RF Energy Exposure and Risk of Autism Spectrum Disorders

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ABSTRACT

Importance In 2012, studies found that fathers are four times more likely than mothers to transmit tiny, spontaneous mutations to their children with autism spectrum disorders (ASDs). This introduces the possibility a genotoxic exposure is affecting male reproductive DNA, causing large increases in ASDs.

Objective To study ASD prevalence in offspring in areas with greater percentages of wireless mobile phone subscribers close in time to conception events.

Design, Setting, and Participants Retrospective cohort study of children aged 8 years (n = 293 582) selected from the Centers for Disease Control and Prevention's Autism and Developmental Disabilities Monitoring (ADDM) Network. Mobile wireless phone subscriber rates were used to create subcohorts of children who lived in ADDM sites in areas of maximum differentiation of subscriber rates. The design goal was to compare ASD imprints in areas with greatest divergence in wireless subscriber percentages.

Main Outcome Measure ASD prevalence

Results The pooled group from regions with the highest percentages of wireless subscribers (high-3) had ASD prevalence of 13.3 per 1000 (95% CI, 12.4-14.1). The pooled group from regions with the lowest percentages of wireless subscribers had ASD prevalence of 7.4 per 1000 (95% CI, 6.9-8.0). The relative risk of ASD diagnosis in the high-3 was 1.78 (95% CI, 1.61-1.96; $P < 0.0001$).

Conclusion and Relevance The pool of ADDM sites with a modestly higher, 1.09 (95% CI, 1.08-1.09) mobile wireless subscriber percentage in 2000 had significantly higher relative risk, 1.78 (95% CI, 1.61-1.96; $P < 0.0001$), of children aged 8 diagnosed with an ASD in 2008. This implies a possible association of mobile wireless phone use close in time to conception events with elevated ASD risk in offspring.

The Centers for Disease Control and Prevention (CDC) estimates the prevalence of ASDs increased 78% during 2002 to 2008.[1] Behavioral interventions for an ASD-diagnosed child cost up to $60,000 per year and nonmedical costs of special education are around $13,000 per year.[2] The cost to families extends into financial problems for communities, states, and the nation.

In 2012, researchers turned up a new clue to the workings of a possible environmental factor in ASDs[3]: fathers were four times more likely than mothers to transmit tiny, spontaneous mutations to their children with the disorders.[4,5,6,7] More information is needed on what may be acting as a genotoxic agent on the reproductive DNA of fathers.

We conducted a retrospective cohort study on children aged 8 using CDC's Autism and Developmental Disabilities Monitoring (ADDM) Network 2008 report.[8] The primary objective was to study the association between higher percentages of mobile wireless phone use close in time to conception events and risk of ASD in offspring.

METHODS

A cohort was selected: children aged 8, based on county-level National Center for Health Statistics postcensal estimates[8], from the 10 ADDM sites that reported during surveillance years 2002, 2006, and 2008. This site selection encompassed the mature core of the ADDM Network with the longest reporting history. ADDM cohort records provided ASD statistics for 10 sites in 10 states: AL, AR, CO, GA, MD, MO, NC, PA, SC, and WI. ADDM sites were selected by a competitive objective review process based on ability to conduct active ASD records-based surveillance.[9]

Two subcohorts were selected. Subcohort A, the high-3, was a pooling of postcensal estimates of children aged 8 living in the counties under surveillance[8] in the three ADDM sites in states with the highest percentage of wireless subscribers in 2000. Subcohort B, the low-3, was a pooling of postcensal estimates of children aged 8 living in the counties under surveillance[8] in the three ADDM sites in states with the lowest percentage of wireless subscribers in 2000.

