ARCTIC MEDICAL RESEARCH

50/91

Vol. 50: Suppl. 4, 1991

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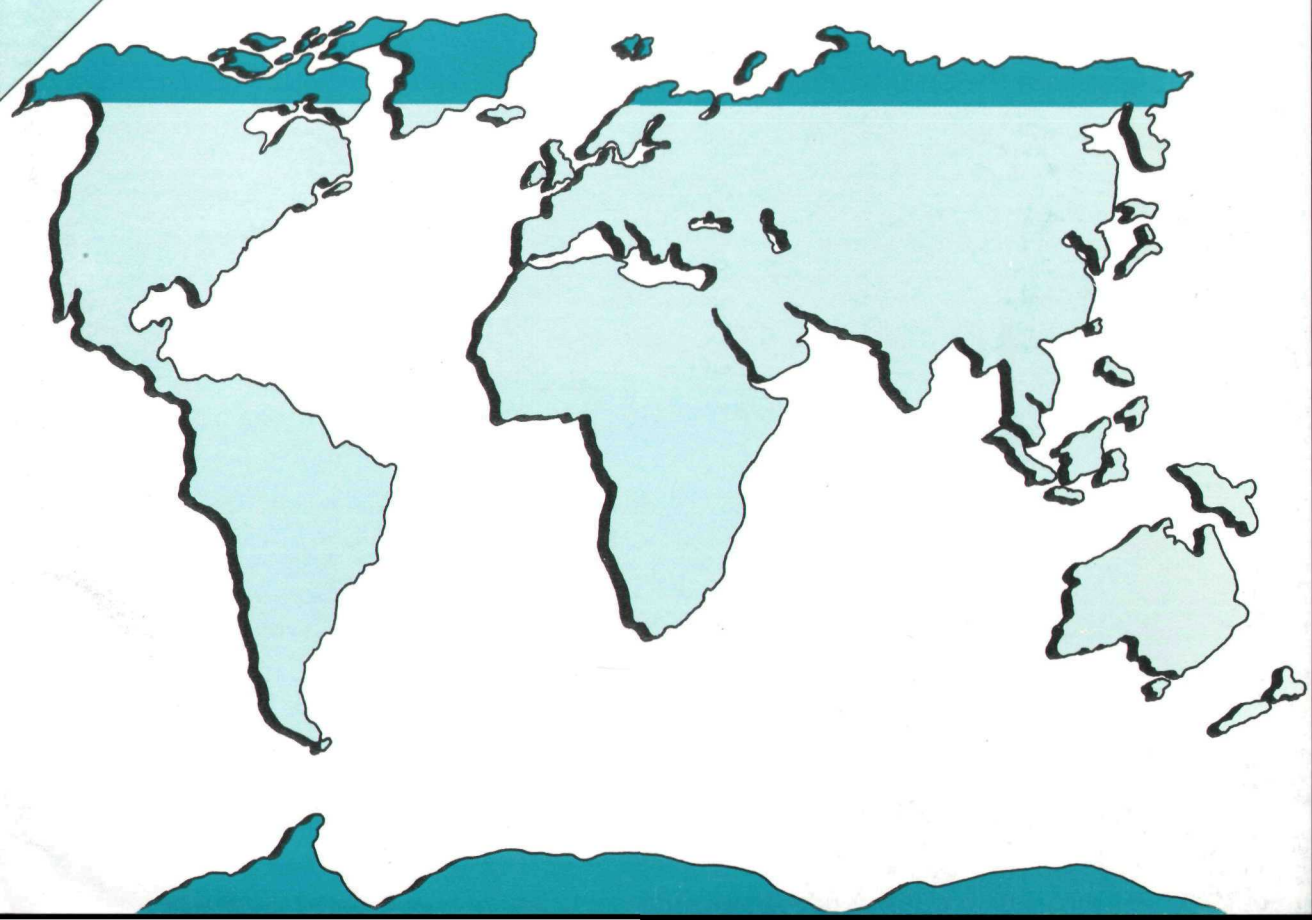

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Published by the Nordic Council for Arctic Medical Research and
the International Union for Circumpolar Health

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Nordic Council for Arctic Medical Research
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Aapistie 3, SF-90220 Oulu, Finland
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DISEASE PATTERN IN GREENLAND:

Studies on morbidity in Upernavik 1979-1980 and mortality in Greenland 1968-1985

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This thesis is based on the following papers:

1. Bjerregaard P. Housing standards, social group, and respiratory infections in children of Upernavik, Greenland. Scand J Soc Med 1983;11:107-11.

2. Bjerregaard P, Bjerregaard B. Disease pattern in Upernavik in relation to housing conditions and social group. Meddr Grønland, Man & Soc 1985;8:1-18.

3. Bjerregaard P. Infectious diseases in Greenlanders of Upernavik. Scand J Prim Health Care 1985;3:163-9.

4. Bjerregaard P. Validity of Greenlandic mortality statistics. Arctic Med Res 1986;42:18-24.

5. Bjerregaard P. Infant mortality in Greenland. Arctic Med Res 1986;42:10-7.

6. Bjerregaard P, Johansen LG. Mortality pattern in Greenland. An analysis of potential years of life lost 1968-83. Arctic Med Res 1987;46:71-7.

7. Bjerregaard P. Causes of death in Greenland 1968-85. Arctic Med Res 1988;47:105-23.

8. Bjerregaard P, Dyerberg J. Mortality from ischaemic heart disease and cerebrovascular disease in Greenland. Int J Epid 1988;17:514-9.

9. Bjerregaard P. Geographic variation of mortality in Greenland. Economic and demographic correlations. Arctic Med Res 1990;49:16-24.

10. Bjerregaard P, Juel K. Avoidable deaths in Greenland 1968-1985: Variations by region and period. Arctic Med Res 1990;49:119-27.

11. Bjerregaard P. Fatal accidents in Greenland. Arctic Med Res 1990; 49:132-41.

ACKNOWLEDGEMENT

I wish in the first place to thank my coauthors on the underlying articles, Dr. Beth Bjerregaard, Dr. Lars G. Johansen, Dr.med. Jørn Dyerberg and Cand.stat. Knud Juel. Thanks also to Lic.med. Finn Kamper-Jørgensen, director of the Danish Institute for Clinical Epidemiology, who helped me during the most critical phases of the project, and to Cand.stat. Mette Madsen who provided invaluable support in statistical and epidemiological matters. Furthermore, I wish to thank Susanne Brenaa and Hanne Færgeman who assisted with the preparation of the manuscripts.

Many people have helped me since the project started in 1979. I would like particularly to mention Dr. Jørgen Hilden, interpreter Marie Møller, architect Mette Thomassen and Dr.med. Jens Peder Hart Hansen.

Financial support was received from The Danish Medical Research Council (grants no. 512-20561, 12-5143, 12-8007), Else and Svend Madsen's foundation, Folketingets Grønlandsfond, Grønlandsfonden af 1959, Karla Marie Jørgensen's Legat and Det Kongelige Grønlandsfond.

PREFACE

The aim of this paper is to arrange and present the results of a number of previously published articles in a manner which conforms with the rules and regulations for a doctoral thesis at the University of Copenhagen. At the same time it has been a wish to present all main results of the study so that the readers, many of which will probably be scattered over the vast circumpolar area with poor access to, library facilities, will be able to benefit from the present presentation without having to refer to the underlying articles. It has been found relevant to include a fairly comprehensive literature review in order to give a broad overview of studies on morbidity and mortality in Greenland. The presentation is therefore somewhat extensive as a doctoral thesis but it is hoped that its usefulness for a broader group of professionals in the circumpolar area will justify this transgression of the recommendations of the University.

All main results are presented in the paper but details of material and methods as well as results must be found in the underlying articles, which are referred to in square brackets in the text. The study has spanned over more than ten years and it has been found necessary to perform a few adjustments of weak parts of the underlying articles as well as some reanalyses of the material in order to ensure comparability and consistency of the presentation.

CONTENTS

ABSTRACT

The disease pattern is described for the population of Upernavik, which is the administrative centre of a very large, sparsely populated municipality in North Western Greenland. The number of medical contacts per person was by and large similar in Upernavik and Denmark despite different health care systems, but the distribution of diagnoses was different. Persons with poor socioeconomic status (housing conditions and social group) were admitted to hospital more often than those with high status. Mortality in Greenland was studied using a computerized register of causes of death covering all deaths in residents of Greenland during 1968-1985. Age standardized mortality rate was twice as high in Inuit of Greenland as in the population of Denmark but five times higher in children. Mortality due to infectious diseases, ischaemic heart disease and certain accidents decreased during the period studied while mortality due to lung cancer, suicide and homicide increased. Regional differences in mortality were pronounced with high infant mortality and high mortality from acute infections and accidents in the socioeconomically poor settlements and remote districts. The suicide and homicide rates were highest in the capital and in the remote East Greenland. Compared with Denmark, mortality rates were higher in Greenland from most causes with ischaemic heart disease as an exception, being significantly less common in Greenland in both males and females. A comprehensive literature review describes the disease pattern in Greenland with special emphasis on the period after 1970. It is concluded that epidemiology can contribute to future health planning in Greenland and that research and development must be given high priority. Some major health problems facing the Greenlandic community are the high mortality from suicides and homicides, the prevalence of violence often triggered by alcohol, the many accidents, the high infant and child mortality and the high mortality from preventable cancers (lung and cervix).

1. INTRODUCTION

Greenland is the world's largest island but 84% are covered with a permanent ice cap and only 341,700 square kilometres are ice free. The northern tip of Greenland is 740 km from the North Pole while the southern tip is situated at 60°N, at the same latitude as central Scandinavia or Anchorage. The climate varies considerably from south to north and from west to east but the whole of Greenland is north of the tree-line and has an arctic climate with summer temperatures below 10°C.

Greenland was colonized by the Danes and Norwegians in the 18th century, Eastern and Northern Greenland though less than 100 years ago. It remained a colony until 1953 when it became, politically, an integrated part of Denmark, and in 1979 Greenlandic home rule became a reality with most administrative areas successively being transferred to local authority. In 1990, the health services remain one of the few areas still waiting for transfer. Until World War II Greenland was sealed off from the rest of the world by a protectionistic colonial policy, but in 1950 the country was opened up and at the same time a rapid development was initiated, the first 30 years mainly designed by the administration in Copenhagen.

The population of Greenland numbers 54,524 (by 1 January, 1988) of which 82% are indigenous Greenlanders of predominantly Inuit ancestry and culture but with some European admixture. The majority of the remaining 18% are Danes, many of which only spend a few years in Greenland working on a contract for the state or a private company. The traditional Greenlandic society subsisted predominantly on the hunting of sea mammals and birds. Today, i.e. according to the census of 1976, only 6% of the native Greenlanders subsist on hunting while 14% rely on fishing for an income and 62% are employees, mainly within service delivery, commercial trade and transport, production and building (the remaining 18% were not classified). Greenland is administratively divided into Western Greenland, which is the economic centre of the country and has 90% of the population, Eastern Greenland and Northern Greenland, but only a narrow, coastal strip and some islands are inhabited and all inhabited places are situated directly on the coast (Fig. 1).

Upernavik is the northernmost municipality in Western Greenland. It had a population of 2117 in 1979, living at 11 places. Upernavik town, with a population of 836, is the administrative centre of the municipality and is situated on a small island. A considerable proportion of the population in the settlements (58%) still, in 1976, subsisted on the hunting of sea mammals, and the municipality is as such not typical of modern Greenland. Upernavik town, however, is close to the average for Greenland with respect to a number of socioeconomic key variables, i.e. age structure, birth rate, income and housing standards.

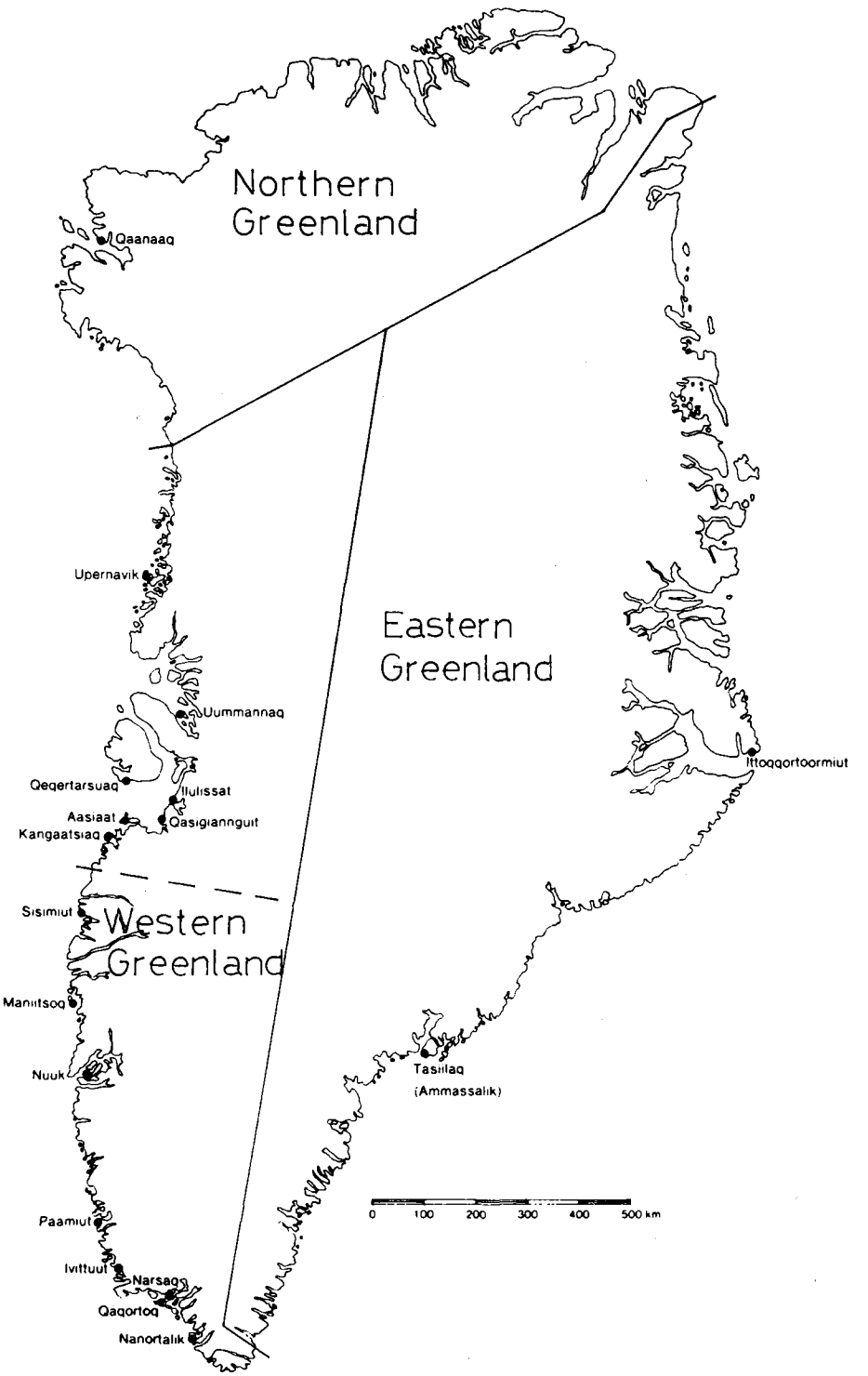

Fig. 1. Map of Greenland with towns and administrative boundaries. The broken line indicates the boundary between southern/central settlements and northern settlements in Western Greenland as defined in the present study.

2. PURPOSE OF THE STUDY

The present study was initiated in 1979 because of the obvious need to compile and update the information on disease patterns in Greenland which at that time mainly consisted of Bertelsen's studies covering the period until 1930 (Bertelsen 1935,1937,1940,1943), the annual reports from the Chief Medical Officer in Greenland and a number of scientific articles and medical reports on a variety of diseases and health problems. The aim of the study was to give an epidemiological description of some major health problems in contemporary Greenland, in particular in the native (Inuit) population.

The purpose of the study was

1. To describe the sickness profile in a well defined Greenlandic population. This is covered by articles no. 1, 2 and 3 and by sections 4 and 6 of the present paper.

2. To establish, validate and continuously update a register on causes of death in Greenland for the period since 1968. This is covered by articles no. 4 and 7 and by section 3 of the present paper.

3. To describe and analyse mortality and causes of death in Greenland since 1968 and to relate this to other circumpolar areas and Denmark. This is covered by articles no. 5, 6 and 7 and by sections 5, 7 and 10 of the present paper.

4. To further analyse diseases and causes of death which are of particular interest, either from a Greenlandic public health point of view or internationally. This is covered by articles no. 8, 10 and 11 and by sections 6 and 7 of the present paper.

5. To test the hypothesis that morbidity and mortality from certain causes are socioeconomically and geographically unevenly distributed within Greenland. This is in particular covered by articles no. 1, 2, 5, 9 and 10 and by section 8 of the present paper.

The study consists of two parts: A community study from Upernavik town conducted from April, 1979, to March, 1980, and the establishment and subsequent analysis of a register on causes of death which covered all deaths 1968-1985 in the resident population of Greenland. In order to give a comprehensive overview of contemporary Greenlandic disease patterns, a literature review with emphasis on studies from the last twenty years has been included.

3. MATERIAL AND METHODS

Upernavik study

The data of the Upernavik study were collected prospectively during my time as District Medical Officer in Upernavik district. Upernavik town is situated on a small island in the archipelago off the West Coast of Greenland at 72°47' N. It is the administrative centre of the municipality of Upernavik which, in 1979, had a population of 2117 persons living at 11 inhabited places. The population of the study were the de facto inhabitants of Upernavik town as per 1 October, 1979, and children born during the period of study, which was from April 1, 1979, to March 31, 1980. The population was defined according to the official list of residents, corrected according to the files of the hospital and the interpreter's knowledge of virtually everybody in town, and numbered 836 persons, 737 Greenlanders and 99 Danes. Temporary workers and visitors were not included in the study.

Information on housing conditions was collected from the files of the municipality and of

Greenland Technical Organization, supplemented by interviews. Information on social conditions was collected from the files of the hospital supplemented by interviews. Social classification was done according to the system of the Institute for Social Research in Copenhagen (Kamper-Jørgensen et al. 1980, Enevoldsen et al. 1980). All members of a household were classified according to the highest social group attained by any of its members. Ethnic classification was done as a general assessment of the family history, language and cultural background of each person and did not present difficulties as everybody was personally known to the investigators and the distinction in almost all cases clear cut. Children of mixed couples were classified as Danes.

During the period of study, all contacts between the population and the investigators, who were the only two medical doctors in the district, were recorded prospectively. Consultations by visiting specialists, nurses or auxiliary health workers were not included in the study. Diagnoses were classified according to "Praksis Sygdoms Klassifikation" (PSK) (Krogh-Jensen 1976) with some modifications (Nordentoft & Reeslev 1979). PSK is a Danish classification of diseases and conditions, designed for use by general practitioners. It is to a certain degree similar to the International Classification of Diseases of WHO (ICD) but allows classification of cases which have not been thoroughly investigated.

Two measures of morbidity were used. The proportion of persons with at least one medical contact due to the disease in question during the year of study was referred to as disease incidence while the total number of contacts per person during the year of study due to the disease in question was referred to as contact rate.

Death register study

Before the present study, a Greenlandic death register did not exist as an entity. The original death certificates for the period since 1967 were available in the archives of the National Board of Health in Copenhagen, and for the period since 1975 computerized registers existed for each year separately. The author established the register for the period 1968-1974 and carried out a combination of the registers for all years into one register covering the whole period and a validation of the information in this register. In 1985, a Greenlandic death register for the period 1968-1983 was thus formed. This has been updated on a regular basis, with 2-3 years delay, and covers presently (April 1990) the period 1968-1987.

Establishment of the death register

Since 1967, all deaths in Greenland have been registered centrally by the Danish National Board of Health in Copenhagen. The death certificates are collected by the Chief Medical Officer in Greenland and forwarded to the National Board of Health in Denmark where they are processed and subsequently stored. Death certificates of persons domiciled in Greenland who died in Denmark are added. The data set from 1967, when these procedures were introduced, was considered incomplete and was excluded from the analysis.

