ISM skriftserie Nr. 21

THE HEALTHY FAITH.

Pregnancy outcome, risk of disease, cancer morbidity and mortality in Norwegian Seventh-Day Adventists.

by
Vinjar Fønnebø

Institute of Community Medicine
University of Tromsø, Tromsø
Norway

ISM skriftserie
blir utgitt av Institutt for samfunnsmedisin
Universitetet i Tromsø.

Forfatterne er selv ansvarlige for sine funn og konklusjoner. Innholdet er derfor ikke uttrykk for ISM´s syn.

Anders Forsdahl
redaktør

ISBN 82 - 90262 - 25 - 6
1992

THE HEALTHY FAITH.
Pregnancy outcome, risk of disease, cancer morbidity and mortality in Norwegian Seventh-Day Adventists.

VINJAR FØNNEBØ

INSTITUTE OF COMMUNITY MEDICINE
UNIVERSITY OF TROMSØ
TROMSØ 1992

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

The present study was carried out at the Institute of Community Medicine, University of Tromsø, Norway. The study was started already in 1975 and came to a conclusion in 1990.

I wish to thank firstly professor Knut Westlund for his encouragement and guidance while I was still a medical student. His help at that stage was extremely valuable and helped me to understand that the task was possible. Also I would like to thank professor Egil Arnesen for his constructive criticism and encouragement in the final years of the study. I would also like to thank the Institute of Community Medicine as a whole for the provision of excellent working conditions in the form of computer facilities and secretarial help.

I would also like to thank the staff of The Central Bureau of Statistics, The Medical Birth registry, The National Health Screening Service and The Cancer Registry. As is shown by a co-authorship I would especially like to thank dr. Are Helseth who provided me with the help needed at the Cancer Registry.

The cooperation of the Seventh-Day Adventist church in Norway has been crucial for this study. I would like to

express my appreciation of the way they facilitated the gathering of the data on their members. All the local church secretaries in all the 72 churches I visited are also worthy of my thanks for receiving me and providing me with the necessary records.

The financial support given me by the Unger-Vetlesen Medical Research fund enabling me to spend a year at the London School of Hygiene and Tropical Medicine was invaluable in giving me a deeper understanding of the methods of epidemiology.

The preparation of a thesis like this often lays a burden on other family members. Although I have tried not to let my work with this thesis overshadow my family duties, I still have had to depart and work at odd hours. For being patient with me in these years I want to thank my wife Liv and my four children: Serena, Adelinn, Carite and Steffen.

The present work has been financially supported by the Unger-Vetlesen Medical Fund, Erna and Olav Aakre's Legacy, Ragnhild and August Gillum's Legacy, Tromsø Sparebank's Medical Research Fund, Doctor Th. Roll's Legacy and the Cardiovascular Research Fund at the University of Tromsø.

LIST OF PAPERS

This thesis is based on the following papers:

I. Pregnancy outcome in Seventh-Day Adventist women. A study of 1326 births by Seventh-Day Adventist mothers and matched controls. (Submitted: British Journal of Obstetrics and Gynaecology)

II. Coronary risk factors in Norwegian Seventh-Day Adventists. A study of 247 Seventh-Day Adventist participants in the Cardiovascular Disease Studies in Norway. (Conditionally accepted: American Journal of Epidemiology)

III. Cancer incidence in Norwegian Seventh-Day Adventists 1961 to 1986. Is the cancer - life-style association overestimated? (In press: Cancer)

IV. Mortality in Norwegian Seventh-Day Adventists 1962-1986. (Conditionally accepted: Journal of Clinical Epidemiology)

The papers will be referred to by their Roman numerals in the text.

1. A SHORT DESCRIPTION OF SEVENTH-DAY ADVENTISTS

The Seventh-Day Adventist church is an evangelical Christian denomination originating in the Millerite movement in the New England states of USA in the middle of the nineteenth century (1). The observation of Saturday as the day of worship and specific life-style regulations have been the factors most clearly separating Seventh-Day Adventists from other Christians. The basis of the life-style regulations in the church is the belief that the body is a temple for the Holy Spirit (2) and must not be defiled. The church professes that what harms the physical aspects of the person also affects its mental powers and spiritual well-being. It is regarded as a solemn responsibility to live in a manner that maintains health in order to be able to both serve God and fellow man.

1.1. Diet

Seventh-Day Adventists are required to abstain from the consumption of unclean animals, fowls, and fish as stated in the Old Testament of the Bible (3). Clean animals are those who have a split hoof completely divided and that chew the cud. Clean water creatures are those which have fins and scales. The unclean birds and clean insects are listed. These dietary regulations on meat and fish are

shared with Moslems.

One of the early Seventh-Day Adventist leaders, Ellen G. White, which by most Seventh-Day Adventists was regarded as a prophetess advocated a diet with no meat at all (4). Her recommendation was based on health considerations and it resulted in the adoption of lacto-ovo-vegetarianism in many of the church members. In those that still consumed meat and/or fish the total consumption was probably well below their contemporaries. Not only did she recommend vegetarianism, but also warned against excesses in refined carbohydrate (5) and fat (6) intake. Ellen White indicates also that the time will come when Seventh-Day Adventists for health reasons should discontinue the use of eggs and dairy products (7), but very few have followed this advice.

1.2. Stimulants

Very early in the history of the church non-medicinal drugs, alcohol, tobacco and caffeine-containing beverages were condemned (8). The teetotaller standpoint has been strongly upheld together with the no-smoking standpoint and has been followed closely in all active church members. The abstention from coffee and tea (9) has not been followed as closely as the standpoint on alcohol and tobacco, and coffee use has been compatible with an active

church membership (9).

1.3. Education

The early members of the church were generally recruited from the lower social classes (10). Due to the emphasis the church lays on education, children born to Seventh-Day Adventists get an education that is higher than average, thereby making later generations of Seventh-Day Adventists of a high social status (10).

1.4. Other factors of life-style

The church encourages regular exercise, sufficient rest and stable psychosocial relationships. A conservative view on sexual morale is also strongly advocated; premarital sex is for example strongly discouraged. Extravagant spending on clothes, the use of jewels, dancing, cinema, theatre, opera and other "worldly" entertainments are discouraged.

The degree to which these recommendations are followed varies somewhat from place to place.

2. EPIDEMIOLOGICAL STUDIES IN RELIGIOUS GROUPS

Possibly the earliest recorded epidemiological study on religious groups is the intervention study recorded in the first chapter of Daniel's book in the Old Testament of the Bible:

> Daniel then said to the guard whom the chief official had appointed over Daniel, Hananiah, Mishael and Azariah, "Please test your servants for ten days: Give us nothing but vegetables to eat and water to drink. Then compare our appearance with that of the young men who eat the royal food, and treat your servants in accordance with what you see." So he agreed to this and tested them for ten days.
>
> At the end of the ten days they looked healthier and better nourished than any of the young men who ate the royal food. So the guard took away their choice food and the wine they were to drink and gave them vegetables instead.

In this century studies have been performed both on organized religious groups (9-26) and groups of people having certain religious attributes in common (27-29).

2.1. Jews

A large cancer mortality study among Jews in New York City (11) showed a SMR for all cancers of 90 in men and 112 in women when compared to the non-Puerto Rican white population. The mortality of respiratory, oesophageal and bladder cancer were particularly low in men while gastrointestinal, lung, ovarian, breast, kidney, skin and haematopoietic cancer mortality were higher than expected in women. The low cancer mortality in men was suggested to be due to a lower prevalence of smoking (30). A higher risk for leukaemia in Jews was also found in the Tri-State Leukaemia Study (12). Orthodox Jews were found to have a lower risk of myocardial infarction than secular Jews in a case-control study from Jerusalem (31). This can be explained by a lower coronary risk profile in both Orthodox Jews (32) and their offspring (33). A low fertility has been observed in Jews both in Canada and USA (13).

2.2. Catholics

In the study from New York City (11), Catholic males had higher and women lower than expected cancer mortality. Respiratory cancer was the major contributor in males while a low mortality of lung, ovary and breast cancer

contributed to the low cancer mortality in women. Catholic nuns in Britain (together with Anglican nuns) (14) who ate little or no meat showed no difference in overall cancer mortality when compared to all women in Britain. Lung and cervical cancer was however significantly lower. All-cause mortality was lower in the nuns indicating a significantly reduced cardiovascular mortality. Blood pressure has been shown to be lower and bacteruria less common in nuns compared to working women (15). Blood pressure rise with age was found to be present only in control women when compared to nuns (16).

2.3. Baptists

Baptist clergymen are found to have a lower mortality than both all white males, males with work experience and white clergymen in general (17). When coronary risk factors were studied in Tromsø (34), Baptists were found to have a lower prevalence of smoking, but lipid and blood pressure values were not different from the general population.

2.4. Amish

Amish were found to have an overall mortality similar to the general population (18), but within specific age- and sex groups they differed. Blood pressure increase with age

was found to be low in the most conservative Amish community (19).

2.5. Mormons

Mormons are recommended to abstain from tobacco, alcohol, tea, coffee and nonmedicinal drugs (21). No specific recommendations are given with regard to diet. Both cancer incidence (21) and cardiovascular mortality (22) has been shown to be lower. Ulcerative colitis is, however, more common in this religious group (23).

2.6. Zen buddhists

Both mortality (24) and coronary risk factor levels (25) were found to be lower in Zen Buddhist priests and monks. This religious group encourages vegetarianism and abstention from smoking, drinking and sexual life.

2.7. Seventh-day adventists

2.7.1. Cancer and cardiovascular disease

2.7.1.1. Morbidity and mortality

Interest in the association between life-style and chronic non-infectious disease led in the 1950's to studies of disease occurrence in Seventh-Day Adventists (35). The largest incidence and mortality studies were performed in California, USA based on two large cohorts of Seventh-Day Adventists identified in 1960 and 1976 (36-39). These studies have shown a significantly reduced risk of both cancer (36,39-41) and cardiovascular disease mortality (37) when compared to the general population. When compared to other subgroups of the population like UCLA graduates (36) or non-smoking respondents to the ACS questionnaire (42,43) the differences were smaller and in some instances seemed to go in the opposite direction. In both the Netherlands (44) and Japan (45) mortality studies have shown significantly lower mortality of both cancer and cardiovascular disease in Seventh-Day Adventists. In a small cancer incidence study from Denmark (46) a significantly lower cancer incidence was found in male Seventh-Day Adventists. A Polish study (47) showed lower mortality in Seventh-Day Adventists. A previous study from Norway showed significantly lower mortality from cancer

and cardiovascular disease in men, but only small differences in women (10).

2.7.1.2. Risk factors for cancer and cardiovascular disease

Risk factors for cardiovascular disease have been studied both in Seventh-Day Adventist children (48,49) and adults (50-57) in the United States. No major differences were found in blood pressure (48,52,58,59), but both smoking (58,60,61) and cholesterol (52,54,55,57,58,62,63) has been substantially lower in Seventh-Day Adventists. In Australia a significantly lower serum cholesterol (64) has again been demonstrated, while the differences in blood pressure have been smaller, but still significant (59,64,65). Studies of risk factors for cardiovascular disease in the Netherlands (44,66) and Norway (9) show the same picture as in Australia and the United States. Risk factor studies with regard to cancer have mainly been concentrated on studies of risk factors for gastrointestinal cancer (67-75) and chromosomal aberrations (76,77). The results have been that Seventh-Day Adventists generally show levels lower than controls.

2.7.2. Respiratory disease

Pulmonary disease has been found to be less common in Seventh-Day Adventists (78). This is thought due to the low prevalence of smoking.

2.7.3. Diabetes

In the Californian Adventist study, mortality of diabetes was found less often in Seventh-Day Adventists than the general population (79), In Papua New Guinea, however, glucose intolerance was found to be positively associated with Seventh-Day Adventist membership (80).

2.7.4. Osteoporosis

In several studies of bone density no difference has been observed when comparing Seventh-Day Adventists and controls (81-85).

2.7.5. Mental health

Seventh-Day Adventists in California were found to experience a somewhat better mental health than controls.

(86).

2.7.6. Dental health

Studies from Finland (87,88) and USA (89,90) have shown a better dental health in Seventh-Day Adventists. This is thought due to their healthier diet. In Papua New Guinea, however, Seventh-Day Adventists had a poorer dental health compared to the rest of the population (81). In this country betel nut chewing practised by non-Seventh-Day Adventists was thought to exercise a cariostatic effect.

2.7.7. Adverse effects of life-style

Studies in both USA (91) and Norway (92) have shown that extreme vegetarianism in some instances have led to vitamin deficiencies in Seventh-Day Adventists.

2.8. Religion in general

Church attendance has in Maryland, USA (26,27) been shown to be associated with a low risk of cardiovascular disease, pulmonary emphysema, cirrhosis of the liver and suicide. Rectum and colon cancer mortality , however, did not occur more often in poor attenders in church.

Blood pressure has been shown to be lower in frequent church attenders (28) and persons with a religious outlook on life (93). A more thorough review of the influence of religion on blood pressure has been given by Levin and Vanderpool (29).

3. AIMS OF THE STUDY

The aim of the present study was to examine the association between being a Seventh-Day Adventist and risk factors for disease, pregnancy outcome, cancer incidence, site-specific mortality and total mortality in an unselected Seventh-Day Adventist population.

The following questions were specifically under scrutiny:

1. Do children born by Seventh-Day Adventist mothers have a different birth-weight and birth-length and risk of early death compared to children by non-Seventh-Day Adventist mothers?

2. Do Seventh-Day Adventists have a different risk of cardiovascular disease as monitored by serum cholesterol, smoking and blood pressure?

3. Do Seventh-Day Adventists have a different cancer incidence rate than the general population?

4. Do Seventh-Day Adventists have a lower mortality rate than the general population?

4. METHODOLOGICAL CONSIDERATIONS

4.1. Study type

The search for "evidence" of etiologic importance in associations between environmental factors and disease is in animal research almost exclusively based on randomized, experimental studies. The researcher is in total control of both the studied exposure and possible confounding factors. In humans this would also have been the scientifically optimal study situation. Although it is technically possible to randomize humans into a study or control exposure group, it is almost only in drug trials that the study subject is unaware of it's study or control status. Ethical considerations limit the use of the experimental design in humans to possible beneficial interventional exposures. The economic cost of such studies can be substantial in that low incidence rates necessitate a long follow-up time of a large number of persons. Due to these ethical and practical limitations, the epidemiological contribution of "evidence" of etiologic significance must to a large degree be built on results from scientifically suboptimal study designs. A number of observational studies, both follow-up and case-control, have been undertaken to examine the relationship between suspected hazardous exposures and mortality,

morbidity or risk factors of the two.

