INFORMATION TO USERS

The most advanced technology has been used to photograph and reproduce this manuscript from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book. These are also available as one exposure on a standard 35mm slide or as a 17" x 23" black and white photographic print for an additional charge.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

UMI

University Microfilms International
A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
313/761-4700 800/521-0600

Order Number 8912136

Socioeconomic factors associated with geographical variations in cerebrovascular disease in Miyagi Prefecture, Japan

Sato, Tokiko, Ph.D.

University of Hawaii, 1988

Copyright ©1988 by Sato, Tokiko. All rights reserved.

U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

SOCIOECONOMIC FACTORS ASSOCIATED WITH GEOGRAPHICAL VARIATIONS IN CEREBROVASCULAR DISEASE IN MIYAGI PREFECTURE, JAPAN

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF
THE UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN GEOGRAPHY

DECEMBER 1988

By

Tokiko Sato

Dissertation Committee:

R. Warwick Armstrong, Chairman
Nancy D. Lewis
Forrest R. Pitts
David H. Kornhauser
Robert W. Gardner
Heather-Jo Hammer

© Copyright by Tokiko Sato 1988
All Rights Reserved

ACKNOWLEDGMENTS

First, I wish to thank my doctoral committee members and fellow graduate students who encouraged and supported me during the preparation and analysis for this dissertation. I wish to thank them all. I also wish to thank the Department of Environmental Health of Miyagi Prefecture, the Health and Hygiene Branch of Karakuwa, the Health Branch of Shiwahime and the residents of Karakuwa and Shiwahime for their patience and warm support in conducting this research. Particularly my deep appreciation goes to Mr. T. Yoshida, the former Chief of Health Statistics at the Branch of Community Health, the Department of Environmental Health of Miyagi Prefecture. He played an important liaison role with the prefectural and local administrators. Without his advice and support I would never have been able to have completed this research.

My thanks also go to Professor Hiroshi Yoshino, Department of Architecture at University of Tohoku, Sendai, Japan, for his kind technical assistance and Professor Masako Sakamoto-Momiyama, Director of the Institute of Medical Geography and Statistics, Tokyo, Japan, for her constant encouragement and support during the field research.

Finally, my deep gratitude goes to my parents who were very generous to me in pursuing higher education. I am glad I can finally give them some relief by completing my long years of education in a foreign country.

Monetary support was provided by the U.S. National Science Foundation Doctoral Dissertation Research Grant, by the East-West Population Institute, Honolulu, Hawaii, and by the Institute of Architecture for Housing, Tokyo, Japan.

ABSTRACT

Mortality from cerebrovascular disease (hereafter called stroke) has marked geographical variations in Japan. It is generally lower in urban and fishing areas than in agricultural areas. This research seeks an explanation for the variations. Particular attention is given to associations with socioeconomic factors which have received less attention than dietary and clinical factors related to stroke. The research tests hypotheses that the distribution of stroke is associated with certain socioeconomic factors. The term "socioeconomic" as used in this research is broadly defined: it includes individual styles of life and behavioral patterns. The specific socioeconomic factors tested are: (1) indoor thermal environment, (2) level of physical work, (3) long absence from home, (4) diet, and (5) health-promoting behavior.

The investigation had two components. First, using data from a mail survey, the relationship between study factors and the frequency of male and female stroke mortality was examined in seven cities and towns which had significantly high or low standardized mortality ratios (SMR) for stroke, in comparison to the SMR of Miyagi as a whole. Second, a detailed investigation of the relationship between socioeconomic factors and stroke mortality was conducted at the indivdiual level, using a matched-pairs case-control design, in two selected towns with different socioeconomic compositions: Shiwahime, an agricultural town with relatively high stroke mortality, and Karakuwa, a fishing town with relatively low stroke mortality. Interviews were conducted with

the spouses of 35 cases and 35 controls in Shiwahime and the spouses of 34 cases and 34 controls in Karakuwa.

Hypertension is a major cause of stroke mortality in Japan. However, high blood lipid levels do not appear to play as important a role as they do in western countries. But hypertension does not seem to be the only causal factor, as evidenced by relatively low stroke mortality rates among people in fishing areas where the prevalence of hypertension is not necessarily lower than in agricultural areas. It is concluded that factors such as high salt intake which is associated with hypertension, a lack of regular blood pressure check-ups, and a poor indoor thermal environment contribute to high stroke mortality rates.

It has been demonstrated that exposure to a sudden change in ambient temperature (by going from a heated room to an unheated room) produces a sharp rise in blood pressure in hypertensive people. Thus, contrasting temperatures in indoor environments can possibly increase the risk of stroke by suddenly elevating the level of blood pressure, particularly for those who already have hypertension.

Hypertension control has for some time been a prime public health initiative in order to decrease stroke mortality rates in Japan. A campaign which focuses on a reduction in the high salt intake associated with hypertension has received particular attention. This research sheds new light on stroke studies by emphasizing the importance of improving the indoor thermal environment, particularly in harsh climates, as another means to reduce the risk of stroke. The research also delineates the significant features of stroke patterns in the Japanese context and provides data for cross-cultural comparative studies of this disease.

TABLE OF CONTENTS

ACKNOWLEDGMENTS iii

ABSTRACT iv

LIST OF TABLES ix

LIST OF FIGURES xi

CHAPTER I INTRODUCTION 1

Objectives of the Study 1
Theoretical Background 6
Climate 6
Hypertension and Lipid Levels 7
Diet 9
Age 10
Sex 10
Association of Thrombotic-Embolic Brain Infarction with Other Diseases 10
Geographical Differentials and Socio-economic Correlates 11
Rationale of the Study 13
Hypotheses 14
H1) Indoor Thermal Environment 16
H2) Level of Physical Work 17
H3) Long Absence from Home 18
H4) Diet 20
H5) Health-Promoting Behavior 21
Overview of the Study 21

CHAPTER II STUDY SETTING

Selection of Miyagi Prefecture as the Study Area. 24
Miyagi Prefecture: Geographical Background . . . 24
Physical Features of Miyagi 25
Human Aspects of Miyagi 30
The Health Environment of Miyagi 31

CHAPTER III MAIL QUESTIONNAIRE SURVEY 35

Selection of the Study Sites 36
Sample Selection 44
Survey Strategies 47
Sample Representativeness 48
Method 49
Results and Discussion 49

	Indoor Thermal Environment	50
	The Level of Physical Work	55
	Long Absence from Home	58
	Diet	58
	Health-Promoting Behavior	59
	Clinical Factors	59
	Conclusion	62
CHAPTER IV	CASE-CONTROL STUDIES IN SHIWAHIME AND KARAKUWA: BACKGROUND	63
	Shiwahime and Karakuwa: Contrasting Physical and Human Environments	63
	Selection of the Study Sites	63
	Characteristics of the Study Sites	66
	Sample Selection	69
	Field Strategies	73
	Restrictions and Limitations of the Study	75
CHAPTER V	CASE-CONTROL STUDIES IN SHIWAHIME AND KARAKUWA: DATA COLLECTION AND RESULTS	80
	Individual Behavioral Patterns	80
	Data Collection	81
	Method of Analysis	82
	Results	84
	Discussion and Conclusion	89
	Household Nutrition Levels	96
	Data Collection	96
	Method of Analysis	99
	Results	101
	Discussion and Conclusion	108
	Indoor Thermal Environments	111
	Data Collection	112
	Method of Analysis	116
	Results	117
	Discussion and Conclusion	132
	Synthesis by Linear Logistic Regression Model	139
	General Background of Logistic Regression in Case-Control Studies	139
	Method of Analysis	141
	Results	143
	Discussion and Conclusion	148
CHAPTER VI	CONCLUSION	151
	Application of Research Findings to the Other Areas	153
	Contribution to Medical-Geographical Study	154
	Further Research	156
	Recommendations	157

APPENDICES 159

Appendix A. Mail Questionnaire 159
Appendix B. Illustration of Table 3.7 168
Appendix C. Estimation of the Relative Risk by Computing the Odds Ratio in a Matched Analysis with One Control Per Case 170
Appendix D. Relative Risk and Chi Square Test of Significance for all Factors Examined in Chapter V ("Individual Behavioral Patterns") 172
Appendix E. Relative Risk of Exposure Categories and Chi Square Test of Significance for all Factors Examined in Chapter V ("Indoor Thermal Environment") 175

BIBLIOGRAPHY 178

LIST OF TABLES

Table		Page
2.1	Population over 15 Years Engaged in Industries in Japan and Miyagi	32
2.2	Life Expectancy at Birth in Japan and for Six Prefectures in the Tohoku District, 1965-1980	33
3.1	Standardized Stroke Mortality Ratio of Miyagi and Selected Study Cities and Towns for Both Sexes, Miyagi, 1979-1981	43
3.2	Number of Questionnaires Received and Response Rate. .	46
3.3	Types of Heaters in the Living Room, the Bedroom and the Toilet	51
3.4	Distribution of Indoor Thermal Environment for Geographical Areas, Miyagi, 1986	52
3.5	Classification of Occupations According to the Level of Physical Work	56
3.6	Distribution of Level of Physical Work and Long Absence from Home for Geographical Areas, Miyagi, 1986	57
3.7	Distribution of Level of Diet and Health-Promoting Behavior for Geographical Areas, Miyagi, 1986	60
3.8	Distribution of Stroke-Related Diseases for Geographical Areas for 50-74 Years Old Group, Miyagi, 1986	61
4.1	Age and Sex Distribution of Case and Control Pairs in Shiwahime and Karakuwa	73
5.1	Hypothetical Set of Data on Matched Cases and Controls	83
5.2	Relative Risk of Selected Variables	85
5.3	Relationship Between Fondness for Salty Food and Blood Pressure Level	92
5.4	Relationship Between Salty Food Consumption and Blood Pressure Level	92

Table		Page
5.5	Blood Pressure Level for Cases in Shiwahime and Karakuwa (50-79 Years Old) in Comparison to the Town Sample Population (50-74 Years Old) Selected for the Mail Survey	93
5.6	Cases with a History of Heart Disease (50-79 Years Old) for Shiwahime and Karakuwa in Comparison to the Town Sample Population (50-74 Years Old) Selected for the Mail Survey	95
5.7	Cases with a History of Diabetes (59-79 Years Old) for Shiwahime and Karakuwa in Comparison to the Town Sample Population (50-74 Years Old) Selected for the Mail Survey	95
5.8	Average Salt Intake per Person per Day by Area	102
5.9	Comparison of Major Sources of Salt Intake between Shiwahime and Karakuwa (grams/person/day)	103
5.10	Intake of Protein, Fat and Carbohydrate (grams/person/day) and the Percentage to the Total Nutrient Components in Terms of Calories	105
5.11	Comparison of Mean Animal Protein Intake by Food Group Between Shiwahime and Karakuwa (grams/person/day)	106
5.12	Comparison of Animal Protein Sources Among the Three Nutrition Surveys (grams/person/day), Shiwahime	109
5.13	Comparison of Salt Intake Among the Three Nutrition Surveys (grams/person/day), Shiwahime	109
5.14	Relative Risk of Selected Exposure Categories and Chi Square Test of Significance	118
5.15	CLO Values for Men and Women in Shiwahime and Karakuwa, Indoors During the Early Evening	137
5.16	Characteristics of Cases and Controls According to Selected Variables	144
5.17	Effects of Selected Variables on Stroke Mortality in Miyagi by Using Several Logistic Regression Models: Unmatched Data (N=135)	145

LIST OF FIGURES

Figure		Page
1.1	Cerebrovascular Disease Mortality in Japan, 1968-1978, by Cities, Towns and Villages, for Males. Standardized Rates with Purple Highest (140 or more) and Blue Lowest (59 or less)	3
1.2	Cerebrovascular Disease Mortality in Japan, 1968-1978, by Cities, Towns and Villages, for Females. Standardized Ratios with Purple Highest (140 or more) and Blue Lowest (59 or less)	5
1.3	Relationship Between Climate and Socioeconomic Environments in Terms of Stroke Mortality	15
2.1	Location of Miyagi in the Tohoku District	26
2.2	Landforms of Miyagi	27
2.3	Climatic Divisions of Miyagi	27
2.4	Major Causes of Death in Japan and Miyagi, Both Sexes, 1950-1985 (Crude Rates per 100,000 Population)	34
3.1	Geographical Distribution of Standardized Mortality Ratios for Stroke (Male) by Cities, Towns and Villages in Miyagi, 1979-1981	38
3.2	Geographical Distribution of Standardized Mortality Ratios for Stroke (Female) by Cities, Towns and Villages in Miyagi, 1979-1981	39
3.3	Cities and Towns Selected for a Mail Questionnaire Survey of Mortality Differential	42
4.1	Population Distribution of Shiwahime and Karakuwa by Age	65
4.2	Towns of Shiwahime and Karakuwa	67
4.3	Leading Causes of Death in Shiwahime, 1975-1985	68
4.4	Leading Causes of Death in Karakuwa, 1975-1985	70
4.5	Meeting with Selected Residents	74
5.1	Traditional vs. Modern Food	87

Figure		Page
5.2	Traditional vs. Modern Food	88
5.3	Major Food Items to Contain High Salt	104
5.4	Thermometer	113
5.5	Self-Recording Thermometer	114
5.6	Room Temperatures in the Living Room, the Bedroom, and the Toilet Room for Shiwahime and Karakuwa When the Outdoor Temperatures are 4°C. (Recorded in Shiwahime on December 3, 1986, and in Karakuwa on December 15, 1986)	120
5.7	Room Temperatures in the Living Room, the Bedroom, and the Toilet Room for Case and Control Households When the Outdoor Temperatures are 4°C. (Recorded in Shiwahime on December 3, 1986, and in Karakuwa on December 15, 1986)	121
5.8	Mean Day-Long Room Temperatures and Outdoor Temperatures at Selected Households in Shiwahime and Karakuwa. (Recorded in Shiwahime from November 20 to December 5, 1986 and in Karakuwa from December 9 to 15, 1986)	123
5.9	Sketches of the House Plans of Selected Houses in Shiwahime and Karakuwa and the Indoor Temperature-Recording Locations	125
5.10	Mean Day-Long Room Temperatures of All Eight Households for Shiwahime and Karakuwa. (Recorded in Shiwahime from November 29 to December 5, 1986 and in Karakuwa from December 9 to 15, 1986)	129
5.11	Change in Room Temperature and Systolic and Diastolic Blood Pressure for Hypertensives	133
5.12	Change in Room Temperature and Systolic and Diastolic Blood Pressure for Normotensives	134
5.13	Hypothetical Causal Model of Stroke Mortality: Shaded Area to be Tested	142
5.14	Causal Model of Stroke Mortality: Shaded Area Indicating Major Causal Pathway	149

CHAPTER I

INTRODUCTION

Objectives of the Study

There is a marked geographical variation in cerebrovascular disease (hereafter called stroke) mortality in Japan (Figures 1.1 and 1.2). The objective of the current research was to examine the factors affecting the geographical distribution of stroke mortality, using Miyagi prefecture as a study area. The research tested the hypothesis that the distribution is related to the specific socioeconomic factors. The term "socioeconomic" as used in this research is broadly defined: it includes individual styles of life and behavioral patterns. The specific socioeconomic factors tested were: (1) indoor thermal environment, (2) level of physical work, (3) long absence from home, (4) diet, and (5) health-promoting behavior.

The investigation had two components. First, using data from a mail survey, the relationship between selected socioeconomic factors and the frequency of stroke mortality was examined for selected cities, towns, and villages.[1] The results were used as basic information for conducting a detailed investigation of the relationship between socio-economic factors and the frequency of stroke mortality. Second, this detailed investigation was conducted in two selected towns--one agricultural town with relatively high stroke mortality, and one fishing town with relatively low stroke mortality, using a matched-pairs case-control design.

Figure 1.1. Cerebrovascular Disease Mortality in Japan, 1968-1978, by Cities, Towns, and Villages, for Males. Standardized Mortality Ratios with Purple Highest (140 or more) and Blue Lowest (59 or less).

Source: Japan Health Promotion and Fitness Foundation, 1981

第25図

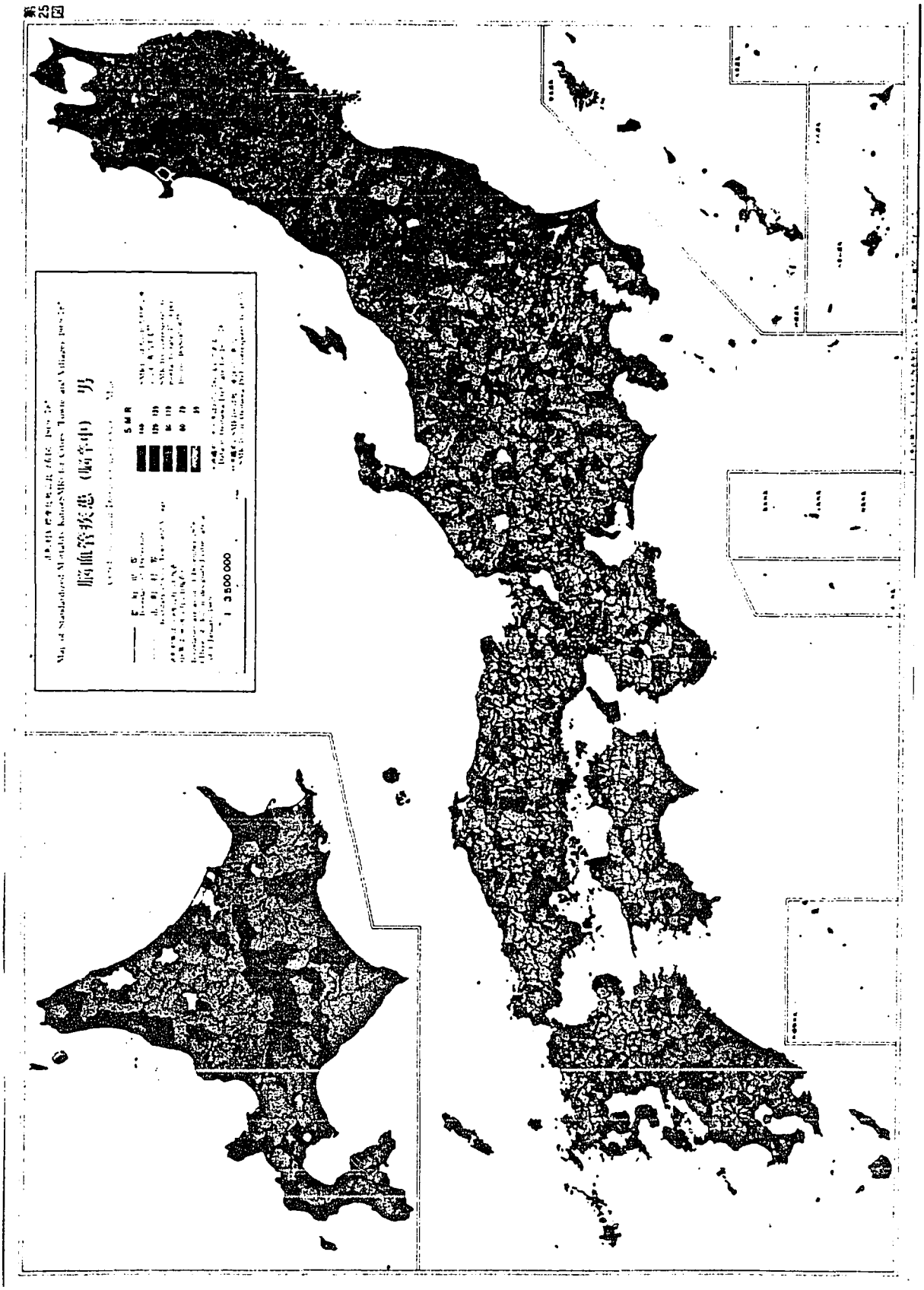
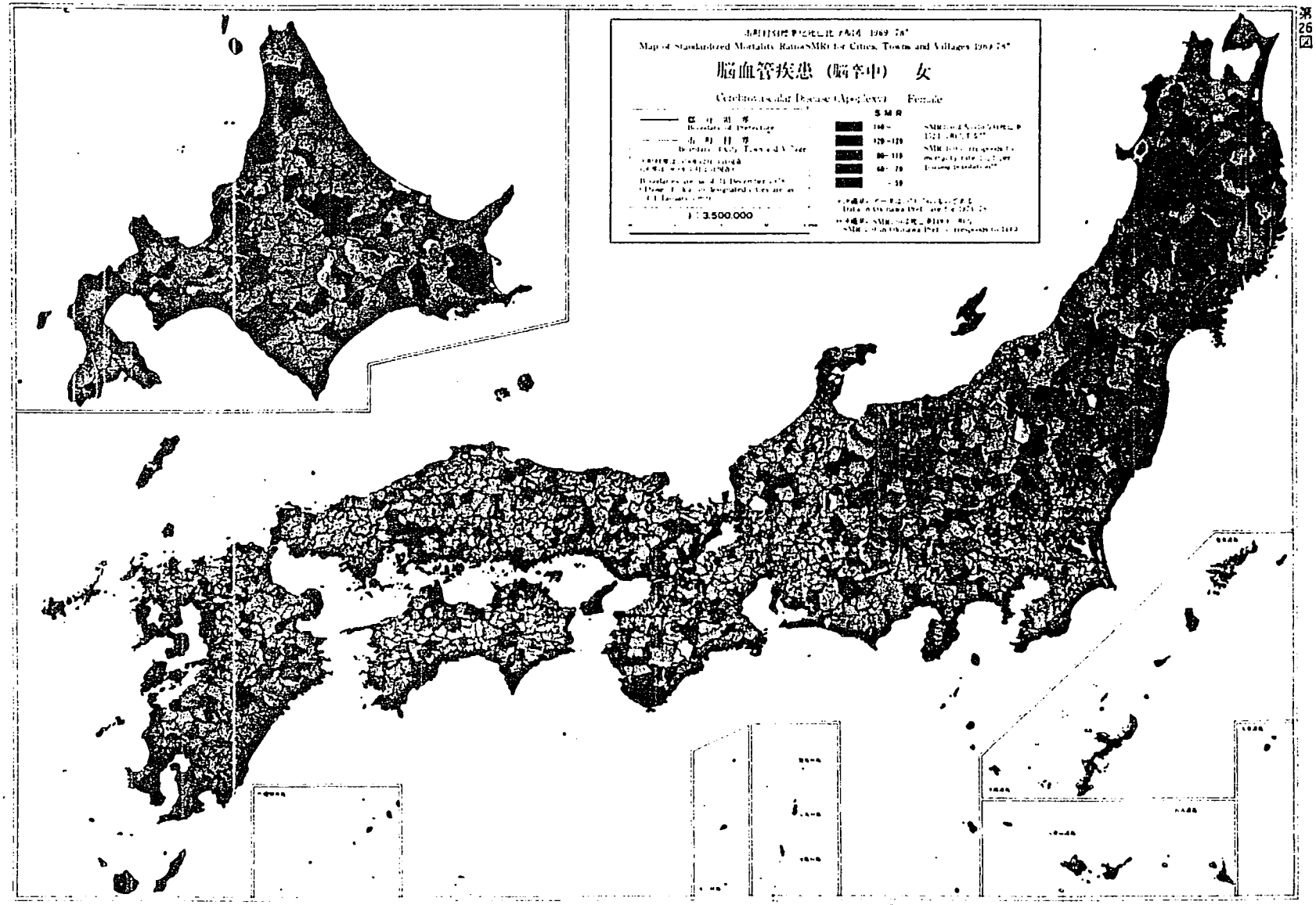


Figure 1.2. Cerebrovascular Disease Mortality in Japan, 1968-1978, by Cities, Towns, and Villages, for Females. Standardized Mortality Ratios with Purple Highest (140 or more) and Blue Lowest (59 or less).

Source: Japan Health Promotion and Fitness Foundation, 1981

第26図


Map of Standardized Mortality Ratio SMR for Cities, Towns and Villages 1969-74
脳血管疾患（脳卒中）　女
Cerebrovascular Disease (Apoplexy)　Female
SMR
1:3,500,000

Cerebrovascular disease, popularly called stroke, refers to a symptom complex of neurologic deficit resulting from damage to the brain by an alteration of its blood supply (9th revision of International Classification of Diseases: 430-438). Among several mechanisms of stroke are: thrombosis, hemmorrhage, and embolism[2] (Mausner et al. 1974). The common denominator for most strokes is atherosclerotic vascular disease[3] whose occurrence increases with age. This in large part explains why stroke becomes increasingly prevalent in the elderly (Kent et al. 1979). The manifestations are variable and depend on the extent and location of the damage to nervous tissues. There may be impairment of speech or cerebration, or paralysis of one or more portions of the body (Mausner et al. 1974). Stroke was the leading cause of death in Japan from 1951 to 1981, when it was replaced by cancer. In spite of reduced mortality rates during the last ten years, stroke still remains one of the most common causes of death among the Japanese.

Theoretical Background

The following is a review of geographical and epidemiological studies of stroke describing factors related to the cause of the disease. Particular attention will be paid to studies done in Japan. Some of the studies are clinical and some are climatic, demographic or socio-economic.

Climate

Some studies found that temperature and the incidence and mortality from hemorrhagic stroke had an inverse relationship, that is, there was high incidence and mortality during the winter (Bokonjic and Zec 1968;

McDowell et al. 1970; Sotaniemi et al. 1972; Bull 1973; Rogot and Padgett 1976; Ramirez-Lazzepas et al. 1980; Brackenridge 1981; Takahashi 1981). It was also found that there was an increase in the incidence and mortality from non-hemorrhagic stroke when the temperature rose (Katayama 1972, 1973; Sotaniemi et al. 1972; Rogot et al. 1976). For example, Katayama (1972, 1973) found that mortality from non-hemorrhagic stroke increased at temperatures above 24 C. Thus, there may be a U-shaped relationship between stroke and temperature: that is, an increase in mortality from hemorrhagic stroke when temperature decreases and an increase in mortality from non-hemorrhagic stroke when temperature increases. Other climatic factors such as atmospheric pressure and humidity may also be associated with stroke (Bokonjic and Zec 1968).

Hypertension and Lipid Levels

It appears to be a consistent finding among all epidemiological studies that an important risk factor in stroke, whether brain hemorrhage or thrombotic brain infarction, is hypertension (Johnson et al. 1967; Horibe 1969; Phillips et al. 1974; Whisnant 1974; Kimura et al. 1976; Sasaki 1977; Ueshima et al. 1984; Szatrowski et al. 1984). Some researchers suggested that control of hypertension played a role in the decline of stroke (Ueshima et al. 1984; Whisnant 1984; Aoki et al. 1985; Tanigaki 1986; Iso 1986). There are many studies which show a strong relationship between hypertension and brain hemorrhage (Dyken 1970; Kimura 1973; Owada et al. 1974; James 1975; Tanaka et al. 1975; Aoki et al. 1977; Ueda et al. 1978; Kagan et al. 1980). On the one hand, it is said that while hypertension may be ordinarily insufficient to cause the rupture of a normal vessel, it often leads to the rupture of

a diseased vessel (Hopps 1964). On the other hand, there is a hypothesis presented by both Western and Japanese researchers, particularly by the Japanese, that the rupture of a normal vessel, such as a small intracranial vessel, is the direct cause of brain hemorrhage and that it is hypertension which causes this rupture (Konishi 1974).

Looking at thrombotic brain infarction gives another interesting view of the relationship between hypertension and stroke. In Western countries lipid levels are generally considered a more important factor in thrombotic brain infarction than is hypertension (Konishi 1974). However, patients of thrombotic brain infarction in Japan do not seem to have high lipid levels but do seem to have hypertension (Kimura 1973; Tanaka et al. 1975; Ozawa et al. 1978; Konishi et al. 1986). Konishi (1974) suggested that in autopsies of Japanese thrombotic brain infarction cases, severe arteriosclerotic changes were recognized both in intracranial and cerebral basilar arteries. These changes were highly influenced by the grade and duration of hypertension, and rarely influenced by hyperlipemia caused by high blood lipids. Kagan et al. (1980) distinguished thrombotic brain infarction by two types: one which occurs more often among Japanese is "small vessel thrombosis" (intracranial vessels such as penetrating intraparenchymal arteries[4]); the other which occurs more often among Westerners is "large vessel thrombosis" (extracranial vessels such as neck arteries and circle of Willis).

On the whole, it appears that populations with a high prevalence of hypertension and low lipid levels tend to have a higher ratio of intracranial strokes, both hemorrhagic and thrombo-embolic, to extracranial strokes (Kuller and Reisler 1971). The findings of the

comparative studies in Honolulu and Hiroshima, and in Hisayama and Minnesota support this view (Baker and Katsuki 1969; Mitsuyama et al. 1979).

Diet

In Japan, hypertension seems to be related to both brain hemorrhage and thrombotic brain infarction. There are studies which suggest that the high frequency of hypertension has roots in the Japanese style of life, particularly the traditional dietary routine which is characterized by a high salt (NaCl) intake (Ozawa 1968; Takahashi 1969; Komachi et al. 1975; Yanagawa et al. 1976; Tanaka et al. 1977; Goto et al. 1980; Kumagai 1981). On the other hand, Komachi and Shimamoto (1976) suggested that raising animal protein and fat intake to a "proper level" would be important in lowering the incidence of stroke regardless of the level of salt intake. They thought that there was a different causal relationship in different populations and hypothesized that in Japan a high intake of animal fat and protein acted protectively against intracranial stroke, both hemorrhagic and thrombo-embolic, and acted favorably for extracranial stroke, although excess intake of fats and proteins induced ischaemic heart disease. The findings in other studies (Kimura et al. 1976; Kagan et al. 1980; Hatano et al. 1984; Takeya et al. 1984) support this hypothesis. Other dietary nutrients such as potassium may also be negatively associated with stroke (Khaw and Barrett-Connor 1987; Takemori et al. 1987).

Age

In spite of much controversy about the decisive etiological factors in stroke, there is one for which there is no disagreement. This is age. It is reported in many studies and is now widely accepted that the frequency of various types of stroke occurrence is closely related to advancing age for both sexes (Melamed et al. 1973; Ostfeld et al. 1974). However, until recently in Japan, stroke was also a significant cause of death in relatively young people (Nishida 1974; Komachi and Shimamoto 1976).

Sex

It is usually stated that stroke affects both males and females equally in different age groups (Kannel et al. 1965; Gertler et al. 1968; Alter et al. 1970; Whisnant et al. 1971; Olivares et al. 1973; Gudmundsson and Benedikz 1977; Brackenridge 1981). In contrast, a study conducted in Israel found that mortality seemed higher among females (Epstein and Zaaroor 1982). In Japan, however, there has been a distinct male preponderance of various types of stroke and of all strokes for both incidence and mortality (Owada et al. 1973; Tanaka et al. 1981; Tanaka et al. 1982), although this phenomenon seems to be disappearing (Owada et al. 1973).

Association of Thrombotic-Embolic Brain Infarction with Other Diseases

Diseases of the heart and diabetes seem to be important risk factors for brain infarction (Gordon et al. 1971; Kannel et al. 1974; Gertler et al. 1975; Akinkugbe 1976). However, a physiological mechanism for

such associations between brain infarction and these diseases has not been proposed.

Geographical Differentials and Socioeconomic Correlates

Although dietary and clinical aspects of the epidemiology of stroke in Japan and elsewhere were studied extensively, there has been less attention to social and economic factors. The pioneer work described below demonstrates evidence of a relationship between stroke and socio-economic factors by geographic area.

In Japan there is higher mortality from stroke in rural areas, particularly mountainous or agricultural areas, and lower mortality in urban areas (Kojima 1966; Nagata 1979; Kagami 1983). Aoki et al. (1982) reported that in Aichi prefecture there is high mortality from brain hemorrhage in regions where there is a high proportion of farmers. They found that people engaged in agriculture perform hard physical work and are constantly exposed to an outdoor climate. They also have poor housing (including insufficient indoor heating), an unbalanced diet, and little access to medical care; many suffer from emotional stress caused by long absences from home due to seasonal migration (dekaseqi[5]). These factors appeared to be associated with stroke.

Takahashi (1969), Momiyama (1982) and Yoshino et al. (1986) (Hasegawa et al. 1985) point to a possible link between indoor heating and stroke mortality. Takahashi (1969) mentioned that a poor indoor thermal environment is associated with high stroke mortality in farming villages in the northeastern part of Japan. Houses in this region tend to have bathrooms and toilet rooms[6] outside the main structure of the

building, and the risk of stroke may be increased by the sudden elevation of the level of blood pressure due to the dramatic change in temperature by going outside, particularly during winter periods. Momiyama (1982) suggested that when seasonal patterns of stroke mortality in the 1960s were compared among the cities of Tokyo, London and New York, Tokyo and London showed a high mortality peak in winter, whereas there was hardly any peak in New York, although in the 1970s the high winter mortality peak in Japan was disappearing and the seasonal pattern was approaching that of New York. Momiyama hypothesized that these phenomena were due to artificial indoor climates, such as central heating, which protected against cold outdoor climates.

Yoshino (Hasegawa et al. 1985) expanded the study of the relationships between stroke mortality and indoor heating suggested by Takahashi (1969) on the basis of room temperatures, housing structure and heating systems. He suggested that the residents were exposed to large temperature differences when they moved from heated to unheated rooms, which may result in sufficient physiological stress to be a risk for stroke.

A study of Americans of Japanese ancestry living in Hawaii, who have lower stroke incidence rates than Japanese living in Japan, indicates that the high incidence rates of stroke in Japan are determined more by behavioral factors than genetic factors (Kagan et al. 1985). On the other hand, the fact that stroke-prone rats can be produced by the mating of rats with stroke histories is an indicator that heredity may have a role (Yamori et al. 1976). Gertler et al. (1968), in a hospital series of 185 men and women with stroke, suggested that family history of stroke might be associated with stroke occurrence. However, the association was not consistent (Herman et al. 1983; Khaw and Barrett-Connor 1986).

Although in Western countries smoking habits and alcohol consumption seem to be important to stroke (Salonen et al. 1982; Rogers et al. 1983; Gill et al. 1986; Abbott et al. 1986)), these factors do not seem to be related to stroke in Japan (Tanaka et al. 1985).

Rationale of the Study

The major contribution of this study is its clarification of the relationship between the frequency of stroke mortality and socioeconomic factors. This relationship is investigated at the micro (individual) level. While the relationship has been examined at the individual level in previous studies in Japan, this study is the first comprehensive analysis of socioeconomic factors in combination with individual-level health factors, comparing two selected towns: one agricultural town with high stroke mortality rates, and one fishing town with low stroke mortality rates. Also unique is the use of a low-risk population in the fishing town for comparison.

Until recently in Japan much data, including health-related data, were available only at the prefecture level. Mortality data at city, town, and village levels have now become available and allow a closer examination of geographical variations in stroke mortality. This new information is examined in the light of socioeconomic data which was collected at these same levels.

A contribution is also made to the subdiscipline of medical geography through the matched-pairs case-control research design. This methodology, which involves matching individual cases of victims and healthy controls, is frequently used in the field of epidemiology, and its usefulness has

been recognized among medical geographers (Sato 1983). This study will exemplify the use of this methodology as a powerful tool in the micro study of geographical variation of disease mortality and morbidity, and thereby will increase the effectiveness and contribution of medical geographers in the investigation of human disease.

Hypotheses

When the distribution of stroke mortality for cities, towns, and villages for males and females in Japan is examined (Figures 1.1 and 1.2), areas which generally have high mortality are located mostly in cold climates. These areas tend to be generally mountainous, rural, and agricultural where people still maintain a "traditional" style of life. They tend to have inferior home heating compared to urban dwellers. Since the people tend to be "traditional," their diet is high in rice and in salty food consumption, such as of miso soup and pickled vegetables, with insufficient animal protein, although since around 1955 the consumption of animal protein has gradually increased. There are also larger proportions of old people who are more vulnerable to extremes of cold climates. In contrast, areas which generally have low stroke mortality are mostly coastal and urban, and have warmer climates than those with high mortality. Moreover, these have an urban micro climate which provides a warmer temperature than in open surroundings. People enjoy a more "modern" style of life (e.g., diet, housing, occupation, etc.) that protects them from stroke to some extent. Such a relationship of physical and human environments is illustrated in Figure 1.3.

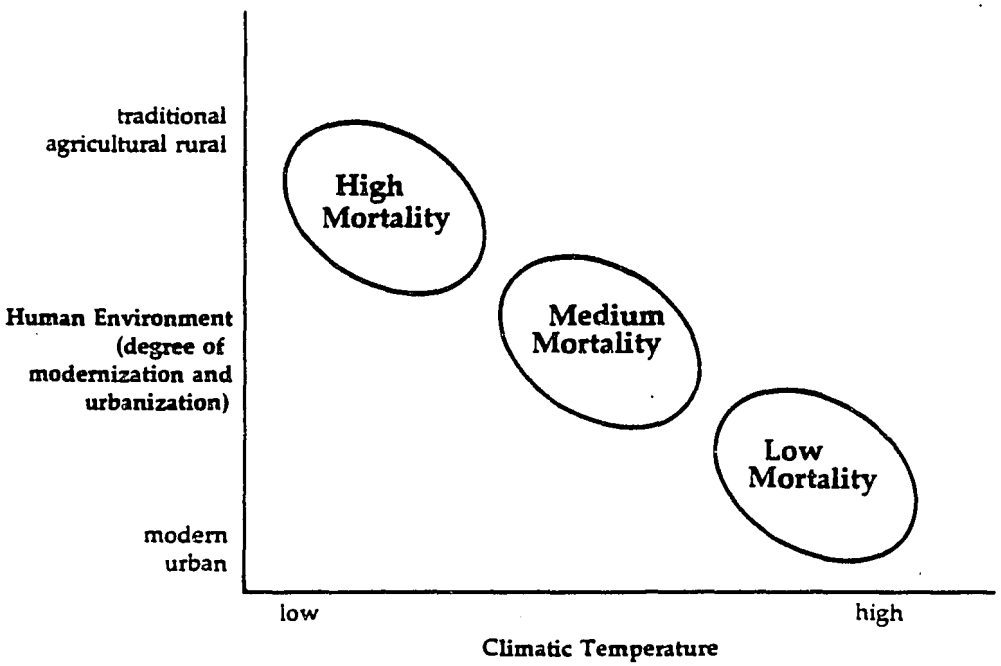


Figure 1.3. Relationship between climate and socioeconomic environments in terms of stroke mortality.

Fishing areas, although rural, have significantly lower stroke mortality than agricultural areas (Naruse et al. 1985). However, since the association between socioeconomic factors and stroke mortality has not been studied in fishing areas, these are not included in Figure 1.3.

H1) Indoor Thermal Environment

The World Health Organization recommends a minimal indoor temperature of 18°C and a 2-3°C warmer minimal temperature for rooms occupied by sedentary elderly, young children, and the handicapped. Below 16°C, resistance to respiratory infections may be diminished. At temperatures below 12°C, cold extremities and slight lowering of core temperature can induce short-term increases in blood pressure. Raised blood pressure and increased blood viscosity in moderate cold may be important causal factors in the increased winter morbidity and mortality due to heart attacks and strokes (Collins 1986).

Yoshino (Hasegawa et al. 1985) conducted the study of the relationships between stroke mortality and indoor heating on the basis of room temperatures, housing structure and heating system. He compared the indoor thermal environment of houses in high and low stroke mortality agricultural towns in Yamagata prefecture. He also compared two study groups in the same towns, consisting of males aged 40-60, classified into two groups by the results of cardiovascular examinations. One was a "normal group" which showed no evidence of cardiovascular problems and the other was an "abnormal group" which showed some sign of cardiovascular problems. The results indicated that the residents were exposed to a large temperature difference when they moved from heated rooms to

unheated rooms, which may result in sufficient physiological stress to be a risk for stroke.

