

# CANCER MORTALITY AMONG MORMONS

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**Preliminary results show that the 1970-72 cancer mortality rate among California Mormon adults is about one-half to three-fourths that of the general California population for most cancer sites, including many sites with an unclear etiology. Furthermore, the cancer death rate in the predominately Mormon state of Utah is about two-thirds to three-fourths of the United States rate, and the lowest in the entire country. Mormons are a large, health-conscious religious group whose Church doctrine forbids the use of tobacco, alcohol, coffee, and tea, and recommends a nutritious diet. Initial indications are that Mormons as a whole smoke and drink about half as much as the general population, and that active Mormons abstain almost completely from tobacco and alcohol. However, they appear to be fairly similar to the general white population in other respects, such as socioeconomic status and urbanization. The significance of these findings is discussed.**

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**M**ANY EPIDEMIOLOGIC STUDIES OVER THE past 25 years<sup>11,15-17</sup> have shown that for each type of cancer there is a large, often 10-fold or more, variation in incidence and death rates throughout the world. These differences are largely unexplained at this time. However, certain human activities have been highly correlated with certain cancers, most notably the strong link between cigarette smoking and lung cancer.<sup>19,35,36,39</sup> Previous studies have shown that nonsmokers experience substantially lower death rates than cigarette smokers from cancer as well as from other major diseases, such as cardiovascular diseases.

One particularly interesting study has focused on Seventh-day Adventists,<sup>27-29,47</sup> a religious group of about 450,000 U.S. members, who abstain almost completely from the use of

tobacco and alcohol, and, to a lesser extent, from coffee, tea, fish, and meat. Findings as early as 1960 showed that California Adventists at least 30 years of age had mortality rates from all cancer and all causes which were 50-80% of the average California rates.<sup>27,28</sup> Recently compiled deaths over the period 1958-1965<sup>33,34</sup> similarly indicate that all California Adventists at least 35 years of age have cancer and total mortality rates which are about 60% of the corresponding California rates, and that lifetime Adventists have mortality rates which are about 40% of the California rates. The Adventist mortality rates might be low in part because of the fairly high socioeconomic status of Adventists, but they still demonstrate substantially lower cancer and total death rates among a well-defined group in the United States. This is noteworthy because previous studies among other religious groups, such as Protestants, Catholics, and Jews, have shown no substantial differences in their total cancer rates from those of the general population, although there are some notable variations in the rates for individual sites.<sup>40</sup>

The Mormons, another religious group which has practices similar to the Seventh-day Adventists in regard to smoking and drinking, are to be examined here. The Church of Jesus Christ of Latter-day Saints (more popularly known as the Mormon Church) has approximately 2.3 million members in the United States today and about 3.4 million members world wide. They are located mainly in the Rocky Mountain states,

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particularly Utah, where they currently comprise over 800,000 of the state's 1.2 million population. There are almost 400,000 members in California.<sup>25,32</sup> There are about the same number of male and female members, and in America they are almost entirely Caucasian. They are interesting from an epidemiologic standpoint because their "Word of Wisdom" forbids the use of tobacco, alcohol, coffee, tea, and drugs, especially addictive drugs.<sup>9,44</sup> Also, to a lesser extent, the religion stresses a well-balanced diet, particularly the use of wholesome grains and fruits and moderation in the eating of meat.<sup>9</sup> It has been informally estimated that about one-half to two-thirds of Mormons adhere to essentially all of this doctrine, except in respect to diet, where Mormons are probably not too much different from the general population.<sup>24</sup> An indirect measurement of adherence is given in Table 1, which shows 1960 and 1970 per capita consumption of cigarettes,<sup>41</sup> distilled spirits (liquor),<sup>13,14</sup> wine,<sup>45,46</sup> malted beverages (beer),<sup>42,43</sup> and total absolute alcohol for Utah, California, and the United States. All the consumption figures are based on taxes collected

from sales and hence are only an approximation of true consumption. The figure for total absolute alcohol is obtained by assuming that liquor is 50% alcohol, wine is 12%, and beer is 3.5%.<sup>18</sup> The per capita consumption in Utah is approximately 50% of that of California and the United States, and furthermore, the 1960 tobacco and 1970 alcohol and tobacco figures for Utah are the lowest in the United States. Because of their "Word of Wisdom," one might reasonably expect Mormons to experience a low incidence of and death from various cancers, similar to that of the Adventists.

## SOURCES OF INFORMATION

### State Mortality Data

Some indication of Mormon cancer rates can be obtained by studying the state of Utah with its large (currently about 70%) Mormon population. Recent cancer mortality data show that Utah does indeed have very low rates. In Table 1, a comparison of Utah with California and the United States is given, using the latest available

TABLE 1. Summary Comparisons of Mortality and Tobacco and Alcohol Consumption for Utah, California, and the United States

	Utah	California	United States
1969-71 crude total mortality rate per 100,000	661.	835.	943.
1969-71 average age-adjusted total death rate per 100,000 using the 1940 standard population			
white males	787.	856.	891.
white females	454.	492.	505.
1969-71 average age-adjusted cancer death rate per 100,000 using the 1940 standard population			
white males	113.	151.	154.
white females	79.	110.	107.
1950-67 average age-adjusted cancer death rate per 100,000 using the 1960 standard population			
white males	132.5	166.0	169.5
white females	102.4	126.9	130.0
1950-69 average age-adjusted cancer death rate per 100,000 using the 1960 standard population			
white males	133.1	171.4	174.0
white females	102.1	128.1	130.1
1960 per capita consumption			
cigarettes (packs/yr)	69.0	142.0	132.3
liquor (gallons/yr)	0.78	1.75	1.33
wine (gallons/yr)	0.44	2.09	0.91
beer (gallons/yr)	8.3	14.8	15.1
absolute alcohol (gallons/yr)	0.73	1.64	1.30
1970 per capita consumption			
cigarettes (packs/yr)	65.5	123.0	126.7
liquor (gallons/yr)	0.88	2.26	1.83
wine (gallons/yr)	0.52	2.93	1.31
beer (gallons/yr)	11.5	18.2	18.6
absolute alcohol (gallons/yr)	0.90	2.12	1.72

1969-71 age-adjusted death rates from all causes and all cancer.<sup>30</sup> The 1969-71 data indicate that the ratio of Utah mortality to United States mortality is as follows: for white males, 88% for all causes and 73% for all cancer; and for white females, 90% for all causes and 74% for all cancer. Also included in Table 1 are 1950-67 and 1950-69 age-adjusted total cancer death rates.<sup>5,31</sup> These cancer rates and total mortality rates for Utah are the lowest of any state in the United States.<sup>5,30</sup>

Additional Utah cancer mortality data are presented in Table 2. Age-adjusted cancer mortality rates by site over the period 1950-69 are given for whites in Utah county, Utah State, and the United States.<sup>31</sup> Averaged over the same period, 1950-69, Utah County, which includes Provo, was approximately 85% Mormon, Utah was approximately 70% Mormon, and the United States was approximately 0.5% Mormon.<sup>32</sup> These results show that the ratio of Utah County to United States cancer mortality is 67% for white males and 72% for white females. The Utah County rates are lower than the Utah rates

and both are lower than the United States rates for all major sites, except prostate in men and nervous system for men and women. The rates are particularly low for the buccal cavity, esophagus, colon, rectum, lung, and bladder in both sexes.

