Intermetropolitan mortality variations in Canada 1971-1976
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ABSTRACT

This paper is an exploratory study of the intermetropolitan mortality variations in Canada for the years 1971 and 1976. A characterization of the mortality variations based on life expectancies is first performed. Through the use of BACKWARD regression, these variations are then explained by marital status and income variables. Major findings are as follows:

(1) There is an east-west spatial pattern for mortality variation with the eastern Census Metropolitan Areas (CMA's) and northern Ontario CMA's experiencing below average life expectancies and the western CMA's having the highest life expectancies.

(2) Victoria B. C. has the longest life expectancy of all of the CMA's for both 1971 and 1976.

(3) For females, the MARRIED and LOW INCOME (under $1,000) variables are statistically significant, with MARRIED negatively related and LOW INCOME positively related to mortality.

(4) For males, the MARRIED and DIVORCED variables are statistically significant. MARRIED is negatively related to mortality, while a negative relationship was found for DIVORCED although this finding is doubted to be a true relationship.

(5) The levels of explanation are not very high. To know whether the unexplained variation is mostly due to chance variation, future research should add more cities to the sample.

ACKNOWLEDGEMENT

I would sincerely like to thank Dr. K. L. Liaw who spent many long hours working with me on this paper throughout the year. Without his guidance, understanding and knowledge this paper would have been very difficult to complete. I would also like to thank him for allowing me to use his micro-computer and rearranging his busy schedule around me.

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1. INTRODUCTION

Research into the spatial variation in mortality is becoming increasingly recognized as an important area of study. Population geographers as well as the general public are interested in this type of information as well as finding out why these variations exist. Once the mortality pattern is identified, research into the factors which may cause these variations to exist may then be conducted.

Previous studies on spatial variations in mortality in Canada have used the provinces as the basic unit of observation. Other research at the smaller geographical unit of the neighbourhood have also been exercised. It has become apparent that there are persistent and large mortality variations in Canada.

The research for this paper uses the Census Metropolitan Areas (CMA) as the geographical unit of study for the years 1971 and 1976. A CMA according to Mitchell et al (1980) is the main labour market area that is centered around an urbanized core (or continuous built up area with not more than one mile discontinuity) that consists of a population of 100,000 or greater. In studying at this intermediate level of spatial disaggregation, it is hoped that the gap in the literature between research at the provincial and neighbourhood levels will be filled.

Since mortality level differs significantly between the two sexes, a characterization of the mortality pattern will be done separately for each sex. Through this analysis, it will be possible to identify areas with high and low mortality rates.

Once the spatial pattern is determined an attempt will be made to see how these differences may be explained by two socioeconomic factors -- marital status and income.

The focus of this paper is narrowed down to only those people aged 45 years and older. There are two reasons for doing this. First, there are more deaths in these age groups which will lessen the problem of random fluctuation. Random fluctuation is a major problem causing unreliability especially in the younger age groups. An example of the problem of random fluctuation would be the estimation of the death rates of children in the 10-14 year age group. It is difficult to get a reliable estimate because there may be no deaths in a CMA within a calendar year. However, from the age 45 onward, more deaths can be observed in a CMA, resulting in a more reliable estimate of the mortality level. The same holds true for the two socioeconomic factors to be used in this study, an example of this would be the divorcehood in the 15-19 year age group. Since there are very few divorces in this age group, the spatial variation in divorcehood among the CMA's cannot be reliably estimated from the data of a single year. In contrast, people aged 45 and more are likely to be found in the divorced category, making the estimated spatial variation in divorcehood more reliable.

The second reason is the mortality gap. In most CMA's mortality rates at younger ages tend to be similar. However, once the age of 45 is reached the mortality rates tend to climb

differently among different groups. Therefore, significant mortality differences are more likely to exist at older ages.

The outline of this paper is as follows. The second section reviews previous mortality studies which have been done including studies on the relationships between mortality, marital status and income. A discussion of the mortality data and the characterization of the mortality pattern is included in section 3. Section 4 deals with the explanation of the spatial variations in mortality using socioeconomic data on marital status and income. A brief summary and concluding remarks end the paper in section 5.

2. PREVIOUS MORTALITY STUDIES

In his careful study of interprovincial mortality variation, Field (1980, pp. 39-40) has found (1) the most populous province, Ontario, had mortality rates close to the national average, with the Atlantic Region characterized by similar rates, (2) that Quebec had above average mortality (eight percent higher than the national average), and (3) that British Columbia and the three Prairie Provinces had the lowest mortality rates, with Saskatchewan being the lowest (eight percent below the national average).

At the neighbourhood level, Wilkins (1983, p. 40) has found that the mortality level is much higher in the Working Class neighbourhood than in the neighbourhoods where the residents are well-off financially. The residents of the most advantaged areas of the city could be expected to live on average nine years longer.

A study that was carried out at the CMA level by Saveland (1983) on the 1971 data, shows that the mortality pattern is roughly similar to what has been found at the provincial level. In his study, the relative loss of potential years of life from age 15 was used to compare the mortality in each CMA. Saskatoon was found to have a substantially low relative loss in comparison to the other CMA's, with a value of 20 percent below average. Following this, the other western CMA's also show below average rates. The CMA's within Ontario and the Atlantic Region were found to be within 10 percent above or below average. Quebec

City and Montreal both show above average losses, with Quebec City being the higher of the two (16 percent above average). There was a substantial exception to the average findings in Ontario; Sudbury had the highest relative loss with 24.2 percent above average.

Research into two socioeconomic factors (marital status and income) has shown a very significant relationship between these factors and mortality.

Adams and Nagnur (1981) have done research into the relationship of marital status and mortality. By disaggregating the 1975-1977 Canadian demographic data by sex and marital status, they found that mortality varies significantly with marital status as well as with gender. Married men can expect to live 72.07 years from birth, while a man who has never married can expect to live only 64.53 years, with the gap being about eight years. Widowed and divorced men live on average 12 years shorter than a man who was married (60.44 and 60.31 years respectively). The differences in life expectancy among females is also quite large. Married women can expect to live 78.85 years, while a single woman can expect to live only 75.89 years. Widowed and divorced women can expect to live 72.99 and 72.72 years respectively. The gap in life expectancy between married and divorced women is approximately six years.

Wigle and Mao (1980), using the 1971 Census of Canada and mortality data on 2228 census tracts in 21 CMA's have found that people who have a higher income can expect to live longer than

those with a lower income. By using median household income as the income variable, it was found that males in the highest income category can expect to live six years longer than those in the lowest income category. The difference in life expectancy between females in the highest and the lowest income categories is also quite sizeable, ie. three years (Wigle and Mao, 1980, pp. 23,24). Field also suggests that "income and related factors play some role in the more detailed [geographical] patterns [of mortality]" (Field, 1980, pg. 50).

