when adjusting for age, calendar period, parity, and age at first birth.[2] Dropping adjustment for age at first birth we get 1.00 (0.94–1.06), and adjusting for age only we get 0.99 (0.93–1.04).[3] Therefore, even when we do not adjust for the behavioral effect through late age at first birth, there is no effect of induced abortion on the risk of breast cancer.

A related misunderstanding is to argue that induced abortion enhances the risk of breast cancer because primigravida women having an induced abortion by definition postpone the first birth that they would otherwise have had. Nevertheless, this effect is again a biological effect of the first birth and not of the induced abortion. What we show in our study is that after an induced abortion the women will have the same risk of breast cancer as before the pregnancy, that is, there is no biological effect of induced abortion.

Mads Melbye
Jan Wohlfahrt
Per Kragh Andersen

Danish Epidemiology Science Center
Statens Serum Institut
Department of Epidemiology Research
Artillerivej 5, DK-2300
Copenhagen, Denmark
(address correspondence to: Mads Melbye)

References

1. Sharpe C. Adjustment for age at first birth in etiologic studies of breast cancer involving exposures that may affect age at first birth (letter). Epidemiology 1999;10:95.
2. Melbye M, Wohlfahrt J, Olsen JH, Frisch M, Westergaard T, Helweg-Larsen K, Andersen PK. Induced abortion and the risk of breast cancer. N Engl J Med 1997;336:81–85.
3. Melbye M, Wohlfahrt J, Andersen PK. Induced abortion and the risk of breast cancer (letter). N Engl J Med 1997;336:1835.

Testosterone Level as a Potential Selection Bias for Semen Donors in Assessing Population Fertility

To the Editor:

Studies assessing time trends in male fertility have relied on the results of analyses of donor-collected semen samples as an outcome measure.[1,2] The characteristics of men who become semen donors are not well understood, however. A number of studies have addressed psychosocial characteristics and motivation in semen donors, highlighting the roles of altruism and financial incentives.[3,4] But semen quality and sperm production are regulated by a variety of hormones, and the possible physiological and hormonal differences that may exist between men in the general population and men who donate semen have not been explored. Testosterone, for example, in addition to being essential for normal sperm production, is also an important determinant of be-