More direct data on Mormon mortality are also available. Crude total death rates have been calculated for Mormon and non-Mormon populations in each state based on Church membership and death records and state death and population data.<sup>6,32,30</sup> Table 3 shows 1970 crude death rates for three areas with large Mormon populations. The ratio of Mormon to non-Mormon crude death rates is: 71% in Utah, 59% in Utah county, and 53% in California. To show the longtime trend of these differences, the Mormon and non-Mormon rates for Utah and California in 1950 and 1960 are also shown in Table 3; similarly low Mormon mortality rates dating as far back as 1900 have been calculated by Church officials.<sup>44</sup> These results could be influenced by differences in the age distribution between the Mormon and non-Mormon popula-

TABLE 2. Comparison of 1950-69 Average Annual Age-Adjusted Cancer Death Rates per 100,000 by Site for Utah County, Utah State, and the United States, Standardized to the 1960 U.S. Population

Cancer site	I C D number (6th revision)	Death rate per 100,000					
		White males			White females		
		Utah County	Utah	United States	Utah County	Utah	United States
Entire buccal cavity and pharynx	(140-148)	2.3(15)	3.36	5.36	0.3(3)	0.93	1.42
Esophagus	(150)	0.7(5)	1.56	4.10	0.3(2)	0.26	1.03
Stomach	(151)	10.1(65)	13.43	15.22	5.3(40)	7.08	7.70
Large intestine (colon)	(153)	9.7(63)	10.89	16.54	10.2(76)	10.77	16.25
Rectum	(154)	4.5(29)	4.28	7.65	2.6(20)	2.99	4.82
Biliary passages and liver	(155)	3.0(20)	3.37	5.16	3.4(25)	4.50	5.34
Pancreas	(157)	5.2(33)	7.93	9.63	4.4(33)	4.54	5.83
Lung, bronchus, trachea	(162, 163)	17.1(115)	21.98	37.98	1.8(13)	3.26	6.29
Breast	(170)				20.7(157)	20.76	25.51
Uterine cervix	(171)				4.1(31)	5.17	7.79
Body of uterus	(172-174)				6.0(45)	5.27	6.13
Ovary, uterine tube, broad ligament	(175)				5.7(42)	6.77	8.57
Prostate	(177)	20.0(120)	19.71	17.84			
Bladder	(181)	2.9(18)	5.11	6.78	1.1(8)	1.58	2.39
Kidney	(180)	1.1(8)	3.00	3.86	1.4(12)	1.53	1.99
Nervous system	(193)	4.8(39)	4.58	4.42	2.9(26)	3.29	2.91
All lymphomas	(200, 202, 205)	3.0(23)	4.47	4.89	1.9(15)	2.81	3.25
All leukemia	(204)	7.0(56)	8.17	8.81	4.8(43)	5.49	5.74
All other sites (not given above)		22.3(155)	21.30	25.80	17.2(135)	15.06	17.14
All cancer (malignant neoplasms)	(140-205)	113.7(764)	133.14	174.04	94.1(726)	102.06	130.10

Averaged over the period 1950-69, Utah County was 85% Mormon, Utah State was 70% Mormon, and the United States was 0.5% Mormon.

Number of cancer deaths are given in parentheses.

TABLE 3. Comparison of Mormon and Non-Mormon Mortality in Three Areas, Using 1950, 1960, and 1970 Crude Total Mortality Rates per 1000, Based on Church Mortality and Membership Data and State Mortality and Population Data, with the Populations Estimated as of July 1

State (number and percentage of Mormons)	Crude mortality rate per 1000		
	Mormon	Non-Mormon	TOTAL
1970			
Utah (770,000; 72%)			
Both sexes	6.0	8.4	6.6
Males	6.9	10.3	7.8
Females	5.2	6.5	5.5
California (360,000; 1.8%)			
Both sexes	4.5	8.4	8.3
Males	4.9	9.5	9.4
Females	4.2	7.4	7.3
Utah County (125,00; 90%)			
Both sexes	4.7	8.0	5.1
Males	5.4	10.0	5.9
Females	4.1	5.9	4.3
1960			
Utah (635,000; 71%)			
Both sexes	6.0	8.4	6.7
Males	6.9	10.8	8.0
Females	5.1	6.6	5.5
California (210,000; 1.3%)			
Both sexes	4.6	8.7	8.6
Males	5.1	10.0	9.9
Females	4.2	7.4	7.3
1950			
Utah (475,000; 68%)			
Both sexes	6.4	9.0	7.3
Males	7.2	11.4	8.5
Females	5.7	6.4	5.9
California (85,000; 0.8%)			
Both sexes	5.5	9.3	9.3
Males	6.3	11.0	10.9
Females	4.8	7.7	7.7

tions, but hardly by a factor of 1.5-2. The accuracy and completeness of Church records, along with Mormon age distributions, will be discussed later.

### California Mormon Mortality Data

Church records have been further used for a detailed comparison of observed and expected cancer mortality among Mormons in California during 1970, 1971, and 1972. From the Church Historical Department,<sup>1,32</sup> annual ward reports for 1970, 1971, and 1972 have been obtained for essentially all the wards (local churches) in California. Names and other identifying information, including sex, date and place of birth, and date and place of death, for 1631 deaths in 1970, 1596 deaths in 1971, and 1638 deaths in

1972 listed in these reports have been transferred to computer cards and processed.

Duplicate names (for example, the same death reported by two different wards) have been removed. The 1970 deaths reported in 1971 and 1972 and the 1971 deaths reported in 1972 have been included, along with the 1970, 1971, and 1972 deaths which were reported in their year of occurrence. The late-reported deaths represent about 2% of the total. Reported deaths of a few clearly indicated nonmembers have been excluded. However, as many as 10% of the listed deaths on the ward reports cannot be found in the master file of deceased members in Salt Lake City, Utah. The reason for this discrepancy is not precisely understood at the present time, but it is probably due to improper or delayed filing. In any case, the names of uncertain members have been retained. This probably represents a slight overcounting of true Mormon deaths.

All of the Mormon names, along with their sex, birthplace, date of birth, and date of death, have been compared with the state index books which alphabetically list all deaths occurring in California; the state file number has been ascertained for each death whenever there is a match between the Mormon and state lists. Approximately 5% of all reported Mormon deaths cannot be found in California mortality records; approximately 4% of deaths at least 35 years of age cannot be found; and approximately 2% of deaths at least 35 years of age occurring in California cannot be found, as shown in Table 4.

Names of persons dying out-of-state (approximately 1% of total) are available from the Annual Mortality File computer tapes containing data on all deceased California residents. Mormon deaths reported by the Church as having occurred out of California have been checked against the out-of-state deaths on the tapes, and an appropriate number (about 1% of total Mormon deaths) have been found to match. Among the Mormon names for which death verification cannot be obtained, special searches have been made, such as looking under variations in spelling of the last name, looking under the maiden name of women, and looking under years of death other than the year stated. The Church-determined cause of death, stating a crude classification such as "cancer," "heart attack," "stroke," etc., is available for most of the deaths in the ward reports. All deaths with "cancer" listed as cause have been checked closely, and only five remain to be verified.

A summary of the verification of names of

TABLE 4. Verification of Church-Reported 1970, 1971, and 1972 California Mormon Deaths with California Mortality Records

Mortality data	1970		1971		1972		≥ 35 years		≥ 35 years	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
Total deaths reported in Church statistical compilation of all ward reports	836	794	859	794	847	850	-	-	-	-
All identified deaths (total deaths in available ward reports)	837	794	834	762	807	831	664	664	652	718
All verified deaths (confirmed by California mortality records)	781	755	784	722	771	797	637	637	626	687
All nonverified deaths (not confirmed by California mortality records)	56	39	50	40	36	34	27	27	26	31
Nonverified deaths occurring outside of California	46	22	32	19	9	10	13	13	6	10
Nonverified deaths occurring in California	10	17	18	21	27	24	14	14	20	21
All verified cancer deaths	135	150	130	154	134	179	145	145	127	162
All nonverified "cancer" deaths	0	0	0	1	1	3	1	1	1	3

1970, 1971, and 1972 deceased California Mormons has been given in Table 4. The verified names with state file numbers have been further compared with the cancer deaths listed on the 1970, 1971, and 1972 California Annual Mortality File computer tapes to determine the site of cancer according to the International Classification of Disease (ICD) number, 8th revision. The distribution by site of the 816 (364 male and 452 female) verified cancer deaths at least 35 years of age is shown in Table 5. The 66 cancer deaths occurring under age 35 have not been included.