Based on the above work, a hypothesis on the indoor thermal environment was formulated. Yoshino's methods were employed for investigation: that is, the use of heating systems inside the house and the housing structure, which might affect the indoor thermal environment, were examined. The temperatures inside the house were also measured. The living room, bedroom, and toilet room received particular attention because they were looked upon as indicators of indoor temperature: the living room was expected to be the warmest in the house, whereas the toilet was the coldest and the bedroom moderate.

> Hypothesis 1a: Insufficient heating of the living room, the bedroom, and the toilet is positively associated with frequency of stroke mortality.
>
> Hypothesis 1b: The differences in temperature among the three are positively associated with frequency of stroke.

H2) Level of Physical Work

Aoki et al. (1982) found that in Aichi prefecture there was high mortality from brain hemorrhage in regions where there was a high proportion of farmers. They suggested that people engaged in agriculture performed hard physical work, and that this might be a cause of high mortality from stroke. Although other literature on stroke in Japan does not mention hard physical work, the possibility of an association was examined in this study.

Japanese agriculture is labor-intensive due to limited cultivatable land. Thus farming requires hard physical work. Although mechanization has been gradually introduced into the agricultural sector, this has not greatly improved the working conditions of farming households. Instead, the number of work hours has been intensified. Over the last two decades it has become common for the heads of the farming households to work full-time outside the house to maintain a steady cash income. They then do their regular farm work in the evening and on weekends. The spouses of household heads are now the major workforce for farming in addition to doing housework. As Aoki et al. (1982) suggested, these working conditions in farming may play an important role in high stroke mortality in agricultural regions.

There are no valid measures for assessing the level of physical work outside laboratories (Laporte et al. 1984). In this research, the level of physical work was estimated by using type of occupation. A brief question on the routine of physical work and exercise was also included. Since the length of sleeping hours tends to be constant, this was also used as a measure. They hypothesis was stated as follows:

> Hypothesis 2: Hard physical work is positively associated with frequency of stroke mortality.

H3) Long Absence from Home

A relationship between "stress" and cardiovascular disease, particularly heart disease, has been strongly suggested (Syme and Reeder, eds. 1967; Bengtsson et al. 1973; Schar et al. 1973; Glass 1977; Haynes et al. 1980). Stress "may be viewed as the intervening variable between

a 'lack of fit' among social structural and individual personality elements, and adaptive or maladaptive individual responses which would include somatic disturbances" (Marks 1967). In the United States, Nesser et al. (1971) demonstrated that social disorganization which tends to result in stress is associated with stroke mortality for the Black population in North Carolina. However, hypertension, which is known to be prevalent in the Black population, was not controlled for in the study.

In Japan, there is a long tradition in the agricultural areas, particularly in Tohoku, that after the main harvest male farmers tend to leave for the cities to engage in construction employment and return to their farms at the onset of the farming season. But during this period, they become socially isolated from the surrounding new environment, and tend to feel lonely and deserted. Aoki et al. (1982) suggested that such a seasonal migration which results in stress may be associated with high stroke mortality. The same thing may be true for those who are at sea for ten to twelve months during a year. Human relationships are made difficult by living together in a confined space for a long period of time. Thus, daily life is stressful.

In this research, the importance of long absences from home due to seasonal migration, including deep-sea fishing, was tested with the following hypothesis:

Hypothesis 3: Long absence from home is positively associated with frequency of stroke mortality.

H4) Diet

In Japan, both brain hemorrhage and thrombotic brain infarction seem to be related to hypertension. It has been suggested that hypertension is related to the traditional Japanese diet which is characterized by a high salt (NaCl) intake (Ozawa 1968; Takahashi 1969; Komachi et al. 1975; Yanagawa et al. 1976; Tanaka et al. 1977; Goto et al. 1980; Kumagai 1981). On the other hand, Komachi and Shimamoto (1976) found that raising animal protein and fat intake to a "proper level" may be important in lowering the incidence of stroke, regardless of the level of salt intake.

A dietary study focusing on the intake of specific nutrients such as salt, fat, and protein is very cumbersome, and accurate measurement is also difficult in a large-sample survey. Thus, for the mail survey, instead of measuring salt intake and intake of animal fat and protein food items, the frequency of eating selected Japanese food items which either induce the intake of foods with high salt content or themselves contain high salt and high animal protein was examined. For the matched-pairs study, the technique used in the annual National Nutrition Survey conducted by the Ministry of Health and Welfare was employed. This survey measures salt intake and the intake of animal fat and protein food items. The dietary routine was examined using a paired comparison of food items: that is, respondents were requested to select either the modern or traditional food items listed (Kimura et al. 1983).

Hypothesis 4a: Salt intake is positively associated with frequency of stroke mortality.

Hypothesis 4b: Animal fat and protein intake is negatively associated with frequency of stroke mortality.

H5) Health-Promoting Behavior

It is well known that the availability of medical care resources and facilities, such as doctors and hospitals, is important in explaining variations in stroke mortality (de Vise 1973). In Japan, due to the expansion of medical care resources and highly developed transportation systems, the availability of such resources is not much of a problem. What seems more important is the individual health-promoting behavior. Thus, the relationship between health-promoting behavior and the frequency of stroke mortality was approached by testing the following hypothesis:

Hypothesis 5: Health-promoting behavior is negatively associated with frequency of stroke mortality.

Overview of the Study

Mortality from cerebrovascular disease in Japan is marked by geographical variation. This research sought an explanation for the geographical variation in stroke mortality in Miyagi prefecture. Particular attention was given to socioeconomic factors which in stroke studies have received less attention than clinical factors.

The dissertation is comprised of six chapters including this introduction. Chapter II describes the selection of Miyagi prefecture as the study area and provides background information on the geography of Miyagi. Chapter III examines certain socioeconomic factors which are associated with stroke mortality, in selected cities and towns which

have significantly high or low stroke standardized mortality ratios (SMRs) in comparison to the male and female stroke SMRs of Miyagi. Chapter IV describes the characteristics of two selected study sites with different socioeconomic compositions: one agricultural town with relatively high mortality, and one fishing town with relatively low mortality, and also discusses the research design for the study of these two sites. Chapter V examines the associations found in Chapter III at two selected study sites, using a case-control design. In Chapter VI an attempt is made to synthesize the information presented in the preceding chapters and to explain the geographical distribution of stroke mortality in Miyagi. In particular, it will be shown how certain socioeconomic factors play a role as a link between human beings and the state of their health.

CHAPTER I--NOTES

[1]Japan is administratively divided into cities, towns, and villages.

[2]Robbins (1967) defined hemorrhage as "the escape of blood from vessels . . . [this] implies rupture of a vessel." Thrombosis consists of "the formation of a blood coagulum within a vessel or the heart." When a thrombus or other physical mass (e.g., clump of bacteria) is carried by the blood from its point of origin to a distant site this is referred to as embolism. The significance of both thrombosis and embolism "lies in their capacity to occlude vessels, impair the flow of blood and give rise to ischemic necrosis and infarction (death) of tissues" (as cited in Mausner et al. 1974:12).

[3]A disease of the arteries in which fatty plaques develop on their inner walls, with eventual obstruction of blood flow (Miller and Keane 1983:107).

[4]These arteries are essential arteries pertaining to the walls of the brain (Miller and Keane 1983:841).

[5]Dekaseqi is a simple form of circulatory migration which allows migration to be integrated with the annual agricultural cycle. After the main harvest male migrants leave for cities to be engaged in construction employment, and return to plough, plant, and weed at the onset of the farming season.

[6]Toilets in Japan tend to be in a separate room with no other function.

CHAPTER II

STUDY SETTING

Selection of Miyagi Prefecture as the Study Area

The Tohoku district is well known for having the highest stroke mortality in Japan. Miyagi, one of the six prefectures in this district, was chosen for study because of available assistance and support.

Miyagi has the lowest stroke mortality rates of all the prefectures in Tohoku (1985 Miyagi Annual Report of Hygienic Statistics). However, it has higher stroke mortality rates than Japan as a whole. For example, the crude stroke mortality rates in Miyagi, Tohoku, and Japan in 1985 were 131.6, 150.1, and 112.2 per 100,000 population, respectively (age-adjusted death rates were not available) (1985 Miyagi Annual Report of Hygienic Statistics). At the same time this prefecture has been less affected by stroke eradication crusades than some of the other prefectures in Tohoku where salt intake reduction campaigns appear to have contributed to lower stroke mortality rates, particularly in areas of high mortality. Miyagi, which is still characterized by considerable variation in stroke mortality at city, town, and village levels, provides us with a useful opportunity to examine goegraphical variations.

Miyagi Prefecture: Geographical Background

Miyagi prefecture is part of Tohoku, which includes the six prefectures of Aomori, Iwate, Akita, Miyagi, Yamagata, and Fukushima. It is located in the center of the Pacific Ocean side of Tohoku, and it

is bordered by Iwate to the north, Yamagata to the west, and Fukushima to the south. The capital of Miyagi is Sendai (Figure 2.1).

Miyagi covers an area of 7286.63 square kilometers. This includes the offshore island area of 38.05 square kilometers, and the inland water area of 11.3 square kilometers (Aono and Birukawa, eds. 1979).

The 1985 population of Miyagi was 2,176,295, about 1.7 percent of the total population of Japan (1985 Population Census of Japan). The population density was 226 persons per square kilometer, which was less than the national average of 325 persons per square kilometer but the highest among Tohoku prefectures (Pocket Statistics of Agriculture, Forestry and Fishery 1987). The sex ratio of 97.0 shows the effects of male outmigration to more industrialized areas.

Physical Features of Miyagi

Landforms. The Ou Mountains lie in the western part of Miyagi. The northeast and southeast corners of Miyagi contain the Kitakami and Abukuma mountain ranges, respectively. The plains running from north to south lie between these three mountain ranges (Figure 2.2). A highly indented rias coastline located to the east of the Kitakami Mountains is known for its beautiful coastal landscape. In contrast, the shoreline to the east of the Abukuma Mountains is smooth and monotonous.

Unlike most of the other prefectures in Tohoku, Miyagi has a low percentage of mountainous lands, and is made up of hills and plateaus. Hills are widely dispersed from north to south, with more in the north. The Sendai plain, which is divided into northern and southern parts, is composed of lowlands, terraces, and low hills. The transition zones

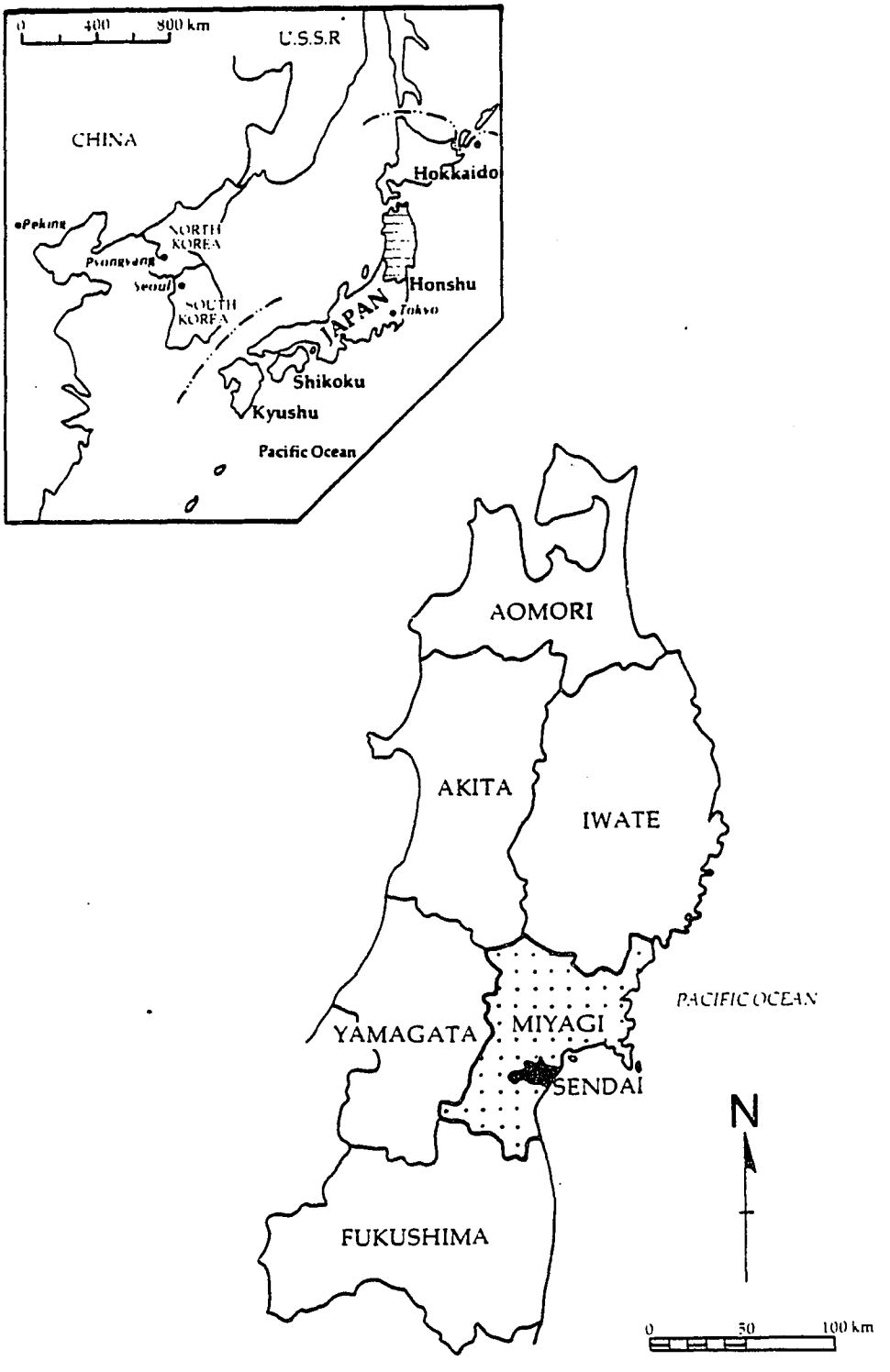
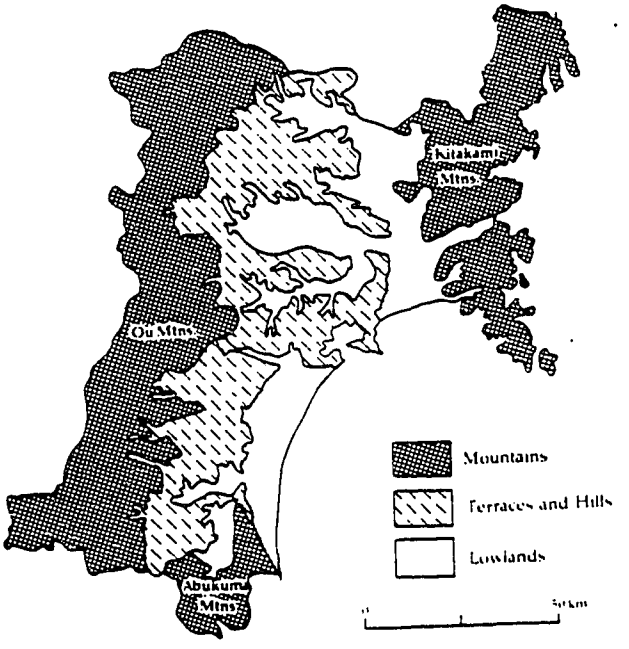
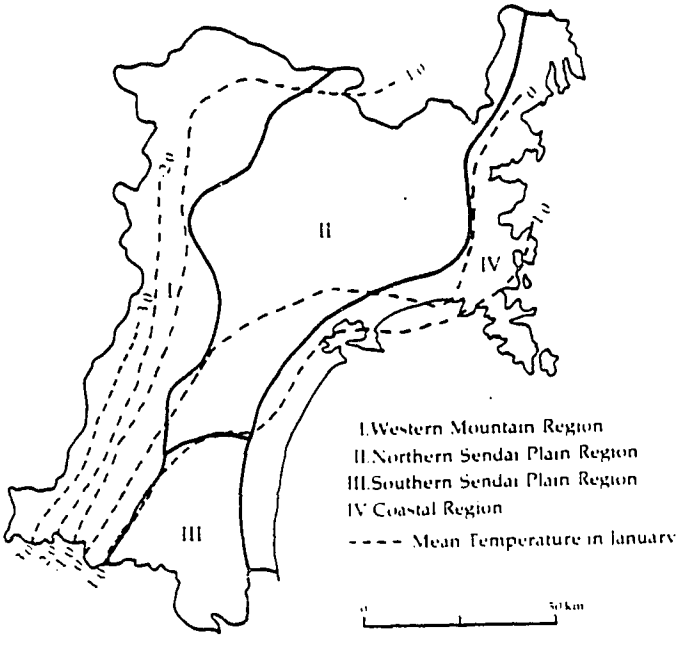


Figure 2.1. Location of Miyagi in the Tohuku District.



Source *Nihon Chishi* 4, p 15

Figure 2.2. Landforms of Miyagi.



Source [illegible] 4, p 20, 24

Figure 2.3. Climatic Divisions of Miyagi.

between hills and lowlands in the northern Sendai plain are complex and there are many ponds and swamps where these two landforms meet. The lowlands tend to be wet and almost all consist of paddy fields. In contrast, the hills and lowlands in the southern Sendai plain exhibit a simple pattern and the lowlands are mostly dry (Aono and Birukawa, eds. 1979).

Climate. The physical landscape of Miyagi is relatively uncomplicated. Thus this area exhibits little climatic variation in comparison to neighboring prefectures.

Since the eastern side of Miyagi faces the Pacific Ocean, it is exposed to the sea breezes that generally develop on summer days and often reach deep into the interior. However, the cooling effects of sea breezes are usually confined to a smaller area along the shore. In the cold season when the prevailing northwest winds develop, beautiful days of clear, dry, but cool weather contrast sharply with the gloomy, snowy weather of the neighboring prefecture facing the Sea of Japan. However, the higher mountain areas of Miyagi prefecture do get some of the snowy weather that is so characteristic of the "Snow Country" farther to the west.

Although regional variations in climate are relatively small in comparison to the neighboring prefectures due to the simple composition of landforms, there are still differences at the micro level. Climatic characteristics differ between mountainous regions and lowland regions throughout the year. Even within the lowlands, there are differences between the northern and southern sections. Coastal areas also have

unique climatic characteristics. Four climatic divisions may be recognized, as shown in Figure 2.3. These divisions are as follows:

Division I. The Western Mountain Region . . . There is heavy snow in winter and snow accumulates during this season. There is much rain during the warm season. Throughout the year, it is moist, and the mean temperatures are the lowest in the prefecture.

Division II. The Northern Sendai Plain Region . . . Compared with the Southern Sendai Plain Region, there are many cloudy days and temperatures are low in winter. In summer, the temperature does not rise high enough to form a heat island as it does in the Southern Sendai Plain Region.

Division III. The Southern Sendai Plain Region . . . There is little rain and there are many fine days in winter. It is warmer compared to the Northern Sendai Plain Region. Temperatures are warm during the summer and a heat island sometimes appears in midsummer. Fine days of cool dry weather in spring and fall often bring frosts.

Division IV. The Coastal Region . . . During summer it is cooler than the areas farther inland as a result of offshore breezes and during winter it is warmer. The southern parts of the region along the shore and the Oshika Peninsula extending to the Pacific Ocean are the warmest areas during the winter (Aono and Birukawa, eds. 1979).

As discussed in Chapter I, stroke seems associated with cold climates during winter. Thus isotherms of January temperature are superimposed on Figure 2.3. These indicate that lower temperature in the prefecture are farthest away from the shore, which is more distinctive in the northern part of the prefecture.

Human Aspects of Miyagi

Tohoku's socioeconomic features more closely resemble those of southern Japan rather than those of Hokkaido. However, its harsh climate makes living conditions less attractive for the Japanese, whose culture evolved in milder sub-tropical environments (Trewartha 1960). Consequently, Tohoku is looked upon as a relatively backward area although the standard of living is improving rapidly.

Among the prefectures in Tohoku, Miyagi has the largest population. However, its function as the center of Tohoku is today rather weak. In the Edo Period (1603-1868), the largest feudal domain in what is now Tohoku was located in what is now Miyagi, and Sendai, which then had a population of 50,000-60,000, prospered as Tohoku's largest castle town. Since the Ou mountains acted as a barrier to westward movement, this feudal domain did not expand toward the rest of Tohoku, and even with the development of railways, most traffic passed through Miyagi on the way to Hokkaido and the transportation system between the east and west of Tohoku was never well developed.

Sendai, the capital of Miyagi, has established itself as the primary urban center of Tohoku. It strengthened this position around 1955 after the railway schedules made Sendai the point of origin for many trains travelling to various parts of Tohoku. About the same time, Tohoku regional offices of large banks and companies were established there (Aono and Birukawa, eds. 1979).

One of the major economic activities in Miyagi is agriculture, with rice being the most prominent crop. The 1986 rice production was 533,300 tons, placing Miyagi in third place among Tohoku prefectures, following

Akita and Yamagata (1987 Pocket Statistics of Agriculture, Forestry and Fishery 1987). Since the fishing area off the Pacific coast of Tohoku is one of the world's most productive, the fishing industry also has long flourished on the coast of Miyagi. An analysis of occupational categories of employed people in Miyagi indicates the importance of agriculture and fishing when compared with the national average (Table 2.1).

The Health Environment of Miyagi

Average life expectancy in Miyagi for 1965, 1970, 1975, and 1980 was the highest of any prefecture in Tohoku and approached the national average, as indicated in Table 2.2. This indicates a fairly high life expectancy of Miyagi in the nation. The trends of major causes of death for both sexes between 1950 and 1985 are shown in Figure 2.4. Crude death rates are used because age adjusted death rates are unavailable. In 1950 the leading cause of death was tuberculosis with stroke in second place and pneumonia/bronchitis in third. However, in 1951 stroke replaced tuberculosis as the primary cause of death, with cancer in second place, and heart disease in third. This rank order remained until 1984 when stroke was replaced by cancer.

When the leading causes of death are viewed at the national level, stroke was the primary cause of death from 1951 to 1981, when it was replaced by cancer. In 1985, heart disease moved into second place replacing stroke. The change in the rank order of major causes of death such as this at the national level demonstrates the convergence of the Japanese disease pattern with the Western pattern, which suggests a gradual Westernization of Japanese styles of life. Miyagi will most likely follow this national pattern in the near future.

Table 2.1

Population over 15 Years Engaged in Industries
in Japan and Miyagi

Type of Industry	Japan		Miyagi	
Primary Industry				
Agriculture	4,851,035	(8.3%)	125,531	(12.1%)
Forestry	139,862	(0.2)	1,774	(0.2)
Fishery	421,296	(0.7)	23,627	(2.3)
Secondary Industry				
Mining	95,316	(0.2)	1,611	(0.2)
Construction	5,266,295	(9.0)	100,876	(9.7)
Manufacturing	13,972,604	(24.0)	174,331	(16.8)
Tertiary Industry				
Electricity, Gas, Water, and Heat Supply	336,841	(0.6)	7,033	(0.7)
Transport and Communication	3,510,034	(6.0)	65,273	(6.3)
Wholesale and Retail Trade and Eating and Drinking Places	13,382,405	(22.9)	250,815	(24.2)
Financing and Insurance	1,729,426	(3.0)	28,831	(2.8)
Real Estate	479,753	(0.8)	6,870	(0.7)
Services	11,949,386	(20.5)	202,916	(19.6)
Government	2,056,461	(3.5)	43,765	(4.2)
Employment Status not reported	166,518	(0.3)	1,992	(0.2)
Total (Includes "Employment Status not reported")	58,357,232	(100%)	1,035,245	(100%)

Source: 1985 Population Census of Japan, Vol. 3.

Table 2.2

Life Expectancy at Birth in Japan and for Six Prefectures in the Tohoku District, 1965-1980

Male								
Area	1965		1970		1975		1980	
Japan	67.74		69.84		71.79		73.57	
Miyagi	67.29	(26)	69.49	(20)	71.50	(23)	73.40	(21)
Aomori	65.32	(46)	67.82	(45)	69.69	(47)	71.41	(47)
Iwate	65.87	(44)	68.03	(43)	70.27	(44)	72.72	(41)
Akita	65.39	(45)	67.56	(46)	70.17	(46)	72.48	(44)
Yamagata	66.49	(40)	68.71	(35)	70.96	(36)	73.12	(29)
Fukushima	66.46	(42)	68.52	(37)	70.71	(39)	72.90	(36)

Female								
Area	1965		1970		1975		1980	
Japan	72.92		75.23		77.01		79.00	
Miyagi	73.19	(17)	75.30	(16)	77.00	(16)	78.85	(25)
Aomori	71.77	(44)	74.68	(32)	76.50	(35)	78.39	(44)
Iwate	71.58	(45)	74.13	(46)	76.20	(44)	78.50	(34)
Akita	71.24	(46)	74.14	(45)	75.86	(47)	78.64	(32)
Yamagata	71.94	(43)	74.46	(39)	76.35	(41)	78.58	(35)
Fukushima	72.04	(41)	74.46	(39)	76.35	(41)	78.46	(41)

( ) -- National Rank

Source: 1985 Miyagi Annual Report of Hygienic Statistics

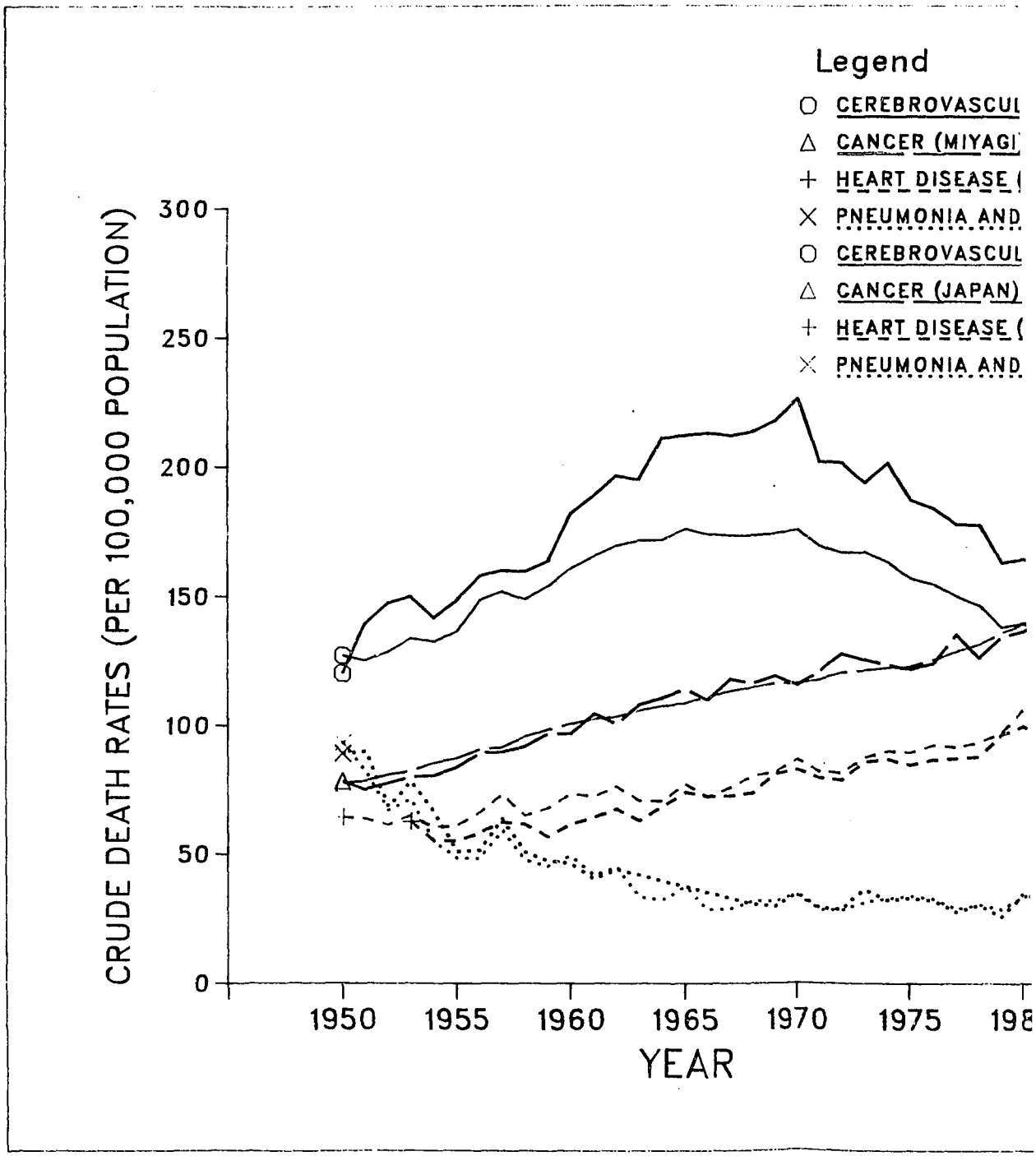
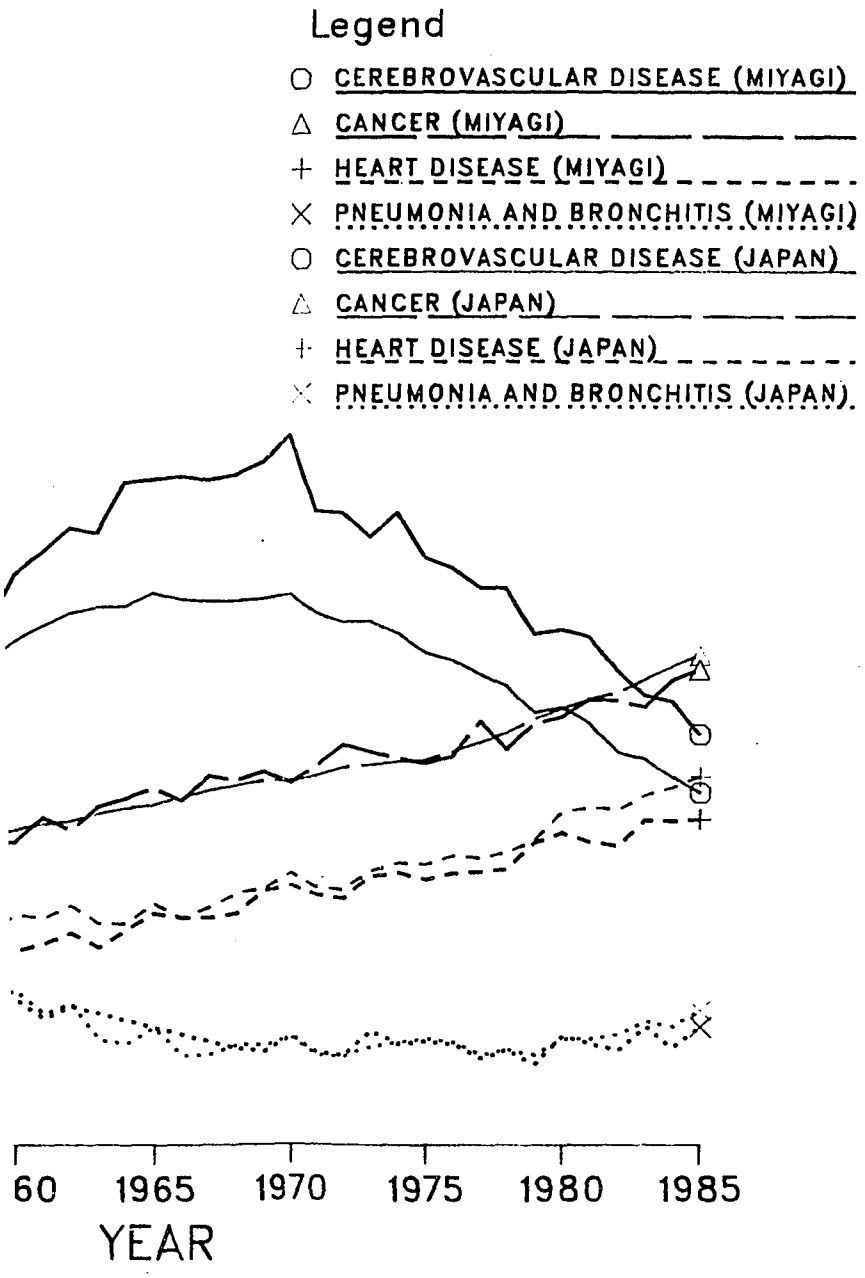


Figure 2.4. Major Causes of Death in Japan and Miyagi, Both Sexes, 1950-1985 (Crude Rates per 100,000 Population)

Source: 1985 Japan Vital Statistics, 1986, and 1985 Miyagi Annual Report of Hygienic Statistics, 1986



yagi, Both Sexes, 1950-
ion)

, 1986, and 1985 Miyagi
atistics, 1986

CHAPTER III

MAIL QUESTIONNAIRE SURVEY

A mail questionnaire survey was conducted in order to examine the socioeconomic characteristics of selected areas in association with geographical variations in stroke mortality. The results were used as basic information for the subsequent detailed investigation of the relationship between socioeconomic factors and the frequency of stroke mortality at the individual level (Chapters IV-V). The factors examined were: (1) the indoor thermal environment, (2) the level of physical work, (3) long absence from home, (4) diet, and (5) health-promoting behavior (see Chapter I for the background of the selection of these factors). The measures used to examine these factors were:

1) The indoor thermal environment: time of housing construction; use of heating device in the living room, bedroom, and toilet room; type of heating device used; and the site of the toilet room;

2) The level of physical work: type of occupation, work/exercise sufficient to induce perspiration, frequency of work/exercise per week, and hours of sleep;

3) Long absence from home: seasonal migration and deep-sea fishery;

4) Diet: frequency of eating certain food items; and

5) Health-promoting behavior: things done or avoided in order to maintain health, particularly health matters which are indicated to be associated with stroke mortality.

Some clinical information, such as usual level of blood pressure, treatment for hypertension, and histories of stroke, diabetes, and heart disease, was also obtained. Study questions used for the questionnaire are shown in Appendix A.

Selection of the Study Sites

In planning the mail questionnaire survey, it was first proposed to select a study population on the basis of random sampling or systematic sampling to insure representativeness. But due to the constraints of time and the cost of obtaining the names and addresses of randomly selected individuals, the selection procedure was changed to a type of stratified sampling: that is, (1) stratification of administrative units was made by mortality rates, and (2) a systematic sample was drawn from the categories of high and low mortality administrative units. Each town had to be visited to use the list of registered voters which contained individual names and addresses.

In comparing mortality rates among regions, the conventional methods of measuring mortality are numerous (Dever 1984). Among these, the Adjusted Death Rate (ADR) and the Standardized Mortality Ratio (SMR) are useful tools because these adjust for differences in population age structure among areas. The method of rate adjustment for the ADR requires a knowledge of the age-specific death rates in all populations to be compared. Since these age-specific stroke death rates were not available for the populations in which adjustments were desired, the Standardized Mortality Ratio (SMR) was chosen for this study to measure the frequencies of stroke mortality for cities, towns, and villages. The age- and sex-specific stroke death rates of the nation in 1980 were applied to the

corresponding age and sex groups of cities, towns, and villages between 1979 and 1981, respectively, to obtain the number of expected deaths from stroke. The total number of observed stroke deaths in each city, town, and village during the same period divided by the sum of these expected deaths in the corresponding city, town, and village gave the SMRs (multiplied by 100). Figures 3.1 and 3.2 show the results for males and females between 1979 and 1981, respectively.

The variability of the stroke SMR was assessed using a confidence interval since an observed mortality or morbidity rate cannot be taken as a true rate for an area. An observed rate is an estimate of the true rate and, as is the case with any estimate, is subject to chance variation. The rationale is that the number of stroke deaths in an area, for example, varies by chance depending on the size of the population and the probability of death--the true mortality rate. As the size of the population increases, the chance component becomes less important and the observed mortality rate becomes a better estimate of the true rate. However, if an area has few deaths, the observed death rate may be very different from the true rate (Miyawaki and Chen 1981; Dever 1984).

Cities/towns/villages which had significantly high and low male and female SMRs in comparison to the respective SMRs of Miyagi (male SMR: 118.31; female SMR: 126.09) were selected for study by using 90 percent confidence intervals as a test of statistical significance. The calculation of the confidence interval was based on the assumption that the distribution of the observed rates can be approximated by the standard normal curve (Dever 1984).

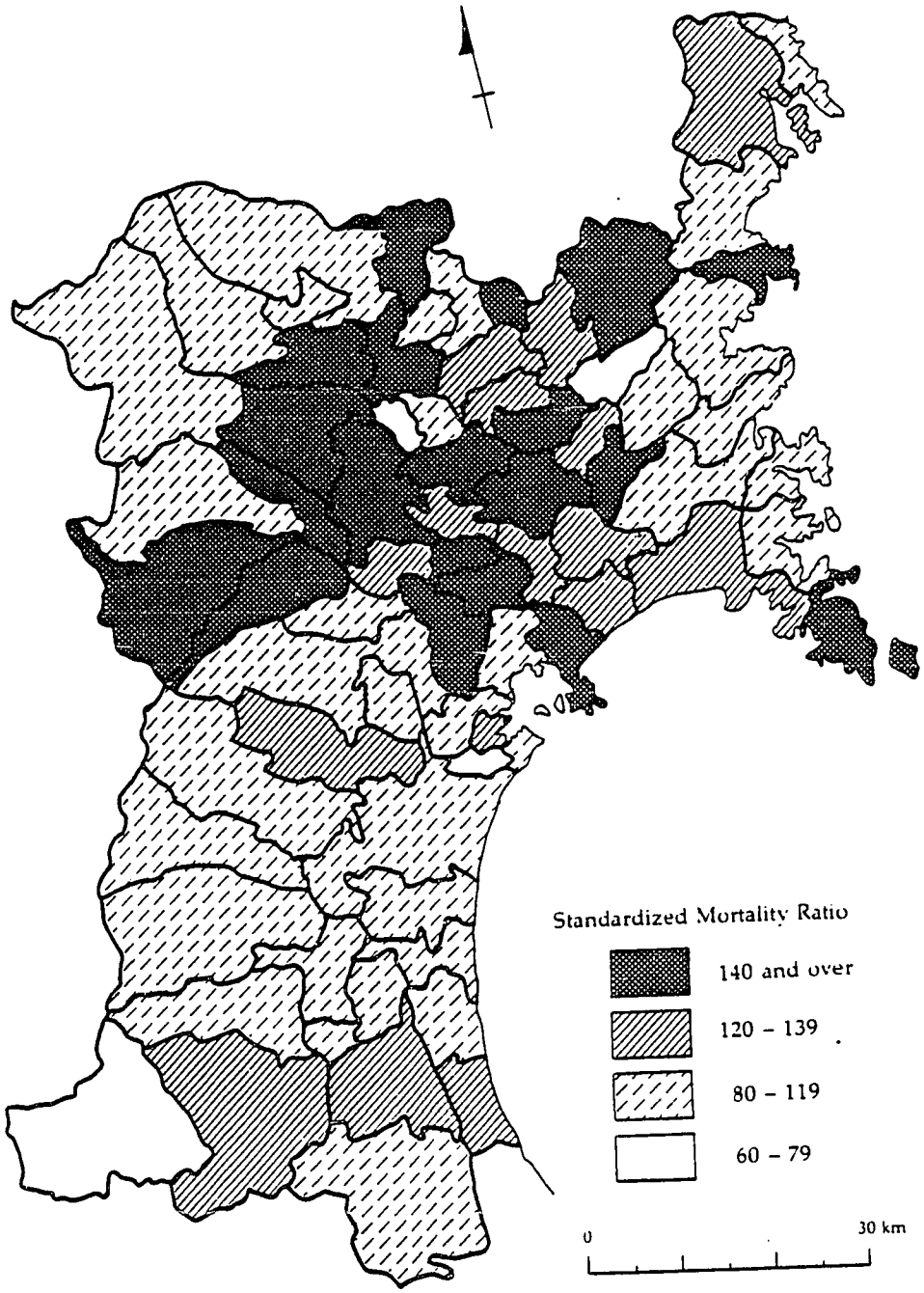


Figure 3.1. Geographical Distribution of Standardized Mortality Ratios for Stroke (Male) by Cities, Towns, and Villages in Miyagi, 1979-1981.