ADDM Criteria

The ADDM Network is a group of programs funded by CDC to determine the number of people with ASDs in multiple communities in the U.S.[1] ADDM sites collect data using the same methods, modeled after CDC's Metropolitan Atlanta Developmental Disabilities Surveillance Program.[1]

ADDM focuses on children aged 8 because a baseline CDC study demonstrated this is the age of identified peak ASD prevalence.[9] Criteria is based on the American Psychiatric Association's Diagnostic and Statistical Manual-IV, Text Revision for: Autistic Disorder; Pervasive Developmental Disorder–Not Otherwise Specified (PDD-NOS, including Atypical Autism); or Asperger Disorder.[9]

Wireless Subscriber Rates

United States Census 2000[10] population data was used to determine population counts for the states encompassing the 10 sites in our cohort. Mobile wireless subscribers in 2000 in the 10 states encompassing the 10 ADDM sites were identified, as reported to the Federal Communications Commission (FCC) by wireless carriers on FCC Form 477.[11] Mobile subscriber rates in 2000 were calculated for states that had sites in our ADDM cohort. There were no duplicate subscriber percentages among the 10 states.

Imprints

To understand if mobile wireless radio frequency (RF) energy may be affecting reproductive DNA, exposure during the time period prior to conception events is of interest. In the case of our cohort of children aged 8 in 2008, this time period is described by wireless subscribers in 1999 and 2000. Although there is immigration and emigration of children with ASD in states during 8 years, it is reasonable that among populations in a pool of states, these movements balance to intangibility. If wireless mobile phone use close to conception events has a measurable association with ASDs in offspring, an imprint will be made on a state's population based upon the percentage of mobile wireless subscribers in the state.

Conceptions and Wireless Subscribers

The FCC's August 2001 Trends in Telephone Service report[11], which provides revised June 2000 mobile wireless subscriber numbers was selected as the most reliable source of wireless subscribers by state. This selection allowed for the most exact fit with U.S. Census 2000 population data. Also, Nextel made a major reclassification of systems to consolidated metropolitan statistical areas between the December 1999 and June 2000 FCC reporting periods[11], making the December 1999 report incongruous with subsequent reporting.

Exact correlation of mobile wireless phone use with precise time before conception was not emphasized. State populations were pooled to achieve large numbers of people. It is assumed that out of large numbers of mobile wireless subscribers, few began subscribing only immediately after a conception event. General trending among a large population was considered a logical method to look for ASD imprints showing possible association with RF energy exposure.

Statistical Analyses

The building blocks for comparative calculation were: total population in subcohort A, total number diagnosed with ASD in subcohort A, total population in subcohort B, and total number diagnosed with ASD in subcohort B. These data points were used to calculate the relative risk of ASD between subcohorts. A *P* value of less than .05 was considered significant. A Z-test outcome statistic outside the range of ±1.96 was considered significant. All calculations were made using standard mathematical models.

RESULTS

A total of 293 582 children aged 8 were included in the study cohort. The cohort was selected from the 2008 ADDM report[8], and included 10 sites that reported since 2002. Subcohorts of children aged 8 were selected based upon child residency in the top-three and bottom-three states by percentage of wireless subscribers in 2000. Six sites from the cohort comprised two subcohorts. Subcohort A, the high-3, was a pooling (n = 71 660) of postcensal estimates of children aged 8 years living in the counties under surveillance[8] in the three

ADDM sites in states with the highest percentage of wireless subscribers in 2000. Subcohort B, the low-3, was a pooling (n = 94 786) of postcensal estimates of children aged 8 years living in the counties under surveillance[8] in the three ADDM sites in states with the lowest percentage of wireless subscribers in 2000. Descriptive characteristics of wireless subscribers in states with cohort populations in 2000 are presented in Table 1. Mobile wireless subscriber counts are listed as reported to the FCC in 2000.[11] The population per state is from the twenty-second United States Census (Census 2000)[10], conducted by the Census Bureau. Mobile subscribers as a percentage of the state population are calculated with a 95% confidence interval. Table 2 presents ASD prevalence in our cohort as reported by ADDM for 2008.[8] The sites are presented in the same order as the states in Table 1. Colorado's smaller population sample is due to results from one county with access to both health and education records being considered by CDC to represent ASD prevalence in Colorado more completely.[8]

Table 3 shows descriptive characteristics of the subcohorts, low-3 and high-3. The low-3 mobile subscriber rate was 27.7% (95% CI, 27.5%-27.9%); the high-3 subscriber rate was 36.3% (95% CI, 36.0%-36.5%). The low-3 ASD prevalence per 1000 children aged 8 was 7.4 (95% CI, 6.9-8.0), and the high-3 was 13.3 (95% CI, 12.4-14.1). The relative risk of ASD diagnosis was 1.78 (95% CI, 1.61-1.96; $P < 0.0001$) for children in the high-3. The Z-test outcome statistic was 11.62.

