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DISEASES of the Nervous System

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The Mathematical Relationship of Drinking Water Lithium and Rainfall to Mental Hospital Admission

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Introduction

Since 1949, lithium, in the form of lithium carbonate, has been used with increasing frequency as an effective sedative in the treatment of both acute and chronic manic-depressive psychosis.[1-3] The results of the clinical studies reported by Cade in 1949 led him to suggest a specific role for lithium in the management and prevention of psychogenic excitement. He felt that this was consistent with the concept that lithium is an essential element for man. Along with others, however, he felt that the nature and limited frequency of such illnesses precluded well controlled human studies. Even in a large mental hospital, many years would be required to accumulate sufficient data to prove statistically significant.[1-4]

In 1968, Gershon reviewed the scattered reports in the literature and added his own studies which indicated beneficial effects of lithium in schizophrenia, other associated behavior disorders and epilepsy as well as in women with premenstrual tension and depression syndrome.[4] Kerry and Owen reported lithium's effectiveness in stabilizing the fluctuating volumes of total body water associated with the mood changes of the manic-depressive.[3] Baer et al. demonstrated with isotope tracers that this is accomplished within the tissue cell by the displacement of sodium and potassium which results in saluresis, kaluresis, and increase in urine volume.[5] Foulks reported that ingested lithium is evenly distributed throughout the body and slowly accumulated intracellularly against a concentration gradient of sodium and potassium.[6]

Lithium has been found widely distributed in the drinking water of major cities in the United States.[7] The metal is present in small, but measureable quantities. Blachly reported that inhabitants of cities with high drinking water lithium levels have a statistically significantly ($P \leq .001$) lower mortality from arteriosclerotic heart disease.[8] However, the correlation between drinking water lithium levels and mental illness has not been reported previously.

This study reports the levels of lithium in the drinking water of numerous Texas communities and the relationship between these levels and both the incidence and frequency of mental illness admissions. The data were gathered as a part of the 1968 National Nutritional Survey in Texas. We have considered the possibility that other environmental features such as altitude, temperature, and/or rainfall may have an effect on the frequency of mental hospital admission and drinking water lithium concentration. These environmental factors have also been examined.

Methods and Materials

During the summer and fall of 1968, the Texas Nutrition Survey was undertaken in municipalities within 26 randomly selected counties in the State of Texas. As a part of the survey procedure, and for the purposes of this paper, multiple samplings (between 2 and 5) of the local tap water were measured for lithium content. Water samplings from

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Galveston were also included because of their availability, even though the city of Galveston was not in the survey protocol. Total lithium content was measured in each sample of tap water using a Perkin-Elmer Spectrophotometer, Model 303, equipped with a Perkin-Elmer Recorder Readout. The concentrations were expressed as μg/liter.

State mental hospital admission data were obtained from the Texas Department of Mental Health and Mental Retardation. The data were in the form of annual reports summarizing the annual admission records to the State Mental Hospitals located at Houston, Harlingen, Austin, Big Spring, Kerrville, Rusk, San Antonio, Terrell, and Wichita Falls. To compare admission data over the same period of time that the municipal water samples were obtained during the nutrition survey, two years of mental health annual reports were used—September 1, 1967 to August 31, 1971.[9,10] These reports itemized all patients admitted to the nine mental hospitals according to their county of residence as well as by type of admission—first, readmissions, and all admission levels. The all admission category was further sub-divided into major diagnostic categories: psychotic, neurotic, personality, alcoholic and drug abuse, mentally deficient, transient, etc. Only the diagnostic groups: psychotic (acute, chronic, unspecified), neurotic, and personality (specific symptoms, transferral behavior, etc.) occurred in sufficient numbers to warrant inclusion in this study.

The absolute number of admissions and the three diagnostic categories were converted into rates of admission and diagnosis. Each absolute value was divided by the county population as calculated for the appropriate time period based on the 1960[11] and 1970 census.[12] All rates were converted to a common population *base rate* per 100,000 of population.