For the period 1968-1974 the register was established at the Danish Institute for Clinical Epidemiology (DIKE) from original sources. The death certificates were compared with the parish registers and for 1973-1974 also with the civil registration records. All recorded deaths were included in the register; for those without a death certificate the cause of death was recorded as unknown. For the period after 1974 the register is identical to the computer based register of the National Board of Health which is established by a computerized combination of information from death certificates with information in the civil registration records. The register is updated on a regular basis and some results of the present study have been updated to include the period 1968-1987.

The causes of death have been coded in the National Board of Health by the same persons who

code the Danish death certificates thus ensuring a comparable coding practice. Causes of death were coded according to the 8th revision of the International Classification of Diseases (ICD) which is the currently used version of ICD in Denmark. The G-list is a condensed version of ICD 8th revision, specifically designed for the present study (Table I).

Background data

Population data were drawn from the published censuses of 1970 and 1976 and from the civil registration records for 1976 and 1982. The population was divided into persons born in Greenland and persons born outside Greenland as a proxy for ethnicity. This is the conventional demographic definition which was used by the two censuses and in the civil registration records, and the same information is found on the death certificates. In the following, persons born in Greenland have been called (native) Greenlanders while persons born outside Greenland have been called Danes. There

TABLE I. G-list of causes of death and corresponding International Classification of Diseases (ICD) categories.

G-list	*Corresponding ICD-list (8th revision)*
1. Infectious diseases	*0-009,020-136,320*
2. Tuberculosis	*010-019*
3. Cancer	*140-209*
3.1 Cancer of lung	*162*
3.2 Cancer of cervix uteri	*180*
3.9 Other cancers	*Rest of 140-209*
4. Heart disease, excluding rheumatic fever	*410-429*
4.1 Ischaemic heart disease	*410-414*
4.9 Other heart diseases	*420-429*
5. Cerebrovascular disease	*430-438*
6. Acute respiratory infections, pneumonia	*460-486*
7. Chronic bronchitis etc.	*490-493*
8. Other natural causes	*Rest of 210-779*
9. Symptoms and ill-defined conditions	*780-796*
10. Marine accidents	*E 830-838, 910*
11. Other accidents	*Rest of E 800-949*
12. Suicides	*E 950-959*
13. Homicides and other external causes	*E 960-999*
13.1 Homicides	*E 960-969*
13.9 Other	*E 970-999*
14. Unknown	

are of course inconsistencies. A pure Inuit child, born in Rigshospitalet in Copenhagen which is referral hospital for Greenland, will be classified as born in Denmark, while an ethnically Danish child born in Greenland while its parents were temporarily working there, will be classified as born in Greenland. The bias introduced by this is probably small, except in young children, since very few adult Greenlanders were born in Denmark and most Danish children born in Greenland eventually return to Denmark, but it has not been attempted to quantify it.

Data on income were prepared for the study by the Central Bureau of Statistics in Denmark (Danmarks Statistik 1984).

Validity of mortality statistics

The completeness of reporting varied considerably during the study period. During 1968-1974, on average 7% of deaths did not have a death certificate and accordingly missed a diagnosis. In 1975-1976 this proportion reached 19% but decreased again to the former level, and since 1981 the proportion of deaths without death certificate and diagnosis has been negligible (< 2 %). The proportion of missing diagnoses was higher in males than in females and highest in the 5-44 year old; it was highest in Eastern Greenland and in settlements in Western Greenland, and in years with an increased number of missing diagnoses a corresponding decrease in the number of deaths from marine accidents was noted. The epidemiological characteristics of deaths with missing diagnosis thus suggest that a substantial proportion of these deaths probably were drowning or boat accidents, a hypothesis which is supported by the fact that this type of death is often registered late and/or in a special way because the body is missing (Bjerregaard 1988c [7]).

The validity of diagnostic information on the death certificates was assessed in a separate analysis (Bjerregaard 1986a [4]). A random sample of 282 deaths (6%) was drawn from the period 1968-81; 1982-85 was not included in the sample as the death register did not cover this period at the time of the study. For 197 non violent deaths all available information which might be relevant for the diagnosis was collected, including case records from admissions to hospitals and outpatient consultations, autopsy protocols etc. 69 violent deaths and 16 deaths without a death certificate were not analysed, but 87% of the death certificates for violent deaths contained supplementary information, most often in the form of an inquest report, which supported the diagnosis.

On the basis of the collected information it was possible to establish a reference or "final" diagnosis in 149 cases, while information was considered inadequate in the remaining 48 cases. The latter were mainly deaths which had occurred in settlements. In Greenland as a whole, 49% of deaths during 1968-1981 occurred in a hospital while 74% of the 149 deaths in the final sample did so. This bias will tend towards an overestimation of the validity of the diagnoses.

The reference diagnoses were compared with the diagnoses on the death certificates at various levels of diagnostic specificity of which only the ICD code and the above mentioned G-list will be discussed. At ICD level, 56% of diagnoses on the death certificate remained as reference diagnosis while 23% were changed to another specific diagnosis and 20% were changed to an unspecific symptom diagnosis (ICD 780-796). In 23% of cases the diagnosis was considered insufficiently founded, in 8% the diagnosis was erroneous, in 5% the death certificate had been incorrectly filled in and in 3% the coding office in the National Board of Health had apparently misinterpreted the death certificate; coding errors were found in 4% of cases. A complete autopsy was only performed in 5% of natural deaths which occurred in Greenland. At G-list level, 71% of diagnoses were unchanged, 9 % were changed to another specific diagnosis and 20% were changed to an unspecific symptom diagnosis.

There was no sex difference, but the validity of diagnoses was considerably higher in deaths below 65 years of age than in older age groups. The secular variation was insignificant. The sample was too small to evaluate the geographic variation, but since the validity of diagnoses was lowest in deaths which occurred outside hospital and highest in deaths which occurred in the central hospital in the

capital, Nuuk, it is probably justified to assume that the validity of diagnoses is lowest in residents of settlements, who more often than other Greenlanders die outside hospital, and highest in residents of the capital, who more often die in the central hospital.

The validity of diagnoses varied considerably among the disease categories (Table II). The diagnoses "Heart disease" and "Acute respiratory infection" on a death certificate were only confirmed by the reference diagnosis in 55% and 57% of cases, respectively, and since around 90% of these two diseases had been detected and entered in the death certificate, there was a considerable net overreporting of these diseases. The main reason was that the two diagnoses were often made without sufficient foundation.

In a similar study from Denmark, 23% of diagnoses were changed (Mabeck & Wichmann 1980), while only 4% of diagnoses in 36-71 year old persons from Sweden were changed (de Faire et al. 1976). Studies from a number of European countries have shown that autopsy changed the clinical diagnosis of death in one fourth to one half of cases (Britton 1974, Asnæs et al. 1980, Hackl 1982). The validity of diagnoses of death in Greenland, although not high, is therefore at an acceptable level compared with European countries, in particular in persons below 65 years of age and at the not too detailed diagnostic specificity of the G-list.

TABLE II. Validity of diagnoses of death in Greenland 1968-1981 at the G-list level of diagnostic specificity. Proportion of death certificate diagnoses confirmed by the reference diagnosis (% confirmed) and proportion of reference diagnoses which had been made and entered in the death certificate (% detected).

G-list	*Death certificate*		*Reference diagnosis*	
	Number	*% confirmed*	*Number*	*% detected*
1. Infectious diseases	*6*	*83*	*6*	*83*
2. Tuberculosis	*3*	*67*	*3*	*67*
3. Cancer	*40*	*78*	*31*	*100*
4. Heart disease	*20*	*55*	*12*	*92*
5. Cerebrovascular disease	*15*	*87*	*14*	*93*
6. Acute respiratory infections, pneumonia	*14*	*57*	*9*	*89*
7. Chronic bronchitis	*12*	*83*	*14*	*71*
8. Other natural causes	*32*	*63*	*23*	*87*
9. Symptoms and ill-defined conditions	*7*	*86*	*36*	*17*
Total	*149*	*71*	*148 *)*	*71*

**) Excluding one accident.*

Epidemiological and statistical methods

For the Upernavik study, data analysis was done by manual sorting of punched cards, while the death register was analysed either on a mainframe computer using SAS or on a microcomputer using SPSS/PC+. Epidemiological and statistical procedures have been described in detail in the original articles. Most analyses were simple direct or indirect standardizations for age and sex, or simple statistical tests, including the chi-square and Mantel-Haenszel tests, and were done according to standard text books (Armitage 1974, Mausner & Bahn 1974, Foldspang et al. 1981, Rothman 1986, Kirkwood 1988). A log-linear model was applied to the data from Upernavik and in one analysis of secular and regional variation of mortality a multiplicative Poisson model was applied (Breslow & Day 1975).

Potential years of life lost (PYLL) were calculated in the 1-64 year old as 65-(i+0.5) where "i" was the actual age in whole years at death of an individual and "i+0.5" the median age of an age group. For Greenland the calculations were performed at individual level while they were performed on five-year age groups for Denmark (Haenszel 1950, Kleinman 1977, Romeder & McWhinnie 1977).

4. DISEASE PATTERN IN UPERNAVIK 1979-1980

The Greenlandic disease pattern as an epidemiological concept, i.e. the occurrence of disease in relation to the size and structure of the background population, has been the subject of few studies. Among these, a study of the diagnoses in patients admitted to hospital in Upernavik during 1950-74 should be mentioned (Kromann & Green 1980). A few descriptions of the work as District Medical Officer in Greenland have given a picture of a relatively high incidence of respiratory, ear and skin infections but the disease classifications were not comparable and comparisons, most often with general practice in Denmark, were not consistent (Alsbirk & Schiøler 1969, Bjerregaard & Bjerregaard 1981, Olsen et al. 1986, Marschall 1989). The annual reports from the Chief Medical Officer in Greenland have information on patients discharged from hospital and on notifiable infectious diseases but these statistics cover only certain diseases and do not allow distinction between Greenlanders and Danes. A study conducted during 1979-80 in Upernavik town is part of the present study and will be discussed in more detail in the following (Bjerregaard & Bjerregaard 1985 [2]).

In a native Greenlandic population of 737 persons, 584 (79%) had at least one contact with the medical officers in the district during the year of study, i.e. 69% of the children, 80% of adult males and 93% of adult females. A total of 2256 outpatient consultations and 219 admissions to hospital were recorded as the consequence of 1661 separate disease episodes. Both outpatient consultation rates and rates of admissions to hospital were about twice as high in adult females than in both children and adult males (Table III).

The contact pattern of Greenlanders of Upernavik town was compared with that of Århus county,

TABEL III. Contact rates per person-year in Greenlanders of Upernavik 1979-80.

	Children 0-14 year	*Adult Males*	*Adult Females*
Out-patient consultations	*2.11*	*2.66*	*4.53*
Admissions to hospital	*0.21*	*0.20*	*0.50*
All contacts	*2.32*	*2.86*	*5.03*

Denmark (Nordentoft & Reeslev 1979). While the population of Upernavik had on average 3.4 contacts with the District Medical Officers in a year, the population of Århus had 4.5 contacts per year with a general practitioner. The age structure of the two populations, however, differed markedly and after age standardization the contact rates were similar in the two studies. The only comparable study from Greenland had a calculated yearly contact rate with the medical officers of also 3.4 per person (Olsen et al. 1986).

Age specific contact rates followed different patterns in Greenland and Denmark. In children, rates were higher in Greenland than in Denmark, while in persons above 45 years of age rates were higher in Denmark than in Greenland. Whereas the contact rates for both males and females in the Danish study showed a constant increase with age, the age increase, although present, was less pronounced in Upernavik (Table IV).

The study design and organization of health care in Upernavik and Århus are not directly comparable. In Upernavik the health care system is very simple and virtually all patients were seen by the district medical officers, day and night and all year round, while the health care system in Denmark is much more diversified. Patients may contact other health professionals, in particular for ear, eye and skin diseases, and may attend the casualty ward of a hospital; also, deliveries normally take place in a hospital without the involvement of the general practitioners. Furthermore, the Århus study only covered the daytime working hours and the number of contacts have therefore probably been underestimated in the Danish study relative to the Greenlandic study, in particular for the above mentioned diseases, accidents and certain conditions in relation to pregnancy and childbirth. On the other hand, 40% of the contacts in Århus were by telephone, an option which was not available in Upernavik.

A number of studies from Denmark during the 1970s showed the contacts after normal surgery hours to range from 0.24 to 0.42 per person-year (Becker-Christensen 1982). Administrative statistics covering the major part of Denmark showed 5.0 contacts per person with general practitioners in 1980, including contacts after normal surgery hours, plus 1.0 contact with medical specialists (Sygesikringens Forhandlingsudvalg 1982). Furthermore, visits to the casualty wards in Århus amounted to 0.13 visits per person-year (Sundhedsstyrelsen 1978). Assuming Århus to follow the general pattern, it can be estimated that the contact rates of the Århus study should be increased by approximately one third in order to be comparable with the Greenlandic study.

The study from Århus reported contact rates instead of disease incidences and in order to be able to compare the two studies, contact rates were also calculated for Upernavik. Table V shows that

TABLE IV. Age specific contact rates per person-year in Greenlanders of Upernavik, Greenland, and population of Århus, Denmark.

	Upernavik		*Århus*		*Rate ratio Upernavik/Århus*	
	Males	*Females*	*Males*	*Females*	*Males*	*Females*
0-14	*2.2*	*2.4*	*1.9*	*1.9*	*1.15*	*1.25*
15-44	*2.6*	*4.8*	*2.4*	*4.8*	*1.08*	*1.00*
45-64	*3.5*	*5.2*	*4.2*	*6.6*	*0.83*	*0.79*
65+	*3.8*	*3.7*	*6.2*	*8.1*	*0.62*	*0.46*

*TABLE V. Main diagnoses for medical contacts of Greenlanders of Upernavik, Greenland, compared with population of Århus, Denmark. Upernavik/Århus contact rate ratios standardized for age and sex. * = $p < 0.05$, Chi-square test.*

Diagnostic group		Number of contacts	%	Standardized contact ratio
1.	*Infectious diseases*	143	5.8	1.13
2.	*Neoplasms*	20	0.8	0.43*
3.	*Endocrine, nutritional and metabolic diseases*	2	0.1	0.03*
4.	*Hematological diseases*	0	0	0*
5.	*Psychiatric diseases*	39	1.6	0.27*
6.	*Diseases of nervous system, eye and ear*	247	10.0	0.99
7.	*Cardiovascular diseases*	64	2.6	0.41*
8.	*Respiratory diseases*	396	16.0	0.88
9.	*Gastrointestinal diseases*	156	6.3	1.33
10.	*Genitourinary diseases*	146	5.9	0.62*
11.	*Diseases of pregnancy, delivery and puerperium*	64	2.6	3.72*
12.	*Skin diseases*	273	11.0	1.97*
13.	*Musculoskeletal and connective tissue diseases*	236	9.5	0.92
14.	*Congenital malformations*	6	0.2	0.67
15.	*Diseases of the newborn*	1	0.04	0.91
16.	*Other undesirable conditions*	98	4.0	0.92
17.	*Accidents*	300	12.1	2.07*
18.	*Other*	123	5.0	0.45*
19.	*Symptoms*	161	6.5	2.48*
	All causes	2475	100	0.97

respiratory diseases, including respiratory tract and lung infections, were the most frequently seen diseases in Upernavik followed by accidents, skin diseases and diseases of the nervous system, eye and ear, both the latter including infections. Age and sex standardized contact rates were significantly lower in Upernavik than in Århus from neoplasms, endocrine, nutritional and metabolic diseases, haematological diseases, psychiatric diseases, cardiovascular diseases, genitourinary diseases and "other", while they were 2-4 times higher from diseases of pregnancy, delivery and puerperium, skin diseases, accidents and symptoms.

The very high ratios for accidents and diseases related to pregnancy primarily reflect the different organization of health care as outlined above. The remaining differences may in part be due the above described differences in study design and organization of health care and differences in the iatrotropic threshold probably also play a role, but the often very pronounced differences in contact rates may generally be taken as indications of a different disease pattern.

The diagnostic groups of the classification used each comprise many single diseases and a study at a more detailed level of diagnostic specificity gave some additional information. The differences observed at this detailed level must, however, be interpreted with caution. The absolute numbers were small and for certain diseases the diagnostic criteria may have differed considerably between the two

studies. Furthermore, the age composition of the two populations were dissimilar: 5% 65 + year old in Upernavik compared with 13% in Århus. With these reservations it may be noted that the crude, i.e. not age standardized contact rates in Upernavik were considerably lower than in Århus for cancer, hypertension, ischaemic heart disease, bronchial asthma, urinary infections and minor mental disorders, headache and insomnia. Thyroid diseases, diabetes mellitus, anemia and allergic rhinitis were not recorded in Upernavik at all.

With accidents and pregnancy related conditions excepted for reasons given above, only few diseases had higher contact rates in Upernavik than in Århus, i.e. gonorrhea, chronic purulent otitis media and impetigo. The magnitude of these differences was so high that the estimated 33% underreporting in the Århus study mentioned above was irrelevant.

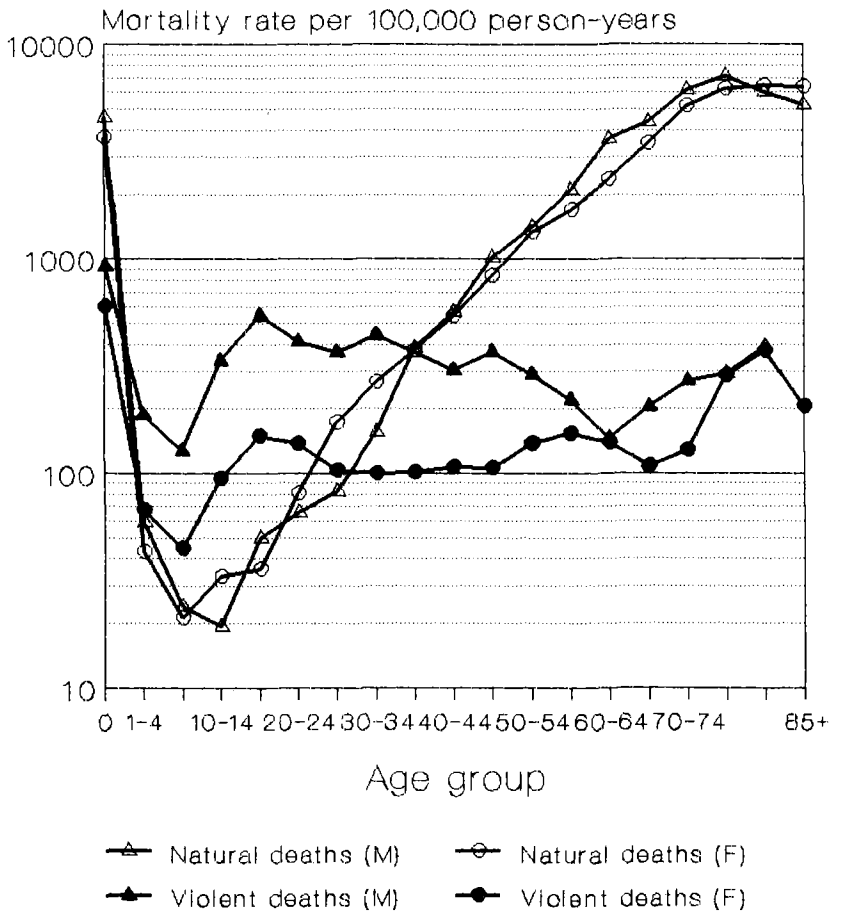

Fig. 2. Age specific mortality rates per 100,000 person-years in the native population of Greenland 1968-1987. 0 year old, 1-4 year old and five-year age groups. Natural deaths (ICD 0-796) and violent deaths (ICD E800-999).

5. MORTALITY AND CAUSES OF DEATH 1968-1985

During 1968-1985, a total of 6,463 deaths were recorded in residents of Greenland, 6,107 (94.5%) in persons born in Greenland, 340 (5.3%) in persons born outside Greenland and 16 (0.2%) in persons with unknown place of birth. In the following, mortality in the native population will be discussed (Bjerregaard 1988c [7]) while mortality in Danish residents of Greenland will be dealt with in sections 6 and 8.