COMMENT

De novo point mutations leading to ASD are overwhelmingly paternal in origin (4:1 bias).[4,5,6,7] Children that inherit such glitches have an elevated risk of autism by 5 to 20 fold.[5] The 78% increase in autism between 2002 and 2008[1] is connected to DNA mutations in men's reproductive cells.

Predominant theories for the high rate of de novo point mutations in male reproductive DNA include high sperm turnover in men[4], and the older age of fathers these days.[4,7] However, National Health Statistics (NHS) Reports show no change between 2002 and 2010 in the percentage of men and women that had a biological child.[12.] Moreover, the mean age of fathers at first birth remained at 25 during 2002 to 2010.[12] Fertility

measures among men and women aged 15–44 based on the 2006–2010 National Survey of Family Growth were generally similar to those reported based on the 2002 National Survey of Family Growth.[12] NHS statistics do not support the idea that an increase in the age of fathers has caused a 78% increase in autism between 2002 and 2008.[1]

One exposure men have increasingly shared since 1995 is mobile wireless phone RF energy. Studies show RF energy from mobile phones is genotoxic to men's reproductive cells. RF energy in the frequency of mobile phones stimulates DNA fragmentation in human spermatozoa.[13.] RF energy increases the percentage of sperm cells with abnormal morphology.[14.] RF energy may lead to behavioral and structural changes in the male germ cell.[15.] RF energy exposure correlates positively with slow progressive motile sperm.[16.] RF energy has a significant genotoxic effect on epididymal spermatozoa.[17.] There are implications for the safety of extensive mobile phone use by males of reproductive age, potentially affecting both their fertility and the health and wellbeing of their offspring.[13]

The findings in this study suggest that wireless mobile phone use near the time of conception events is associated with an increased risk of ASD in offspring. This association suggests a bridge between existing research that shows RF energy is genotoxic to male reproductive DNA[13,14,15,16,17] and existing research that shows fathers are four times more likely than mothers to transmit tiny, spontaneous mutations to their children with autism spectrum disorders.[4,5,6,7]

Based on Coulomb's inverse-square law, the comparative force of RF energy on reproductive DNA between the sexes may be calculated. When carried in a front trouser pocket, a mobile phone is in the order of 20 centimeters in distance from female reproductive DNA, but only 5 centimeters in distance from male reproductive DNA. By Coulomb's law, as distance is increased by a factor of four, electrostatic force is decreased by a factor of 16. In our trouser pocket scenario, male reproductive DNA receives 16 times greater force of RF radiation than female reproductive DNA.

Additional studies inadvertently support a bridge between RF energy damage to male reproductive DNA and fathers passing mutations leading to 80% of autism. A cohort study based on the Amsterdam Born Children and their Development study achieved results that suggest maternal mobile phone use during pregnancy does not increase the odds of behavior problems in their children.[18] Women who use mobile phones during pregnancy are likely to have used them before conception events. That their offspring do not seem to run elevated risk of behavior problems is congruous with the hypothesis that 20 centimeters of barrier space protects women's reproductive DNA from RF energy damage. This seems consistent with data showing mothers pass only 20% of genetic mutations leading to ASDs.[4,5,6,7]

A study of over 26 600 men in France revealed a significant and continuous decrease in sperm concentration of 32.2% (CI 95% 26.3–36.3) from 1989 to 2005, along with a significant decrease in the percentage of sperm with morphologically normal forms.[19] Because the period from 1989 to 2005 correlates with the time that men in developed countries such as France began carrying mobile wireless phones in large numbers, this may be a sign of RF energy damage to men's reproductive DNA.