3. THE MORTALITY DATA AND THE MORTALITY PATTERN

3.1 Mortality Data

The mortality data was acquired in the form of life tables from my supervisor Dr. Liaw who obtained the detailed raw data from Dr. D. N. Nagnur of Statistics Canada. These tables contain age-specific death rates as well as the life expectancies for each CMA for both 1971 and 1976.

Officially, there were 22 CMA's in 1971 and 23 CMA's in 1976. The reason for this is that Oshawa was only a Census Agglomeration (CA) in 1971. In this study, the CA values for Oshawa were substituted into the 1971 mortality data.

3.2 Life Expectancy vs Crude Death Rate as an Overall Measure of Mortality Level

Life expectancy is the average number of years to be lived from a specific age. By looking at the differences in life expectancies for males and females between the CMA's, we can identify areas where people live longer and shorter lives.

Life expectancy instead of the crude death rate (CDR) is used as a measure of mortality level in order to make sure that the measure is not biased by the age composition of the population. The CDR is not a suitable measure for comparing the mortality levels of the CMA's because the CMA's differ substantially in age composition. For example, the CDR of Victoria, B. C. is misleadingly high, because Victoria has a high proportion of elderly people.

Therefore, the mortality pattern determined in this study will be based on the life expectancies of both males and females beyond age 45.

3.3 Quality of Information

When doing research it is always necessary to check the quality of the data in order to have confidence in the results. We use two ways to check the mortality data: (1) check whether there is consistency for the same sex between two time periods and (2) check whether there is consistency between the two sexes in the same time period. It is assumed that some amount of consistency should be apparent if the quality of the data is high.

In order to do this the life expectancies at 45 in 1971 and 1976 for both sexes were extracted from the life tables. Four graphs were then constructed for (1) females 1976 against females 1971, (2) males 1976 against males 1971, (3) males 1971 against females 1971 and (4) males 1976 against females 1976. Regression analysis was then performed on the sets of two variables in each graph.

The results show that there is a relatively weak relationship between the data for the same sex between the two time periods. The R^2 for the female values between 1971 and 1976 is low (34.4 percent). Figure 1 shows that the major outlying points are St. John's, Chicoutimi and Oshawa. Since these three CMA's have a very small population, it seems that the mortality data of small CMA's tend to be less reliable. The

relationship for males between 1971 and 1976 is also relatively weak, with the R^2 being 37.8 percent. Figure 2 shows that St. John's, Regina, Saskatoon and Sudbury are the major outlying points. Again, all of them have a relatively small population.

The consistency between the two sexes within the same year is relatively high (see Figures 3 and 4). The values of R^2 are 69.0 percent for 1971 and 68.4 percent in 1976. An examination of the residuals from the two regression analyses shows that there are more outlying points in 1971 than in 1976.

In summary, we conclude (1) that the data for smaller CMA's is less reliable, and (2) that the 1971 data is somewhat less reliable than the 1976 data. In subsequent analysis, we will depend mainly on the 1976 data.

3.4 Comparison of the CMA's to the Rest of Canada

It is interesting to note how the mean life expectancy for the CMA's as a whole compare to the rest of Canada (excluding the CMA's) as well as compare to Canada as a whole. The average life expectancy for females in both years tend to be just slightly higher than the rest of Canada (1971--+0.37, 1976--+0.13 years) (Table 1). The average life expectancy for males living in CMA's tend to be slightly lower than the life expectancy for the non-metropolitan areas with a value of -0.37 years for 1971 and 1976. When comparing the average CMA life expectancies against the Canadian average the same result appears, females in both 1971 and 1976 have slightly higher life expectancies than the Canadian mean (0.25 and 0.09 years

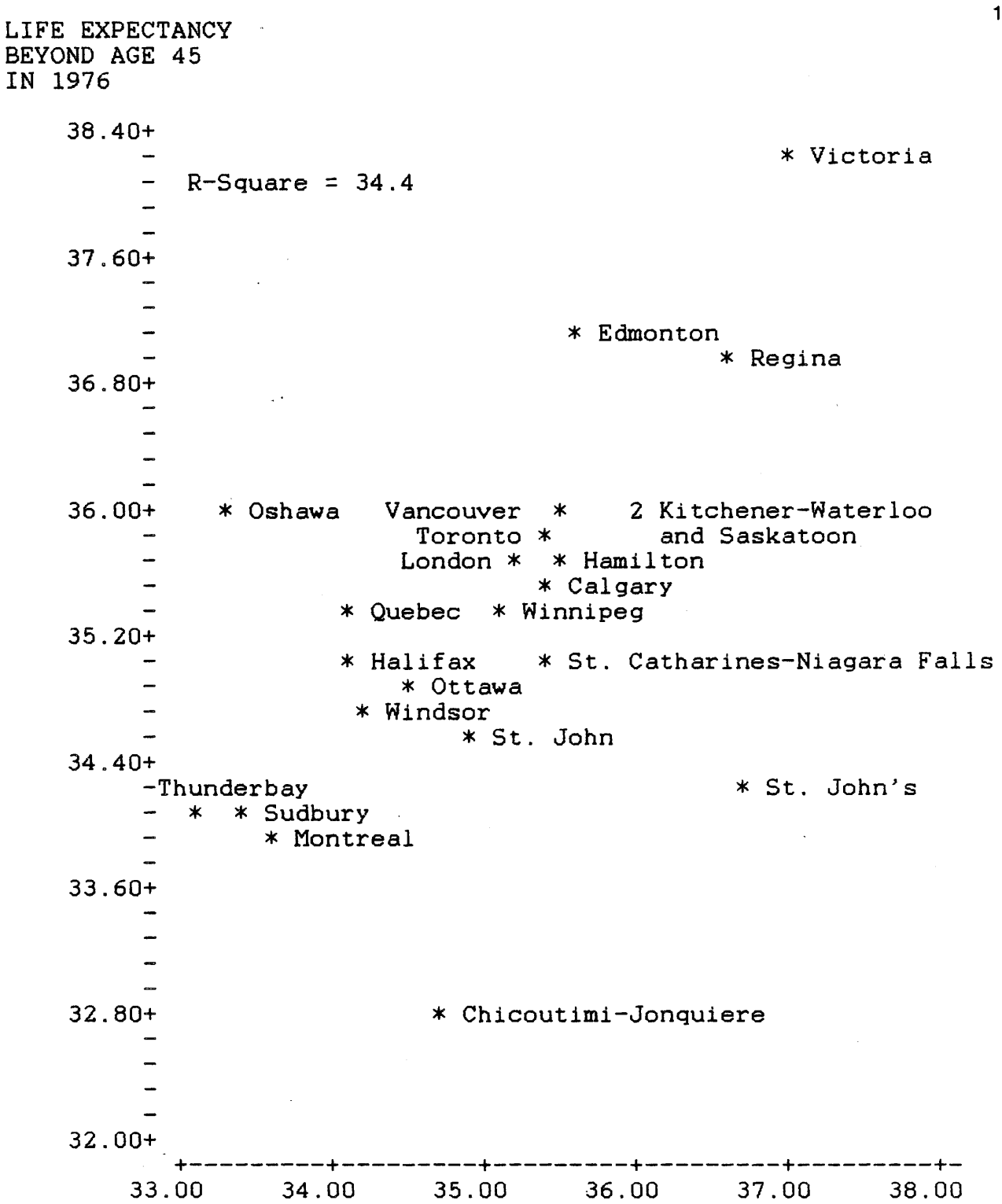

FIGURE 1. THE RELATIONSHIP OF FEMALE LIFE EXPECTANCIES IN 1971 AND 1976 AMONG THE 23 CENSUS METROPOLITAN AREAS.