The lithium levels were clustered into four groups which would provide about equal distribution of the population of measured values at consistent increments. The four lithium groups were: $\leq$11.0, 11.0-29.9, 30.0-69.9, and $\geq$70.0 μg/liter. The admission and diagnosis rates, elevation, median temperature, and average annual rainfall of the respective counties were examined within these four levels of lithium water content.

Comparison of the group means did not reveal any mathematical relationship between either county elevation or median annual temperature and any of the other parameters. However, variations in mean rainfall fluctuated with changes in lithium water content, the admission rates, and diagnostic categories by county of residence. Consequently, all of these parameters were then regrouped on the basis of the county's mean annual rainfall at 5 inch intervals from $\leq$20 to $\geq$35 inches of annual rainfall. This grouping provided five distinct groups of lithium water content to be compared to three types of admissions and the three diagnostic categories.

The Students' "t" test was used to determine the statistical significance of the difference in mean values: (1) types of admission and diagnostic categories versus the low (11.0 μg/liter) and high ($\geq$70.0 μg/liter) lithium level and, (2) level of lithium water content, rates of admission, and diagnostic categories versus the lower ($\leq$25 inches) and high ($\geq$35.0 inches) annual rainfall communities.

The data from Lampasas county have been excluded from some of the computations and analyses for several reasons. Their municipal water supply was not the exclusive source of drinking water as many inhabitants obtained their water from private wells. The municipal water treatment facilities of Lampases were being enlarged and the water source altered during 1968-69 (The period covered in this study.)

Results

The concentration of lithium in 27 municipal drinking waters of Texas ranged from zero to 160 μg/liter. Negligible variation was observed in the multiple measurements of any of the individual water samples. In Table I the 27 counties are listed that were involved in the study with the following identification characteristics: (1) principle municipalities contributing the water samples, (2) the river basin that provided the surface water for each of the communities' water supply, (3) the elevation of each municipality, (4) the median annual temperature, as well as (5) the average annual rainfall of each county. These factors have been grouped according to their representative lithium levels. Since most of their drinking waters contained lower concentrations of lithium, the inclusive ranges of higher lithium level groups were expanded progressively to develop adequate groups of near equal size. In this manner, there resulted four major groups which provide interesting differences for comparative and correlative analyses.

Water supply from the Trinity River Basin appeared only in the cluster of communities whose drinking waters contained less than 11.0 μg/liter of lithium. In contrast, the Rio Grande River Basin provided the drinking water source for four of the six communi-

TABLE I: MUNICIPAL WATER LITHIUM LEVELS IN 27 TEXAS COMMUNITIES, RIVER BASINS, AND RESPECTIVE COUNTY ELEVATIONS, AVERAGE ANNUAL RAINFALL, AND MEDIAN TEMPERATURE.

County	Municipality	River Basin	Elevation*	Annual Rainfall*	Median Temperature*	Lithium
Lithium: <11.0 ug/liter						
Dallas	Dallas	Trinity	512	35	65.5	0
Tarrant	Fort Worth	Trinity	670	31	65.5	0
Wichita	Wichita Falls	Red	946	28	64.0	0
Limestone	Groesbeck	Brazos	477	38	66.5	0
McLennan	Waco	Brazos	427	32	66.5	4
Travis	Austin	Colorado	550	33	68.0	10
Anderson	Palestine	Trinity	510	41	65.5	6
Hardin	Silsbee	Neches	79	53	67.5	8
Newton	Newton	Sabine	190	57	66.5	2
Galveston	Galveston	Coastal	20	42	68.0	8
Guadalupe	Seguin	Guadalupe	520	31	69.0	0
Uvalde	Uvalde	Nueces	913	23	68.0	10
		means:	485	37	66.7	4
Lithium: 11.0 - 29.9 ug/liter						
Ector	Odessa	Colorado	2890	14	63.5	25
Washington	Brenham	Brazos	350	39	69.0	15
Harris	Houston	San Jacinto	55	46	69.0	12
Bexar	San Antonio	Guadalupe	701	28	68.0	11
Frio	Pearsal	Nueces	646	23	70.0	22
		means:	928	30	67.9	17
Lithium: 30.0 - 69.9 ug/liter						
Haskell	Haskell	Brazos	1553	23	63.5	51
Jones	Anson	Brazos	1750	23	63.5	38
Nueces	Corpus Christi	Nueces	35	28	70.5	33
San Patricio	Aransas Pass	Nueces	20	31	70.5	60
		means:	838	26	67.0	46
Lithium: ≥70.0 ug/liter						
El Paso	El Paso	Rio Grande	3762	8	63.0	130
Lampasas	Lampasas	Brazos	1025	31	66.0	102
Dimmit	Carrizo Springs	Nueces	602	21	70.5	79
Cameron	Harlingen	Rio Grande	36	26	73.0	112
Duval	San Diego	Rio Grande	312	23	72.0	160
Hidalgo	Weslaco	Rio Grande	70	19	73.0	139
		means:	968	21	69.6	122