Mortality

Fig. 2 shows mortality rates by age and sex, and separately for natural and violent deaths, the latter comprising accidents, suicides and homicides. The curves for natural causes were almost similar for males and females: U-shaped with very high infant mortality. Mortality rates from violent causes were higher in males than in females until around 60 years of age. The curves were parallel for males and females and they did not show as pronounced a variation with age as those for natural deaths. The very high infant mortality rates due to violent causes were probably overestimates due to wrong diagnoses as will be discussed below. In both males and females, low mortality rates due to violent causes in the 1-14 year old were followed by a small peak in the 15-24 year old. In males, the curve then declined to meet that of females in age group 60-64, after which another small peak was seen in both sexes.

Age standardized mortality rates from all causes together showed a slight, statistically insignificant increase in both males and females during the study period, in males from 929 per 100,000 person-years in 1968/73 to 971 in 1980/85 and in females from 705 to 714, but the trend was different in different age groups. Mortality rates in infants and children below 15 years of age decreased significantly, those of adults remained constant, and in the 65+ year old mortality rates increased significantly.

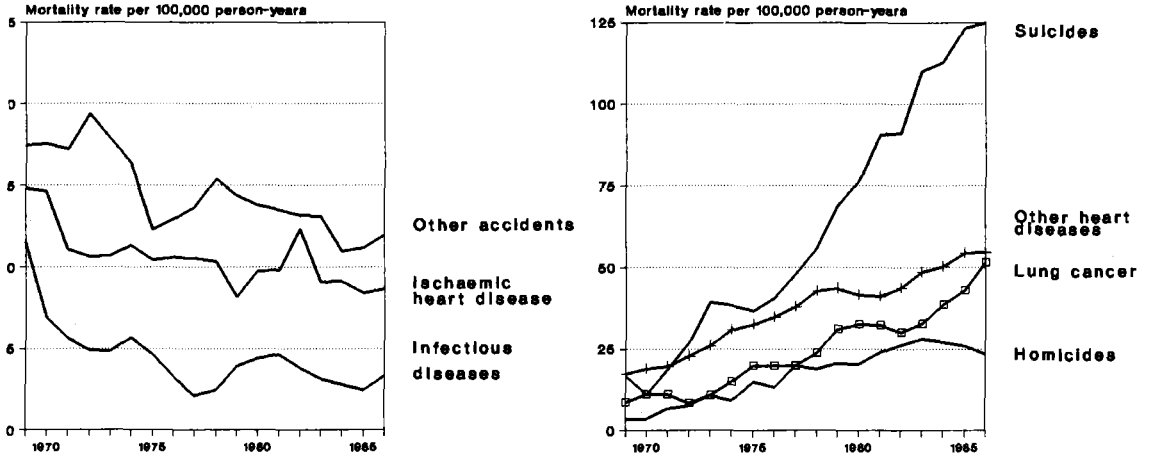

Fig. 3. Crude mortality rates per 100,000 person-years in the native population of Greenland 1969-1986. three year moving averages.

Causes of death

Table VI shows mortality according to the G-list for 1968-1985. The most frequent specific causes of death during 1968-1985 were suicides, marine accidents, stroke, acute respiratory infections and ischaemic heart disease (about 400 deaths from each) but their relative importance changed, in particular because the suicide rate increased while the mortality rate due to ischaemic heart disease decreased.

TABLE VI. Mortality rates in native Greenlanders 1968-1985 according to the G-list. Rates per 100,000 person-years with 95% confidence intervals (from tabulated values of the Poisson distribution) in parentheses.

G-list	Males		Females	
	Number	Rate	Number	Rate
1. Infectious diseases	*93*	*25(20-31)*	*92*	*25(21-31)*
2. Tuberculosis	*56*	*15(11-20)*	*52*	*14(11-19)*
3. Cancer	*379*	*103(93-113)*	*466*	*129(117-141)*
3.1 Cancer of lung	*105*	*28(23-34)*	*58*	*16(12-21)*
3.2 Cancer of cervix uteri			*65*	*18(14-23)*
3.9 Other cancers	*274*	*74(66-83)*	*343*	*95(85-105)*
4. Heart disease, excluding rheumatic fever	*351*	*95(85-105)*	*297*	*82(73-92)*
4.1 Ischaemic heart disease	*211*	*57(50-65)*	*183*	*51(44-59)*
4.9 Other heart diseases	*140*	*38(32-45)*	*114*	*32(26-38)*
5. Cerebrovascular disease	*227*	*61(54-70)*	*246*	*68(60-77)*
6. Acute respiratory infections, pneumonia	*197*	*53(46-61)*	*202*	*56(48-64)*
7. Chronic bronchitis etc	*85*	*23(18-28)*	*135*	*37(31-44)*
8. Other natural causes	*543*	*147(135-160)*	*440*	*122(111-134)*
9. Symptoms and ill-defined conditions	*106*	*29(23-35)*	*108*	*30(24-36)*
10. Marine accidents	*413*	*112(101-123)*	*53*	*15(11-19)*
11. Other accidents	*332*	*90(80-100)*	*206*	*57(49-65)*
12. Suicides	*344*	*93(84-104)*	*78*	*22(17-27)*
13. Homicide and other external causes	*118*	*32(26-38)*	*78*	*22(17-27)*
3.1 Homicide	*65*	*18(14-22)*	*54*	*15(11-20)*
14. Unknown	*295*	*80(71-90)*	*115*	*32(26-38)*
All Causes	*3539*	*958(927-990)*	*2568*	*710(683-738)*

Fig. 3 shows the most important changes in mortality during the period. Mortality rates from acute infectious diseases, ischaemic heart disease and certain accidents decreased significantly in both males and females, while mortality rates from lung cancer, "other heart diseases", suicides and homicides increased. The pattern was similar in males and females. An age standardized comparison of three periods, i.e. 1968/73, 1974/79 and 1980/85, showed the changes to be statistically significant in both males and females, except for the increase due to "other heart diseases" in males (Bjerregaard 1988c [7]). In addition to these changes, mortality from symptoms and ill- defined conditions increased significantly, possibly reflecting a more realistic attitude towards diagnostic discrimination on clinical grounds. Mortality from marine accidents showed a drop around 1975- 1976 which as was discussed above probably is an artefact.

Comparison with Denmark

The age standardized mortality rate from all causes together was 2.1 times higher in native Greenlanders than in the population of Denmark for both males and females, but whereas the ratio was 5:1 in infants and even higher in 1-14 year old children it decreased with age and was little more than 1:1 in the 65 + year old (Bjerregaard 1988c [7]).

The Greenland:Denmark ratios were particularly high for marine accidents and tuberculosis (> 20:1 in both males and females) and for infectious diseases and homicides (> 10:1 in both males and females). The mortality rate from acute respiratory infections was six times higher in Greenlanders and the mortality rates from most other diseases, accidents and suicides were all significantly higher in native Greenlanders than in Denmark. The main exception was ischaemic heart disease, for which the mortality rates were significantly lower in Greenlanders for both males and females. The total cancer mortality was similar in the two populations but there were significant differences for specific cancers, e.g. cervix cancer which had a 3.2 times higher mortality rate in Greenlanders (Bjerregaard 1988c [7]).

Infant mortality

Infant mortality rate is very high in Greenland. It showed no conclusive change during the 1960's but around 1970 a significant decrease took place followed by another period of stagnation (Hansen HO 1982). In the capital, Nuuk, the perinatal mortality rate decreased from 1964/68 to 1969/73 but increased slightly again in 1974/78 (Hansen PK 1982). In 1975/79, the infant mortality rate in Greenland was 37 per 1,000 live births, mainly due to neonatal deaths, infections, sudden unexpected deaths and accidents (Jørgensen et al. 1982).

During 1968-1983, the average infant mortality rate in Greenland was 43.4 per 1,000 live births for both sexes together, 48.4 in males and 38.1 in females (Bjerregaard 1986b [5]). The rate was calculated for the whole population and the rate for children of mothers born in Greenland was estimated at 49.5 per 1,000 live births. Neonatal mortality remained at a constant level during 1968-1983 and the decline in infant mortality was predominantly due to a decline in postneonatal mortality.

Fig. 4 shows infant mortality rates in Greenland during 1969-1986 and in Denmark during 1939-1956. The curves follow each other and intersect in several places. However, whereas the curve for Denmark shows a fairly constant decrease during the whole period, the curve for Greenland exhibits a decrease from 1969 to 1973 followed by a plateau and another decrease from 1984. Only in 1974 and 1982/83 did the two curves differ significantly from each other and it is accordingly proposed that infant mortality in Greenland during the last 20 years has developed in a similar way as infant mortality in Denmark 30 years earlier. From 1968 to 1987 the infant mortality rate in Denmark dropped from 16.4 to 8.3 per 1,000 live births.

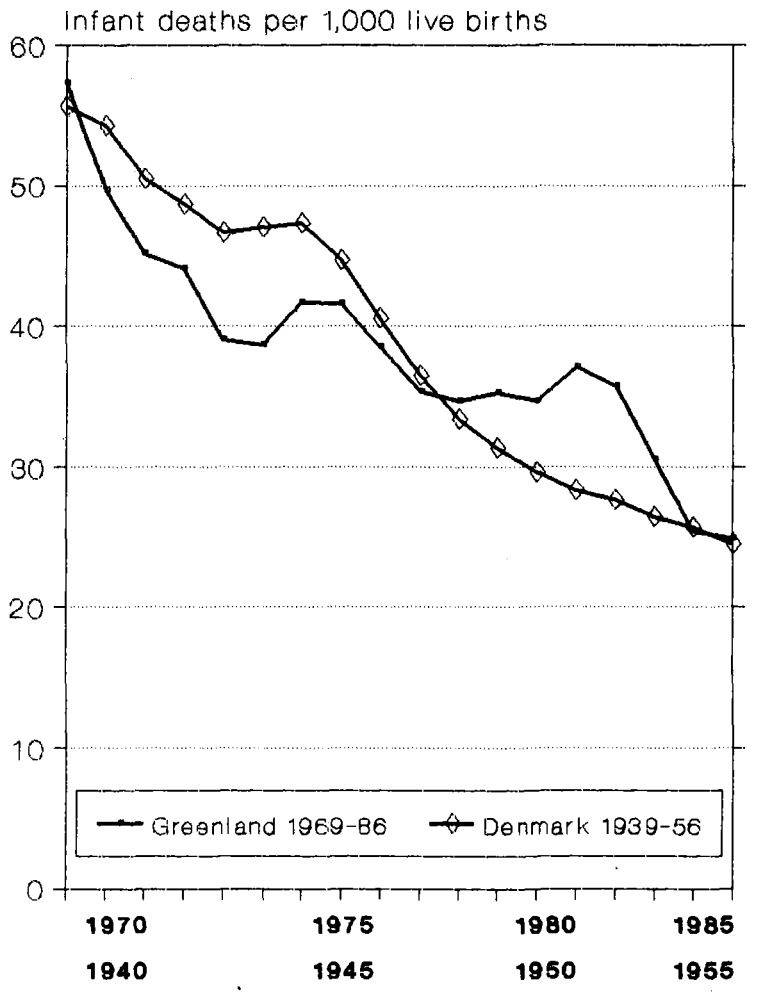

Fig. 4. Infant mortality rate per 1,000 live births in Greenland 1969-1986 (whole population) and in Denmark 1939-1956. Three year moving average for Greenland.

Causes of infant mortality

Infant mortality rates were higher in Greenland than in Denmark for most diagnoses. The mortality rate from cardiovascular malformations was one and a half times higher in Greenland but there was no difference for other malformations. The mortality rate from birth lesions and other perinatal causes was almost three times higher in Greenland and the mortality rate from respiratory diseases and accidents was more than ten times higher in Greenland (Bjerregaard 1986b [5]).

Sudden infant death syndrome (SIDS) deserves special discussion with due respect to the fact that without an autopsy the diagnosis is uncertain. The registered mortality from SIDS was 2.3 per 1,000 live births in Greenland during 1968-1983 compared with 0.8 in Denmark, and in Greenland the rate increased significantly from 1.8 in 1968/72 to 3.8 in 1979/83 (Bjerregaard 1986b [5]). Mortality from mechanical suffocation, which decreased significantly during the same period, had several epidemiological characteristics in common with SIDS and it is therefore proposed that a proportion of the early deaths due to mechanical suffocation were in fact misdiagnosed cases of SIDS. The infant mortality rate from SIDS plus mechanical suffocation was 4.3 per 1,000 live births in Greenland during 1968-1985 while the mortality rate from SIDS ranged from 0.8 to 1.9 in three regions of Denmark in

1980-1982 (Bjerregaard 1990b [11], Helweg-Larsen & Liebach 1985). Correspondingly high infant mortality from SIDS was reported in Canadian Indians (3.7 per 1,000 live births) (Moffat et al. 1988).

6. SELECTED DISEASES AND CAUSES OF DEATH

In the following, some important diseases and causes of death, which have been analysed in the present study, will be discussed separately under the headings 'Infectious diseases', 'Chronic diseases', 'Accidents' and 'Suicides and homicides'.

Infectious diseases

A general overview of literature concerning infectious diseases is given in section 9. Although mortality from acute infections has decreased significantly during the last 30 years, morbidity and mortality from acute infections are still high in Greenland.

Upernavik study

In Upernavik, 41% of all contacts with the medical officers were due to acute or chronic infections, in particular acute respiratory infections (13.5%) and skin infections (12.6%), corresponding to 1.4 contacts per person-year in the native population (Bjerregaard 1985 [3]). The total of 1,006 contacts due to infections, which included respiratory (including middle ear) and gastrointestinal infections, infections of eye, urinary tract and female genital organs, skin infections and sexually transmitted diseases, were the result of 705 disease episodes, i.e. 1.0 per person-year. Both incidence and contact rate were highest in infants and small children and females had generally higher rates than males, except for skin infections.

Eighty of the disease episodes (11%) resulted in admission to the local hospital, ranging from 2-3% for sexually transmitted diseases and acute upper respiratory tract infections to 23% for chronic respiratory infections and 27% for 'other infections', including, inter alia, salpingitis, urinary tract infections and gastroenteritis. The 80 admissions to hospital made up 37% of all admissions.

A seasonal trend was demonstrated for acute and chronic respiratory infections, which had a pronounced peak in July, and skin infections which had somewhat higher incidence during the winter months, from October to March.

Post traumatic skin infections included 15 contacts due to a peculiar disease, 'blubber finger' or 'seal finger', which followed minor cuts or abrasions while handling seals or certain fish. It was a prolonged non purulent inflammatory condition of one or a couple of fingers, which did not respond to treatment with penicillin and sometimes resulted in long lasting disability. A recent review concluded that the etiology is still unknown, although it is probably an infection, and that the condition should be treated with Tetracycline (Bergholt et al. 1989).

The contact rates from infections were estimated to be slightly higher in Upernavik than in general practice in Denmark, but due to the many chronic diseases in the older population of Denmark, the proportion of contacts due to infections was considerably higher in Upernavik, i.e. 38% compared with 21% to 33% in a number of Danish studies (Bjerregaard 1985 [3]) (due to different study designs only certain infections could be compared, which is why the proportion was reduced from 41% to 38% for Upernavik).

In comparison with Denmark the contact rates in Upernavik were particularly high due to gonorrhea, chronic purulent otitis media and impetigo, while contact rates due to epidemic children's diseases, influenza and urinary tract infections were lower in Upernavik than in Denmark (Bjerre-

gaard & Bjerregaard 1985 [2]). The high prevalence of chronic otitis media has been confirmed for other parts of Greenland (Pedersen & Zachau-Christiansen 1988).

Death register study

Mortality was studied for infectious diseases (G 1), tuberculosis (G 2) and acute respiratory infections (G 6), and separately for whooping cough, meningococcal disease and meningitis (ICD 036, 320) and measles. Infectious diseases and acute respiratory infections together were only responsible for 4.2% of potential years of life lost between ages 1 and 65 (Bjerregaard & Johansen 1987 [6]) but 22% of infant deaths were due to these causes (Bjerregaard 1986b [5]).

Mortality rates from infectious diseases were high in infants and low during adult life with a slight increase in the 65 + year old, while mortality rates from acute respiratory infections were equally high in infants and 65 + year old persons and low in between (Fig. 5) (Bjerregaard 1988c [7]). Mortality rates were significantly higher in Greenland than in Denmark with age standardized ratios of 10.5:1 for infectious diseases, 5.5:1 for acute respiratory infections and 7.0:1 for meningitis and meningococcal disease ($p < 0.001$))(Bjerregaard 1988c [7], Bjerregaard & Juel 1990 [10]).

The mortality rate from infectious diseases decreased from 1968/73 to 1980/85, in males from 37

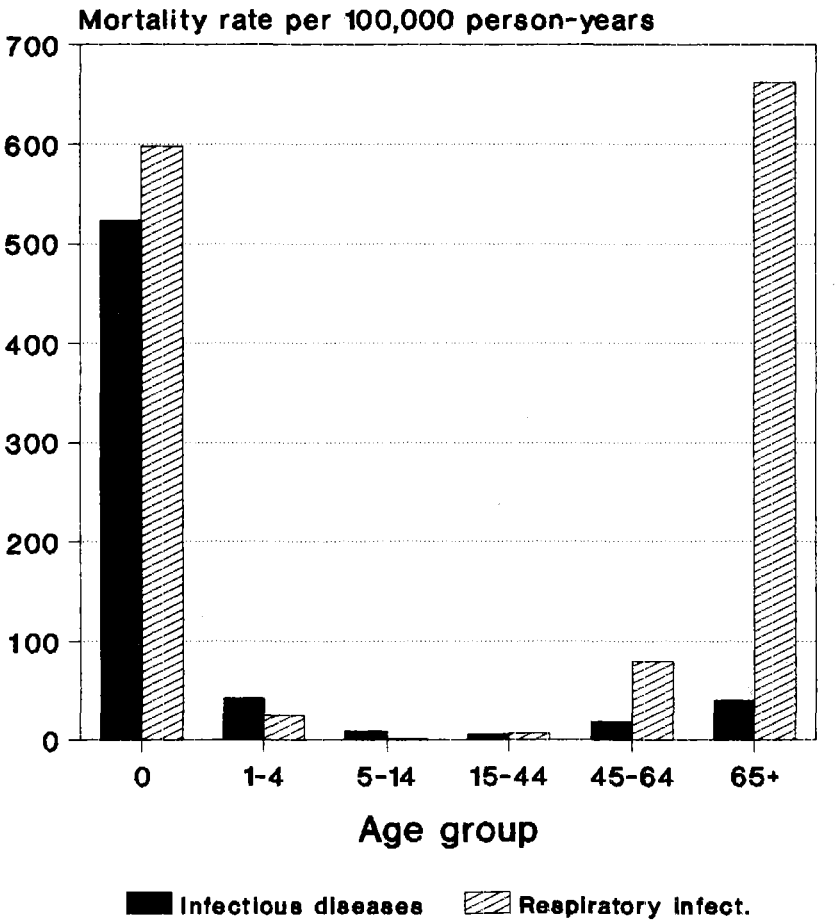

Fig. 5. Age specific mortality rates per 100,000 person-years in the native population of Greenland 1968-1985. Infectious diseases (G 1) and acute respiratory infections (G 6).

to 17 per 100,000 person-years ($p = 0.002$) and in females from 34 to 20 ($p = 0.039$), while the decrease was less pronounced for acute respiratory infections, i.e. from 54 to 46 per 100,000 person-years in males and from 65 to 46 in females ($p > 0.10$)(Bjerregaard 1988c [7]). When only the 0-49 year old are analysed, the decrease in mortality due to acute respiratory infections was significant, i.e from an index value of 1.00 in 1968/73 to 0.39 in 1980/85 ($p < 0.001$) (Bjerregaard & Juel 1990 [10]).

The mortality rate from meningitis and meningococcal disease in the 0-64 year old showed no significant secular change (Bjerregaard & Juel 1990 [10]). One fourth of the fatal cases were diagnosed as meningococcal disease compared with one fifth in Denmark. The incidence of notified cases increased from 12 per 100,000 person-years in 1980 to 36 in 1986 (Chief Medical Officer 1986) while the incidence in Denmark was only 8 per 100,000 person-years (1983-1987 average reported by the State Serum Institute). During 1981-1983, the incidence and case fatality rate of meningitis caused by ampicillin resistant Haemophilus influenzae were very high, possibly due to the high consumption of penicillin in Greenland, and a change in the initial treatment of purulent meningitis was recommended (Cordtz et al. 1987).