The studies here presented on Seventh-Day Adventists in Norway are observational studies of this type. The Seventh-Day Adventists studied are either compared to the general population (cancer incidence, mortality, birth weight/length) or study population (health studies) controls. The subjects in the health studies were blinded to the fact that they were being studied as Seventh-Day Adventists, but of course not to the fact that a study was being performed.

When using matched controls, the choice of number of controls is taken on the basis of the cost of acquiring index persons and controls. The number of Seventh-Day Adventists in the studies here presented was fixed in that no sample was taken. The matched controls were chosen from a computerised registry and three controls could be obtained at the same price as one. To ensure a high statistical power in the analyses three matched controls were chosen for every Seventh-Day Adventist. Expanding the number of controls beyond 3-4 yields little gain in statistical power (94).

With the existence in Norway of a number of county-wide health studies in addition to the death and cancer registries, it was possible to conduct a study on health and disease in Seventh-Day Adventists without the personal

cooperation of a single member. Volunteering as a Seventh-Day Adventist is thereby completely eradicated.

4.2. Study population

By personally visiting all the Seventh-Day Adventist churches in Norway it was possible to register all known Seventh-Day Adventists in the country. All churches in Norway outside of the state Lutheran Church are subject to regular government control (95) and gain economic support from the authorities for each registered member. This ensures a high quality of all membership rosters. Some of the churches had membership rosters that dated back to before 1900. Altogether 10602 Seventh-Day Adventists are registered. The use of an eleven-digit personal identification number was introduced in Norway for all persons alive in November, 1960. Some of the 10602 Seventh-Day Adventists registered had died, moved out of the country or left the church before the autumn of 1960. The 7451 Seventh-Day Adventists living in the country and registered to be alive January 1, 1961 or who had become Seventh-Day Adventists after that date were sought identified by the identification number in the Central Bureau of Statistics. The number was found for 7285 persons (98%). These Seventh-Day Adventists form the basis of the present studies.

4.3. Reference population

In the comparison of the Seventh-Day Adventist total life-style with a non-Seventh-Day Adventist life-style population controls should be used. When using population controls one can not differentiate between religion, diet, smoking habits, social class, education, area of residence or other factors as responsible for a difference or similarity in incidence or mortality of disease or risk factor level. If one wished to single out specific aspects of the Seventh-Day Adventist life-style and study their relation to risk of disease, incidence of disease or mortality one could either use subgroups of the population as controls or employ comparisons within the Seventh-Day Adventist population. Both of these methods have been employed in previous studies on Seventh-Day Adventists (40,42,53,96). In the papers presented in this thesis population controls were used in all studies except in the Health studies. In that study participation in the study was a selection criteria. This ensured that Seventh-Day Adventist participants were compared to control participants.

4.4. Study variables

The variables registered from the Seventh-Day Adventist church rosters were name, date of birth, sex, place of residence, place of birth, date of entry into the church, date of leaving the church and date of death. When the national eleven-digit personal identification number was entered a double-check could be made on name, sex, date of birth and date of death. The values in the Central Bureau of Statistics were regarded as correct and the variables were corrected if any discrepancies were present. No specific rules were preset for regarding a match correct, but the 166 persons who were excluded were regarded as not identifiable in the Central Bureau of Statistics.

The other variables used in the papers on births of Seventh-Day Adventist mothers and on risk factors for coronary heart disease are selected variables in the data collected routinely in the Medical Birth Registry and in the Health Studies in Norway. The chosen variables for study were the ones regarded necessary in order to address the issues under study.

The investigating personnel of the Health studies were completely unaware of the religious affiliation of the participants, and no observer bias could thus be introduced in the recording of the risk factor level of

the Seventh-Day Adventist participants.

4.5. Ascertainment of cases

The case ascertainment followed the same routine in Seventh-Day Adventists as in the controls. All the cases in the incidence and mortality studies have been identified and classified in the normal routine of the Cancer Registry and the Death Registry of Norway. Reporting to the Norwegian Cancer Registry is mandatory and the validity is regarded as high (97). The proportion of causes of death based on autopsy is generally low (14% in 1976) (98) and is lowest in the oldest. Although an evaluation of the Birth Registry has demonstrated some major validity problems (99), these problems do not concern the variables used in this study.

Although the religious affiliation of the cancer patient or the deceased might be known to the doctor, it has not been likely to influence the diagnostic procedure. In the Birth Registry no record of the religious affiliation of the mother is included.

4.6. Study design

Most of the previous epidemiological studies on Seventh-

Day Adventists have been prospective in their design (37-42,44,53,100-102). Two major aspects however, differentiates the studies in the present thesis from most previous prospective studies on Seventh-Day Adventists:

1. All registered Seventh-Day Adventists have been included in the follow-up regardless of their degree of participation in church activities and own religious activity.

   This is different from California, USA, where the studies are based on volunteers (38,39). Only about 50% of the Seventh-Day Adventist population have been included. These 50% are likely to be the most active segment of the Seventh-Day Adventist population both with regard to health and religious activity. In order to monitor the effect of a Seventh-Day Adventist life-style this might be an accurate method, but a response rate of just above 50% is a reason for concern that bias could be present.

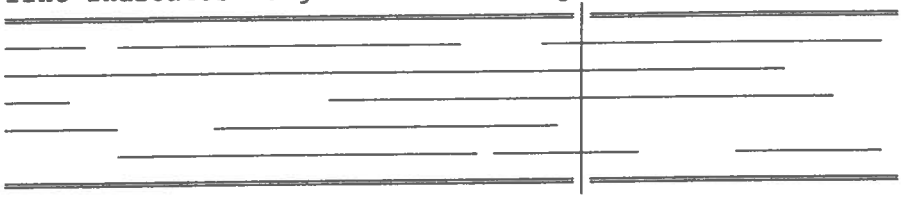
   A third method was used in the previous Norwegian study on Seventh-Day Adventists (10). All persons that indicated that they were Seventh-Day Adventists in the national 1960 census were included in the study. This method ensures that all persons that regard themselves as Seventh-Day Adventists are included regardless of their official membership status. The study had 48175

Seventh-Day Adventist person-years in the age group 35-90 in the period January 1, 1961 to December 31, 1977. In the mortality study in this thesis (IV) there were 59459 Seventh-Day Adventist person-years in the age group 35+ in the period January 1, 1962 to December 31, 1977. This discrepancy which would have been larger if the present study also included 1961 indicates that the main effect of the previous Norwegian study design is to exclude inactive members and thereby the design comes close to the volunteer design used in California.

2. Members entering the church in the study period are included in the study.

Both the Californian (38,39) and the previous Norwegian (10) studies have used a cross-sectional baseline to identify members who are then followed to end of study or leaving the church. This method will tend to include more long-time members (figure 1). This

Figure 1. Definition of follow-up candidates by a cross-sectional survey at start of study. Length of line indicates length of membership.



phenomenon can be compared to what in screening is called length bias (103). Persons with a long

detectable pre-clinical phase have a greater chance of being picked up in the screening survey and thereby can bias estimates of survival and overestimate the possible benefits of the screening program. In the same manner epidemiological studies of special membership groups or vocational groups could give a biased estimate of the hazard or benefit of the group membership only by means of including mostly long-time members in the group.

4.7. Analytical methods

In the studies on births of Seventh-Day Adventist women and Seventh-Day Adventist participants in the Health studies the Seventh-Day Adventist was compared to three controls. When comparing continuous variables in a matched design with three controls per index person, a randomized block design is the preferable method (104) to be used. In the Health studies this was done, but in the study of births the computer had insufficient memory to accommodate the calculations. A one-sample t-test was therefore applied comparing the mean of the three controls with the value in the Seventh-Day Adventist birth. The lower variance of the mean of three measurements ensures that the use of three controls versus one yields a higher statistical power in the analysis. When applying this method in the Health studies parallel to the randomized block method, it turned out that the two methods yielded

mostly identical results. It was therefore regarded as a valid method in the study on births.

In the studies on incidence of disease standardized incidence ratio (SIR) was used and standardized mortality ratio (SMR) was used in the mortality studies. These measures are useful when the interest is the comparison of a group with a single reference population. The greater statistical stability when using the "indirect" method of standardization is useful especially when analyzing site-specific incidence or mortality (105).

In studies on Seventh-Day Adventists it is also of interest to compare incidence and mortality between countries. When this is attempted SIR and SMR are of little value. A SIR or SMR can be very different in two countries although the crude incidence or mortality rates are the same in the two Seventh-Day Adventist populations. In the cancer incidence article (III) an example is given comparing male cancer incidence rates in Norway and Denmark. This shows that cancer incidence is probably the same in Norwegian and Danish Seventh-Day Adventist men. The difference in SIR arises because the countries differ in national rates. Studies on Seventh-Day Adventists can thus seem to differ more between countries than crude rates might indicate.

5. SUMMARY OF RESULTS

The papers in this thesis are all based on the Norwegian Seventh-Day Adventist population. This population has been linked to official Norwegian health, disease and death registries.

1. Pregnancy outcome in births of Seventh-Day Adventist mothers.

The first paper examines birth weight and length and mortality from 28 weeks of gestation and onwards in children born by Seventh-Day Adventist mothers. The study shows a birth weight 94 grams higher in children born by Seventh-Day Adventist mothers compared to control children. Body length was also slightly higher in the Seventh-Day Adventist births. Risk of death was slightly lower in Seventh-Day Adventist births but this difference was not statistically significant. When the births were stratified by marital status and parity this did not alter the results.

2. The risk of coronary heart disease in Norwegian Seventh-Day Adventists.

The second paper describes risk factors for coronary heart disease in Norwegian participants in the county-wide health studies performed in Norway from 1973 to 1987. The results show that serum cholesterol is approximately 15% lower in Seventh-Day Adventist men and 10% lower in women compared to matched controls. Smoking is less prevalent in Seventh-Day Adventists in both sexes, while blood pressure is only significantly lower in Seventh-Day Adventist women above the age of 40. The Westlund coronary risk score is significantly lower in Seventh-Day Adventists in both sexes.

The paper also shows that persons who have left the church are a group with a higher risk for coronary heart disease compared to those who stay in the church.

3. Cancer incidence in Norwegian Seventh-Day Adventists.

Cancer incidence was not significantly different in Seventh-Day Adventists compared to the general population. A weak trend was seen in total cancer incidence showing the highest incidence in the persons entering the church after the age of 35. Site-specifically, the only site showing a significantly lower incidence before the age of

75 was respiratory cancer. The study may indicate that etiologic factors for cancer in Norway must be sought in areas where Seventh-Day Adventists do not differ from the general population.

4. Mortality in Norwegian Seventh-Day Adventists.

Seventh-Day Adventist men in Norway have a significantly lower mortality compared to the general population, especially before the age of 75. In women no significant difference in mortality was seen. There was, however, a significant trend in mortality showing a higher mortality in persons joining the church late in life in both sexes. Site-specifically the difference in mortality in men is almost exclusively due to a very low cardiovascular mortality in Seventh-Day Adventist men.

Cancer mortality was not significantly different in Seventh-Day Adventists compared to the general population.

Noteworthy in this study was the finding of no difference in mortality between Seventh-Day Adventists and the general population for those Seventh-Day Adventists entering the church after the age of 35.

6. GENERAL DISCUSSION

6.1. Introduction

The studies presented in this thesis give a picture of Norwegian Seventh-Day Adventists as a population group with a starting point in life similar to the offspring of non-smokers in the general population. Their risk of cancer seems to be similar to the general population, but both level of some risk factors for cardiovascular disease and mortality from these diseases is lower than in the general population. The low mortality is especially pronounced when church membership is commenced in teen-age. Other studies by the author contribute to the same description of the Seventh-Day Adventist group (34,77,106) with the possible exception of the lower selenium level (9) found in Seventh-Day Adventists.

6.2. Bias considerations

Studies on religious groups can have two objectives. On the one hand one might wish to study the effect of religion as such. This would lay emphasis on the religious experience and would want to quantify the effect of religion irrespective of specific aspects of life-style.

On the other hand religious groups that have specific life-style recommendations are interesting to study because they represent a "natural experiment" with regard to effect of specific life-style factors. The connection to religion is likely to ensure a high adherence to the life-style and the group is easily identified.

When considering possible bias in the present studies, one has to discuss these two study objectives separately.

If the studies in this thesis are regarded as a study of the total effect of the Seventh-Day Adventist faith, a negligible selection bias is present (98% of the registered Seventh-Day Adventists are in the study). If the studies were primarily a study of the effects of the specific Seventh-Day Adventist dietary and tobacco, alcohol and coffee recommendations, the lack of selection could introduce a misclassification bias. Members who do not follow the recommended life-style should have been excluded. However, one has to keep in mind that when the general population is used as the reference group this population includes both the Seventh-Day Adventists in the study (in Norway about 0.1% of the population) and an unknown proportion of the population who are not members of the church, but who follow more or less the same life-style as Seventh-Day Adventists. This leads to a possible misclassification also in the reference group.

There is a possibility that this misclassification could be differential. Persons with symptoms and signs indicating a serious disease could be more prone to turn to religion than those with no medical problems. If this were the case an underestimation of the effect of the Seventh-Day Adventist life could be present. Starting follow-up one or ten years after entry into the church has however in both the cancer incidence study and the mortality study not affected the estimate of SMR or SIR. The main possible misclassification is therefore non-differential and this always leads to a conservative estimate of the difference between groups (105).

If the specific effect of life-style should be estimated it would be necessary to compare with a population who only differed from Seventh-Day Adventists in specific life-style factors. All other aspects of their life-style should be similar. This necessitates the use of volunteers and the "volunteer" studies from California have been based on down to 50% of registered Seventh-Day Adventists. This can result in a sizeable "healthy volunteer" bias (107). Comparison of Seventh-Day Adventists with other volunteer groups in California demonstrated differences smaller than when using the general population as the reference (42).