* From the Texas Almanac, Dallas, Texas, 1970 Ed.

ties whose lithium contents were above 70 μg/liter.

Variations in altitude and differences in median annual temperature did not vary significantly with the lithium levels. Only a few degrees Fahrenheit separated the highest lithium group's median temperature from that of the lowest group. At the extremes of median temperature the highest (69.9 F.) was associated with the greatest mean lithium level (122 μg/liter), while the lowest median temperature (66.7 F.) was associated with the least mean lithium level (4 μg/liter).

The mean annual rainfall of the four groups varied inversely with the mean lithium levels (Table I). The grouping of municipal lithium levels according to annual rainfall at 5 inch increments is illustrated in Figure I. Only three of the communities studied had an annual rainfall of less than 20 inches. The mean lithium content of their drinking waters was 98 μg/liter. With each additional 5 inches of rainfall per year, a progressive decrease in the mean lithium level was observed. Eight of the 27 municipalities had an annual rainfall in excess of 35 inches, with a mean lithium content of their water supply of 6 μg/liter.

Figure 2 shows the geographic zones of average annual rainfall across the state. The sites included in the Texas Nutrition Survey are dotted. Comparison of the measured lithium levels of the water supplies with the rainfall suggests an inverse relationship of lithium level with mean annual rainfall. High levels of rainfall and low water levels of lithium occurred predominately in the eastern section of the state. Progressively lower levels of rainfall and higher levels of lithium were found among the survey sites as one moved westward.

The admission rates to state mental hospital by county of residence have been grouped according to water lithium level in Table II. Included are (1) rate of total admissions, regardless of diagnosis; (2) first admissions, as well as (3) readmissions for continuing treatment. The calculated population of each county is included for reference. From these data, there was an inverse relationship between drinking water lithium level and each of the following: (1) the total admission rates (Figure 3); (2) mean of overall admission rate which declined from 37.0 to 16.3 per 100,000 (3) mean incidence of first admissions which dropped from 18.2 to 10.5 per 100,000 and (4) the mean rate of readmission which also dropped from 20.5 to 7.8 per 100,000. These changes were stepwise and proportional to the variations in drinking water levels of lithium.

The rates of admission by diagnostic criteria have been examined within the same

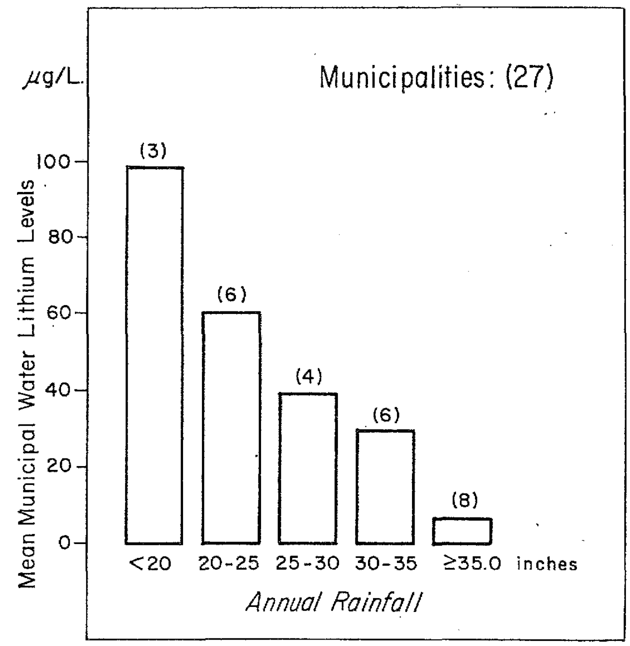

Fig. 1: Variation of Municipal Drinking Water Levels with Annual Rainfall (from the 1970 Texas Almanac, Dallas, Texas).

