Lithium in Drinking Water and the Incidences of Crimes, Suicides, and Arrests Related to Drug Addictions

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Received August 3, 1989; Accepted October 20, 1989

ABSTRACT

Using data for 27 Texas counties from 1978–1987, it is shown that the incidence rates of suicide, homicide, and rape are significantly higher in counties whose drinking water supplies contain little or no lithium than in counties with water lithium levels ranging from 70–170 μg/L; the differences remain statistically significant ($p < 0.01$) after corrections for population density. The corresponding associations with the incidence rates of robbery, burglary, and theft were statistically significant with $p < 0.05$. These results suggest that lithium has moderating effects on suicidal and violent criminal behavior at levels that may be encountered in municipal water supplies. Comparisons of drinking water lithium levels, in the respective Texas counties, with the incidences of arrests for possession of opium, cocaine, and their derivatives (morphine, heroin, and codeine) from 1981–1986 also produced statistically significant inverse associations, whereas no significant or consistent associations were observed with

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the reported arrest rates for possession of marijuana, driving under the influence of alcohol, and drunkenness. These results suggest that lithium at low dosage levels has a generally beneficial effect on human behavior, which may be associated with the functions of lithium as a nutritionally-essential trace element. Subject to confirmation by controlled experiments with high-risk populations, increasing the human lithium intakes by supplementation, or the lithiation of drinking water is suggested as a possible means of crime, suicide, and drug-dependency reduction at the individual and community level.

Index Entries: Lithium; crime; violent behavior; suicide; drug use; cocaine; heroin; marijuana; morphine; drunkenness; drunk driving; lithium supplementation; drinking water, lithiation of; crime prevention; suicide prevention; drug dependency, reduction of.

INTRODUCTION

Lithium is a trace element that appears to be essential for higher animals (*1,2*). However, although the element is widely used at pharmacological dosages in the treatment of various mental disorders (*3*), its effects at normal nutritional levels have not yet received much attention.

Dawson, Moore and McGanity (*4*) previously compared the lithium concentrations in the regional drinking water supplies with the incidence of admissions and readmissions for psychoses, neuroses, and personality disorders in 27 Texas state mental hospitals and observed a statistically significant inverse relationship. The same authors subsequently showed that the homicide rates were also inversely correlated with the lithium levels in the drinking water and the urinary excretion of lithium by normal residents in their respective areas (*5*). The associations remained significant after consideration of possible confounding variables, such as population density, the distance to the nearest state hospitals, and rainfall. Although rainfall was positively correlated with the county rates of first mental hospital admission, as well as with homicide rates, rainfall was also found to be inversely correlated with the lithium levels in the drinking water and the urinary excretion of lithium by healthy subjects, demonstrating a dilution effect of rainfall on the water supplies. With the suicide rates, the association with water lithium levels was inverse, but did not reach statistical significance. Since incidence data for only two years, 1967–1969, were used in these studies, we decided to reinvestigate the relationships between drinking water lithium with homicide and suicide rates for 10 years, using data from 1978–1987, and extend the study to other crimes (rapes, robberies, thefts, burglaries, assault, motor vehicle thefts, and the total crime rate). As the addiction to narcotics may be regarded as a self-destructive trait, which thus could depend on the same environmental influences as suicide, comparisons were also made between the drinking water lithium levels in the respective counties and the incidences of arrests for possession of opium, cocaine, and their derivatives (morphine, heroin, and codeine), and possession of marijuana, as well as arrests for drunk driving and drunkenness, using data from 1981–1986.