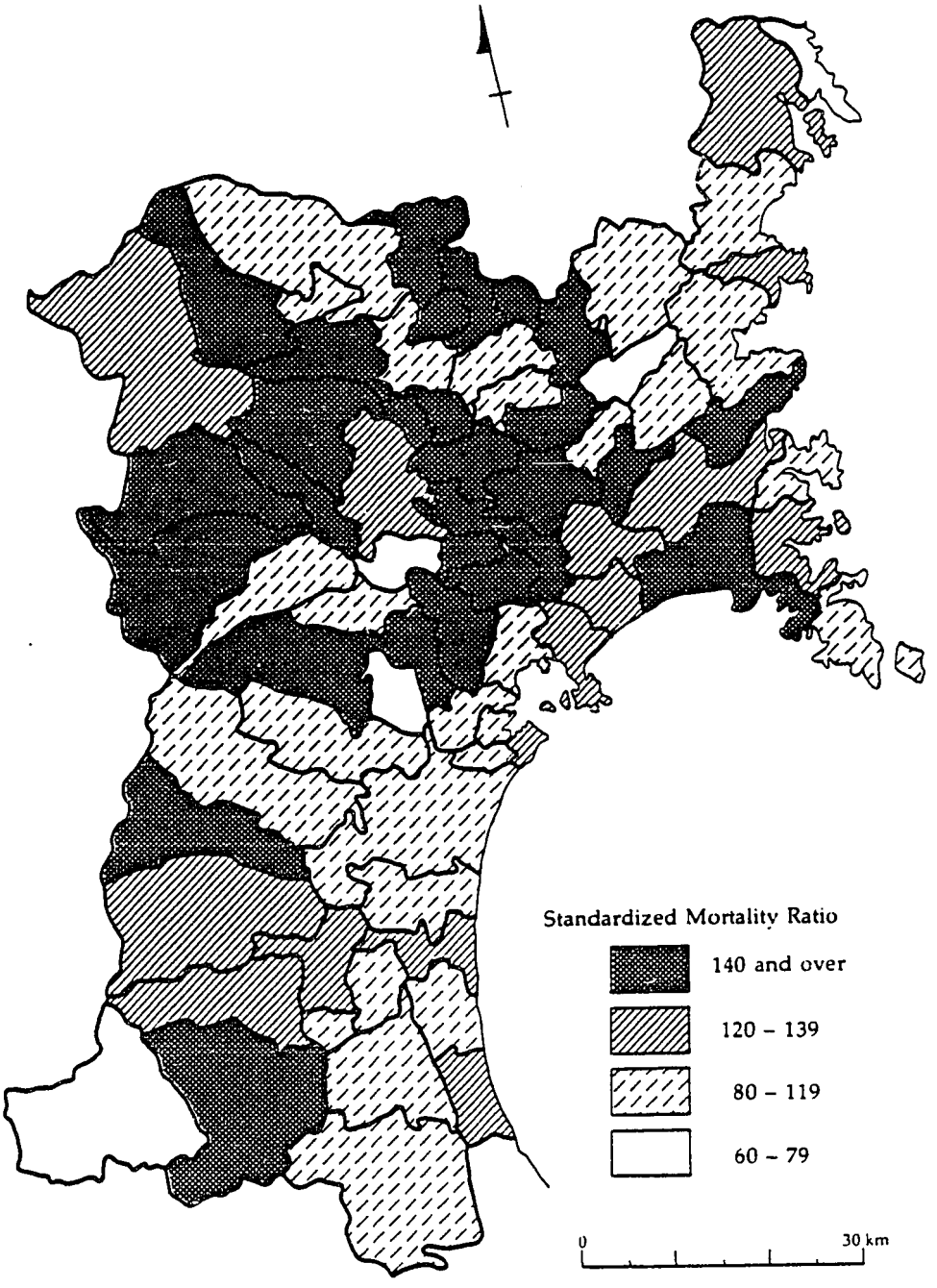


Figure 3.2. Geographical Distribution of Standardized Mortality Ratios for Stroke (Female) by Cities, Towns, and Villages in Miyagi, 1979-1981.

The 90 percent confidence interval was constructed using the following formula:

$$CI\ (90\%) = SMR \pm (1.645 \times SE)$$

where:

$$SE\ (\text{Sample Error}) = \frac{SMR}{\sqrt{\text{observed number of deaths}}}$$

This procedure is illustrated below:

Using the male data from Sendai,

1. $\sqrt{1035} = 32.17$
2. $SE = 100.78/32.17 = 3.133$
3. $1.645 \times 3.133 = 5.15$
4. $100.78 + 5.15 = 105.93$ (high limit)

   $100.78 - 5.15 = 95.63$ (low limit)

   $CI = 95.63$ to 105.93

For the selection of study sites, the confidence intervals of stroke SMRs for each city, town, and village in Miyagi were compared with that of the stroke SMR for Miyagi as a whole: if the confidence interval of the stroke SMR for Miyagi contained that of the observed SMR (the SMR being compared with Miyagi), there was no statistically significant difference.

Seven towns (all agricultural) were significantly high at the 90 percent confidence level. One town (a fishing town) and one city (the capital of Miyagi) were significantly low at the 90 percent confidence level. There were three modifications to this approach:

1) Since only one fishing community (Karakuwa) was selected, it was not considered to represent the characteristics of fishing communities as a whole. Therefore one more town was added. This town (Ogatsu) had a similar physical and socioeconomic environment to Karakuwa and also had a relatively low stroke SMR.

2) Since Karakuwa, the fishing town with significantly low SMR, had an unusually high mortality from senility for those 80 years of age and over, some of whom undoubtedly died from stroke, it was presumed that mortality from stroke would be actually higher if deaths from senility were more specifically diagnosed. In fact, when stroke mortality for those under 80 was compared between Karakuwa and Miyagi, mortality in Karakuwa was slightly higher. For instance, the death rate of stroke for Karakuwa of those between 50-79 years old in 1985 was 381.4 per 100,000, while the rate for Miyagi was 278.3 per 100,000. Thus it was assumed that the stroke SMR of Karakuwa was not significantly different from that of Miyagi at the 90 percent confidence interval, rather than significantly low. Karakuwa was originally assigned to the low category.

3) Although the town of Toyoma had a significantly high SMR at the 90 percent confidence interval, it was dropped from the study as it had less than 30 deaths from stroke. It was replaced with the town of Shiwahime which had a relatively high stroke SMR (but not statistically significant), and which was the study site of the second component.

Altogether, one city and nine towns were selected as study towns for the mail questionnaire survey (Figure 3.3). Their stroke SMRs are listed in Table 3.1. Selected study towns were classified into three socioeconomic groups as follows:

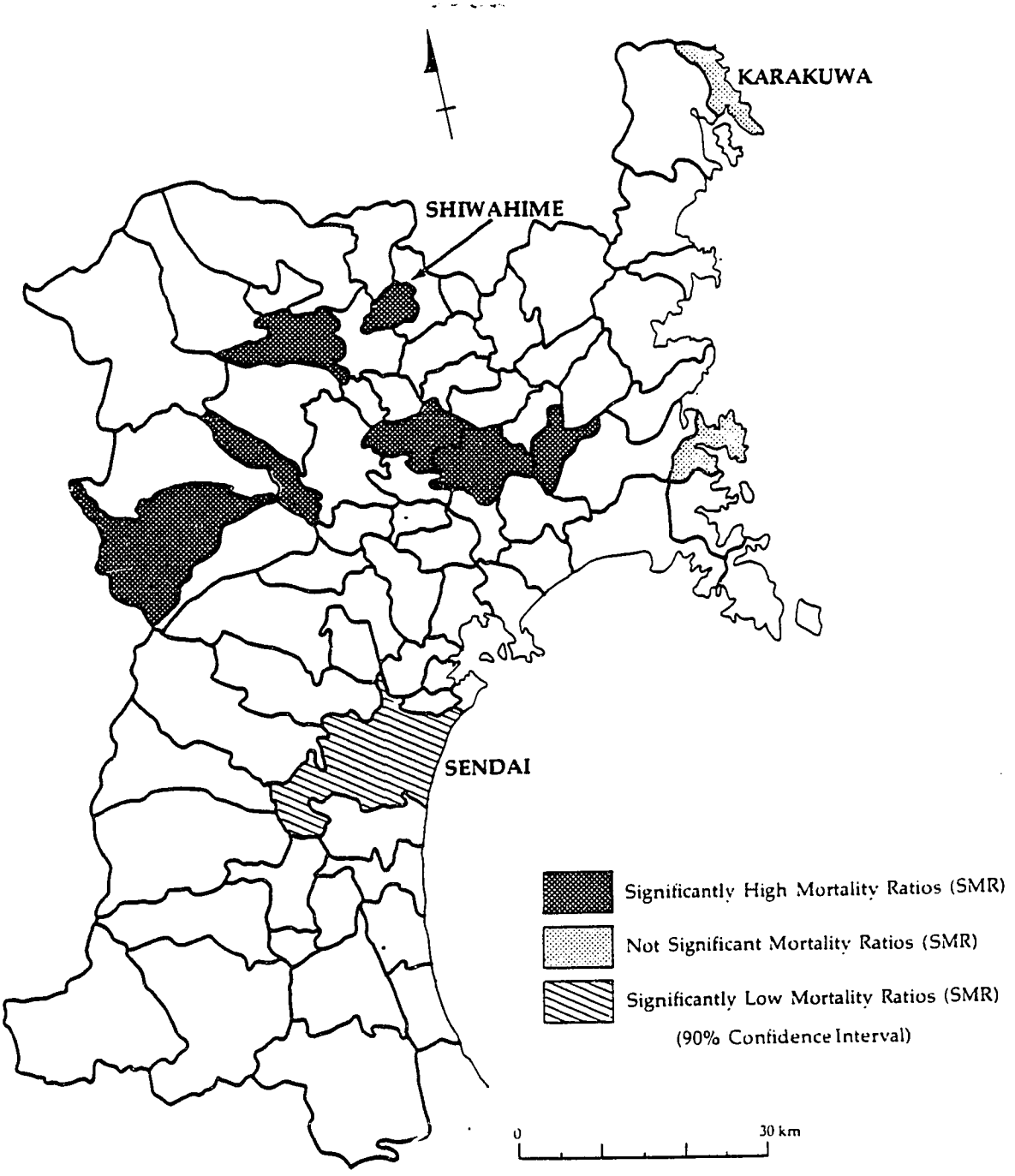


Figure 3.3. Cities and Towns Selected for a Mail Questionnaire Survey of Mortality Differential.

1) Cities (significantly low)--Sendai;

2) Fishing Towns (not significantly different from Miyagi SMR)--Karakuwa and Ogatsu;

3) Agricultural Towns (significantly high)--Monou, Wakuya, Tajiri, Onoda, Nakaniida, Ichihazama, and Shiwahime.

Table 3.1

Standardized Stroke Mortality Ratio of Miyagi and Selected Study Cities and Towns for Both Sexes, Miyagi, 1979-1981

Cities and Towns	Standardized Stroke Mortality Ratio	
	Male	Female
Miyagi	118.31	126.09
Sendai	100.78	115.38
Karakuwa	81.68	60.82
Ogatsu	94.57	89.89
Monou	183.51	203.35
Wakuya	169.30	179.11
Tajiri	168.15	163.51
Onoda	170.15	244.00
Nakaniida	174.94	175.15
Ichihazama	159.35	208.89
Shiwahime	111.95	143.65

It should be noted that there were other fishing towns as well as agricultural towns whose stroke SMRs were not significantly different from the Miyagi SMR.

The above classification confirms the observations in the past that agricultural areas tend to have high stroke mortality, but does

not support the findings of previous studies that fishing towns tend to have significantly low stroke mortality rates.

Sample Selection

Individuals 30-74 years of age were selected from the list of registered voters in each study town. Voter registration is compulsory in Japan. Those under 29 years of age were excluded because stroke mortality rates are insignificant in this age group. Those 75 years of age and over were also excluded because of unreliable accuracy of the responses to the questionnaire due to old age. Each study town was visited and eventually a random sample of individuals, complete with full name, age, and address, was completed. However, information on age could not be obtained in Sendai. Systematic sampling was employed to select individuals in each town. The procedure to determine the sample size was as follows:

First Step: The desired number of respondents was determined on the basis of a discussion with an expert in mail questionnaire surveys in Japan. Accordingly, at least 100 respondents from each agricultural town (total = 700), 200 respondents from each fishing town (total = 400), and 400 respondents from a city, were proposed. However, due to financial constraints, the number of respondents for the city was reduced to 200.

Second Step: As response rates for mail surveys are generally low in Japan, it was decided to try to raise the response rate as high as possible, as discussed in the following section. The overall response rate was expected to be 60 percent. Thus in order to obtain the desired

number of respondents, the number of individuals to receive the questionnaire was expanded. The formula to obtain this number was calculated as follows:

i.e.,	City	200/0.6 = 334
	Fishing Towns	400/0.6 = 667
	Agricultural Towns	700/0.6 = 1167

(0.6 = Expected Response Rate)

Third Step: The voter registration list records persons 20 years of age and over. Since the age range needed for the study was between 30-74 years, the ratio of those between 30-74 years to those 20 years of age and over was calculated using the age structure of urban and rural areas, respectively. This ratio was used to calculate the adjusted number of people to be considered for a systematic sample. The 1985 census preliminary report, which was available at the Japanese Bureau of Statistics in Tokyo, was used to obtain the age structure of both urban and rural populations. The formula to obtain the adjusted number for a systematic counting is as follows:

Desired Sample Size - Ratio [Number of People 30-74 Years of Age (Urban/Rural) - Number of People 20-74 Years of Age (Urban/Rural)]

i.e.,	City	$334/\frac{701,800\ (30\text{-}74)}{908,700\ (20\text{ and over})}$	=	433
	Fishing Towns	$667/\frac{455,300\ (30\text{-}74)}{587,500\ (20\text{ and over})}$	=	861
	Agricultural Towns	$1167/\frac{455,300\ (30\text{-}74)}{587,500\ (20\text{ and over})}$	=	1,506

Persons 20-29 years of age and 75 years of age and over were not recorded.

Fourth Step: The final number of persons receiving the questionnaire in each fishing town and agricultural town was determined by taking the population in each study town as a proportion of the total population of the fishing and agricultural towns, respectively.

The systematic sample was drawn by first calculating the sampling interval K on the basis of the total number of voters. Then after the first person in the sample was selected at random within this interval, every Kth person was selected. The final total of questionnaires sent to each group was different from the planned number. This was because the approximate ratio of people between 30-74 years to those 20 years of age and over was calculated using the crude data obtained from the 1985 Census Preliminary report where the total population by five-year age interval was estimated on the basis of 5 percent samples. Table 3.2 shows the final total number of the questionnaires sent to each town and city.

Table 3.2

Number of Questionnaires Received and Response Rates

Cities and Towns	Questionnaires Received	Response Rate
Sendai	315	60%
Karakuwa	386	72
Ogatsu	294	59
Monou	125	66
Wakuya	277	64
Tajiri	203	72
Nakaniida	191	70
Onoda	125	74
Ichihazama	153	69
Shiwahime	103	59
Total	2172	66%

Survey Strategies

One problem with a mail survey is attaining a "good" response rate. Official government surveys have the best response rate in Japan (e.g., the response rate for surveys conducted by Miyagi prefecture is usually 50-70 percent depending on the socioeconomic status of the study population), so the questionnaire used in this study was made as "official" as possible. Several strategies were adopted:

1) The survey was conducted under the name of the Institute of Medical Geography and Statistics where the writer's field supervisor was the chief. Each mailing package enclosed a brochure which described the work of the Institute.

2) Two official letters were also enclosed which requested cooperation in responding to the questionnaire. One was a letter from the Branch of Community Health, the Department of Health Environment of Miyagi. The other was a letter from the local health centers which administer health affairs of the study towns. The health center in the city was an exception due to political conflicts between the administration of this city and Miyagi prefecture which assisted in the study.

3) In addition to the above, the health branch of the administration office of each study town was visited. The purpose of the study was explained to local health officials who were asked to encourage cooperation in the survey if any questions regarding the survey were addressed. The officials were also requested to introduce the survey in a monthly-published local health newsletter, but only three towns (Karakuwa, Monou, and Tajiri) acted on this request.

4) A small gift was also included for respondents. In Japan this is generally believed to increase the response rate by about 5-10 percent.

In spite of all these efforts, the response rate for the first mailing was unexpectedly low. Accordingly a follow-up mailing was done. This mailing improved the response rate about 20 percent on the average, and thus a higher response rate was obtained than the 50 percent originally expected (Table 3.2). Even after the follow-up considering the questions some respondents asked on the phone, the questionnaire still seemed to be viewed as being mailed from an unidentified organization. Two actions might have further improved the response rate:

1) To ask the Department of Health Environment of Miyagi and the local health centers to stamp their names on their official letters so that these would seem truly official; and

2) To request a local institution in Miyagi to be an official research agency, instead of the Institute of Medical Geography and Statistics, located in Tokyo, so that people would feel more closely involved in the survey.

Sample Representativeness

When the general populations of the study towns and the respondents of these towns were compared for both males and females, there was an overrepresentation of older people and an underrepresentation of younger people for the study population, particularly for people living in the urban area. Analysis to control for these differences revealed that they would not affect the study results in any important way. Thus the effect of age bias was assumed to be minor.

Method

The chi square test was employed to find significant socioeconomic factors associated with the urban-rural geographical variations in stroke mortality. The chi square test was first performed only for the significantly high (agricultural towns) and significantly low (city) mortality areas.

Stroke mortality rates are strongly associated with the urban/rural characteristics of a place; that is, the significantly low mortality area is an urban area, and the significantly high mortality areas are all rural areas (see Chapter I, "Hypotheses"). However, although fishing areas are also rural, their mortality rates were found not to be significant. Thus, the same test was also performed further to examine the relationship between study factors and the rural areas with different stroke mortality rates: a significantly high mortality area (agricultural towns) and a non-significant mortality area (fishing towns). In the remaining sections of this chapter, the significantly low mortality rate area will be labeled as the urban area, the significantly high mortality rate area as the agricultural area, and the non-significant mortality area as the fishing area.

Results and Discussion

Tables 3.4 and 3.6-3.8 show the results of the chi square test of the relationship between study factors and the geographical areas. Missing values and "don't know" answers were excluded from analysis. The results and discussion follow.

Indoor Thermal Environment

Table 3.3 shows the types of heaters used in the living room, the bedroom, and the room for the toilet in the study areas. The toilet in Japan is built as a small separate room, either indoors or outdoors, and is separate from a bathroom. Table 3.4 indicates that, compared with households in the urban area, residents of households in the agricultural area tend to live in old houses built before World War II. Houses tend to be less adequately heated in the bedroom and the toilet. Twenty-five percent of the agricultural households still have outdoor toilets, and only 14 percent of these have heating devices in the toilet. Bedroom heating tends to be partial, using electric blankets, electric footwarmers, hot water foot warmers, and electric stoves. In contrast, in the urban area, there are no outdoor toilets and 37 percent of the households have heating devices in the toilet. The types of heaters in the bedroom tend to have more power such as oil/gas stoves, oil/gas fan heaters and central heating, as well as partial heating.

The heating in living rooms, however, seems to be little different between the agricultural and urban areas. The only difference is that many households in the agricultural area have oil stoves and foot heaters, either electric or charcoal, whereas households in the urban area have more diverse types of heating devices such as oil/gas stoves, oil/gas fan heaters and central heating as well as partial heating from electric blankets, electric foot warmers, hot water foot warmers, and electric stoves.

The fishing area has the lowest percentage of households using heaters in toilets and bedrooms among the three areas. However, fishing

Table 3.3

Types of Heaters in the Living Room, the Bedroom, and the Toilet

HEATING TYPES (LIVING ROOMS)	
partial room heating:	electric stove electric carpet electric/charcoal kotatsu
whole room heating:	oil/gas/charcoal (firewood) stove gas/oil fan heater central heating
combination:	partial and whole room heating
HEATING TYPES (BEDROOMS)	
partial room heating:	electric blanket electric foot warmer hot water foot warmer electric stove
whole room heating:	oil/gas stove oil/gas fan heater central heating
combination:	partial and whole room heating
HEATING TYPES (TOILETS)	
partial room heating:	toilet seat heater
whole room heating:	electric stove central heating
combination:	partial and whole room heating

Table 3.4

Distribution of Indoor Thermal Environment
for Geographical Areas, Miyagi, 1986

Responses	Geographical Areas		
	Agricultural	Urban	Fishing
INDOOR THERMAL ENVIRONMENT			
1. housing construction period[a]			
before the war	112 (15%)	12 (7%)	79 (18%)
1945-1974	399 (52)	97 (56)	224 (51)
since 1975	254 (33)	63 (37)	134 (31)
2. adequacy of living room heating			
partial	20 (2)	4 (2)	20 (4)
whole	134 (17)	39 (22)	68 (15)
combination	644 (81)	134 (76)	368 (81)
3. adequacy of bedroom heating[b,d]			
no heating	194 (26)	34 (20)	157 (37)
partial	427 (58)	78 (45)	217 (51)
whole	33 (4)	32 (19)	16 (4)
combination	87 (12)	28 (16)	36 (8)
4. adequacy of toilet heating[b,d]			
no heating	672 (86)	111 (65)	425 (94)
partial	91 (12)	40 (23)	15 (3)
whole & combination	19 (2)	21 (12)	10 (2)
5. toilet location[b,d]			
indoor	601 (75)	176 (100)	387 (85)
outdoor	199 (25)	0 (0)	68 (15)
6. room temperature discrepancy[b,e]			
three rooms heated (least decrepancy)	14 (2)	8 (5)	3 (1)
living room & toilet heated	6 (1)	13 (8)	7 (2)
living room & bedroom heated	105 (14)	48 (29)	49 (12)
living room heated only (most discrepancy)	600 (83)	98 (58)	364 (86)

Table 3.4 (continued) Distribution of Indoor Thermal Environment for Geographical Areas, Miyagi, 1986

---

[a]agricultural-urban differences significant at the 5 percent level

[b]agricultural-urban differences significant at the 1 percent level

[c]agricultural-fishing differences significant at the 5 percent level

[d]agricultural-fishing differences significant at the 1 percent level

[e]Definition of terms for room temperature discrepancy

not heated:	not heated at all partial room heating
heated:	whole room heating or combination of partial room heating and whole room heating

areas have a significantly higher percentage of households having indoor toilets than agricultural areas. Although there is a significantly lower percentage of households using heating devices in bedrooms and toilets in the fishing area as compared to those in the agricultural area, this is due to a higher percentage of partial heating in the agricultural area and thus the room temperatures may not differ..

On the whole, there is little difference in the adequacy of heating in the living room among the urban, agricultural, and fishing areas. However, in the agricultural and fishing areas the temperature inside the house is lower in the bedroom and in the toilet due to less use of heating devices, thus the room temperature discrepancy between the living room and the bedroom, and between the living room and the toilet, is greater than those in the urban area.

In terms of heating in the agricultural area people live in comparatively poor housing conditions. Even though heating systems in living rooms are not very different between the agricultural and urban areas, other rooms such as the toilet and bedroom are poorly heated.

People in the fishing area also have poor housing conditions, and the style of life in terms of heating is quite similar to that of the agricultural areas. This is in part due to the housing structure of these areas. For example, fewer houses in both areas have Western-style toilets in a small separate room than do those in the urban area. This discourages use of heaters inside the toilet space since these are not usually effective in the well-ventilated and unlined Japanese-style toilet rooms. However, there are some differences between the two study areas. One is that the fishing area has relatively fewer outdoor toilets

than does the agricultural area. Thus the overall temperature in the toilet may be a little higher than that in the agricultural area. The other difference is that the climate is milder in the fishing area. Thus the housing of the fishing town may not require the same intensity of heating as that of the agricultural area.

On the whole, the results from the comparison of geographical areas with different mortality rates indicate that there is a distinct difference between urban and rural areas in terms of heating. This suggests that the relationship between mortality level, as indicated by geographical area, and the indoor thermal environment could be a reflection of differences in the style of life between the urban and rural areas. However, it is noted that the fishing area, which has intermediate mortality between the agricultural and urban areas, is also intermediate in terms of the percentage of indoor toilets. The housing structure and indoor temperature were examined in more detail in the case control study.

The Level of Physical Work

Table 3.5 indicates the types of occupation according to the level of physical work. Table 3.6 indicates that a higher percentage of people in both agricultural and fishing areas engaged in hard physical work than those in the urban area. People in the fishing area tend to be engaged in the occupation of fishery (79 percent), whereas people in the agricultural area tend to have agricultural work and skilled labor/ manufacturing work/physical labor (73 percent). In contrast, people in the urban area have more sedentary work such as professional/technical, administrative, secretarial, sales and service work than do those in

Table 3.5

Classification of Occupations According to the Level of Physical Work

Level of physical work	
light work:	professional/technical
	administrative
	secretarial
	housewife
	retired
moderate work:	sales
	transportation/communication
	skilled labor/manufacturing
	security
	service
heavy work:	agricultural
	forestry
	fishery
	mining
	construction
	heavy transporting

Source: Nutrition Requirements for the Japanese (Japan Ministry of Health and Welfare, 1984)

other two areas. Thus only 45 percent of respondents take exercise or have work sufficient to induce perspiration.

Although there is a statistically significant difference in sleeping hours between those in the agricultural and fishing towns, it is not an appropriate measure of the level of physical work due to an irregular sleeping pattern of fishermen at sea.

On the whole, people in the agricultural area have more strenuous physical work, whereas those in the urban area have more sedentary work. People in the fishing area also have strenuous physical work, although

Table 3.6

Distribution of Level of Physical Work and Long Absence from Home for Geographical Areas, Miyagi, 1986

Responses	Geographical Areas					
	Agricultural		Urban		Fishing	
LEVEL OF PHYSICAL WORK						
1. level of physical work[a]						
heavy	343	(43%)	4	(2%)	167	(39%)
moderate	186	(23)	48	(28)	98	(23)
light	261	(34)	122	(70)	167	(38)
2. exercise or work to induce perspiration[a]						
yes	451	(57)	49	(28)	261	(58)
no	342	(43)	126	(72)	191	(42)
3. sleeping hours a day[b]						
3- 6 hrs.	73	(9)	18	(10)	63	(14)
7-15 hrs.	726	(91)	157	(90)	392	(86)
LONG ABSENCE FROM HOME						
1. seasonal migration or deep-sea fishing[b]						
no	772	(97)	174	(99)	72	(16)
yes	27	(3)	2	(1)	381	(84)

[a]agricultural-urban differences significant at the 1 percent level

[b]agricultural-fishing differences significant at the 1 percent level

the types of occupation differ from those in the agricultural areas. In summary, people in the rural area are engaged in hard physical work, whereas those in the urban area are engaged in sedentary work. Thus the relationship between the physical work and stroke mortality may also be a reflection of the difference in the style of life between urban and rural areas. The relationship between stroke mortality and physical work was examined in detail in the case control study.

Long Absence from Home

Long absence from home, which was used to measure stress, had a small number of people in the agricultural area (Table 3.6). In the past, seasonal migration was common in agricultural areas and was associated with high mortality from stroke (Aoki et al. 1982), but this is no longer the case.

Diet

Table 3.7 indicates that people in the agricultural and fishing areas are more likely to have a traditional diet in terms of rice, pickled vegetables and miso soup than those in the urban area. In contrast, there is no statistically significant difference in the frequency of animal protein food item intake among the three areas.

The majority of people in the agricultural area have a traditional diet. There is a much higher intake of rice, pickled vegetables and miso soup which are considered to be the basic food items in the Japanese traditional diet. But this is also true for people in the fishing area. This means that rural residents tend to have a dietary routine which induces a high salt intake. There is little difference in animal protein

intake among the three areas. In the past, the agricultural area was notorious for a poor protein intake, but this is no longer true due to the advocacy of nutrition improvement together with higher standards of living.

On the whole, the relationship between diet and stroke mortality seems to be due to a different dietary routine between urban and rural areas, notably by a high salt intake in the rural areas. This proposition was examined in detail in the case control study.

Health-Promoting Behavior

There is no statistical difference in health promoting behavior among the three areas (Table 3.7). This may be because the questions were broad in scope. This topic was addressed with more specific questions in the case control study.

Clinical Factors

When stroke-related clinical factors and the geographical areas with mortality differentials were examined for the age group 50-74 years with a high risk of stroke-related diseases, the findings were as follows (Table 3.8):

1) The prevalence rates of hypertension were significantly higher in the agricultural area than in the urban area. The rates were also higher in the agricultural area than in the fishing area although the difference was not statistically significant. Hypertension here includes those who have normal blood pressure owing to the treatment of hypertension.

Table 3.7

Distribution of Level of Diet and Health-Promoting Behavior for Geographical Areas, Miyagi, 1986

Responses	Geographical Areas					
	Agricultural		Urban		Fishing	
DIET						
1. frequency of traditional food items[a]						
often	567	(71%)	49	(28%)	303	(67%)
less often	228	(29)	127	(72)	148	(33)
2. frequency of major protein-rich food items						
always	47	(6)	13	(7)	23	(5)
usual	748	(94)	164	(93)	423	(95)
3. frequency of other protein-rich food items						
always	181	(23)	42	(24)	109	(24)
usual	600	(75)	134	(76)	335	(75)
seldom	13	(2)	12	(2)	6	(1)
HEALTH-PROMOTING BEHAVIOR						
1. attempt to avoid stroke						
no attempt	139	(17)	37	(21)	94	(21)
some attempt	657	(83)	139	(79)	359	(79)

[a]agricultural-urban differences significant at the 1 percent level

See Appendix B for the illustration of Table 3.7.

Table 3.8

Distribution of Stroke-Related Diseases for Geographical Areas for 50-74 Years Old Group, Miyagi, 1986

Prevalence	Geographical Areas		
	Agricultural	Urban	Fishing
Hypertension[a,b]			
Yes	51%	31%	46%
No	49	69	54
	100%	100%	100%
	(442)	(84)	(242)
Treatment of Hypertension[b]			
Yes	42%	27%	36%
No	58	73	64
	100%	100%	100%
	(452)	(86)	(243)
Diabetes			
Yes	6%	9%	5%
No	94	91	95
	100%	100%	100%
	(458)	(88)	(246)
Heart Disease			
Yes	15%	14%	11%
No	85	86	89
	100%	100%	100%
	(459)	(88)	(246)

[a]Hypertension includes those who have normal blood pressure due to the treatment of hypertension.

[b]agricultural-urban differences significant at the 1 percent level.

2) A significantly higher percentage of respondents in the agricultural area had undergone treatment for hypertension than in the urban area. There was no statistically significant difference in hypertension treatment between those in the agricultural and fishing areas.

3) There was no significant difference in the relationship between diabetes and the geographical area and between heart disease and the geographical area.

In summary, it was found that the indoor thermal environment, level of physical work, and diet are important factors in assessing urban-rural geographical variations in stroke mortality. However, the results did not show such clear differences in these factors between agricultural and fishing towns due to similar rural styles of life. Only with the indoor thermal environment did the fishing area and the agricultural area differ due to a significantly higher percentage of indoor toilets in the fishing area. As far as stroke-related diseases are concerned, in contrast to hypertension, heart disease and diabetes seem to have little association with the geographical variation in stroke mortality.

Conclusion

The results indicate that there are distinct differences in the study factors between high mortality (agricultural) and low mortality (urban) areas. These differences seem related to the differences in styles of life between urban and rural areas.

It is concluded that the geographical variation in stroke mortality is associated with certain socioeconomic factors, namely, indoor thermal environment, level of physical work, and diet. The results of the survey also corroborate the association of hypertension with the variation.

CHAPTER IV

CASE-CONTROL STUDIES IN SHIWAHIME AND KARAKUWA: BACKGROUND

A detailed investigation of the relationship between socioeconomic factors and stroke mortality was conducted at the individual level in two towns with different socioeconomic compositions--one an agricultural town with relatively high stroke mortality, the other a fishing town with relatively low stroke mortality. The investigation used a matched-pairs case-control design[1] in order to explore the associations discovered in the analysis of the mail survey. Particular attention was paid to the indoor thermal environment, physical work, and diet, factors which were found to be associated with stroke mortality in the mail survey.

Shiwahime and Karakuwa: Contrasting Physical and Human Environments

Selection of the Study Sites

The initial plan was to select a town from a group of agricultural sites with high stroke SMRs and a town from a group of fishing sites with low stroke SMRs.

In the low mortality group, Karakuwa was the first choice because it had the lowest stroke SMR of all administrative units in Miyagi (SMR of 83 for males and 61 for females between 1979 and 1981, SMR for Japan as standard=100). There also was no difficulty in obtaining official cooperation. The head of the health branch of the administration office welcomed the study and promised any needed assistance.

In the high mortality group, Ichihazama was the first choice because it had the highest stroke SMR (SMR of 159 for males and 209 for females between 1979 and 1981), but the head of the local health center advised against this because the study would be adversely affected by certain local political problems. Instead Shiwahime, a neighboring town with a relatively high stroke SMR (SMR of 112 for males and 144 for females between 1979 and 1981) was recommended, partly because the mayor had expressed interest in health promotion.

When data on the of Karakuwa's residents were examined during the conduct of the study, it was found that the town had unusually high mortality from senility for those 80 years of age and over. Senility is the cause of death often given for the old instead of a specific cause. This used to be a common medical practice, particularly in the rural areas of Japan. Thus, many deaths classified as senility might have been due to stroke and it is possible that mortality from stroke in Karakuwa was underreported. However, even if diagnoses were adjusted, Karakuwa would not have a SMR as high as that of Shiwahime. For instance, the stroke death rate for Karakuwa of those between 50-79 years in 1985 was 381.4 per 100,000, while the rate for Shiwahime was 504.8 per 100,000, and the rate for all Miyagi was 278.3 per 100,000. Even if the deaths assigned to senility were correctly distributed, Karakuwa would still remain as an appropriate study site with relatively low stroke mortality rates in comparison to mortality rates in Shiwahime. Since the age distribution of both towns' populations are similar (Figure 4.1), the higher stroke mortality rates in Shiwahime cannot be explained by a higher percentage of elderly with their higher risk of stroke.

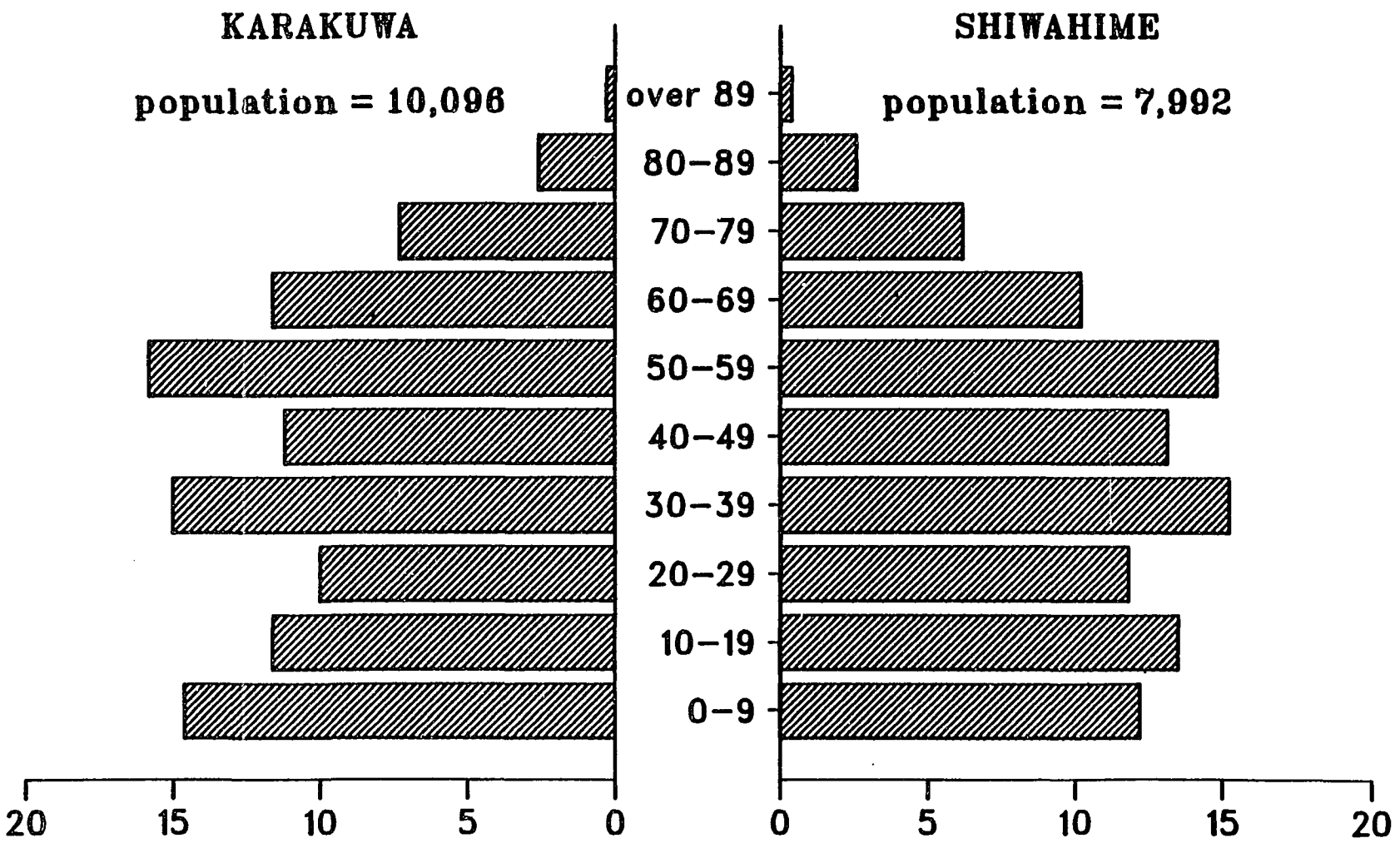


Figure 4.1. Population Distribution of Shiwahime and Karakuwa by Age
Source: 1985 Census Preliminary Report, 1986

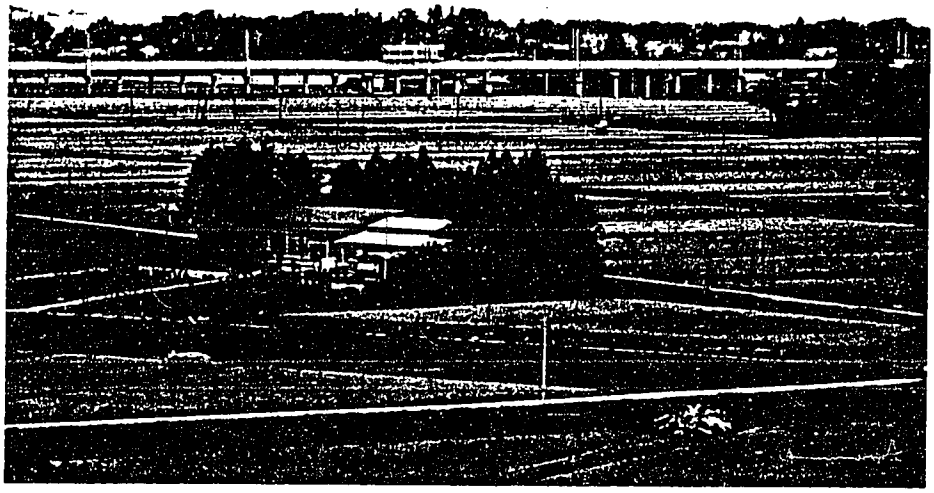
Characteristics of the Study Sites

Shiwahime: Shiwahime lies in the northern Sendai plain (Figure 4.2). The climate falls into the climatic division of the northern Sendai plain region (Chapter II). It is usually hot in summer, but it is cold in winter. It usually snows in winter but the snow does not linger. The major industry of Shiwahime is rice farming and the quality of rice is considered to be among the best in Japan.