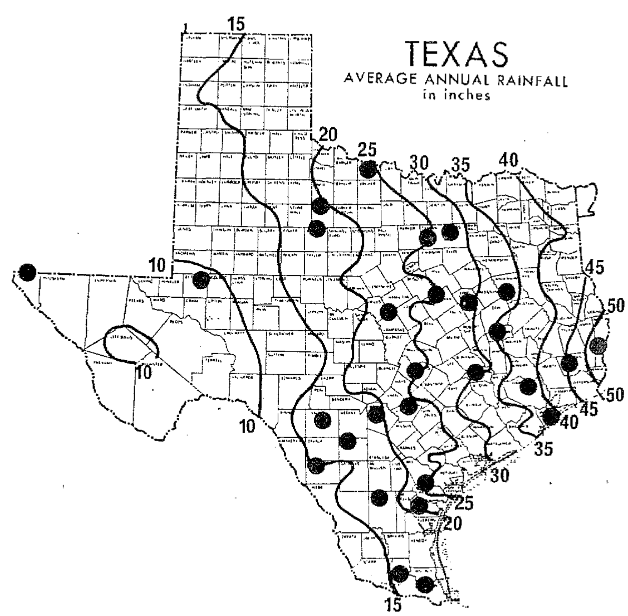

Fig. 2: Geographic distribution of the sites included in the Texas Nutrition Survey and the average annual rainfall.[13]

increments in lithium levels as the overall admission rates, and are itemized in Table III. The means of all three diagnostic categories demonstrated identical progressive decreases as the water lithium levels increased. These increases occurred within individual categories as well as when the means of all categories were combined (Figure 3).

The analyses of the "t" test for the significance of the occurrence of admission and the three diagnostic categories are given in Table IV. All mean differences examined in each of

TABLE II: THE CALCULATED STATE MENTAL HOSPITAL ADMISSION RATES PER COUNTY OF RESIDENCE ARBITRARILY GROUPED ACCORDING TO MUNICIPAL WATER LITHIUM LEVELS, FROM SEPT. 1, 1967 TO SEPT. 1, 1969.

Lithium Level/County	Populations*	Admissions Per 100,000 Population		
	Thousands	All	First	Secondary
<11.0 ug/l.:				
Dallas	1,234	31.5	17.9	13.6
Tarrant	677	11.3	5.1	6.2
Wichita	119	46.8	19.8	27.0
Limestone	18	33.4	21.7	11.7
McLennan	144	27.8	14.5	13.3
Travis	274	73.9	30.0	43.9
Anderson	28	65.8	31.5	34.3
Hardin	28	32.5	17.5	15.0
Newton	10	36.2	23.8	12.4
Galveston	161	22.4	10.4	12.0
Guadalupe	32	23.1	9.4	13.7
Uvalde	16	39.0	16.8	22.2
means:	229	37.0	18.2	20.5
11.0 - 29.9 ug/l.:				
Ector	90	35.2	18.5	16.5
Washington	18	27.0	14.0	13.0
Harris	1,627	28.2	13.0	15.2
Bexar	834	29.0	13.9	15.1
Frio	16	22.4	12.1	10.3
means:	516	28.4	14.3	14.0
30.0 - 69.9 ug/l.:				
Haskell	8	28.9	22.0	6.9
Jones	16	33.3	17.3	16.0
Nueces	231	17.1	7.6	9.5
San Patricio	44	26.3	15.1	11.2
means:	75	26.4	15.5	10.9
≥70.0 ug/l.:				
El Paso	341	11.0	4.9	6.1
Lampasas*	9	51.3	24.0	27.3
Dimmit	9	13.1	7.6	5.5
Cameron	140	31.5	15.9	15.6
Duval	11	12.9	7.7	5.2
Hidalgo	175	12.8	6.3	6.5
means:	114	16.3	10.5	7.8

8 Calculated from 1960 and 1970 Census Reports.

the categories were statistically significant with a P value of ⩽0.01 except for the difference in the incidence of first admissions versus the lithium water level which was at the ⩽.05 P value.