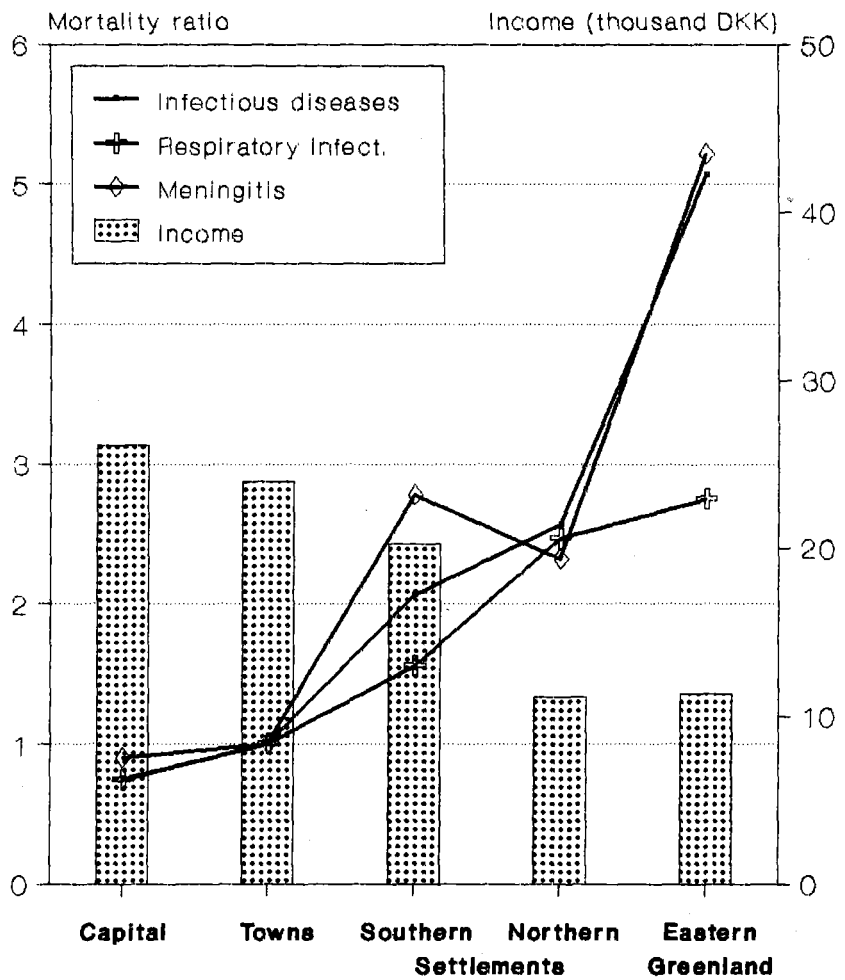

Fig. 6. Mortality due to infectious diseases (G 1), acute respiratory infections (G 6) and meningitis (ICD 36, 320), and average yearly income per person in 1979-1980 in the native Greenlandic population of different geographic areas. Ratios between age standardized mortality rates 1968-1985 with rates of towns in Western Greenland chosen as 1.00.

Infectious diseases showed a pronounced geographic variation and a negative association with income (Fig. 6). Mortality rates were low in the capital and slightly higher in other towns in Western Greenland, while settlements and in particular Eastern Greenland had high rates. At a more detailed geographic level (20 locations), an association was observed between income and mortality from acute respiratory infections (R(Spearman) = -0.57; p = 0.012) (Bjerregaard 1990a [9], Bjerregaard & Juel 1990 [10]).

Immunizable diseases

In Greenland, all children are offered immunization against tuberculosis, whooping cough, diphtheria, tetanus, poliomyelitis and measles, and since 1987 also against mumps and rubella.

Tuberculosis was a major cause of morbidity and mortality until the late 1950s. General BCG vaccination was introduced in 1949 along with other epidemiologic interventions as part of the tuberculosis eradication campaign. Although tuberculosis has ceased to be a major public health problem and only accounts for 0.3% of potential years of life lost, the mortality rate from tuberculosis in the 5-64 year old, which is considered an avoidable cause of death, was 42 times higher in Greenland than in Denmark (Bjerregaard & Juel 1990 [10]). The morbidity rate from tuberculosis decreased steeply during the 1950s and the decline continued during the 1960s and 1970s (Fig. 7). The incidence is still significantly higher in Greenland than in Denmark: in 1988 there were 34.4 new cases per 100,000 inhabitants in Greenland compared with 5.9 per 100,000 inhabitants in Denmark (crude rates) (Andersen 1989).

The mortality rate from whooping cough was 44 times higher in Greenland than in Denmark during 1980/85 but the number of deaths was small (2 in Greenland). Mortality decreased over time (Bjerregaard & Juel 1990 [10]). In the 1950s and 1960s, epidemics with very high incidence rates took place. Since the last great epidemic in 1968, two small epidemics took place in 1977 and around 1982 (Fig. 7).

A few epidemics of diphtheria took place during the 19th century (Bertelsen 1943). Tetanus has never occurred in Greenland (Bertelsen 1935, 1940, 1943, Chief Medical Officer 1951-89). General immunization of children was nevertheless introduced in 1951, probably in order to have similar vaccination programmes in Greenland and Denmark, but revaccination against tetanus following injuries or of pregnant women has never been a routine in Greenland. Clostridium tetani has been demonstrated in Greenlandic soil although to a significantly lower degree than in Danish soil so the possibility of locally contracted tetanus does exist (Bjerregaard et al. 1986).

Poliomyelitis has occurred repeatedly in Greenland in the form of epidemics. The first cases were described in 1858. In the first half of the present century, four epidemics were described in 1913, 1920, 1925 and 1933, and in 1952-1953 Greenland had its last major polio epidemic with 286 notified cases, 144 paretic cases and 22 deaths (Fog-Poulsen 1955, Eskesen & Glahn 1955). Immunization against polio with inactivated vaccine was introduced in 1955 and in 1963 oral polio vaccination with live vaccine was introduced. A small epidemic occurred in 1959 (13 cases of which 3 were paretic) and the last notified case occurred in 1962 (Fig. 7).

Measles was probably not introduced into Greenland until 1945 but due to prompt isolation of the affected household only two secondary cases occurred. In 1951, however, the first of a series of major epidemics took place. The virus was repeatedly introduced into Greenland and by 1955 most of Western Greenland had been hit (Christensen et al. 1954, Fog-Poulsen 1957). After a major epidemic in 1962, all of Greenland except a few remote places had had one or more measles epidemics. Vaccination was performed already in 1965 in those places which had not yet had measles epidemics and in 1976 measles vaccination was added to the general vaccination programme for children. In 1987, measles vaccination was substituted by a combined measles-mumps-rubella vaccination. Since the last major epidemic in 1962, measles epidemics have occurred every 3-5 years, latest in 1989, which is an indication that the vaccination programme does not function optimally (Fig. 7). Mortality from

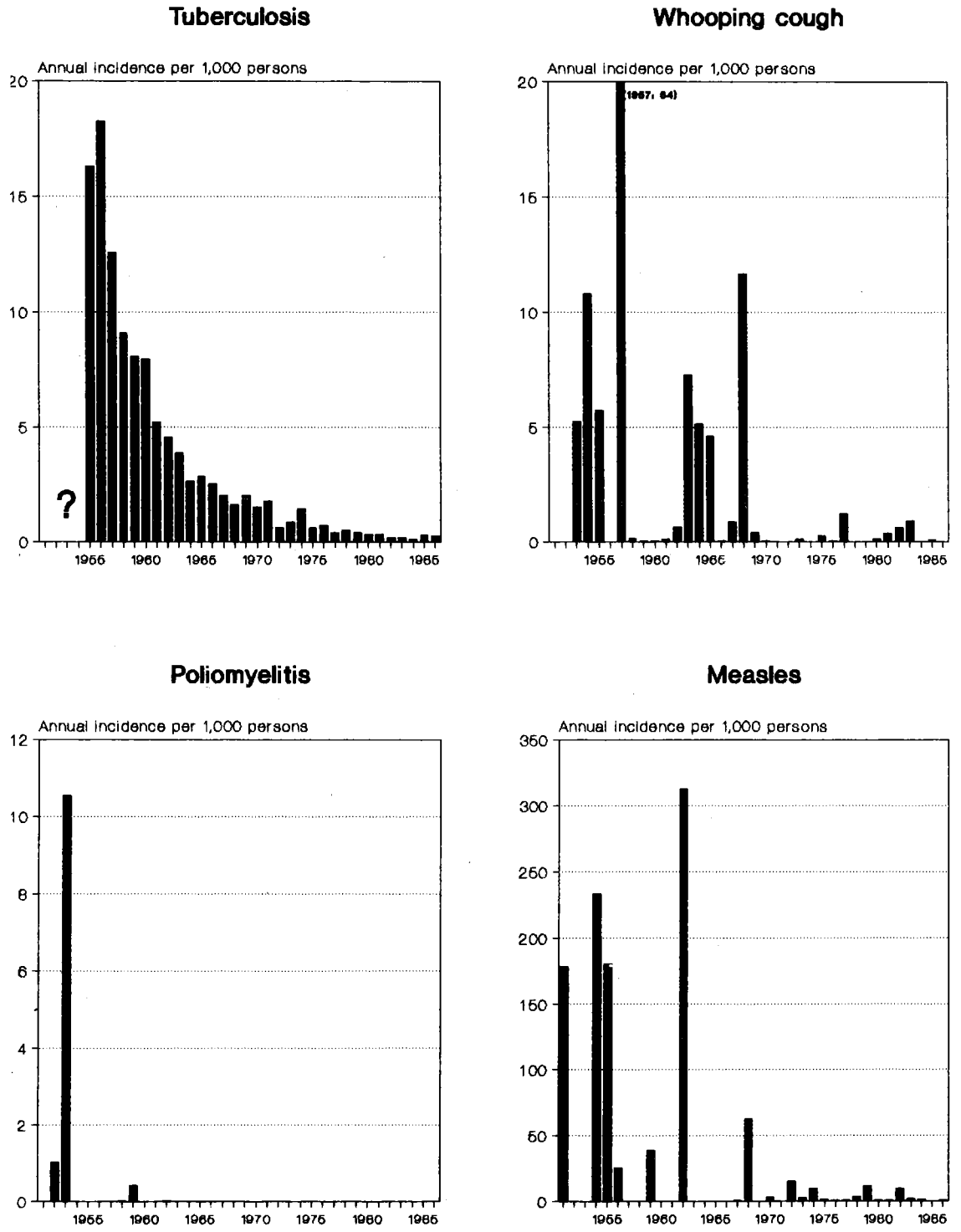

Fig. 7. Annual incidence rates of certain infectious diseases per 1,000 native Greenlanders 1951-1986. Notified cases according to the Chief Medical Officer for Greenland.

measles during 1980/85 was 25 times higher in Greenland than in Denmark but a significant drop in measles mortality occurred in Greenland from 1968/73 to 1980/85. Measles mortality was lowest in the capital and other towns on the West Coast and considerably higher in settlements and in Eastern Greenland (Bjerregaard & Juel 1990 [10].

Chronic diseases

Cancer

Current knowledge of the Greenlandic cancer pattern is reviewed in section 9. The topic is well studied and the present study has little to add. In the Upernavik study (Bjerregaard & Bjerregaard 1985 [2]), the age standardized contact ratio between Upernavik and Århus was found to be 0.43:1 ($p < 0.05$) for neoplasms and the whole difference was caused by malignant neoplasms. There were only 20 contacts due to neoplasms which are of course far too few to illustrate the cancer pattern.

Cancer was an important cause of death also in the younger age groups. In both males and females, cancer ranked highest among the natural causes of potential years of life lost (PYLL), responsible for 24% and 32%, respectively, of PYLL due to diseases (Bjerregaard & Johansen 1987 [6]). PYLL rates due to cancer increased in males and decreased in females from 1968/72 to 1979/83 while the cancer mortality rates increased in both sexes, although not statistically significant (Bjerregaard 1988c [7]).

The increase in mortality rates was caused by a significant increase in mortality from lung cancer in both males and females from 1968/73 to 1980/85, i.e. from 14 to 38 per 100,000 person-years in males and from 6 to 24 in females ($p < 0.001$), while mortality rates from cancer of cervix uteri and other cancers remained constant (Bjerregaard 1988c [7]). No difference was observed between towns and settlements but the mortality rate from lung cancer was lower in Eastern Greenland than in the rest of the country and the mortality rate from cervix cancer higher, however not statistically significant (Bjerregaard & Juel 1990 [10]). Compared with Denmark, the mortality rates from lung cancer and all other cancers were similar in males while mortality rates in females were significantly higher in Greenlanders, i.e. 1.6 times higher for lung cancer, 3.2 times higher for cervix cancer and 1.1 times higher for all other cancers (Bjerregaard 1988c [7]).

Ischaemic heart disease, hypertension and stroke

The incidence rates of ischaemic heart disease and hypertension have generally been considered to be low in Greenland. Simper (1976) found low blood pressure in Inuit from Thule district but in other studies the blood pressure of Greenlanders has been comparable to that of a Danish population (Bjerager et al. 1982). In Upernavik, low contact rates were observed due to hypertension and ischaemic heart disease (Bjerregaard & Bjerregaard 1985 [2].

The death register study confirmed a low mortality rate from ischaemic heart disease in native Greenlanders compared with Danes living in Denmark, failed to show a difference for hypertensive disease mortality and showed a higher mortality rate due to other heart diseases in native Greenlanders. Total cardiovascular mortality, excluding stroke, was similar in Greenlandic and Danish males but higher in Greenlandic females than in Danish females (ratio 1.4:1; 95% confidence interval 1.2-1.6:1) (Bjerregaard & Dyerberg 1988 [8]).

The age standardized ratio of mortality rates from ischaemic heart disease between native Greenlanders and the population of Denmark was 0.6:1 (0.5-0.7:1) in males and 0.9:1 (0.7-1.1:1) in females. The mortality rates from ischaemic heart disease decreased from 1968/72 to 1979/83 in both males and females and in all age groups, a trend which is also seen in most industrialized countries (Thom 1989). The mortality rate from ischaemic heart disease was furthermore lower in Greenlandic settlements than in towns, in particular for females (Bjerregaard & Dyerberg 1988 [8]).

In view of the poor validity of diagnoses of heart diseases, it is probable that the diagnostic distinction between ischaemic heart disease and other heart diseases is uncertain. The decreasing secular trend for ischaemic heart disease and the increasing trend for other heart diseases almost balanced each other and the trends may to some unknown extent be influenced by a shift in diagnostic habits. Although it seems probable that mortality from ischaemic heart disease is lower in Greenland than in Denmark and that the secular and geographic trends described above are correct, the ultimate description of mortality from ischaemic heart disease in Greenland is unlikely to come from a death register study.

In the above mentioned study covering 1968-1983 (Bjerregaard & Dyerberg 1988 [8]), it was concluded that mortality from ischaemic heart disease in males was similar in Danes living in Greenland and Denmark. This question is important for the discussion about a dietary cause of the low mortality from ischaemic heart disease in Greenland and the analysis of male mortality from ischaemic heart disease was therefore repeated with information from the period 1968-1987 (Table VII). Greenlanders had significantly lower mortality rates from ischaemic heart disease than Danes living in Greenland, in particular in early age. Danes living in Greenland had significantly lower mortality rate from ischaemic heart disease than the population of Denmark but the difference was only seen in the 45-64 year old. Danes living in Greenland are, however, probably healthier than the general population of Denmark, which is supported by the observation of lower mortality rates from all natural causes in the former, and the proportion of deaths from ischaemic heart disease to all natural deaths did not differ between Danes living in Greenland and in Denmark (Table VII).

It is concluded that Danish males living in Greenland have a significantly higher mortality rate from ischaemic heart disease than Greenlandic males, but that the difference between Danish males in Greenland and Denmark is only found in the 45-64 year old and that it may be due to a generally more healthy population of Danes in Greenland. Furthermore, ethnic misclassification may also play a role if a number of persons classified as Danes on the basis of their place of birth were in fact Greenlanders. Although the mortality rates from ischaemic heart disease may be similar in Danes living in Greenland and in Denmark, this should not be taken as evidence against a dietary explanation of the low mortality rate from ischaemic heart disease in Greenland since the Danes living in

TABLE VII. Mortality from ischaemic heart disease and all natural causes in males. Comparison between Greenlanders and Danes living in Greenland (1968-1987), and between Danes living in Greenland (1968-1987) and population of Denmark (1970/76/82 average). Mantel-Haenszel ratios and test.

	Greenlanders/ Danes (in Greenland)		*Danes in Greenland/ Population of Denmark*					
Mortality due to:	*Ischaemic heart disease*		*Ischaemic heart disease*		*All natural causes*		*IHD as % of all natural causes*	
Age group	*ratio*	*p*	*ratio*	*p*	*ratio*	*p*	*ratio*	*p*
15-44	*0.33*	*0.009*	*1.18*	*0.61*	*0.84*	*0.26*	*1.42*	*0.19*
45-64	*0.64*	*0.038*	*0.59*	*0.003*	*0.60*	*<0.001*	*0.98*	*0.88*
65-84	*0.60*	*0.129*	*0.95*	*0.86*	*0.97*	*0.85*	*0.98*	*0.94*
All	*0.60*	*0.001*	*0.72*	*0.021*	*0.71*	*<0.001*	*1.05*	*0.73*

Greenland have not been characterized with respect to relevant exposure variables.

Casuistic reports have demonstrated extensive arteriosclerosis in native Greenlanders (Helweg-Larsen 1984) and ultrasonographic examinations of arteries showed the occurrence of arteriosclerosis to be similar in Greenlanders and Danes (Hancke et al. 1990). The lipid metabolism of Greenlanders on a traditional diet rich in n-3 polyunsaturated fatty acids is shifted towards a pattern which favours antithrombotic activity. The most important factors are probably decreased platelet aggregability and increased bleeding time (Bang & Dyerberg 1981, Dyerberg & Bang 1982, Dyerberg 1989). It has furthermore been suggested that C3-polymorphism in the complement system is associated with arteriosclerosis and that the C3F gene, which is significantly less frequent in native Greenlanders than in Danes, is positively associated with arteriosclerotic disease (Dyerberg & Bang 1982, Stoffersen et al. 1982).

Bang & Dyerberg's hypothesis is attractive but it does not explain why mortality from ischaemic heart disease decreases at a time when the Greenlandic community becomes increasingly westernized also regarding dietary habits (Helms 1982). Neither is the probable occurrence of arteriosclerosis at a European level explained.

Mortality from stroke was significantly higher in native Greenlanders than in Denmark with no certain secular trend, but to what extent this was due to thrombosis and to what extent to haemorrhagic disease is unknown (Bjerregaard & Dyerberg 1988 [8]). For males the rate was significantly lower in Greenlandic settlements than in towns. The high mortality rate from stroke in Greenland may also be explained by the above described altered lipid metabolism, decreased platelet aggregability and increased bleeding time.

For the sake of completeness it should be mentioned that a high incidence of bleeding intracranial aneurysms in native Greenlanders compared with Danes has been tentatively explained by different connective tissue properties in the two populations (Kristensen 1983).

Accidents

Although the mortality rate from accidents has decreased in Greenland during the last century, the relative importance of accidents as causes of death has increased. Their study has nevertheless attracted limited attention from the medical profession. In Upernavik district, accidents accounted for 12% of all contacts with the medical officers, second in importance only to respiratory diseases (Bjerregaard & Bjerregaard 1985 [2]).

The importance of accidents as a public health problem and its close association with alcohol misuse has been stressed in several recent publications (Hovesen & Jørgensen 1983, Jørgensen et al. 1984, Thorn et al. 1986). During 1979-1983, fatal accidents accounted for 38% of Potential Years of Life Lost before the age of 65 (PYLL) in native Greenlandic males, more than one and a half times as many as due to all diseases together, and 22% in females (Bjerregaard & Johansen 1987 [6]).

Mortality rates from all accidents together were higher in males than in females at all ages but differences were small in age groups 0-4 and 65+. In males, the mortality rate was very high in infants, low in 1-14 year old children and high in adults with a peak in the 20-29 year old and another peak in the 70+ year old (Fig 8). In females, a high mortality rate in infants was followed by low rates in children and young adults and a steadily increasing trend from 45 years of age.