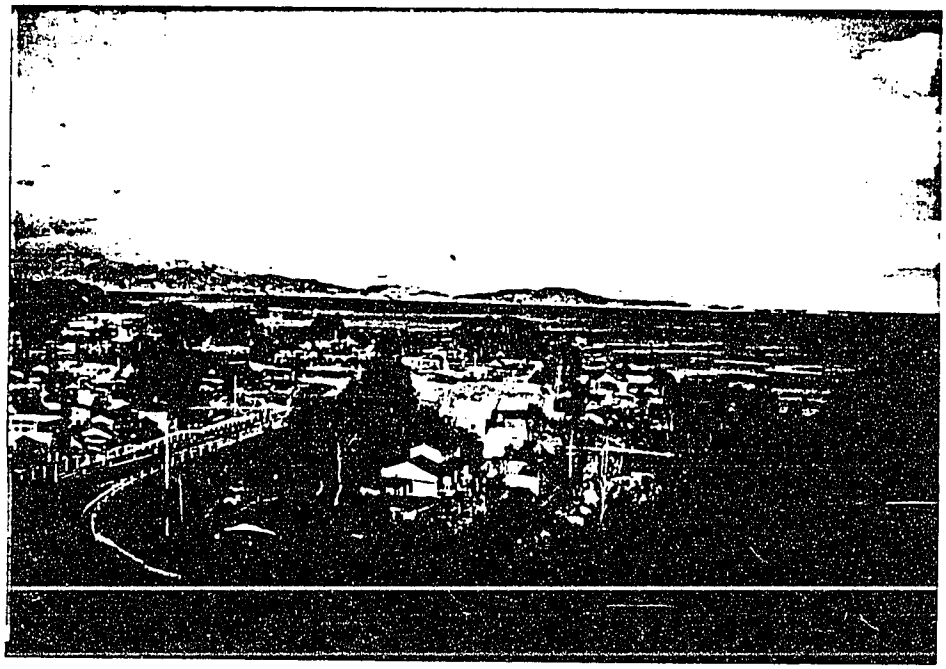
The mortality rate for all causes of death in 1985 was 1,113.6 per 100,000. The leading causes of death in Shiwahime in 1985 were cancer, followed by heart disease, stroke, and pneumonia/bronchitis. From 1975 through 1985, stroke was the leading cause of death in all years except in 1978 and 1985. In 1985 it was exceeded by cancer and heart disease (Figure 4.3).

Among those 30-74 years of age who responded to the mail questionnaire, 20 percent were hypertensive (Chapter III). This includes those with normal or low blood pressure induced by medication.

Karakuwa: Karakuwa lies in the eastern part of the Kitakami Range near the highly indented rias coast (Figure 4.2). The climate therefore falls into the climatic division of the coastal region (Chapter II). It is generally cooler in summer and warmer in winter when compared with more inland locations. The major industry of Karakuwa is dry field farming and fishing. Both deep-sea and inshore fishing are common and many men are absent from home for ten to twelve months during the year. Women do dry field farming as well as laver (sea-weed) and oyster farming.



(1) Shiwahime



(2) Karakuwa

Figure 4.2. Towns of Shiwahime and Karakuwa

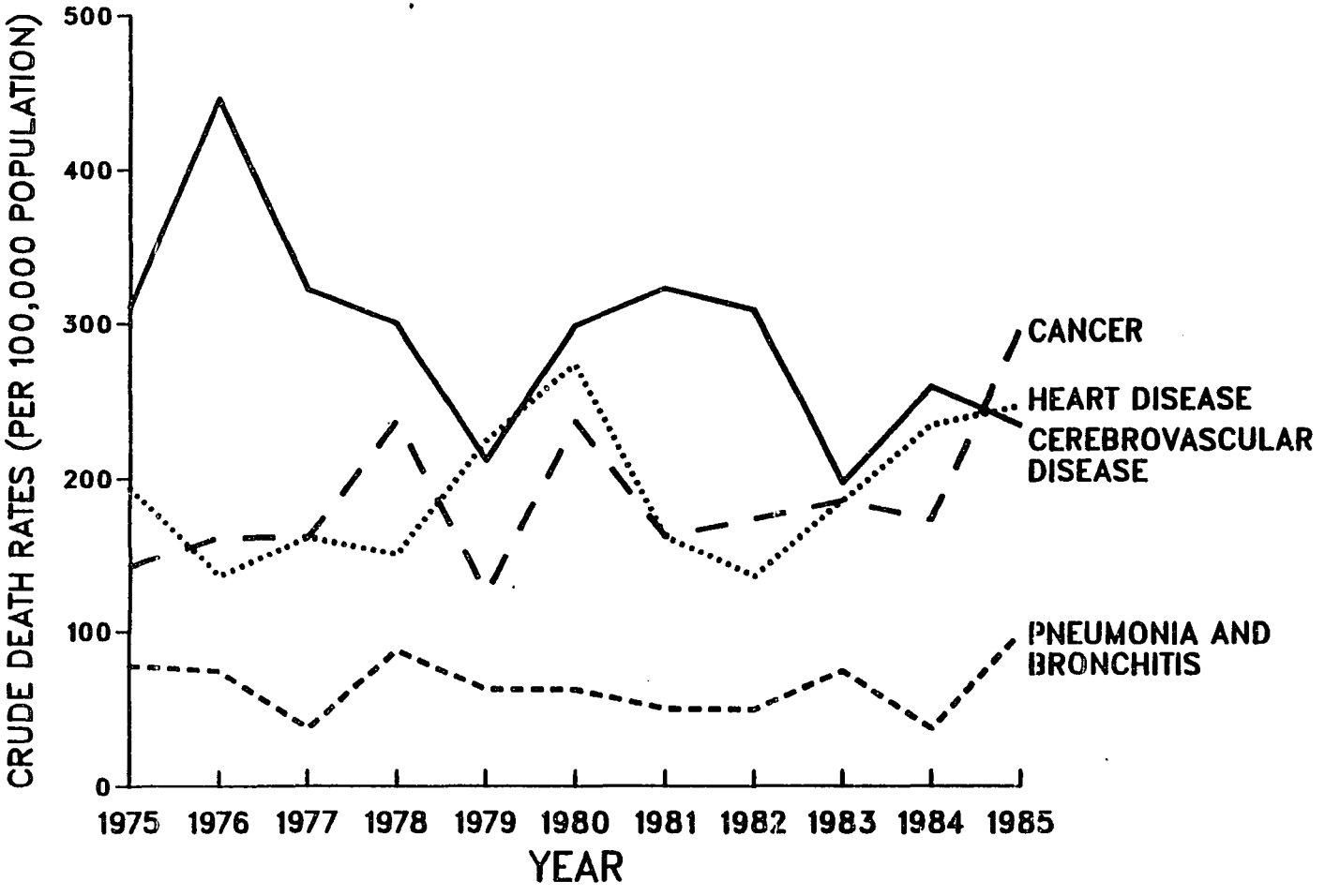


Figure 4.3. Leading Causes of Death in Shiwahime, 1975-1985
(Crude Rate per 100,000 population)

Source: 1985 Shiwahime Health Statistics, 1986

In 1985, in Karakuwa, the mortality rate for all causes of death was 713.2 per 100,000. The leading causes of death in 1985 were stroke, senility, cancer and heart disease. Stroke had not always been the primary cause of death but gained that position in 1985 (Figure 4.4). This change may be associated with a decrease in the diagnosis of senility, although mortality from senility is still high. According to the public health nurses in Karakuwa, the local families at the time of death of an old family member prefer senility as a cause of death because senility implies longevity and a peaceful death. Physicians who practice medicine in Karakuwa for a long time have good acquaintances with local residents. Thus one reason why senility appears high in Karakuwa is because physicians tend to listen to the residents' requests for senility as a cause of death. Among those 30-74 years of age who responded to the mail questionnaire, 32 percent were hypertensive (Chapter III), including those with normal or low blood pressure due to medication for hypertension. Thus, even though stroke mortality was lower in Karakuwa than in Shiwahime, the prevalence rate of hypertension was higher. Mortality from cancer and heart disease as well as stroke was lower in Karakuwa than in Shiwahime even if mortality from senility was taken into account. Thus the reason for lower stroke mortality in Karakuwa cannot be explained by a greater number of deaths from competing diseases at earlier ages.

Sample Selection

Thanks to the cooperation of local public health centers which administer the health affairs of the study sites, confidential

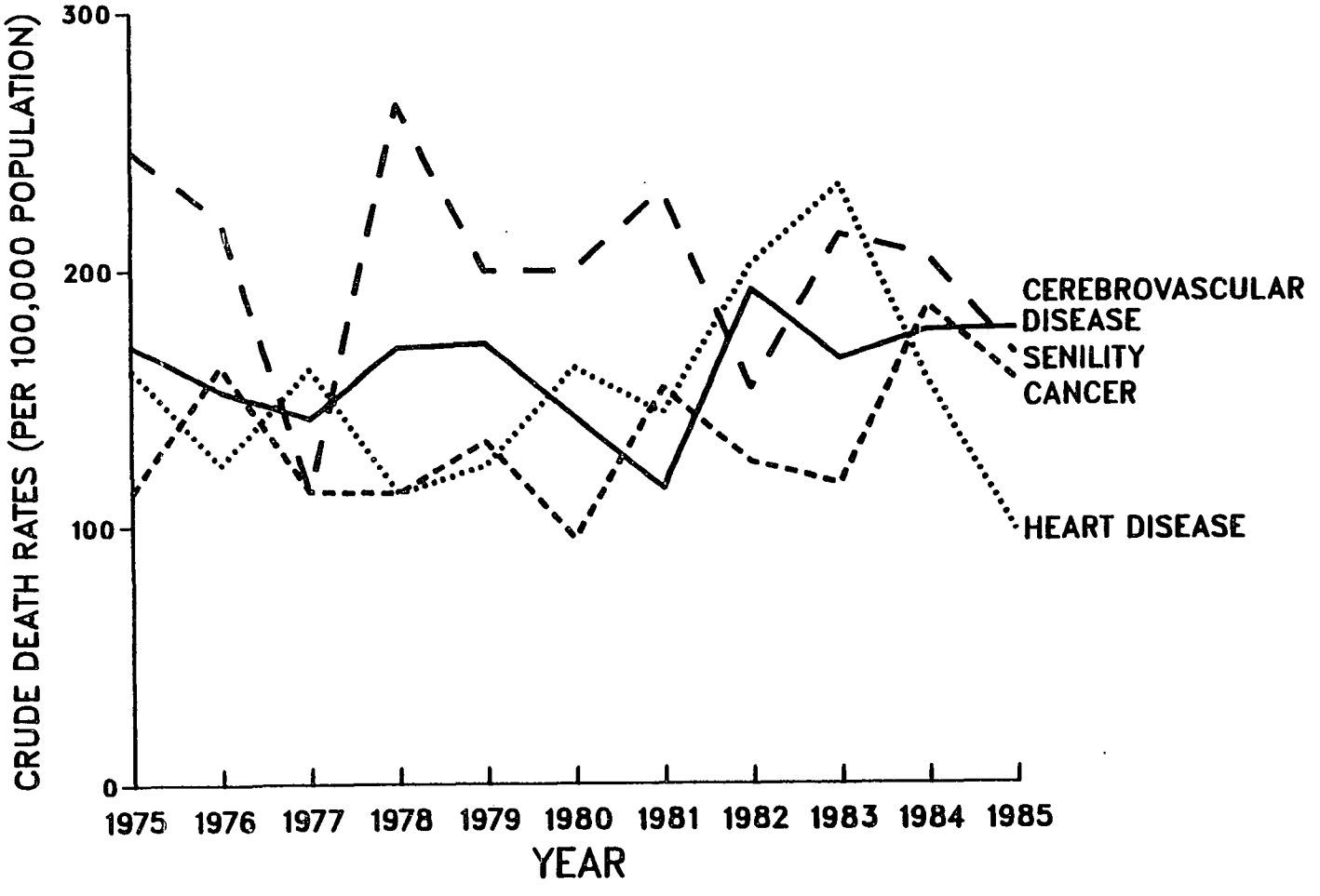


Figure 4.4. Leading Causes of Death in Karakuwa, 1975-1985
(Crude Rate per 100,000 population

Source: 1985 Karakuwa Health Statistics, 1986.

information on the name, age at the time of death, sex, diagnoses at the time of death, and home address, were provided from the death certificates of each case studied. These were of individuals who had lived in the study towns for more than 30 years and who had died of stroke as either direct or indirect cause of death in the last five years. Five years was selected since this was considered to be the limit for obtaining reliable information on the deceased. In fact the public health centers kept records for only the last five years.

The following people were excluded from the study:

1) Those who had died of stroke more than one year after an initial stroke, because they might have developed other disease complications from the incident;

2) Those who had died of subarachnoidal hemorrhage because of its fundamentally different nature; and

3) People 50 years of age and under and 80 years of age and over, because stroke is not an important cause of death among the former, and the diagnosis is suspected as unreliable among the latter.

Based on age and sex for the cases studied, age and sex-matched controls were identified as follows:

1) Those who were free from hypertension (according to the WHO definition of high blood pressure: a systolic blood pressure above 160 and a diastolic blood pressure above 95); and

2) Those who had never received hypertension treatment; and

3) Those who were free from a history of stroke, heart disease, and diabetes.

The reason why individuals who were free from the above stroke-related diseases were selected as controls is because controls with such diseases are potential stroke cases. Stroke-related conditions, such as hypertension, are known to be common in Japanese stroke cases. Thus if these diseases and conditions were not controlled for in the selection of controls, the study would lose power in its capacity to identify risk factors.

The selection procedure was as follows:

1) List by 5 year age-intervals potential controls between the ages of 50 and 79;

2) Randomly select individuals from the list who were matched to the cases in terms of 5-year age intervals and sex;

3) Examine the disease history of each individual selected by using the health records maintained at the administration office of the health department.

If the records were not available, public health nurses telephoned the individuals and asked about health histories. If the individual could not be matched to a case, another age and sex-matched individual was selected at random. (The problem of health record accuracy and the validity of information obtained directly from the participants is discussed later in this chapter.)

Since the cases were already deceased, their spouses were selected as respondents. The spouses of the controls were also selected as respondents to avoid bias that might occur because of different sources of information for the cases and the controls. If the spouses were deceased, children were interviewed. Of 44 individuals selected as cases

in Shiwahime and 42 individuals in Karakuwa, 35 and 34, respectively, agreed to participate in the study and were competent to answer the questions provided. For the matched-pairs case-control design, the same number of individuals were selected as controls in both towns. Since there was only one control spouse who declined to participate, this person was replaced by another qualified individual. Age and sex distributions of case and control pairs are shown in Table 4.1.

Table 4.1

Age and Sex Distribution of Case and Control Pairs in Shiwahime and Karakuwa

	Shiwahime		Karakuwa	
Age Group	Male	Female	Male	Female
50-54	0%	0%	5%	8%
55-59	0	5	9	23
60-64	19	5	29	8
65-69	31	0	9	15
70-74	13	27	29	15
75-79	37	63	19	31
Total Percentage	100%	100%	100%	100%
(Total Number)	(16)	(19)	(21)	(13)

Field Strategies

In order to have a good participation rate, meetings were held with selected individuals to explain the purpose of the study (Figure 4.5). The arrangements were made by the town administration health

Figure 4.5. Meeting with Selected Residents

branch and an official letter was sent to participants requesting their attendance at a town-sponsored meeting. Attendance was about 50 percent in both towns. The half which did not attend the meeting was visited at home, and their cooperation was requested for the study.

The meeting did not assist the study participation rate as much as expected, as the rate was much lower in the case group than in the control group. The reasons seem to be that the case families did not feel comfortable cooperating with the study, or due to the death of the household head they were working and could not spare the time. However, the meeting did make it easier to approach the selected individuals whether they attended the meeting or not since the town-sponsored meeting gave assurance that the administrative office was responsible for the study which was expected to improve health conditions of town residents.

Restrictions and Limitations of the Study

Restrictions are twofold:

1) There was a small number of subjects selected for this study, and although this is a fundamental consideration in planning a case-control investigation, the size of the study was restricted by the number of available cases, finances, and time. For example, in a study such as this where controls were population-based rather than hospital-based, random selection of individuals from the target population was expensive and time consuming.

2) Strokes were not examined by pathological type but treated as a single entity because of the small number of cases and the questionable accuracy of diagnosis by pathological type. Cases of subarachnoidal hemorrhage were excluded from the study because of their fundamentally

different nature. Despite the questionable accuracy of diagnosis, this was not expected to affect the results of the study due to the small number of such cases.

One limitation was the accuracy of the data source for case and control selections. For case selections, death certificates were used. Problems in the diagnostic accuracy of stroke in death certificates have been discussed previously (Kuller et al. 1972; Ostfeld 1980). In discussing high stroke prevalence in Japan, Netsky and Miyagi (1976) concluded that diagnostic practices by physicians and the methods used to record causes of death on death certificates tended to inflate the rates, especially for brain hemorrhage. However, there is not complete agreement on this contention (Komachi et al. 1977). Since stroke is a common cause of death in Japan, it is possible that physicians may have a bias toward overdiagnosis, particularly for persons 80 years of age and over, whose specific cause of death is not of great concern. On the other hand, there is also the possibility that some physicians may favor senility in determining the cause of death in an elderly person when in fact the cause may have been stroke. In a small community with only one or two physicians, such bias could seriously affect the accuracy of medical records. In Karakuwa, senility was recorded as the cause on death certificates for 50 percent of those 80 years of age and over and 10 percent of those 70-79 years. In Shiwahime, senility was recorded for 32 percent of those 80 years of age and over, but there were none in the 70-79 year age group. In this study, the population was confined to persons between 50 and 79, so the problem of senility and the possible bias from overdiagnosis of stroke was largely avoided.

Selection of control participants was based on information obtained either from the persons themselves or from the health records maintained in each town. Therefore, the accuracy of recall on self-statements about medical history and health can be questioned. The health records used were the official records maintained at the town administration office. Since 1983, a law has required local governments to collect health records, including blood pressure levels and medical histories, of all residents 40 years of age and over. Since the health branch of the town administration in Karakuwa had such records, the necessary information for control selection was obtained. However, since the records were not complete, information on some of the selected individuals had to be obtained directly from the interviews.

Shiwahime has not yet compiled such health records, so the information was obtained from the most recent one-year total record of medical services reported to the national health insurance system. This record gives the names of hospitals and clinics and types of services used by clients. One record year was believed sufficient since hypertension, heart disease, and diabetes are chronic and people receive medical services for such diseases over a long period of time. However, those selected by this procedure were also contacted by telephone to confirm the blood pressure levels and medical histories. Telephone inquiry was also used for those who had a different insurance coverage because, as this was usually paid by employers, insurance records were not available.

It is uncertain how accurate case and control selection procedures were, based on the medical information obtained. It is also uncertain

what kinds of biases would be introduced by excluding those who answered "don't know" or "don't remember" in the screening of medical histories. However, in spite of such limitations, the findings in this study are consistent with previous observations and expand knowledge on the possible relationships between socioeconomic factors and geographic differentials of stroke mortality.

CHAPTER IV--NOTE

[1]"The case control study . . . follows a paradigm that proceeds from effect to cause. In a case-control study, individuals with a particular condition or disease (the cases) are selected for comparison with a series of individuals in whom the condition or disease is absent (the controls). Cases and controls are compared with respect to existing or past attributes or exposures thought to be relevant to the development of the condition or disease under study" (Schlesselman 1982:14). Matched "refers to the pairing of one or more controls to each case (in this study one control to each case) on the basis of their 'similarity' with respect to selected variables. Any characteristic or attribute of an individual, such as age, sex, race, blood group, hospital of admission, neighborhood, marital status, income, blood pressure, weight, occupation, parity, personal or family history of disease, and so on, may serve as a basis for pairing. To the extent that cases and controls are similar on the matching variables, their difference with respect to disease may be attributed to some other factor. Furthermore, if the cases and controls differ with respect to some exposure variable, suggesting an association with the study disease, then this association cannot be explained in terms of case-control differences on the matching variables" (Schlesselman 1982:105).

CHAPTER V

CASE-CONTROL STUDIES IN SHIWAHIME AND KARAKUWA: DATA COLLECTION AND RESULTS

In Japan there is higher mortality from stroke in rural areas, particularly mountainous and/or agricultural regions, and lower mortality in fishing and urban areas (Nagata 1979; Kagami 1983; Naruse et al. 1985). However, the reason for lower stroke mortality in fishing regions as compared to agricultural regions has received less attention. According to the results from the mail survey (Chapter III), the prevalence of hypertension (which is associated with stroke mortality) among those 30-74 years of age, is higher in Shiwahime than in Karakuwa despite lower stroke mortality rates in Karakuwa. Therefore, non-clinical factors seem important in explaining the different mortality rates between these towns.

The matched-pairs case-control study conducted in Shiwahime and Karakuwa focused on individual behavioral patterns, household nutrition levels and the indoor thermal environment. Socioeconomic factors which were found to be associated with stroke in the mail survey were examined in detail.

Individual Behavioral Patterns

In this section the following hypotheses were tested to examine the behavioral patterns of cases and controls.

Level of Physical Work (Hypothesis 2, p. 17):
Hard physical work is positively associated with frequency of stroke mortality.

Long Absence from Home (Hypothesis 3, p. 18):
Long absence from home is positively associated with frequency of stroke mortality.

Diet (Hypothesis 4a, p. 20):
Salt intake is positively associated with frequency of stroke mortality.

Health-Promoting Behavior (Hypothesis 5, p. 21):
The utilization of medical services and health-promoting behavior are negatively associated with frequency of stroke mortality.

Data Collection

The study population consists of the cases and the controls who were selected in the manner described in Chapter IV. Thirty-five cases and 35 controls were selected from Shiwahime, and 34 cases and 34 controls from Karakuwa.

Structured interviews were conducted between November 29 and December 5, 1986, in Shiwahime and between December 9 and December 15, 1986, in Karakuwa to inquire about levels of physical work, long absence from home, diet, and health-promoting behavior. Since the questions were all factual and not attitudinal, the questionnaire was constructed with a set of closed-ended response categories. Questions on medical problems, family history of stroke, heart disease or diabetes and alcoholic beverages were also incorporated in the interview in order to examine any association with stroke mortality (Gertler et al. 1968; Yamori et al. 1976; Ueshima et al. 1986).

The study factors were examined by questions on the following topics:

1. Level of physical work: occupational history and level of physical effort for each occupation listed.

2. Long absence from home: current and past participation in seasonal migration or deep-sea fishing.

3. Diet: frequency of eating and fondness for traditional foods, modern foods, and salty foods.

4. Health-promoting behavior: check-ups of blood pressure levels on a regular basis, and medical check-ups of the circulatory system or general physical examinations.

5. Medical problems: stroke-related diseases such as history of diabetes and heart disease, blood pressure level, and treatment for hypertension.

6. Family history: cause of death of parents and siblings due to stroke, heart disease or diabetes.

7. Alcoholic beverages.

Three interviewers who spoke the Sendai dialect and were familiar with the town were employed in each study town. A training session was given to the interviewers to inform them of the research objectives and the purpose of the interview. Specific instructions for each question were given, and difficult situations that might occur during the interviews were also explained. The interviewers contacted the assigned respondents and visited them whenever it was convenient for the respondents during the study period.

Method of Analysis

The relative risk (RR) was estimated by computing odds-ratios for the variables of matched pairs case-control data for the two towns separately and together. The chi-square test was used as a test of statistical significance. (See Appendix C for a detailed explanation of the estimation of relative risk.) As an example of the calculations, the hypothetical set of data in Table 5.1 is considered.

Table 5.1

Hypothetical Set of Data on Matched Cases and Controls

	Cases		
Controls	With Factor	Without Factor	Total
With Factor	f=25	g=25	c=50
Without Factor	h=75	j=375	d=450
Total	a=100	b=400	N=500

$$\text{The relative risk} = \frac{h}{g} = \frac{75}{25} = 3.0$$

$$x2 = \frac{(|g-h| - 1)^2}{g + h} = \frac{(|25-75| - 1)^2}{25 + 75} = \frac{(49)^2}{100} = 24.1$$

with 1 degree of freedom. In this sample the estimate of risk of those with the factor is three times that of those without the factor. There is less than 1 chance in 100 that this observed risk can arise from a population where the risks are equal (Lilienfeld et al. 1967). As shown in the example, statistical significance is not based on the value of a ratio. Significance is determined from the absolute values of the data.

When there was a zero in the numerator or the denominator in the relative risk, no relative risk or chi-square test was calculated. If one respondent in a pair had a "don't know" answer, the pair was dropped from the analysis. The medical problems variable was excluded from the computation since this variable was already controlled for in the selection procedure for controls. Controls were free from stroke-related

diseases, that is, any history of diabetes, heart disease, hypertension, and/or treatment for hypertension.

The level of significance for testing hypotheses was set at $\alpha = .05$. Due to the small size of the sample in the matched-pair study, it was difficult to judge whether the exposure categories which show a high risk of stroke are truly significant or are a result of random variation. To solve this problem, a sample size analysis was conducted to determine the resulting power of detecting various values of relative risk for selected variables.[1] This power, $1-\beta$, is the probability of finding that the sample estimate of relative risk is significantly different from unity (β: the probability of making a Type II error, claiming that exposure is not associated with disease, when in fact it is). For example, if the relative risk in the sample populations is RR=8.0, a case-control study of n=35 per group has only a 44 percent chance of finding that the sample estimate of the relative risk is significantly different from unity at the 5 percent level of significance.

Results

Several variables were found to be risk factors for stroke although only the variable of "no blood pressure check-up" had sufficient power for the sample estimate of relative risk to be significantly different from unity (Table 5.2). An increase in the sample size would improve the power of the estimate of relative risk of selected variables. (See Appendix D for the relative risk of all the variables examined.)

In the two towns combined the significant variables were: (1) higher frequency of drinking "green tea" than "black tea or coffee"

Table 5.2

Relative Risk of Selected Variables

Variables	Shiwahime	Karakuwa	Total
Frequency of Traditional Food vs. Modern Food			
1. higher frequency of green tea than black tea or coffee	n.a.	5.00	8.00[a]
Preference for Traditional Food vs. Modern Food			
2. boiled greens preferred to fried vegetables	2.75	2.00	2.33[a]
3. cooked vegetables preferred to uncooked vegetables	n.a.	2.67	4.00[a]
4. No Blood Pressure Check-up	15.00[b,c]	n.a.	21.00[b,d]
5. Fondness for Salt	2.60	5.00[b]	3.50[b]
6. Normal Salt Consumption vs. Salt Consumption with Caution	3.00	3.67	3.33[a]
7. Family History	3.50[a]	1.57	2.27[a]

n.a. = not applicable (a zero in the numerator of the denominator in the relative risk)

[a]Significant at the 0.05 level, chi square with 1 d.f.

[b]Significant at the 0.01 level, chi square with 1 d.f.

[c]Power = 95%

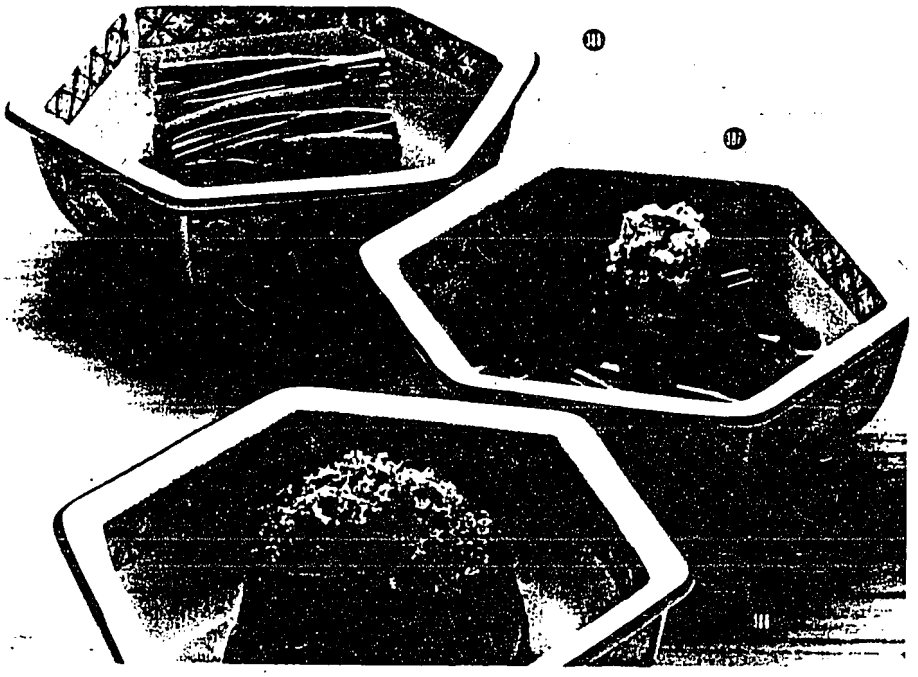
[d]Power = 100%

(RR=8.0, $P<0.05$); (2) preference for "boiled vegetables with dressing" to "fried vegetables" (RR=2.3, $P<0.05$), (3) "preference for cooked vegetables" to "uncooked vegetables" (RR=4.0, $P<0.05$) (Figure 5.2).

The results indicate a clear association between salt intake and stroke mortality. All three exposure categories with higher risks are traditional dietary items which tend to induce a high salt intake. Green tea is served when traditional food is eaten, and for the preparation of boiled vegetables with dressing and cooked vegetables, soy sauce which is high in salt content is often used. The category of "fondness for salty foods" also had a high risk for Karakuwa (RR=5.0, $P<0.01$), and for the two towns combined (RR=3.5, $P<0.01$). It should be noted that since the sample size for both cases and controls is small, the relative risk is less likely to be statistically significant when each town is examined separately. However, with a larger sample size when the two towns are combined, the relative risk is more likely to be statistically significant.

A comparison between the different frequency level of salty food intake also showed a significantly higher risk in the "normal" exposure category than in the "with caution" exposure category for the two towns combined. The risk for the exposure category of "normal consumption of salty foods" or "the consumption of salty foods as much as one likes" were significantly higher than "the consumption of salty foods with caution or hardly any" (RR=3.3, $P< 0.05$).

Other exposure categories such as "no regular blood pressure check-up" and "family history of stroke, heart disease or diabetes" (RR=3.5, $P<0.05$) are significantly associated with stroke mortality for Shiwahime



(1) Traditional Food: boiled vegetables with dressing

(2) Modern Food: fried vegetables

Figure 5.1. Traditional vs. Modern Food
(Shufunotomo Co., Ltd., 1987)

(1) Traditional Food: cooked vegetables

(2) Modern Food: uncooked vegetables

Figure 5.2. Traditional vs. Modern Food
(Shufunotomo Co., Ltd., 1987)

(RR=15.0, $p<0.01$, Power=95%; RR=3.5, $p<0.05$) and for the two towns combined (RR=21, $P<0.01$, Power=100%; RR=2.3, $P<0.05$), respectively. Although "no regular blood pressure check-up" stands out, it should be noted that this exposure category includes regular check-ups after high blood pressure had been detected. In other words, cases and controls categorized as "no blood pressure check-up" are both those who did not regularly take blood pressure tests, and those who regularly had check-ups only after hypertension was diagnosed. This implies that subjects in this category have not individually monitored blood pressure levels.

One problem with the category of "no regular blood pressure" is that in the control selection procedure a certain degree of self-selection of those who individually monitor blood pressure levels was probably made, particularly in the town of Shiwahime. Controls are those who are free of hypertension. In Shiwahime, where appropriate health records were lacking, information on blood pressure levels was obtained from the participants themselves. This means that healthy individuals who were ignorant of blood pressure levels were excluded. However, it is noted that people generally do know their blood pressure levels, either high or normal, and it is seen that there were only a few potential controls who said "don't know." None of the variables for level of physical work, long absence from home, and alcoholic drinks showed any significant difference between cases and controls in either town.

Discussion and Conclusion

In 1960 Dahl (1960) noted the existence of an animal model for sodium-induced hypertension and reported marked international differences in sodium intake and sodium excretion. He found that hypertension was

uncommon in populations consuming less than 4 or 5 g of salt per day and common in those populations that consume more salt, and put forward the following hypothesis for the etiology of hypertension: higher blood pressures would be expected in populations consuming greater quantities of salt. Dahl's salt hypothesis is supported by many studies in western countries.

There are also consistent findings in Japan on the blood pressure and salt intake relationship. Using rats which have a genetic predisposition to high stroke incidence, Yamori et al. (1976) found that stroke was incurred by hypertension due to excessive salt consumption. Intervention studies in Japan further confirmed the blood pressure and salt relationship. In towns where residents were instructed to reduce their salty food intake, the incidence of stroke decreased, in comparison to control towns where there was no such guideline (Iso 1986). The control of salt intake for hypertensive residents in one town also reduced both hemorrhagic and thrombo-embolic stroke incidence (Tanigaki 1986).

The results in this study indicate that some traditional food items were likely high risks for stroke mortality. Although it is not clear why some have significantly high risks while others do not, a higher intake of salty foods poses a possible risk when viewing the total results of the two towns combined. The comparison of the exposure category of "fondness for salty food" between the cases and the controls indicates that the cases were likely to have a preference for salty food in Karakuwa and in the combined towns. The reason why the relative risk for Shiwahime was not statistically significant is probably because the respondents in Shiwahime were reluctant to admit fondness for salty food as the salt

reduction campaign had been more active in Shiwahime than in Karakuwa. In addition, the cases were definitely more reluctant to take regular blood pressure tests in Shiwahime and in the two towns combined.

The results of the chi-square test for blood pressure levels and fondness for salty food (Table 5.3) and the analysis of blood pressure levels and salty food intake (Table 5.4) indicate statistically significant differences in blood pressure levels according to fondness for salty food and salty food intake: that is, the more you eat or the more you are fond of salty food, the higher your blood pressure level will be. Considering all the above evidence, the study confirms the previous observations of the relationship between blood pressure and salt intake.

In Japan, hypertension is strongly associated with stroke mortality. For example, a ten-year follow-up study dealing with 1,662 residents, age 40 and over, revealed 121 cases of stroke among 551 hypertensive residents (22 percent), five times as high as the 29 stroke cases among 716 normal blood-pressure residents (4 percent) (Nishida 1974). The current study also indicates that cases had a higher percentage of hypertension and a higher percentage of treatment for blood pressure (Table 5.5) than the respective town sample populations used for the mail survey in Chapter III.

High blood lipid levels and obesity, which are considered important risk factors for stroke as well as hypertension in western countries are not important in Japan for either hemorrhagic or thrombo-embolic strokes. Instead, these appear to act to prevent stroke incidence, particularly in rural areas (Owada et al. 1974; Konishi et al. 1986). Konishi (1974), using autopsy cases, found that mortality from ischemic

Table 5.3

Relationship Between Fondness for Salty Food and Blood Pressure Level

Blood Pressure Level	Fondness for Salty Food	
	yes	no
high and somewhat high	45%	26%
normal and low	55	74
Total Percentage (Total Number)	100% (45)	100% (77)

Significant at the 0.05 level, chi square with 1 d.f.

Table 5.4

Relationship Between Salty Food Consumption and Blood Pressure Level

	Salty Food Consumption		
Blood Pressure Level	normal	with caution	hardly any
high and somewhat high	55%	28%	28%
normal and low	45	72	72
Total Percentage (Total Number)	100% (42)	100% (75)	100% (18)

Significant at the 0.05 level, chi square with 2 d.f.

Table 5.5

Blood Pressure Level for Cases in Shiwahime and Karakuwa (50-79 Years Old) in Comparison to the Town Sample Population (50-74 Years Old) Selected for the Mail Survey

Blood Pressure Level	Shiwahime		Karakuwa	
	Population	Case[a]	Population	Case[a]
high	12%	34%	13%	44%
somewhat high	16	26	25	35
normal or low with treatment for hypertension	3	9	8	6
normal or low without treatment	63	31	53	15
no answer/don't know	6	0	1	0
Total Percentage (Total Number)	100% (32)	100% (35)	100% (143)	100% (35)

[a]Since the records of blood pressure levels of cases were not accessible, the information was obtained by interviewing the spouses of the cases.

heart disease in Japan is also strongly associated with hypertension and that there are only a few cases which are associated with high levels of blood lipids. Yanagawa et al. (1976) also found that there is a similar dietary pattern between areas of high stroke mortality and areas of high ischemic heart disease mortality. This study indicates that there was a high percentage of the cases with a history of heart disease in both towns (Table 5.6). These cases had a higher percentage of heart disease than the town sample population used for the mail survey in

Chapter III, which seems to suggest a possible relationship between stroke and heart disease, with hypertension as a common major risk factor. However, it is noted that in the mail survey no relationship between stroke and heart disease by geographical area was found (see Chapter III, Mail Questionnaire Survey, Table 3.8). Thus this relationship needs to be further studied. Diabetes, on the other hand, does not seem to be associated with stroke mortality in either town (Table 5.7).

Family history of stroke, heart disease or diabetes is a likely important factor when looking at Shiwahime and the two towns combined. The findings in this case-control study (Table 5.2) indicate a possible link between heredity and stroke mortality.

While there is evidence from other studies that hard physical work and long absence from home are important factors for stroke, the exposure categories of these factors did not show high risks in this study. Alcohol consumption was not important, either.

In summary it is found that a lack of regular blood pressure check-ups was found associated with stroke mortality in Shiwahime and both towns combined. Karakuwa maintains good health records by conducting regular physical examinations including blood pressure check-ups, which may be why there is no difference between the cases and the controls in blood pressure check-ups. In contrast, in Shiwahime the cases were more likely not to have taken a blood pressure check-up than the controls. Thus a lack of blood pressure check-ups may contribute to explaining higher stroke mortality in Shiwahime than in Karakuwa. Hard physical work, which has been recognized as an important factor in stroke

Table 5.6

Cases with a History of Heart Disease (50-79 Years Old) for Shiwahime and Karakuwa in Comparison to the Town Sample Population (50-74 Years Old) Selected for the Mail Survey

Heart Disease	Shiwahime Population	Shiwahime Cases	Karakuwa Population	Karakuwa Cases
with history	16%	40%	8%	35%
without history	84	43	92	65
no answer/don't know	0	17	0	0
Total Percentage (Total Number)	100% (32)	100% (35)	100% (143)	100% (34)

Table 5.7

Cases with a History of Diabetes (50-79 Years Old) for Shiwahime and Karakuwa in Comparison to the Town Sample Population (50-74 Years Old) Selected for the Mail Survey

Diabetes	Shiwahime Population	Shiwahime Cases	Karakuwa Population	Karakuwa Cases
with history	6%	14%	4%	9%
without history	94	69	96	88
no answer/don't know	0	17	0	3
Total Percentage (Total Number)	100% (32)	100% (35)	100% (143)	100% (34)

mortality, was not found to be associated with stroke mortality in this study. Neither was long absence from home associated with stroke mortality. The reason why a high consumption of salty food was not an important variable for both towns in spite of recognition of strong association with stroke is most probably due to the reporting bias. Respondents for the cases were perhaps embarrassed to admit a high consumption of salty food because the risk of high salt intake for stroke was well known. This statement is documented by the Nutrition Survey in the following section where the households of both Shiwahime and Karakuwa had a high consumption of salty foods. This is also probably true for reluctance to admit cases' fondness for salty food in Shiwahime, as mentioned earlier, where the campaign for the reduction of salt intake was more active than in Karakuwa.