The study on coronary risk factors in this thesis does not include all registered Seventh-Day Adventists. In a study

where the taking of a blood sample, blood pressure measurement and questionnaires are involved, one is forced to rely on voluntary participation. Seventh-Day Adventist participants are therefore compared to non-Seventh-Day Adventist participants. Could the reason to participate be different in the two groups? In addition to disease or travelling prohibiting physical attendance, one would think that in both groups the individuals who would not want to expose their life-style would be the ones not willing to participate. Although it was claimed in an early Seventh-Day Adventist study (42) that non-responders did not have a higher death risk than responders, later publications have indicated this form of possible bias (107). Taking this possible bias into account one can only conclude from the risk factor study that it gives a picture of the risk factors of voluntary participants in Seventh-Day Adventists and non-Seventh-Day Adventist controls. The high participation rate of 70-80% gives, however, an indication of which life-style factors are the most important in differentiating Seventh-Day Adventists from non-Seventh-Day Adventists.

6.3. Confounding

In the discussion of Seventh-Day Adventist morbidity and mortality the question about selection has been discussed (43). In this case not the selection of a subgroup of the

registered Seventh-Day Adventists but the process leading to some persons becoming Seventh-Day Adventists and some not. Could there be a possible confounding factor that was independently associated with both morbidity/mortality and likelihood of becoming a religious person? Even if several aspects of religion other than diet, smoking etc. have been proposed as salutary with regard to disease (108,109) and psychosocial factors have been demonstrated to possibly affect mortality after myocardial infarction (110), little is known as to the reasons for joining the Seventh-Day Adventist church.

Whether genetic factors that could influence physical health are different in Seventh-Day Adventists are possibly indirectly studied for the first time in the paper in this thesis studying offspring of Seventh-Day Adventist mothers. The slightly higher birth weight and length for an equal gestational length indicates a higher fulfilment of a intrauterine growth potential. This finding combined with an indication of a slightly lower mortality could indicate healthier babies. The magnitude of this benefit, however, is not greater than what is found in offspring of non-smoking mothers in the general population. Data from Tromsø showing a sister chromatid exchange rate similar in Seventh-Day Adventist children compared to non-Seventh-Day Adventist controls (77) also seem to support the notion that children of Seventh-Day Adventist mothers differ very little from other children

at birth when evaluated by the hard end-points of neonatal health care. Not all Seventh-Day Adventists, however, are born by Seventh-Day Adventist mothers, and not all children born by Seventh-Day Adventist mothers join the church later in life. Since the Medical Birth Registry of Norway was established as late as in 1967 it is not yet possible to study the children who were born by Seventh-Day Adventist mothers and evaluate their hard endpoints with regard to the child's later membership status.

6.4. Further comments.

The above-mentioned considerations of bias and confounding could indicate that the studies presented in this thesis give a correct picture of the health effect of being a Seventh-Day Adventist, but a possible underestimate of the health effect of specific aspects of the Seventh-Day Adventist life-style. These specific aspects have in both ecological studies and in population subgroups been demonstrated to be important determinants of cancer and cardiovascular disease risk (111-118). Both in ecological studies between countries as well as in studies over time within countries many possible confounders are present and it is difficult to pinpoint the relative importance of different life-style factors. The effect of self-selection to population subgroups makes estimates of the effect of specific life-style factors also in these studies

uncertain.

The studies here presented of a subset of the population with specific life-style recommendations and a near 100% follow-up of all registered members may give insight into the population effect of such recommendations. The general population does not consist of only "willing converters" (119). Some are characterized as laggards. No population will be without these people and the study on Seventh-Day Adventists in Norway could indicate the magnitude of the population health effect of a shift in life-style as large as the Seventh-Day Adventist one with still a sizable proportion of the population not complying.

Paper IV gives a description of Seventh-Day Adventist mortality in comparison with Norwegian and Japanese mortality. As can be seen from the table all Seventh-Day Adventist men have a mortality in the 45-74 year age group that is practically identical to Japanese mortality. For men entering the church before 19 years of age mortality after age 55 is considerably lower. In women it is the Seventh-Day Adventists entering before 19 that resemble most closely the Japanese women. These data indicate that a life-style change as dramatic as the difference between Norway and Japan might be necessary in Norway in order to accomplish a mortality reduction as large as in Seventh-Day Adventists. The goal set out in the Norwegian Health for All 2000 document (120) of a 15% reduction in cancer

mortality and a 25% reduction on cardiovascular mortality might be difficult to accomplish when Seventh-Day Adventists for neither of these diseases have reached these goals. This in spite of a difference in life-style that is much greater than what can be expected in the general population in the coming decade.

At what period in life the life-style is most important in determining future health risk is yet not clear. Controlled intervention studies on a large scale have frustrated researchers in that life-style changes seem to fail to result in changes in total mortality (121-128). Only the Belgian part of the WHO European Collaborative Trial in the Multifactorial Prevention of Coronary Heart Disease (129) has shown a significant difference in total mortality. In a comment to the risk reductions in both intervention and control groups in the Gøteborg trial (122) professor Geoffrey Rose called this a disappointment for researchers while a great success for preventers.

The downward secular trend in cardiovascular disease mortality rates in several Western countries has been largely ascribed to changes in the life-style of the population (112,113). Support for this thought can be found in the cardiovascular disease mortality data from Norway during the 1940-45 war period (130) and the Finnish study on coronary heart disease mortality in mental hospitals (127). A dramatic dietary change seemed to

coincide with a significant drop in cardiovascular mortality. The data from the present Seventh-Day Adventist studies are not in accordance with these findings. Persons joining the church at 35 years or above have a mortality and cancer incidence not significantly different from the general population. The changes in diet made by persons converting to the Seventh-Day Adventist faith may, however, not have been dramatic enough to result in the desired fall in cardiovascular mortality.

Persons joining in early age, however, have a mortality risk that is almost half of the general population's (mainly cardiovascular mortality). This indication of a large effect of a different life-style early in life seems to indicate that the pace of atherosclerotic development is set in childhood/teen-age. Other studies from Norway (131), Hawaii (132), Britain (133,134), Finland (135) and Sweden (136) have seen associations between living conditions in childhood and mortality from several diseases in adult life. This taken together with the demonstration of associations between living conditions in childhood and risk factors for coronary heart disease in adults (137,138) seems to indicate a very early influence on risk of adult disease. Whether this early risk determination is stronger than life-style modification in adult life is still unclear. An indication of this is the finding in these studies of a risk factor level in late converters similar to early converters (unpublished data),

but a clearly higher death risk in these late converters.

The finding of no difference between late converters and the general population could also be interpreted along a different line of thought. Important for the occurrence of especially cardiovascular disease is not just the atherosclerotic process. A correlation between the intake of marine oil and thrombosis (139), platelet aggregation (140) and blood pressure (141) has been found. Thrombus formation at the site of atherosclerotic narrowing of the arteries could thus be inhibited. A prospective epidemiologic study from the Netherlands (142) has found an inverse relation between fish intake and coronary heart disease mortality. One aspect of the Seventh-Day Adventist life-style is a low intake of fish and thereby marine fat (9). If a person through the first 35 years of life has had an atherosclerotic development similar to all other persons in the country and then removes a possible protective factor (marine fat) with regard to thrombus formation, the possible benefits of a atherosclerotic-lowering life-style could be outweighed by an increased risk of thrombus formation. For those persons with a low atherosclerotic development from childhood/teenage this possible detrimental factor could be of minor importance and their general risk of cardiovascular disease would remain low throughout life. Dietary advice to persons converting late in life should maybe be modified in that they should be recommended to keep their fish intake

fairly high while at the same time lowering meat intake.

6.5. Implications for prevention

An increased life expectancy through a low risk of cancer and cardiovascular disease in early life is for many an unquestionable benefit. A postponement of the major killers in Western societies could lead to a rectangularization of the survival curve with a possible compression of morbidity. If, however, the extra years are spent in suffering from non-lethal, disabling conditions, many might choose to enjoy "the unhealthy pleasures of life" with an abrupt death instead of a few additional years in a nursing home. The benefit of prevention of early cancer and cardiovascular disease might in that case have to be reconsidered.

In the search for optimal health in a population these issues will have to be carefully considered. Further epidemiological research should include the question: Will an adherence to the Seventh-Day Adventist life-style from young age lead to an increased person-time before death with dependency on others?

7. CONCLUDING REMARKS

The papers in the present thesis show that children born by Seventh-Day Adventist mothers have a "gain" in starting point in life that is comparable to children of other non-smoking mothers. Norwegian Seventh-Day Adventists have a risk factor level for cardiovascular disease well below that of non-Seventh-Day Adventists. The risk of acquiring cancer or dying from cancer in the period 1961-1986 is not significantly lower in Seventh-Day Adventists. The risk of dying from cardiovascular disease is significantly lower in men and in both sexes for those entering the church before the age of nineteen. The net result with regard to life expectancy from age 20 is 5 years gained in both sexes.

The final conclusion of this work is that the generally advocated healthy life-style should be established in childhood. This life-style seems to have little influence on cancer risk in Norway, but may result in a 50% reduction in cardiovascular disease mortality in both sexes. The life-style changes made by middle-aged Seventh-Day Adventists do not seem to influence their later risk of either cancer or cardiovascular disease. This might warrant a closer study into possibly different life-style recommendations at different points in life.

8. REFERENCES

1. Seventh-Day Adventist Encyclopedia. Washington DC: Review and Herald, 1966:1179-82.

2. First Corinthians chapter 6, verse 20. In: The Bible.

3. Leviticus chapter 11. In: The Bible.

4. White EG. Counsels on diet and foods. Washington DC: Review and Herald, 1946:373-416.

5. White EG. Counsels on diet and foods. Washington DC: Review and Herald, 1946:327-35.

6. White EG. Counsels on diet and foods. Washington DC: Review and Herald, 1946:349-60.

7. White EG. Counsels on diet and foods. Washington DC: Review and Herald, 1946:359.

8. White EG. Temperance. Washington DC: Review and Herald, 1949.

9. Fønnebø V. The Tromsø Heart Study: coronary risk factors in Seventh-Day Adventists. Am J Epidemiol 1985;122:789-93.

10. Waaler HT, Hjort PF. Høyere levealder hos norske adventister 1960-1977: Et budskap om livsstil og helse? Tidsskr Nor Laegeforen 1981;101:623-7 (English summary on page 653).

11. Seidman H. Cancer death rates by site and sex for religious and socioeconomic groups in New York City. Env Research 1970;3:234-50.

12. Graham S, Gibson R, Lilienfeld A, Schuman L, Levin M. Religion and ethnicity in leukemia. Am J Public Health 1970;60:266-74.

13. Long LH. Fertility patterns among religious groups in Canada. Demography 1970;7:135-49.

14. Kinlen LJ. Meat and fat consumption and cancer mortality: A study of strict religious orders in Britain. Lancet 1982;i:946-9.

15. Kunin CM, McCormack RC. An epidemiologic study of bacteriuria and blood pressure among nuns and working women. N Engl J Med 1968;278:635-42.

16. Timio M, Verdecchia P, Venanzi S, et al. Age and blood pressure changes. A 20-year follow-up study in nuns in a secluded order. Hypertension 1988;12:457-61.

17. Locke FB, King H. Mortality among Baptist clergymen. J Chron Dis 1980;33:581-90.

18. Hamman RF, Barancik JI, Lilienfeld AM. Patterns of mortality in the Old Order Amish. I. Background and the major causes of death. Am J Epidemiol 1981;114:845-61.

19. Jorgenson RJ, Bolling DR, Yoder OC, Murphy EA. Blood pressure studies in the Amish. Hopkins Med J 1972;131:329-50.

20. Jarvis GK, Northcott HC. Religion and differences in morbidity and mortality. Soc Sci Med 1987;25:813-24.

21. Lyon JL, Gardner JW, West DW. Cancer incidence in Mormons and non-Mormons in Utah during 1967-75. J Natl Cancer Inst 1980;65:1055-61.

22. Lyon JL, Wetzler HP, Gardner JW, Klauber MR, Williams RR. Cardiovascular mortality in Mormons and non-Mormons in Utah, 1969-1971. Am J Epidemiol 1978;108:357-66.

23. Penny WJ, Penny E, Mayberry JF, Rhodes J. Prevalence of inflammatory bowel disease amongst Mormons in Britain and Ireland. Soc Sci Med 1985;21:287-90.

24. Ogata M, Ikeda M, Kuratsune M. Mortality among

Japanese Zen priests. J Epidemiol Community Health 1984;38:161-6.

25. Kita T, Yokode M, Kume N, et al. The concentration of serum lipids in Zen monks and control males in Japan. Jpn Circ J 1988;52:99-104.

26. Comstock GW. Fatal arteriosclerotic heart disease, water hardness at home, and socioeconomic characteristics. Am J Epidemiol 1971;94:1-10.

27. Comstock GW, Partridge KB. Church attendance and health. J Chron Dis 1972;25:665-72.

28. Graham TW, Kaplan BH, Cornoni-Huntley JC, et al. Frequency of church attendance and blood pressure elevation. J Behav Med 1978;1:37-43.

29. Levin JS, Vanderpool HY. Is religion therapeutically significant for hypertension? Soc Sci Med 1989;29:69-78.

30. Seidman H. Lung cancer among Jewish, Catholics and Protestants in New York City. Cancer 1966;19:185-90.

31. Friedlander Y, Kark JD, Stein Y. Religious orthodoxy and myocardial infarction in Jerusalem - a case-control study. Int J Cardiol 1986;10:33-41.

32. Friedlander Y, Kark JD, Kaufmann NA, Stein Y. Coronary heart disease risk factors among religious groupings in a Jewish population sample in Jerusalem. Am J Clin Nutr 1985;42:511-21.

33. Friedlander Y, Kark JD, Stein Y. Religious observance and plasma lipids and lipoproteins among 17-year-old Jewish residents of Jerusalem. Prev Med 1987;16:70-9.

34. Fønnebø V. The Tromsø Heart Study: diet, religion, and risk factors for coronary heart disease. Am J Clin Nutr 1988;48:826-9.

35. Wynder EL, Lemon FR, Bross IJ. Cancer and coronary artery disease among Seventh-Day Adventists. Cancer 1959;12:1016-28.