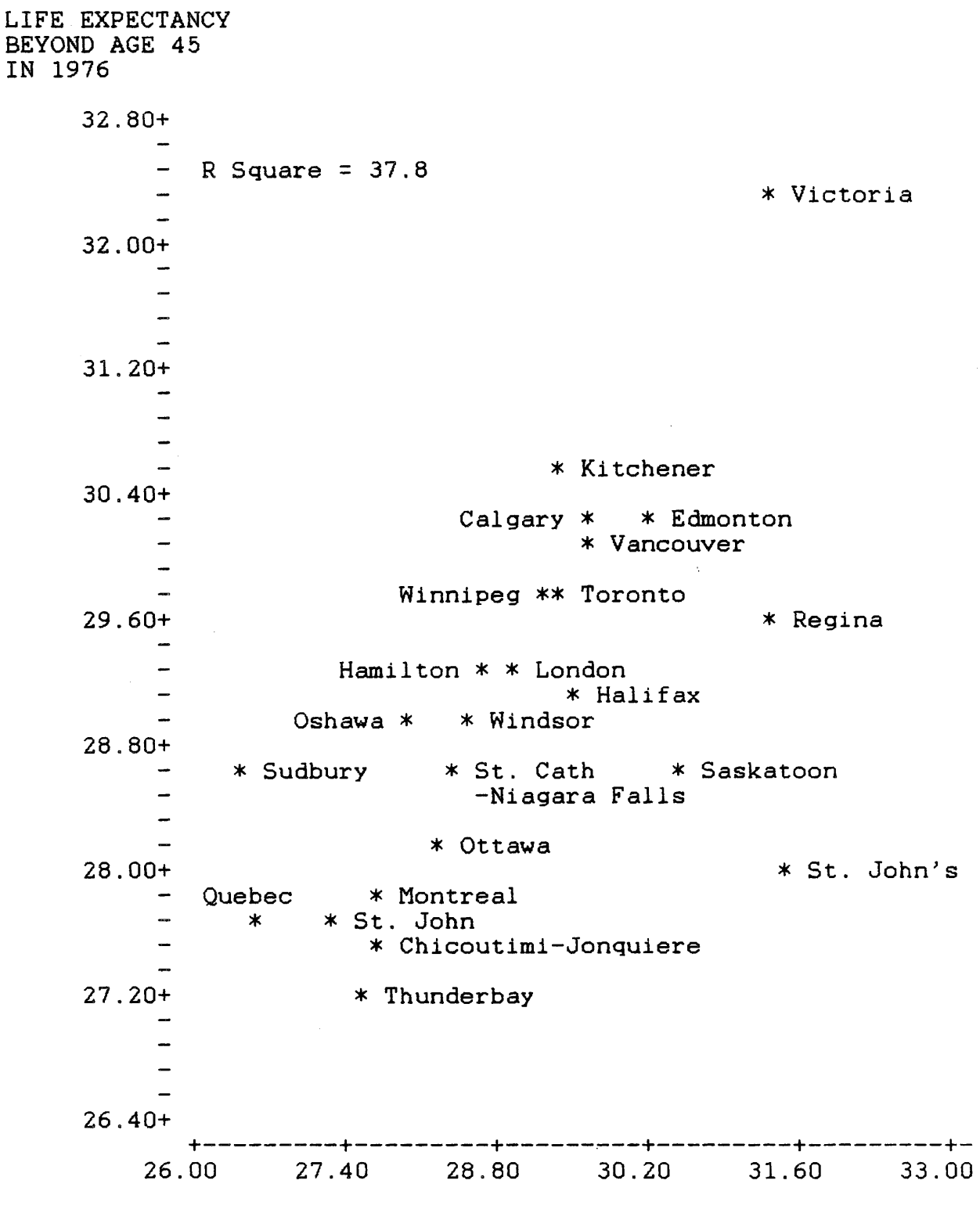

FIGURE 2. THE RELATIONSHIP OF MALE LIFE EXPECTANCIES IN 1971 AND 1976 AMONG THE 23 CENSUS METROPOLITAN AREAS.