Household Nutrition Levels

A nutrition survey focusing on the intake of specific nutrients such as salt, animal fat, and animal protein was conducted to test the following hypotheses:

Hypothesis 4a (p. 20): Salt intake is positively associated with frequency of stroke mentality.

Hypothesis 4b (page 21): Animal fat and animal protein intakes are negatively associated with frequency of stroke mortality.

Data Collection

A detailed nutrition survey was conducted in 14 households (6 case households and 8 control households) in Karakuwa from October 25 to 27,

1986 and a total of 18 households (8 case households and 10 control households) in Shiwahime, from November 5 to 7, 1986, using the technique employed by the National Nutrition Survey. (The Ministry of Health and Welfare conducts an annual nutrition survey of households in randomly selected sampling units across the nation on any three consecutive ordinary workdays of November.)

There are various techniques to measure nutrition levels of households and individuals (Kojima 1976). As the cases are of individuals already deceased, the survey was conducted at the household level. Among the various techniques available, those used by the National Nutrition Survey were adopted due to the following advantages over the other methods:

1. The results can be compared to those obtained from the National Nutrition Survey.
2. Since many dietitians have some knowledge of the survey technique, the training period can be reduced.

The disadvantage is that this technique requires tedious work for both researchers and participants, making it difficult to obtain the participants' cooperation. An attempt was made to minimize this difficulty by requesting that the town administration intercede in obtaining the cooperation of the selected households. However, despite such efforts, the initially planned number of 20 randomly selected households in Karakuwa and 18 households in Shiwahime participated.

The participants were the primary food preparers, generally housewives, of the households under study. They were requested to record

the meal menu and weigh all food items used in meal preparation and the contents of between-meal snacks during a three-day period. If some family members ate outside, these menus were also recorded. Moreover, they were requested to weigh leftovers which were eventually discarded in order to compute the weight of the unused food.

In Shiwahime, since there were no appropriate dietitians in the town itself, four local dietitians living near the town were hired. Two were assigned to visit five households and two were assigned to visit four households each. In Karakuwa, however, local dietitians in the town or near the town could not be found, so two undergraduate students (seniors) majoring in nutrition science were hired from Sendai. Each visited seven households.

The dietitians visited the households at least once a day during the three-day study period. During the visit, they checked the information recorded by the participants. They also answered any questions the participants might have had regarding the survey. During the final visit, they thoroughly checked all the records and obtained any additional information necessary to compute nutrition levels of the household. This included:

1. Structure of the household: name of family members, age, sex, relation to the head of the household, pregnancy status (if so, how many months?), nursing status (if so, how many months?), occupation, and level of physical work;
2. Physical features: height and weight of each member of the household.

After data collection was completed, one additional dietitian was hired to examine the data. When questions regarding ambiguous recordings or unreasonable amounts of food items eaten arose, the households in question were contacted to verify the responses. After all questions were answered, the dietitian sorted the records into computer readable form: that is, food items were classified into food group categories and the total weights of each category were recorded so that nutrients consumed could be computed.

Method of Analysis

The data were sent for analysis to the Department of Environmental Health at the administrative office of Miyagi prefecture in Sendai. The information obtained was as follows:

1. Average nutrient intake including calories per person per day for each household;
2. Average nutrient intake requirements per person per day of certain nutrients including calories for each household;
3. Percentage caloric intake by nutrient components (carbohydrate, protein, and fat) for each household;
4. Percentage animal protein intake of the total protein and percentage animal fat intake of the total fat for each household;
5. Average salt intake per person per day for each household; and
6. Weight of food items by food group (e.g., groups of cereals, beans, fruit, fish, and meal).

The data used for this study included average salt intake per person per day and the average nutrient intake per person per day which included animal protein and fat. In addition to the above information, the intakes of animal protein from meat, fish, eggs, and dairy products were calculated. The salt intake was also calculated according to the major food sources.

In a stricter sense, it is not appropriate to use the average nutrient intake per person to compare the nutrition levels of households with different household structures. For comparison, it is useful to use a converted value of the nutrient intake per person per day which is calculated by taking account of the nutrient intake requirements of the household members according to age, sex, weight, the level of physical work, pregnancy, and nursing status. This method controls for difference in the household structure, but the nutrient intake requirement, which is necessary for the calculation of the converted value of the nutrient intake per person per day, is not established for animal protein, animal fat, or salt. Thus the converted value was not available for use. To examine the validity of the average nutrient intake measure, the household age and sex structures were compared between the two towns and between the cases and the controls in each town. This revealed that there was a large difference in household composition between case and control households in Karakuwa; specifically, that there were three times as many male adults in the control households as in the case households. This means that more food would be consumed in the control households since male adults tend to eat larger amounts than female adults and children. When average nutrient intake per person is calculated by

dividing the household total of nutrient intake by the number of household members, there would be an overrepresentation of nutrient intake in the control households. Thus, the results must be interpreted with caution.

As the data samples were small, vigorous statistical techniques were not employed. Instead, the results were presented graphically. The t-test was used when the mean salt, animal protein, and animal fat weights were compared between the two towns and between the case and control households based on the variance of two sample populations being equal at the 5 percent significance level. When the variance was not equal between the towns and between the case and control households, the Welch test was used.

Results

The Level of Salt Intake. Table 5.8 shows the average salt intake per person per day by location. The 1985 salt intake for Japan was 12.1 g, while that of Miyagi prefecture was 14.1 g which is 2 g higher than the national average and 0.1 g higher than the average of the Tohoku region. According to the survey conducted in this study, Shiwahime and Karakuwa salt intakes were 16.4 g and 17.5 g, respectively, considerably higher than the prefectural average. However, the difference between the two towns was not statistically significant at the 5 percent level, because of the small sample size.

The salt intake per person per day for the case and control households was compared in Shiwahime and Karakuwa, respectively. In Shiwahime the case households had a higher salt intake than the control households.

Table 5.8

Average Salt Intake Per Person Per Day by Area

	National Average (1985)	Tohoku Average (1985)	Miyagi Average (1985)	Shiwahime Average (1986)	Karakuwa Average (1986)
Salt Intake	12.1 g	14.0 g	14.1 g	16.4 g	17.5 g

Sources for National, Tohoku, and Miyagi Average: 1985 Project Report (Miyagi, Department of Health Environment, 1987).

In contrast to Shiwahime, the control households in Karakuwa had a higher salt intake than those of the case households. However, in neither town was there a statistically significant difference at the 5 percent level in salt intake between the case and control households. Average salt intake per person per day in each household ranged from a high of 26 g to a low of 10 g in Shiwahime and from a high of 35 g to a low of 6 g in Karakuwa.

Table 5.9 indicates the comparison of major sources of salt intake between the towns. Soy sauce, miso and table salt are three major sources of salt intake in both towns. In Karakuwa, the consumption of table salt was as high as that of soy sauce. This is because the Karakuwa residents often broil fresh fish flavored with table salt. Fresh fish is easily available in Karakuwa, as expected, but since Shiwahime is an agricultural town, fresh fish is comparatively less available. Thus, there was about 11 percent of salt intake from salt-preserved fish and processed fish in Shiwahime compared to only 2 percent in Karakuwa.

Miso soup and pickled vegetables, which are two major food items with high salt content, are served daily in both towns (Figure 5.3).

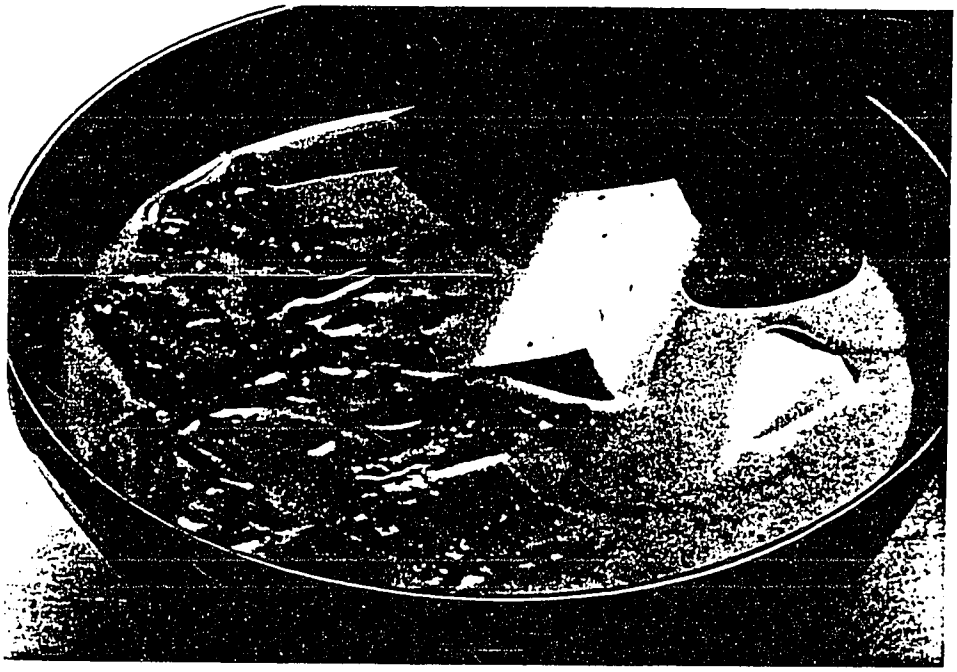
Table 5.9

Comparison of Major Sources of Salt Intake
Between Shiwahime and Karakuwa (grams/person/day)

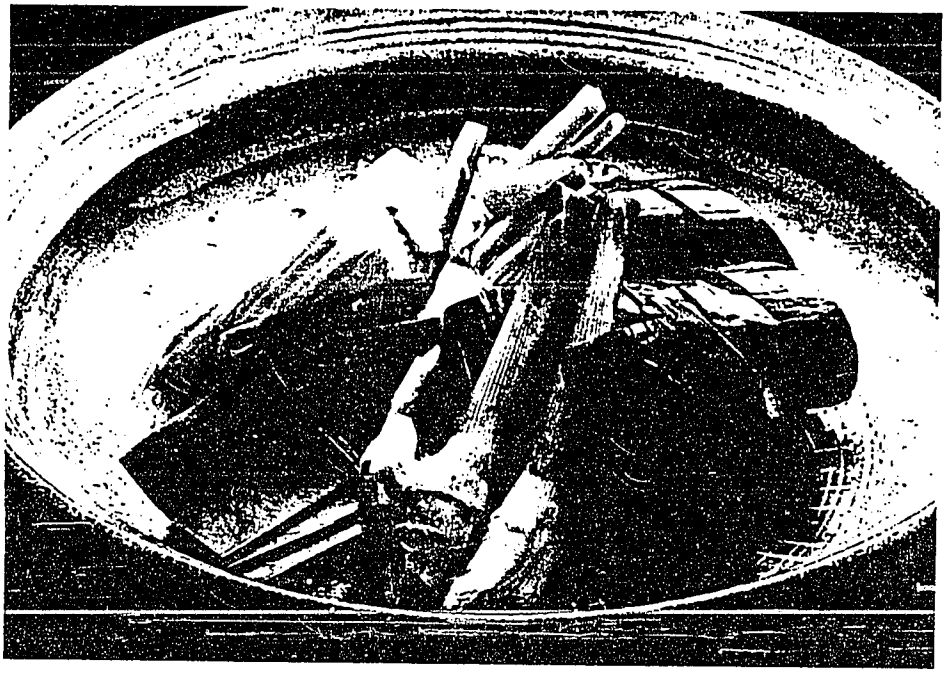
Sources	Shiwahime		Karakuwa	
soy sauce	4.5	(27.4%)	4.4	(25.3%)
miso	3.1	(18.9)	3.6	(20.7)
table salt	2.2	(13.4)	4.5	(25.8)
pickles	1.3	(7.9)	0.9	(5.2)
salt-preserved and processed fish	1.9[a]	(11.6)	0.5[a]	(2.9)
others	3.4	(20.8)	3.5	(20.1)
Total	16.4	(100.0%)	17.4	(100.0%)

[a]Significantly different at the 5 percent level.

The Level of Animal Protein Intake. Table 5.10 shows the intake of nutrient components (protein, fat, and carbohydrate) and their percentage of the total nutrient components in terms of calories. As expected, animal protein intake in Karakuwa exceeds that of Shiwahime and the national average. In contrast, Shiwahime's intake is lower than the national average. However, the difference between the two towns was not statistically significant at the 5 percent level. Agricultural towns in the past have shown a low intake of animal protein (Nojiri et al. 1985; Iida et al. 1987). Thus, Shiwahime was expected to have much lower animal protein intake than Karakuwa, but this was not the case.



(1) Miso Soup (Kodansha 1985)



(2) Pickled Vegetables (Shufunotomo 1987)

Figure 5.3. Major Food Items to Contain High Salt

Table 5.10

Intake of Protein, Fat and Carbohydrate (grams/person/day) and the Percentage to the Total Nutrient Components in Terms of Calories

	Protein			Fat			Carbohydrate
	A*	P*	T*	A	P	T	
Shiwahime (1985)	37.6 (7.0%)	45.2 (8.5%)	82.8 (15.5%)	23.4 (17.2%)	27.8 (20.4%)	51.2 (37.6%)	329.6 (46.9%)
Karakuwa (1986)	41.4 (7.5)	44.4 (8.1)	85.8 (15.6)	20.3 (12.5)	33.3 (20.6)	53.6 (33.1)	335.8 (51.3)
Nation (1985)	40.1 (7.8)	38.9 (7.3)	79.0 (15.1)	27.6 (12.1)	29.3 (12.4)	56.9 (24.5)	298.0 (60.4)

*A -- Animal
P -- Plant
T -- Total

Table 5.11 compares mean animal protein intake of major animal protein food groups between the towns. Those in Karakuwa, a fishing town, consumed much more fish than those in Shiwahime. Only 10.3 percent of the total fish consumption was salt-preserved fish and processed fish, compared to 43.6 percent for Shiwahime. In contrast, people in Shiwahime consumed more eggs, milk, and other dairy products, which indicates a difference in food availability and choice in differing geographical environments.

Table 5.11

Comparison of Mean Animal Protein Intake by Food Group Between Shiwahime and Karakuwa (grams/person/day)

Food Group	Shiwahime		Karakuwa	
fish	23.9*	(62.4%)	33.2*	(75.3%)
meat	6.0	(15.6)	5.5	(12.7)
eggs	5.0**	(13.1)	3.2**	(7.2)
dairy products	3.4*	(8.9)	2.1*	(4.8)
Total	38.3	(100.0%)	44.1	(100.0%)

*Significantly different at the 0.05 percent level.
**Significantly different at the 0.01 percent level.

The animal protein intake per person per day for the case and control households was compared in Shiwahime and Karakuwa, respectively. The averages between the case and control households in Shiwahime differed little, while in Karakuwa, the control households had a higher average intake than the case households. However, in neither town was there

a statistically significant difference at the 5 percent level between the case and control households.

The average animal protein intake per person per day in Shiwahime case households varied relatively little, ranging from 30 g to 48 g, while it showed greater variation in Shiwahime control households, ranging from 24 g to 36 g. In Karakuwa, there was a wide differential in both household types with case households ranging from 12 g to 64 g and control households ranging from 26 g to 66 g.

The Level of Animal Fat Intake. Although both towns had a lower fat intake than the national average, Shiwahime had a higher animal fat intake than Karakuwa (Table 5.10). However, the difference between the two towns was not statistically significant at the 5 percent level. Both obtained a large proportion of animal fat from fish and meat food groups, but since fish contains less fat than meat Karakuwa residents consumed less animal fat than those in Shiwahime, in spite of higher consumption of animal protein.

The animal fat intake per person per day for case and control households was compared in Shiwahime and Karakuwa, respectively. In both, case households had higher intakes than control households. However, in neither town was there a statistically significant difference at the 5 percent level between the case and control households.

The average intake per person per day in Shiwahime and Karakuwa case households varied greatly, ranging from 10 g to 50 g, and from 10 g to 54 g, respectively. In contrast, the control households showed less variation with ranges of 12 g and 34 g in Shiwahime and 10 g and 30 g in Karakuwa.

Discussion and Conclusion

None of the differences in salt, animal protein, and animal fat consumption between Shiwahime and Karakuwa households, and between case and control households, were statistically significant. Improvements in nutritional levels in agricultural towns such as Shiwahime are noteworthy compared to twenty years previously (Shiwahime Health Branch, 1983). In 1967, a nutrition survey which examined thirty farming households and eleven households with hypertensive children was conducted in Shiwahime, using the same National Nutrition Survey method as that employed in this study. The results revealed that a major energy source in the diet was staple food which was chiefly obtained from home plots. In 1982 a nutrition survey employing the same method was again conducted in the town among 100 randomly selected households, and when the results of these surveys as well as the survey in this study were compared, a dramatic increase in the consumption of meat and dairy products was indicated from 1967 through 1982, although there has been a slight decline of meat consumption from 1982 through 1987 (Table 5.12). Salt consumption has also declined greatly from 1967 through 1982 although it has increased slightly from 1982 through 1987 (Table 5.13). However, due to the sample size in the survey, these results must be interpreted with caution.

Agricultural towns in the past had poor diets which were characterized by low levels of animal protein and fat and high levels of salt (NaCl), whereas fishing towns had better diets because of higher levels of animal protein (Komachi et al. 1975; Nojiri et al. 1985). In terms of animal protein and fat, it seems that the nutrition level of Shiwahime

Table 5.12

Comparison of Animal Protein Sources Among the Three Nutrition Surveys (grams/person/day), Shiwahime

	Fish	Meat	Eggs	Dairy Products	Total
1967 Survey	23.2	2.9	5.3	2.0	33.4
1982 Survey	24.1	8.1	5.2	3.4	40.8
1987 Survey	23.9	5.0	5.0	3.4	38.5

Table 5.13

Comparison of Salt Intake Among the Three Nutrition Surveys (grams/person/day), Shiwahime

	1967 Survey	1982 Survey	1987 Survey
Salt	29.8	14.4	16.2

increased to that of Karakuwa, which is consistent with the finding of the other study where in the past 20 years the diet in a selected agricultural town showed dramatic increases in the consumption of animal protein and fat (Iida et al. 1987).

Stroke mortality in Shiwahime declined as nutritional levels improved, which is in contrast to the slow decrease in stroke mortality rates in Karakuwa in spite of reduced salt consumption. (A possible reduction in salt intake in Karakuwa was assumed after an interview with local public health nurses and dietitians, since no historical data of nutrition levels in Karakuwa were available before this study.) The rapid decrease of stroke mortality in Shiwahime is certainly associated

with reduced salt consumption. And it may be true that the effect of an increase in the consumption of animal protein and fat consumption is associated with the decrease in stroke mortality.

As far as salt intake is concerned, both Shiwahime and Karakuwa still showed comparatively high levels. This finding is consistent with the findings of other studies that while salt intake was reduced in both agricultural and fishing towns, it was still relatively high here (Nojiri et al. 1985; Iida et al. 1986). The results of the mail survey (Chapter III) indicate that the prevalence of hypertension in both fishing and agricultural areas, where people had traditional diets, was higher than in urban areas where people had a less traditional diet, although the difference was statistically significant only between agricultural and urban areas.

In spite of findings which suggest a relationship between stroke mortality and salt, animal protein and animal fat intake, the differences in salt, animal protein, and animal fat consumption between the case and control households were slight. The following two reasons may be suggested: (1) The sample size was small and (2) measures of the average nutrient intake per person per day might not be the best comparative method in a small sample study due to the effect of difference in the household structure on the value. The dietary routine of the case and control household members was examined, rather than the cases and the controls per se.

The latter reason may be important because the interviews with respondents in both the case and control households revealed a greater fondness for salty food among the cases than the controls. While this

survey has not clearly identified how nutrition may be associated with stroke mortality, high salt intake does seem to be associated with stroke on the basis of previous findings, and the findings and observations in this study.

Stroke mortality rates in Shiwahime should further decrease due to the time-lag effect of reduced salt consumption, and the mortality rates between Shiwahime and Karakuwa should become closer. However, this does not mean that high salt intake is the only major factor in stroke mortality, as many medical doctors and scientists in Japan believe. When hypertension prevalence is compared between the towns in the future, the prevalence will probably be still lower in Shiwahime than in Karakuwa, and the stroke mortality rates should be similar. This means that Shiwahime may have much lower hypertension prevalence in order to reach similar stroke mortality rates as Karakuwa. Factors other than high salt intake probably play important roles in stroke mortality.

Indoor Thermal Environments

Case and control households were asked to complete a questionnaire on the indoor thermal environment and to keep a record of indoor temperatures. The purpose of the data collection was to test Hypotheses 1a and 1b (p. 17):

> Hypothesis 1a: Insufficient heating of the living room, the bedroom, and the toilet is positively associated with frequency of stroke mortality.
>
> Hypothesis 1b: The differences in temperature among the three rooms are positively associated with frequency of stroke mortality.

Data Collection

The survey of indoor thermal environments was conducted from November 29 to December 5, 1986 in Shiwahime, and from December 9 to 15, 1986 in Karakuwa in the households of the matched-pairs of cases and controls (35 pairs in Shiwahime and 34 pairs in Karakuwa). One member of each case and control household was asked to complete a questionnaire on the indoor thermal environment. This was to be done on any one day during the survey period. Attached to the questionnaire was a sheet to record the temperature of the living room, the bedroom, and the room with the toilet during the survey period. The bedrooms of the spouse of each case, and the bedrooms of each control were used. In households where the spouse of a case was also deceased, the bedroom of the case's closest kin (usually a child) was selected. Three thermometers were provided to each household for use in the three selected rooms (Figure 5.4), which were placed one meter above the floor away from stoves or other heating devices and away from direct sunlight. Householders were asked to record the temperature in each room three times a day: (1) in the morning when one of the household members first awoke, (2) in the afternoon between noon and 3:00 P.M. and (3) in the evening when the household members gathered in the living room after dinner, which is a normal routine for most Japanese families.

In order to examine the indoor temperature more closely, eight households in each study town were selected from case and control households to record temperature continuously indoors and outdoors for one week of the survey period using self-recording thermometers (Figure 5.5). These eight houses were selected at random throughout each town. Thus

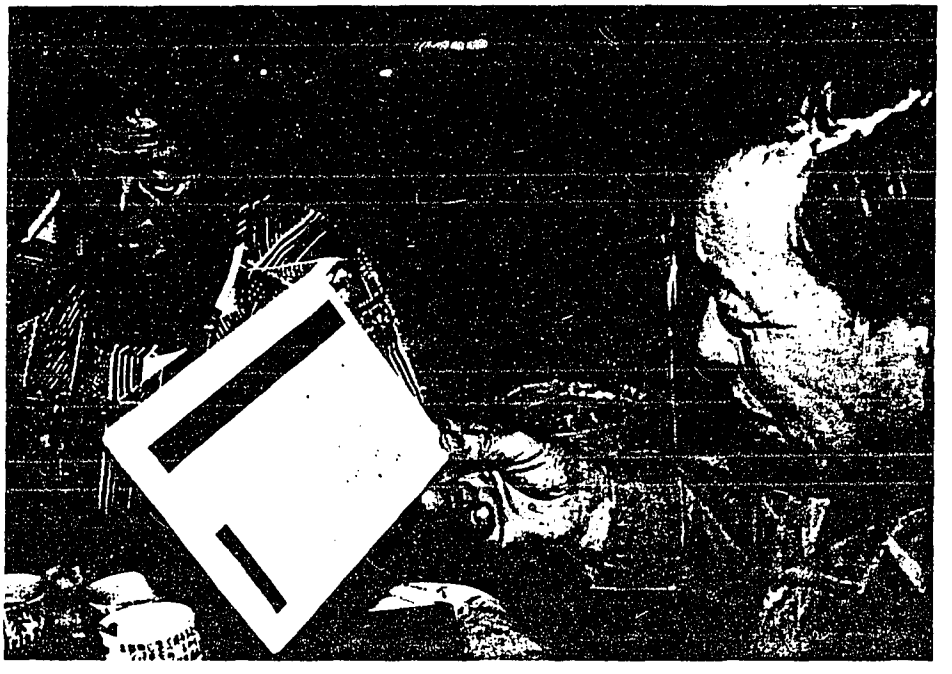


Figure 5.4. Thermometer

Figure 5.5. Self-Recording Thermometer

no comparison was made between matched pairs of case and control households. Temperatures were measured at the following points:

1) temperatures 1.1 m above the floor in the living room, and 1.0 m above the floor in the bedroom and in the room for the toilet;

2) 5 cm above the floor in the living room;

3) Inside a black globe 1.1 m above the floor in the living room;

4) Outdoor temperature.

The globe temperature is the air temperature inside a black copper ball as shown in Figure 5.5. When the globe temperature is higher than the ambient air temperature, a person feels warmer than in the surrounding temperature due to the effect of radiant heat. In contrast, when the globe temperature is lower than that of the ambient air, a person feels colder even when the air temperature is higher. Outdoor temperatures were not measured in all eight households but were measured at those selected as representative of each of the regions in the study towns.

Along with the indoor thermal environment survey, an experimental study of the relationship between temperature and hypertension was conducted. Ten subjects in Shiwahime and seven in Karakuwa volunteered to participate in this experiment for one day during the indoor thermal environment survey period. The subjects were requested to wear a Recklinghausen Sphygmomanometer, which records blood pressure every five minutes for at least two hours while the wearer is engaging in normal non-vigorous activity. At the same time, a thermometer was attached to the participant's clothing, away from the mouth and the nose, to record the surrounding air temperature.

Method of Analysis

Questionnaire on the Indoor Thermal Environment. Data from the questionnaire on the indoor thermal environment was analyzed using standard methods for matched-pairs of cases and controls. Relative risks were estimated by odds-ratio for each variable to determine whether there was a disease-exposure association (Appendix E). The chi-square test test was used to determine statistical significance (Lilienfeld et al. 1967). Where either the numerator or the denominator in a relative risk computation was zero, no calculation was performed. A sample size analysis was also conducted to determine the resulting power of detecting various values of relative risk for selected important variables (Schlesselman 1982). If one of the pairs had a "don't know" answer, the pair was dropped from the analysis. Some detailed questions that were not appropriate for computation of relative risk were also excluded, but were incorporated into the discussion instead.

Measurement of Weekly Temperatures. One-week temperatures were examined as follows:

(1) Indoor temperatures in the living room, the bedroom, and the toilet space were compared between Shiwahime and Karakawa and between case and control households when the outdoor temperatures were about $4^{o}C$ in both towns (between 6:00 and 9:00 P.M. on December 3 in Shiwahime; between 6:00 and 9:00 P.M. on December 15 in Karakuwa). If the temperature at one of the households in a matched pair was recorded other than during these hours, the pair was dropped from the analysis.

(2) Mean weekly temperatures recorded in the three rooms in the morning, in the afternoon, and in the evening were compared between case and control households in both towns.

The t-test was used to determine statistical significance based on the variance of two sample populations being equal. Where the variance was not equal between towns and between case and control houses, the Welch test was used instead.

Record of Weekly Temperatures by Self-Recording Thermometers. Among the eight houses in which self-recording thermometers were placed, day-long changes in room temperatures along with changes in outdoor temperatures were graphically shown in three households whose dwellings were built in three different periods (1930s, 1960s, and 1980s). In this analysis no comparison between matched-pairs of case and control households was made. The change in the mean day-long room temperatures of all eight houses was also graphically presented for each town.

Results

Questionnaire on the Indoor Thermal Environment. Table 5.14 indicates the relative risks of selected important study variables and their statistical significance. However, the relative risks for these variables were not reliable at the 95 percent power level according to the sample size analysis. Only a few relative risks were statistically significant. The relative risk of "no window curtains" was statistically significant at the 5 percent level for the matched-pairs of Shiwahime. An unexpected result was the relative risk of "living room space with more than 10 jo" in comparison to "living room space with 8-9 jo"

(Jo [tatami] is a straw mat used as flooring in Japanese traditional houses. It is also used as a unit to measure the room space. The size of 1 jo is 0.9 x 1.8 square meters.) Thus, a living room space with 8-9 jo was significantly associated with stroke mortality compared to a room space with more than 10 jo in Shiwahime, and to the total of the two towns. Although a larger living room was expected to be associated with stroke mortality since this suggests less efficient heating, the data indicated the reverse.

Table 5.14

Relative Risk of Selected Exposure Categories and Chi Square Test of Significance

	Shiwahime	Karakuwa	Total
space of living room: 10 jo and more vs. 8-9 jo	0.20*	0.60	0.33*
10 jo and more vs. less than 10 jo	0.25*	0.63	0.40*
curtains not used for living room windows	9.00*	0.50	1.71
feel cold in a room with the toilet	5.00	3.50	4.00*

Note: Jo is a unit to measure room size. One jo is 0.9 x 1.8 m^2.
*Significant at the 5 percent level, chi square with 1 d.f.

Since 10 jo seems to be a threshold in association with stroke mortality, the relative risk for living rooms with 10 jo or more was computed in comparison to living rooms with less than 10 jo, and the relative risk for Shiwahime was statistically significant (relative risk = 0.25, $P<0.05$). The relative risk for the total of the two towns was

also statistically significant (relative risk=0.40, $P<0.01$). This seems to indicate that large spaces in living rooms are negatively associated with stroke mortality. Large spaces in living rooms generally indicate a high income for households. The more efficient heating may be provided in such households. The relative risk of thermal sensation of coldness in toilet rooms was also statistically significant at the 5 percent level for the two towns combined.

Measurement of Weekly Temperatures. Figures 5.6 and 5.7 show room temperatures in living rooms, bedrooms, and toilet spaces for both towns and for the case and control households, when the outdoor temperatures were $4^{o}C$. When temperatures between the towns were compared (Figure 5.6), Karakuwa tended to have higher room temperatures than Shiwahime in bedrooms and toilet rooms. Differences in the mean temperatures of toilet rooms were statistically significant at the 5 percent level. Mean temperature discrepancies between living rooms and toilet areas were also statistically significant at the 5 percent level when the two towns were compared: that is, those were $6.6^{o}C$ for Shiwahime and $5.5^{o}C$ for Karakuwa. However, none of the other relationships were statistically significant at the 5 percent level. When the room temperatures between the case and control households were compared (Figure 5.7), there were no statistically significant differences in the mean temperatures in the three rooms at the 5 percent level.

The mean weekly room temperatures in living rooms, bedrooms, and toilet rooms were examined for the case and control households of each town in the morning, in the afternoon, and in the evening. In Shiwahime, none of the relationships were statistically significant at the 5 percent

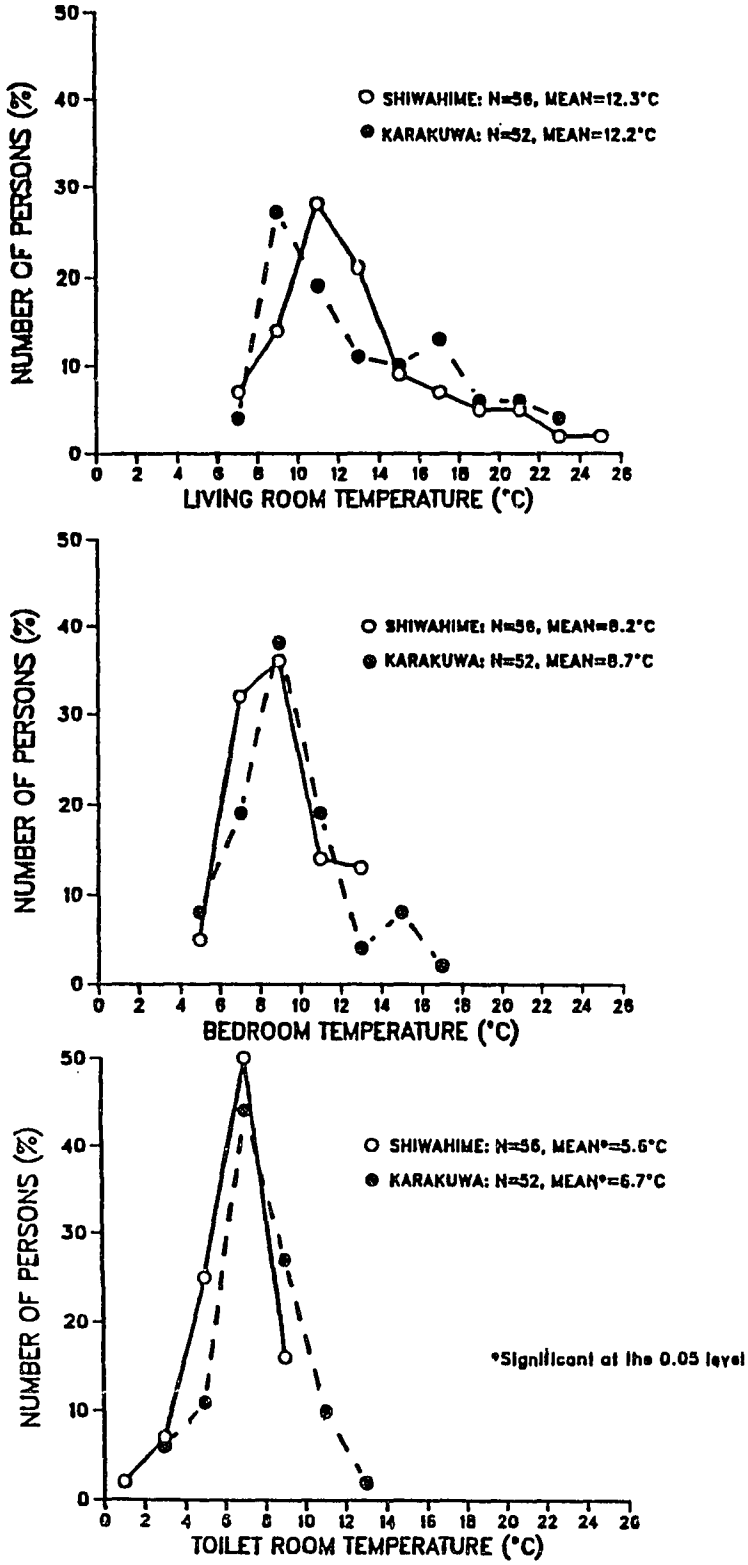


Figure 5.6. Room Temperatures in the Living Room, the Bedroom, and the Toilet Room for Shiwahime and Karakuwa When the Outdoor Temperatures are 4°C. (Recorded in Shiwahime on December 3, 1986 and in Karakuwa on December 15, 1986.)

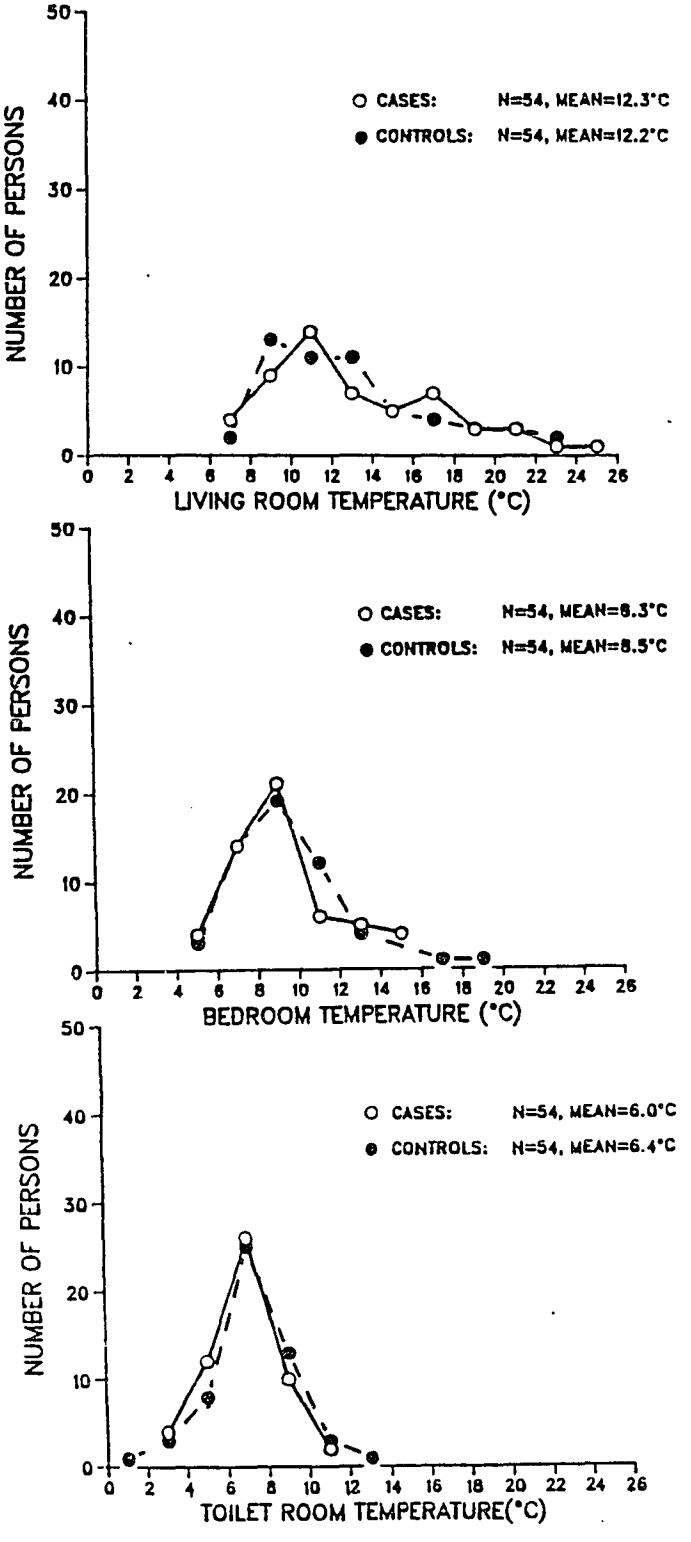


Figure 5.7. Room Temperatures in the Living Room, the Bedroom, and the Toilet Room for Case and Control Households when the Outdoor Temperatures are 4°C. (Recorded in Shiwahime on December 3, 1986, and in Karakuwa on December 15, 1986.)

level. On the other hand, in Karakuwa, differences in the mean temperatures of bedrooms in the morning, and of toilet rooms in the afternoon were statistically significant at the 5 percent level (case mean = 7.6°C and control mean = 8.5°C for the bedroom in the morning; case mean = 8.9°C for the bedroom in the morning; case mean = 8.9°C and control mean = 10.1°C for the toilet room in the afternoon). There were no statistically significant differences in mean temperature discrepancies between the living room and other rooms when case and control households were compared in each town.

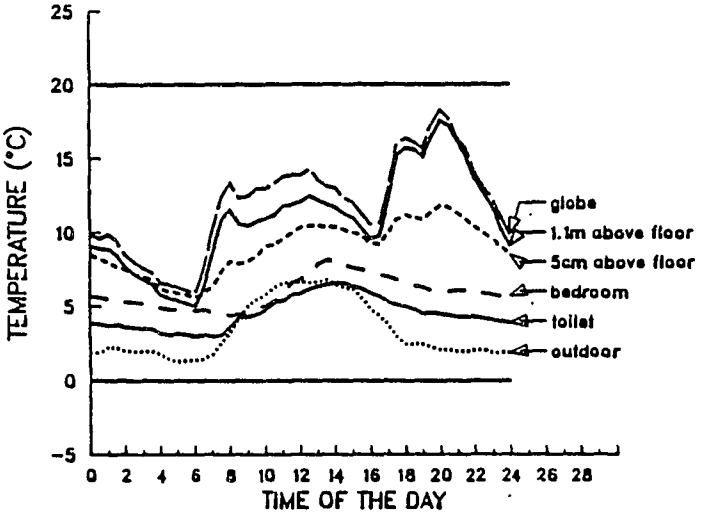
Record of Weekly Temperatures by Self-recording Thermometers. Three dwellings built in different periods were selected as examples to show mean day-long changes in room temperatures in Shiwahime and Karakuwa. Figure 5.8 shows outdoor temperatures and room temperatures 1.1 m and 5 cm above the floor in living rooms; of globes in living rooms; and 1.0 m above the floor in bedrooms, and in toilet areas. Sketches of the house plans and the indoor temperature-recording locations are shown in Figure 5.9.