There are important limitations of our study. The first is an autism poverty paradox, which is that autism prevalence is positively correlated with socioeconomic status[20] but regions with substantially low socioeconomic status where mobile phones are uncommon do not keep records of either mobile phone subscribers or ASD diagnoses. Wealthy countries have comparatively excellent records but approach near universal exposure to certain elements such as RF energy. There is no U.S. state since 1993 where mobile phones have not been carried. Mobile phone use increased almost linearly between 1992 and 2003.[21] The clearest view of RF energy impact in wealthy countries is to compare areas with modestly differing wireless subscriber rates—in the case of this study, a differential percentage in single digits.

An additional limitation to this study is that wireless subscriber data reported by carriers is undercounted by a small amount because carriers with less than 10 000 lines in a state were not required to file FCC Form 477 prior to September 2005.[22]

Another limitation of this study is that ADDM sites had different reporting mechanisms. Some sites reported ASD diagnoses via “health only source types” and others by “education and health source type”. ASD prevalence was significantly higher in ADDM sites with access to education sources compared with sites that relied only on health sources for case identification.[8] This may have influenced calculated ASD prevalence rates.

Further studies are needed to identify relative risk of ASD in offspring among fathers who did not carry mobile phones prior to conception. Further studies are needed to identify relative risk of ASD in offspring among fathers with increased usage of mobile phones prior to conception.

This study supports an association between mobile phone use close to conception events and ASDs in offspring. Because fathers are passing 80% of DNA mutations leading to ASDs[4,5,6,7], these findings support a bridge to existing research showing RF energy is genotoxic to male reproductive DNA.[12,13,14,15,16,17] This study suggests RF energy from mobile phones may not be genotoxic to female reproductive DNA because of a protective distance barrier as described by Coulomb’s inverse-square law.

ACKNOWLEDGEMENT

Author The author had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of data analysis.

Conflict of Interest Disclosure The author has completed the ICMJE Form for Disclosure of Potential Conflicts of Interest. There are no conflicts of interest.

Funding/Support There was no funding for this study.

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TABLES

Table 1. Wireless Subscriber (WI) Percentages in 2000, by State

U.S. State[a]	Census 2000 Population[b]	WIs in 2000[c]	WI Percentage of Population, 95% CI[d]
Wisconsin	5,363,675	1,342,908	25.0 (25.0-25.0)
Alabama	4,447,100	1,253,084	28.2 (28.2-28.2)
South Carolina	4,012,012	1,236,338	30.8 (30.8-30.9)
Pennsylvania	12,281,054	3,850,372	31.4 (31.4-31.4)
Arizona	5,130,632	1,624,668	31.7 (31.7-31.7)
Georgia	8,186,453	2,687,238	32.8 (32.8-32.8)
Missouri	5,595,211	1,848,775	33.0 (33.0-33.0)
North Carolina	8,049,313	2,730,178	33.9 (33.9-33.9)
Maryland	5,296,486	2,013,058	38.0 (38.0-38.0)
Colorado	4,301,261	1,654,989	38.5 (38.5-38.6)

[a]Reporting states are listed in order, low to high, of wireless subscriber percentage as a percentage of population.
[b]U.S. Department of Commerce, U.S. Census Bureau. Census 2000. Consistent with the January 1999 U.S. Supreme Court ruling (Department of Commerce v. House of Representatives, 525 U.S. 316, 119 S. Ct. 765 (1999)), the resident population counts used in the apportionment population counts do not reflect the use of statistical sampling to correct for overcounting or undercounting.
[c]Revised data for June 2000 reported in Trends in Telephone Service: August 2001 by Federal Communications Commission.
[d]confidence interval (CI)

Table 2. Estimated Prevalence of Autism Spectrum Disorders (ASDs) per 1,000 Children Aged 8 Years, per ADDM 2008[a]