The group mean and range by admission occurrence and diagnostic category within the average annual rainfall appear in Table V and VI. The tendency of these parameters to vary inversely in proportion to the annual rainfall is illustrated by the bar graph in Figure 4. The incremental increase in the rates of admission occurrence and the diagnoses for psychosis, neurosis, and personality disorders is nearly linear and comparable to the alterations observed with increasing lithium levels

TABLE III: STATE MENTAL HOSPITAL DIAGNOSTIC RATES PER 100,000 FOR EACH COUNTY FROM SEPT. 1, 1967 TO SEPT. 1, 1969 ARBITRARILY GROUPED ACCORDING TO MUNICIPAL WATER LITHIUM LEVELS.

County	Psychosis (A)	Neurosis (B)	Personality (C)	Combined (A+B+C)
Lithium: <11.0 ug/liter				
Dallas	9.6	2.4	3.9	15.9
Tarrant	2.8	0.5	1.7	5.0
Wichita	7.5	2.9	10.6	20.9
Limestone	11.1	4.5	3.3	18.9
McLennan	7.2	4.3	11.7	23.2
Travis	13.3	3.4	12.5	29.2
Anderson	13.3	4.2	8.4	25.9
Hardin	7.1	0.7	5.3	13.2
Newton	4.8	1.9	12.4	19.0
Galveston	5.6	1.2	3.1	9.9
Guadalupe	5.6	1.6	3.1	10.2
Uvalde	7.8	1.2	1.8	10.8
mean:	8.0	2.4	6.5	16.9
Lithium: 11.0 - 29.9 ug/liter				
Ector	4.8	1.9	7.4	14.1
Washington	12.4	3.2	1.6	17.3
Harris	6.5	1.8	5.2	13.4
Bexar	5.1	1.1	4.1	10.3
Frio	4.7	0.9	3.8	9.4
mean:	6.7	1.8	4.4	12.9
Lithium: 30.0 - 69.9 ug/liter				
Haskell	2.3	2.3	23.	6.9
Jones	6.7	1.2	5.5	13.5
Nueces	2.6	1.3	2.5	6.4
San Patricio	3.8	1.8	5.0	10.6
mean:	3.9	1.7	3.8	9.3
Lithium: ≥70.0 ug/liter				
El Paso	2.6	0.4	1.2	4.3
Lampasas	13.1	0.0	6.6	19.7*
Dimmit	3.3	0.0	0.0	3.3
Cameron	6.1	2.1	3.6	11.7
Duval	4.3	0.0	0.0	4.3
Hidalgo	4.4	0.2	0.7	5.3
mean:	4.1	0.5	1.1	5.8

* Not Computed in Group Means.