In order to estimate the number of cancer deaths per year expected among California Mormons, the size and age distribution of the population at risk has been estimated. The official Church total of California Mormons was 348,837 at the end of 1969, 367,615 at the end of 1970, 367,521 at the end of 1971, and 372,938 at the end of 1972.<sup>32</sup> A compilation of the membership statistics in the same ward reports used to obtain the deaths yielded a total California membership of 357,492 (169,198 males and 188,294 females) as of December 31, 1970 and 362,636 (171,610 males and 191,026 females) as of December 31, 1971. The average membership for the 3-year 1970-72 period as of July 1, 1971 has thus been taken to be 360,000 (170,000 males and 190,000 females).

The age distribution of the California Mormon population as of July 1, 1971 is not available, because no compilation of Mormon birthdates has been previously undertaken. It would be essentially impossible to recreate an individually identified population-at-risk, because this would mean searching through 3.4 million alphabetically-filed membership cards in Salt Lake City in order to find and manually tabulate data on 360,000 California Mormons. However, during the last 2 years the Mormon Church has been computerizing its living membership file, and this process is now about 80 to 90% complete in California and Utah. The address and birthdate are among the items included in the computerized record of each member. A special compilation has been made of age-sex distributions using the computerized records of California and Utah Mormons as of July 1, 1975.<sup>26</sup> These data must be considered preliminary; there exist problems in assessing its accuracy. In particular, the computerized membership records may not be entirely representative of the total membership; an estimated 20% of the computerized members are listed twice under different addresses, reflecting

a recent move from one ward to another. The raw distributions compiled by the Church have been modified by using what is known about population mobility as a function of age.<sup>6</sup> These matters are discussed in more detail later.

The July 1, 1975 modified age distribution for Utah Mormons is very young, but fairly close to the July 1, 1970 Utah state age distribution, with both having about 34% of the population at least 35 years of age and 7.5% at least 65 years of age. This is reasonable since Utah is about 70% Mormon. The July 1, 1975 modified age distribution for California Mormons is extremely young, with only 33% of the members at least 35 years of age and only 5% at least 65 years of age. This is in contrast to the California state age distribution of July 1, 1970, with 42% at least 35 years of age and 9% at least 65 years of age.

The expected number of cancer deaths per year among the California Mormon population is determined by multiplying the number of Mormons in each 10-year age group by the corresponding 1970 age-specific mortality rate for each cancer site, and then summing over all age groups from 35 years of age and up.<sup>4,8</sup> These numbers are then all multiplied by 3.03 to give expected mortality among California Mormons for the 3-year time period 1970-72, including a 1% increase each year in the 1971 and 1972 rates as indicated by California cancer trends.<sup>4,38</sup> It should be mentioned that the cancer and total mortality rates for whites are identical to rates for everyone in California to within 1%.<sup>8,38</sup> This is pointed out because California Mormons are almost all white. The observed and expected numbers of deaths among California Mormons at least 35 years of age are given in Table 5 for 18 of the most common sites, as well as for all sites of cancer and all causes. The expected number of deaths has been calculated for three underlying age distributions: the July 1, 1975 modified distribution and the July 1, 1970 Utah and California state distributions. The state distributions have been included for comparison because there are some indications that the true distribution may be closer to these, as will be shown later.

For all three assumed Mormon age distributions, the ratio of observed to expected mortality is substantially less than one for the male sites of esophagus, stomach, colon, rectum, pancreas, lung, prostate, bladder, and kidney, and for the female sites of colon, lung, breast, and entire uterus. This is particularly interesting because, except for lung and esophagus, these sites have not been definitively related to specific risk fac-

TABLE 5. Observed and Expected Cancer and Total Deaths in 1970, 1971, and 1972 Among California Mormons at Least 35 Years of Age

Cancer site	ICD number (8th revision)	Observed*	Males			Deaths (≥ 35 years)			Females				
			Modified	Expected <sup>1</sup>		Observed	Modified	Expected		Observed	Modified	Expected	
				Utah	California			Utah	California			Utah	California
Entire buccal cavity and pharynx	(140-149)	11	20.4	23.8	28.0	11	10.3	11.0	13.7				
Esophagus	(150)	6	14.3	16.8	19.7	6	6.8	7.4	9.3				
Stomach	(151)	22	31.1	39.9	46.7	18	21.7	24.9	31.5				
Large intestine (colon)	(153)	37	46.3	60.3	70.5	42	62.9	72.9	92.6				
Rectum	(154)	11	17.2	22.5	26.3	16	16.8	19.4	24.6				
Biliary passages and liver	(155, 197.7, 197.8)	5	11.1	13.5	15.9	11	8.8	10.0	12.6				
Pancreas	(157)	23	33.5	41.3	48.4	31	29.4	33.8	42.8				
Lung, bronchus, trachea	(162)	105	177.9	211.9	248.5	40	62.6	65.8	81.7				
Breast	(174)	-	-	-	-	103	123.3	129.6	161.0				
Uterine cervix	(180)	-	-	-	-	17	23.9	24.7	30.5				
Body of uterus	(182)	-	-	-	-	16	19.0	21.4	27.0				
Ovary, uterine tube, broad ligament	(183)	-	-	-	-	24	44.1	46.9	58.4				
Prostate	(185)	23	45.4	66.3	77.2	-	-	-	-				
Bladder	(188)	14	20.5	27.5	32.1	7	9.6	11.7	15.0				
Kidney	(189.0-189.2)	7	13.5	16.1	18.9	5	7.1	8.1	10.2				
Nervous system	(191, 192)	14	16.0	17.0	20.1	10	12.7	13.0	16.0				
All lymphomas	(200, 202)	17	16.8	19.9	23.4	16	19.0	21.1	26.5				
All leukemias	(204-207)	22	20.8	26.1	30.5	19	19.7	22.1	27.9				
All other sites (not given above)		47	78.2	93.4	109.3	60	76.1	85.6	107.6				
All cancer (malignant neoplasms)	(140-209)	364	563.0	696.3	815.5	452	573.8	629.4	788.9				
All causes (all verified deaths)		1893	2867.1	3628.0	4246.2	1978	2572.3	3019.7	3854.6				
All causes (all identified deaths)		1969	2867.1	3628.0	4246.2	2067	2572.3	3019.7	3854.6				

\* Observed deaths (≥35 years) represent the number of confirmed deaths occurring among California Mormons during 1970, 1971, and 1972 based upon the names of deceased found in the ward reports, as summarized in Table 4.

<sup>1</sup> Expected deaths (≥35 years) represent the number of deaths which would occur in 3 years among the July 1, 1971 California Mormon population (170,000 males and 190,000 females) if it had the age-specific cancer mortality rates of all Californians. Three age distributions have been assumed for the California Mormon populations: the July 1, 1975 modified distribution described in the text, the July 1, 1970 Utah State distribution, and the July 1, 1970 California State distribution.

tors. The ratio is less than 1 to a very high degree of statistical significance ( $p \ll .001$ ) for all cancer sites and for all causes of death. It is not meaningful to discuss the statistical significance of differences for individual sites because of the uncertainty in the underlying age distribution.