36. Phillips RL. Role of life-style and dietary habits in risk of cancer among seventh-day adventists. Cancer Res 1975;35:3513-22.

37. Phillips RL, Lemon FR, Beeson WL, Kuzma JW. Coronary heart disease mortality among Seventh-Day Adventists with differing dietary habits: a preliminary report. Am J Clin Nutr 1978;31:S191-8.

38. Phillips RL, Garfinkel L, Kuzma JW, Beeson WL, Lotz T, Brin B. Mortality among California Seventh-Day

Adventists for selected cancer sites. J Natl Cancer Inst 1980;65:1097-107.

39. Mills PK, Beeson WL, Abbey DE, Fraser GE, Phillips RL. Dietary habits and past medical history as related to fatal pancreas cancer risk among Adventists. Cancer 1988;61:2578-85.

40. Phillips RL, Snowdon DA. Dietary relationships with fatal colorectal cancer among Seventh- Day Adventists. J Natl Cancer Inst 1985;74:307-17.

41. Phillips RL, Snowdon DA. Association of meat and coffee use with cancers of the large bowel, breast, and prostate among Seventh-Day Adventists: preliminary results. Cancer Res 1983;43:2403-8.

42. Phillips RL, Kuzma JW, Lotz TM. Cancer mortality among comparable members versus non-members of the Seventh-Day Adventist church. In: Banbury Report 4. New York:Cold Spring Harbor Laboratory, 1980:93-108.

43. Phillips RL, Kuzma JW, Beeson WL, Lotz T. Influence of selection versus lifestyle on risk of fatal cancer and cardiovascular disease among Seventh-day Adventists. Am J Epidemiol 1980;112:296-314.

44. Berkel J, de-Waard F. Mortality pattern and life

expectancy of Seventh-Day Adventists in the Netherlands. Int J Epidemiol 1983;12:455-9.

45. Kuratsune M, Ikeda M, Hayashi T. Epidemiologic studies on possible health effects of intake of pyrolyzates of foods, with reference to mortality among Japanese Seventh-Day Adventists. Environ Health Perspect 1986;67:143-6.

46. Jensen OM. Cancer risk among Danish male Seventh-Day Adventists and other temperance society members. J Natl Cancer Inst 1983;70:1011-4.

47. Jedrychowski W, Tobiasz-Adamczyk B, Olma A, Gradzikiewicz P. Survival rates among Seventh Day Adventists compared with the general population in Poland. Scand J Soc Med 1985;13:49-52.

48. Harris RD, Phillips RL, Williams PM, Kuzma JW, Fraser GE. The child-adolescent blood pressure study: I. Distribution of blood pressure levels in Seventh-Day-Adventist (SDA) and non-SDA children. Am J Public Health 1981;71:1342-9.

49. Cooper R, Allen A, Goldberg R, et al. Seventh-Day Adventist adolescents - Life-style patterns and cardiovascular risk factors. West J Med 1984;140:471-7.

50. Fraser GE, Babaali H. Determinants of high density lipoprotein cholesterol in middle- aged Seventh-Day Adventist men and their neighbors. Am J Epidemiol 1989;130:958-65.

51. Melby CL, Goldflies DG, Hyner GC, Lyle RM. Relation between vegetarian/nonvegetarian diets and blood pressure in black and white adults. Am J Public Health 1989;79:1283-8.

52. Fraser GE, Dysinger W, Best C, Chan R. Ischemic heart disease risk factors in middle-aged Seventh-day Adventist men and their neighbors. Am J Epidemiol 1987;126:638-46.

53. Kahn HA, Phillips RL, Snowdon DA, Choi W. Association between reported diet and all-cause mortality. Twenty-one-year follow-up on 27,530 adult Seventh-Day Adventists. Am J Epidemiol 1984;119:775-87.

54. Fraser GE, Swannell RJ. Diet and serum cholesterol in Seventh-day Adventists: a cross-sectional study showing significant relationships. J Chronic Dis 1981;34:487-501.

55. Taylor CB, Allen ES, Mikkelson B, Kang-Jey H. Serum cholesterol levels of Seventh-day Adventists. Paroi Arterielle 1976;3:175-9.

56. West RO, Hayes OB. Diet and serum cholersterol

levels. A comparison between vegetarians and nonvegetarians in a Seventh-day Adventist group. Am J Clin Nutr 1968;21:853-62.

57. Walden RT, Schaefer LE, Lemon FR. Effect of environment in the serum cholesterol-triglyceride distribution among Seventh-day Adventists. Am J Med 1964;36:269-76.

58. Fraser GE. Determinants of ischemic heart disease in Seventh-day Adventists: a review. Am J Clin Nutr 1988;48:833-6.

59. Beilin LJ, Rouse IL, Armstrong BK, Margetts BM, Vandongen R. Vegetarian diet and blood pressure levels: incidental or causal association? Am J Clin Nutr 1988;48:806-10.

60. Snowdon DA, Phillips RL, Fraser GE. Meat consumption and fatal ischemic heart disease. Prev Med 1984;13:490-500.

61. Wynder EL, Lemon FR. Coronary Artery disease and smoking, A preliminary report on differences in incidence between Seventh-Day Adventists and others. Cal Med 1958;89:267-72.

62. Webster IW, Rawson GK. Health status of Seventh-Day

Adventists. Med J Aust 1979;1:417-20.

63. Simons LA, Gibson JC, Paino C, Hosking M, Bullock J, Trim J. The influence of a wide range of absorbed cholesterol on plasma cholesterol levels in man. Am J Clin Nutr 1978;31:1334-9.

64. Rouse IL, Beilin LJ, Armstrong BK, Vandongen R. Vegetarian diet, blood pressure and cardiovascular risk. Aust N Z J Med 1984;14:439-43.

65. Rouse IL, Armstrong BK, Beilin LJ. The relationship of blood pressure to diet and lifestyle in two religious populations. J Hypertens 1983;1:65-71.

66. Berkel J. The clean life. Thesis. Utrecht: University of Utrecht, 1979.

67. Stich HF, Hornby AP, Dunn BP. Beta-carotene levels in exfoliated mucosa cells of population groups at low and elevated risk for oral cancer. Int J Cancer 1986;37:389-93.

68. Lipkin M, Uehara K, Winawer S, et al. Seventh-Day Adventist vegetarians have a quiescent proliferative activity in colonic mucosa. Cancer Lett 1985;26:139-44.

69. Shultz TD, Leklem JE. Selenium status of vegetarians,

nonvegetarians, and hormone- dependent cancer subjects. Am J Clin Nutr 1983;37:114-8.

70. Reddy BS, Sharma C, Wynder E. Fecal factors which modify the formation of fecal co-mutagens in high- and low-risk population for colon cancer. Cancer Lett 1980;10:123-32.

71. Macdonald IA, Webb GR, Mahony DE. Fecal hydroxysteroid dehydrogenase activities in vegetarian Seventh-Day Adventists, control subjects, and bowel cancer patients. Am J Clin Nutr 1978;31:S233-8.

72. Finegold SM, Sutter VL, Sugihara PT, Elder HA, Lehmann SM, Phillips RL. Fecal microbial flora in Seventh Day Adventist populations and control subjects. Am J Clin Nutr 1977;30:1781-92.

73. Goldberg MJ, Smith JW, Nichols RL. Comparison of the fecal microflora of Seventh-Day Adventists with individuals consuming a general diet. Implications concerning colonic carcinoma. Ann Surg 1977;186:97-100.

74. Ferguson LR, Alley PG, Gribben BM. DNA-damaging activity in ethanol-soluble fractions of feces from New Zealand groups at varying risks of colorectal cancer. Nutr Cancer 1985;7:93-103.

75. Ferguson LR, Alley PG. Faecal mutagens from population gropus within New Zealand and different risk of colo rectal cancer. In: Sorsa M, Vainia H, eds. Mutagens in our environment. New York:Alan R. Liss, 1982:423-9.

76. Wulf HC, Iversen AS, Husum B, Niebuhr E. Very low sister-chromatid exchange rate in Seventh-Day Adventists. Mutat Res 1986;162:131-5.

77. Hermansen R, Waksvik H, Fønnebø V. Sister-chromatid exchange in children of Seventh-Day Adventists and controls. Carcinogenesis 1991;12:423-5.

78. Dysinger PW, Lemon FR, Crenshaw GL. Pulmonary emphysema in a non-smoking population. Chest 1963;43:17-25.

79. Snowdon DA, Phillips RL. Does a vegetarian diet reduce the occurrence of diabetes? Am J Public Health 1985;75:507-12.

80. King H, Finch C, Collins A, et al. Glucose tolerance in Papua New Guinea: ethnic differences, association with environmental and behavioural factors and the possible emergence of glucose intolerance in a highland community. Med J Aust 1989;151:204-10.

81. Howden GF. The cariostatic effect of betel nut

chewing. P N G Med J 1984;27:123-31.

82. Marsh AG, Sanchez TV, Mickelsen O, Keiser J, Mayor G. Cirtical bone density of adult lacto-ovo-vegetarian and omnivorous women. J Am Diet Assoc 1980;76:148-51.

83. Marsh AG, Sanchez TV, Chaffee FL, Mayor GH, Mickelsen O. Bone mineral mass in adult lacto-ovo-vegetarian and omnivorous males. Am J Clin Nutr 1983;37:453-6.

84. Hunt IF, Murphy NJ, Henderson C. Food and nutrient intake of Seventh-day Adventist women. Am J Clin Nutr 1988;48:850-1.

85. Hunt IF, Murphy NJ, Henderson C, et al. Bone mineral content in postmenopausal women: comparison of omnivores and vegetarians. Am J Clin Nutr 1989;50:517-23.

86. Mozar HN, Farag SA, Andren HE, Peters JR. The mental health of Seventh-day Adventists. Med Arts Sci 1967;21:59-63.

87. Linkosalo E, Halonen P, Markkanen H. Factors related to dental health and some salivary factors in Finnish Seventh-Day Adventists. Proc Finn Dent Soc 1988;84:279-89.

88. Linkosalo E. Dietary habits and dental health in

Finnish Seventh-Day Adventists. Proc Finn Dent Soc 1988;84:109-15.

89. Glass RL, Hayden J. Dental caries in Seventh-Day Adventist children. J Dent Child 1966;33:22-3.

90. Holmes CB, Collier D. Periodontal disease, dental caries, oral hygiene and diet in adventist and other teenagers. J Periodontol 1966;37:100-7.

91. Bachrach S, Fisher J, Parks JS. An outbreak of vitamin D deficiency rickets in a susceptible population. Pediatrics 1979;64:871-7.

92. Johnsen JB, Fønnebø V. Vitamin B12-mangel ved strengt vegetabilsk kosthold. Hvorfor f¢lger noen et slikt kosthold, og hva vil de gj¢re ved B12-mangel. Tidsskr Nor Laegeforen 1991;111:62-4.

93. Walsh A. The prophylactic effect of religion on blood pressure levels among a sample of immigrants. Soc Sci Med 1980;14B:59-63.

94. Kleinbaum DG, Kupper LL, Morgenstern H. Matching in Epidemiologic Studies. In: Epidemiologic Research. New York:Van Nostrand Reinhold, 1982:377-402.

95. Lov om trudomssamfunn og ymist anna. In: Norges Lover

1685-1985. Oslo:Grøndahl og Søn, 1986:1765-8.

96. Mills PK, Beeson WL, Phillips RL, Fraser GE. Dietary habits and breast cancer incidence among Seventh-day Adventists. Cancer 1989;64:582-90.

97. Lund E. Pilot study for the evaluation of completeness of reporting to the Cancer Registry. In: Incidence of Cancer in Norway 1978. Oslo:The Cancer Registry of Norway, 1981.

98. Glattre E, Blix E. En vurdering av dødsårsaksstatistikken. Feil på dødsmeldingene. Oslo: Statistisk Sentralbyrå, 1980.

99. Lundgren RA. Reliabiliteten av medisinsk fødselsregistrering - hvor pålitelige er opplysningene? Tromsø: Master's Thesis, University of Tromsø, 1989.

100. Snowdon DA. Animal product consumption and mortality because of all causes combined, coronary heart disease, stroke, diabetes, and cancer in Seventh-day Adventists. Am J Clin Nutr 1988;48:739-48.

101. Snowdon DA, Phillips RL, Choi W. Diet, obesity, and risk of fatal prostate cancer. Am J Epidemiol 1984;120:244-50.

102. Walker AR. Colon cancer and diet, with special reference to intakes of fat and fiber. Am J Clin Nutr 1976;29:1417-26.

103. Foldspang A, Olsen SJJ, Sabroe S. Vurdering av screening programmer. In: Epidemiologi. Sygdom og befolkning. Copenhagen:Munksgaard, 1986:171-86.

104. Kleinbaum DG, Kupper LL. Randomized blocks. Special cases of two-way ANOVA. In: Applied regression analysis and other multivariate methods. Boston:Duxbury Press, 1989:289-314.

105. Rothman KJ. Modern Epidemiology. Boston/Toronto: Little, Brown and Company, 1986:221-35.

106. Ringstad J, Fønnebø V. The Tromsø Heart Study: serum selenium in a low-risk population for cardiovascular disease and cancer and matched controls. Ann Clin Res 1987;19:351-4.

107. Beeson WL, Mills PK, Phillips RL, Andress M, Fraser GE. Chronic disease among Seventh-day Adventists, a low-risk group. Rationale, methodology, and description of the population. Cancer 1989;64:570-81.

108. Kaplan BH. A note on religious beliefs and coronary heart disease. J S Carol Med Ass 1976;Supp.:60-4.

109. Byrne JT, Price JH. In sickness and in health: The effects of religion. Health Educ 1979;10:6-10.

110. Ruberman W, Weinblatt E, Goldberg JD, Chaudhary BS. Psychosocial influences on mortality after myocardial infarction. N Engl J Med 1984;311:552-9.

111. Doll R, Peto R. The causes of cancer: Quantitative estimates of avoidable risks of cancer in the United States. J Natl Cancer Inst 1981;66:1191-308.

112. Epstein FH. The relationship of lifestyle to international trends in CHD. Int J Epidemiol 1989;18:S203-9.

113. Rose G. Causes of the trends and variations in CHD mortality in different countries. Int J Epidemiol 1989;18:S174-9.