MATERIALS AND METHODS

The 27 Texas counties of refs. (*4,5*) were classified into High, Medium, and Low groups according to the lithium content in the municipal water supplies, with populations of 1986 (in thousand) given in parentheses and the average per capita annual income for 1981:

Group A, High (mean Li content 123 ± 25 μg Li/L, range 70–160 μg/L): El Paso (579), Lampasas (14), Dimmit (11), Cameron (259), Duval (13), and Hidalgo (377). Average income: $6842 ± 1082;

Group B, Medium (mean Li content, 35 ± 15 μg/L, range 13–60 μg/L): Washington (27), Ector (122), Frio (17), Haskell (7), Jones (17), Nueces (297), and San Patricio (59). Average income: $9,717 ± 2051;

Group C, Low (mean Li content, 5 ± 4 μg/L, range 0–12 μg/L): Dallas (1,874), Tarrant (1,131), Harris (2,782), Bexar (1,187), Wichita (129), Limestone (25), McLennan (191), Travis (559), Anderson (45), Hardin (40), Newton (13), Galveston (209), Guadelupe (60), and Uvalde (24). Average income was $9,895 ± 2243; and

Group D. Because Group C contains four counties with large cities, where higher crime rates may be expected on the basis of population density alone, the analyses were also conducted with the counties of Group C, excluding Dallas, Tarrant, Harris, and Bexar. In this group, the average income was $9,032 ± 1888.

County crime incidences were taken from the Annual Crime Reports issued by the US Department of Justice for the years 1978–1987(*6*) and suicide mortalities from annual US vital statistics handbooks issued by the Department of Health and Human Services (*7*). Crime rates were calculated by dividing the combined crime incidences by the total populations per group, as calculated from data from 1978–1987, obtained from the Texas Department of Health (*8*).

The levels of statistical significance between the means were determined by Student's *t*-test, with Bonferroni correction for multiple comparisons or, where a time-trend was apparent, by paired *t*-tests on an IBM-PC, using the biostatistics program developed by S. A. Glantz (*9*).

RESULTS

Table 1 shows that the mean annual incidence rates of homicide, suicide, rape, robbery, burglary, theft, and total crime during 1978–1987 were lower in group A (high-Li counties) than group C (all low-Li

Table 1
Mean Crime and Suicide Rates in 27 Texas Counties from 1978–1987[a] in Relation to Drinking Water Lithium Levels

Category	Group A, High Lithium (70–160 μg Li/L)	Group B, Medium Lithium (15–60 μg Li/L)	Group C, Low Lithium (0–12 μg Li/L), all counties	Group D, Low Lithium (0–10 μg Li/L), low pop. counties
Homicide	7.5 ± 1.8	13.4 ± 3.7	16.9 ± 2.1	12.7 ± 2.4
Suicide	8.7 ± 0.85	14.8 ± 2.9	14.2 ± 1.3	13.9 ± 1.2
Rape	28.3 ± 5.3	47.6 ± 6.4	58.8 ± 6.6	50.9 ± 6.4
Robbery	110.3 ± 9.5	123.3 ± 21.9	264.6 ± 39.9	150.5 ± 16.6
Burglary	1537 ± 194	1970 ± 243	2135 ± 216	1847 ± 220
Theft	3076 ± 447	3986 ± 582	4033 ± 577	3827 ± 511
MV Theft	435 ± 36	427 ± 83	668 ± 114	365 ± 32
Assault	357 ± 104	270 ± 69	298 ± 38	283 ± 31
Total crime	5533 ± 763	6838 ± 790	8097 ± 1022	6805 ± 838

t-Values and Levels of Statistical Significance

	A–B	A–C	A–D	B–C	B–D	C–D	Remarks
Homicide	5.07*	8.07***	4.47**	3.01*	NS	3.61*	
Suicide	7.84***	7.14**	6.70**	NS	NS	NS	***$p < 0.005$.
Rape	5.13*	8.11***	6.00**	3.94*	NS	NS	
Robbery	NS	13.98***	3.64*	12.80***	NS	10.34***	**$p < 0.01$.
Burglary	4.42*	6.10***	3.16*	NS	NS	2.94*	*$p < 0.05$.
Theft	3.82*	4.02*	3.16*	NS	NS	NS	NS = Not Significant
MV Theft	NS	6.99**	NS	7.23**	NS	9.09***	
Assault	NS	NS	NS	NS	NS	NS	
Total crime	3.39*	6.67**	3.31*	3.28*	NS	3.36*	

[a]Standard deviations, statistical significance of differences, as calculated by Students *t*-test; *p* values with Bonferroni correction for multiple comparisons. Degrees of freedom: between groups, 3; within groups, 36. Numbers based on per 100,000 population.