Different accident types, however, exhibited different age patterns (Table VIII) (Bjerregaard 1990b [11]). Deaths due to motor vehicle accidents, accidental shots and mechanical suffocation had their highest incidence in children. Mechanical suffocation caused 64% of all accidents in infants and if it is accepted that most of these deaths are in fact misdiagnosed cases of SIDS, as it was argued above, the high infant mortality rate from accidents is reduced accordingly to approximately the same level as seen in 1-4 year old children. Drowning and boat accidents were frequent in all age groups but the highest mortality rates were seen in young adults. Fatal accidents due to cold and falls had the highest incidence in persons above 45 years and 65 years, respectively, and deaths due to fire showed

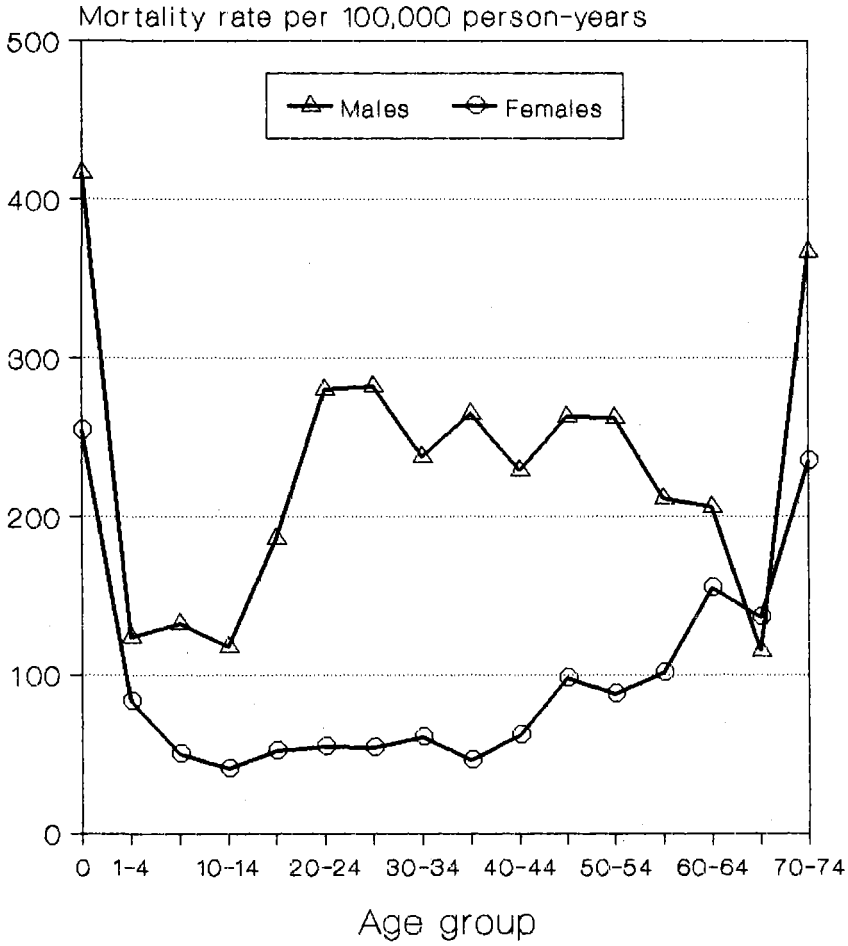

Fig. 8. Age specific mortality rates from accidents (ICD E800-949). Rates per 100,000 person-years in the native population of Greenland 1968-1985. 0 year, 1-4 years and five-year age groups.

a U-shaped curve with high incidence in infants and older persons.

The mortality rate from all accidents together decreased significantly from 1968/73 to 1980/85 and this held true for most accident types although the decrease was not always statistically significant (Table VIII). The mortality rate from boat accidents increased slightly as the result of a decreased mortality rate from alcohol related boat accidents and a significantly increased mortality rate from boat accidents not related to alcohol (Bjerregaard & Juel 1990 [10], Bjerregaard 1990b [11]). An explanation of the increased mortality from boat accidents may be that in an increasingly affluent society an increasing number of new unexperienced boat owners put themselves at risk. The mortality rate from accidents due to fire showed no secular change and the incidence of fatal falls increased but not statistically significant. Danes living in Greenland had a lower mortality rate from accidents than Greenlanders (ratio 0.29:1; $p < 0.001$) but higher mortality rate than Danes living in Denmark, in particular for males (ratio 2.46:1; $p < 0.001$). In Greenland, the accident pattern of Danes differed considerably from that of Greenlanders also after control for age and sex: Danes had a lower proportion of drowning, boat accidents and accidental shots and a higher proportion of car accidents, mechanical suffocation, work related accidents and other accidents.

TABLE VIII. Epidemiological characteristics of types of accidents in the native population of Greenland 1968-85: Age and sex pattern and secular trend.

ACCIDENT TYPE (external cause)	*Number*	*% in Males*	*Age pattern: Highest incidence in age group*	*Secular trend**	*p***
Drowning from land or ice	*240*	*81*	*15-24*	*0.77*	
Boat traffic	*190*	*96*	*15-44*	*1.08*	
Fire	*93*	*46*	*U-shaped*	*0.98*	
Cold	*70*	*60*	*45+*	*0.63*	*0.112*
Fall	*57*	*51*	*65+*	*1.50*	
Motor vehicle traffic	*53*	*58*	*1-4*	*0.81*	
Accidental shot	*48*	*88*	*5-14*	*0.36*	*0.080*
Work related	*47*	*100*	*15-64*	*0.58*	*0.100*
Mechanical suffocation	*45*	*67*	*0*	*0.33*	*0.008*
Other	*161*	*65*	*U-shaped*	*0.47*	
TOTAL	*1004*	*74*	*U-shaped*	*0.75*	*<0.001*

* *1980-85/1968-73 rate ratio.*

** *Mantel-Haenszel test for no difference between the two periods. Only p values less than 0.15 are shown.*

Accidents and alcohol

Alcohol misuse is recognized as a major problem in Greenland, not least by the health services, and it is therefore surprising that relatively few studies have been made on this topic by health professionals. During colonial times, it was in principle forbidden to serve alcohol to the indigenous population but alcohol was at the same time used as payment or reward for services rendered and thus attained a social value as it was connected with the higher status of the Danish administrators and their Greenlandic helpers. In 1954, the purchase of alcohol was allowed for all adults but the local brewing of 'imiaq' had been widespread for years. From around 1960, the import of alcohol increased steeply until the early 1970s when the estimated annual consumption exceeded 15 litres of 100% alcohol per adult compared with 10 litres in Denmark, which has the highest registered alcohol consumption in the Nordic countries. The trend is still increasing though less pronounced. (Ministry for Greenland 1986, Danmarks Statistik 1987).

In one West Greenlandic town (Ilulissat), 12% of admissions to hospital during 1983 were caused by alcohol, either consumed by the patient or, in case of violence, by another person (Pedersen et al. 1984). This is comparable to the results of studies in Denmark and other western countries, but in Greenland two thirds of the admissions were due to accidents or violence and only a few cases were due to disease caused by chronic alcohol misuse, which is the most common cause in western countries. Men and women were equally represented.

42% of all cases were caused by violence inflicted by another person, often very serious lesions, e.g. contusion of the eye resulting in blindness, jaw fractures, fracture of the cervical spine with compression of the spinal cord, and gunshot wounds. The author has witnessed a very similar picture in Upernavik and the description is probably typical of most Greenlandic towns.

In the death register study on mortality from accidents, an alcohol related death was defined as a death where the underlying or contributory diagnosis was alcoholic psychosis (ICD 291), alcoholism (ICD 303), alcoholic cirrhosis of the liver (ICD 571.0) or acute alcohol intoxication (ICD E860, N979, N980). Most alcohol related deaths (82%) were classified as such on the basis of a contributory diagnosis of alcoholism, which includes inebriation (ICD 303) and this proportion was constant throughout the study period. As such a contributory diagnosis is included at the discretion of the medical officer responsible for filling out the death certificate, the frequency of alcohol related deaths must be a minimum figure, but as the study covered a much longer period than the average stay of a medical officer in Greenland, it is not probable that personal diagnostic habits have biased the registration of alcohol relation.

A total of 228 of the 1004 fatal accidents registered during 1968-1985 (23%) were classified as alcohol related. Alcohol related deaths made up a significantly higher proportion of fatal accidents in females than in males but the absolute numbers and mortality rates were higher in males. For all age groups together, 20% of fatal accidents in males and 30% in females were alcohol related ($p < 0.001$) but in the 25-64 year old, alcohol related accidents made up 34% in males and 61% in females ($p < 0.001$). The proportion of alcohol related accidents varied much among different accident types, ranging from 51% in accidents due to cold and 35% in falls to 22-23% in drowning and boat accidents and less than 10% in motor vehicle accidents, accidental shots, work related accidents and mechanical suffocation (Bjerregaard 1990b [11]).

Mortality from alcohol related accidents showed a decreasing secular trend. The proportion of alcohol related accidents to all fatal accidents decreased from 26% in 1968/73 to 19% in 1980/85 ($p = 0.06$) and the ratio between the age standardized mortality rates in the two periods was 1:0.45 ($p < 0.001$)(Bjerregaard 1990b [11]). The decrease was predominantly caused by marine accidents, i.e. drowning and boat accidents, and for these accident types the secular trend was different for alcohol related accidents and non alcohol related accidents (Bjerregaard & Juel 1990 [10], Bjerregaard 1990b [11]). The mortality rate from alcohol related drowning and boat accidents decreased significantly while the mortality rate from drowning not related to alcohol remained constant and the mortality rate from boat accidents not related to alcohol increased significantly (1980/85:1968/73 ratio = 1.56:1; $p = 0.021$) (Bjerregaard 1990b [11]).

A comparison of mortality during a period with restriction on the sale of alcohol (1979-1982) and a control period showed a decrease in alcohol related mortality from both natural causes and accidents in the restricted period, but the decrease was more than counterbalanced by increased mortality from drowning and boat accidents not related to alcohol. It is thus possible that alcohol restriction does not reduce mortality but merely changes the mortality pattern (Bjerregaard 1988b).

The decreasing secular trend for alcohol related accidents is puzzling in the light of the increased alcohol consumption. The proportion of fatal accidents classified as alcohol related on the basis of a contributory diagnosis was constant during the study period, which indicates stable diagnostic habits and coding practices. Furthermore, the mortality rate from alcohol related natural deaths increased significantly during the same period and a selective underreporting of alcohol relation for accidents is unlikely (Bjerregaard & Juel 1990 [10]). An explanation may be looked for in the drinking habits of the population: If a fixed group of persons is responsible for most of the increased alcohol consumption and these people increasingly concentrate on drinking and do not mix alcohol with potentially dangerous activities, the resulting mortality pattern would resemble the observed pattern.

Suicides and homicides

Suicides

During the first half of this century, the suicide rate was very low in Greenland, i.e. 3-4 per 100,000 person-years (Bertelsen 1935), but since 1950 and in particular since 1970 it has increased dramatically to one of the highest suicide rates in any population group in the world. Similar very high suicide rates have been observed in other circumpolar areas (Rodgers 1982, Hlady & Middaugh 1987). The official Greenlandic suicide statistics are reliable (Thorslund & Misfeldt 1989). The performers were predominantly young men 15-24 years old and the increase was particularly pronounced in this group. The methods are determined, most often shooting or hanging, and the motives often reported as being obscure (Lynge 1985).

Suicide rates differed very much among the municipalities in Greenland and the highest rates were found in the capital and in certain remote areas that were colonized late, i.e. less than 100 years ago, while the geographic pattern for low rates was less clear (Lynge 1985). It must, however, be born in mind that a Greenlandic municipality does not present uniform living conditions since it comprises both a small town and a number of settlements, and accordingly a geographic analysis at municipality level will often yield confusing results.

A common experience of those who committed or attempted suicide was a poor emotional atmosphere in the parental home, i.e. disharmony, quarrels and alcohol abuse, while broken homes apparently did not play a role (Grove & Lynge 1979). The results of a sociopsychologic study on suicides in young Greenlanders showed that the suicide risk was highest in the less developed towns, and in towns it was highest in hunters, fishermen and those unemployed or with unstable occupation (Thorslund 1989, 1990).

The present study confirmed the magnitude of suicides as a public health problem: Suicides were responsible for 24% of potential years of life lost before age 65 (PYLL) in native Greenlandic males and 16% in females during 1968-1983 and the PYLL rate tripled from 1968/72 to 1979/83 (Bjerregaard & Johansen 1987 [6]). In 1974/79 and 1980/85, suicides were the most frequent single cause of death in males with marine accidents as number two while, in females, it climbed from number nine on the list of single causes of death in 1974/79 to number four in 1980/85 (Bjerregaard 1988c [7]). The relationship between suicides and alcohol is complex and it was decided not to analyse suicide mortality in relation to information on alcohol in the death certificates because it would be very difficult to interpret the results in a meaningful way.

The geographic variation was pronounced and showed a clear pattern (Bjerregaard 1990a [9]): In the capital and in Eastern Greenland (one of the above mentioned areas that was colonized late), the age standardized suicide rates were high, i.e. 102 and 105 per 100,000 person-years, respectively. The suicide rate was also high in a third area that was colonized late, i.e. Northern Greenland, but because of its small population it was not included in the analysis cited. In towns in Western Greenland, excluding the capital, the suicide rate was 50 per 100,000 person-years and in settlements in Western Greenland it was only 25 per 100,000 person-years, which is the same level as found in Denmark.

An analysis at a more detailed geographical level (20 locations) demonstrated a positive correlation between population change and suicides and, in Western Greenland, between community size and suicides. The findings of Thorslund (1989, 1990) that the suicide rate was highest in the less developed (small) towns, were not confirmed.

Homicides

Also the homicide rate is very high in Greenland and has increased considerably over the last 30 years, from less than 2 per 100,000 person-years in 1946/50 to more than 20 per 100,000 person-years since 1976, similar to rates in certain Latin American countries and big cities in the USA. For a comparison,

the rates in Denmark have remained stable around 1 per 100,000 person-years throughout the period (Hansen JPH 1985). Homicides were not analysed separately in the present study but the high rates and a five fold increase for males from 1968/73 to 1980/85 were confirmed. The homicide rates were higher in Greenlandic towns than in settlements for both sexes, approximately 1.7 times higher for males and 1.3 times higher for females but the differences were not statistically significant (Bjerregaard 1988c [7])

7. AVOIDABLE DEATHS AND POTENTIAL YEARS OF LIFE LOST

From a certain point of view some deaths can be regarded as avoidable. This concept was formulated by Rutstein and coworkers in 1976 (Rutstein et al. 1976). It implies that death from certain causes may be averted either through preventive medical care or medical treatment or through more general interventions at community level such as, e.g., an alcohol policy or the use of seatbelts. Rutstein proposed a large number of diseases and causes of death which in certain age groups were considered to be avoidable and subsequent studies have chosen from this list. The selection of a list of avoidable deaths for a particular study is culture- and time specific and must take into account not only the mortality pattern in the community to be studied, but also the level and organization of health care, political attitudes towards health and other relevant factors.

Another epidemiological measure which implies that certain deaths are more undesirable than others is "Potential Years of Life Lost" (PYLL) (Haenszel 1950, Romeder & McWhinnie 1977). This measure weights each death according to the number of years the deceased could have lived until an arbitrary cutoff point, which is often chosen as the age of 65. Usually, also a lower age limit is defined and deaths before 1 year of age are not included.

Avoidable deaths

For Greenland, 15 causes of death were proposed to be avoidable in certain age groups and studied with focus on secular and regional variation (Bjerregaard & Juel 1990 [10]). All causes were significantly more common in Greenland than in Denmark. Table IX shows the secular variation during 1968-1985. Whereas mortality from acute and most chronic infectious diseases and alcohol related accidents decreased over time, mortality from lung cancer, boat accidents not related to alcohol, suicides and alcohol related natural deaths increased significantly. The decreasing trend for infectious diseases may be interpreted as a combined result of general improvement of living conditions and an improved health care system. Tuberculosis and meningitis did not share the decreasing trend of the other infectious diseases. Mortality from tuberculosis has decreased drastically since the 1950s, when it accounted for 1/3 of all deaths, but it has remained constant since 1960 and is still very high compared with Denmark. This may be an aftermath of the previous epidemic but further studies of the reasons for the high mortality rate are relevant. Meningitis was discussed above.

The factors responsible for the increased mortality rates from lung cancer, boat accidents, suicides, and alcohol related natural deaths must all be sought for outside the health care system since medical prevention or treatment of these conditions is not possible to any relevant extent. The increase in lung cancer mortality parallelled increased smoking of cigarettes and the only relevant way to reduce mortality from lung cancer is through a reduction of cigarette smoking. The peculiar pattern for boat accidents, in particular the pronounced decrease in the middle period, is probably explained by a high proportion of missing death certificates in 1975-1976, many of which are suspected to be from marine accidents. Boat accidents and suicides were further discussed above.

Some general aspects of alcohol related deaths were discussed above in relation to accidents. A study from one Greenlandic district found relatively few admissions to hospital caused by chronic alcohol misuse, and suggested that this was because the high consumption of alcohol only started

TABLE IX. Secular changes in mortality due to avoidable deaths in the native population of Greenland 1968-1985. Index values standardized for age and region. 1968/73 chosen as 1.00.

Disease	*Age group*	*Number*	*1968/73*	*1974/79*	*1980/85*	*p**
Decreasing trend:						
Measles	*0-14*	*20*	*1.00*	*0.25*	*0.17*	*0.005*
Cervix cancer	*5-64*	*58*	*1.00*	*0.96*	*0.84*	
Chronic rheumatic heart disease	*5-44*	*18*	*1.00*	*0.51*	*0.37*	
Acute respiratory infections	*0-49*	*162*	*1.00*	*0.60*	*0.39*	*< 0.0001*
Chronic bronchitis	*0-49*	*29*	*1.00*	*0.84*	*0.64*	
Alcohol related accidents	*15+*	*221*	*1.00*	*0.50*	*0.45*	*< 0.0001*
Constant trend:						
Tuberculosis	*5-64*	*68*	*1.00*	*1.58*	*1.10*	
Meningitis	*0-64*	*60*	*1.00*	*1.34*	*0.85*	
Increasing trend:						
Lung cancer	*5-64*	*109*	*1.00*	*2.56*	*3.11*	*< 0.0001*
*Boat accidents***	*All*	*173*	*1.00*	*0.55*	*1.48*	*< 0.0001*
Suicides	*10+*	*405*	*1.00*	*1.80*	*3.55*	*< 0.0001*
Alcohol related natural deaths	*15+*	*138*	*1.00*	*1.39*	*1.95*	*0.009*

** p-value for the test of no difference between periods (Multiplicative Poisson model). Only p values less than 0.10 are shown.*
*** excluding alcohol related accidents*

relatively recently, i.e. in the 1960s (Pedersen et al. 1984). This seems plausible and their fear that the health services in the years to come will be burdened by diseases due to chronic alcohol misuse were supported by our findings of a significantly increasing secular trend for mortality due to alcohol related natural causes (Bjerregaard & Juel 1990 [10]). The secular increase parallelled the increased alcohol consumption and the suicide rate, which is not surprising since alcohol misuse and suicides may both be viewed as selfdestructive behaviour and reflect underlying psychic problems. Alcohol related disease was the main diagnosis in 27% of cases but this proportion increased significantly over time from 8% in 1968/73 to 38% in 1980/85 ($p = 0.01$), which suggests that the increasing trend of mortality from alcohol related disease is not to be explained by an increased tendency to add an alcohol related diagnosis to the main diagnosis on the death certificate and that alcohol is becoming an increasingly important factor.

A remarkable geographic variation was observed for most avoidable deaths. This supports the hypothesis that external and potentially modifiable factors are responsible for these deaths (Bjerregaard & Juel 1990 [10]).

Potential years of life lost (PYLL)

As an indicator of premature death, potential years of life lost (PYLL) were calculated as the number of years from the age at death to 65 years in persons who died between ages 1 and 64. During 1968-1983, 215 potential years of life were lost per 1,000 person-years in Greenlandic males and 89 in females (Bjerregaard & Johansen 1987 [6]). For all natural causes of death together, the PYLL rates in Greenland were 2.1 times higher than in Denmark for males and 2.4 times for females, while they were 7.1 and 5.4 times higher, respectively, for violent causes of death.