114. Prevention of coronary heart disease. Geneva: World Health Organization, 1982.

115. Stamler J. Towards cardiovascular health. Ann Med 1989;21:141-55.

116. McIntosh HD. Risk factors for cardiovascular disease and death: a clinical perspective. J Am Coll Cardiol

1989;14:24-30.

117. Troyer H. Review og cancer among 4 religious sects: Evidence that life-styles are distinctive sets of risk factors. Soc Sci Med 1988;26:1007-17.

118. Roe FJ. Occupational cancer: interaction with life style factors. Postgrad Med J 1990;66:378-83.

119. Rogers EM. Diffusion of Innovations. New York: Free Press, 1983.

120. Helsedirektoratet. Helse for alle i Norge? Oslo: Kommunalforlaget, 1987.

121. WHO European Collaborative Group. European collaborative trial of multifactorial prevention of coronary heart disease: final report on the 6-year results. Lancet 1986;i:869-72.

122. Wilhelmsen L, Berglund G, Elmfeldt D, et al. The multifactor primary prevention trial in Gçteborg, Sweden. Eur Heart J 1986;7:279-88.

123. Multiple Risk Factor Intervention Trial Research Group. Multiple risk factor intervention trial. Risk factor changes and mortality results. JAMA 1982;248:1465-77.

124. Miettinen TA, Huttunen JK, Naukkarinen V. Multifactorial primary prevention of cardiovascular diseases in middle-aged men. JAMA 1985;254:2097-102.

125. Hjermann I, VelveByre K, Holme I, Leren P. Effect of diet and smoking intervention on the incidence of coronary heart disease. Report from the Oslo study group of a randomised trial in healthy men. Lancet 1981;ii:1303-10.

126. Salonen JT, Puska P, Mustaniemi H. Changes in morbidity and mortality during comprehensive community programme to control cardiovascular diseases during 1972-7 in North Karelia. Br Med J 1979;2:1173-8.

127. Turpeinen O. Effect of cholesterol-lowering diet on mortality from coronary heart disease and other causes. Circulation 1979;59:1-7.

128. Rose G, Tunstall-Pedoe HD, Heller RF. UK Heart disease prevention project: Incidence and mortality results. Lancet 1983;i:1062-6.

129. Kornitzer M, De Backer G, Dramaix M, et al. Belgian heart disease prevention project: Incidence and mortality results. Lancet 1983;i:1066-70.

130. Strøm A, Jensen RA. Mortality from circulatory

diseases in Norway 1940-45. Lancet 1951;i:126-9.

131. Forsdahl A. Are poor living conditions in childhood and adolescence an important risk factor for arteriosclerotic heart disease? Br J Prev Soc Med 1977;31:91-5.

132. Yano K, Blackwelder WC, Kagan A, Rhoads GG, Cohen JB, Marmot MG. Childhood cultural experience and the incidence of coronary heart disease in Hawaii Japanese men. Am J Epidemiol 1979;109:440-50.

133. Barker DJ, Osmond C. Infant mortality, childhood nutrition, and ischaemic heart disease in England and Wales. Lancet 1986;1:1077-81.

134. Barker DJ. Childhood causes of adult diseases. Arch Dis Child 1988;63:867-9.

135. Notkola V, Punsar S, Karvonen MJ, Haapakoski J. Socio-economic conditions in childhood and mortality and morbidity caused by coronary heart disease in adulthood in rural Finland. Soc Sci Med 1985;21:517-23.

136. Peck AM, Vagero DH. Adult body height, self perceived health and mortality in the Swedish population. J Epidemiol Community Health 1989;43:380-4.

137. Forsdahl A. Living conditions in childhood and subsequent development of risk factors for arteriosclerotic heart disease. The cardiovascular survey in Finnmark 1974-75. J Epidemiol Community Health 1978;32:34-7.

138. Arnesen E, Forsdahl A. The Tromsø heart study: coronary risk factors and their association with living conditions during childhood. J Epidemiol Community Health 1985;39:210-4.

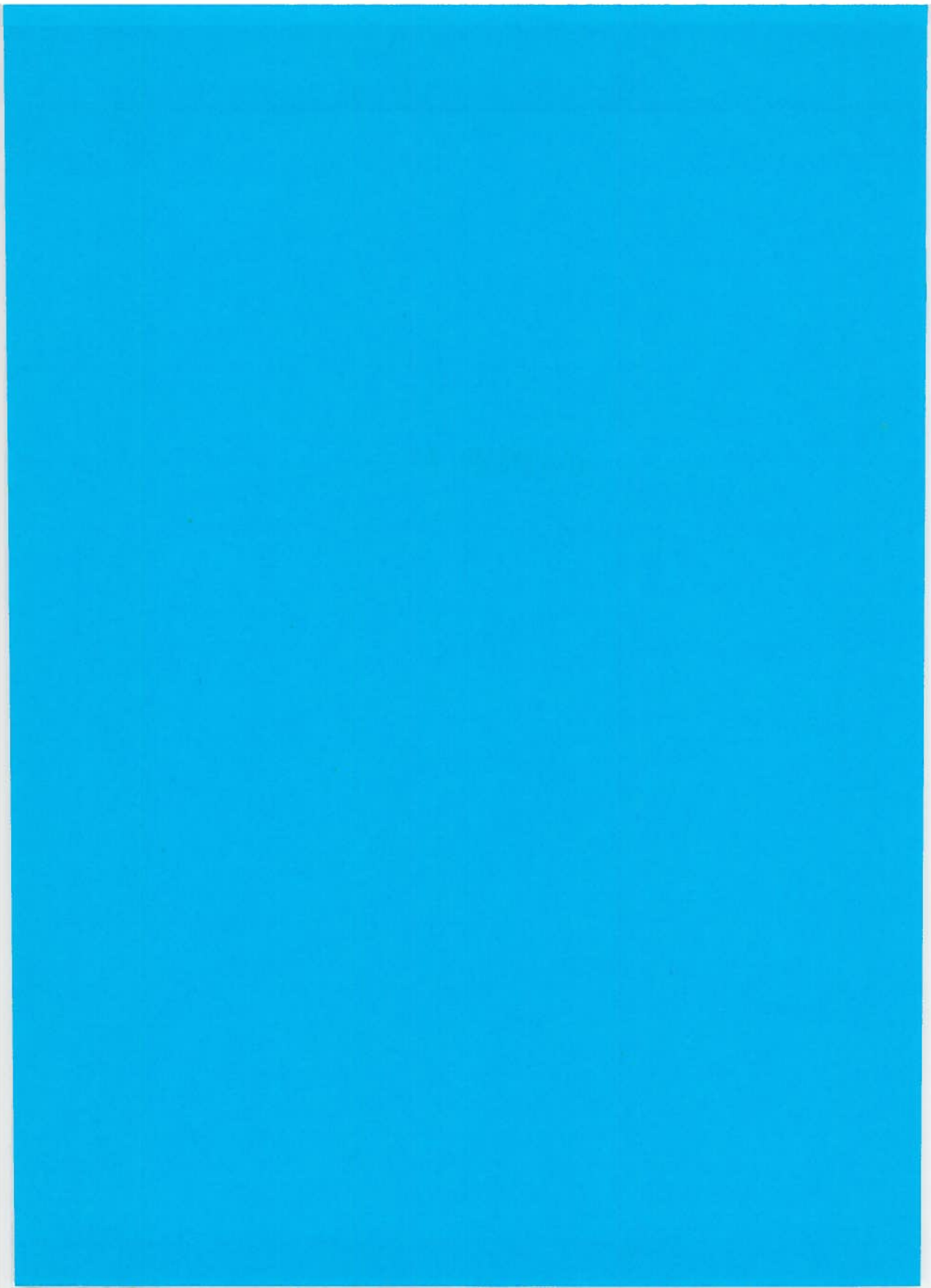
139. Dyerberg J, Bang HO, Stoffersen E, Moncada S, Vane JR. Eicosapentaenoic acid and prevention of thrombosis and atherosclerosis. Lancet 1978;ii:117-9.

140. Mehta JL, Lopez LM, Lawson D, Wargovich TJ, Williams LL. Dietary supplementation with omega-3 polyunsaturated fatty acids in patients with stable coronary heart disease. Am J Med 1988;84:45-52.

141. Bønaa KH, Bjerve KS, Straume B, Gram IT, Thelle D. Effect of eicosapentaeoic and docosahexaenoic acids on blood pressure in hypertension. N Engl J Med 1990;322:795-801.

142. Kromhout D, Bosschieter EB, Coulander CL. The inverse relation between fish consumption and 20-year mortality from coronary heart disease. N Engl J Med 1985;312:1205-9.

PAPER I



PREGNANCY OUTCOME IN SEVENTH-DAY ADVENTIST WOMEN.

A study of 1326 births by Seventh-Day Adventist mothers and matched controls.

Vinjar Fønnebø MD, MSc Epidemiology.

Institute of Community Medicine

University of Tromsø

Tromsø

Address for correspondence and reprints:

Vinjar Fønnebø

Institute of Community Medicine

University of Tromsø

Postuttak

N-9000 TROMSØ

Norway

Telephone number: 083 44809 (business), 083 92118 (home)

Fax number: 083 44831

PREGNANCY OUTCOME IN SEVENTH-DAY ADVENTIST WOMEN. A study of 1326 births by Seventh-Day Adventist mothers and matched controls.

Vinjar Fønnebø MD, MSc Epidemiology.

To investigate pregnancy outcome in Seventh-Day Adventists, 1326 births of Seventh-Day Adventist mothers and matched controls were compared. Birth weight was 99 grams higher (95% CI:65 to 133) and length 0.3 centimetres longer (95% CI:0.1 to 0.5) in children born by Seventh-Day Adventist mothers. Relative risk of death from 28 weeks gestation to one year of age was 0.87 (95% CI:0.43 to 1.76) in Seventh-Day Adventist births. The differences found in this study are not greater than would be expected in a population group with a life-style characterized by few smokers and a low alcohol consumption.

Key words: birth-weight, religion, life-style

Studies on Seventh-Day Adventists in the United States, the Netherlands, Poland and Norway have shown a greater life expectancy for adult Seventh-Day Adventists compared to the general population (Lemon & Kuzma 1969; Berkel 1979; Jedrychowski et al. 1985; Waaler & Hjort 1981). This is thought to be due to lower mortality of cancer and cardiovascular disease.

The Seventh-Day Adventist church has no child members due to their practice of baptism at an age where the individual itself can be responsible for the decision. This has made studies on Seventh-Day Adventist children difficult and as far as is known, no studies on the birth experience of children born by Seventh-Day Adventist women have been performed. Assumptions have been made on reduced mortality in Seventh-Day Adventist children (Waaler & Hjort 1981). These assumptions could heavily influence estimates of life expectancy at birth.

In The Tromsø Heart Study (Fønnebø 1985) the author showed that Seventh-Day Adventist women in a child-bearing age had a life-style that differed from non-Seventh-Day Adventists in several respects. Seventh-Day Adventist women were more likely to be non-smokers and non-drinkers and they used considerably less coffee, meat and fish. The educational level was similar in the two groups.

Alcohol consumption during pregnancy has been associated with pre-term delivery (Berkowitz 1981) and intra-uterine growth retardation (Kuzma & Sokol 1982; Wright et al. 1983). Smoking is also associated with pre-term delivery (Shiono et al. 1986), low birth-weight (Butler et al. 1972; van der Welde & Treffers 1985) and higher perinatal mortality (Butler et al. 1972; van der Welde & Treffers 1985). In addition long-term psychological effects in the children of mothers who smoked during pregnancy have been observed (Rantakallio 1983; Streissguth et al. 1984). Malnutrition in pregnancy has also been associated with low birth weight (Metcoff et al. 1981; Susser 1981).

The aim of the present study is to see whether length and weight at birth and early mortality differs in children born of Seventh-Day Adventist mothers compared to children of non-Seventh-Day Adventist mothers.

METHODS

Information on 10602 Seventh-Day Adventists in Norway has been collected from the official rosters of the 73 churches. Name, sex, birth date, place of birth, address, date of entry into and leaving the church was registered. Unique identification has been ensured with the use of the national eleven-digit personal identification number which was ascertained for 98% of the church members. A more

detailed description of the methods used in identifying the population has been presented previously (Fønnebø & Helseth 1991).

Beginning January 1, 1967 a computerized medical birth registry was established in Norway. The child, the mother, and the father are registered with their personal identification number. All deliveries occurring after 16 weeks of gestation in the country are included. The birth registry has information on the medical background of the mother, medical problems during pregnancy and medical information on the birth of the child. It also updates it's register with regard to later death by regular linking with the official death registry.

Births occurring during church membership of the 2019 Seventh-Day Adventist women born after January 1, 1917 were included in the present study. The births were found by a linkage with the birth registry based on the personal identification number. Altogether 1326 births had occurred between January 1, 1967 and December 31, 1984. For each birth by a Seventh-Day Adventist mother three control births were matched on the following criteria: Age (five-year groups), county of residence, parity (one, two, three, four or five or more births) of the mother, and birth year and sex of the child. For four births only one control was found and for nine births only two controls

were found.

Only births with a gestational age of at least 28 weeks are included in this study. This is due to a lower ascertainment of births in the short pregnancies. Due to the low total number of births and the low perinatal (1988: 7.9/1000) and infant (1988: 8.3/1000) mortality rates in Norway, only one measure of death is computed: Risk of death from 28 weeks of gestation to one year of age.

For the continous variables the statistical analysis is done by one-sample t-test comparing the mean of the controls' birth weight, length and gestational age with the values for the Seventh-Day Adventist. Two-way analysis of variance was also performed using the quadruplet as a block unit (Kleinbaum & Kupper 1989). The statistical program used was PROC GLM in SAS statistical package (SAS/STAT Guide for personal computers 1985).

For relative risk of low birth-weight, preterm birth and death the data are analyzed by the method used for matched cohort studies: The estimate of relative risk is the crude relative risk estimate ignoring the matching. For confidence interval estimation the following formula is used for the Mantel-Haenschel chi-square (df=1) estimate:

$$X^2 = (|3*\mathrm{Sum}(A) - \mathrm{Sum}(B)| - 2)^2 / (4*\mathrm{Sum}(C) - \mathrm{Sum}(C^2))$$

where A is the number of Seventh-Day Adventists sick or dead in each quadruplet, B the number of controls sick or dead in each quadruplet and C the total number of sick or dead in each quadruplet. Confidence limits are test-based (Rothman 1986). Multiple regression is performed with the PROC REG in the SAS statistical package (SAS/STAT Guide for personal computers 1985).