Table 2
Homicide Rates[a] in 27 Counties of Texas, Classified in Four Categories, According to the Lithium Content in the Municipal Drinking Water Supplies

Year	Group A, High Li (70–160 μg/L)	Group B, Medium Li (13-60 μg/L)	Group C, Low Li (0–12 μg/L), all counties	Group D, Low Li (0–10 μg Li/L), low pop. counties
1978	5.8	12.0	19.3	18.5
1979	5.5	8.2	17.9	12.9
1980	10.6	14.7	18.8	13.1
1981	7.9	21.4	18.9	12.0
1982	8.3	17.2	18.3	13.5
1983	7.9	14.6	17.0	13.7
1984	5.6	12.7	15.8	11.8
1985	6.4	12.3	14.3	9.9
1986	8.2	12.4	15.6	11.2
1987	6.3	8.8	13.4	10.2
$\bar{x} \pm SD$	7.5 ± 1.8	13.4 ± 3.7	16.9 ± 2.1	12.7 ± 2.4

[a]Per 100,000 population.

counties); all differences except those for assault were statistically significant ($p < 0.01$).

Significant differences in the incidence rates of these crimes were also observed between high- and low-Li counties with similar population densities, as evidenced by the comparisons between the high-Li group A and low-Li Group D, in which the counties with the four largest cities (Dallas, Houston, Forth Worth, and San Antonio) are excluded. The differences were most significant with the incidences of homicide, rape, and suicide ($p < 0.01$). For example, Table 2 shows that the homicide rates during the decade studied were consistently lower (by 30–50%) in the high- than the medium- or low-Li counties. The incidences of robbery, burglary, theft, and the total crime rates were also lower in the high-Li counties, but the respective differences involving assault were statistically insignificant. The associations with motor vehicle (MV) theft was significant only between Groups A–C, but not between groups A–D, primarily reflecting the higher incidence of MV theft in the large cities of Group C.

In medium-Li Group B, the suicide and crime rates were, in general, intermediate between those in Groups A and C; but with group D, the corresponding associations were all not significant. This suggests that the lithium levels in group B were possibly below threshold and that the respective counties, arbitrarily assigned to group B, could also have been placed into the low-Li Groups C or D.

Table 3 indicates that the arrests for possession of drugs (cocaine, morphine, heroin, codeine, opium, and so on) in the years 1981–1986 were consistently lower in Group A than in Groups B–D. The incidence of arrests for drug possession increased during the period of observation,

Table 3
Mean Arrest Rates (from 1981–1986[a]) in 27 Texas Counties for Possession of Opium, Cocaine, and Their Derivatives (Morphine, Heroin, and Codeine), Possession of Marijuana, Driving Under the Influence of Alcohol, and for Drunkenness, in Relation to Drinking Water Lithium Levels

Category	Group A, High Lithium (70-160 μg Li/L)	Group B, Medium Lithium (13-60 μg Li/L)	Group C, Low Lithium (0–12 μg Li/L), all counties	Group D, Low Lithium (0–10 μg Li/L), low pop. counties
Possession of opium, cocaine, and so on	18.4 ± 6.0	28.1 ± 13.9	53.7 ± 24.7	61.8 ± 22.4
Possession of marijuana and so on	180.0 ± 27	147.8 ± 27.3	201 ± 24	197.0 ± 31
Driving under the influence of alcohol	758 ± 153	875 ± 136	635 ± 100	837 ± 114
Drunkenness	1661 ± 68	2535 ± 500	1580 ± 244	1678 ± 143

t-Values and Levels of Statistical Significance[b]

	A–B	A–C	A–D	B–C	B–D	C–D	Remarks
Possession of opium and so on	2.25*	4.18**	6.14***	5.14***	4.92***		***$p < 0.005$.
Possession of marijuana and so on	NS	NS	NS	2.75*	2.39*	NS	**$p < 0.01$.
Driving under the influence	NS	NS	NS	i	NS	2.63*	*$p < 0.05$.
Drunkenness	5.23***	NS	NS	i	i	NS	i = opposite trend. NS = Not significant.