In order to provide additional detail, the 1970-72 California Mormon age-specific cancer death rates are presented in Table 6, assuming the modified age distribution. They are compared with the 1969-71 Utah, 1970 California, and 1970 United States age-specific rates. The United States data are for whites, and the California Mormon, Utah, and California are essentially for whites, because they are unchanged by their nonwhite component. The California Mormon rates do not differ much from the Utah rates; however, they would be substantially lower if either the Utah or California age distribution were assumed.

Furthermore, the age-specific rates and observed-to-expected ratios for a number of sites should drop even lower when only nonsmoking and nondrinking Mormons are analyzed. For instance, previous studies<sup>28,29,35</sup> have shown that nonsmokers have only about 20% of the lung cancer deaths expected among the general population, much lower than the 45-60% observed for all Mormons in Table 5. The data in Table 5 for California Mormons are generally consistent

with the low Utah County and Utah State cancer rates given in Table 2, and in fact are higher than the Utah County data if the modified age distribution is assumed. The only notable discrepancy is the male prostate cancer rate, which is low in California, but slightly above the national average in Utah.

### Alameda County Data

Independent data on Mormons come from the results of a 1965 "Health and Ways of Living" survey and subsequent followup of a probability sample of 6928 adult residents of Alameda County, California, conducted by the Human Population Laboratory of the California State Department of Public Health (now called Department of Health).<sup>2,3,21,23</sup> Included in the survey were 111 Mormons. They have been compared with the total sample for Alameda County in Table 7. The Mormons comprised  $111/6928 = 1.6\%$  of this adult sample, which was their percentage in the total population as estimated from the available 1965 Alameda County ward statistics, namely  $16,000/1,020,000 = 1.6\%$ . Furthermore, the 1965 results showed that Alameda County Mormons had an age distribution which was similar to that of other citizens; that 67% of the male Mormons and 76% of the female Mormons did not smoke, compared with 51% of the men and 60% of the

TABLE 6. Age-Specific Cancer Death Rates per 100,000 for California Mormons Assuming the Modified Age Distribution, Compared with Rates for Utah, California, and the United States

Age (years)	Males				Females			
	1970-72 California Mormon death rates (assuming the modified age distribution)	1969-71 Utah death rates	1970 California death rates	1970 United States white death rates	1970-72 California Mormon death rates (assuming the modified age distribution)	1961-71 Utah death rates	1970 California death rates	1970 United States white death rates
35-44	35.5	31.3	51.7	50.1	70.7	41.1	68.3	62.4
45-54	83.7	103.8	166.9	172.0	119.6	115.3	186.1	177.3
55-64	325.9	328.9	480.6	498.1	299.3	257.1	359.2	338.6
65-74	680.0	804.3	992.9	997.0	429.6	429.2	575.5	554.7
75-84	1080.3	1299.5	1611.2	1592.7	702.3	682.9	900.2	903.5
85+	1351.4	1303.9	1901.8	1772.2	1188.0	740.7	1154.0	1126.6
TOTAL cancer deaths $\geq 35$	(364)	(1566)	(15,387)	(155,360)	(452)	(1243)	(13,739)	(131,826)

All the rates can be considered representative for whites, because nonwhites do not significantly alter the California Mormon, Utah, or California rates.



women in the total sample; and that 46% of the male Mormons and 59% of the female Mormons did not drink, compared with 16% of the men and 29% of the women in the total sample. Surveys of the United States showed that among the 1966 population at least 17 years of age, 51% of the males and 68% of the females did not smoke,<sup>98</sup> and that among the 1965 population at least 21 years of age, 23% of the males and 40% of the females did not drink.<sup>12</sup> Table 7 shows that the differences in habits between Mormons and the total sample are concentrated among Mormon "every week" church attenders, almost 100% of whom do not smoke or drink. About 42% of the Mormons regularly attend services

every week. Infrequent church attenders among the Mormons tend to smoke and drink as the general population. Additional results from the study showed that Mormons are similar to the total sample in most other respects, including socioeconomic status, as measured by amount of education and amount of income, and health care as measured by frequency of dental checkups, frequency of medical checkups, and number of visits to the doctor. Finally, the results showed that during the 6½-year followup period, 3.6% of the Mormons died, as compared with 6.5% of the total sample. In other words, the Mormons have had 55% of the mortality rate of the total sample. Furthermore,

TABLE 7. Results from the 1965 "Health and Ways of Living" Survey Conducted by the Human Population Laboratory, California State Department of Public Health of a Probability Sample from Alameda County of 6928 Total Persons, Including 111 Mormons (48 Males and 63 Females)

	Both sexes		Males			Females			
	TOTAL	Mormons	"Every week" Mormons	TOTAL	Mormons	"Every week" Mormons	TOTAL	Mormons	"Every week" Mormons
<b>Age distribution</b>									
16-29	23.7%	22.5% (25)		22.5%	16.8% (8)		24.6%	27.0% (17)	
30-44	33.0	34.2 (38)		33.8	42.7 (20)		30.8	28.6 (18)	
45-64	31.4	30.7 (34)		32.4	36.2 (17)		30.5	27.0 (17)	
65-99	12.9	12.6 (14)		11.4	6.3 (3)		14.1	17.5 (11)	
TOTAL (6928)		(111)		(3158)	(48)		(3770)	(63)	
<b>Percentage mortality after 6½ years' followup</b>									
	6.5% (449)	3.6% (4)	0% (0)	7.6% (239)	4.1% (2)	0% (0)	5.6% (210)	3.2% (2)	0% (0)
<b>Cigarette smoking distribution</b>									
Never smoked				29.1%	37.5% (18)	64.8% (13) <sup>†</sup>	47.9%	62.0% (39)	88.9% (24) <sup>‡</sup>
Formerly smoked				21.1	27.1 (13)	31.6 (6)	11.2	11.2 (7)	7.4 (2)
Now smoke				49.2	33.3 (16)	0.0 (0) <sup>§</sup>	39.7	23.8 (15) <sup>†</sup>	0.0 (0) <sup>§</sup>
Unknown					(1)	(0)		(2)	(1)
<b>Drinking quantity distribution</b>									
Never drink				15.7%	45.9 (22) <sup>§</sup>	100% (19) <sup>§</sup>	28.8%	58.7% (37) <sup>§</sup>	88.9% (24) <sup>§</sup>
1-2 drinks at a time				49.6	27.1 (13) <sup>†</sup>	0.0 (0) <sup>§</sup>	55.0	28.6 (18) <sup>†</sup>	11.1 (3) <sup>§</sup>
3-4 drinks at a time				24.3	18.7 (9)	0.0 (0) <sup>†</sup>	12.9	9.6 (6)	0.0 (0) <sup>†</sup>
5+ drinks at a time				10.1	6.3 (3)	0.0 (0)	2.9	3.2 (2)	0.0 (0)
Unknown					(1)	(0)		(0)	(0)
<b>Drinking frequency distribution</b>									
Never drink				15.7%	45.9% (22) <sup>§</sup>	100% (19) <sup>§</sup>	28.8%	58.7% (37) <sup>§</sup>	88.9% (24) <sup>§</sup>
<1 times a week				29.6	22.9 (11)	0.0 (0) <sup>†</sup>	39.6	22.2 (14) <sup>†</sup>	11.1 (3) <sup>†</sup>
1-2 times a week				24.2	14.6 (7)	0.0 (0) <sup>†</sup>	15.7	14.3 (9)	0.0 (0) <sup>†</sup>
>2 times a week				30.1	16.7 (8)	0.0 (0) <sup>†</sup>	15.6	4.8 (3) <sup>†</sup>	0.0 (0) <sup>†</sup>
Unknown					(0)	(0)		(0)	(0)
TOTAL				(3158)	(48)	(19)	(3770)	(63)	(27)

The sample includes the noninstitutional adult population of at least 20 years of age, plus 47 married persons between 16 and 19 years of age. Comparisons are made between the total sample, all 111 Mormons, and 46 Mormons who attend church every week. For each cell, the percentage of persons is always given and for the Mormons the number of persons is included in parentheses. The percentages where Mormons are statistically different from the total are indicated as follows: <sup>†</sup> p < .05, <sup>‡</sup> p < .01, <sup>§</sup> p < .001, assuming Poisson variation.

not a single one of the 46 regular church-attending Mormons in the sample died during the 6½-year followup period. Because of the small number of Mormons involved, the mortality differences are not statistically significant, but it is useful to note that they are consistent with the differences between Mormon and non-Mormon crude mortality rates shown in Table 3.