RESULTS

Table 1 shows the difference in gestational age and birth weight and length for children born of Seventh-Day Adventist mothers compared to children born by non-Seventh-Day Adventist mothers. Seventh-Day Adventist children were 99 grams heavier (95% CI:65 to 133) and 0.3 centimeters longer (95% CI:0.1 to 0.5). Gestational age was not significantly different in Seventh-Day Adventist children. A separate analysis including only married women showed results almost identical to the results for the whole group (Data not shown).

Table 2 shows that the risk of a pre-term delivery (<37 weeks gestation) is 0.90 for Seventh-Day Adventist births relative to non-Seventh-Day Adventist births (95% CI:0.68 to 1.20). The relative risk of a low-weight delivery given the child is not pre-term is 0.70 (95% CI: 0.36 to 1.35).

The risk of death from 28 weeks of gestation to one year of age is 0.87 for children born by Seventh-Day Adventists (95% CI:0.43 to 1.76) relative to controls (Table 3).

Table 4 shows differences in gestational length and length and weight at birth for parity one to four. Quadruplets with twin or triplet births are excluded and thus no siblings are present within each parity group. Differences with regard to gestational length and length and weight at birth within each parity group resembles the findings when all parity groups are combined. Due to lower number of differences the confidence intervals, however, are wider.

In table 5 relative risk of pre-term birth, low birth-weight given fullterm and relative risk of death are shown in parity one to four. Interaction of birth weight and risk of death with parity might carefully be suggested by the increasing relative risk with increasing parity. The number of events are, however, very small and the trends are not statistically significant.

Table 6 shows that in children born by Seventh-Day Adventist mothers there is no association between birth weight and mother's years of membership in the church when controlling for gestational age, age of the mother and parity.

DISCUSSION

This study shows that children born of Seventh-Day Adventist women differ significantly from matched controls in birth weight and length at birth. Bearing in mind the differences in risk of cardiovascular disease and cancer between adult Seventh-Day Adventists and the general population in many countries (Fønnebø 1985; Rouse et al. 1983; Berkel & de-Waard 1983; Jensen 1983; Kahn et al. 1984; Cooper et al. 1984; Fraser et al. 1987) it might be surprising that the differences in pregnancy outcome are relatively small.

Do, however, all the women registered as Seventh-Day Adventists in the membership records follow the recommended life-style? If the Seventh-Day Adventist women studied in the Tromsø Heart Study are representative of all women of child-bearing age in the church in Norway, approximately 30% are religiously inactive (Fønnebø, 1985) with a life-style similar to non-Seventh-Day Adventist women. Some non-Seventh-Day Adventist women, on the other hand, change their life-style in a Seventh-Day Adventist "direction" during pregnancy (Little et al. 1976; Rosett et al. 1980; Meberg et al. 1986; Fox et al. 1987). A differential misclassification could thus be present and a biased result could emerge. The possible bias will in this case result in

an underestimate of a possible beneficial effect of the "recommended" life-style during pregnancy.

The controls in this study are not a random sample of the general population of mothers. The matching on variables (mother's age, parity and place of residence) known to be associated with pregnancy outcome excludes possible confounding by these factors. Comparison with national figures for the same time period shows that children of the controls have low values for perinatal and infant mortality (Statistical Yearbook 1986) (Data not shown). This indicates that Seventh-Day Adventist mothers choose to have their babies at an age and in a number that is beneficial with regard to pregnancy outcome. If these choices are governed by church recommendations, the differences presented in the present study would be underestimates of the total effect of these recommendations. The issue of suitable controls in studies on Seventh-Day Adventists has been previously discussed by Phillips (Phillips et al. 1980a).

The data analysis of the continuos variables in this study used a comparison between the mean of the controls' values and the Seventh-Day Adventist value. This method will give a lower variance of the differences compared to a one to one match and thereby increase the statistical power of the comparisons. Two-way analysis of variance regarding the

quadruplet as a block unit is an alternative analytical method. Due to the large number of quadruplets the statistical program was unable to perform the analysis for all quadruplets simultaneously. The analysis was therefore done stratified by sex and parity. Utilization of the weighted mean of the differences and standard deviations in each subgroup resulted in estimates of differences between Seventh-Day Adventist and controls that were identical to the method described.

There were no pre-term or low-weight births and no deaths in the four quadruplets that had two missing controls. In the nine quadruplets that had one missing control one Seventh-Day Adventist was born pre-term and two control births were pre-term. No births in the full-term births were low-weight. Three deaths occurred in the controls. Excluding these thirteen quadruplets from the results in the tables has not introduced any serious bias in the results.

The results in this study are in accordance with other studies on specific life-style factors' influence on pregnancy outcome (Berkowitz 1981; Kuzma & Sokol 1982; Wright et al. 1983; Shiono et al. 1986; Butler et al. 1972; van der Welde & Treffers 1985; Rantakallio 1983; Streissguth et al. 1984). The difference in birth weight, however, is somewhat less than in studies of birth weight

in offspring of smoking mothers compared to non-smoking mothers (Butler et al. 1972; van der Welde & Treffers 1985). The observed relative risk of death of 0.87 in children of Seventh-Day Adventist mothers compared to children of control mothers was similar to Butler's relative risk of perinatal mortality of 0.78 in non-smokers relative to smokers in Great Britain (Butler et al. 1972). Although the confidence interval in the present study is very wide, the data suggest that children of Seventh-Day Adventist mothers do not experience a reduction of mortality greater than can be expected when considering the mother's life-style in pregnancy.

Finding no association between duration of membership in the church and birth-weight tentatively suggests that factors acting during pregnancy are more important for birth weight than duration of a healthy or unhealthy life-style previous to pregnancy.

In this study the psychosocial aspects of religion, apart from the associated life-style (smoking, drinking and diet), could possibly be a confounding factor. The life-style effect can, however, only be isolated if the controls have the same religion, but not the associated life-style. In the Seventh-Day Adventist Church religion and life-style are so tightly associated that a suitable control group is very hard to find.

The question of genetic selection has been raised in epidemiological studies on Seventh-Day Adventists (Phillips et al. 1980b). The contribution of the present study is to show that the offspring of women in the church seem to possibly have a slightly better start in life than non-Seventh-Day Adventist children. This benefit, however, is not larger than would be expected in children generally with non-smoking and temperate mothers. A genetic selection into the church of individuals with birth weight and length and death risk substantially different from others is not possible to detect.

ACKNOWLEDGEMENTS

Data on both Seventh-Day Adventist and control births were kindly provided by The Birth Registry of Norway, University of Bergen, Bergen, Norway (Head: Lorentz Irgens).

REFERENCES

Berkel J. (1979) The clean life. Thesis University of Utrecht, Utrecht.

Berkel J. & de-Waard F. (1983) Mortality pattern and life expectancy of Seventh-Day Adventists in the Netherlands. Int J Epidemiol **12**, 455-459.

Berkowitz G.S. (1981) An epidemiologic study of preterm delivery. Am J Epidemiol **113**, 81-92.

Butler N.R., Goldstein H. & Ross E.M. (1972) Cigarette smoking in pregnancy: Its influence on birth weight and perinatal mortality. Br Med J **2**, 127-130.

Cooper R., Allen A., Goldberg R., Trevisan M., Van-Horn L., Liu K., Steinhauer M., Rubenstein A. & Stamler J. (1984) Seventh-Day Adventist adolescents - Life-style patterns and cardiovascular risk factors. West J Med **140**, 471-477.

Fox N.L., Sexton M.J. & Hebel J.R. (1987) Alcohol consumption among pregnant smokers: Effects of a smoking cessation intervention program. Am J Public Health **77**,

211-213.

Fraser G.E., Dysinger W., Best C. & Chan R. (1987) Ischemic heart disease risk factors in middle-aged Seventh-day Adventist men and their neighbors. Am J Epidemiol **126**, 638-646.

Fønnebø V. (1985) The Tromsø Heart Study: coronary risk factors in Seventh-Day Adventists. Am J Epidemiol **122**, 789-793.

Fønnebø V. & Helseth A. (1991) Cancer incidence in Norwegian Seventh-Day Adventists. Is the cancer - life-style association overestimated?. Cancer (In press).

Jedrychowski W., Tobiasz-Adamczyk B., Olma A. & Gradzikiewicz P. (1985) Survival rates among Seventh Day Adventists compared with the general population in Poland. Scand J Soc Med **13**, 49-52.

Jensen O.M. (1983) Cancer risk among Danish male Seventh-Day Adventists and other temperance society members. J Natl Cancer Inst **70**, 1011-1014.

Kahn H.A., Phillips R.L., Snowdon D.A. & Choi W. (1984) Association between reported diet and all-cause mortality. Twenty-one-year follow-up on 27,530 adult Seventh-Day

Adventists. Am J Epidemiol **119**, 775-787.

Kleinbaum D.G. & Kupper L.L. (1989) Randomized blocks. Special cases of two-way ANOVA. In: Applied regression analysis and other multivariate methods. Duxbury Press, Boston,pp. 289-314.

Kuzma J.W. & Sokol R.J. (1982) Maternal drinking behavior and decreased intrauterine growth. Alc Clin Exper Res **6**, 396-402.

Lemon F.R. & Kuzma J.W. (1969) A biologic cost of smoking. Decreased life expectancy. Arch Environ Health **18**, 950-955.

Little R.E., Schultz F.A. & Mandell W. (1976) Drinking during pregnancy. J Stud Alcohol **37**, 375-379.

Meberg E., Halvorsen B., Holter B., Ek I.J., Askeland A., Gaaserud W. & Steinsvåg J. (1986) Moderate alcohol consumption - Need for intervention programs in pregnancy?. Acta Obstet Gynecol Scand **65**, 861-864.

Metcoff J., Costiloe J.P., Crosby W., Bentle L., Seshachalam D., Sandstead H.H., Bodwell C.E., Weaver F. & McClain P. (1981) Maternal nutrition and fetal outcome. Am J Clin Nutr **34**, 708-721.

Phillips R.L., Kuzma J.W. & Lotz T.M. (1980a) Cancer mortality among comparable members versus non-members of the Seventh-Day Adventist church. In: Banbury Report 4, Cold Spring Harbor Laboratory, New York, pp. 93-108.

Phillips R.L., Kuzma J.W., Beeson W.L. & Lotz T. (1980b) Influence of selection versus lifestyle on risk of fatal cancer and cardiovascular disease among Seventh-day Adventists. Am J Epidemiol **112**, 296-314.

Rantakallio P. (1983) A follow-up study up to age of 14 of children whose mothers smoked during pregnancy. Acta Paediatr Scand **72**, 747-753.

Rosett H.L., Weiner L., Zuckerman B., McKinlay S. & Edelin K.C. (1980) Reduction of alcohol consumption during pregnancy with benefits to the newborn. Alc Clin Exper Res **4**, 178-184.

Rothman K.J. (1986) Fundamentals of epidemiologic data analysis. In: Modern Epidemiology, Little, Brown and Company, Boston,pp. 131-151.

Rouse I.L., Armstrong B.K. & Beilin L.J. (1983) The relationship of blood pressure to diet and lifestyle in two religious populations. J Hypertens 1, 65-71.

SAS/STAT Guide for personal computers (1985) SAS Institute.

Shiono P.H., Klebanoff M.A. & Rhoads G.G. (1986) Smoking and drinking during pregnancy. JAMA **255**, 82-84.

Statistical Yearbook 1986 (1986) Central Bureau of Statistics, Oslo.

Streissguth A.P., Martin D.C., Barr H.M., Sandman B.M., Kirchner G.L. & Darby B.L. (1984) Intrauterine alcohol and nicotine exposure: Attention and reaction time in 4-year-old children. Dev Psychol **20**, 533-541.

Susser M. (1981) Prenatal nutrition, birthweight, and psychological development: an overview of experiments, quasi-experiments, and natural experiments in the past decade. Am J Clin Nutr **34**, 784-803.

van der Welde W.J. & Treffers P.E. (1985) Smoking in pregnancy: The influence on percentile birth weight, mean birth weight, placental weight, menstrual age, perinatal mortality and maternal diastolic blood pressure. Gynecol Obstet Invest **19**, 57-63.

Waaler H.T. & Hjort P.F. (1981) Hçyere levealder hos norske adventister 1960-1977: Et budskap om livsstil og helse?.

Tidsskr Nor Laegeforen 101, 623-627.

Wright J.T., Waterson E.J., Barrison I.G., Toplis P.J., Lewis I.G., Gordon M.E., MacRae W.D., Morris N.F. & Murray-Lion I.M. (1983) Alcohol consumption, pregnancy and low birth weight. Lancet i, 663-665.

Table 1. Gestational age at birth and length and weight at birth. 1326 children born by Seventh-Day Adventist mothers and matched controls.

	n	SDA births	non-SDA births	Difference	95% CI. of difference
Gestational age(days)	1326	281.3	281.9	-0.6	-1.5 to 0.3
Length(cms.)	1307	50.7	50.4	0.3	0.1 to 0.5
Weight(gms.)	1323	3599	3500	99	65 to 133

Table 2. Risk of pre-term birth(<37 weeks gestational age) in the 1313 full quadruplets and low birth-weight (<2500 grams) in the 1074 full-term quadruplets. One Seventh-Day Adventist birth versus three non-Seventh-Day Adventist births.

SDA child pre-term	Number of controls pre-term				Relative risk	95% CI of relative risk
	0	1	2	3		
Yes	52	9	2	0		
No	1068	168	14	0	0.90	0.68 to 1.20
SDA child low birth-weight	Number of controls low birth-weight					
	0	1	2	3		
Yes	12	1	0	0		
No	998	51	2	0	0.70	0.36 to 1.35

Table 3. Risk of death in the 1313 full quadruplets. One Seventh-Day Adventist birth versus three non-Seventh-Day Adventist births.