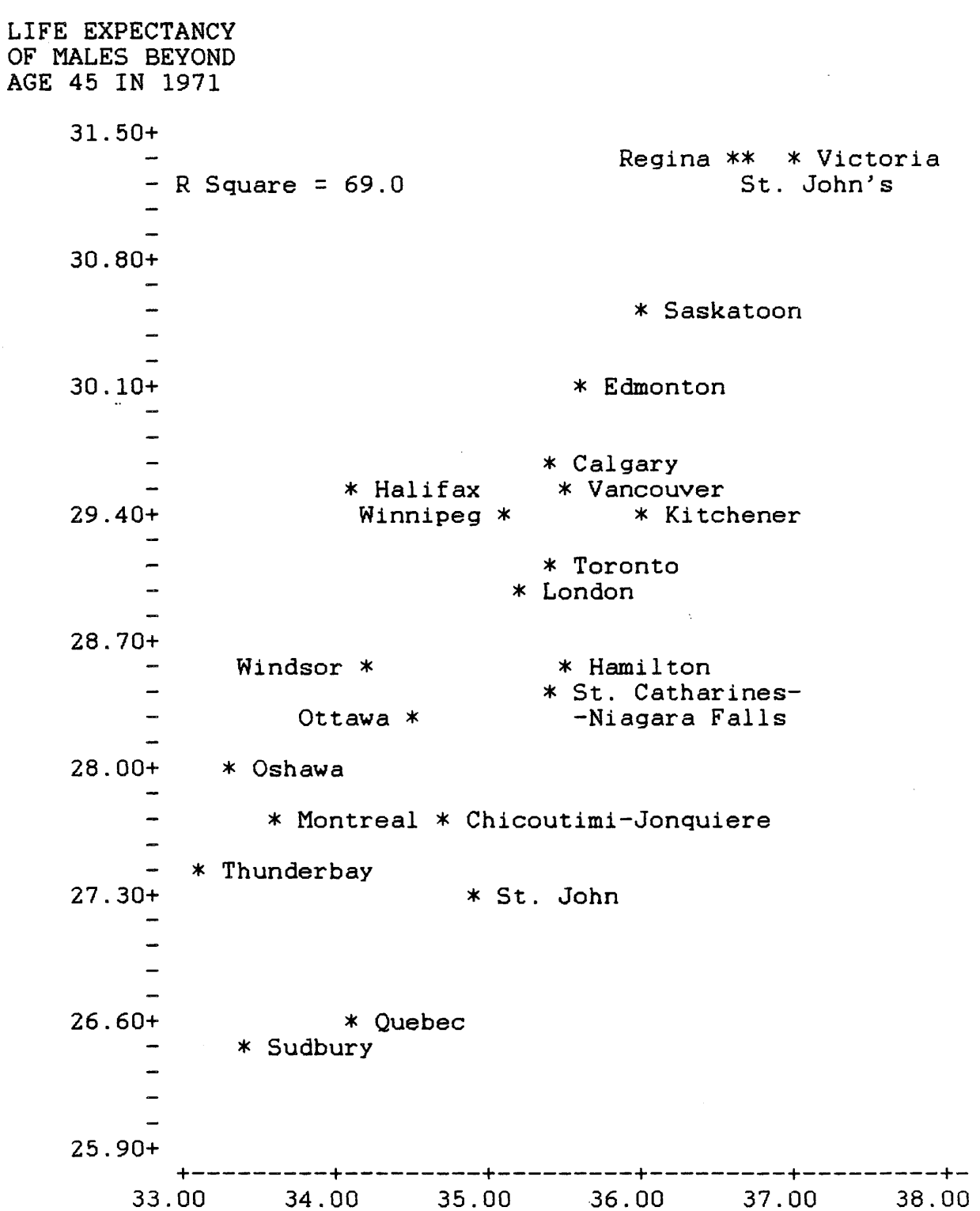

FIGURE 3. THE RELATIONSHIP OF FEMALE AND MALE LIFE EXPECTANCIES IN 1971 AMONG THE 23 CENSUS METROPOLITAN AREAS.

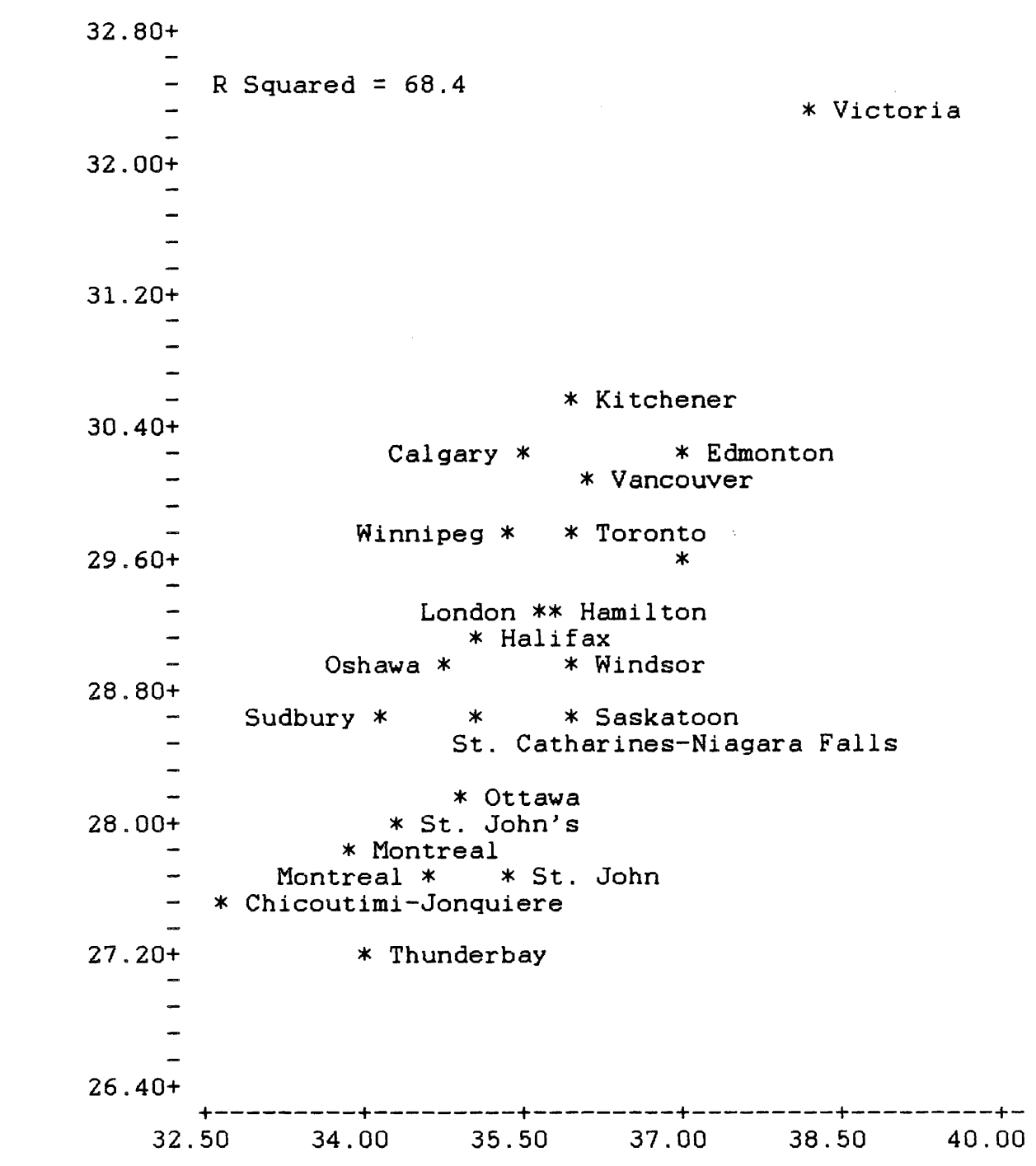

FIGURE 4. THE RELATIONSHIP OF FEMALE AND MALE LIFE EXPECTANCIES IN 1976 AMONG THE 23 CENSUS METROPOLITAN AREAS.

respectively), while men living in the CMA's tend to live slightly shorter lives with the difference being -0.11 and -0.21 years for 1971 and 1976. These comparisons suggest that the level of urbanization is not a primary factor on mortality variation in Canada.

3.5 Intermetropolitan Mortality Variation

It should be mentioned once again that the mortality pattern which will be described is based mainly on the 1976 data due to the stronger confidence placed in it.

The CMA's which have the highest life expectancies for males beyond the age of 45 are Victoria (32.35 years), Kitchener-Waterloo (30.62 years), Calgary (30.21 years) and Edmonton (30.18 years) (Table 1). Since its life expectancy in 1971 was only slightly above the national average, Kitchener-Waterloo seems to have experienced a marked improvement in mortality level during the 1971-76 period. It is interesting to note the wide gap in life expectancy (1.73 years) between Victoria and the second highest CMA.