Estimates made for Mormons in Los Angeles County indicate that about 40% of the members are very active and attend church regularly, about 20% are moderately active and attend church fairly often, and about 40% are inactive and almost never attend church.<sup>24</sup> Essentially all the active members abstain from tobacco, alcohol, coffee and tea. These estimates are similar to the Alameda County results.

#### POSSIBLE SYSTEMATIC ERRORS

In order to have confidence in the validity of these results, it is important to understand all the possible sources of systematic error, in addition to the statistical error which has been discussed. The most probable sources of error are inaccuracy and incompleteness of the reporting of either Mormon deaths or membership figures and the age distribution of the Mormon population.

#### Record Keeping System

The Mormon Church places emphasis on genealogy because of its strong belief in the importance of the family, both present and former generations. This gives rise to one of the most extensive record keeping systems in existence. The Church clerks throughout the world, including the clerks for the approximately 850 individual California wards, are instructed to file complete and accurate records in their annual ward report, including membership data and deaths.<sup>10</sup> Both the bishop and the clerk of each ward must sign that their ward report is complete and accurate before mailing it to Salt Lake City. It is from these ward data that Church summary statistics are compiled and upon which the Mormon mortality rates in this paper are based.

A single ward clerk keeps an up-to-date record of membership, as well as missionaries, marriages, births, blessings, baptisms, ordina-

tions, divorces, and deaths among the members of his ward. Each ward clerk is given explicit instructions from Church headquarters on how to complete a "Certificate of Membership" for each new ward member.<sup>10</sup> Members include all children, adults, and converts above 8 years of age who are baptized, as well as unbaptized children of adult members. Unbaptized children are removed from membership upon reaching 21 years of age. One copy of the membership record is retained in the ward and another copy is forwarded to the Membership Department at Mormon Church headquarters in Salt Lake City. When a member moves out of the area of a ward, the membership record for that person is sent to Salt Lake City and then forwarded to the ward for the area to which the person moved.

Membership records in each ward are kept up to date by the ward clerk on a very regular basis.<sup>24,30</sup> Each ward has several members who serve as "home teachers;" these home teachers try to make a house call on all the other members in the ward once a month. Depending on the ward and the time of the year, they are usually able to make personal contact with 50-90% of the members in any given month. Those members who cannot be reached in person are phoned; if they still cannot be reached, then letters of concern are mailed to them. Address corrections are requested on these letters; if the members have moved the ward clerk will know very promptly. There is usually a small percentage of inactive members in each ward, not more than 10% of the total membership, who never want to be visited by the home teachers. These people are visited on an annual basis by the ward bishop. Thus it is highly unlikely that inactive members will remain on the membership list of a given ward if they have moved, died, or otherwise left the ward.

Since the members of a ward are usually quite familiar with one another, most events, such as deaths, are reported to the ward clerk almost immediately, especially among active members. Such occurrences among very inactive members may take somewhat longer to be reported, but usually friends of the inactive member will learn of the event and report it to the ward clerk, if it has not already been ascertained by the normal monthly contact procedures. In addition, ward clerks sometimes report the deaths of former members who moved to a new ward shortly before they died or of non-members who were related to members. These

procedures are the same for each ward of the Mormon Church throughout the world.<sup>10,30</sup>

### Accuracy

A check on the accuracy of the membership data in California and Utah as reported in Church records is available to some extent. In Alameda County, the 1965 sample survey of the Human Population Laboratory showed that the percentage of Mormons in the total population was the same as the percentage obtained from the Church statistics, namely 1.6%, as mentioned earlier. From the 1970 Utah County ward reports, the membership statistics and deaths have been processed and tabulated. The membership statistics show that the county was 90% Mormon (125,000 out of 139,000) as of July 1, 1970. The age and sex distributions of the deaths, which were not verified with state records, show a number of deaths close to but not exceeding the county total in each 5-year age group. This indicates that in an area which is known to be almost entirely Mormon, the Church membership and death statistics are consistent with census and mortality records obtained independently of the Church. Specifically, there is no obvious overcounting of membership statistics and there are no noticeable errors in the recording of deaths. Finally, a historical indication of the accuracy of Church membership figures is given by the last Bureau of the Census survey of religious groups in 1936.<sup>7</sup> This special census collected membership data from individual churches and then compiled them by denomination. It showed that in 1936 there were 34,623 Mormons in California and 336,184 Mormons in Utah, in agreement with official Church membership figures of 35,585 and 333,472, respectively.

A check on the accuracy of the mortality data, i.e. the extent to which Church-reported deaths are consistent with external records, comes from the fact that among 4036 Church-reported deceased Mormons at least 35 years of age, summarized in Table 3, 3871 or 96% have been confirmed as valid deaths in California Annual Mortality Files for 1970-72. The remaining 165 names have not been initially confirmed as valid deaths, but it appears from Church data that only 88 of these deaths occurred in California. The persons who died out-of-state were probably not California residents at the time of their death. Also, there may have been some er-

rors or omissions in the California mortality records. Further checking is necessary in order to determine the exact status of the 165 unconfirmed names, but the fact that there is already a 96% matching shows the high quality of the Church data.

### Completeness

Equally important to accuracy is the extent to which Church-reported deaths are complete. This is the most obvious possible source of systematic error giving rise to falsely low death rates. A first check on the completeness of the mortality records comes from the characteristics of the membership lists. From Table 3 it can be seen that the Mormons in Utah and California have experienced substantially lower mortality rates than the general population for decades. If this lower mortality was largely due to the under-reporting of deaths, then the membership lists which are kept by each ward and by the Church headquarters would by this time contain the names of a substantial number of "lost," actually deceased persons. This is an unlikely possibility, because the membership lists are kept up-to-date almost continuously. Because of the contact of the home teachers, ward clerks, and ward bishops with all the members, using techniques discussed earlier, the whereabouts and status of most of the members are well known. However, for the members whose exact location is uncertain, the Church maintains a "lost and unknown" category, which is completely separate and distinct from the membership and mortality records of the known members.<sup>28</sup>

A second check on completeness is the fact that the Mormon mortality rate is consistently lower than the general mortality rate throughout California. To demonstrate this, California has been broken into 23 groups of one or more counties each, and the 1970 crude mortality rate has been calculated for Mormons<sup>32</sup> and the total population<sup>8</sup> in each group. If the ward death reporting system were randomly incomplete and the death rates among Mormons and the rest of the population actually were equal, then the mortality ratio of Mormons to total population for the county groups should vary from 0 (no reporting) to 1 (complete reporting). However, what is observed, as given in Table 8, is that the ratio is very narrowly distributed about a weighted mean of 0.53 with a weighted standard