Temperatures in living rooms changed according to the use of household heating systems. Temperatures 1.1 m above the floor in living rooms exceeded 15°C in most households in the morning and in the evening. However, these dropped rapidly after the heating system was turned off, falling to about 5°C in Shiwahime households and to about 8°C in Karakuwa households.

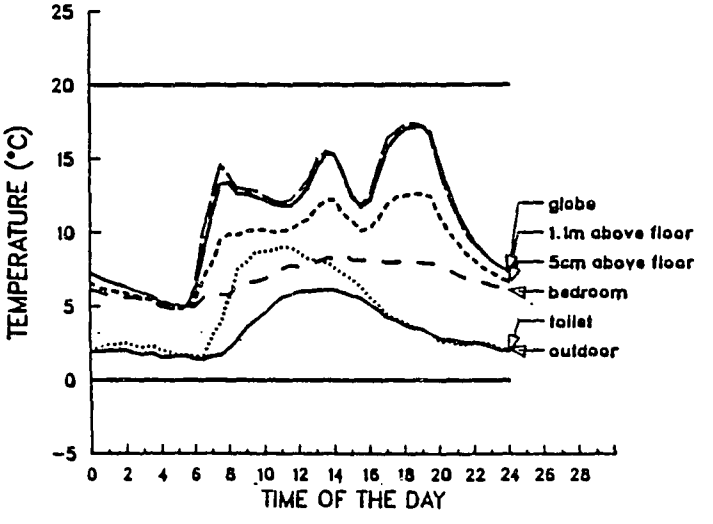
Temperature differences between 1.1 m and 5 cm above the floor in living rooms are also clearly shown. The maximum temperatures 5 cm above the floor were about 12°C for most households, which indicates

Shiwahime

Case (1) Built in 1930s



Case (2) Built in 1960s



Case (3) Built in 1980s

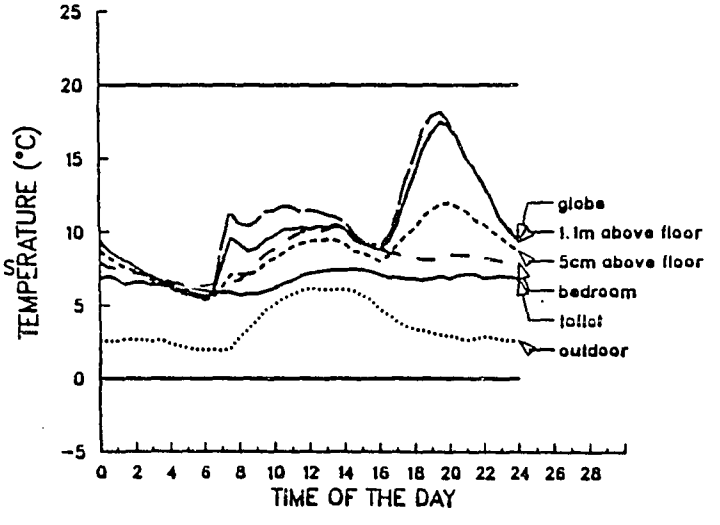
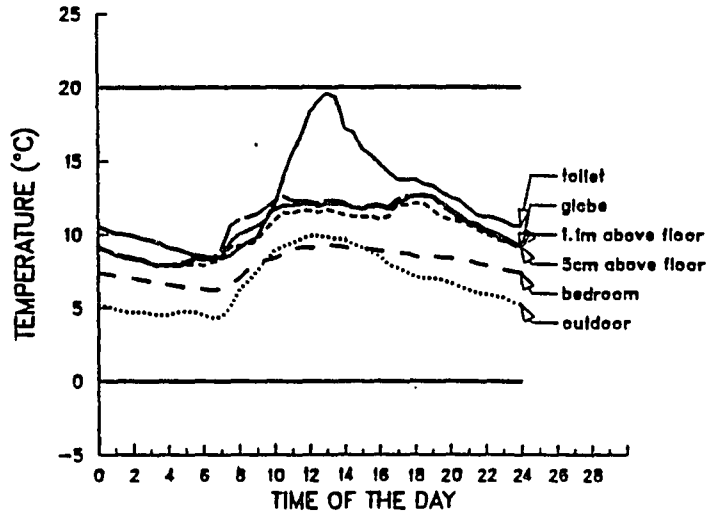


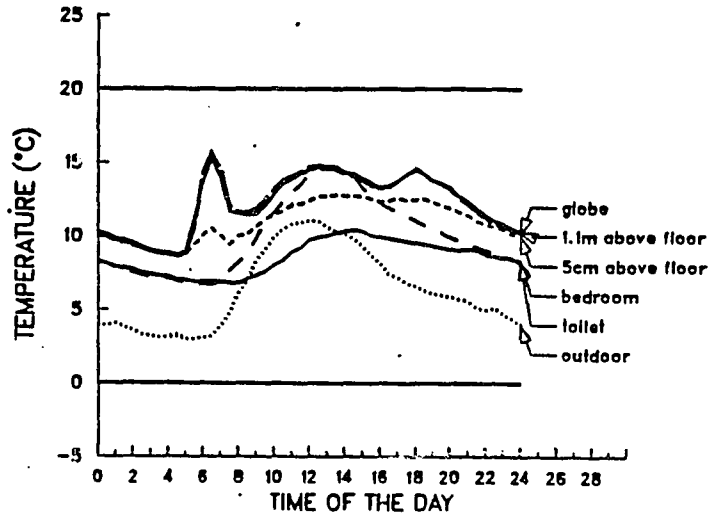
Figure 5.8. Mean Day-Long Room Temperatures and Outdoor Temperatures at Selected Households in Shiwahime and Karakuwa (Recorded in Shiwahime from November 29 to December 5, 1986 and in Karakuwa from December 9 to 15, 1986.)

Karakuwa

Case (1) Built in 1930s



Case (2) Built in 1960s



Case (3) Built in 1980s

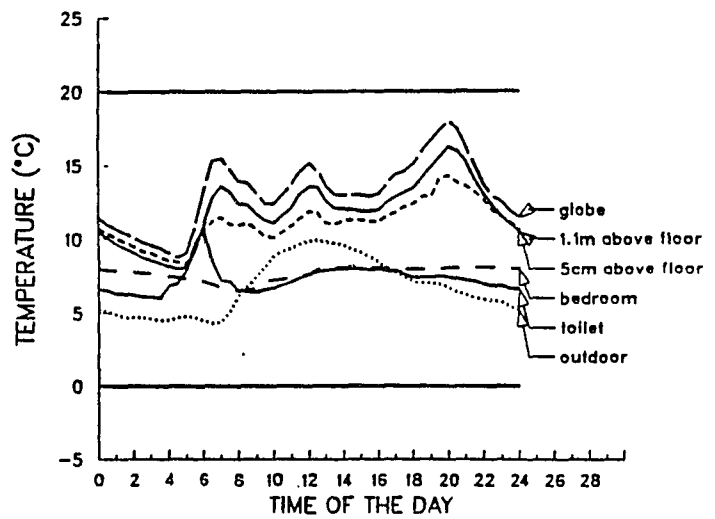
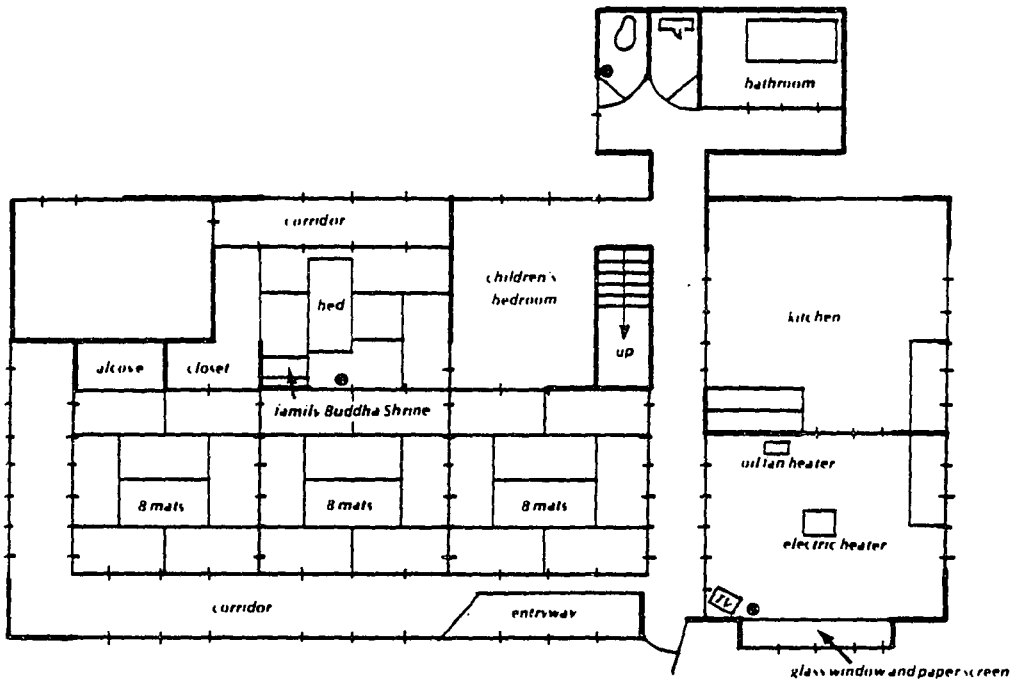


Figure 5.8 (continued). Mean Day-Long Room Temperatures and Outdoor Temperatures at Selected Households in Shiwahime and Karakuwa (Recorded in Shiwahime from November 29 to December 5, 1986 and in Karakuwa from December 9 to 15, 1986).

Shiwahime Case (1) Built in 1930s



● Temperature-recording Locations

Shiwahime Case (2) Built in 1960s

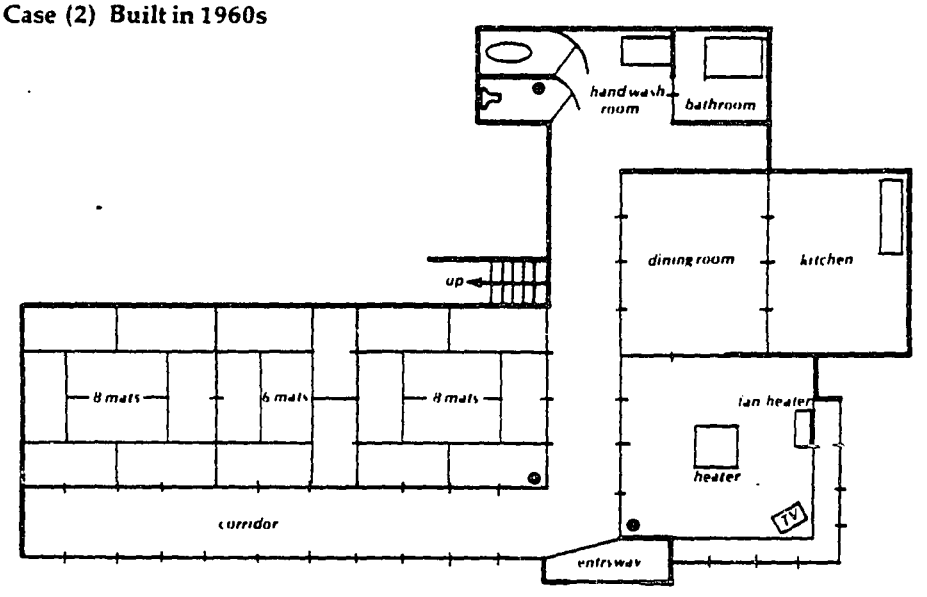
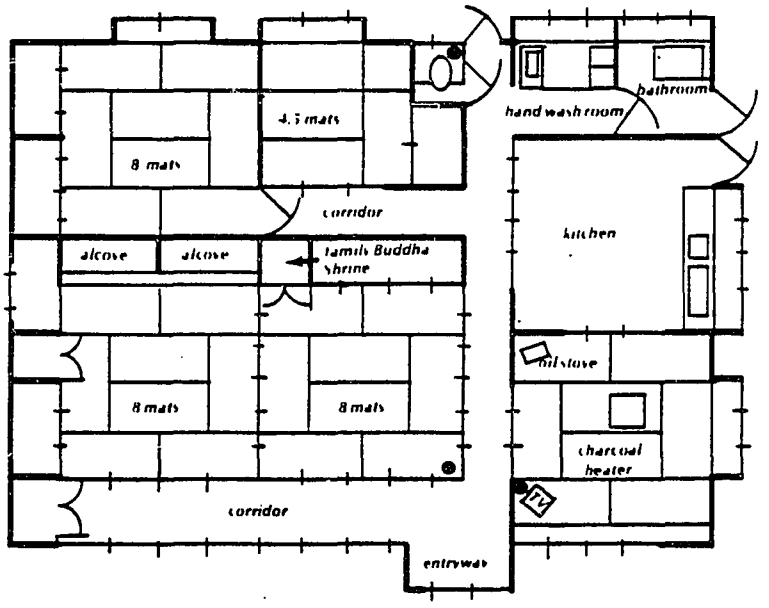


Figure 5.9. Sketches of the House Plans of Selected Houses in Shiwahime and Karakuwa and the Indoor Temperature-recording Locations.

Shiwahime Case (3) Built in 1980s



● Temperature-recording Locations

Karakuwa Case (1) Built in 1930s

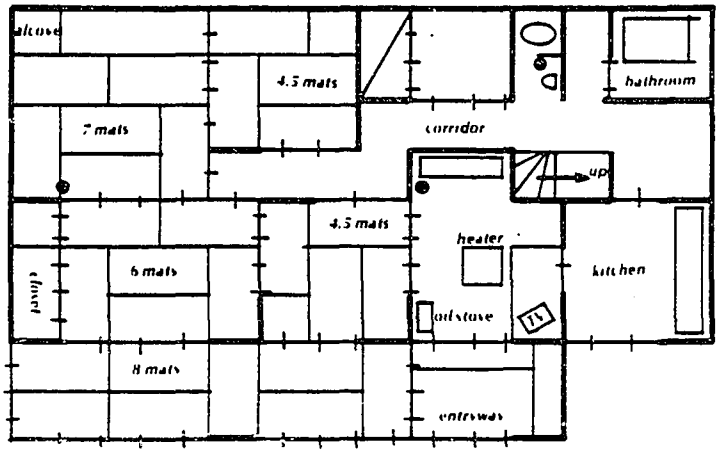
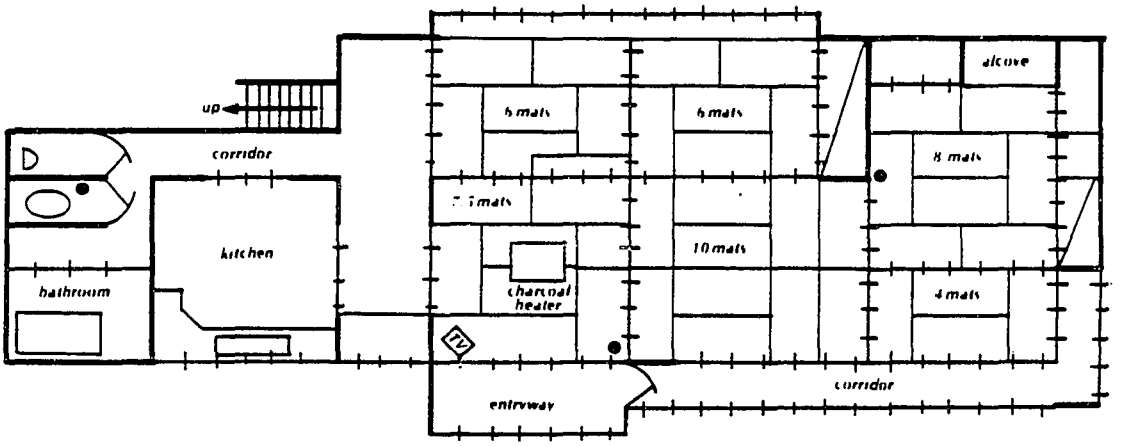


Figure 5.9 (continued) Sketches of the House Plans of Selected Houses in Shiwahime and Karakuwa and the Indoor Temperature-recording Locations.

Karakuwa Case (2) Built in 1960s



● Temperature-recording Locations

Karakuwa Case (3) Built in 1980s

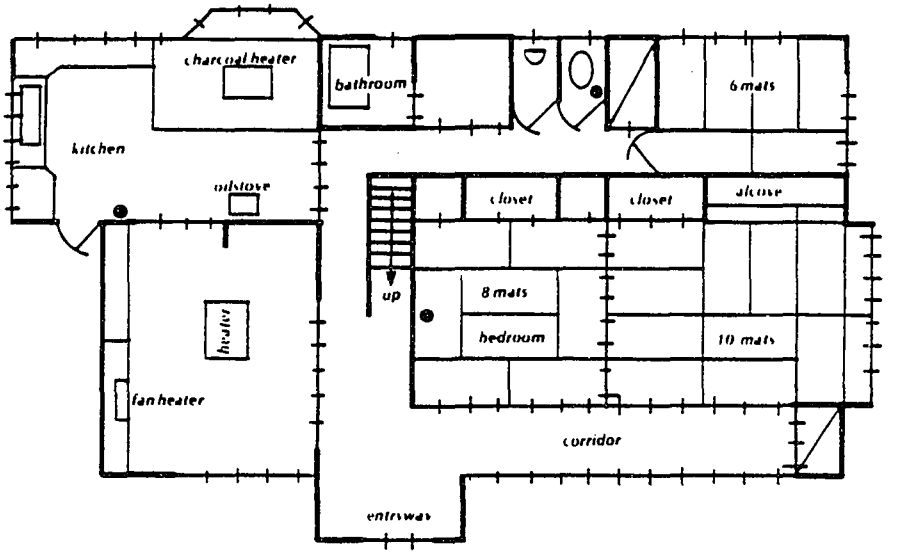


Figure 5.9 (continued). Sketches of the House Plans of Selected Houses in Shiwahime and Karakuwa and the Indoor Temperature-recording Locations.

cooler air closer to the floor. Thus, either electric or coal foot-heaters were used. Globe temperatures in the living room of case (1) in Shiwahime, and case (3) in Karakuwa, were 0-2^{o}C higher and 1-2^{o}C higher, respectively, than temperatures 1.1 m above the floor in the same room. This is probably due to the effect of radiant heat from an open-type oil stove in case (1) in Shiwahime, and from an oil fan heater in case (3) in Karakuwa.

Heating systems were not used in rooms other than the living room in either town. Accordingly, temperatures in rooms outside the living room were low all day and variations between the maximum and minimum temperatures were small. There was no difference in the pattern of room temperatures of households according to the housing construction period. Temperatures in the toilet area of case (1) in Karakuwa rose almost to 20^{o}C in the daytime, and those in the bedroom of case (2) in the same town also rose close to 15^{o}C in the daytime, due to their location in sunny places.

Figure 5.10 shows the mean day-long room temperatures of living rooms, bedrooms, and toilets of all eight households in Shiwahime and Karakuwa during the survey period. Heated living rooms in both towns showed most variation throughout the day, and differed most from outdoor temperatures. Bedrooms in both towns were generally warmer than outdoor temperatures but showed less variation than living rooms. Toilet areas in Shiwahime were cooler throughout the day. In contrast, these were more varied in Karakuwa.

Record of Blood Pressure Level by Recklinghausen Sphygmomanometer. Among 17 participants, 10 were hypertensive, and two elevated blood

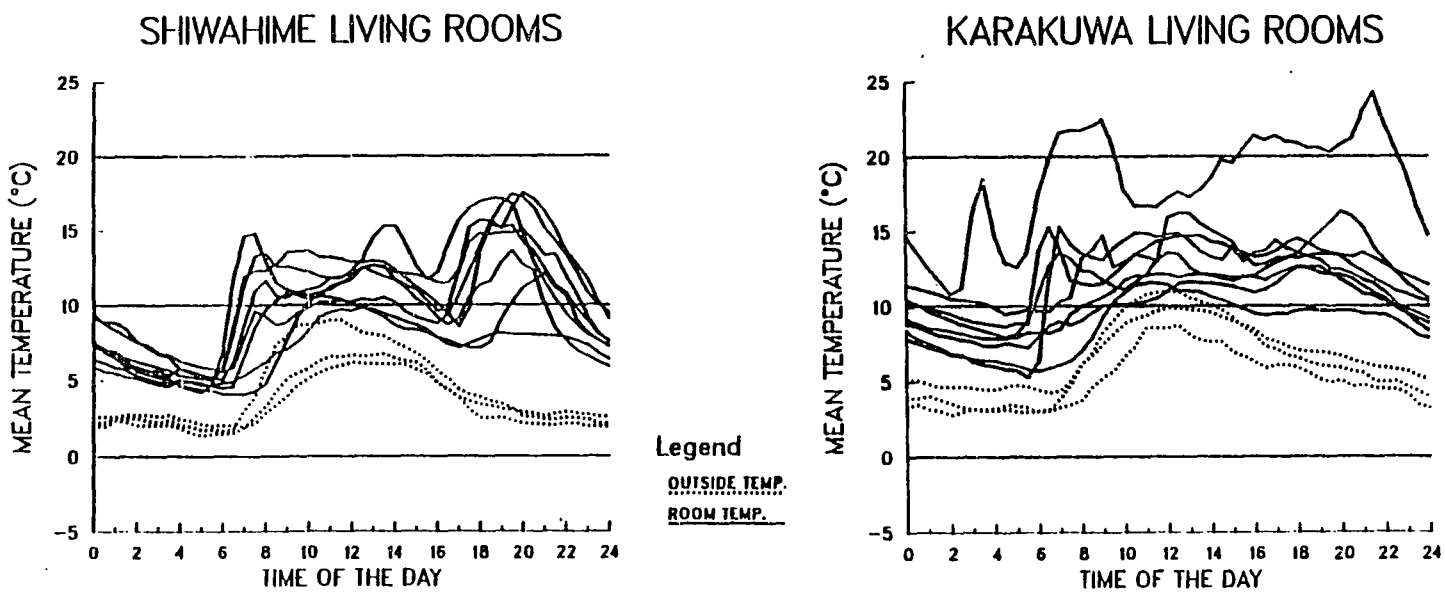


Figure 5.10. Mean Day-Long Room Temperatures of All Eight Households for Shiwahime and Karakuwa (Recorded in Shiwahime from November 29 to December 5, 1986 and in Karakuwa from December 9 to 15, 1986).

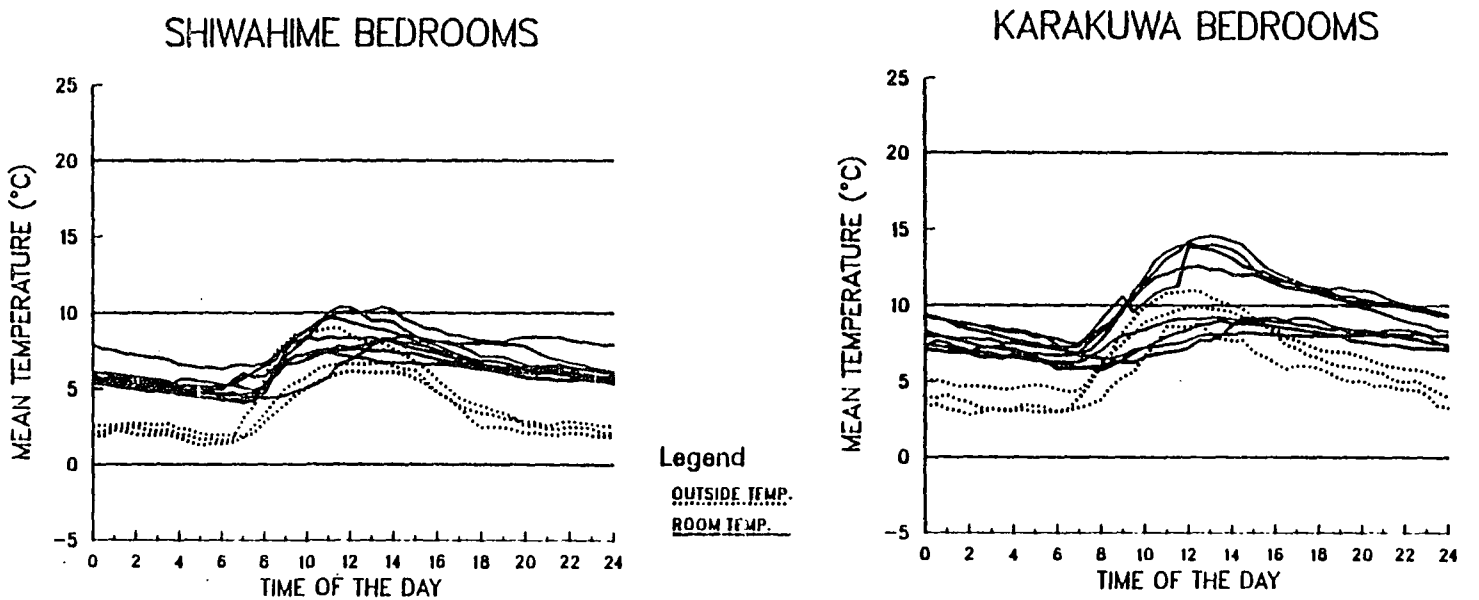


Figure 5.10 (continued). Mean Day-Long Room Temperatures of All Eight Households for Shiwahime and Karakuwa (Recorded in Shiwahime from November 29 to December 5, 1986 and in Karakuwa from December 9 to 15, 1986).

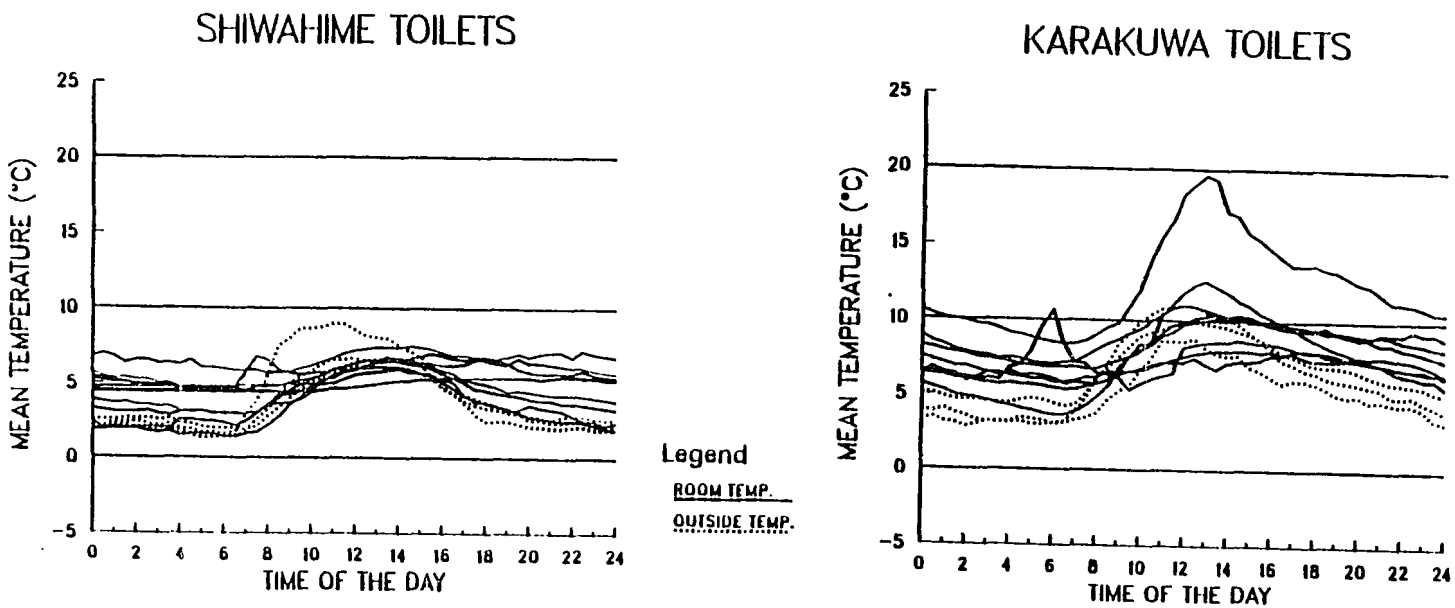
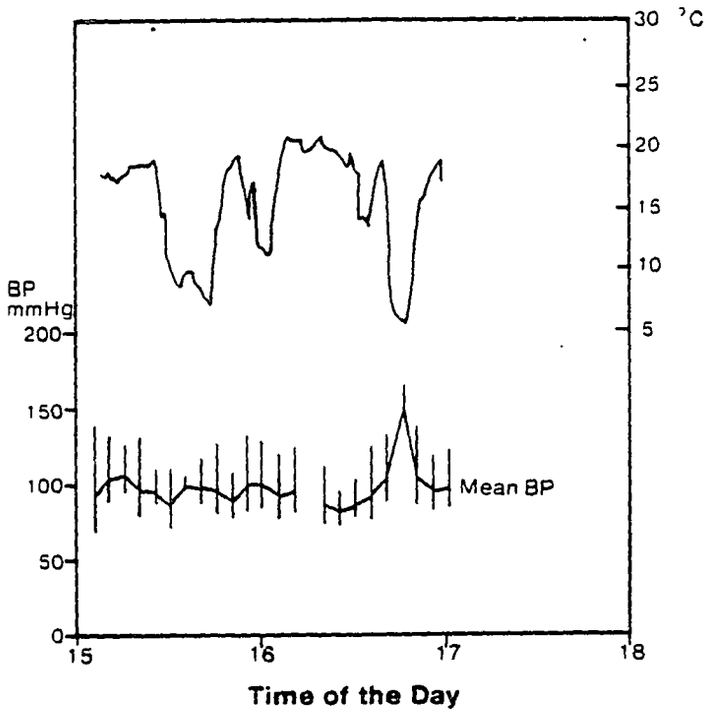


Figure 5.10 (continued). Mean Day-Long Room Temperatures of All Eight Households for Shiwahime and Karakuwa (Recorded in Shiwahime from November 29 to December 5, 1986 and in Karakuwa from December 9 to 15, 1986).

pressure levels dramatically when there was a sudden temperature drop when entering the toilet (Figure 5.11). During the time of blood pressure elevation, one had a systolic pressure of 165 mmHg and a diastolic pressure of 143 mmHg, and the other a systolic pressure of 154 mmHg and a diastolic pressure of 135 mmHg. Both usually complained of headache and were under treatment for hypertension. Although no clear-cut temperature drop occurred for other hypertensive people, both systolic and diastolic blood pressures were also elevated among them as temperatures dropped. In contrast, the blood pressure for people with normal blood pressure was affected only a little when temperatures dropped. For example, one normotensive person had a systolic pressure of 141 mmHg, and a diastolic pressure of 68 mmHg, and the other a systolic pressure of 152 mmHg and a diastolic pressure of 100 mmHg when the temperature suddenly dropped (Figure 5.12).

Discussion and Conclusion

Yoshino's study of urban housing in the Tohoku district found living room temperatures taken 1.1 m above the floor during the evening to be about 20°C when the outdoor temperatures were zero. Temperatures in bedrooms ranged from 4 to 20°C and in hallways from 4° to 10°C (Hasegawa et al. 1988). However, in the rural areas of Yamagata prefecture, when the outdoor temperatures were zero, the living room temperatures 1.1 m above the floor were closer to 18°C, the bedroom temperatures were below 10°C, and the room for the toilet, hallway, and dressing room temperatures below 6°C. According to these measurements, temperatures in rural area living rooms were about 3°C lower than those in urban areas. Temperatures in other rooms of rural houses were also



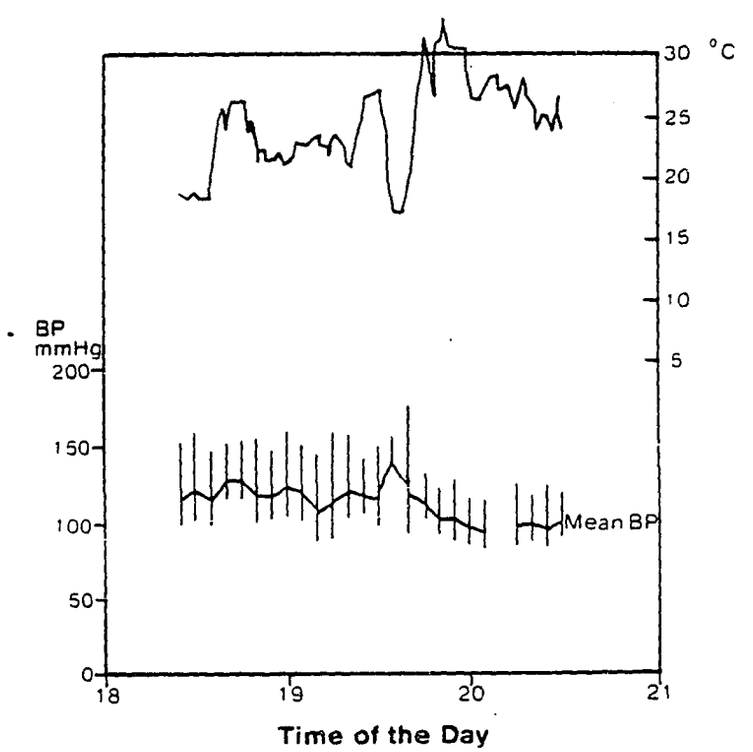
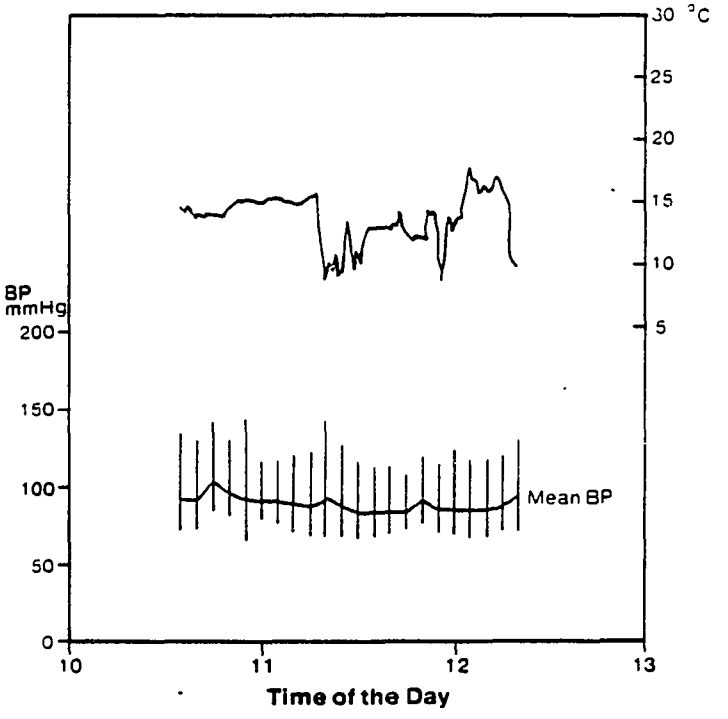


Figure 5.11. Change in Room Temperature and Systolic and Diastolic Blood Pressure for Hypertensives.



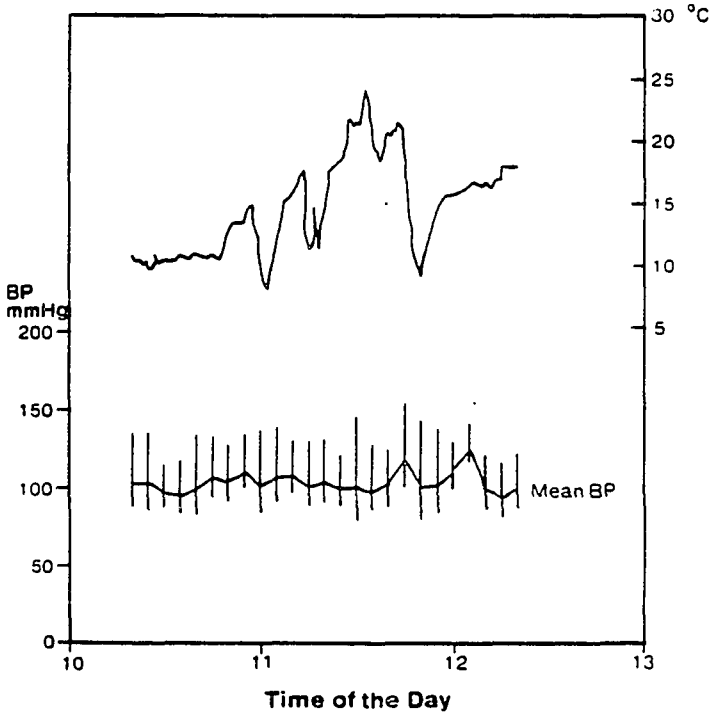


Figure 5.12. Change in Room Temperature and Systolic and Diastolic Blood Pressure for Normotensives.

cooler than those in urban houses. The reason for lower temperatures in rural areas is probably a result of the size and thermal insulation conditions of the houses, since the heating pattern is not different between urban and rural houses (Hasegawa et al. 1985). The findings in this study of the indoor thermal environment of rural areas are consistent with those of Yoshino's studies. However, according to the mail survey (Chapter III), the heating patterns of urban and rural living rooms differ little as Yoshino mentioned, but bedrooms and rooms for the toilet in urban areas are more often equipped with a heating device. Thus it seems that the temperature differences between living rooms and other rooms in urban and rural houses are influenced by the use of heating systems as well as by the room size and thermal insulation materials of the houses.

A common characteristic of indoor heating for both Shiwahime and Karakuwa is for only one room, the living room, to be heated, resulting in a large temperature discrepancy between the heated living room and the other unheated rooms. Although outdoor temperatures did not fall below zero (C) from late November to mid December (the study period), it was found that the residents were exposed to a sudden temperature discrepancy when going from a warm room to a cold room--a temperature discrepancy which would be even greater in January and February.

Although the living room was the warmest room in the house, room temperatures were still cool. For example, mean temperatures for Shiwahime and Karakuwa were 12.3^{o}C and 12.2^{o}C, respectively, when the outdoor temperatures were 4^{o}C. There was also a large temperature difference inside living rooms between the 1 m and 5 cm levels, and the

residents were exposed to low temperatures close to their feet, even though their feet were warmed by foot heaters. The range of temperatures between times when rooms were heated and unheated was also great because of cold breezes from outdoors and from adjoining rooms.

Despite the low room temperatures, people did not express feelings of being cold except in rooms for the toilet. Table 5.15 shows the clothing worn by men and women during the evening in terms of a CLO value. In 1941, Dr. A. P. Gagge, a Fellow at the Pierce Foundation, introduced a useful clothing insulation unit, the CLO, or the insulation value of garments worn. A CLO value of 1.0 was selected for convenience as the insulation value of an ordinary man's business suit at that time. For example, when the CLO value is 1.2 for men and women, which was the most common value among the residents in both towns of this study, the temperature required for comfort in the living room in the evening was about 21^{o}C (Nevins et al. 1974), though only a few houses in the study had room temperatures greater than 21^{o}C. However, the residents often did not wear clothing that would be seen as suitable, according to Gagge, to the room temperatures. There seems to have been an adaptation to low temperatures or perhaps there was simple acceptance--that winter is cold. However, the subjects certainly express that they felt cold in rooms for the toilet, where the mean room temperatures were 5.6^{o}C and 6.7^{o}C for Shiwahime and Karakuwa, respectively. These findings would indicate that the houses of both towns have inferior household thermal environments compared to more uniformly heated urban houses.