In Greenlandic males, 70% of PYLL were due to accidents, suicides or homicides, and in females 52%, while considerably less (34% and 16%) of all deaths were due to these causes, which means that the average age at death is less for violent deaths than for all deaths together (Fig. 9). This stresses the importance of the violent causes of death as a public health problem as these deaths are not only common but also occur in young people. In males, half of the PYLL were lost due to just two causes, i.e. marine accidents and suicides.

The most important natural cause of PYLL was cancer for both males and females; this was also the case in Denmark. While heart diseases were an important cause of PYLL in males in Denmark, responsible for almost one quarter of PYLL from natural causes, they only accounted for 8% in Greenland. For natural causes, the largest differences between Greenland and Denmark were observed for acute infectious diseases and cerebrovascular disease which were 5-10 times as common a cause of PYLL in Greenland as in Denmark.

The secular trends of PYLL from different causes were similar to those of mortality rates described above, the most important changes being a decrease due to infectious diseases and "other accidents", balanced by an increase due to suicides. The high PYLL rates were geographically unevenly dis-

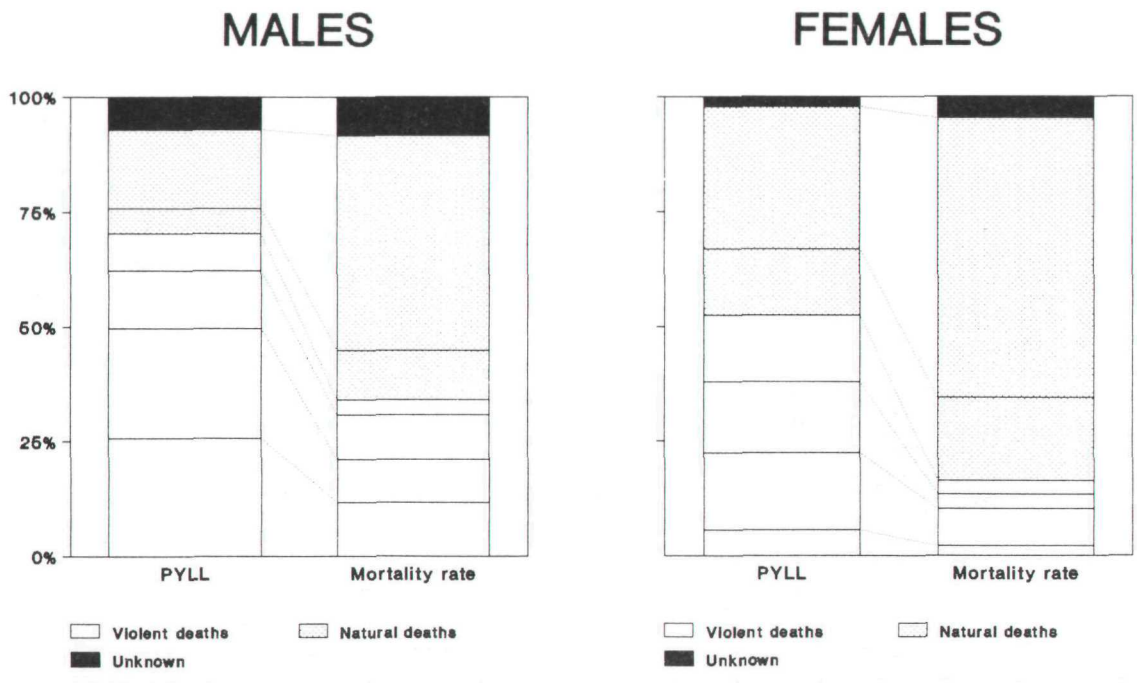

Fig. 9. Relative distribution of potential years of life lost (PYLL) (1968-1983) and mortality rate (1968-1985) in the native population of Greenland. Selected violent and natural causes (from bottom to top: Marine accidents, suicides, other accidents, other violent causes, cancer, other natural causes and unknown).

tributed as high PYLL rates from suicides were found in towns and high PYLL rates from marine accidents in settlements. PYLL rates from all causes together were 1.33 times higher in settlements than in towns for males but similar in towns and settlements for females.

8. SOCIOECONOMIC AND GEOGRAPHIC VARIATIONS

For several of the causes of death described above some consideration was given to the geographic variation within Greenland. In the following, an overview will be given of the variation of morbidity and mortality by ethnic, socioeconomic and geographic factors found in the Upernavik study and the death register study, preceded by a general description of ethnic, geographic and socioeconomic variation in Greenland.

Background variables

The population of Greenland is small but living conditions and genetic inheritance are diversified. Ethnically, the population is made up of a little more than 4/5 of Greenlanders of mixed Inuit and European genetic origin with a distinct culture and language, and slightly less than 1/5 of Danes, many of whom have come to Greenland to work as skilled labourers, administrators or professionals and stay for a limited period of time. Administratively, the two population groups can only be distinguished by place of birth as a proxy for ethnic classification. Socioeconomically, the two ethnic groups differ considerably. In 1979-1980, the average income of a Greenlander was DKK 22,158 while that of a Dane living in Greenland was DKK 91,427 (Danmarks Statistik 1984). There is an overweight of males in the Danish population (68%) and 15-64 year old males made up 57% of the Danish population compared with 29% of the Greenlandic population. This explains some of the income differences between the two population groups, but Danes still hold the better paid jobs.

Greenland is administratively divided into three parts, i.e. Western, Eastern and Northern Greenland, and 18 municipalities. The largest inhabited place in a municipality is called the town although it may have less than 1,000 inhabitants, while the rest are called settlements. Towns have a small hospital staffed with one or more medical officers, they have communications by air and sea with the rest of Greenland, and the district administration and school are located there, while settlements lack these facilities except possibly a primary school. The capital, Nuuk, is a rapidly growing town with a modern hospital and several flights a week to Denmark and Canada.

The major distinctions of the population according to socioeconomic conditions and living conditions at macro level are between the population of the relatively affluent Western Greenland (91% of Greenlanders in 1982) and the population of Eastern or Northern Greenland, and between people living in towns (76% of Greenlanders) and settlements. The socioeconomic differences between various regions probably play a much greater role for health than strictly geographic differences, e.g. climate, latitude and soil conditions.

In the Upernavik study, two different measures of the socioeconomic status of households were used, i.e. housing standard and occupation. In analyses of the death register, the place of residence was used as a proxy for socioeconomic conditions. The population was classified either as residents of towns or settlements, or according to a more detailed geographic classification as residents of one of six regions: [1] the capital (Nuuk), [2] other towns in Western Greenland, [3] settlements in south and central Western Greenland, [4] settlements in north Western Greenland, [5] Eastern Greenland and [6] Northern Greenland (Bjerregaard 1990a [9]). This regional classification covered more than 99% of the native population and left out the small mining community of Ivittuut, the mining community of Qullissat which was closed down in 1973, and the population of certain atypical communities outside the Greenlandic community proper, e.g. weather stations, airfields and US defence areas. Northern Greenland, however, was excluded from most analyses because of its small

Table X. Demographic and economic characteristics of the native population in six geographic regions of Greenland.

REGION[a]	Population[b] (Greenlanders) no.	%	Income[c] DKK	Population change[d] %	Community size[e] no.	Age distribution: % 0-14 year
Capital (1)	*5,833*	*14.4*	*26,131*	*+30*	*8,540*	*34*
Other towns in Western Greenland (12)	*22,090*	*54.4*	*23,985*	*+15*	*2,159*	*39*
Settlements in south and central Western Greenland (23)	*4,234*	*10.4*	*20,232*	*-19*	*199*	*39*
Settlements in north Western Greenland (27)	*4,554*	*11.2*	*11,100*	*- 6*	*171*	*44*
Eastern Greenland (10)	*2,810*	*6.9*	*11,322*	*+12*	*308*	*43*
Northern Greenland (5)	*677*	*1.7*	*11,363*	*+19*	*143*	*42*
TOTAL (78)	*40,198*	*99.0*	*21,514*	*+ 8*	*606*	*39*

a) Number of inhabited places (communities) in parentheses
b) 1970-82 average population born in Greenland
c) Average yearly taxable income per person 1979-80
d) Population change from 1970 to 1982
e) Average total population (Greenlanders and Danes) of a community

population and accordingly uncertain mortality rates.

Demographic and socioeconomic variation was pronounced among the regions (Table X). Annual income ranged from more than 20,000 DKK per person in towns and southern/central settlements in Western Greenland to around 11,000 DKK in the more remote parts of Greenland. A population decrease was noted in settlements in Western Greenland while towns and particularly the capital increased, but also the populations of Eastern and Northern Greenland grew. On average 39% of the population was less than 15 years old, but this ranged from 34% in the capital to 42-44% in Eastern and Northern Greenland and in northern settlements in Western Greenland.

Previous studies

A few previous studies have described variations in morbidity and mortality which relate to the above described ethnically, socioeconomically or geographically defined population groups of Greenland. The social standard of families with a child with cardiac malformation was found to be low compared with the Greenlandic standards (Harvald & Hels 1969). In a study from southern Greenland it was found that people with poor housing conditions had more episodes of common cold and otitis than people with good housing conditions, but no associations were found between housing conditions and

tonsillitis or gastroenteritis (Berg & Adler-Nissen 1976).

In the capital of Greenland (Nuuk), perinatal mortality was considerably lower in children of Danish mothers than in children of Greenlandic mothers, but the difference appeared to diminish during the period 1964-1978 (Hansen PK 1982). Neonatal and postneonatal mortality was found to be higher in the rest of Western Greenland than in the capital and higher still in Eastern Greenland (Jørgensen et al. 1982). In one district in Western Greenland, indications of an increased risk of otitis was observed in children from a low social stratum (Pedersen & Zachau-Christiansen 1986) and in the same district poor social background was found to be of major importance for the malfunctioning of 10 out of 26 handicapped children (Marschall & Hjelt 1988).

Upernavik study

Ethnic differences

Ethnic differences in morbidity were pronounced in Upernavik where 92% of the Danes belonged to social groups I-III compared with 50% of the Greenlanders. Compared with Greenlanders of social groups I-III, the Danes had significantly fewer outpatient contacts than the Greenlanders (2.2 and 3.0 per person; $p < 0.01$) and fewer admissions to hospital (0.1 and 0.2 per person; $p < 0.01$) after adjustment for age- and sex differences. The same difference was observed for skin infections, respiratory infections and accidents (Bjerregaard & Bjerregaard 1985 [2]).

The native Greenlandic population

In Greenlanders of Upernavik, the contact rate from all causes together showed no variation with socioeconomic status but the rate of admission to hospital was highest in the lowest housing standard group as well as in the lowest occupational group (Bjerregaard & Bjerregaard 1985 [2]). Socioeconomic variation was studied separately for contacts due to respiratory infections, skin infections and accidents, but although there was a tendency towards higher contact rates due to respiratory and skin infections in the lowest socioeconomic groups this was not statistically significant. No socioeconomic variation was noted for accidents.

The proportion of persons with at least one contact during the year of study did not vary with socioeconomic status but patients from the lowest socioeconomic groups each had more disease episodes during the year and/or more contacts in the course of each disease episode. Together with the higher rate of admission to hospital this may be interpreted as the existence of a more severe disease pattern in the low socioeconomic groups.

In children, no social variation was observed for contacts due to all respiratory infections together, but whereas children from the lowest social group had a higher contact rate due to chronic purulent otitis media than children from the highest social group, the latter had the highest contact rates due to acute infections (Bjerregaard 1983 [1]).

Death register study

Ethnic differences

Ethnic differences in mortality rates were only studied in 15-44 year old males which comprise 49% of the Danish population in Greenland. For all causes together, the ratio between the mortality rates of Greenlanders and Danes living in Greenland was 3.6:1 ($p < 0.001$) and between mortality rates of Danes living in Greenland and the population of Denmark 1.2:1 ($p > 0.05$) (Bjerregaard 1988c [7]).

For most causes of death, in particular acute infections, cerebrovascular disease, accidents, suicides and homicides, mortality rates were considerably lower in Danes than in Greenlanders. Ischaemic heart disease and accidents were discussed separately above.

Mortality from acute infections, accidents, suicides and homicides were higher in Danes living in Greenland than in the population of Denmark, while mortality from cancer and "other natural causes" was lower. The absolute numbers of deaths were small and the differences were not statistically significant.

The native Greenlandic population

Mortality from all causes together was significantly higher in the Greenlandic settlements than in towns (age standardized ratio 1.2:1;$p < 0.001$) for both males and females. This was predominantly due to higher mortality rates from acute infections and accidents, while mortality rates from ischaemic heart disease, cerebrovascular disease (in males), suicides and homicides were higher in towns (Bjerregaard 1988c [7]).

For certain causes of death, variation was studied at the more detailed geographic level described above (Bjerregaard 1990a [9], 1990b [11], Bjerregaard & Juel 1990 [10]) or according to a similar but not identical regional classification (Bjerregaard 1986b [5]). All comparisons were made between age and sex standardized rates. Most causes of death followed one of a limited number of geographic patterns (Fig. 10):

- Mortality rates due to acute infections, including inter alia meningitis, measles and acute respiratory infections, and marine accidents were lowest in the capital and increased gradually from

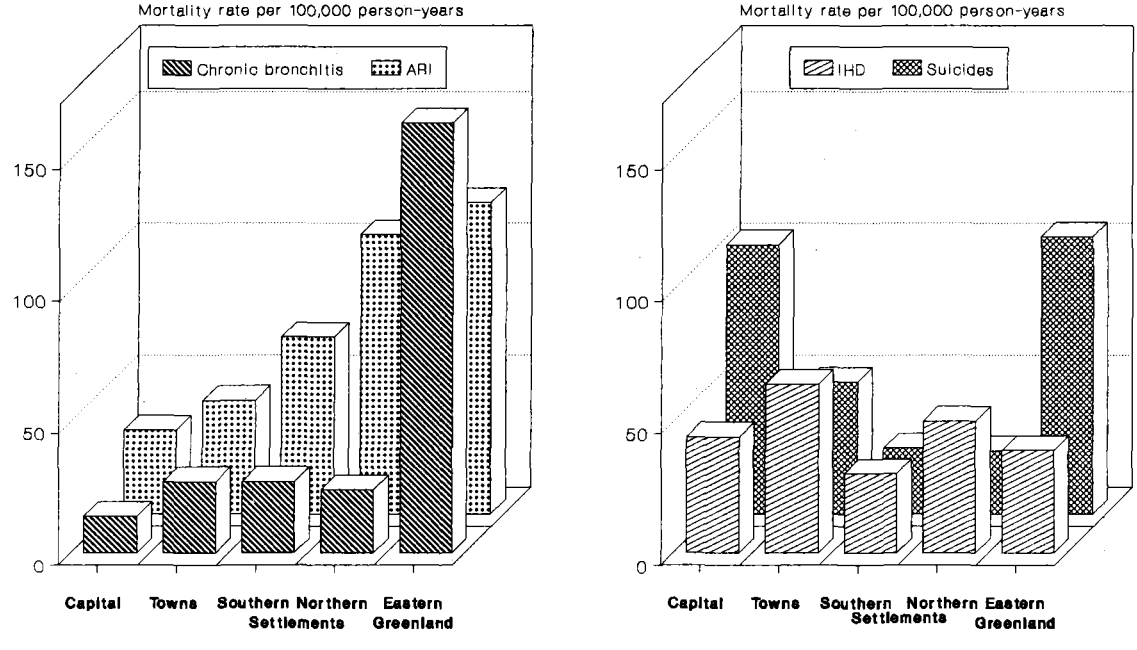

Fig. 10. Age standardized mortality rates per 100,000 person-years in the native Greenlandic population of different geographic areas in Greenland (1968-1985). ARI = Acute respiratory infections; IHD = Ischaemic heart disease.

other West Greenlandic towns to southern and central settlements, northern settlements and Eastern Greenland.
- Mortality rates due to chronic bronchitis and "other accidents" were almost similar in the four regions of Western Greenland but much higher in Eastern Greenland.
- Mortality rates from ischaemic heart disease and cerebrovascular disease did not exhibit pronounced geographic variations, but for both diseases the mortality rates were higher in the towns of Western Greenland (excluding the capital) than in the rest of the country.
- Mortality rates from suicides and homicides were very high in the capital and in Eastern Greenland, medium high in other towns and low in settlements in Western Greenland while the mortality rate from alcohol related diseases was high in the capital and Eastern Greenland and low in northern settlements in Western Greenland.

The validity of diagnoses is probably lowest in settlements and highest in the capital but it is hard to imagine the existence of a systematic bias which would seriously invalidate the findings. Total mortality was lowest in the capital (739 per 100,000 person-years) and at the same level in other West Greenlandic towns (777); it was somewhat higher in southern and northern settlements in Western Greenland (855 and 853) and very high in Eastern Greenland (1423 per 100,000) (Bjerregaard 1990a [9]).

Analyses at a still more detailed geographic level gave less clear results, possibly because the mortality estimates were imprecise due to the very few deaths in each geographic unit. An analysis with 20 geographic units showed a negative association between income and mortality rates from acute infections, chronic bronchitis and accidents. The associations were rather weak (R(Spearman) = -0.5-0.6) but statistically significant ($p < 0.05$). Population change was positively correlated with the suicide rate and negatively correlated with mortality rate from marine accidents. Community size was positively correlated with mortality rate from ischaemic heart disease and negatively with mortality rate from marine accidents, with similar levels of correlation coefficients and statistical significance as for income. These associations were also found for Western Greenland alone where an additional positive correlation was observed between community size and suicide rate (Bjerregaard 1990a [9]).

A comparison of mortality rates in Greenlandic regions with Danish mortality rates gave some interesting results. The suicide rate is usually thought of as being very high in Greenland in general but it was at the same level in settlements of Western Greenland as in Denmark. Similarly, the high Greenlandic mortality rate from cerebrovascular disease was not found in the capital where the level was the same as in Denmark (Bjerregaard 1990a [9]).

Infant mortality

Infant mortality also exhibited pronounced regional variation, but whereas postneonatal mortality ranged from 9.7 per 1,000 live births in the capital to 63.4 per 1,000 in East Greenlandic settlements, neonatal mortality only ranged from 17.7 to 22.8 per 1,000.

The reduction in infant mortality from 1968/72 to 1979/83 was 4% in the capital, around 12% in other West Greenlandic towns and 15-35% in settlements, which tended to reduce the regional differences. In 1979/83, however, there was still marked variation: low infant mortality (around 25 per 1,000 live births) in the capital and the large towns on the central West Coast, slightly higher rates in the rest of the West Greenlandic towns and in most settlements on the West Coast (33-36 per 1,000), an intermediate rate in the towns of Eastern Greenland (47 per 1,000) and high rates in settlements in Eastern and Northern Greenland and remote settlements in Western Greenland (68 per 1,000). The most pronounced variation was found for respiratory diseases and "other natural causes" both of which included many infectious diseases, but also death from birth lesions, hypoxia and other perinatal causes and accidents were more common in the poor regions (Bjerregaard 1986b [5]).

9. DISEASE PATTERN IN GREENLAND: A LITERATURE REVIEW

In the following, morbidity and mortality studies in Greenland will be reviewed with emphasis on recent studies, i.e. studies published during the last two decades. It has not been attempted to write a complete bibliography but in conjunction with the studies on morbidity and mortality described above, the review will provide a fairly comprehensive picture of contemporary Greenlandic disease patterns. Many studies on morbidity and mortality in Greenland have been published in Danish only but as far as possible reference has been given to papers in English.

Until 1950

Around 900 A.D. Greenland was populated by Neoeskimo hunters coming from Canada and by Norse farmers coming from Scandinavia via Iceland. While the former remained as the ancestors of the present day Inuit, the latter disappeared during the 15th century and with them the European knowledge about Greenland. Resen, in his 17th century compilation of available written records on Greenland, stated that nothing was known about the diseases of the Greenlanders (Møller 1987). Recently, 8 well preserved, mummified bodies of six Inuit women and two small children from the 15th century have been examined (Hansen JPH & Gulløv 1989). The height of the adult women was similar to that recorded for Inuit women from North West and North Greenland in this century. One is believed to have died from nasopharyngeal cancer, one of the children probably had Down's syndrome and Legg- Calvé-Perthes disease, in one a kidney stone was found and one young woman had heavy anthracosis of the lungs, probably caused by soot from the lamps which polluted the indoor atmosphere (Hansen JPH 1989).