The CMA's with the lowest life expectancies for males are Thunderbay (27.15 years), Chicoutimi-Jonquiere (27.54 years), Quebec (27.64 years) and St. John, New Brunswick (27.71 years). Being a city with highly polluted air, Sudbury does not fall in these low values surprisingly, it is 14th overall, although for 1971 it was shown to have the lowest life expectancy for males at 26.44 years and relatively low life expectancies for females in both time periods as well.

TABLE 1

LIFE EXPECTANCY AT 45 YEARS OF AGE (e45) FOR THE 23 CMA'S IN CANADA, 1971 AND 1976

	CMA	FEMALES		MALES	
		1971	1976	1971	1976
	ATLANTIC REGION				
1.	ST.JOHN'S	36.73	34.25	31.40	27.95
2.	HALIFAX	34.09	35.09	29.50	29.10
3.	ST. JOHN	34.94	34.60	27.25	27.71
	PROVINCE OF QUEBEC				
4.	CHICOUTIMI	34.71	32.72	27.74	27.54
5.	QUEBEC	34.11	35.28	26.53	27.64
6.	MONTREAL	33.58	33.92	27.73	27.87
	PROVINCE OF ONTARIO				
7.	OTTAWA	34.46	34.94	28.26	28.08
8.	OSHAWA	33.33	36.01	28.01	28.92
9.	TORONTO	35.44	35.88	29.17	29.80
10.	HAMILTON	35.52	35.71	28.62	29.32
11.	ST. CATHARINES	35.38	35.04	28.36	28.66
12.	KITCHENER	36.04	36.00	29.39	30.62
13.	LONDON	35.23	35.73	29.00	29.31
14.	WINDSOR	34.19	34.73	28.52	29.00
15.	SUDBURY	33.42	34.14	26.44	28.70
16.	THUNDERBAY	33.09	34.03	27.48	27.15
	WESTERN REGION				
17.	WINNIPEG	35.14	35.39	29.33	29.72
18.	REGINA	36.55	36.96	31.36	29.58
19.	SASKATOON	35.98	36.02	30.49	28.69
20.	CALGARY	35.41	35.54	29.68	30.21
21.	EDMONTON	35.59	37.04	30.16	30.18
22.	VANCOUVER	35.49	36.07	29.57	30.10
23.	VICTORIA	37.03	38.27	31.30	32.35
24.	REST OF CANADA	34.65	35.23	29.30	29.42
25.	CANADA	34.77	35.27	29.04	29.26

In comparing the two extremes, males living in Victoria B.C. can expect to enjoy living 5.2 years longer than males living in Thunderbay, Ontario.

The CMA's with the highest life expectancies with respect to females are all western CMA's: Victoria (38.27 years), Edmonton (37.04 years), Regina (36.96 years) and Vancouver (36.07 years). Victoria has a life expectancy for females 1.23 years longer than the second highest CMA.

The CMA's where females life expectancies are shortest are Chicoutimi-Jonquiere (32.72 years), Montreal (33.92 years), Thunderbay (34.03 years) and Sudbury (34.14 years). The difference between the two extremes is 5.55 years.

For males, 13 CMA's fall below the Canadian average of 29.26 and 10 CMA's fall above. There are 14 of the 23 CMA's clustered within one year of the male Canadian average in both a positive and negative direction, two of the remaining 9 CMA's fall above the Canadian average by more than one year (Victoria and Kitchener-Waterloo), and 7 fall below by more than one year. The two lowest CMA's,Thunderbay and Chicoutimi have values 2.11 and 1.72 years below the Canadian average.

For females, only 9 CMA's fall below the Canadian average of 35.27 years and 14 CMA's are above the average. Of the 23 CMA's 15 have a life expectancy within one year either side of the Canadian average. Eight CMA's, therefore, fall above or below the Canadian average by more than one year. Three of these eight CMA's have life expectancies of greater than one year

above the Canadian mean: Victoria (3.0 years above), Edmonton (1.77 years) and Regina (1.69 years above). The two lowest of the five CMA's below the Canadian average life expectancy by more than one year are Chicoutimi-Jonquiere (2.55 years below) and Montreal (1.35 years below).

Based on the life expectancies of both males and females a spatial pattern can be seen to exist across Canada. The CMA's in the Atlantic region have slightly below average life expectancies, Quebec CMA's have values below those found in the Atlantic CMA's, Ontario tends to have average or slightly above average life expectancies with the exception of the northern CMA's (Sudbury and Thunderbay), which have life expectancies far below the Canadian average. The Prairie Provinces have CMA's which have above average life expectancies, while British Columbian CMA's have the highest life expectancies of all. As can be seen from this spatial pattern, life expectancies tend to increase in a westerly direction across Canada, dipping lower from the Atlantic Region to Quebec and then increasing from there to British Columbia.

4. EXPLANATION OF THE SPATIAL VARIATION IN MORTALITY

4.1 The Explanatory Variables

It has been shown thus far that there are variations in mortality between the CMA's. To further explore these variations data was collected on two socioeconomic factors (marital status and income) in order to study the relationship between these explanatory variables and mortality. The marital status data was collected for 1971 and 1976 for both sexes for each CMA. The numbers of males and females in each CMA for the age groups 45-49, 50-54,...90+ who were single, married, widowed and divorced were given in this data. The income data was only available for the year 1971, since the census for the mid years (1966, 1976, 1986,...) are not as indepth as the census given in (1961, 1971, 1981,...). These intermediate censuses do not ask as many questions, therefore, no income questions are asked. As a result, the analysis will have to use the 1971 income to explain the variations in both 1971 and 1976.

The income data is available for three age groups (45-54, 55-64 and 65+) and for both sexes in each CMA. There were nine income categories for males (ranging from No Income to $15,000+) and eight for females (ranging from No Income to $10,000+). However, when matching this income data to the 1976 mortality and marital status data, the age groups were aligned such that income for the age group 45-54 was matched with the marital status age groups 50-54 and 55-59; the 55-64 income data was matched with the 60-64 and 65-69 marital status data; and the 65+ income data

was matched with the remaining age groups in the marital status data. The data for both variables were arranged so that the age specific percentage of males and females in each category for each CMA were obtained.

To study the effect of marital status on mortality the following four explanatory variables are used:

1. SINGLE - The percentage of a CMA's population who are single in a specific age group.

2. MARRIED -- The percentage of a CMA's population who are married in a specific age group.

3. WIDOWED -- The percentage of a CMA's population who are widowed in a specific age group.

4. DIVORCED -- The percentage of a CMA's population who are divorced in a specific age group.

Furthermore, to study the effect of income on mortality, we use only one more explanatory variable.

5. LOW INCOME -- The percentage of a CMA's female population who have an income under $1,000, or the percentage of a CMA's male population who have an income under $2,000.

The values of these five variables for a few selected age groups are shown in Appendix Tables A-H.