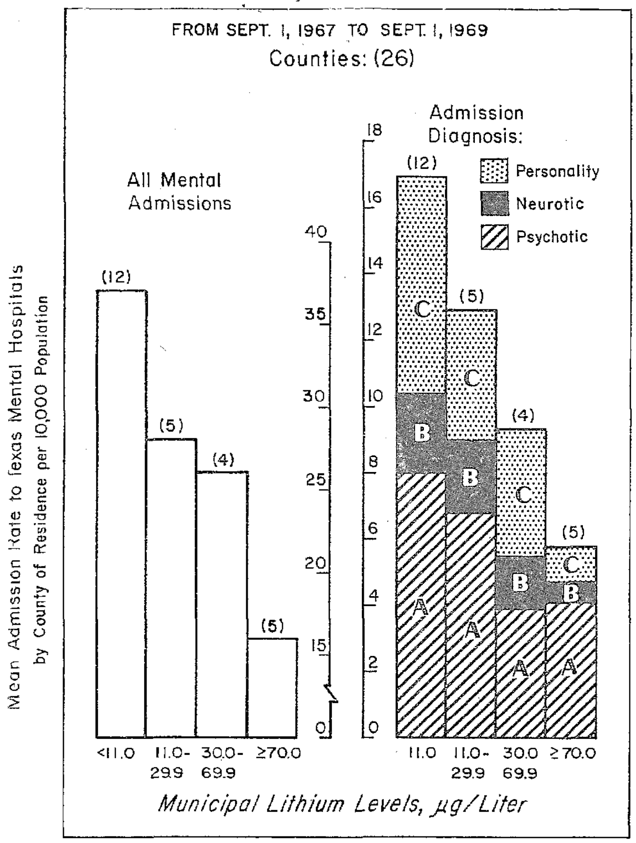

Fig. 3: Variations in the prevalence of psychotic, neurotic, and personality admission rates and all mental hospital admissions with drinking water lithium levels.

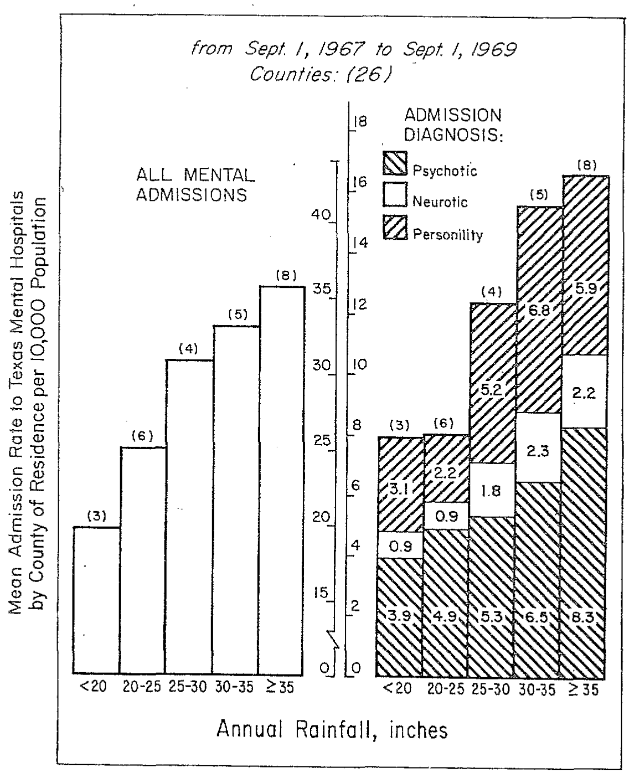

Fig. 4: Variations in the prevalence of psychotic, neurotic, and personality admission rates and all mental hospital admissions with average annual rainfall.

(Figure 3).

The results of the statistical test for significance of the difference between the mean lithium water levels and both admission and diagnostic rates below 25 inches and above 35 inches of rainfall are given in Table VII. The most significant difference was in the water lithium level (72.7 ± 20.1 versus 6.4 ± 2.1 µg/liter, $P \leq .01$). This level of probability tends to confirm the relationship between rainfall and drinking water lithium levels reported above. The prevalence of psychosis, neurosis, and personality disorder diagnoses at higher rainfall levels was statistically significant, but *with lower levels of probability.* ($P \leq .01$ or $\leq .05$)

The levels of probability of rates of all first and secondary admissions compared with the county's annual rainfall were not statistically significant.

Discussion

Approximately 36 percent of all hospital admissions for mental illness in Texas were to State Mental Hospitals. The remainder were hospitalized in private, municipal, and federal institutions. Each of these other institutions tends to serve different types of patient needs. The private institutions serve patients with sufficient funding to cover their own expenses; the municipal hospitals tend to admit mentally ill patients only briefly for diagnosis and then such patients will be transferred to another mental hospital. The federally operated hospitals usually serve and service committed patients, most of whom are male. In addition, there are numerous ambulatory patients, most of whom are male. In addition, there are numerous ambulatory patient clinics and private practice offices throughout the state which treat patients with mental illness not requiring hospitalization. Thus, it might be concluded that those patients included in this study are those who were sufficiently ill to require hospitalization, are medically indigent, and did not qualify for a federal hospital. We suspect that the proximity of the patient's residence to one of the nine state mental hospitals, as well as the bed availability in each of the state hospitals, also influenced admissions. Be that as it may, the combined capacity of all of the nine state mental hospitals is sufficient to insure that their patient load includes a broad cross section of many forms of serious mental illness, in all age groups and ethnic and cultural backgrounds. Of the 23 metropolitan areas in our state, the eleven largest were included in the Texas Nutrition Survey. These eleven plus the other fifteen counties of the study contained 65 percent of the total 1970 population of our state.