Hans Egede, the missionary who started the colonization of Greenland in 1721, lived on the west coast of Greenland near present day Nuuk (Godthåb) for 15 years. He reported (author's translation): "They [the Greenlanders] are furthermore strong and able-bodied. You seldom see someone with a natural ailment or disease except for a weakness of the eyes, caused by the keen winds of spring and the snow and ice which hurt the eyes. I have also seen a few who resembled lepers. It is strange, however, that even though they have free intercourse with other people these are not infected. Those who live far north also often suffer badly from dysentery, bloody diarrhea, weakness of the chest, boils, convulsions etc. No other epidemic diseases as plague, smallpox and their like were known to the Greenlanders until AD 1734...", when the first epidemic of smallpox allegedly killed more than two thousand people! Egede continues:"They are very plethoric, therefore they often bleed from the nose. Few of them reach an age of more than 50 or 60 years but many die when they are young and even more as infants." (Egede 1741). The presence of lepra has not been confirmed (Bertelsen 1940).

A review of the health of the Eskimos in the earliest written accounts concluded tentatively that at the beginning of their contact with western culture, the Eskimos were generally healthy and well fed (Fortuine 1971). Nose bleeding was frequently observed and sore eyes were common. Crippled people, mental retardation and convulsive disorders were noted. Information about infectious diseases was difficult to interpret but the devastating effects of several epidemic diseases suggested that these were introduced from outside. Whether or not tuberculosis was present before contact with the western world was unclear.

Precise information is scarce from the following century but epidemics of respiratory infections and influenza, smallpox and typhoid fever were probably recurrent (Gad 1974). Vaccination against smallpox was introduced already in 1802 and soon became widespread. In 1839 the first two permanent physicians took up their positions as District Medical Officers in Qaqortoq (Julianehåb) and Nuuk (Godthåb) and yearly reports on the state of health in Greenland began to be submitted to Copenhagen from where the colony of Greenland was governed. During the next century, the health care system was gradually extended and developed but information on the disease pattern remained of limited value for two main reasons. In the first place, the disease categories of last century were inexact

and rested on dubious diagnostic criteria seen with today's eyes. Secondly, although the physicians were responsible for a whole district they stayed most of the time in the "Colony" (town) and did not visit the settlements where the majority of the population lived, so their descriptions of the disease patterns are biased (Meldorf 1904). A comprehensive medical bibliography on Greenland covering the period since 1721 was published in 1921 (Bertelsen 1921).

For the period 1900-1950, information on the Greenlandic morbidity and mortality pattern is good. Routine medical statistics improved and several studies were published among which the works of Bertelsen represent an outstandingly comprehensive and meticulous compilation of the reports of earlier medical officers in Greenland (Bertelsen 1935, 1937, 1940, 1943). The following description rests on Bertelsen's studies where not otherwise indicated.

The sickness profile of the period was dominated by tuberculosis, which accounted for 31% of deaths in 1924-33, acute infections (23%) and accidents (10%). Severe epidemics of respiratory infections including influenza occurred almost every spring and fall (Meldorf 1907) and epidemics of diarrhea, whooping cough and poliomyelitis were common. For several epidemic diseases the Greenlandic population was too small to act as a reserve for the infectious agent, which was reintroduced from outside every time. Typhoid fever, dysentery, hepatitis and meningitis were endemic and puerperal fever and skin infections common. The last epidemic of smallpox took place in 1852, although a few, isolated cases were seen later on, and measles was not introduced until 1945 (Fog-Poulsen 1957).

Gonorrhea was introduced into a mining community on the southern west coast (Ivittuut) in the second half of the 19th century but remained localized until 1913 when it started spreading to the rest of Greenland where it established itself as a common, endemic disease. Apart from a few localized, minor epidemics in southern Greenland, syphilis did not establish itself in Greenland until 1969 (Marcussen & Rendal 1949, Olsen 1966, From 1980).

Heart diseases and cerebrovascular disease were common in older people and cancer was probably not less frequent than in Denmark. Acute and chronic malnutrition was still common and scurvy, the ancient companion of Europeans in the Arctic, had been introduced into the native population along with increased westernization of the diet. Suicides happened but were not common.

In 1948-49 an epidemiological field study was carried out in Uummannaq in northern Western Greenland with a view to examining the etiological factors responsible for a number of so-called diseases of civilization. The study concluded that allergy, peptic ulcer, gall stone, symptoms of arteriosclerosis, pulmonary emphysema and rheumatic fever were less common than in southern Finland while the incidence of hypertension was higher (Ehrström 1951).

None of the above mentioned studies satisfy modern diagnostic criteria or disease classifications nor do the epidemiological methods used allow anything more than the most cautious and broad conclusions.

1950-1970

This period represents a transition between the traditional society and a modern Greenland both in general and as regards the disease patterns. Greenland which until then had been deliberately isolated by the Danish authorities, became integrated in the world community. An intensive development was initiated and communications by sea and air within Greenland and between Greenland and Denmark were vastly improved.

Fertility and mortality

Fertility was very high in Greenland during the period, around 50 per thousand which today is only seen in a few tropical developing countries (Fig. 11). From approximately 1966 to 1972, however, the

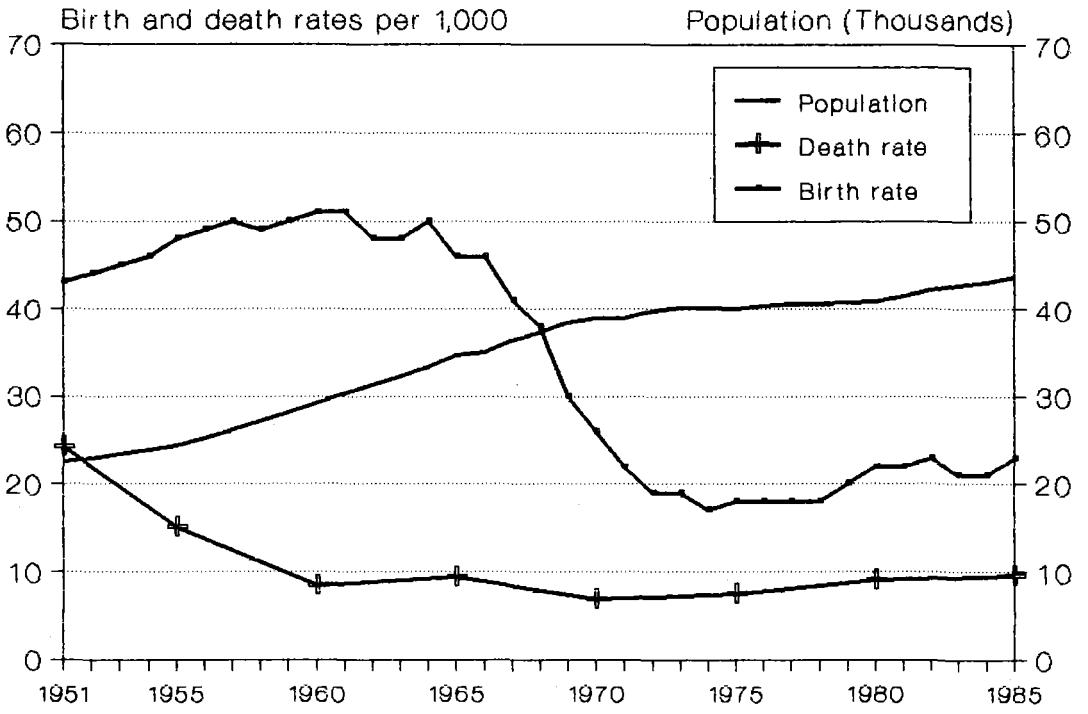

Fig. 11. Birth rate, crude death rate and population size. Native population of Greenland 1951-1985.

fertility rate was reduced to less than 20 per thousand and has remained constant at this level since. An important direct factor for the decline was the launching, in 1967, of a large scale family planning campaign (Berg 1972, Misfeldt 1977). During 1966-70, a total of 4,500 IUD's were inserted in a population of approximately 9,000 women of fertile age. Data is not readily available on the number of reinsertions or the period of acceptance but it must still be a significant proportion of the population at risk that was affected. Other types of contraception were used to a lesser extent. Furthermore, the proportion of pregnancies terminated by legal abortion increased from approximately 5% in 1966 to approximately 15% in 1972. Fertility has been shown to be higher in settlements than in towns (Hansen HO 1985) but although there was a population movement from settlements to towns during the period this cannot explain the sudden change in overall fertility.

The indigenous population increased steadily during the period at an average rate of 2.8% per year. Danes constituted approximately 5% of the population in 1950, which was already twice the prewar proportion, and increased during the period to 16% in 1970.

The age standardized mortality rate for all causes of death together decreased from 2,500 to 800 per 100,000 person-years during the period and the mortality pattern changed drastically (Fig. 12). Tuberculosis virtually disappeared as a cause of death and mortality due to acute infectious diseases decreased substantially. Not only did the chronic diseases become more visible in the absence of infectious diseases but the mortality rate from cancer increased and the mortality rate from heart diseases showed a peak around 1955. The mortality rate from accidents remained at a constant, high level (Smith 1961) and the suicide rate increased slightly. A similar pattern was observed in Upernavik for tuberculosis and suicides (Green & Kromann 1983).

Disease pattern

An epidemiological study of admissions to hospital in Upernavik district showed higher incidence of apoplexy and epilepsy than in Denmark, and lower incidence of acute myocardial infarction, diabetes mellitus, thyrotoxicosis, bronchial asthma, multiple sclerosis and psoriasis, but as the authors pointed out, the incidence rates were probably underestimated because of the relative inaccessibility of the health care system in this vast district with a scattered population (Kromann & Green 1980). The cancer pattern differed from the Danish cancer pattern, in particular with a high incidence of upper respiratory tract cancers including cancers of salivary glands and pharynx, and a low but probably increasing incidence of lung cancer.

Most medical papers on Greenland during the period focused on tuberculosis, the successful eradication of which was the major public health task of the 1950s (Helms 1957, Stein et al. 1968, Iversen 1971), and acute infectious diseases, e.g. measles which was introduced for the first time and from which the country suffered several severe epidemics (Christensen et al. 1954, Littauer & Sørensen 1965). Like the rest of the world, Greenland had its epidemics of poliomyelitis (Eskesen & Glahn 1955, Fog-Poulsen 1955) and influenza (von Magnus 1968). Gonorrhea was on the increase and syphilis gained foothold (Olsen 1966, From 1980). Greenland's so far only case of human rabies occurred in 1960 (Lassen 1962).

Towards the end of the period, valuable contributions were made in other fields also. Both juvenile and maturity onset diabetes mellitus were proved to be rare in Greenland (Sagild et al. 1966) while the incidence of congenital heart diseases, abdominal hernia and epilepsy were shown to be higher than in Denmark (Harvald & Hels 1969, 1970). The incidence of congenital heart disease (estimated at 1.3-1.9%), mostly ventricular septal defect, was the highest registered in any ethnic group (Harvald & Hels 1969). The incidence of inguinal hernia in East Greenlandic children was 2-3 times higher in boys and 10 times higher in girls compared with European children (Hansen MV 1985).

After 1970

The last two decades have seen an expanding volume of scientific papers on several aspects of disease in Greenland. Comprehensive studies have been performed in a number of important areas and these have been supplemented by studies and casuistic reports on an array of topics. In the following, a general overview will be given while a number of specific topics of particular interest were discussed above.

Fertility remained stable at a rate just below 20 per thousand since 1972. From 1980 it increased slightly (Fig. 11). The overall mortality rate increased slightly and the most conspicuous changes in mortality were a drastically increasing suicide rate and a decreasing mortality rate from acute infections towards the end of the period (Fig. 12). The indigenous population remained stable during the 1970s and showed a slight increase since 1980 and the proportion of Danes varied only slightly with a maximum of 19% in 1974-75.

Genetically, the Inuit of Greenland can be divided into three groups, i.e. the west coast population which is heterogeneous and show a considerable admixture of European genes, the population of Eastern Greenland which probably most closely resembles the Eskimos of the Middle Ages, and the inhabitants of Northern Greenland which are still insufficiently studied (Persson 1970). The genetic epidemiology of Greenland was reviewed by Harvald (1989). A number of autoimmune disorders, e.g. insulin dependent diabetes mellitus and rheumatoid arthritis, are rare, possibly due to their associations with rare HL-A alleles (Kissmeyer-Nielsen 1971, Harvald 1982, 1989). The low incidence of ischaemic heart disease may partly be due to a low frequency of the C3F gene (Arvilommi et al. 1973, Stoffersen et al. 1982), Some rare, familial disorders have been described (Nielsen et al. 1986). Congenital heart disease and inguinal hernia were discussed above and other diseases with a genetic aetiological component, e.g. angle-closure glaucoma, lactose and sucrose malabsorption and spon-

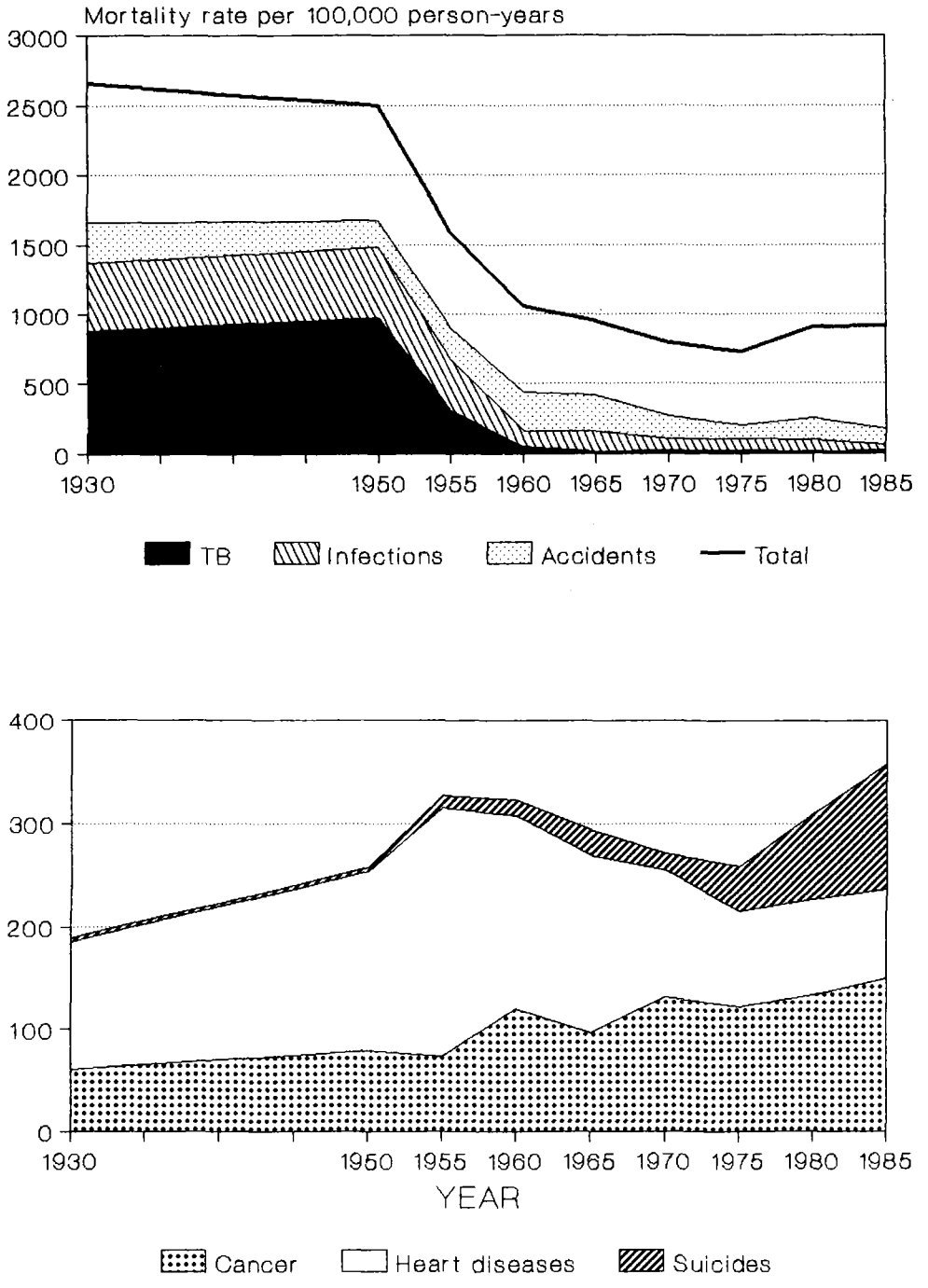

Fig. 12. Age standardized mortality rates from selected causes per 100,000 person-years in the native population of Greenland 1930-1985. Source of data: Bertelsen 1935, Chief Medical Officer 1951-1967, Bjerregaard 1988c.

dylolisthesis will be discussed below.

Infectious diseases

Acute and chronic infections still play a significant role for both morbidity and mortality in Greenland. Certain infectious diseases were reviewed in connection with the discussion of the author's own studies while others will be discussed here.

The incidence of gonorrhea increased steadily during the 1950s and 1960s but from the end of the 1960s the incidence rose steeply (From 1980). From a maximum of approximately 13,000 reported cases in 1982, which equals an incidence of 378 per 1,000 person-years in the 15-59 year old, the incidence dropped off steadily to only one fifth of the 1982 level in 1988. The male:female ratio was 1.5:1. Although gonococcal strains often showed reduced sensitivity to ampicillin, penicillinase producing organisms did not occur (Misfeldt 1989). The epidemiology was characterized by many reinfections in a core group of patients (Olsen 1976). The incidence of syphilis increased steeply from 1970 and two epidemic peaks can be observed: one in 1976 (746 new cases) and one in 1987 (658 new cases) with a low in 1984 (142 new cases) (From 1980, Jørgensen et al. 1988). In Greenland there is no homosexual subculture of any relevant size and the male:female ratio of syphilis is low, i.e. 1.1:1 (Jørgensen et al. 1988). The incidence pattern of syphilis during the 1980s was the reverse of the gonorrhea pattern, i.e. low incidence of syphilis and high incidence of gonorrhea in the beginning of the period and the opposite towards the end. It is possible, that a high incidence of gonorrhea with widespread use of penicillin has cured or masked a significant number of syphilis infections (Misfeldt 1989).

An outbreak of chancroid was recorded in 1977 but after 1980 only sporadic cases have been recorded. Lymphogranuloma venereum has never occurred in Greenland (Misfeldt 1988). Chlamydia infection, however, is common (Mårdh et al. 1980). In males with urethritis, the presence of Chlamydia trachomatis was demonstrated in 47% and Neisseria gonorrhoeae in 75% (Worm 1988). Human immunodeficiency virus (HIV 1) has been introduced into Greenland and, in 1989, 14 HIV positive persons and one case of AIDS were known (Melbye et al. 1989).

Hepatitis A epidemics have occurred repeatedly, the last time in 1970-1974 when 11% of the population were clinically ill (Skinhøj et al. 1977). Hepatitis B is highly endemic in Greenland. Indications of infection with hepatitis B virus (HBsAg or anti-HBs) were found in 47% of the population of central Western Greenland, 60% of the population of north Western Greenland and 81% of the population of Eastern Greenland, and the prevalence of HBsAg ranged from 1.2% to 25.4% in various geographic areas (Skinhøj et al. 1974, Skinhøj 1977). The prevalence has been constant during the last twenty years and steep increases in seropositivity in early childhood and in the 15-24 year old indicate that sexual transmission is important in addition to neonatal infection (Olsen et al. 1989). In spite of the high frequency of hepatitis B virus infection, the incidence rates of primary hepatocellular carcinoma and cirrhosis are low, but a general immunization programme has been initiated (Melbye et al. 1984, Misfeldt 1990).