4.2 The Hypotheses and the Statistical Method

The age-specific mortality rate was calculated by dividing the number of deaths in the age group by the number of people in that age group. The logit of the mortality rate was used as the dependent variable.

It was hypothesized that the signs of the regression coefficients would be as follows: positive for LOW INCOME

(i.e. the risk of dying is hypothesized to be higher for low income groups), the same was also expected for the WIDOWED and DIVORCED variables. Positive values were expected for the MARRIED variable which implies that as the percentage of the married population increases the mortality rate decreases. The regression coefficient for the explanatory variable SINGLE is expected to be negative for younger age groups where most of the people who are not single are mostly married (rather than being widowed or divorced). However, for older age groups, SINGLE may have a negative sign because many of the very old people who are not single may be either widowed or divorced and because single people tend to live longer than those who are widowed or divorced.

A multiple regression procedure using the BACKWARD method was performed in order to see which of the five explanatory variables have a significant relationship with mortality.

In this method, as many explanatory variables as possible are included in the model at the beginning, the least important variable is removed at each step. The procedure continues, until all remaining variables have a POUT value (the probability of committing a Type One error) equal to or less than .10.

4.3 The Statistical Results

The BACKWARD regression shows the data for females 1976 to have the best results with all of the regression coefficients having the expected sign and every age group except the last has

at least one significant variable. It becomes apparent from this result that the explanatory variables LOW INCOME and MARRIED are most significant in explaining the mortality rates for females 1976 (Table 2). LOW INCOME is the sole significant variable for the age groups 50-54 and 60-64, MARRIED is the single significant variable for the age group 75-79. Both LOW INCOME and MARRIED are included in the equation for the age groups 70-74 and 80-84 with the R^2 for these two age groups being 0.49 and 0.41 respectively. WIDOWED is significant for two age groups: singularly for 55-59 and coupled with MARRIED for the age group 65-69. The explanatory variables SINGLE and DIVORCED are not included in the equation for any age group, and there were no significant variables for the age group 85-89.

For the female 1971 data a similar result occurs (Table 3). MARRIED is the sole explanatory variable for the age group 80-84. LOW INCOME and MARRIED together are significant for the age groups 65-69 and 70-74 with R^2 being as high as 0.77 and 0.62 respectively. MARRIED, WIDOWED and DIVORCED are significant for the age group 45-49. However, the regression coefficient for the MARRIED variable has the opposite sign to that expected. There were no significant variables for the age groups 50-54, 55-59, 60-64, 75-79 and 85-89 and single was not significant for any age group.

When looking at the variables which are significant for males in both 1971 and 1976 (bottom half of Tables 2 and 3), a confusing result occurs. The explanatory variable DIVORCED,

TABLE 2

BACKWARD REGRESSION OF THE MORTALITY LOGIT AGAINST MARITAL STATUS AND INCOME VARIABLES 1976

AGE GRP	INCOME	SINGLE	MARRIED	WIDOWED	DIVORCED	R	ADJR	DF
			FEMALES					
50-54	0.01 (2.8)	----	----	----	----	0.28	0.25	20
55-59	----	----	----	0.1 (2.5)	----	0.24	0.20	20
60-64	0.01 (2.9)	----	----	----	----	0.30	0.27	20
65-69	----	----	-0.03 (-3.0)	0.05 (3.6)	----	0.55	0.50	19
70-74	0.1 (4.1)	----	-0.02 (-2.2)	----	----	0.49	0.43	19
75-79	----	----	-0.03 (-2.8)	----	----	0.29	0.25	20
80-84	0.03 (2.2)	----	-0.05 (-2.8)	----	----	0.41	0.35	19
85-89	----	----	----	----	----	----	----	--
			MALES					
50-54	----	----	-0.1 (-2.6)	----	-0.1 (-2.8)	0.41	0.35	19
55-59	----	----	----	0.3 (3.4)	-0.1 (-2.5)	0.63	0.59	19
60-64	----	----	----	----	-0.1 (-3.7)	0.40	0.37	20
65-69	----	----	-0.03 (-2.7)	----	-0.1 (-3.2)	0.49	0.44	19
70-74	0.1 (4.1)	----	----	0.05 (4.6)	----	0.67	0.63	19
75-79	----	0.02 (2.4)	----	----	-0.1 (-2.7)	0.39	0.33	19
80-84	----	-0.03 (-2.5)	-0.03 (-3.8)	----	----	0.43	0.37	19
85-89	----	----	----	----	----	----	----	--

Note: The variables shown are only those which remained in the equation after using BACKWARD regression.

TABLE 3

BACKWARD REGRESSION OF THE MORTALITY LOGIT AGAINST MARITAL STATUS AND INCOME VARIABLES 1971

AGE GRP	INCOME	SINGLE	MARRIED	WIDOWED	DIVORCED	R	ADJR	DF
			FEMALES					
45-49	----	----	0.6 (2.6)	0.2 (3.4)	0.1 (2.3)	0.43	0.33	18
50-54	----	----	----	----	----	----	----	--
55-59	----	----	----	----	----	----	----	--
60-64	----	----	----	----	----	----	----	--
65-69	0.05 (6.2)	----	-0.3 (-6.7)	----	----	0.77	0.75	19
70-74	0.1 (5.0)	----	-0.03 (-3.5)	----	----	0.62	0.58	19
75-79	----	----	----	----	----	----	----	--
80-84	----	----	-0.3 (-2.7)	----	----	0.26	0.22	20
85-89	----	----	----	----	----	----	----	--
			MALES					
45-49	----	----	----	----	----	----	----	--
50-54	----	----	-0.05 (-3.2)	----	-0.1 (-2.3)	0.43	0.37	19
55-59	----	----	----	----	----	----	----	--
60-64	-0.03 (-2.9)	----	-0.04 (-2.8)	----	-0.1 (-3.4)	0.55	0.48	18
65-69	----	----	-0.1. (-3.1)	----	----	0.33	0.29	20
70-74	-0.01 (-2.8)	----	-0.04 (-5.3)	----	----	0.61	0.57	19
75-79	----	----	----	----	----	----	----	--
80-84	----	----	----	0.03 (3.3)	----	0.35	0.32	20
85-89	----	----	----	----	----	----	----	--

Note: The variables shown are only those which remained in the equation after using BACKWARD regression.

although significant for several age groups, has a wrong sign (i.e. it consistently has a negative rather than positive sign). In two age groups, the LOW INCOME variable also remains in the regression model with a wrong sign. However, the remaining three marital status variables all have correct signs when they are retained in the regression model.