The results indicate that naturally occurring lithium in drinking water exerts a positive influence on the incidence of initial and readmission rates of State Mental Hospitals, as well as the frequence of admissions in the diagnostic categories — psychosis, neurosis, and personality problems. The municipal water lithium levels were very low (0-160 μg/liter) as compared to the initial daily therapeutic dosage of approximately 5 gm. of

TABLE IV: RESULTS OF STUDENTS "t" COMPARISON BETWEEN RATES OF ADMISSIONS AND DIAGNOSIS GROUPED BELOW 11.0 UG/L. AND ABOVE 70.0 UG/L. DRINKING WATER LITHIUM.

Rates	Water Lithium		"t"	P
	<11	≥70		
N	12	5		
Admission:				
All	37.0 ± 5.4	16.3 ± 4.3*	3.00	≤.01 y
First	18.2 ± 2.1	10.5 ± 2.4	2.48	≤.05 y
Secondary	20.5 ± 3.6	7.8 ± 2.2	3.02	≤.01 y
Diagnosis:				
Psychosis	8.0 ± 1.0	4.1 ± 0.7	3.61	≤.01 y
Neurosis	2.4 ± 0.4	0.5 ± 0.4	3.17	≤.01 y
Personality	6.5 ± 1.3	1.1 ± 0.7	3.86	≤.01 y

* Mean ± SEM, Rates per 100,000 County Population.
y Statistically Significant.

TABLE V: STATE MENTAL HOSPITAL ADMISSION RATES FROM SEPT. 1, 1967 TO SEPT. 1, 1969 GROUPED ACCORDING TO AVERAGE ANNUAL RAINFALL OF THE PATIENTS' COUNTY OF RESIDENCE.

Annual Rainfall	Counties	Admission Rates per 100,000 Population*		
Inches	N	All	First	Secondary
<20	3	19.8 (11.0-35.2)	9.9 (4.9-18.5)	9.7 (6.1-16.5)
20 - 25	6	24.9 (12.4-39.0)	13.9 (7.6-22.0)	11.0 (5.2-22.2)
25 - 30	4	31.1 (17.1-46.8)	14.3 (7.6-19.8)	16.8 (9.5-27.0)
30 - 35	5	32.5 (11.3-73.9)	14.8 (9.4-30.0)	17.7 (6.2-43.9)
≥35	8	34.6 (22.4-65.8)	18.7 (10.2-31.5)	15.9 (11.7-34.3)

* Mean (range).

lithium carbonate (520 mg. lithium). If one assumes a total water intake of two liters per day per person, this would provide not more than 320 μg of lithium per day. This would appear to be an insignificant quantity; however, any quantity of ingested lithium gradually cumulates in tissues,[6] and this could eventually exert a pharmacodynamic effect. This accumulative action is demonstrated in clinical practice as the stabilizating dosage is designed to maintain the plasma level at 0.4-0.8 mEq./liter in order to avoid the toxic manifestations of lithium.

The relationship between water lithium

TABLE VI: STATE MENTAL HOSPITAL DIAGNOSTIC RATES FROM SEPT. 1, 1967 TO SEPT. 1, 1969 GROUPED ACCORDING TO AVERAGE ANNUAL RAINFALL OF THE PATIENTS' COUNTY OF RESIDENCE.