ADDM Site[b]	Number of Children Aged 8	Number with ASDs	ASD Prevalence, 95% CI[c]
Wisconsin	34,451	267	7.8 (6.9-8.7)
Alabama	36,566	174	4.8 (4.1-5.5)
South Carolina	23,769	264	11.1 (9.8-12.5)
Pennsylvania	18,440	245	13.3 (11.7-15.1)
Arizona	32,601	507	15.6 (14.3-17.0)
Georgia	50,427	601	11.9 (11.0-12.9)
Missouri	25,668	357	13.9 (12.5-15.4)
North Carolina	36,913	525	14.2 (13.1-15.5)
Maryland	27,022	336	12.4 (11.2-13.8)
Colorado	7,725	91	11.8 (9.6-14.5)

[a]Prevalence of Autism Spectrum Disorders – Autism and Developmental Disabilities Monitoring Network, 14 sites, United States, 2008 reported in Morbidity and Mortality Weekly Report 2012
[b]Listed in same order as states in Table 1.
[c]confidence interval (CI)

Table 3. Autism Spectrum Disorder (ASD) Prevalence in 2008 per 1,000 Children Aged 8 Years per ADDM 2008[a], Pooled by Sites in Regions with Lowest and Highest Wireless Subscriber (WI) Percentages in 2000

Pool	Census 2000[d] State Pop.[e]	WIs in 2000[f]	WI Percentage of Pop.[e], 95% CI[g,h]	Number of Children Aged 8	Number with ASDs	ASD Prevalence, 95% CI[g]
Low-3 Pool[b]	13,822,787	3,832,330	27.7 (27.5-27.9)	94,786	705	7.4 (6.9-8.0)
High-3 Pool[c]	17,647,060	6,398,225	36.3 (36.0-36.5)	71,660	952	13.3 (12.4-14.1)

[a]Prevalence of Autism Spectrum Disorders - Autism and Developmental Disabilities Monitoring Network, 14 sites, United States, 2008 reported in Morbidity and Mortality Weekly Report 2012

[b]Wisconsin, Alabama, South Carolina

[c]North Carolina, Maryland, Colorado

[d]U.S. Department of Commerce, U.S. Census Bureau. Census 2000.

[e]Population (Pop.)

[f]Revised data for June 2000 reported in Trends in Telephone Service: August 2001 by Federal Communications Commission.

[g]confidence interval (CI)

[h]confidence interval (CI) calculated on population of parents of cohort

REFERENCES

1. Centers for Disease Control and Prevention. Community report from the Autism Developmental Disabilities Monitoring (ADDM) Network: Prevalence of autism spectrum disorders (ASDs) among multiple areas of the United States in 2008. Available from: http://www.cdc.gov/ncbddd/autism/documents/ADDM-2012-Community-Report.pdf

2. Amendah D, Grosse SD, Peacock G, Mandell DS. The economic costs of autism: A review. In: Amaral D, Geschwind D, Dawson G (Eds.), Autism spectrum disorders (pp. 1347-1360). Oxford: Oxford University Press. June 23, 2011

3. National Institute of Mental Health. Spontaneous gene glitches linked to autism risk with older dads: Non-inherited mutations spotlight role of environment. Jules Asher. NIMH Press Office. April 4, 2012. Available from: http://www.nih.gov/news/health/apr2012/nimh-04.htm

4. O'Roak BJ, Vives L, Girirajan S, et al. Sporadic autism exomes reveal a highly interconnected protein network of de novo mutations. *Nature*. 2012;485:246-250. Available from: http://www.nature.com/nature/journal/v485/n7397/full/nature10989.html

5. Sanders SJ, Murtha MT, Gupta AR, et al. De novo mutations revealed by whole-exome sequencing are strongly associated with autism. *Nature.* 2012;485:237-241. Available from: http://www.nature.com/nature/journal/v485/n7397/full/nature10945.html

6. Neale BM, Kou Y, Liu L, et al. Patterns and rates of exonic de novo mutations in autism spectrum disorders. *Nature*. 2012;485:242-245. Available from: http://www.nature.com/nature/journal/v485/n7397/full/nature11011.html