The unexpected finding for the explanatory variables DIVORCED and LOW INCOME cannot be generalized for individual persons without committing what is called the Ecological Fallacy. The Ecological Fallacy occurs when results found in a study at the aggregate ecological level are inferred to the individual level. By inferring the results of the study to the individual level, there may be error due to the fact that other influential variables are missing from the data set. The relationship between two variables could be due to their dependence on a third missing variable. In the case of the negative relationship between DIVORCED and mortality rates, this could also be due to missing some other factor such as pollution or occupation. Perhaps in the west where there is a high percentage of divorced individuals, the pollution content in the air is quite low, thus decreasing the mortality rate. In the research for this paper only marital status and income variables are used as explanatory variables with no variable set out for such relevant variables as pollution and occupation. Therefore, the divorce variable may have also taken on the effects on mortality which are explained by pollution, leaving a negative relationship

instead of a positive one. The reason that this negative relationship between divorce and mortality is doubted to be a real one is the fact that Adams and Nagnur (1981) performed a study on mortality and marital status at the individual level which found that those people who were divorced tended to live shorter lives than those who were married and single. From this we hypothesize that mortality and divorce would have a positive relationship. Therefore, little confidence is placed in the fact that this study has found mortality and DIVORCED to have a negative relationship.

5. CONCLUSION

This study has investigated the intermetropolitan mortality variations in Canada. A characterization of the mortality variations between Canada's CMA's has been made as well as an explanation of some of this variation through the use of the two socioeconomic factors -- marital status and income.

The quality of the mortality data used in this study was checked and it was found that (1) the data for smaller CMA's is less reliable and (2) the 1971 data is somewhat less reliable than the 1976 data. Therefore, the subsequent analyses were based mainly on the 1976 data.

The characterization of the mortality pattern showed that life expectancies increase in a westward direction with the Atlantic CMA's having slightly below average life expectancies. Quebec CMA's have life expectancies below those in the Atlantic Region. Ontario CMA's have average to slightly above average life expectancies with the exception of the northern CMA's (Sudbury and Thunderbay), which have the lowest life expectancies of all of the Canadian CMA's. The CMA's in the Prairie Provinces have above average life expectancies, while British Columbia has the CMA's with the longest life expectancies.

Most explanatory variables, when they are significant, turned out to have the hypothesized effects. However, the levels of explanation in most cases are not very high. Since the degrees of freedom are rather small, it is not clear if the large unexplained variability is due to chance variation or some

factors like pollution and differences in occupational structure. To settle this important question, future research should add more cities to the sample.

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APPENDIX

TABLE A

PERCENTAGE OF MALES AGED 45-49 IN EACH MARITAL STATUS CATEGORY IN THE 23 CMA'S IN 1976

INDEX	CMA	SINGLE	MARRIED	WIDOWED	DIVORCED
		ATLANTIC REGION			
1	ST. JOHN'S	10.1	87.8	1.0	.8
2	HALIFAX	8.0	88.3	1.0	2.6
3	ST. JOHN	8.8	87.3	.9	3.1
		PROVINCE OF QUEBEC			
4	CHICOUTIMI	6.9	90.8	1.1	1.4
5	QUEBEC	11.6	85.5	1.0	1.9
6	MONTREAL	8.9	87.4	1.2	2.5
		PROVINCE OF ONTARIO			
7	OTTAWA-HULL	6.5	89.9	1.0	2.5
8	OSHAWA	5.4	91.5	1.0	2.1
9	TORONTO	7.0	89.6	.9	2.5
10	HAMILTON	5.5	91.1	.9	2.5
11	ST.CATHARINES	5.2	91.5	.8	2.5
12	KITCHENER	5.5	91.7	.8	2.2
13	LONDON	5.0	91.5	.7	2.8
14	WINDSOR	7.1	89.2	.9	2.9
15	SUDBURY	7.0	90.1	1.4	1.6
16	THUNDERBAY	10.0	86.5	1.0	2.6
		WESTERN REGION			
17	WINNIPEG	7.2	89.1	.8	2.9
18	REGINA	6.5	89.9	1.1	2.8
19	SASKATOON	6.7	90.2	1.0	2.1
20	CALGARY	5.4	89.7	.8	4.1
21	EDMONTON	7.4	88.2	.8	3.6
22	VANCOUVER	8.3	86.5	.9	4.4
23	VICTORIA	5.4	89.8	.9	3.9

TABLE B

PERCENTAGE OF MALES AGED 65-69 IN EACH MARITAL STATUS CATEGORY IN THE 23 CMA'S IN 1976

INDEX	CMA	SINGLE	MARRIED	WIDOWED	DIVORCED
		ATLANTIC REGION			
1	ST. JOHN'S	10.9	81.2	7.9	.6
2	HALIFAX	9.9	79.9	8.5	1.9
3	ST. JOHN	9.9	81.2	7.8	1.5
		PROVINCE OF QUEBEC			
4	CHICOUTIMI	6.2	84.5	9.3	.4
5	QUEBEC	12.3	79.1	7.9	.6
6	MONTREAL	8.6	81.8	8.5	1.1
		PROVINCE OF ONTARIO			
7	OTTAWA-HULL	7.7	83.7	7.6	1.1
8	OSHAWA	6.4	84.0	7.7	1.7
9	TORONTO	7.0	83.6	7.6	1.8
10	HAMILTON	6.3	85.0	7.2	1.7
11	ST.CATHARINES	6.5	86.1	6.2	1.3
12	KITCHENER	6.3	85.7	6.8	1.2
13	LONDON	7.5	83.6	7.3	1.6
14	WINDSOR	7.1	83.5	7.6	2.0
15	SUDBURY	8.0	79.8	10.4	1.8
16	THUNDERBAY	11.9	77.7	8.6	1.8
		WESTERN REGION			
17	WINNIPEG	7.9	83.1	7.0	2.1
18	REGINA	6.8	86.0	5.5	1.8
19	SASKATOON	6.9	86.0	4.9	1.9
20	CALGARY	7.2	83.3	6.4	3.1
21	EDMONTON	8.2	82.4	6.3	3.0
22	VANCOUVER	8.9	80.8	7.0	3.3
23	VICTORIA	4.8	87.2	5.2	2.7

TABLE C

PERCENTAGE OF FEMALES AGED 45-49IN EACH MARITAL STATUS CATEGORY IN THE 23 CMA'S IN 1976

INDEX	CMA	SINGLE	MARRIED	WIDOWED	DIVORCED
		ATLANTIC REGION			
1	ST. JOHN'S	7.9	84.6	5.7	1.7
2	HALIFAX	7.4	83.6	5.0	4.1
3	ST. JOHN	7.5	83.6	5.6	3.3
		PROVINCE OF QUEBEC			
4	CHICOUTIMI	9.0	83.4	5.6	1.9
5	QUEBEC	15.4	76.6	5.1	2.8
6	MONTREAL	9.6	81.6	5.0	3.8
		PROVINCE OF ONTARIO			
7	OTTAWA-HULL	7.1	84.5	4.6	3.8
8	OSHAWA	3.1	89.8	4.2	2.9
9	TORONTO	6.0	85.4	4.2	4.4
10	HAMILTON	4.1	88.4	4.1	3.5
11	ST. CATHARINES	3.5	89.1	4.3	3.0
12	KITCHENER	4.6	88.1	4.1	3.2
13	LONDON	4.9	86.2	4.1	4.9
14	WINDSOR	4.6	86.4	4.8	4.2
15	SUDBURY	2.6	89.8	5.5	1.9
16	THUNDERBAY	3.5	87.9	5.9	2.9
		WESTERN REGION			
17	WINNIPEG	7.0	83.9	4.7	4.5
18	REGINA	5.6	84.8	5.2	4.5
19	SASKATOON	7.0	83.3	5.7	4.2
20	CALGARY	4.3	84.8	3.9	7.0
21	EDMONTON	4.6	85.0	4.1	6.3
22	VANCOUVER	5.3	83.9	4.2	6.6
23	VICTORIA	4.4	85.5	3.7	6.4