Annual Rainfall	Counties	Diagnostic Rates per 100,000 Population*			
Inches	N	(A) Psychotic	(B) Neurotic	(C) Personality	(A+B+C)
<20	3	3.9 (2.6-4.8)	0.8 (0.2-1.9)	3.1 (0.7-7.4)	7.8 (3.5-14.1)
20-25	6	4.9 (2.3-7.8)	0.9 (0.0-2.3)	2.2 (0.0-5.5)	8.0 (2.3-15.6)
25-30	4	5.3 (2.6-7.5)	1.8 (1.1-2.9)	5.2 (2.5-10.6)	12.3 (6.2-21.0)
30-35	5	6.5 (2.8-13.3)	2.3 (0.5-4.3)	6.8 (1.7-12.5)	15.6 (5.0-30.1)
≤35	8	8.3 (4.8-13.3)	2.2 (0.7-4.2)	5.9 (1.6-12.4)	16.4 (7.1-29.9)

* Mean (range).

TABLE VII: RESULTS OF STUDENTS "t" COMPARISON BETWEEN LITHIUM LEVELS AND ADMISSION DIAGNOSTIC RATES OF THE AVERAGE ANNUAL RAINFALL GROUPS BELOW 25 INCHES AND ABOVE 35 INCHES.

Rates	Annual Rainfall		"t"	P
	<25"	≥35"		
N	9	8		
Lithium	72.7 ± 20.1	6.4 ± 2.1*	3.25	≤.01[x]
Admissions:				
All	23.2 ± 4.0	34.6 ± 5.1[y]	1.78	≤.10
First	12.6 ± 2.1	18.7 ± 2.5	1.91	≤.10
Secondary	10.6 ± 2.2	15.9 ± 2.9	1.47	≤.20
Diagnosis:				
Psychosis	4.5 ± 0.6	8.8 ± 1.2	3.14	≤.02[x]
Neurosis	0.9 ± 0.3	2.2 ± 0.5	2.17	≤.05[x]
Personality	2.5 ± 0.7	5.9 ± 1.4	2.27	≤.05[x]

* Mean ± SEM, ug/L.
y Mean ± SEM, Rates per 100,000 County Population.
x Statistically Significant

and rainfall is obviously due to physical factors. Drinking water in the Texas communities originates primarily from rainfall.[13] Only five of the drinking water samples from our study municipalities did not have measureable amounts of lithium present. Whether the variation in water lithium level is a reflection of the regional soil content, the leaching out phenomena related to rainfall amounts or some other environmental factor affecting the area can not be answered at this time. We do feel that the apparent relationship of annual rainfall to both the admission and diagnostic rates is not a primary effect. The higher level of statistical probability between lithium water levels and annual rainfall than between annual rainfall and the admission or diagnostic rates supports this hypothesis. While the relationship between therapeutic lithium and some forms of mental illness is well documented, to seriously suggest that falling rain influences the occurrence of mental illness in the populations extends the imagination beyond the stretch point. We have analyzed the drinking water samples for many other elements and have found a mathematical relationship between annual rainfall and the level of calcium, magnesium, sodium, and fluoride identical to the water lithium-rainfall correlation. These data will be reported in the near future.

Approximately 95 percent of the ingested lithium used in therapy is excreted in the urine.[4] Urinary lithium levels have been measured in the over 3000 subjects sampled in the 26 counties during the Texas Nutrition Survey. These levels are being compared to the incidence and prevalence of mental illness and the drinking water lithium levels and will be reported separately.

Conclusion

Lithium was found in measureable quantities in the drinking waters of 22 of 27 county seats throughout the state of Texas. The incidence of patient's first admissions and prevalence of readmission as well as the diagnosis of psychosis, neurosis, and personality disorder to state mental hospitals from each of the counties was inversely proportional to the lithium content of their residential drinking water. We suggest that the quantity of lithium in the local drinking water may be dependent upon either the soil content or the amount leached from the soil and then diluted by the amount of rainfall in the region. There is a trend for lower lithium levels and greater prevalence of mental hospital admissions among residents in the eastern part of the state than in any other section of our state of Texas.

This study neither confirms nor refutes Cade's theory that lithium is an essential element. However, supportive evidence is presented that naturally occurring lithium exerts a measureable and statistically significant influence on the incidence of patients admitted to our state's mental hospitals and on the certain diagnostic categories of mental illness.

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