The question of interest to this study was whether there was any difference in the indoor thermal environment between case and control households, but when the aggregated data of case and control households

Table 5.15

CLO* Values for Men and Women in Shiwahime and Karakuwa, Indoors During the Early Evening

CLO Values	Men		Women	
	Shiwahime	Karakuwa	Shiwahime	Karakuwa
under 0.75	6%	6%	1%	3%
0.75 - 0.99	6	12	10	15
1.00 - 1.24	43	29	6	12
1.25 and over	23	25	56	45
Japanese kimono	10	9	14	10
no answer	12	19	13	15
Total Percentage (Total Number	100% (70)	100% (68)	100% (70)	100% (68)
Mean CLO Values excluding Kimono and no answer	1.2	1.2	1.3	1.2

*CLO is the insulating value of the garments worn.

for both towns were compared with an outdoor temperature of 4°C, there was no statistically significant difference in living rooms, bedrooms, and rooms for the toilet temperatures between case and control households.

When room temperatures between the two towns were compared with an outdoor temperature of 4°C, there was little difference in the living room and the bedroom, whereas the temperature in the room for the toilet was higher in Karakuwa than in Shiwahime. Furthermore, the temperature difference between the living room and the room for the toilet was 6.6°C for Shiwahime and 5.5°C for Karakuwa, a difference of 1.1°C, which was

statistically significant at the 5 percent level. These findings suggest that residents of Shiwahime are exposed to larger temperature differences when going from a heated room to an unheated room than residents of Karakuwa.

Among hypertensive people, there were instances where blood pressure rose quickly when the room temperature suddenly dropped (for example, by going from the living room to the room for the toilet). This suggests that hypertension as well as temperature may be involved in the relationship with stroke. Since sudden changes in temperature affect hypertensive people more, residents in Shiwahime may be more at risk of stroke than those in Karakuwa thanks to a colder indoor environment, particularly in rooms for the toilet, even though there is a lower percentage of hypertensive people. This confirms the previous findings of experimental studies with human subjects (Hines 1940; Zbrozyna and Krebbel 1985).

Hines (1940) conducted a "cold pressor test" on 1856 subjects of which 1015 were normotensive subjects, and 841 were well-established hypertensive patients. In the cold pressor test, a subject immersed a hand or foot into water at $4^{o}C$ for 30-60 seconds. Toward the end of this period most subjects experienced pain in the immersed limb. The cold pressor test may therefore be considered as generating a noxious or aversive stimulus. The cardiovascular response to this stimulus reached its peak at the end of 60 seconds of immersion or during the following 10-20 seconds. It has been demonstrated that in hypertensive subjects the pressor response is larger than that in normotensives, indicating the "hyperreactivity" of hypertensive subjects. Zbrozyna

and Krebbel (1985) then compared the course of habituation of the cold pressor response in normo- and hypertensive human subjects. It was found that the mean systolic and diastolic pressures during the resting period between the tests were consistently and significantly higher in hypertensives than in normotensives. Blood pressure increases in response to the repeated cold test remained of similar magnitude in hypertensives, while in normotensives pressures gradually diminished.

In summary, sujbects in both Shiwahime and Karakuwa live under lower room temperatures than those in urban areas. Residents in Shiwahime are exposed to colder toilet space than those in Karakuwa, and the temperature differences between living rooms and rooms for the toilet are also greater for Shiwahime. It is thus concluded that colder or more contrasting indoor thermal environments may increase the risk of stroke by suddenly elevating the level of blood pressure, particularly for those who are already hypertensive. This may be one reason why Shiwahime has a higher stroke mortality than Karakuwa in spite of the lower prevalence of hypertension.

Synthesis by Linear Logistic Regression Model

General Background of Logistic Regression in Case-Control Studies

The elementary techniques for stratified analysis of case-control studies, in particular the Mantel-Haenzel combined relative risk estimate and test statistic, have served epidemiologists well for over two decades (Breslow and Day 1980). Nonetheless, there are certain limitations inherent in these techniques. "If many potentially confounding factors

must be controlled simultaneously, a stratified analysis will ultimately break down. Individual strata simply become so large in number and small in size that many contain only cases or only controls. This means that substantial amounts of data are effectively lost" (Breslow and Day 1980: 192). "[Perhaps] . . . even more important are the deficiencies in the techniques for evaluating interactions among risk and nuisance variables. Other than calculating a separate estimate for each stratum, no provision is made for incorporating such interactions into the estimates of relative risk" (Breslow and Day 1980:192).

Another limitation is the number of cases available for study within a reasonable time period. "While this number may be perfectly adequate for assessing the relative risks associated with a few discrete levels of a single risk factor, these are usually insufficient to provide separate estimates for the large number of categories generated by combining even a few more or less continuous factors. Thus, in order to estimate the risks in each one, we are faced with the problem of having to make smoothed estimates which do utilize information from surrounding categories" (Breslow and Day 1980:193).

The basic tool to overcome such limitations is the linear logistic regression model. This assumes a categorical dependent variable. Independent variables may be either continuous or categorical. Since the late 1960s, newly developed methods, such as this model, have improved the analysis of cross-classified tables (Vitaliano 1978). "There is no overriding biological rationale for general use of logistic regression, whose widespread application to the analysis of epidemiological studies can only be supported on grounds of mathematical convenience, much like

the extensive use of multiple linear regression analysis in various fields" (Schlesselman 1982:229-230).

Method of Analysis

Various techniques have already been employed to identify important factors in terms of causal relationships with stroke mortality, as shown in the previous chapter. In this chapter variables found to be important in the previous chapter are examined by multivariate logistic regression analysis to estimate the level of contribution towards explaining the cause of death by stroke.

When two or more independent variables have highly redundant associations among themselves, none of them may show a non-trivial unique relationship (Cohen and Cohen 1975). In order to reduce this problem of multicollinearity, only five independent variables were selected for the logistic regression analysis. The selection of an important variable from the variables which are correlated was based on the previous findings. For example, the importance of dietary factors, such as "green tea rather than black tea or coffee," "boiled greens preferred to fried vegetables," "cooked vegetables preferred to uncooked vegetables," "fondness for salt" and "normal salt consumption vs. salt consumption with caution" have been discussed in the previous chapter in association with stroke mortality. However, only "normal salt consumption vs. salt consumption with caution" was selected because high salt intake in general has been found important in other studies. Figure 5.13 shows the basic causal model of stroke mortality to be tested by logistic regression analysis in this chapter.

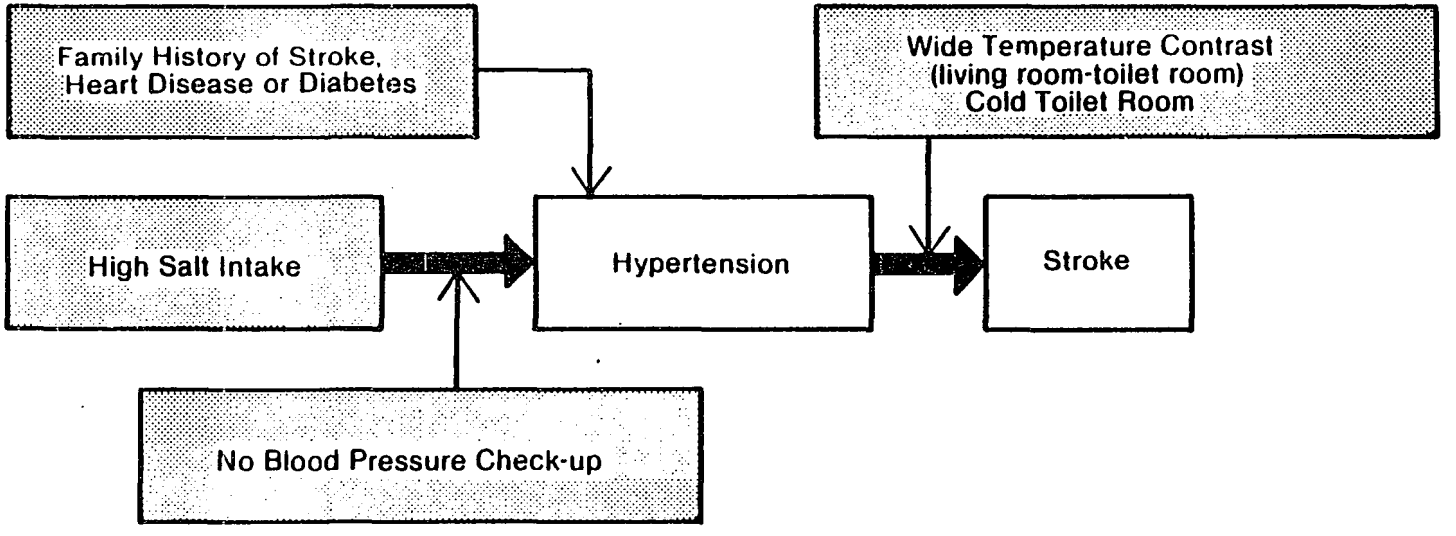


Figure 5.13. Hypothetical Causal Model of Stroke Mortality: Shaded Area to be Tested.

In this analysis, unconditional logistic regression, which is usually used for group data, was employed using the SAS LOGIST procedure. The use of conditional logistic regression has been suggested for matched-pairs case-control analysis such as in this study, but it is not used here due to the small sample size (Holford et al. 1978; Breslow et al. 1978; Breslow and Day 1980).

The analysis followed a binary "choice" model which compared the 67 cases and 68 controls, for a total of 135 observations. Seven cases and five controls were dropped due to missing data. In summary, the variables selected were: (1) lack of blood pressure check-up, (2) higher salt consumption, (3) family history of stroke, heart disease or diabetes, (4) wide temperature contrast between living and toilet rooms, (5) cold rooms for the toilet (Table 5.16).

In the previous chapter, it was hypothesized that the hypertensives were more likely to have a high risk of stroke when exposed to a sudden change in room temperature, particularly when visiting cooler rooms for the toilet. What this implies is the possibility of a joint effect of hypertension and the temperature contrast between rooms. But since the controls were all hypertension free, the data were not appropriate to measure this effect by logistic regression. Thus the effect was not examined. Nor for the same reason was the factor of hypertension included in this phase of the analysis.

Results

In order to examine the significance of selected variables in determining the probability of dying from stroke, three models (equations) were established and tested. Table 5.17 summarizes the results of

Table 5.16

Characteristics of Cases and Controls
According to Selected Variables

Variables	Level	Cases	Controls	Odds Ratio[a]
No blood pressure check-up	yes	34	14	
	no	35	55	21.00[c,d]
Higher salt consumption	yes	28	14	
	no	41	55	3.33[c]
Familial Association with stroke	yes	34	21	
	no	33	47	2.27[b]
	missing	2	1	
Wide temperature contrast between living room and toilet (temperature difference $\geq 6^{o}C$)	yes	32	31	
	no	30	33	1.24
	missing	7	5	
Cold toilet temperature (temperature $\leq 6^{o}C$)	yes	40	35	
	no	22	29	1.07
	missing	7	5	

[a]Odds ratio calculated from matched data.

[b]Significant at the 0.05 level, chi square with 1 d.f.

[c]Significant at the 0.01 level, chi square with 1 d.f.

[d]Power at the 0.95 level.

Table 5.17

Effects of Selected Variables on Stroke Mortality in Miyagi by Using Several Logistic Regression Models: Unmatched Data (N=135)

Determinant	Model I Odds Ratio	Model II Odds Ratio	Model III Odds Ratio
Health-Promoting Behavior			
No blood pressure check-up	4.34 (<0.01)	4.30 (<0.01)	3.62 (<0.01)
Diet			
Higher salt consumption		3.24 (<0.01)	3.08 (<0.01)
Family History			
Yes			2.65 (<0.05)
Indoor Thermal Environment			
Room Temperature Discrepancy (Living Room - Toilet)			
Temperature Difference >6°C			1.78 (*)
Toilet Room Temperature			
Temperature <6°C			1.00 (*)
Maximum Likelihood Ratio Chi-Square	17.72 (<0.01)	27.23 (<0.01)	32.10 (<0.01)
R2	0.071	0.105	0.112

Figures in parentheses are (P = level of significance) values.

*P >0.05

fitting several regression models. Model I examines the effect of no blood pressure check-up on stroke mortality. Model II in relation to Model I adds the effect of salt intake for investigation. Model III in relation to Model II adds the effect of family history and the indoor thermal environment. The relative importance of each independent variable should be examined in the full Model III.

An odds ratio gives an estimate of the relative risk of dying from stroke for a particular category, compared with another category of the same independent variable: an odds ratio of more than one indicates a higher risk of dying from stroke for that particular category; and an odds ratio of less than one indicates a lower risk of dying from stroke for that particular category. For example, the odds ratio of 4.34 in Model I means that those who have never had a regular blood pressure check-up have 4.34 times higher chance of dying than those who have had regular blood pressure check-ups. The P (probability) values indicate how significant the association is. The maximum likelihood ratio at the bottom of the table tests the significance of each model. The obtained maximum likelihood ratio of 17.72 in Model I is significant at the one percent level. This means that the variable included in the analysis is statistically significant as a whole. The explanatory power of a model measured by a "pseudo R2," similar to the multiple correlation coefficient in a normal setting (Harrell, Jr. 1986; Walsh 1987), indicates how much each model has explained the "choice" in the dependent variable: the increase in the value according to the modified model indicates that the model is more able to explain the "choice" in the dependent variable.

All the models were statistically significant at the one percent level. There is a reasonably good agreement with the Mantel-Haenszel approach except for the variable of "no blood pressure check-up" where there were few cases and controls in some strata. Hence, this variable is probably underestimated here because of the "thin" data (Breslow and Day 1980).

Model I introduces the variable of "no blood pressure check-up" where the risk of dying from stroke was 4.34 times higher if people did not regularly check blood pressure. Model II tests the significance of "no blood pressure check-up" and "higher salt consumption," ignoring the effects of the other variables. Both variables had a strong influence on risk of dying from stroke. The risk was 4.30 times higher if people did not regularly check blood pressure, and 3.24 times higher if they had high salt intake. Even with the introduction of other variables in Model III, the magnitude did not much change, which indicates that both variables have strong independent effects which are not explained by the contribution of the other variables.

In Model III, as expected, a lack of blood pressure check-up was found to be important. "Higher salt consumption" was also significant in stroke mortality. This factor might have explained more if bias in responses had not been introduced in the survey. (Bias in the responses was discussed in Chapter IV.) "Family history of stroke, heart disease or diabetes" was statistically significant. The risk of dying from stroke was 2.65 times higher among those whose parents died of stroke-associated diseases. Temperature discrepancy between living rooms and rooms for the toilet was not significant. Neither were low temperatures

in rooms for the toilet. The overall explanatory power using five factors in the full Model III was only 11 percent. The explanatory power would have greatly improved if "hypertension" and possible joint effect of "hypertension" and the "temperature contrast between the living rooms and rooms for the toilet," had been included.

Discussion and Conclusion

The multivariate analysis supports the relevance of the causal model as shown in Figure 5.13. "No blood pressure check-up," "higher salt consumption" and "family history" were confirmed as significant factors although the overall explanatory power was small. The association of "no blood pressure check-up" with stroke mortality indicates the importance of health-promoting behavior. An increase in blood pressure is easily found if people regularly take a blood pressure check-up. Thus they can be advised to modify their dietary routines to reduce salt intake, which may reduce the likelihood of hypertension. Figure 5.14 shows a causal model based on the results of logistic regression and the findings from the previous chapter. This model suggests that geographical variation in stroke mortality varies depending on socio-economic factors and hypertension as well as on family history. However, there is no question that hypertension, which is directly associated with high salt intake, is the most important factor. On the whole, it is concluded that, hypertension being equal, socioeconomic factors such as poor indoor thermal environment and lack of blood pressure check-ups may play a role in explaining variations.

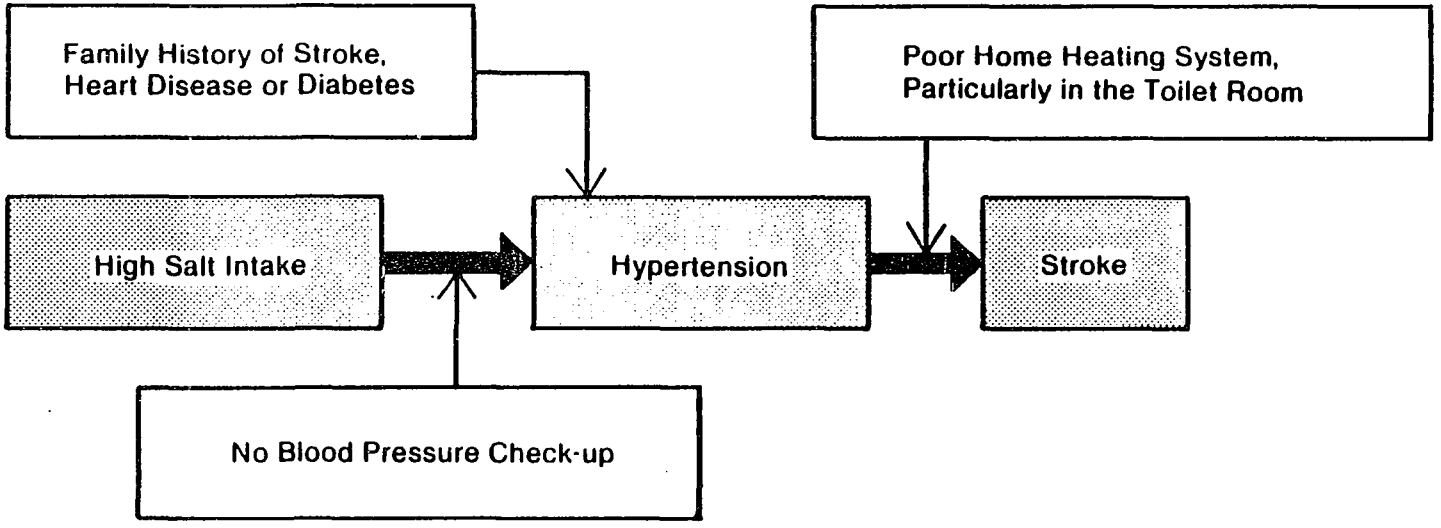


Figure 5.14. Causal Model of Stroke Mortality: Shaded Area Indicating Major Causal Pathway.

CHAPTER V--NOTE

[1]The power of a matched-pair study was calculated by the formula:

$$\hat{Z}_\beta = [-Z_\alpha/2 + \sqrt{m(P-1/2)^2} \; / \; \sqrt{P(1-P)}], \quad \text{where}$$

$Z\alpha$ = values from the standard normal distribution corresponding to α

m = number of discordant pairs

$P \simeq RR/(1+ RR)$.

Note: RR = Relative Risk

The power is determined from tables of the normal distribution by finding the probability that $\hat{Z}_\beta$ is not exceeded, Power = $P(Z \leq \hat{Z}\beta)$.

Since the study employed a two-sided test of hypotheses, Z is taken to be the value of the standard normal distribution that is exceeded with probability $\alpha/2$. In this study, $Z_{0.05} = 1.96$ was used, α being specified as 0.05 (Schlesselman 1982:160-162).

CHAPTER VI

CONCLUSION

Japan now ranks among the nations having the lowest mortality rates in the world. This achievement has been due largely to decreases in infant mortality and tuberculosis deaths among adolescents. With the postwar development of public health education, preventive medicine and improvements in public health administration, diseases associated with advanced age have replaced infectious and communicable diseases as the major causes of death. Among the diseases associated with advanced age, stroke was the primary cause of death from 1951 to 1981, when it was replaced by cancer, but it remains one of the most common causes of death in Japanese.

When stroke mortality for cities, towns, and villages is examined for males and females, there is a distinctive geographical distribution. Areas with high mortality are located primarily in cold climates. These areas tend to be mountainous, rural and agricultural, and residents tend to maintain a "traditional" style of life. In contrast, areas which generally have low mortality are mostly coastal and urban, and have warmer climates.

This study, conducted in Miyagi prefecture in the Tohoku region, attempts to explain this distinctive geographical distribution. The focus was on socioeconomic factors in combination with individual health factors. In methodology, the study combined a mail survey at the macro (areal) level and a matched-pairs case-control design at the micro

(individual) level. The results of the former were used as basic information in conducting the latter investigation.

The Tohoku region, of which Miyagi is a part, has the highest stroke mortality rates in Japan. It has long been recognized as economically and culturally backward. Until 1970 it also had the highest mortality rates for all causes of death in Japan until 1970 when stroke mortality began to decline. In spite of decreasing mortality rates in the last 18 years, stroke rates remain high when compared with the national average. Thus, in Tohoku stroke prevention is a continuing and important health issue.

The results of this study indicate that hypertension is probably the most important single factor in stroke mortality, and socioeconomic factors such as a high salt intake also seem to be directly associated with hypertension. But hypertension cannot by itself explain all the variation in stroke mortality.

When two selected towns with differing socioeconomic compositions--one agricultural town with relatively high stroke mortality and one fishing town with relatively low stroke mortality--were compared, the blood pressure levels were not significantly different at the 5 percent level. Thus, there must be other factors which differentiate mortality rates between the study towns, and it is concluded that socioeconomic factors, such as the indoor thermal environment and no regular blood pressure check-ups, are also important factors in explaining geographical variations in stroke mortality. It would also appear to be important for the hypertensive to improve indoor thermal environments, particularly in toilet areas. The findings in this study are consistent with previous

observations and expand knowledge on the possible relationships between socioeconomic factors and geographic differentials of stroke mortality.

Although the relationship between climate and stroke was not examined in this study, it is worth mentioning that the harsher climate of an agricultural area, especially in a mountainous setting, is more likely to contribute to higher mortality than is the more moderate climate of a coastal fishing area. As described in Chapter II, the climates of the inland agricultural area differ from those of the coastal fishing area. The agricultural area has a harsh climate, hot in summer and cold in winter, whereas the fishing area has a milder climate, cool in summer and warm in winter. Considering that blood pressure is affected by cold temperatures, residents in the agricultural area are more likely to have higher blood pressure during winter and to be more exposed to sudden changes in temperature by going outside the house or from heated to unheated rooms. Thus it is noted that climate also seems to play an important role, particularly among the hypertensive.

A widespread campaign to reduce salt consumption, improvements in standards of living, and rapid changes in styles of life have made the study of geographical variations in stroke mortality more complex. Individual and community awareness in stroke prevention seem to have played particularly important roles in explaining significant mortality differences in the agricultural area. Further research here should draw more attention to individual and community health concerns.

Application of Research Findings to the Other Areas

How applicable are the results found in this study of Miyagi to the other parts of the Tohoku region and to the rest of the nation?

The findings from the agricultural area are certainly applicable to the other agricultural areas of Tohoku where residents have similar styles of life and climatic environments. The results are also probably applicable to other agricultural areas in Japan, particularly to cold mountainous regions, except those in Hokkaido, the northernmost main island, where houses generally have double windows and a substantial home heating system.

In contrast, the fishing towns in this study cannot be considered to represent the other fishing areas of Tohoku or the rest of the nation, since the fishing area studied was unique in terms of a heavy concentration of off-shore fishing.

Stroke etiology in western countries is different from that in Japan. In western countries high blood lipid levels are associated with stroke as well as hypertension, whereas in Japan hypertension alone is more significant. Thus, this study presents the stroke pattern in the Japanese context, and provides data for cross-cultural comparative examination.

Contribution to Medical-Geographical Study

There is enormous global variation in the incidence of and mortality from human disease. Relevant to this study, morbidity and mortality rates for stroke vary between countries. Within countries there are wide variations between states and between counties. Some geographers have used aggregated, census-derived demographic and socio-economic data in multivariate statistical analyses to explain the distribution of such phenomena. Some have used microscale, interview, and field-mapped data to illuminate connecting paths between

environmental, cultural, and demographic patterns and occurrence of disease. Whatever the scale or approach, accounting for the spatial distribution of health-related phenomena is the dominant purpose of medical-geographical inquiry (Meade et al. 1988).

This study is an example of a medical-geographical investigation which attempts to explain the distinctive geographical distribution of stroke in Japan. It explores varying disease patterns from place to place: that is, between towns in Miyagi and more generally between Miyagi and the rest of Japan and between Japan and western countries.

The importance of human environments in understanding such patterns is also emphasized by the case-control research design. This methodology, which involves matching individual cases of victims and healthy controls, is frequently used in the field of epidemiology, and its usefulness has been recognized among medical geographers (Sato 1983). Armstrong (1976) developed the concept of self-specific environment using this methodology for cancer studies in Malaysia. The focus was the self-specific environments of cases and controls: that is, it focused on individual case and control subjects at the same scale, and provided a relevant geographical context for the examination of study data. In this study, a case-control design was used as a tool in the micro study of geographical variations of stroke mortality. In this way systematic links of conventional macro-scale studies (the use of aggregated areal data), with more micro-scale studies (the use of data specific to individuals and households), were exemplified. It is believed that the use of case-control research designs will further increase the effectiveness and contribution of medical geographers in the investigation of geography of human disease in the future.

Further Research

Further research should take four directions.

1. More case studies of fishing towns are necessary to accumulate larger samplings of data.

2. In this study, it is found that an agricultural town with relatively high stroke mortality has a higher mean age at death due to stroke than a fishing town with relatively low stroke mortality. Since the age structure is similar between the two towns, other factors need to be considered.

One possible factor has been recently presented by Mizuno (1987), who suggests that stroke mortality rates increase if large amounts of fish are consumed due to an increase in eicosapentaenoic acid (EPA). When Mizuno compared Tokyo with Higashiizu, a fishing town, he found that in Higashiizu there was higher mortality from hemorrhagic stroke than in Tokyo. In contrast, as shown in the study of Eskimos, mortality from myocardial infarction and cerebral embolism, which are associated with hardening of the arteries, was lower. In comparison to Tokyo, cases of hemorrhagic stroke were more severe and the fatality rate was higher in Higashiizu. Mizuno suggested that EPA is positively associated with hemorrhagic stroke but is negatively associated with arteriosclerotic disease. Judging from the information collected by interview in this study, the incidence of stroke was also severe and fatality rates were high among those 50 to 69 years of age in the fishing town. It is possible that differences in the age structure of cases between fishing and agricultural towns are a result of higher rates of hemorrhagic stroke mortality among certain age groups in the

fishing towns because of high fish consumption. However, more studies on this subject are needed.

3. A third future research direction should focus on the further verification of the interrelationships of temperature, hypertension, and stroke mortality, as suggested by this study.

4. It has been hypothesized in this study that a sudden drop in room temperature was associated with a sudden rise in blood pressure levels among the hypertensive. Although the level of physical work was not found to be important, this may have the same effect on the hypertensive as do sudden declines in temperature. Further research is necessary to examine how the level of physical work relates to the blood pressure level in a hypertensive group.

Recommendations

Hypertension control is the primary intervention to decrease stroke mortality. Fortunately, many Japanese cities and towns are making considerable efforts to control hypertension as a step toward the reduction of stroke (Fukuzawa et al. 1984). This involves decreases in dietary salt, increased use of antihypertensive agents, increased intake of animal protein and fat, and improvement in indoor thermal environments, with emphasis on the first two items. However, it is important that improvements in indoor climate should receive more attention, particularly in areas of harsh, cold climates. In practice, it is difficult because of cost to improve the indoor climate (Yoshino et al. 1986). Results of this study suggest that improvements in the home heating system should be emphasized especially among hypertensive individuals. In contrast, encouraging higher intake of animal

protein and fat, which is associated with a decrease in the incidence of stroke, could receive less emphasis because of recent dietary improvements, and an increase in the incidence of heart disease. Depending on the outcome of current research, it may be more important in the future to extend advice about possible risks associated with an excessive intake of fish, and to propose a more balanced consumption of various protein sources. However, these recommendations need to conform to current knowledge of diet in relation to heart disease, cancer, and other dietary-related diseases as well as to stroke.

APPENDIX A

MAIL QUESTIONNAIRE

Japanese Version

昭和61年8月

＿＿＿＿＿＿＿＿＿＿＿＿＿＿殿

医学地理・統計研究所
所長（研究代表者）舟山政子

157 東京都世田谷区南烏山
3－12－6－2
TEL 03（300）8461

健康状態に関するアンケート調査（お願い）

皆様には、ますます御清栄のこととお慶び申し上げます。

当研究所では、かねがね、気候・風土と疾病の関係を研究してまいりましたが、今回、宮城県の御指導および御協力により、宮城県にお住まいの方々を対象として、健康状態の実態について調査を行うことになりました。

今回の調査の対象者として、あなた様を選ばせていただきました。

調査結果は、今後の保健対策を考える上での貴重な資料となりますので御多忙中まことに恐れ入りますが、アンケート用紙に御記入下さるようお願い申し上げます。なお、お送りいただいた調査票は、他の目的には使用いたしませんので、重ねて御協力をお願い申し上げます。

調査に御協力して下さった方に、粗品を送らせていただきます。

この調査の問い合わせ先
医学地理・統計研究所連絡所（岩出山町）
TEL 0229（72）3013
担当 佐藤都喜子

性別　男・女　　年令（満）　歳

現在お住いになっている住宅についておたずねします

1. 現在の住宅（借家、借間を含む）の建設時期はいつですか。該当する番号に○印をつけて下さい。

1. 戦前
2. 昭和20年代～昭和40年代
3. 昭和50年代以降
4. 不明

2. 寒い時期に居間の暖房器具はどんなものを使用していますか。該当する番号すべてに○印をつけて下さい。

1. 石油ストーブ（対流式または反射式）
2. ガスストーブ
3. 電気ストーブ
4. 石油温風（ファン）ヒーター
5. 煙突付石油ストーブ（ＦＶ式半密閉型石油ストーブ）
6. ＦＦ式石油温風暖房器
7. 石炭（まき）ストーブ
8. 電気ごたつ
9. 電気カーペット
10. 練炭ごたつ
11. その他

3. お宅の便所は屋内・屋外のどちらにありますか。該当する番号に○印をつけて下さい。なお、便所が複数の場合は、家族がもっともひんぱんに使う便所で答えて下さい。

1. 屋内（スリッパのまま）
2. 屋内（下足にはきかえる）
3. 屋外

4. 寒い時期に、その便所に暖房器具／設備はありますか。

1. ある［具体的に：（**例えば、**便座暖房）　］
2. ない

5. 寒い時期に、あなたの寝室に暖房器具／設備はありますか（電気毛布も含む）。

1. ある［具体的に：　］
2. ない

仕事についておたずねします

6. 該当する番号すべてに○印をつけて下さい。

1. 常勤またはパートで収入になる仕事をしている
2. 自営業（農業・漁業・商業・その他）
3. 家業（農業や店の仕事など）の手伝いをしている
4. 主婦である
5. 無職

6a. あなたが実際に従事している主な仕事の内容を具体的に書いて下さい。
（**例えば**、米作り、まぐろ船機関士、農協事務、トラックの運転など）

（　　）

6b. あなたは、出稼ぎとか遠洋漁業などで、自宅を留守にする事がありますか。該当する番号に○印をつけて下さい。

1. ある ——→ 1年に平均して何カ月位自宅を留守にしますか。（　　）カ月位
2. ない

6c. あなたは、汗を流すような運動または労働をしてますか。該当する番号に○印をつけて下さい。

1. はい ——→ 1週間に何日位ですか。（　　）日位
2. いいえ

食生活についておたずねします

7. あなたはふだん次の食品をどの程度食べていますか．できるだけ近いものの番号に○印をつけて下さい。

(1) ごはん

1. 一日に3回　2. 一日に2回　3. 一日に1回　4. 全く食べない

(2) つけもの

1. 一日に3回　2. 一日に2回　3. 一日に1回　4. 全く食べない

(3) みそ汁（お吸い物も含む）

1. 一日に3回　2. 一日に2回　3. 一日に1回　4. 全く飲まない

(4) 鮮魚

1. ほとんど毎日　2. 二日に1回位　3. 週に1・2回　4. ほとんど食べない

(5) 肉（牛肉、豚肉、鳥肉、鯨肉など）

1. ほとんど毎日　2. 二日に1回位　3. 週に1・2回　4. ほとんど食べない

(6) 卵（鳥卵、うずら卵など）

1. ほとんど毎日　2. 二日に1回位　3. 週に1・2回　4. ほとんど食べない

(7) 牛乳、乳製品（チーズ、ヨーグルトなど）

1. ほとんど毎日　2. 二日に1回位　3. 週に1・2回　4. ほとんど飲まない（食べない）

睡眠、健康についておたずねします

8. あなたは、平均して1日どれ位睡眠をとりますか。

寝る時刻　（　　）時頃
起きる時刻　（　　）時頃

9. あなたは、健康に気をつけていることがありますか。該当する番号に○印をつけて下さい。

1. ある ⟶
2. ない

具体的には、どんなことをなさっていますか。該当する番号すべてに○印をつけて下さい。

1. 塩からい物をできるだけ食べないようにしている
2. 酒類はできるだけひかえるように気をつけている
3. 冬はなるべく暖かく暮すように、寒いめにあわないように気をつけている
4. 夜は早めに寝たり、昼寝をしたりしてつとめて休養をとっている
5. おこったり、興奮しない様にしている
6. 自分の血圧に注意して、時々血圧を測っている
7. 適度な運動をしている
8. その他

10. あなたはふだん、血圧はどのようですか。該当する番号に○印をして下さい。

1. 高い　2. やや高い　3. 正常　4. 低い　5. 不明

11. あなたは、高血圧の治療をうけていますか。

1. はい　2. いいえ

12. あなたはいままでに、医師に脳卒中と云われた事がありますか。

1. ある　2. ない

13. あなたはいままでに、医師に糖尿病と云われた事がありますか。

1. ある　2. ない

14. あなたはいままでに、医師に心臓病と云われた事がありますか。

1. ある　2. ない

御協力　ありがとうございました

早速同封の返送用封筒に入れ、送付方お願いします。

（切手を貼る必要はございません）

9月15日 までにご投函ください。

English Version

QUESTIONS	ANSWERS
1. Time of housing construction:	1. before the war 2. 1945-1974 3. since 1975 4. don't know
2. Types of heating apparatus used during winter:	
2-1 oilstove	1. used 2. unused
2-2 gas stove	1. used 2. unused
2-3 electric stove	1. used 2. unused
2-4 gas/oil fan heater	1. used 2. unused
2-5 charcoal/firewood stove	1. used 2. unused
2-6 electric/charcoal kotatsu	1. used 2. unused
2-7 electric carpet	1. used 2. unused
2-8 central heating	1. used 2. unused
3. Site of the toilet:	1. indoor (unnecesssary to use footgear) 2. indoor (necessary to use footgear) 3. outdoor
4. Whether heating apparatus used in the toilet during a cold period:	1. yes 2. no
4a. If yes, types of heating apparatus used in the toilet:	
1. toilet seat with heating	1. used 2. unused
2. electric heaters such as electric stove	1. used 2. unused
3. oil fan heater/central heating	1. used 2. unused
5. Whether heating apparatus used in the respondent's bedroom during a cold period	1. yes 2. no
5a. If yes, types of heating apparatus used in the respondent's bedroom during a cold period:	
1. electric blanket/electric foot warmer/hot water foot warmer	1. used 2. unused
2. electric heaters such as electric stove	1. used 2. unused
3. oilstove/gas stove/gas & oil fan heater/central heating	1. used 2. unused
4. electric kotatsu	1. used 2. unused
5. electric carpet	1. used 2. unused

6. Employment status:	
6-1 earn money by full-time/part-time	1. yes 2. no
6-2 self-employed	1. yes 2. no
6-3 assist family occupation	1. yes 2. no
6-4 housewife	1. yes 2. no
6-5 unemployed	1. yes 2. no
6a. Major work:	
1. professional/technical work	1. yes 2. no
2. administrative work	1. yes 2. no
3. secretarial work	1. yes 2. no
4. sales work	1. yes 2. no
5. agricultural/forestry work	1. yes 2. no
6. fishery work	1. yes 2. no
7. mining work	1. yes 2. no
8. transportation/correspondence work	1. yes 2. no
9. skilled labor/manufacturing work/ physical labor	1. yes 2. no
10. security work	1. yes 2. no
11. service work	1. yes 2. no
6b. Absent from home due to dekaseqi (circular migration) or deep-sea fishery:	1. yes 2. no
1. if yes, how many months?	1. 1-3 months 2. 4-6 months 3. 7-9 months 4. 10-12 months
6c. Exercise or work to make you perspire:	1. yes 2. no
1. if yes, how many days per week?	1. 1-2 days 2. 3-4 days 3. 5-6 days 4. 7 days
7. Eating habits of the following food items:	
7-1 rice	1. three times a day 2. twice a day 3. once a day 4. hardly any or not at all
7-2 pickled vegetables	1. three times a day 2. twice a day 3. once a day 4. hardly any or not at all
7-3 miso soup	1. three times a day 2. twice a day 3. once a day 4. hardly any or not at all

7-4	fresh fish	1. almost every day 2. once per two days 3. once/twice a week 4. hardly any
7-5	meat	1. almost every day 2. once per two days 3. once/twice a week 4. hardly any
7-6	eggs	1. almost every day 2. once per two days 3. once/twice a week 4. hardly any
7-7	milk and milk products	1. almost every day 2. once per two days 3. once/twice a week 4. hardly any
8.	Average sleeping hours a day:	1. 3-6 hrs. 2. 7-9 hrs. 3. 10-15 hrs.
9.	Attempt to maintain health:	1. yes 2. no
9a.	if yes, how?	
	1. avoid salty foods	1. yes 2. no
	2. restrain drinking alcohol as much as possible	1. yes 2. no
	3. prevent from coldness	1. yes 2. no
	4. take a rest	1. yes 2. no
	5. keep temper	1. yes 2. no
	6. care about blood pressure	1. yes 2. no
	7. take exercise	1. yes 2. no
	8. others	1. yes 2. no
10.	Level of usual blood pressure:	1. high 2. somewhat high 3. normal 4. low
11.	Treatment for hypertension:	1. yes 2. no
12.	History of stroke:	1. yes 2. no
13.	History of diabetes:	1. yes 2. no
14.	History of heart disease:	1. yes 2. no

APPENDIX B

ILLUSTRATION OF TABLE 3.7

1. The table of diet is illustrated as follows:

Frequency of traditional food items (rice, pickled vegetables and miso soup)

1: once a day
2: twice a day
3: three times a day

often

1. one of the three items eaten once a day

2. two of the three items eaten once a day or
   one of the three items eaten twice a day

3. three items eaten once a day or
   one of the three items eaten once a day and another eaten twice a day or
   one of the three items eaten three times a day

4. one of the three items eaten twice a day and the other two eaten once a day or
   one of the three items eaten once a day and one of the other two eaten once a day or
   two of the three items eaten twice a day

5. one of the three items eaten three times a day and the other two eaten once a day or
   two of the three items eaten twice a day and the other eaten once a day

6. one of the three items eaten three times a day, another eaten twice a day and the other eaten once a day
   two items eaten three times a day or
   all the three items eaten twice a day

less often

7. two of the three items eaten three times a day and the other eaten once a day
   one of the three items eaten three times a day and the other two eaten twice a day

8. two of the three items eaten three times a day and the other eaten twice a day

9. all the three items eaten three times a day

Major protein rich food items (fresh fish and meat) and protein rich food items (eggs and dairy products)

0: hardly any
1: once/twice a week
2: three times a week
3: almost every day

seldom

0. two items hardly eaten

usual

1. one of the two items eaten once/twice a week

2. two items eaten once/twice a week or
one of the two eaten three times a week

3. one of the two items eaten almost every day or
one of the two eaten three times a week and the other eaten once/twice a week

always

4. two items eaten three times a week or
one item eaten once/twice a week and the other eaten almost every day

5. one item eaten almost every day and the other eaten three times a week

6. two items eaten almost every day

2. The table of health concerns is illustrated as follows:

Some attempts to avoid stroke

1. avoid salty foods
1. limit alcohol
1. stay warm
1. take a rest
1. avoid losing temper
1. care about the blood pressure

APPENDIX C

ESTIMATION OF THE RELATIVE RISK BY COMPUTING THE ODDS RATIO IN A MATCHED ANALYSIS WITH ONE CONTROL PER CASE

"The correct analysis of a properly matched study retains the pairing of cases and controls. To begin, suppose that one has matched a single control to each case, and that the exposure under study is dichotomous. Denoting the presence or absence of exposure by + or - respectively, the four possible outcomes for each pair (case, control) are: (+ +), (+ -), (- +) and (- -). The table below shows the data layout for the analysis. The term A denotes the number of pairs (+ +) in which both the case and the control were exposed to the study factor. The term B denotes the number of pairs (+ -) in which only the case was exposed, and so forth. The marginal totals A + B and C + D represent respectively the numbers of exposed and unexposed cases, whereas the marginal totals A + C and B + D represent the corresponding numbers of exposed and unexposed controls. The term N denotes the total number of pairs, so that the total number of cases and controls is 2N" (Schlesselman 1982:207).