SDA child dead	Number of controls dead			
	0	1	2	3
Yes	17	1	0	0
No	1235	59	1	0

Relative risk(SDAs versus controls): 0.87 95% CI: 0.43 to 1.75

Table 4. Difference in gestational age at birth and length and weight at birth. 1169 non-twin children of Seventh-Day Adventist mothers and matched controls by parity one to four of the mother.

	n	Difference between SDA and non-SDA births	95% confidence interval of difference
PARITY=1:			
Gestational age(days)	414	-0.2	-2.0 to 1.6
Length(cms.)	406	0.4	0.2 to 0.6
Weight(gms.)	413	85	32 to 138
PARITY=2:			
Gestational age(days)	393	-1.5	-3.3 to 0.3
Length(cms.)	390	0.2	-0.1 to 0.5
Weight(gms.)	392	109	46 to 172
PARITY=3:			
Gestational age(days)	246	-0.6	-2.4 to 1.2
Length(cms.)	242	0.3	0.0 to 0.6
Weight(gms.)	246	90	8 to 172
PARITY=4:			
Gestational age(days)	116	-0.9	-3.8 to 2.0
Length(cms.)	113	0.5	-0.1 to 1.1
Weight(gms.)	115	173	54 to 292

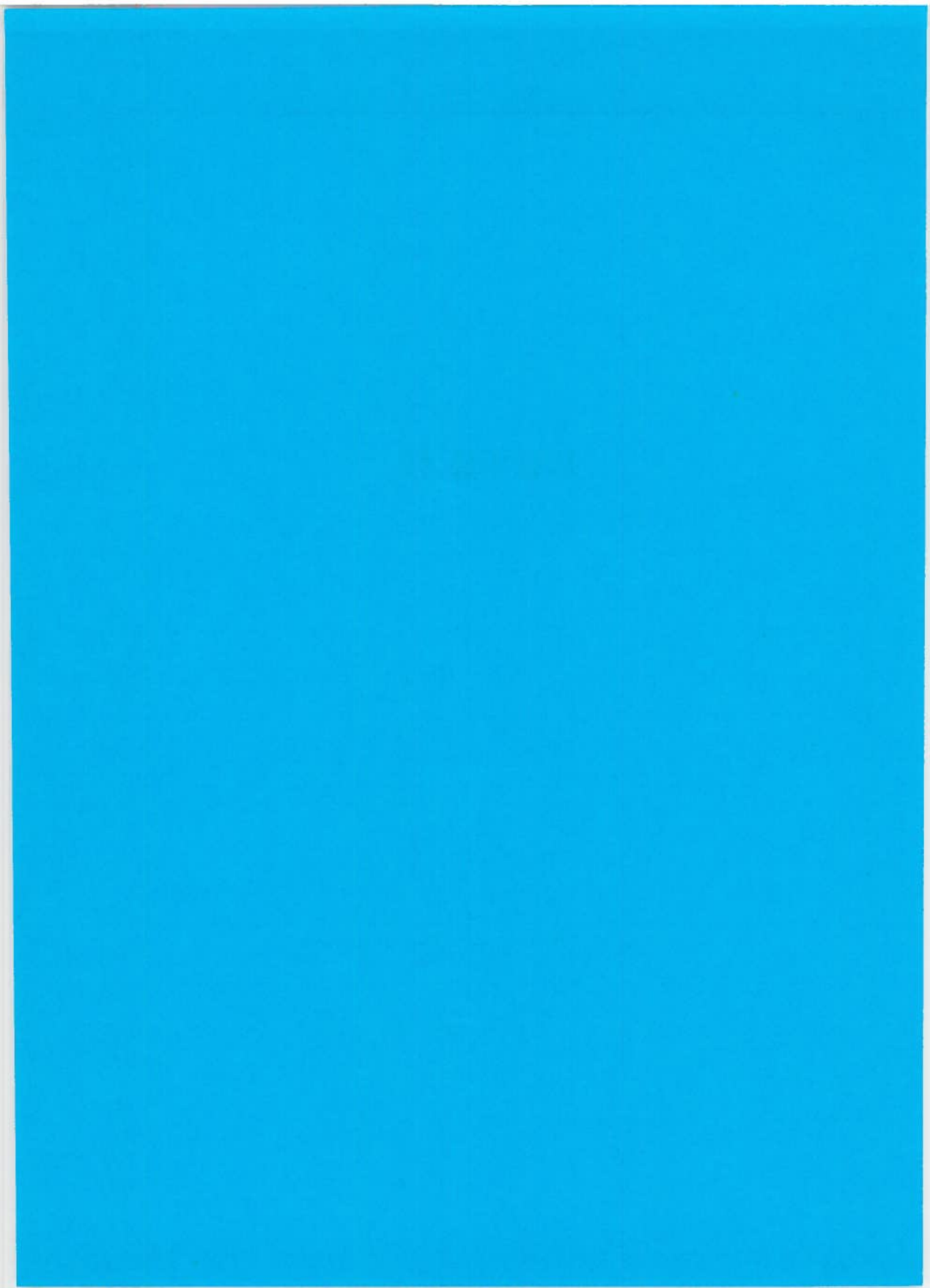
Table 5. Relative risk of pre-term birth, relative risk of low-weight birth given fullterm, and relative risk of death in 1169 non-twin children of Seventh-Day Adventist mothers relative to three matched controls by parity one to four of the mother (Only full qudruplets are included).

	Number of quadruplets	SDA events	Non-SDA events	Relative risk
PRE-TERM BIRTH:				
Parity=1	414	20	70	0.86
Parity=2	393	11	44	0.75
Parity=3	246	11	36	0.92
Parity=4	116	5	21	0.71
LOW-WEIGHT BIRTH GIVEN ALL FOUR IN THE QUADRUPLET FULLTERM:				
Parity=1	331	5	21	0.71
Parity=2	338	5	14	1.07
Parity=3	201	3	6	1.50
Parity=4	93	0	4	0.00
DEATH:				
Parity=1	414	4	17	0.71
Parity=2	393	3	13	0.69
Parity=3	246	4	12	1.00
Parity=4	116	3	9	1.00

Table 6. Multiple regression coefficients for the association between birth weight and duration of church membership, gestational age, parity and mother's age in 1283 births by Seventh-Day Adventist mothers.

	beta	95% CI of beta
Duration of SDA membership(years)	-1.44	-7.22 to 4.34
Mother's age(years)	-2.50	-11.87 to 6.87
Gestational age(days)	16.73	14.90 to 18.56
Parity(Number of previous births)	88.37	60.13 to 116.61

PAPER II



Coronary Risk Factors in Norwegian Seventh-Day Adventists.

A Study of 247 Seventh-Day Adventist Participants and Matched Controls in the Cardiovascular Disease Studies in Norway.

Vinjar Fønnebø[1]

AUTHOR'S AFFILIATION:

[1]Institute of Community Medicine

University of Tromsø

Norway

ADDRESS FOR REPRINTS:

Vinjar Fønnebø

Institute of Community Medicine

University of Tromsø

Postuttak

N-9000 TROMSØ

Norway

ACKNOWLEDGEMENTS:

Data on both Seventh-Day Adventists and controls were kindly provided by The National Health Screening Service of Norway. Oslo, Norway (Head: Dr. Kjell Bjartveit), Section for Dietary Research, Institute for Nutrition Research, University of Oslo and The Tromsø Heart Study, University of Tromsø, Norway.

RUNNING HEAD:

Coronary Risk in Norwegian Seventh-Day Adventists

Coronary risk factors in Seventh-Day Adventists are compared to non-Seventh-Day Adventist matched controls in the Norwegian Cardiovascular Disease Studies 1973-1987. Only ten percent of Seventh-Day Adventists were smokers ($p<0.001$) and serum cholesterol was 0.86 mmol/l (95 percent CI:0.59-1.13) lower in men and 0.48 mmol/l (95 percent CI:0.25-0.71) in women. Diastolic blood pressure was significantly lower only in women. Ex-members and members not complying with the recommended life-style have a risk factor level significantly higher than current complying Seventh-Day Adventists. Am J Epidemiol

KEY WORDS: cholesterol, blood pressure, life-style, religion

Seventh-Day Adventism is regarded as a natural experiment on the role of life-style in the etiology of chronic disease (1-5). This religious group encourages vegetarianism, and discourages the use of stimulants (drugs, tobacco, alcohol, and caffeine-containing beverages). In previous studies on coronary risk factors in Seventh-Day Adventists the members have known they were studied because of their church membership (6-11). The present study describes coronary risk factors in Seventh-Day Adventist participants in the Cardiovascular Disease Studies in Norway. At the time of the survey both the screening team and the church member were unaware of the fact that church membership later would be identified. This gives an unbiased description of coronary risk factors in Seventh-Day Adventists.

MATERIALS AND METHODS

The Cardiovascular Disease Studies in Norway are cross-sectional studies of men and women between 20 and 64 years of age in nine counties, more than 160,000 persons were invited. The examination included measurement of height, weight and blood pressure, a non-fasting venous blood sample and a questionnaire on smoking habits, physical activity, stress factors in social life and symptoms of, and own and family history of coronary heart disease.

The examination was performed by trained screening teams from The National Health Screening Service using the same protocols in all areas (12). The blood samples were analyzed at the Central Laboratory, Ullevaal Hospital in Oslo (12,13) and for the Tromsø study, the Division of Clinical Chemistry, University Hospital of Tromsø (14).

A multiplicative coronary risk score based on sex (Men: 5.0, Women: 1.0), smoking (Graded from 0 cigarettes per day: 1.0 to 25 cigarettes per day or more: 4.0), cholesterol (Graded from less than 190 mg/100ml: 1.0 to 450 mg/100ml or more: 25.0) and systolic blood pressure (Graded from less than 135 mmHg: 1.0 to 170 mmHg or more: 4.5) was calculated for every person participating (12). Questions on coffee consumption were included in all but two of the surveys. In four counties this information was collected on a separate dietary questionnaire. Coffee drinkers were classified as persons consuming one cup per day or more.

Seventh-Day Adventist population

A computer linkage (permission given by the Norwegian Data Inspectorate) was done for the 7285 Seventh-Day Adventists alive on January 1, 1961 or who had joined the church at a later date. Of 351 Seventh-Day Adventists invited, 247

(70.4 percent) participated. Twenty-two of these had left the church before participating in the study and three had participated before joining the church.

The Seventh-Day Adventists were categorized according to adherence to smoking and coffee recommendations. Non-smokers who did not drink coffee were regarded as best adherers, non-smoking coffee drinkers as intermediate adherers and smokers regardless of coffee consumption as poor adherers.

Three age-, sex-, and residence-matched participating controls were chosen for every Seventh-Day Adventist. The identification and matching of Seventh-Day Adventists and controls were done independent of the author at the National Health Screening Service in Oslo for all study areas except Tromsø.

Statistic analysis

For continuous variables two-way analysis of variance was performed using the quadruplet as a block unit (15). The program used was PROC GLM in SAS (16). The coronary risk score was logarithmically transformed due to it's skewed distribution. Coffee consumption was dichotomized as users (one cup per day or more) or nonusers (less than one cup per day). For category variables matched analysis with

three controls per case was used (17). The adjustment for study area in tables 2 and 3 was done to ensure that differences in measurements between studies did not confound the comparisons.

RESULTS

Twenty-three of the 222 (10.4 percent) Seventh-Day Adventists were daily smokers ($p<0.001$ for difference compared to non-Seventh-Day Adventists) and forty-three of 130 (33.1 percent) were coffee drinkers ($p<0.001$).

No significant differences in body mass index between Seventh-Day Adventists and controls were seen. Cholesterol was 0.86 mmol/l (95 percent CI:0.59 to 1.13) lower in Seventh-Day Adventist men and 0.48 mmol/l (95 percent CI:0.25 to 0.71) lower in women (table 1). Triglycerides were 0.28 mmol/l lower in Seventh-Day Adventists men (95 percent CI: 0.02 to 0.54), while no significant difference was found in women. No significant differences in blood pressures were found in men. Diastolic blood pressure was 2.3 mm Hg (95 percent CI: 0.4 to 4.2) lower in Seventh-Day Adventist women compared to controls. The computed coronary risk score was significantly lower in Seventh-Day Adventists of both sexes.

No significant associations were found between differences

in cholesterol, triglycerides, risk score or blood pressure and age at entry into the church (data not shown).

The Seventh-Day Adventist men with the closest adherence to the smoking and coffee recommendations had a total cholesterol value 1.21 mmol/l lower than the men who were daily smokers (trend test: $p<0.01$) (table 2). In women the difference was 0.56 mmol/l (trend test: $p=0.07$). Triglycerides and body mass index in men were also significantly different in the three groups. Blood pressure, however, showed no significant relationship to degree of adherence to the smoking and coffee recommendations.

Table 3 shows in men a significantly higher cholesterol and blood pressure and a higher frequency of smokers among ex-Seventh-Day Adventists compared to current Seventh-Day Adventists resulting in a significantly higher coronary risk score. The only significant difference in women was fewer smokers in current Seventh-Day Adventists, but the other differences were in the same direction as in men.

DISCUSSION

That Norwegian Seventh-Day Adventists have a low level of total cholesterol and few smokers is in accordance with

other Seventh-Day Adventists studies (6-11,18).

In addition to the elimination of observer bias, thiocyanate measurements (data not shown) in two counties indicate a minimal recall bias with regard to smoking status. Inclusion of all registered members in this study gives a conservative estimate of the Seventh-Day Adventist life-style influence on risk factors in that religiously active members differ from their nonactive counterparts (18) in both life-style and risk factors. The categorization by smoking and coffee drinking habits in this study is an index of both general following of the life-style and level of religious activity.

Low levels of serum cholesterol in Seventh-Day Adventists have also been observed elsewhere (7,8,10,11,19) and may be at least partly responsible for their low cardiovascular mortality (2,3,5,20). Which components of the Seventh-Day Adventist way of life are responsible for the low cholesterol values? Studies from Australia (7,21) have implicated dietary fat and meat. Low coffee intake may also be involved in the subjects of this study since in Scandinavia, coffee consumption is associated with serum cholesterol (14,22). Coffee abstinence together with a low intake of meat and animal fat (23) may be responsible for the 10 to 15 percent difference in cholesterol. A study of Baptists (24) did not support claims that religious commitment or affiliation influences

cholesterol levels. The size of the cholesterol difference indicates a reduction in cardiovascular mortality of 34 percent in men and 5 percent in women (Knut Westlund, University of Tromsø, personal communication, 1990). This is well in accordance with the actual deficit in cardiovascular mortality in Seventh-Day Adventists (25).