[a]Per 100,000 pop.
[b]Calculated by paired t test.

more strongly in Groups B–D than in Group A. In contrast, the incidence rates of arrests for possession of marijuana, driving under the influence, and drunkenness revealed either no consistent or only weak associations with drinking water lithium. No significant or consistent associations between the incidence rates of the crimes and socioeconomic parameters, such as annual income, were observed.

DISCUSSION

The present results suggest a beneficial effect of lithium at nutritional levels, especially on suicidal and violent criminal behavior, and on serious drug addiction. These could be related to the roles of lithium as an essential trace element. No significant or consistent inverse associations of drinking water lithium with the arrest rates for the more common crimes of theft, motor vehicle theft, assault, marijuana possession, drunk driving, or drunkenness were observed. The incidence rates of these crimes were very similar in all four groups, except that arrest rates for drunkenness were higher, for some reason, in Group B. Otherwise, the basic societal factors determining crime and its enforcement in the four groups were very similar.

Lithium as the carbonate at therapeutic dosage (300 mg/d) has previously been used to control episodic outbreaks of rage among prisoners (*10,11*) and in the management of drug abusers (*12*). Animal experiments have demonstrated that lithium suppresses the cocaine-induced supersensitivity, as well as the supersensitivity induced by haloperidol, the kindling phenomenon following the chronic application of pentylenetetrazole, a central nervous system stimulant, and head-twitching in response to the administration of mescaline (*13*). Furthermore, lithium has been found to decrease distractability by irrelevant stimuli and produce a dose-independent improvement of selective attention to stimuli that provide detailed information about the environment. It prevents behavioral alterations owing to social isolation, lowers aggressivity owing to confinement in isolated environments, and causes a normalization of spontaneous motor activity (*14*). The majority of these effects may be associated with the dampening of phosphoinositide-mediated neurotransmission, which was also suggested to explain the normalizing effects of lithium in treating both mania and depression (*15*).

Since human lithium intakes are extremely variable, the potential for chronically suboptimal intakes exists at the individual and collective level. Thus, although the diet typically provides from 1–2.5 mg Li/d, only 25 percent of this amount is bioavailable (*16*). Since the lithium content of foods is highly variable, some populations could have very low dietary lithium intakes. In other regions, substantial additional amounts of lithium may be obtained from the drinking water. In the high-Li counties of Texas, for example, adults consuming drinking water with a Li content of 100 μg/L would obtain an extra 200 μg of fully bioavailable Li per day.

Schroeder and Nason (*17*) previously reported 800 μg as the 24 h urinary lithium output of human adults. Although similar urinary Li outputs are reached by adults in the high-Li counties (*5*), only ½ to ⅓ as much is excreted by residents in the low-Li areas, where the total lithium intakes reach only 200 μg/d or less. On the other hand, some subjects may reach lithium intakes of 2 mg/d or more through the regular consumption of certain brands of mineral water (*18*). Since hair appears to be a reliable indicator of lithium status (*19*), it is interesting to note that lower hair lithium levels have been observed in violent offenders than nonviolent controls (*20*).

Because of the large variations of human dietary lithium intakes, controlled experiments with prisoners, drug addicts, or other subjects at risk of exhibiting aggressive or self-destructive behavior should now be conducted with lithium at dosage levels of about 2 mg/d, either by the addition of lithium to the drinking water or the administration of lithium in the form of supplements. It is possible that lithium at this low dosage, after sufficiently long periods of administration, will have a normalizing effect on behavior and additional beneficial effects in subjects that, as such, are not clinically mentally ill. In some subjects, higher dosages may be necessary; the absolute lithium requirements may also be dependent on the total salt intake, the frequency and extent of physical exertion, variations of the clearance rate, and other physiological parameters.

Subject to confirmation by controlled studies, low-dose lithium supplementation could become an effective method of violence reduction in institutionalized subjects. In the general population, the lithiation of the communal drinking water supplies could provide a simple, safe, and economical means of reducing the incidences of violent crimes, suicides, and the use of narcotic drugs.

ACKNOWLEDGMENT

Support for this work by the Wacker Foundation, Dallas, Texas, is gratefully acknowledged.

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