TABLE D

PERCENTAGE OF FEMALES AGED 65-69 IN EACH MARITAL STATUS CATEGORY IN THE 23 CMA'S IN 1976

INDEX	CMA	SINGLE	MARRIED	WIDOWED	DIVORCED
		ATLANTIC REGION			
1	ST. JOHN'S	11.7	51.4	36.1	.5
2	HALIFAX	13.0	51.9	33.5	1.6
3	ST. JOHN	13.9	49.6	34.7	1.7
		PROVINCE OF QUEBEC			
4	CHICOUTIMI	11.1	54.5	34.4	.4
5	QUEBEC	24.0	44.3	31.3	.4
6	MONTREAL	15.5	48.7	34.6	1.2
		PROVINCE OF ONTARIO			
7	OTTAWA-HULL	15.0	48.5	35.0	1.6
8	OSHAWA	5.8	54.0	37.8	2.1
9	TORONTO	9.3	52.2	36.0	2.5
10	HAMILTON	8.3	55.9	34.0	1.8
11	ST.CATHARINES	5.8	58.0	34.7	1.4
12	KITCHENER	9.6	56.6	32.5	1.3
13	LONDON	10.0	53.5	34.2	2.3
14	WINDSOR	6.2	55.0	36.7	2.0
15	SUDBURY	5.5	55.3	37.8	.9
16	THUNDERBAY	5.5	54.6	39.2	1.3
		WESTERN REGION			
17	WINNIPEG	10.5	52.6	34.6	2.3
18	REGINA	10.5	52.9	34.6	2.0
19	SASKATOON	8.7	55.7	33.6	2.3
20	CALGARY	6.1	55.9	35.0	2.9
21	EDMONTON	6.0	55.3	35.6	3.0
22	VANCOUVER	7.4	55.2	33.3	4.0
23	VICTORIA	9.2	59.5	28.3	3.0

TABLE E

RANKING OF THE PERCENTAGE OF MALES AGED 45-49 IN THE LOW INCOME CATEGORY FROM HIGHEST TO LOWEST FOR THE 22 CMA'S IN 1971

CMA	RANK	PERCENTAGE
ST. JOHN'S	1	12.13
QUEBEC	2	9.92
ST. JOHN	3	9.84
VANCOUVER	4	8.62
MONTREAL	5	8.38
REGINA	6	6.83
SASKATOON	7	6.74
LONDON	8	6.69
HALIFAX	9	6.17
CHICOUTIMI	10	6.16
VICTORIA	11	5.82
EDMONTON	12	5.80
WINNIPEG	13	5.59
TORONTO	14	5.55
THUNDERBAY	15	5.45
CALGARY	16	5.08
WINDSOR	17	5.01
OTTAWA-HULL	18	4.87
ST. CATHARINES	19	4.81
HAMILTON	20	4.59
KITCHENER	21	4.22
SUDBURY	22	3.17

NOTE: Those males included in the low income category have an income less than $2,000.

TABLE F

RANKING OF THE PERCENTAGE OF MALES AGED 65+ IN THE LOW INCOME CATEGORY FROM HIGHEST TO LOWEST FOR THE 22 CMA'S IN 1971

CMA	RANK	PERCENTAGE
ST. JOHN'S	1	46.94
CHICOUTIMI	2	46.18
THUNDERBAY	3	44.96
SASKATOON	4	42.53
EDMONTON	5	42.34
VANCOUVER	6	41.60
QUEBEC	7	40.31
CALGARY	8	39.57
MONTREAL	9	38.10
ST.JOHN	10	37.19
WINNIPEG	11	36.71
REGINA	12	35.43
OTTAWA-HULL	13	33.49
HALIFAX	14	32.67
HAMILTON	15	32.38
TORONTO	16	32.27
ST. CATHARINES	17	31.70
LONDON	18	30.93
KITCHENER	19	30.86
SUDBURY	20	30.03
VICTORIA	21	28.79
WINDSOR	22	27.26

NOTE: Those males included in the low income category have an income less than $2,000.

TABLE G

RANKING OF THE PERCENTAGE OF FEMALES AGED 45-49 IN THE LOW INCOME CATEGORY FROM HIGHEST TO LOWEST FOR THE 22 CMA'S IN 1971

CMA	RANK	PERCENTAGE
CHICOUTIMI	1	78.16
ST. JOHN'S	2	66.40
QUEBEC	3	63.85
SUDBURY	4	61.69
MONTREAL	5	55.36
ST. CATHARINES	6	55.17
HAMILTON	7	53.63
ST. JOHN	8	53.61
WINDSOR	9	53.05
HALIFAX	10	52.10
THUNDERBAY	11	51.81
VANCOUVER	12	49.22
VICTORIA	13	48.35
CALGARY	14	47.84
OTTAWA-HULL	15	46.73
SASKATOON	16	46.37
EDMONTON	17	45.75
LONDON	18	45.66
WINNIPEG	19	45.23
KITCHENER	20	44.46
REGINA	21	42.90
TORONTO	22	42.63

NOTE: The females included in the low income category have an income less than $1,000.

TABLE H

RANKING OF THE PERCENTAGE OF FEMALES AGED 65+ IN THE LOW INCOME CATEGORY FROM HIGHEST TO LOWEST FOR THE 22 CMA'S IN 1971

CMA	RANK	PERCENTAGE
SUDBURY	1	25.69
WINDSOR	2	21.90
ST. CATHARINES	3	20.48
THUNDERBAY	4	20.18
CHICOUTIMI	5	19.46
SASKATOON	6	19.37
HAMILTON	7	19.24
KITCHENER	8	18.97
TORONTO	9	18.70
MONTREAL	10	18.64
QUEBEC	11	18.11
WINNIPEG	12	17.77
HALIFAX	13	17.41
CALGARY	14	17.34
VICTORIA	15	17.00
ST. JOHN	16	16.81
OTTAWA	17	16.73
VANCOUVER	18	16.67
EDMONTON	19	16.65
LONDON	20	16.32
ST. JOHN'S	21	15.70
REGINA	22	14.92

NOTE: Those females included in the low income category have an income of less than $1,000.