TABLE 8. 1970 Distribution of Population and 1970 Crude Mortality Rates for Mormons and the Total Population in Various County Groups in California

County group	Mormon population			Crude death rate per 1000		
	Number	Percent	Percent urban	Mormon	TOTAL	Ratio (95% conf. limits)
Alameda	19,439	1.8%	99%	4.9	8.7	.56 (.46-.68)
Butte + Colusa + Glenn + Sutter + Yuba	6,073	2.8	59	5.4	9.8	.55 (.38-.77)
Contra Costa	12,092	2.2	94	3.7	6.9	.54 (.39-.72)
Fresno + Kings + Madera + Mariposa + Merced + Tulare	9,864	1.2	63	5.3	8.7	.61 (.46-.80)
Humboldt + Del Norte	2,237	2.0	46	3.0	9.5	.32 (.13-.66)
Kern + Inyo	5,908	1.7	77	4.9	9.9	.49 (.33-.70)
Los Angeles	114,589	1.7	99	5.2	8.8	.59 (.54-.64)*
Marin	3,341	1.6	92	3.2	7.1	.45 (.22-.81)
Monterey + San Benito + Santa Cruz	4,571	1.2	73	4.2	9.1	.46 (.28-.71)
Orange	31,681	2.2	99	3.0	6.0	.50 (.41-.61)
Placer + Eldorado + Nevada	7,185	4.9	37	3.2	10.0	.32 (.21-.48)
Riverside	9,361	2.1	79	4.1	9.9	.41 (.29-.56)
Sacramento + Yolo	15,736	2.2	92	5.4	7.6	.71 (.57-.88)*
San Bernardino	15,639	2.3	89	4.1	8.3	.49 (.38-.63)
San Diego	23,054	1.7	94	5.0	7.4	.68 (.57-.82)*
San Francisco	4,954	0.7	100	6.6	12.5	.53 (.37-.74)
San Joaquin + Amador + Stanislaus + Tuolumne	8,618	1.7	70	3.7	9.2	.40 (.28-.56)
San Luis Obispo	2,001	1.9	75	5.8	9.7	.60 (.31-1.05)†
San Mateo	6,963	1.3	98	5.2	7.1	.73 (.52-1.00)†
Santa Clara	22,973	2.2	98	2.0	5.8	.34 (.25-.45)*
Shasta + Siskiyou + Tehama	4,125	3.0	41	5.4	9.9	.55 (.35-.83)
Sonoma + Lake + Mendocino + Napa + Solano	8,566	1.7	66	4.3	9.7	.44 (.31-.60)
Ventura + Santa Barbara	14,099	2.2	90	3.0	6.5	.46 (.33-.62)
State	357,492	1.8	91	4.4	8.3	.53 (.50-.56)

\* 95% confidence limits do not encompass the state ratio of .53.

† 95% confidence limits encompass the ratio of 1.00.

deviation of 0.10, with a minimum of 0.32 and a maximum of 0.73. Total population of each group was the weighting factor. For only 2 groups is the ratio consistent with 1 to the 95% confidence level ( $p < .05$ ); both of these groups are very small and there is large statistical error. All but 4 groups are consistent with the state ratio of 0.53; the small fluctuations which exist in the 4 groups may be due either to differences in the underlying age distributions or in the actual mortality rates. If the consistently low mortality ratio throughout the state is not genuine, then it could only occur in this manner if all of the wards were systematically reporting only about one-half of their deaths. No evidence for such systematic under-reporting has yet been uncovered.

A third check on the completeness of Mormon mortality records comes from the Los Angeles

County Cancer Surveillance Program of the University of Southern California.<sup>20</sup> This program began in 1972 and now receives reports on essentially all of the diagnosed cancer cases in Los Angeles County, excluding cervix in situ and nonmelanomic skin cancer cases. Approximately 50 Los Angeles County Mormons who were both incident and fatal cancer cases in 1972 have been found in the records of both the Cancer Surveillance Program and the Mormon Church. A search of all the cancer cases identified as "Mormon" in the files of the Cancer Surveillance Program yielded not one name of an actual Mormon Church member who died in 1972 beyond the names already known to the Church. This is, of course, only a partial check on completeness of mortality data, because the Cancer Surveillance Program records only incident cancer cases and then finds deaths just

among these incident cases. In any case, this check is a reasonable indication that the Mormon mortality records are not grossly incomplete and, in fact, it tends to show that they may be quite thorough.

A fourth check on completeness is indicated by the consistency between Utah County and Utah State cancer mortality rates in Table 2, the California Mormon cancer deaths in Table 5, and the age-specific rates in Table 6. Generally the California-Mormon to total-California cancer mortality ratio is about the same as the Utah County (85% Mormon) to United States (0.5% Mormon) cancer mortality ratio. For all cancer, assuming the modified age distribution, the California ratio is 0.65 for males and 0.79 for females, and the Utah County to United States ratio is 0.65 for males and 0.72 for females. The California and Utah data are not directly comparable because they cover different time periods and different geographical regions. But they suggest that Mormons do indeed have lower mortality rates than the general population for most cancer sites, and that the Church records for California yield results which are similar to Church-independent results for Utah and Utah County.

Finally, Table 3 shows that the Church-determined 1970 Mormon crude mortality rate in Utah (6.0 per 1000) is only 9% less than the crude rate for the entire state (6.6 per 1000), as determined from state population and mortality data. Furthermore, the 1970 Mormon crude mortality rate in Utah County (4.7 per 1000) is only 8% less than the crude rate for the entire county (5.1 per 1000). Thus if the Mormon and non-Mormon rates were actually the same in Utah, the Church under-reporting of deaths would be no more than about 10%, since there appears to be no major difference between the Mormon and total age distributions in Utah. This could be considered as a reasonable upper limit on under-reporting. More exhaustive checks are necessary, particularly following an individually identified Mormon population at risk, but based on the available evidence there is no indication that the Mormon membership or mortality records are inaccurate or incomplete to any substantial degree.

### Age Distributions

The next important aspect is the age distribution of the California Mormon population. Data

presented in Table 7 show that the Mormons in the 1965 Alameda County study have the same age distribution as the total population, but this small sample is not necessarily representative of all California Mormons in 1971. The 1975 computerized Mormon membership file indicates that the modified age distribution is more correct. However, this distribution may not be completely accurate either because the entire membership is not computerized. Furthermore, there may have been some changes in California Mormon age distribution between 1971 and 1975. Also, about 20% of the computerized names are entered twice under different addresses due to members moving from one ward to another. This means double counting of many members under 35 years of age, who are the most mobile part of the population. An attempt has been made to estimate and adjust for this effect in arriving at the modified age distribution, but it has not been possible to verify this or any other possible inaccuracies. The fact that the modified distribution for Utah Mormons is not greatly different from the predominately Mormon Utah state distribution is an indication of no gross errors, but there may be important modifications yet to be determined. The total Utah age distribution is already the youngest in the United States, with a median age of 23.1 years, as compared with 28.1 years in both California and the United States in 1970.<sup>6</sup> This is largely due to the high birth rate in Utah.