7. Kong A, Frigge ML, Masson G, et al. Rate of de novo mutations and the importance of father's age to disease risk. *Nature*. 2012;488:471-475. Available from: http://www.nature.com/nature/journal/v488/n7412/full/nature11396.html

8. Centers for Disease Control and Prevention. Prevalence of autism spectrum disorders — Autism and Developmental Disabilities Monitoring Network, 14 Sites, United States, 2008. *Morbidity and Mortality Weekly Report*. 2012;61(No.SS-3). http://www.cdc.gov/mmwr/pdf/ss/ss6103.pdf

9. Centers for Disease Control and Prevention. Prevalence of autism spectrum disorders — Autism and Developmental Disabilities Monitoring Network, United States, 2006. *Morbidity and Mortality Weekly Report*. 2009;58(No.SS-10). Available from: http://www.cdc.gov/mmwr/pdf/ss/ss5810.pdf

10. U.S. Department of Commerce, U.S. Census Bureau. Census 2000. Resident population of the 50 States, the District of Columbia, and Puerto Rico: April 1, 2000 (Census 2000) and April 1, 1990 (1990 Census) and numeric and percent change for 1990 to 2000, detailed tables, Table 5. Available from: http://www.census.gov/population/www/cen2000/maps/files/tab05.pdf

11. Federal Communications Commission. Industry Analysis Division, Common Carrier Bureau. Trends in telephone service. August 2001. Available from: http://transition.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/IAD/trend801.pdf

12. Martinez G, Daniels K, Chandra A. Fertility of men and women aged 15–44 years in the United States: National survey of family growth, 2006–2010. National Health Statistics Reports. 2012;51. Available from: http://www.cdc.gov/nchs/data/nhsr/nhsr051.pdf

13. De Iuliis GN, Newey RJ, King BV, Aitken RJ. Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLoS ONE*;4(7): e6446. Available from: http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0006446

14. Wdowiak A, Wdowiak L, Wiktor H. Evaluation of the effect of using mobile phones on male fertility. *Annals of Agricultural and Environmental Medicine*. 2007;14:169-172. Available from: http://www.aaem.pl/pdf/14169.pdf

15. Erogul O, Oztas E, Yildirim I, et al. Effects of electromagnetic radiation from a cellular phone on human sperm motility: An in vitro study. *Archives of Medical Research*. 2006;37(7):840-843. Available from: http://drwdowin.com/CellPhonesAndSpermMotility.pdf

16. Fejes I, Zavaczki Z, Szollosi J, et al. Is there a relationship between cell phone use and semen quality? *Systems Biology in Reproductive Medicine*. 2005;51(5):385-393. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16087567

17. Aitken RJ, Bennetts LE, Sawyer D, et al. Impact of radio frequency electromagnetic radiation on DNA integrity in the male germline. *International Journal of Andrology*. 2005;28(3):171-179. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15910543

18. Guxens M, Eijsden M, Vermeulen R, et al. Maternal cell phone and cordless phone use during pregnancy and behaviour problems in 5-year-old children. *Journal of Epidemiology and Community Health*. 2013 [Epub ahead of print]. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23386674

19. Rolland M, Le Moal J, Wagner V, et al. Decline in semen concentration and morphology in a sample of 26 609 men close to general population between 1989 and 2005 in France. *Human Reproduction*. 2012;0(0):1-9. Available from: http://humrep.oxfordjournals.org/content/early/2012/12/02/humrep.des415.full.pdf

20. Durkin MS, Maenner MJ, Meaney FJ, et al. Socioeconomic inequality in the prevalence of autism spectrum disorder: Evidence from a U.S. cross-sectional study. *PLoS ONE*. 2010;5(7):e11551. Available from: http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0011551

21. Federal Communications Commission. Industry Analysis Division, Common Carrier Bureau. Trends in telephone service. May 2004. Available from: http://transition.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/IAD/trend504.pdf

22. Federal Communications Commission. Industry Analysis Division, Common Carrier Bureau. Trends in telephone service. February 2007. Available from: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-270407A1.pdf