The magnitude of the problems related to sexually transmitted diseases is best illustrated by the fact that, during the 1980s, the number of syphilis cases was the same in Greenland as in Denmark and the number of gonorrhea cases almost twice as high, in a population which amounts to only 1 percent of the population of Denmark. It has been shown that an active heterosexual life starts earlier in Greenland than in Denmark and that the young Greenlanders have more partners. This extensive sexual behaviour was more frequent in young people of low social status, with poor housing standards and from broken homes (Olsen 1973). The increase in gonorrhea, which to some extent parallelled an increase in extramarital births, was explained as the result of a profoundly changed sexual behaviour primarily due to acculturative stress (Olsen 1976).

Cases of botulism are not uncommon, in particular in the warmer parts of Greenland south of Disko Bay, due to the local favouring of raw, partly fermented meat (Hansen PK & Bennike 1982).

Rabies is enzootic in the whole of Greenland. The arctic fox is the natural reservoir of the infection and infected foxes probably frequently cross over from Canada to northern Greenland. Epizootics in dogs are recurrent, in particular in north Western and Northern Greenland but there have been no human cases since 1960 (Bjerregaard & Zoffmann 1986, Holck 1989).

Cancer

The Greenlandic cancer pattern has been extensively studied and has been shown to differ in many significant ways from that of the western world. A study of cancer incidence 1950-74 and a follow-up study covering the period until 1983 showed the age standardized incidence from all cancer types together to be lower than in Denmark in the beginning of the period. The incidence reached the Danish level during the 1960s for females but remained low in males with an observed to expected ratio of 0.8:1 (Nielsen & Hansen 1985, Nielsen 1986).

The incidence rates of anaplastic carcinoma of nasopharynx and salivary glands were among the highest in the world (Nielsen et al. 1977, 1978). Both these cancer types show a special geographic pattern with high incidence in Inuit and southern Chinese and both are associated with Epstein-Barr virus infection. Epstein-Barr virus DNA has been demonstrated in nasopharynx carcinomas and a salivary gland carcinoma from Greenlandic Inuit (Saemundsen et al. 1982). Infectious mononucleosis is a rare disease in Greenlandic Inuit (Melbye et al. 1984a) and serologic studies show that Inuit are infected very early in life with Epstein-Barr virus (Melbye et al. 1984b, Albeck et al. 1985). The high titres of certain antibodies to Epstein-Barr virus observed in Inuit children have been suggested to be the result of a large inoculum of virus at the time of infection as well as infection early in life (Melbye et al. 1984b).

The incidence of esophageal cancer was 6 to 8 times higher in Greenland than in Denmark, and particularly high in southern Greenland where it was 4 to 5 times higher than in the rest of Greenland. In females, breast cancer incidence was low while the incidence of cancer of cervix uteri increased dramatically to one of the world's highest. An extensive but uncoordinated cytological screening activity during 1976 to 1985 failed to reduce the incidence of invasive cancer (Nielsen et al. 1988). The incidence of cancer of corpus uteri was low. A previously very high incidence of invasive trophoblastic tumours decreased considerably since 1970.

Lung cancer incidence was low in the 1950s. In males it soon increased to the Danish level while the incidence in females became one of the highest in the world. The increase followed an increase in cigarette smoking and tumour location and histology are consistent with tobacco as a key etiological factor (Nielsen & Hansen 1982). Compared with Denmark, significantly lower incidence rates were furthermore observed for skin cancer, malignant melanoma, cancer of urinary bladder, rectum, prostate and testis, and cancers of lymphatic and hematopoietic tissue.

Greenlandic Inuit immigrants in Denmark had retained the special Greenlandic cancer pattern to a certain extent and significantly increased incidence rates compared with Danes were demonstrated for nasopharyngeal cancer and cancer of cervix uteri (Prener et al. 1987). Incidence of rectal cancer in males was also significantly increased but no explanation of this has so far been proposed.

Eye diseases

The risk of blindness is 2-3 times higher in Greenland than in Denmark and in persons above 70 years of age it is 10 times higher, in particular because of senile macular degeneration (Rosenberg 1982, 1987a, 1987b).

The prevalence of primary angle-closure glaucoma is very high in Greenland and was found by screening in Uummannaq to be 2% in males and 10% in females above 40 years of age (Alsbirk 1988). Ocular dimensions in the general population deviated towards the values found in patients with

angle-closure glaucoma, i.e. shallow anterior chambers and narrow angles which were observed in further 9% of males and 18% of females. Familial clustering indicated a genetic determination of anterior chamber size and the hypothesis was put forward that the small anterior chamber in Eskimos is the result of genetic adaptation to the arctic environment. Corneal protection against cold in the hunters was the advantage with the increased prevalence of angle-closure glaucoma in particular in elderly women being a less important cost (Alsbirk 1976).

Environmental medicine

Greenland is situated far from the major industrialized areas of the world and within Greenland polluting sources like motor vehicle traffic and industry are few. The Greenlandic environment might therefore be assumed to be free from heavy metal pollution but this is not the case. Mercury is present in marine mammals in fairly high concentrations and persons with a high dietary intake of seal or whale meat, in particular the population of north Western Greenland, Eastern and Northern Greenland, have very high blood mercury levels. Fetal exposure is even higher and umbilical cord blood had approximately 80% higher concentrations of mercury than the blood of the mothers. In spite of the high mercury load, signs or symptoms related to mercury intoxication have not been described. The mercury concentration in hair has increased considerably since the 15th century and is likely to increase further due to an increased worldwide use of mercury. Fetal intoxication is not unlikely to occur at concentrations close to the observed ones and the situation must be monitored closely (Hansen JC 1981, 1988, Hansen JC et al. 1984, Grandjean 1985, Hansen JC & Pedersen 1986).

In the absence of local sources of pollution, blood lead concentrations were surprisingly high, i.e. at the same level as in Europe. This has been explained as the result of long distance atmospheric transport of particulate lead and of specific dietary factors which enhance lead absorption. A casuistic report has related an elevated blood lead concentration to the presence of lead shot in the appendix (Johansen & Nygård 1987). The blood concentrations of cadmium were at the same level as in Europe and appear to be caused by tobacco smoking. Cadmium concentrations are very high in the traditional diet but this had hardly any influence on the blood concentrations in human beings.

A local nuclear accident took place in Greenland in 1968 when a US Airforce B52 carrying nuclear bombs crashed on the frozen sea near Thule Air Base in Northern Greenland. Several hundred Danish workers participated in the cleaning up and were potentially exposed to radioactive tritium, plutonium and americium. So far, studies have failed to show any differences in mortality, cancer incidence or hospital admissions between those potentially exposed and a control group (Juel 1987, Storm 1987) The Greenlandic community was not directly affected by the accident, but the extent of the spread of radioactive material is not precisely known.

Other diseases

Certain peculiarities have been described in the metabolism of Greenlanders. Lactose malabsorption was present in 55% of Greenlanders and in 84% of Greenlanders without (known) Danish ancestors, a finding which is common in non European ethnic groups (Gudmand-Høyer et al. 1969, 1973). Sucrose malabsorption was present in 11% which is a much higher incidence than found in any other ethnic group (McNair et al. 1972, Gudmand-Høyer et al. 1987).

A generally low serum calcium in Greenlanders has been explained by a low dietary intake of calcium and has been offered as an explanation to the early onset of osteoporosis in Greenlanders (Jeppesen & Harvald 1983), while a high serum magnesium was explained as the result of a high intake of magnesium and an enhanced intestinal absorption of magnesium due to a low dietary calcium level (Jeppesen et al. 1984a). An apparently low incidence of urinary calculi was explained by the low serum calcium/magnesium ratio (Jeppesen et al. 1984b).

The incidence of Reiter's syndrome is high in Western Greenland (Bardin et al. 1985, 1987). Classical seropositive rheumatoid arthritis and anchylosing spondylitis have been described (Velander et al. 1982, Humaidan et al. 1982). The frequency of spondylolisthesis was found to be ten times higher in Greenlanders than in Europeans (Simper 1983).

Most psychiatric patients are treated in Greenland either at the district hospitals or in the department of psychiatry in Nuuk, but compulsory commitments and medicolegal cases are treated in Denmark (Køster et al. 1986). Also mentally retarded Greenlanders have largely been treated in Denmark although recently a tendency to retain the less severely handicapped patients in Greenland has prevailed. One fifth of the patients treated in Denmark suffered from the sequelae of meningitis but the number of new cases due to meningitis has decreased considerably in recent years (Dyggve & Kodahl 1971, 1983). The very high and still increasing suicide rate, which was discussed above, is an indicator of an increasing disability to cope with modern life, and the widespread alcohol misuse which very often results in violence is another testimony that the demands of life are too high for many people (Lynge 1981, 1982, 1985).

10. INTERNATIONAL COMPARISONS

Comparisons have throughout been made with Denmark but some comparisons with other countries, in particular other Inuit areas, are also relevant.

Circumpolar areas

Infections, and in particular respiratory tract infections and infections of the middle ear or skin, were frequent causes of contact with the health services in native Canadian communities in North West Territories (NWT)(Lupin 1976, Goulston et al. 1980, Ross & Jensen 1980), but differences in the organization of health services and in study designs preclude a closer comparison of morbidity patterns. Infectious diseases including respiratory infections were frequent causes of mortality in Canadian Inuit and Alaska natives although the mortality rates decreased considerably over time (Duval & Therien 1982, Wotton 1985, Young 1986). Alaska Inuit had very high rates of invasive Haemophilus influenzae infection (Ward et al. 1986).

There are some similarities in the cancer patterns of Inuit from Alaska, Canada and Greenland but also differences. The incidence of nasopharyngeal carcinoma, which is related to Epstein-Barr virus infection, was high in all three areas (Lanier et al. 1982, Young 1986). Hepatitis B virus infection has a high prevalence also in Inuit populations of Canada and in particular Alaska (Schreeder et al. 1983, Larke et al. 1987, McMahon 1988) and primary liver cancer which is associated with hepatitis B virus infection, has a high incidence in Alaska but not in Greenland (Young 1986). The importance of lung cancer is increasing in all three areas. The incidence of ischaemic heart disease is reputedly low in Inuit but studies supporting this assumption are few also from Alaska and Canada (Young 1986). A study of death certificates from Alaska showed the mortality rate from ischaemic heart disease in the native population (Inuit, Indians and Aleuts) to be 63% of that of other Alaskans, but unlike in Greenland males had considerably higher rates than females (Middaugh 1990).

Accidents are major causes of mortality in all Inuit communities. The suicide rate in Alaska natives was four times higher than the national average for the USA and the rate was particularly high in 15-29 year old males, but the highest rate of 257 per 100,000 person- years which was found in 20-24 year old males was lower than the corresponding rate in Greenland (Hlady & Middaugh 1987). Similar high suicide rates were found in Canadian Inuit (Duval & Therien 1982, Rodgers 1982, Wotton 1985).

Infant mortality rates are high in all the Inuit groups. In 1961-65, infant mortality rate was 60-70 per 1,000 live births in Alaska and Greenland and twice as high in Canada's NWT. The decreasing trend in the three areas had different slopes and in 1981-83 the infant mortality rate in Inuit of Alaska

was less than 20 per 1,000 live births while the rates in Canada and Greenland were approximately twice as high, and Greenland has had the highest infant mortality rate since 1976-80 (Young 1986). In Canadian Inuit, high infant mortality and morbidity was found to be associated with poor housing conditions, an impoverished life style and the drinking of alcohol (Hobart 1976).

Many Indian communities in Alaska and Canada have a similar mortality pattern with high mortality rates from accidents, suicides and infections, and high infant mortality rates (Young 1983, 1986, 1988, Robinson 1985, 1988). In Scandinavia, the morbidity and mortality pattern of the Samek (Lapps) is not significantly different from that of the surrounding communities and the infant mortality rate is at the same low level (Haraldson 1983, Soininen & Åkerblom 1985).

Developing countries

Finally, a few comparisons with (other) developing countries are relevant. Greenland shares certain characteristics with the typical developing countries, e.g. a colonial background, difficult communications and a hostile climate, but per capita income and health services are far above the standards of developing countries. Also, the absence of those important tropical diseases which burden most developing countries, in particular malaria, makes the Greenlandic disease pattern very different from that of a typical, tropical developing country. It is therefore thought provoking to find that infant mortality, which may be taken as a general measure of health status, in Greenland is at the same level as in one of the very poor developing countries in Africa, i.e. Kenya (Bjerregaard 1988a). With the omission of three provinces in Kenya which are heavily burdened by malaria, infant mortality in the remaining five provinces ranged from 45 to 75 per 1,000 live births (1984 estimate by UNICEF) while it was 30 and 55 per 1,000 in Greenlandic towns and settlements (1968-1983), respectively.

Acute infections were major causes of death in both countries: In a rural district in Kenya, 52% of infant deaths (1975-1978) were due to pneumonia, gastroenteritis and measles while in Greenland (1973- 1983), 22% of infant deaths were due to acute infections. Accidents were much more frequent causes of infant death in Greenland (6%) than in Kenya (0.4%)(Omondi-Odhiambo et al. 1984, Bjerregaard 1986b [5]). Infant deaths due to the cited causes are potentially avoidable and make up around 10% of infant deaths in Denmark.

After the eradication of malaria and control of whooping cough in the late 1940s, infant mortality in Mauritius was around 80 per 1,000 live births. From 1950, infant mortality decreased steadily to 24 per 1,000 in 1985 (Wong & Phillips 1986). A very similar pattern was seen in Greenland starting approximately ten years later: Very high infant mortality rates decreased considerably during the 1950s and in 1960 the infant mortality rate was approximately 80 per 1,000 live births. From 1960, a steady decrease took place and in 1986-1987 the infant mortality rate was 24 per 1,000 (Chief Medical Officer 1989). It is evident that the level, trend and pattern of infant mortality in Greenland are much more similar to those of certain developing countries than to those of Denmark.

11. CONCLUDING REMARKS

The major methodological problems of the study have been caused by the small populations involved, in particular in the Upernavik study. Statistical significance depends on the magnitude of the associations and on the number of disease episodes or deaths, and in studies of small populations with few disease episodes or deaths, valuable information can be missed by accepting only statistically significant associations as having information value. In such a situation, confidence intervals of rate estimates are wide and differences between subpopulations must therefore be large, and often obvious, in order to reach statistical significance at the commonly used 5% level. This limits the degree to which a data set can be subdivided and analyses will have to be performed for broad population

groups and over long periods of time in order to accumulate the events studied. Furthermore, crude diagnostic classifications will have to be used.

A former professor of medical statistics pointed out that "... formal tests of significance...can, and should, remind us of the effects that the play of chance can create, and they will instruct us in the likely magnitude of those effects. Beyond that they contribute nothing to the 'proof' of our hypothesis." (Hill 1965). The analytic approach to an existing, limited amount of data must be varied and only rely on statistical testing as one of a number of analytic tools. From a number of aspects of an association, which should be considered when a causal inference is evaluated (Hill 1965, Rothman 1986), the following have been particularly relevant for the present study.

1. The strength of the association, i.e. the magnitude of the ratio between incidence rates.
2. The consistency of the association, which refers to the repeated observation of an association in different populations and different circumstances, e.g. in both sexes and several age groups and in different periods of time.
3. The biologic gradient, which refers to the presence of a dose response curve, e.g. the increasing mortality rate from infections with increasingly poor living conditions.
4. The plausibility of the association, i.e. the existence of supplementary evidence to support the hypothesis.

Another methodological problem of the present study is the validity of the data. The strength of both the Upernavik study and the death register analyses is that the material is complete since both populations were well defined and well registered. The validity of the mortality analyses, however, was affected by the rather low validity of the diagnoses of causes of death due to natural causes, but in the broad categories of the G-list and in particular below the age of 65 years the validity of most diagnoses is acceptable. In order to improve the validity of the diagnoses of causes of death in Greenland, it is proposed that increased interest is taken in the filling out of death certificates. If the diagnosis is unknown this should be stated, and if the coding gives problems the medical officers should be contacted by the department of medical statistics in Copenhagen. An increased autopsy rate is necessary to solve certain problems, inter alia the frequency of ischaemic heart disease and thrombotic or haemorrhagic cerebrovascular disease, but would add little to our knowledge of deaths due to accidents and suicides.

The main outcome of the study is

1. A comprehensive, general description of the outpatient sickness profile in a Greenlandic community. This is the first general description of morbidity in Greenland since the study of Bertelsen (1940, 1943) and the first study to calculate morbidity rates.
2. The establishment and running of a computerized register of causes of death in the resident population of Greenland, which allows scientific analyses of population subgroups according to place of birth (= ethnicity), domicile etc.
3. A description of the mortality patterns and causes of death in the two main ethnic groups in Greenland, i.e. Greenlanders (persons born in Greenland) and Danes (persons born outside Greenland), including variations by age, sex and period.
4. The epidemiologic analysis of a number of potentially avoidable causes of death as a first step towards the reduction of these causes of death, in particular infectious diseases, accidents and suicides.
5. A confirmation of the suspected low mortality rate from ischaemic heart disease in Greenlanders.
6. A description of geographic variations of mortality which can be related to socioeconomic differences between geographic regions, and the identification at individual level of socioeconomic variations in morbidity.

It is proposed that future studies concentrate on diseases and causes of death which are of public

health importance to the Greenlandic community. Infant and child mortality is very high due to a number of causes, and detailed epidemiological analyses will be necessary for the design of appropriate strategies for the reduction of mortality in this vulnerable age group. For the same reasons, epidemiological descriptions of accidents are important, and further epidemiological analyses of suicides will be able to supplement psychosocial analyses. The increasing incidence of lung cancer, the high mortality from acute infectious diseases, the high incidence of sexually transmitted diseases and the many health related and social problems due to alcohol misuse are other problem areas which deserve further study. Finally, analyses of atherosclerosis and ischaemic heart disease, although not of major public health relevance in Greenland presently, should be pursued because Greenland offers a unique situation for the study of this disease which is so important for the world community.

12. CHALLENGES FOR HEALTH POLICY IN GREENLAND

The near future will se a transfer of the responsibility for health care in Greenland from the Danish state to the Greenlandic home rule authorities, and with it the need of formulating a health policy. Also in Greenland it is true that you cannot have everything: modern health care technology has so much to offer that a choice is necessary for economic reasons. Furthermore, Greenland is so large, communications so difficult and the population so small and scattered that equal access to health care for all citizens, let alone access at a level comparable to that of the population of Denmark, is not realistic under present economic conditions. Epidemiology is a scientific discipline which can contribute to health care planning by constructing a rational basis for setting priorities and allocating scarce resources (Knox 1979). A Greenlandic health policy will have to take certain epidemiological facts into consideration, some of which have been pointed out by the present study:

- The excessively high suicide and homicide rates as well as the many social problems due to inappropriate use of alcohol are indications that something is fundamentally wrong in the community. The health care system cannot cope with these problems alone but has its role to play.

- The high mortality from accidents is to a large extent a function of the Greenlandic hunting and fishing culture but many fatal accidents also in children and elderly people can without doubt be prevented, e.g. through a change in the attitude towards accidents, which are regarded as being inevitable, and through a change in alcohol consumption.

- The high infant and child mortality and the high mortality due to acute infectious diseases are particularly a problem in settlements and Eastern Greenland. This shows that living conditions and the access to high quality health care are far from evenly distributed within Greenland. Inequalities also exist between social groups.

- Mortality from cervix cancer is several times higher than in Denmark and mortality from lung cancer shows a considerably increasing secular trend. Both cancer types are preventable, the former through a change in sexual habits but also through screening, and the latter through a reduction of cigarette smoking.

- The demographic structure of the population of Greenland, characterized by large birth cohorts from the mid-1950s to the late 1960s, will necessitate successive changes in the health care system during the next decades. These birth cohorts are now in their twenties and their health problems are in particular related to accidents, suicides and venereal diseases. As they grow older a shift towards a more chronic disease pattern will take place and this will place different demands on the health care system. The large birth cohorts will give rise to other large birth cohorts in the late 1980s and the early 1990s and the demands in the health care sector will be fluctuating for a long

time.

- Research and development must be given high priority in order to be able to follow the change in disease patterns and offer the people of Greenland the best possible preventive and curative health care.

Several organizations and authorities in Greenland and Denmark have taken valuable initiatives in one or more of the above mentioned fields (Misfeldt 1990b). It is suggested that a future Greenlandic health policy build on epidemiological knowledge and on these existing initiatives.

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