The fact that the age-specific rates in Table 6 are similar for California Mormons and Utahans indicates that the modified age distribution is not unreasonable, but it is so young that even small adjustments in the older age groups mean significant changes in the expected deaths and age-specific rates. As can be seen in Table 5, the ratio of observed to expected cancer deaths for California Mormons at least 35 years of age is 0.65 for males and 0.79 for females, assuming the modified age distribution; 0.52 for males and 0.72 for females, assuming the Utah age distribution; and 0.45 for males and 0.57 for females, assuming the California age distribution. Based on a comparison of Tables 2 and 5, if the modified age distribution is correct, then the male and female esophagus and lung cancer rates for California Mormons would be higher than the rates in Utah and substantially higher than the rates in Utah County. Also, the female rates for several other sites would be higher among California Mormons. One might expect

that California Mormons and Utah County residents, who are almost entirely Mormon, would have rather similar rates, thereby implying that the modified age distribution is too young. Furthermore, if California Mormons and Utah Mormons have similar age distributions, then the Utah state distribution is most appropriate. Thus, it appears plausible that the true California Mormon age distribution lies somewhere between that of the modified and California distributions. However, any more definite statement must await confirmation of the accuracy of the computerized membership file or examination of a large representative sample of individually identified California Mormons. This constitutes the greatest uncertainty in the results as they are now presented.

### **Demographic Characteristics**

Some indication of the urbanization of Mormons is obtained by comparing Utah with the United States. According to the 1970 census,<sup>6</sup> the percentage of the population in urban areas (places of more than 2500 people) was 80% in Utah, 88% in Utah County, and 74% in the United States. In order to determine the urban-rural distribution of California Mormons, the percentage of Mormons has been calculated for 23 county groups throughout California, including almost the entire 1970 state Mormon population. The county groups, the percentage of the population in urban areas, and the Mormon population and their percentage are given in Table 8. The percentage of Mormons in the state is 1.8%; the Mormons are very uniformly distributed throughout the state, with most counties close to the state percentage. There are both urban and rural counties which are either above or below the state average, but most Mormons live in areas where their percentage is close to the state average. Mormon county membership figures are based on assigning each entire ward to a certain county group without regard to the exact county residence of individual members; uncertainty in county residence arises only for wards located near county boundaries.

It should be noted that this is a highly migratory population, since only about 10% of the California Mormons who died in 1970 were born in California. But, by comparison, only about 10% of all Californians who died in 1970 were born in the state, reflecting the migratory

nature of the entire population. Indeed, the growth of the Mormon Church in California, as well as of the entire state, has been rapid in the past 20 or more years, as seen in Table 3. In fact, if the California Mormon age distribution is unusually young, it may be due to a large influx of young Mormons from other states and of young converts within California, along with a high birth rate.

### **Socioeconomic Status**

As a check on the socioeconomic status of Mormons, a study has been made of the distribution of the last occupation as assigned by the state registrar and given on the state death certificate for the census year 1970. Occupational groups based on the Hollingshead classification of occupations have been used.<sup>22</sup> The Mormons have been compared with the California white population using cancer deaths among males, females, and both sexes. These distributions are very similar, with the Mormon percentage and the California white percentage statistically equal for each occupational group, as shown in Table 9. Indirect information on the socioeconomic status of Mormons is available by comparing 1970 census data for Utah with data for California and the United States.<sup>6</sup> Comparisons of occupational distribution and of family income distribution show no great differences in the different geographical areas. For instance, the median white family income in 1969 was \$9356 in Utah, \$8381 in Utah County, \$10,969 in California, and \$9960 in the United States. The Mormons in Alameda County had average incomes. The educational level in Utah is substantially higher than the national average, but the Mormons in Alameda County have an average educational level. All this suggests Mormons are close to average in socioeconomic status.

### **Additional Factors**

It is possible that Mormons seek earlier diagnosis and treatment for cancer, resulting in better survival. This could partially explain their lower risk of cancer deaths, if in reality the differential in risk of developing cancer is not as great. However, there is no evidence available to support this possibility, as indicated by the Alameda County study which showed no more extensive health care among Mormons, as measured by frequency of dental and medical

TABLE 9. Occupational Distribution of California Mormons and California Whites at Least 35 Years of Age Who Died of Cancer in 1970, According to Last Occupation as Given on Death Certificate

Occupational group	Both sexes California		Percent Distribution Males California		Females California	
	Mormons	Whites	Mormons	Whites	Mormons	Whites
Professional	2.3% (6)*	4.8%	4.2% (5)	7.8%	0.7% (1)	1.5%
Technical and administrative	16.3 (43)	16.1	23.5 (28)	20.7	10.4 (15)	11.1
Clerical and sales	15.2 (40)	14.0	16.8 (20)	13.2	13.9 (20)	14.7
Skilled	11.0 (29)	14.3	21.9 (26)	26.3	2.1 (3)	1.1
Semiskilled	16.3 (43)	13.3	22.7 (27)	15.9	11.1 (16)	10.4
Laborers, except farm and mine	4.2 (11)	5.1	9.2 (11)	9.5	0.0	0.3
Farm laborers and foremen	0.0	1.1	0.0	2.0	0.0	0.1
Farmers and farm managers	0.8 (2)	2.0	1.7 (2)	3.7	0.0	0.2
Students	0.0	0.0	0.0	0.0	0.0	0.0
Housewives, retired, never worked, no occupation, unemployed	33.9 (89)	29.3	0.0	0.8	59.8 (89)	60.6

\* Number of Mormon deaths in parentheses.

checkups and in number of visits to the doctor. Alternatively, it should be mentioned that about 40% of Mormons in California are converts; that is, they joined the Church as adults as opposed to being born and raised in a Mormon family.<sup>32</sup> Conversion often involves a rather marked shift in lifestyle. In addition, as pointed out earlier, about 40% of the members are inactive and tend to ignore Mormon health practices. If some of the components of Mormon lifestyle are significantly related to cancer risk, then the mortality rates presented above might considerably overestimate the mortality rates for observant lifetime Mormons, because a large proportion of Mormons have followed or still follow a lifestyle similar to the general population. This would be especially important if environmental carcinogenic factors exert their influence primarily in the early years of life.

#### SIGNIFICANCE AND CONCLUSION

Assuming these results are correct within the limitations discussed above, their significance lies in the fact that the mortality rates for Mormons are substantially lower than those of the general population and similar to those of previously reported nonsmoking populations in the United States,<sup>35</sup> including Seventh-day Adventists as a whole.<sup>33,34</sup> For the six major American studies of U.S. white males reported as of 1964<sup>35</sup> and the two major followup studies reported in 1966,<sup>19</sup> the average age-adjusted

total mortality ratio for nonsmokers at least 35 years of age to U.S. white males in 1960 was 55%, with a range from 46% to 64% in the eight studies. The 1970-72 age-adjusted total mortality ratio for California Mormon men at least 35 years of age is between 46 and 69%, depending on the age distribution assumed. For each of these studies the age-adjusted cancer mortality ratio is the same as the age-adjusted total mortality ratio to within a couple of percentage points. These studies each included between 50,000 and 2 million man-years of exposure to mortality.

Furthermore, the earlier studies involved self-selected populations which as a whole were healthier than average U.S. white males.<sup>46</sup> For instance, these studies enrolled persons with above average socioeconomic status, excluding seriously ill persons, and may not have traced all deaths.<sup>35</sup> Data in this paper refer to all Mormons, including members who ignore Church regulations, as evidenced by the substantial number of lung cancer deaths shown in Table 5 and the substantial percentage of smokers and drinkers in Alameda County. Sick members have not been excluded; Mormons have an average socioeconomic status. When results of a true comparison are available, active lifetime Mormons should be shown to have lower mortality rates than all Mormons and possibly to be healthier than any sizeable group of Americans thus far studied.