Frequency of Exposure
Among N Case-Control Pairs*

		Control		
		+	-	Total
Case	+	A	B	A + B
	-	C	D	C + D
Total		A + C	B + D	N

*Exposed (+), non-exposed (-)

"In a comparison of the proportion of exposed cases (A + B)/N versus the proportion of exposed controls (A + C)/N, the case-control difference is simply (B - C)/N. Thus, information regarding differential exposure to a study factor is revealed by the discordant pairs. McNemar (1947) proposed that inference regarding the difference in proportions derived from matched pairs be made solely on the basis of B and C. This conditional form of statistical inference has also been proposed for estimation of the odds ratio. (See Cox 1958, 1970 for the theoretical rationale.) The maximum likelihood estimate of the odds

ratio, conditional on the number of discordant pairs B + C, is given by Kraus 1960; also see Cox 1958):

$$\hat{\chi} = B/C.$$

Basing the analysis of a pair-matched study solely on discordant pairs can be further explained intuitively. A study factor can distinguish pair members only if they differ on it. For example, suppose that a case-control study of thromboembolic disease and oral contraceptive use were carried out in three areas: area A, where no women take the pill, area B, where some do and some do not, and area C, where all do. Area B is obviously the only one that can contribute to our knowledge of whether taking oral contraceptives alters the risk of thromboembolic disease, since within areas A and C the cases and controls are perfectly matched on exposure (Pike and Morrow 1970).

Interestingly, the Mantel-Haenszel combined estimate of the odds ratio ($\hat{\chi}_{mh}$) computed over the N subgroups defined by the case-control pairs gives precisely the estimate above. To see this, consider each pair as a subgroup with a corresponding 2 X 2 table, as in the table on page 170. In this situation, the frequencies a_i, b_i, c_i, and d_i can only take the values 1 or 0, and n = 2. A simple check on the computation of $\hat{\chi}_{mh}$ from equation

$$\hat{\chi}_{mh} = \sum_{i=1}^{K} (A_i\ d_i/N_i) / \sum_{i=1}^{K} (b_i C_i/N_i)$$

shows that $\hat{\chi}_{mh} = B/C$ (Mantel and Haenszel 1959). The consideration of each pair as a separate subgroup has a useful application to the logistic analysis of paired data, and to the analysis of matched studies with multiple or variable numbers of controls per case" (Schlesselman 1982:207-208.

Frequency of Exposure Among Cases and Controls in the i-th Subgroup

	Cases	Controls	Total
Exposure:			
Yes	a_i	b_i	m_{1i}
No	c_i	d_i	m_{2i}
Total	n_{1i}	n_{2i}	n_i

APPENDIX D

RELATIVE RISK AND CHI SQUARE TEST OF SIGNIFICANCE FOR ALL FACTORS EXAMINED IN CHAPTER V ("INDIVIDUAL BEHAVIORAL PATTERNS")

Factor	Relative Risk		
	Shiwahime	Karakuwa	Total
Occupation several years before death for cases and at present for controls:			
professional/technical work	n.a.	1.00	2.00
administrative work	n.a.	0.67	0.67
secretarial work	n.a.	n.a.	n.a.
sales work	n.a.	1.00	0.50
agricultural/forestry work	0.33	0.60	0.41
fishery work	n.a.	1.50	1.50
mining work	n.a.	n.a.	n.a.
transportation/correspondence work	n.a.	1.00	1.00
skilled labor/manufacturing work/ physical labor	1.00	0.50	0.67
security work	n.a.	n.a.	n.a.
service work	n.a.	n.a.	n.a.
Seasonal migration/deep-sea fishing before death for cases and at present for controls	n.a.	n.a.	n.a.
Hard work/exercise	1.33	1.60	1.50
Hard work/exercise more than 3 days	1.33	1.40	1.38
Occupation when younger (30's-50's years old)			
professional/technical work	n.a.	1.00	2.00
administrative work	n.a.	0.67	0.67
secretarial work	n.a.	1.00	1.00
sales work	n.a.	n.a.	n.a.
agricultural/forestry work	0.67	1.40	1.00
fishery work	n.a.	1.20	1.20
mining work	n.a.	1.00	0.50
transportation/correspondence work	n.a.	n.a.	n.a.

Factor	Relative Risk		
	Shiwahime	Karakuwa	Total
skilled labor/manufacturing work/ physical labor	1.00	0.29	0.44
security work	n.a.	n.a.	n.a.
service work	n.a.	n.a.	n.a.
Seasonal migration/deep-sea fishing when younger	0.80	1.25	1.00
Hard work/exercise when younger	2.40	0.86	1.50
Hard work/exercise more than 3 days when younger	2.75	0.75	1.42
Frequency of traditional food vs. modern food			
rice than bread	n.a.	n.a.	n.a.
pickled vegetables than salad	3.33	1.29	1.90
miso soup than western style soup	n.a.	n.a.	n.a.
Japanese stew than western style stew, and curry	0.50	0.17	0.33
process fish than fresh fish	2.00	1.00	1.50
process meat than fresh meat	2.00	2.00	2.00
boiled greens with dressing than fried vegetables	1.20	2.50	1.78
green tea than black tea or coffee	n.a.	5.00	8.00*
Japanese sweets than cake or pastry	0.75	2.00	1.38
cooked vegetables than uncooked vegetables	2.50	0.67	1.00
Preference for traditional food vs. modern food			
rice than bread	n.a.	0.33	0.33
pickled vegetables than salad	1.43	2.50	1.82
miso soup than western style soup	n.a.	1.00	1.00
Japanese stew than western stew and curry	1.50	0.60	1.09
process fish than fresh fish	n.a.	n.a.	1.00
process meat than fresh meat	3.00	1.33	1.75
boiled vegetables with dressing than fried vegetables	2.75	2.00	2.33*
green tea than black tea or coffee	n.a.	3.00	4.00
Japanese sweets than cake or pastry	1.20	1.00	1.10
cooked vegetables than uncooked vegetables	n.a.	2.67	4.00*

Factor	Relative Risk		
	Shiwahime	Karakuwa	Total
No regular blood pressure check-up	15.00**	n.a.	21.00**
No physical examination or check-up on circulatory system	2.00	n.a.	2.17
Fondness for alcohol	1.17	1.25	1.20
Alcohol consumption			
average consumption or as much as one likes vs. drinks with caution or hardly any	7.00	1.50	2.60
average consumption or as much as one likes vs. drinks with caution	3.00	0.75	1.20
drinks with caution vs. hardly any	1.25	0.20	0.67
Fondness for salty food	2.60	5.00**	3.50**
Salty food consumption			
average consumption or as much as one likes vs. eats with caution or hardly any	3.00	3.67	3.33*
average consumption or as much as one likes vs. eats with caution	3.50	3.33	3.40*
eats salty food with caution vs. hardly any	n.a.	1.00	2.50
Familial association with			
stroke	3.50*	1.57	2.27*
diabetes	n.a.	1.00	5.00
heart disease	2.00	1.33	1.67

n.a. = not applicable (a zero in the numerator or the denominator in the relative risk computation)

*Significant at the 0.05 level, chi square with 1 d.f.
**Significant at the 0.01 level, chi square with 1 d.f.

APPENDIX E

RELATIVE RISK OF EXPOSURE CATEGORIES AND CHI SQUARE TEST OF SIGNIFICANCE FOR ALL FACTORS EXAMINED IN CHAPTER V ("INDOOR THERMAL ENVIRONMENT")

Factor	Relative Risk		
	Shiwahime	Karakuwa	Total
Housing construction period:			
prewar vs. postwar	0.75	1.50	1.07
prewar vs. 1945-1974	0.38	1.00	0.64
1945-1974 vs. 1975-1986	1.00	1.67	1.29
Housing not remodelled after construction	0.60	1.00	0.73
No thermal insulation	2.00	0.86	1.20
Space of living room:			
8 jo and over vs. 7 jo and less	0.63	0.57	0.60
6-7 jo vs. 5 jo and less	n.a.	n.a.	n.a.
8-9 jo vs. 6-7 jo	0.67	1.00	0.75
10 jo and more vs. 8-9 jo	0.20*	0.60	0.33*
No curtains	9.00*	0.50	1.71
No shutter	0.60	2.00	1.23
Living room not sun-lit	0.75	2.00	1.23
Floor component of living room:			
straw mat vs. straw mat and carpet/wooden floor and carpet	1.50	1.14	1.27
Perception of drafts:			
feels vs. hardly feels	0.73	0.50	0.61
feels all the time vs. feels when wind blows	n.a.	n.a.	n.a.
feels when wind blows vs. hardly feels	0.70	0.50	0.59

Factor	Relative Risk		
	Shiwahime	Karakuwa	Total
Site of toilet:			
outdoor vs. indoor	1.17	1.00	1.08
outdoor vs. indoor (footgear necessary)	n.a.	2.00	1.00
indoor (footgear necessary) vs. indoor (footgear unnecessary)	n.a.	0.67	0.40
Toilet			
Japanese style vs. western style	0.67	1.50	1.00
no flush toilet	n.a.	0.75	1.50
no heating devices	1.00	0.67	0.75
Toilet heating types:			
no toilet seat with heating	1.00	2.00	1.33
no effective heating devices	n.a.	0.40	0.40
Living room heating start period:			
middle and late October vs. late September-early October	1.20	3.00	1.71
early November-early December vs. late September-early October	0.20	0.33	0.27
Living room heating end period:			
early March-late March vs. early April-late April	1.00	4.00	1.75
early April-late April vs. early May-	4.50	1.00	2.00
Living room heating types:			
no fan heater	1.67	1.00	1.36
no oil/gas stove	0.50	1.00	0.72
no foot heater	1.33	6.00	2.50
no electric stove/electric carpet	n.a.	0.67	0.67
foot heater only vs. other heating devices	n.a.	n.a.	n.a.
other heating devices vs. foot heater and other heating devices	1.14	1.14	1.14
Bedroom heating types:			
no fan heater	n.a.	1.00	0.33
no oil/gas stove	n.a.	n.a.	n.a.
no electric stove/electric carpet	n.a.	n.a.	3.00

Factor	Relative Risk		
	Shiwahime	Karakuwa	Total
no electric heater	n.a.	1.00	1.50
no electric blanket/foot warmer	1.14	1.33	1.23
No bedroom heating devices in the morning	n.a.	3.00	0.75
No heating devices other than in living room and bedroom	1.13	1.00	1.07
No concern about room temperature	0.56	0.64	0.60
Concern about room temperature:			
no concern vs. once a day	0.75	0.33	0.50
once a day vs. twice or three times a day	0.22	1.00	0.36
Thermal sensation:			
feels cold in living room	1.00	n.a.	2.00
feels cold in bedroom	0.89	3.33	1.50
feels cold in toilet	5.00	3.50	4.00*

n.a. = not applicable (a zero in the numerator or the denominator in the relative risk computation)

*Significant at the 5% level, chi square with 1 d.f.

BIBLIOGRAPHY

In English

Abbott, R. D.; Yin, Y.; Reed, D. M.; and Yano, K. 1986. Risk of stroke in male cigarette smokers. New England Journal of Medicine 315:712-720.

Akinkugbe, O. O. 1976. Epidemiology of hypertension and stroke in Africa. In Hypertension and stroke control in the community, S. Hatano, I. Shigematsu, and T. Strasser, eds., pp. 28-42. Geneva: World Health Organization.

Alter, M.; Christoferson, L.; Resch, J.; Myers, G.; and Ford, J. 1970. Cerebrovascular disease: Frequency and population selectivity in an upper Midwestern community. Stroke 1:454-465.

Armstrong, R. W. 1976. The geography of specific environments of patients and non-patients in cancer studies, with a Malaysian example. Economic Geography 52:161-170.

Baker, A. B. and Katsuki, S. 1969. Stroke: U.S. and Japan--Summary and conclusion. Geriatrics 24:124-132.

Bengtsson, C.; Hallstrom, T.; and Tibblin, G. 1973. Social factors, stress experience and personality traits in women with ischaemic heart disease, compared to a population sample of women. Acta Medica Scandinavica (Suppl.) 549:82-92.

Bokonjic, R. and Zec, N. 1968. Strokes and the weather--A quantitative statistical study. Journal of the Neurological Sciences 6:483-491.

Brackenridge, C. J. 1981. Daily variation and other factors affecting the occurrence of cerebrovascular accidents. Journal of Gerontology 36:176-179.

Breslow, N. E. and Day, N. E. 1980. Statistical methods in cancer research. Lyon: WHO International Agency for Research on Cancer.

Breslow, N. E.; Day, N. E.; Halvorsen, K. T.; Prentice, R. L.; and Sabai, C. 1978. Estimation of multiple relative risk functions in matched case-control studies. American Journal of Epidemiology 108:299-307.

Bull, G. M. 1973. Meteorological correlates with myocardial and cerebral infarction and respiratory disease. British Journal of Preventive and Social Medicine 27:108-113.

Cohen, J. and Cohen, P. 1975. Applied multiple regression/correlation analysis for the behavioral sciences. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Collins, K. J. 1986. Low indoor temperatures and morbidity in the elderly. Age and Ageing 15:212-220.

Dahl, L. K. 1960. Possible role of salt intake in the development of essential hypertension. In Essential hypertension, K. D. Bock and P. T. Cottier, eds., pp. 53-65. Berlin: Springer.

de Vise, P. 1973. Misused and misplaced hospitals and doctors: A locational analysis of the urban health care crisis. Commission on College Geography, Resource Paper No. 22. Washington, D.C.: Association of American Geographers.

Dever, G. E. A. 1984. Epidemiology in health services management. Rockville, Maryland: An Aspen Publication.

Dyken, M. L. 1970. Participating factors, prognosis and demography of cerebrovascular disease in an Indiana community: A review of all patients hospitalized from 1963 to 1965 with neurological examination of survivors. Stroke 1:261-269.

Epstein, L. and Zaaroor, M. 1982. Mortality from ischemic heart disease and cerebrovascular disease in Israel 1969-1978. Stroke 13:570-573.

Gertler, M. M.; Leetma, H. E.; and Koutrouby, R. J. 1975. The assessment of insulin, glucose and lipids in ischemic thrombotic cerebrovascular disease. Stroke 6:77-84.

Gertler, M. M.; Rush, H. A.; Whiter, H. H.; Leetma, H. E.; and Ehrenkranz, M. 1968. Ischemic cerebrovascular disease: The assessment of risk factors. Geriatrics 23:135-141.

Gill, J. S.; Zezulka, A. V.; Shipley, M. J.; Gill, S. K.; Beevers, D. G. 1986. Stroke and alcohol consumption. New England Journal of Medicine 315:1041-1046.

Gordon, T.; Sorlie, P.; and Kannel, W. B. 1971. Coronary heart disease, atherothrombotic brain infarction, intermittent claudication--A multivariate analysis of some factors related to their incidence: Framingham Study, 16 year follow-up. Washington, D.C.: U.S. Government Printing Office.

Gudmundsson, G. and Benedikz, J. E. G. 1977. Epidemiological investigation of cerebrovascular disease in Iceland, 1958-1968 (Ages 0-35 years)--A total population survey. Stroke 8:329-331.

Harrell, F. Jr. 1986. The logic procedure. In SUGI Supplemental Library User's Guide, Version 5, SAS Institute Inc., ed., pp. 269-293. Cary, NC: SAS Institute Inc.

Hatano, S.; Minowa, M.; Omura, T.; Nagai, M.; Fujita, T.; Takeuchi, K.; and Tsukamoto, M. 1984. Stroke mortality and proportional expenditure on selected food items in Japanese communities. Annals of Clinical Research 16 (Suppl. 43):163-169.

Haynes, S. G.; Feinleib, M.; and Kannel, W. B. 1980. The relationship of psychosocial factors to coronary heart disease in the Framingham Study III. Eight-year incidence of coronary heart disease. American Journal of Epidemiology 111:37-58.

Herman, B.; Schmitz, P. I. M.; Leyten, A. C. M.; Van Luijk, J. H.; Frenken, C. W. G. M.; Op De Coul, A. A. W.; and Schulte, B. P. M. 1983. Multivariate logistic analysis of risk factors for stroke in Tilburg, the Netherlands. American Journal of Epidemiology 118:514-525.

Hines, E. A. Jr. 1940. The significance of vascular hyperaction as measured by the cold-pressor test. American Heart Journal 19: 408-416.

Holford, T. R.; White, C.; and Kelsey, J. L. 1978. Multivariate analysis for matched case-control studies. American Journal of Epidemiology 107:245-255.

Hopps, H. C. 1964. Principles of pathology, 2nd ed. New York: Appleton-Century-Crofts.

Horibe, H. 1969. Cerebro- and cardiovascular diseases in a Japanese rural community, Akabane. Japanese Circulation Journal 33:1477-1481.

James, P. D. 1975. Cerebrovascular disease in Uganda. Tropical and Geographical Medicine 27:125-131.

Johnson, K. G.; Yano, K.; and Kato, H. 1967. Cerebral vascular disease in Hiroshima, Japan. Journal of Chronic Disease 20:545-559.

Kagan, A.; Popper, J. S.; and Rhoads, G. G. 1980. Factors related to stroke incidence in Hawaii Japanese men--The Honolulu Heart Study. Stroke 11:14-21.

Kagan, A.; Popper, J. S.; Rhoads, G. G.; and Kato, H. 1985. Dietary and other risk factors for stroke in Hawaiian Japanese men. Stroke 16:390-396.

Kannel, W. B.; Dawber, T. R.; and McNamara, P. M. 1965. Vascular disease of the brain--epidemiological aspects: The Framingham Study. American Journal of Public Health 55:1355-1366.

Kannel, W. B.; Gordon, T.; and Dawber, T. R. 1974. Role of lipids in the development of brain infarction: Framingham Study. Stroke 5:679-685.

Kent, T. H.; Hart, M. N.; and Shires, T. K. 1979. Introduction to human disease. New York: Appleton-Century-Crofts.

Khaw, K.-T and Barrett-Connor, E. 1986. Family history of stroke as an independent predictor of ischemic heart disease in men and stroke in women. American Journal of Epidemiology 123:59-66.

Khaw, K.-T. and Barrett-Connor, E. 1987. Dietary potassium and stroke-associated mortality--a 12-year prospective population study. The New England Journal of Medicine 316:235-240.

Kimura, N. 1973. A population survey on cerebrovascular and cardiovascular diseases in Kyushu, Japan. Singapore Medical Journal 14:230-233.

Kuller, L. H.; Cook, L. P.; and Friedman, G. D. 1972. Survey of stroke epidemiology studies. Stroke 3:579-585.

Kuller, L. H. and Reisler, D. M. 1971. An explanation for variations in distribution of stroke and arteriosclerotic heart disease among populations and racial groups. American Journal of Epidemiology 93:1-9.

Laporte, R. E.; Adams, L. L.; Savage, D. D.; Brenes, G.; Dearwater, S.; and Cook, T. 1984. The spectrum of physical activity, cardiovascular disease and health: An epidemiological perspective. American Journal of Epidemiology 120:507-517.

Lilienfeld, A. M.; Pedersen, E.; and Dowd, J. E. 1967. Cancer epidemiology: Methods of study. Baltimore: Johns Hopkins Press.

Marks, R. U. 1967. A review of empirical findings. Milbank Memorial Fund Quarterly 45 (April Part 2):51-108.

Mausner, J. and Bahn, A. K. 1974. Epidemiology. Philadelphia: W. B. Saunders Company.

McDowell, F. H.; Louis, S.; and Monahan, K. 1970. Seasonal variation of non-embolic cerebral infarction. Journal of Chronic Disease 23:29-32.

Meade, M. S.; Florin, J. W.; and Gesler, W. M. 1988. Medical geography. New York: The Guilford Press.

Melamed, E.; Cahane, E.; Carmon, A.; and Lavy, S. 1973. Stroke in Jerusalem District 1960 through 1967: An epidemiological study. Stroke 4:465-471.

Miller, B. F. and Keane, C. B. 1983. Encyclopedia and dictionary of medicine, nursing, and allied health, 3rd ed. Philadelphia: W. B. Saunders Co.

Mitsuyama, Y.; Thompson, L. R.; Hayashi, T.; Lee, K. K.; Keehn, R. J.; Resch, J. A.; and Steer, A. 1979. Autopsy study of cerebrovascular disease in Japanese men who lived in Hiroshima, Japan, and Honolulu, Hawaii. Stroke 10:389-395.

Miyawaki, N. and Chen S.-C. 1981. A statistical consideration on the mapping of mortality. Social Science and Medicine 15D:93-101.

Naruse, Y.; Kagamimori, S.; Watanabe, M.; Minowa, M.; and Iibuchi, Y. 1985. Mortality rates for farmers and fishermen in Japan compared with England and Wales. Social Science and Medicine 21:139-143.

Nesser, W.; Tyroler, H.; and Cassel, J. 1971. Social disorganization and stroke mortality in the Black population of North Carolina. American Journal of Epidemiology 93:166-175.

Netsky, M. G. and Miyagi, T. 1976. Prevalence of cerebral hemorrhage and thrombosis in Japan: Study of the major causes of death. Journal of Chronic Disease 29:711-721.

Nevins, R.; McNall Jr., P.E.; and Stolwijk, J. A. J. 1974. How to be comfortable at 65 to 68 degrees. Ashrae Journal (April):41-43.

Olivares, L.; Castaneda, E.; Grife, A.; and Alter, M. 1973. Risk factors in stroke: A clinical study in Mexican patients. Stroke 4:773-781.

Ostfeld, A. M.; Shekelle, R. B.; Klawans, H.; and Tufo, H. M. 1974. Epidemiology of stroke in an elderly welfare population. American Journal of Public Health 64:450-458.

Ostfeld, A. M. 1980. A review of stroke epidemiology. Epidemiologic Reviews 2:136-152.

Owada, K.; Tanaka, H.; Ueda, Y.; and Date, C. 1973. Epidemiology of cerebrovascular disease in Japan. Osaka City Medical Journal 19:37-49.

Phillips, R. L.; Lilienfeld, A. M.; Diamond, E. L.; and Kagan, A. 1974. Frequency of coronary heart disease and cerebrovascular accidents in patients and sons of coronary heart disease index cases and controls. American Journal of Epidemiology 100:87-100.

Ramirez-Lassepas, M.; Haus, E.; Lakatua, D. J.; Sackett, L.; and Swoyer, J. 1980. Seasonal (circannual) periodicity of spontaneous intracerebral hemorrhage in Minnesota. Annals of Neurology 8:539-541.

Rogers, R. L.; Meyer, J. S.; Shaw, T. G.; Mortel, K. F.; Hardenberg, J. P.; and Laid, R. R. 1983. Cigarette smoking decreases cerebral blood flow suggesting increased risk for stroke. Journal of the American Medical Association 250:2796-2800.

Rogot, E.; Fabsitz, R.; and Feinleib, M. 1976. Daily variation in USA mortality. American Journal of Epidemiology 103:198-211.

Rogot, E. and Padgett, S. 1976. Associations of coronary and stroke mortality with temperature and snowfall in selected areas of the United States, 1962-1966. American Journal of Epidemiology 103: 565-575.

Salonen, J. T.; Puska, P.; Tuomilehto, J.; Homan, K. 1982. Relations of blood pressure, serum lipids, and smoking to the risk of cerebral stroke. A longitudinal study in eastern Finland. Stroke 13:327-333.

Sato, T. 1983. Current trends and developments in medical geography. Unpublished ms. submitted to UH Geography course 691, History of Geographic Thought.

Schar, M.; Reeder, L. G.; and Dirken, J. M. 1973. Stress and cardiovascular health: An international cooperative study II. The male population of a factory at Zurich. Social Science and Medicine 7:585-604.

Schlesselman, J. J. 1982. Case control studies: Design, conduct, analysis. New York: Oxford University Press.

Sotaniemi, E.; Palva, E. P.; and Hakkarainen, H. 1972. Effect of environmental temperature on hospital admissions for cerebrovascular accidents. Annals of Clinical Research 4:233-235.

Syme, S. L. and Reeder, L. G. 1967. Social stress and cardiovascular disease. Milbank Memorial Fund Quarterly 45 (April Part 2): entire issue.

Szatrowski, T. P.; Peterson Jr., A. V.; Shimizu, Y.; Prentice, R. L.; Mason, M. W.; Fukunaga, Y.; and Kato, H. 1984. Serum cholesterol, other risk factors, and cardiovascular disease in a Japanese cohort. Journal of Chronic Disease 37:569-584.

Takahashi, E. 1981. Geographical distribution of cerebrovascular disease and environmental factors in Japan. Social Science and Medicine 15D:163-172.

Takeya, Y.; Popper, J. S.; Shimizu, Y.; Kato, H.; Rhoads, G. G.; and Kagan, A. 1984. Epidemiologic studies of coronary heart disease and stroke in Japanese men living in Japan, Hawaii and California: Incidence of stroke in Japan and Hawaii. Stroke 15:15-23.

Tanaka, H.; Hayashi, M.; Date, C.; Imai, K.; Asada, M.; Shoji, H.; Okazaki, K.; Yamamoto, H.; Yoshikawa, K.; Shimada, T.; and Lee, S. I. 1985. Epidemiologic studies of stroke in Shibata, a Japanese provincial city: Preliminary report on risk factors for cerebral infarction. Stroke 16:773-780.

Tanaka, H.; Ueda, Y.; Hayashi, M.; Date, C.; Baba, T.; Yamashita, H.; Shoji, H.; Tanaka, Y.; Owada, K.; and Detels, R. 1982. Risk factors for cerebral hemorrhage and cerebral infarction in a Japanese rural community. Stroke 13:62-72.

Tanaka, H.; Ueda, Y.; Date, C.; Baba, T.; Masada, K.; and Owada, K. 1975. Multivariate analysis of stroke risk factors in Japanese rural districts. Osaka City Medical Journal 21:149-153.

Tanaka, H.; Ueda, Y.; Tanaka, Y.; Date, C.; Baba, T.; Hayashi, M.; Horimoto, T.; Okazaki, K.; Yoshikawa, K.; Yamamoto, H.; Shimada, T.; and Owada, K. 1981. Supplemental study on incidence of stroke in Shibata, 1976 through 1978: The Shibata Stroke Study. Osaka City Medical Journal 27:117-133.

Trewartha, G. T. 1960. Japan, a physical, cultural and regional geography. Madison: University of Wisconsin Press.

Ueshima, H.; Ohsaka, T.; and Asakura, S. 1986. Regional differences in stroke mortality and alcohol consumption in Japan. Stroke 17:19-24.

Vitaliano, P. P. 1978. The use of logistic regression for modelling risk factors: With application to non-melanoma skin cancer. American Journal of Epidemiology 108:402-414.

Walsh, A. 1987. Teaching understanding and interpretation of logit regression. Teaching Sociology 15:178-183.

Whisnant, J. P. 1974. Epidemiology of stroke: Emphasis on transient cerebral ischemic attacks and hypertension. Stroke 5:68-70.

Whisnant, J. P. 1984. The decline of stroke. Stroke 15:161-168.

Whisnant, J. P.; Fitzgibbons, J.; Kurland, L. T.; and Sayre, G. P. 1971. Natural history of stroke in Rochester, Minnesota, 1945 through 1954. Stroke 2:11-22.

World Health Organization. 1975. Manual of the international statistical classification of diseases, injuries, and causes of death: Based on the recommendations of the Ninth Revision Conference, 1975, and adapted by the Twenty-Ninth World Health Assembly. Geneva: World Health Organization.

Zbrozyna, A. W. and Krebbel, F. 1985. Habituation of the cold pressor response in normo- and hypertensive human subjects. European Journal of Applied Physiology 54:136-144.

In Japanese

Translated into English by T. Sato (author)

Aoki, N.; Horibe, H.; Ohno, Y.; Hayakawa, S.; and Okada, H. 1977. Epidemiological evaluation of funduscopic findings as a risk factor of cerebrovascular diseases. Japanese Journal of Public Health 24:483-488.

Aoki, N.; Horibe, H.; and Kasaji, H. 1985. Mortality trends in stroke and ischaemic heart disease of the global level between 1958-1978. Japanese Journal of Public Health 32:36-44.

Aoki, N.; Horibe, H.; Ohno, Y.; Sasaki, R.; Aoki, K.; Kato, T.; and Okada, H. 1982. The geographical distribution and socioeconomic factors in stroke and cardiovascular deaths in Aichi, Japan. Japanese Journal of Public Health 29:172-179.

Aono, T. and Birukawa, S., eds. 1979. Regional geography of Japan 4. Tokyo: Ninomiya Shoten.

Fukuzawa, Y.; Kishimoto, T.; Tada, M.; Yanagawa, H.; and Hashimoto, T. 1984. Registration of stroke cases and health examination of cardiovascular disease by local governments. Japanese Journal of Public Health 31:347-355.

Goto, A.; Yokoyama, H.; Hashimoto, T.; Yanagawa, H.; Kikuchi, H.; and Nishimura, T. 1980. Relationship between salt intake from miso soup and mortality from cerebrovascular disease--a comparison between villages of Tochigi Prefecture and Fukui Prefecture. Japanese Journal of Public Health 27:431-440.

Hasegawa, F.; Yoshino, H.; and Akabayashi, S. 1983. Study of indoor thermal environment of detached wooden houses in city areas of Tohoku district in winter. Proceedings of Association of Japanese Architecture 326:91-101.

Hasegawa, F.; Yoshino, H.; Arai, H.; Iwasaki, K.; Akabayashi, S.; and Kikuta, M. 1985. Study of the relationship between cerebral vascular accident and housing indoor thermal environment in winter. Japanese Journal of Public Health 32:181-193.

Health and Welfare Statistics Association. 1987. Trend of national hygiene. Tokyo: Health and Welfare Statistics Association.

Iida, M.; Konishi, M.; Nakanishi, N.; Naito, Y.; Terao, A.; Nakamura, M.; Komachi, Y.; Shimamoto, T.; Inada, H.; Doi, M.; Iso, H.; Fukuuchi, K.; Kojima, S.; and Funaki, S. 1987. Changes of risk factors for cerebrovascular diseases in Akita farmers--especially in regard to change of total serum cholesterol level and dietary intake for twenty years. Japanese Journal of Public Health 33:213-222.

Iso, H. 1986. Study on evaluation of a community-based long-term program for prevention of stroke--comparison between the two communities with and without long-term program. Japanese Journal of Public Health 33:153-161.

Japan. Department of Health Care, Ministry of Health and Welfare. 1984. Nutrition requirements for the Japanese. Tokyo.

Japan. Department of Statistical Information, Ministry of Agriculture, Forestry and Fishery. 1987. Pocket statistics of agriculture, forestry and fishery. Tokyo.

Japan. Management and Coordination Agency, Statistics Bureau. 1986. 1985 Census preliminary report. Tokyo.

Japan. Management and Coordination Agency, Statistics Bureau. 1987. 1985 population census of Japan, vol. 3--results of the second basic complete tabulation. Tokyo.

Kagami, M. 1983. Regional patterns of cerebrovascular disease mortality in Japan. Geographical Review of Japan 56:311-323.

Karakuwa. Health Branch, Karakuwa Town Administration. 1986. 1985 Health Statistics. Karakuwa (unpublished record).

Katayama, K. 1972. A biometeorological study in the seasonal variation of stroke mortality and its relation with temperature in Japan. Japanese Journal of Public Health 19:15-23.

Katayama, K. 1973. A biometeorological study in the seasonal variation of mortality from cerebral hemorrhage and cerebral thrombosis and embolism. Japanese Journal of Public Health 20:609-617.

Kimura, K.; Isoda, A.; and Adachi, M. 1983. Food-ecological study on the modernization of diet in relation to dental health. Proceedings of Japanese Association of Nutrition and Food 37:103.

Kimura, T.; Nakayama, Y.; and Tashiro, H. 1976. The 15 years follow-up population survey on cerebrovascular disease in rural Kyushu, Japan. Japanese Journal of Internal Medicine 65:1357-1360.

Kodansha. 1975. Dictionary of home cooking of side dishes, 2nd ed. Tokyo: Kodansha.

Kojima, S. 1966. Distinctive features of cerebral apoplexy seen around Akita District. Japanese Journal of Public Health 13:907-923.

Kojima, S. 1976. Nutrition survey. In Nutrition status of the Japanese and cardiovascular disease, R. Kamoya, Y. Komachi and T. Watanabe, eds., pp. 215-230. Tokyo: Hoken Dojin Co.

Komachi, Y.; Iida, N.; Ozawa, H. et al. 1975. Interrelationship of food and stroke in Japan. Annual Report of Center for Adult Disease 15:82-98.

Komachi, Y.; Ozawa, H.; Iida, M. et al. 1977. Epidemiology of stroke. Current Medicine 9:545-552.

Komachi, Y. and Shimamoto, A. 1976. Problems of epidemiological studies. Japanese Clinic 34:18-24.

Konishi, M. 1974. Epidemiological studies of cerebrovascular diseases with special reference to the pathological findings on stroke in Akita District. Japanese Journal of Public Health 21:485-500.

Konishi, M.; Iida, M.; Nakanishi, N.; Naito, Y.; Terao, A.; Isomura, K.; Ii, M.; Itou, M.; Irino, T.; Miyake, K.; Kuno, K.; Shimamoto, T.; Iso, H.; and Komachi, Y. 1986. The epidemiological study on the factors responsible for stroke classified with CT findings. Japanese Journal of Public Health 33:97-103.

Kumagai, H. 1981. A study on the causes and prevention of cerebral apoplexy in Akita Prefecture. Japanese Journal of Public Health 28:370-383.

Matsuda, M. 1976. Considerations of mortality survey on group examination participants for circulatory diseases. Journal of Public Health Practice 40:654-660.

Miyagi. Department of Health Environment, Miyagi Prefecture Administration. 1987. 1985 Annual report of hygienic statistics. Sendai.

Miyagi. Department of Health Environment, Miyagi Prefecture Administration. 1987. 1985 Project report. Sendai.

Mizuno, M. 1987. Warning of overconsumption of fish meat on the basis of epidemiological studies. Life and Health 9:85.

Momiyama, M. 1982. Medico-geographical factors of cerebrovascular disease. Pathological Physiology 1:283-289.

Nagata, H. 1979. Death rates in 44 communities in Kyoto Prefecture and their social environments. Japanese Journal of Public Health 26:419-424.

Nishida, T. 1974. An epidemiological study of cerebro-vascular diseases--10 years follow-up data in Shirasu-Cho, Yamanashi, Japan. Japanese Journal of the Association of Medicine for the Old 11:382-392.

Nojiri, M.; Nakano, M.; Arai, H.; and Awasawa, Y. 1985. Changes in nutrition intake of the inhabitants living in the fishing villages of Nishiizu District. Japanese Journal of Public Health 32:694-697.

Owada, K.; Tanaka, H.; Ueda, Y.; Date, C.; and Tsue, Y. 1974. A study of causes of cerebrovascular diseases and ischemic heart diseases in Japanese. Japanese Journal of Public Health 21:425-433.

Ozawa, H. 1968. Geographical variations in mortality from cerebrovascular diseases and previous dietary habits. Japanese Journal of Public Health 15:551-566.

Ozawa, H.; Iida, M.; Shimamoto, A.; Ueshima, H.; Tanigaki, M.; and Komachi, Y. 1978. Health guidance on stroke prevention. Journal of Public Health Practice 42:76-83.

Research Committee on Geographical Distribution of Disease. 1981. National atlas of major disease mortalities for cities, towns and villages in Japan--all causes of death, cancer, cardiovascular diseases, diabetes mellitus, liver cirrhosis and tuberculosis--1968-1978. Tokyo: Japan Health Promotion Foundation.

Sasaki, N. 1977. Characteristics of stroke in Japanese--from an epidemiological point of view. Japanese Journal of the Association of Medicine for the Old 14:365-370.

Shiwahime. Health Branch, Shiwahime Town Administration. 1983. Report of dietary life of town people. Shiwahime.

Shiwahime. Health Branch, Shiwahime Town Administration. 1986. 1985 Health statistics. Shiwahime (unpublished record).

Shufu no Tomo. 1987. Daily side dishes 1000. Tokyo: Shufu no Tomo Co.

Takahashi, E. 1969. Food, clothing and shelter in a village of the Tohoku (North-Eastern) region of Japan and cerebrovascular disease control. Journal of Public Health Practice 33:131-135.

Takemori, K.; Nihira, S.; Mikami, S.; Sasaki, N.; and Ohtaka, M. 1987. Relation of intake of sodium and potassium with blood pressure in Amori Prefecture, Japan. Ethnological Hygiene 53:140-153.

Tanaka, H.; Date, C.; Ueda, Y.; Baba, T.; Hayashi, M.; and Owada, K. 1977. Cross-sectional study of stroke and nutrition. Journal of Public Health Practice 41:641-647.

Tanigaki, M. 1986. Effects and problems of the stroke prevention program at Noichi Town in Kochi Prefecture. Japanese Journal of Public Health 33:665-677.

Ueda, Y.; Tanaka, H.; Date, C.; Baba, A.; Hayashi, M.; Yamashita, H.; and Owada, K. 1978. Secular change in levels of blood pressure and causes of cerebrovascular disease. Journal of Public Health Practice 42:729-735.

Ueshima, H.; Tatara, K.; and Asakura, S. 1984. Mortality trends in stroke, blood pressure, and the treatment rate of hypertension between 1956 and 1980 in Japan. Japanese Journal of Public Health 31:589-599.

Yamori, S.; Horie, R.; Sato, M.; and Fukase, M. 1976. Stroke-prone SHR--a study of the cause and prevention of stroke, using stroke model animals. Japanese Pathology 34:25-34.

Yanagawa, H.; Hashimoto, T.; Fukutomi, K.; Kawaguchi, T.; Takeuchi, K.; and Shigematsu, I. 1976. A statistical analysis of geographical differences in the mortality rates from cerebrovascular diseases, ischemic heart diseases and hypertensive diseases in relation to dietary intake. Japanese Journal of Public Health 23:711-718.

Yoshino, H.; Arai, H.; Iwasaki, K.; Makita, H.; and Miyazaki, E. 1986. Change in home heating systems and room temperatures in Yawata-cho, Yamagata-ken, a snowy cold area, after 4 years of education of improvement of indoor thermal environment. Japanese Journal of Public Health 34:774-781.