Equally significant is the fact that the

Mormons have low cancer mortality rates for most sites, including many sites which have not been clearly associated with specific etiologic factors, such as smoking or drinking. This phenomenon of universally low cancer rates has not been observed to such an extent in any other group of Americans, except Seventh-day Adventists.<sup>34</sup> This suggests the development and exploration of new etiologic hypotheses for cancer and may lead to understanding a lifestyle which produces low risk to cancer of all types.

It remains to be determined exactly what components of Mormon lifestyle, including the

"Word of Wisdom," are related to their low mortality rates. Several possible factors are: low consumption of tobacco, alcohol, coffee, tea, soft drinks, and drugs; certain dietary habits; general health practices, including exercise and proper sleep and weight; various social and psychological aspects connected with the nature of their religion; and other environmental effects. Elucidation of previously undiscovered factors protective against cancer could have considerable implication for cancer control and prevention. These factors are to be studied further.

#### REFERENCES

1. Arrington, L. J.: Personal communication, October 26, 1972.
2. Belloc, N. B., and Breslow, L.: Relationship of physical health status and health practices. *Prev. Med.* 1:409-421, 1972.
3. Belloc, N. B.: Relationship of health practices and mortality. *Prev. Med.* 2:67-81, 1973.
4. Buell, P.: Trends in Cancer Mortality—California, 1950-1970. Berkeley, State of California Department of Public Health, 1972.
5. Burbank, F.: Patterns in cancer mortality in the United States—1950-1967. *Natl. Cancer Inst. Monogr.* 33:1-594, 1971.
6. Bureau of the Census: United States Census of the Population—1970. Washington, DC, U.S. Government Printing Office, 1972.
7. Bureau of the Census: Religious Bodies—1936. Washington, DC, U.S. Government Printing Office, 1941.
8. California State Department of Public Health: Vital Statistics of California, 1970. Berkeley, 1973.
9. Church of Jesus Christ of Latter-day Saints: The Word of Wisdom. From the Doctrine and Covenants of the Church of Jesus Christ of the Latter-day Saints, Section 89, Salt Lake City, Utah, 1972.
10. Church of Jesus Christ of Latter-day Saints: Instructions for Ward Record of Members and Children. Form PB-94, Salt Lake City, Utah, 1965.
11. Clemmesen, J.: Statistical Studies in the Aetiology of Malignant Neoplasms—I. Review and Results. Copenhagen, Munksgaard, 1965.
12. Department of Health, Education and Welfare: Alcohol and Health. Washington, DC, U.S. Government Printing Office, 1971.
13. Distilled Spirits Institute, Inc.: Annual Statistical Review—The Distilled Spirits Industry—1960. Washington, DC, 1960; p. 39.
14. Distilled Spirits Institute, Inc.: Annual Statistical Review—The Distilled Spirits Industry—1970. Washington, DC, 1970.
15. Doll, R.: Prevention of Cancer—Pointers from Epidemiology. London, Nuffield Provincial Hospitals Trust, 1967.
16. Doll, R., Muir, C. S., and Waterhouse, J.: Cancer Incidence in Five Continents, vol. 2. Switzerland, International Union Against Cancer, 1970.
17. Dunham, L. J., and Bailar, J. C., III: World maps of cancer mortality rates and frequency ratios. *J. Natl. Cancer Inst.* 41:155-203, 1968.
18. Encyclopedia Britannica, Inc.: Encyclopedia Britannica. Chicago, 1970; vol. 1, p. 542, vol. 3, p. 379, vol. 23, p. 577.
19. Haenszel, W.: Epidemiological approaches to the study of cancer and other chronic diseases. *Natl. Cancer Inst. Monogr.* 19:1-204, 1966.
20. Hisserich, J. C., Martin, S. P., and Henderson, B. E.: An areawide cancer reporting network. *Public Health Rep.* 90:15-17, 1975.
21. Hochstim, J. R., and Athanasopoulos, D. A.: Personal follow-up in a mail survey—Its contribution and its cost. *Public Opinion Q.* 34:69-81, 1970.
22. Hollingshead, A., and Redlick, F. C.: Social Class and Mental Illness—A Community Study. New York, Wiley, 1958.
23. Human Population Laboratory, California State Department of Public Health: Alameda County Population 1965. Series A. No. 7, April, 1966.
24. Iba, G. B.: Personal communication, July 3, 1974.
25. Kleinman, C. L.: Personal communications, April 11, 1973 and July 30, 1974.
26. Koelliker, P. E.: Personal communication, July 2, 1975.
27. Lemon, F. R., Walden, R. T., and Woods, R. W.: Cancer of the lung and mouth in Seventh-day Adventists. *Cancer* 17:486-497, 1964.
28. Lemon, F. R., and Walden, R. T.: Death from respiratory system disease among Seventh-day Adventist men. *JAMA* 198:117-126, 1966.
29. Lemon, F. R., and Kuzma, J. W.: A biologic cost of smoking—Decreased life expectancy. *Arch. Environ. Health* 18:950-955, 1969.
30. MacNairy, L. N.: Personal communication, May 22, 1974.
31. Mason, T. J., and McKay, F. W.: U.S. Cancer Mortality by County—1950-1969. DHEW Publication No. (NIH) 74-615. Washington, DC, U.S. Government Printing Office, 1974.
32. Olson, E. E.: Personal communications, March 22, 1973 and April 16, 1973.
33. Phillips, R. L.: Cancer and Adventists. *Science* 183:471, 1974.
34. Phillips, R. L.: Prepublication data and personal communication, May 21, 1974.



35. Public Health Service: Smoking and Health—Report of the Advisory Committee to the Surgeon General of the Public Health Service. Public Health Service Publication No. 1103. Washington, DC, U.S. Government Printing Office, 1964.
36. Public Health Service: The Health Consequences of Smoking—A Report to the Surgeon General—1971. Washington, DC, U.S. Government Printing Office, 1971.
37. Public Health Service: Vital Statistics Rates in the United States, 1940–1960. Public Health Service Publication No. 1677. Washington, DC, U.S. Government Printing Office, 1968.
38. Public Health Service: Vital statistics of the United States—1969, 1970, and 1971. Washington, DC, National Center for Health Statistics, 1974.
39. Royal College of Physicians: Smoking and Health Now—A New Report and Summary on Smoking and Its Effects on Health from the Royal College of Physicians. London, Pitman Medical and Scientific, 1971.
40. Seidman, H.: Cancer death rates by site and sex for religious and socioeconomic groups in New York City. *Environ. Res.* 3:234–249, 1970 (and references cited therein).
41. Tobacco Tax Council: The Tax Burden on Tobacco—Historical Compilation, vol. 7. Richmond, VA, 1972; p. 18.
42. United States Brewers Association, Inc.: *Brewers Almanac* 1966. New York, 1966; p. 56.
43. United States Brewers Association, Inc.: *Brewing Industry in the United States—Brewers Almanac* 1972. Washington, DC, 1972.
44. Widtsoe, J. A., and Widtsoe, L. D.: *The Word of Wisdom: A Modern Interpretation*. Salt Lake City, Deseret Book Company, 1950.
45. Wine Institute: Economic Research Report, No. ER-3, September 26, 1968. San Francisco, 1968; p. 14.
46. Wine Institute: 1971 Wine Industry Statistical Report. Economic Research Report No. ER-19, October 13, 1972. San Francisco, 1972.
47. Wynder, E. L., Lemon, F. R., and Bross, I. J.: Cancer and coronary artery disease among Seventh-day Adventists. *Cancer* 12:1016–1028, 1959.
48. Yerushalmy, J.: Statistical considerations and evaluation of epidemiological evidence. In *Tobacco and Health*, G. James and T. Rosenthal, Eds. Springfield, IL, Charles C Thomas, 1962.