In this study only Seventh-Day Adventist women differ from controls in blood pressure, ex-members are similar to present members and there is no relationship between blood pressure and degree of following the smoking and coffee recommendations. Previous studies in Seventh-Day Adventists have with few exceptions (11,26) shown a significantly lower blood pressure (9,10,19,27,28). Despite a possibly higher urinary excretion of sodium and potassium (19), the combined effect of recommended dietary practices (29,30) and religious commitment (31-34) would be expected to result in a significantly lower blood pressure than controls. The low fish intake (18) compared to other Norwegians could possibly be a blood pressure-increasing component (35).

An important reason for leaving the church is non-compliance with the recommended life-style resulting in leavers being a high-risk group. Whether they have been at high risk before entering or have developed the high risk later is impossible to establish from the present data.

REFERENCES

1. Phillips RL. Role of life-style and dietary habits in risk of cancer among seventh-day adventists. Cancer Res 1975;35:3513-22.

2. Phillips RL, Lemon FR, Beeson WL, Kuzma JW. Coronary heart disease mortality among Seventh-Day Adventists with differing dietary habits: a preliminary report. Am J Clin Nutr 1978;31:S191-8.

3. Waaler HT, Hjort PF. Høyere levealder hos norske adventister 1960-1977: Et budskap om livsstil og helse? Tidsskr Nor Laegeforen 1981;101:623-7.

4. Jensen OM. Cancer risk among Danish male Seventh-Day Adventists and other temperance society members. J Natl Cancer Inst 1983;70:1011-4.

5. Berkel J, de-Waard F. Mortality pattern and life expectancy of Seventh-Day Adventists in the Netherlands. Int J Epidemiol 1983;12:455-9.

6. Webster IW, Rawson GK. Health status of Seventh-Day Adventists. Med J Aust 1979;1:417-20.

7. Fraser GE, Swannell RJ. Diet and serum cholesterol in Seventh-day Adventists: a cross-sectional study showing significant relationships. J Chronic Dis 1981;34:487-501.

8. Taylor CB, Allen ES, Mikkelson B, Kang-Jey H. Serum cholesterol levels of Seventh-day Adventists. Paroi Arterielle 1976;3:175-9.

9. Rouse IL, Armstrong BK, Beilin LJ. The relationship of blood pressure to diet and lifestyle in two religious populations. J Hypertens 1983;1:65-71.

10. Rouse IL, Beilin LJ, Armstrong BK, Vandongen R. Vegetarian diet, blood pressure and cardiovascular risk. Aust N Z J Med 1984;14:439-43.

11. Fraser GE, Dysinger W, Best C, Chan R. Ischemic heart disease risk factors in middle-aged Seventh-day Adventist men and their neighbors. Am J Epidemiol 1987;126:638-46.

12. Bjartveit K, Foss OP, Gjervig T, Lund-Larsen PG. The Cardiovascular Disease Study in Norwegian Counties. Oslo: National Mass Radiography Service, 1979.

13. Hjermann I, VelveByre K, Holme I, Leren P. Effect of diet and smoking intervention on the incidence of coronary heart disease. Report from the Oslo study group of a randomised trial in healthy men. Lancet 1981;ii:1303-10.

14. Thelle DS, Arnesen E, Førde OH. The Tromsø Heart Study: Does coffee raise serum cholesterol? N Engl J Med 1983;308:1454-7.

15. Kleinbaum DG, Kupper LL. Randomized blocks. Special cases of two-way ANOVA. In: Applied regression analysis and other multivariate methods. Boston:Duxbury Press, 1989:289-314.

16. SAS/STAT Guide for personal computers. SAS Institute, 1985.

17. Breslow NE, Day NE. Classical methods of analysis of matched data. In: Statistical methods in cancer research. Volume 1 - The analysis of case-control studies. Lyon:International Agency for Research on Cancer, 1980:162-89.

18. Fønnebø V. The Tromsø Heart Study: coronary risk factors in Seventh-Day Adventists. Am J Epidemiol 1985;122:789-93.

19. Armstrong B, Clarke H, Martin C, Ward W, Norman N, Masarei J. Urinary sodium and blood pressure in vegetarians. Am J Clin Nutr 1979;32:2472-6.

20. Kuratsune M, Ikeda M, Hayashi T. Epidemiologic studies

on possible health effects of intake of pyrolyzates of foods, with reference to mortality among Japanese Seventh-Day Adventists. Environ Health Perspect 1986;67:143-6.

21. Simons LA, Gibson JC, Paino C, Hosking M, Bullock J, Trim J. The influence of a wide range of absorbed cholesterol on plasma cholesterol levels in man. Am J Clin Nutr 1978;31:1334-9.

22. Tuomilehto J, Tanskanen A, Pietinen P, et al. Consumption of coffee is correlated with serum cholesterol in middle-aged Finnish men and women. J Epidemiol Community Health 1987;41:237-42.

23. Prevention of coronary heart disease. Geneva: World Health Organization, 1982.

24. Fønnebø V. The Tromsø Heart Study: diet, religion, and risk factors for coronary heart disease. Am J Clin Nutr 1988;48:826-9.

25. Fønnebø V. Mortality in Norwegian Seventh-Day Adventists 1962-86. J Clin Epidemiol 1991;(In Press)

26. Harris RD, Phillips RL, Williams PM, Kuzma JW, Fraser GE. The child-adolescent blood pressure study: I. Distribution of blood pressure levels in

Seventh-Day-Adventist (SDA) and non-SDA children. Am J Public Health 1981;71:1342-9.

27. Beilin LJ, Rouse IL, Armstrong BK, Margetts BM, Vandongen R. Vegetarian diet and blood pressure levels: incidental or causal association? Am J Clin Nutr 1988;48:806-10.

28. Armstrong B, van-Merwyk AJ, Coates H. Blood pressure in Seventh-day Adventist vegetarians. Am J Epidemiol 1977;105:444-9.

29. Stamler J, Rose G, Stamler R, Elliott P, Dyer A, Marmot M. INTERSALT study findings. Public health and medical care implications. Hypertension 1989;14:570-7.

30. Beilin LJ. Diet, alcohol and hypertension. Clin Exp Hypertens A 1989;11:991-1010.

31. Kunin CM, McCormack RC. An epidemiologic study of bacteriuria and blood pressure among nuns and working women. N Engl J Med 1968;278:635-42.

32. Timio M, Verdecchia P, Venanzi S, et al. Age and blood pressure changes. A 20-year follow-up study in nuns in a secluded order. Hypertension 1988;12:457-61.

33. Graham TW, Kaplan BH, Cornoni-Huntley JC, et al.

Frequency of church attendance and blood pressure elevation. J Behav Med 1978;1:37-43.

34. Walsh A. The prophylactic effect of religion on blood pressure levels among a sample of immigrants. Soc Sci Med 1980;14B:59-63.

35. Bønaa KH, Bjerve KS, Straume B, Gram IT, Thelle D. Effect of eicosapentaeoic and docosahexaenoic acids on blood pressure in hypertension. N Engl J Med 1990;322:795-801.

TABLE 1. Total cholesterol, triglycerides, blood pressure and coronary risk score (logaritmically transformed) in 222 Seventh-Day Adventists (98 men and 124 women) and matched controls (3 to 1 match). The Cardiovascular Disease Studies in Norway 1973-1987.

		Seventh-Day Adventist	Mean of three controls	Difference	95% CI of difference
Cholesterol (mmol/l):					
Men		5.42	6.28	-0.86	-1.13 to -0.59
Women		5.37	5.85	-0.48	-0.71 to -0.25
Triglycerides (mmol/l):					
Men		1.66	1.94	-0.28	-0.54 to -0.02
Women		1.16	1.20	-0.04	-0.17 to 0.09
Blood pressure (mmHg):					
Men	Systolic	130.7	131.7	-1.0	-4.0 to 2.0
	Diastolic	82.2	81.9	0.3	-1.9 to 2.5
Women	Systolic	120.8	123.3	-2.5	-5.2 to 0.2
	Diastolic	75.5	77.8	-2.3	-4.2 to -0.4
Log coronary risk score:					
Men		1.02	1.33	-0.31	-0.40 to -0.22
Women		0.24	0.44	-0.20	-0.26 to -0.14

TABLE 2. Adjusted* levels of coronary risk factors by degree of adherence to the Seventh-Day Adventist recommendations on smoking and coffee drinking in 163 Seventh-Day Adventists. The Cardiovascular Disease Studies in Norway 1973-1987.

	Men					Women				
	Non-smoker No coffee n=42	Non-smoker Coffee use n=11	Smoker n=11	p	p for trend	Non-smoker No coffee n=57	Non-smoker Coffee use n=30	Smoker n=12	p	p for trend
Cholesterol (mmol/l)	5.51	6.08	6.72	<0.01	<0.01	5.24	5.73	5.80	0.10	0.07
Triglycerides (mmol/l)	1.10	1.22	2.36	0.03	<0.01	1.19	1.17	1.04	0.74	0.44
Body mass index (kg/m^2)	23.6	24.9	27.0	0.05	0.02	23.8	24.3	24.4	0.69	0.40
Blood pressure (mm Hg)										
Systolic	131.9	135.2	135.7	0.55	0.36	121.0	120.6	120.3	0.97	0.81
Diastolic	83.5	90.7	85.0	0.17	0.71	75.2	75.2	74.0	0.90	0.66

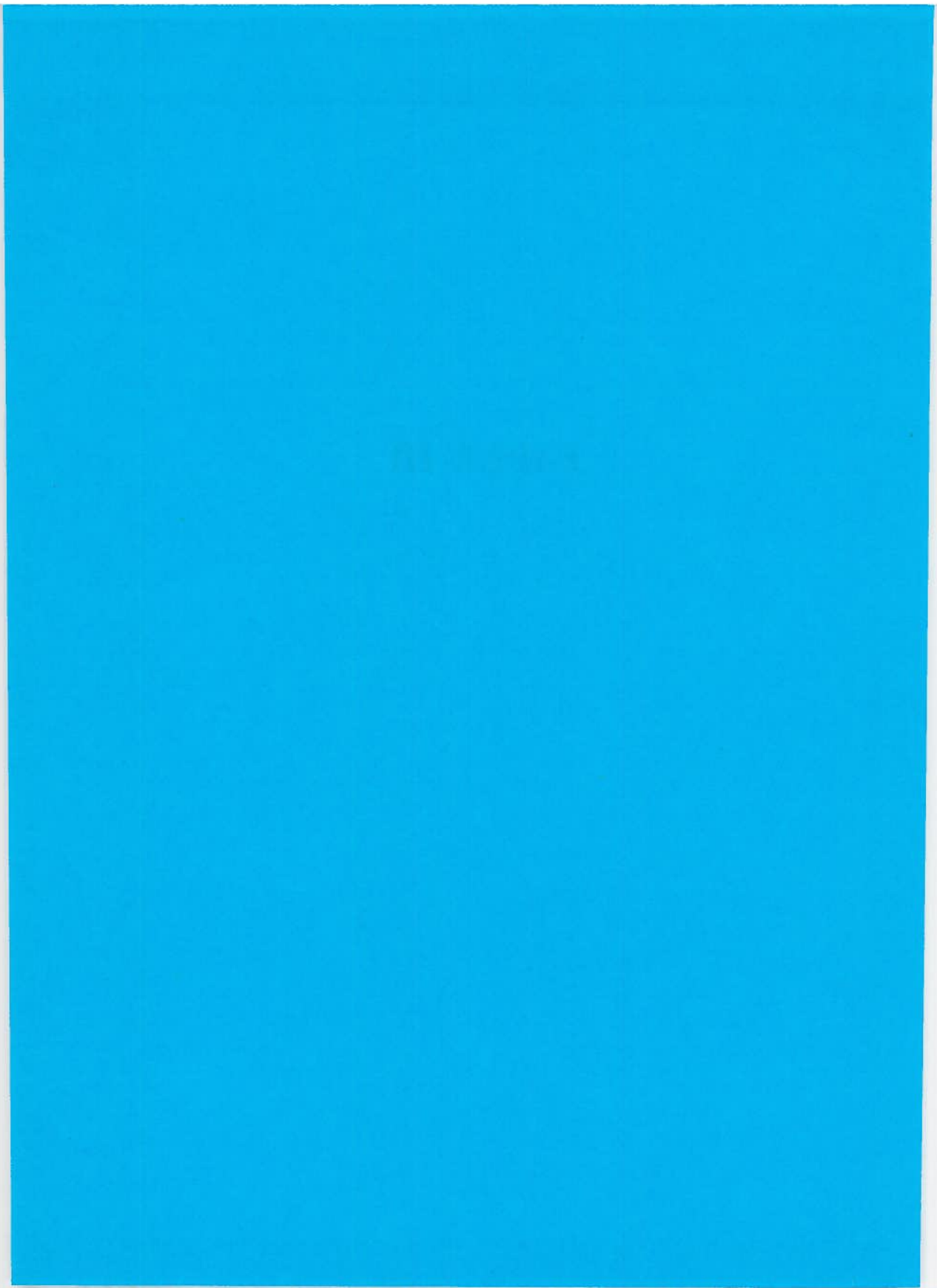
*Adjusted for age and study area.

TABLE 3. Adjusted* levels of coronary risk factors in 22 ex-Seventh-Day Adventist and 222 Seventh-Day Adventists. The Cardiovascular Disease Studies in Norway 1973-1987.

	Seventh-Day Adventist Men			Seventh-Day Adventist Women		
	Current n=98	Ex n=13	p	Current n=124	Ex n=9	p
Cholesterol (mmol/l)	5.44	6.63	0.002	5.43	5.44	0.99
Triglycerides (mmol/l)	1.62	1.66	0.90	1.17	1.22	0.84
Body mass index (kg/m^2)	24.8	25.7	0.44	23.5	23.9	0.76
Blood pressure (mm Hg)						
Systolic	130.5	142.4	0.002	121.2	120.2	0.80
Diastolic	81.7	89.0	0.02	75.2	79.8	0.12
Per cent smokers	11.3	68.8	<0.001	9.7	44.4	0.002
Log coronary risk score	1.02	1.62	<0.001	0.25	0.38	0.25

*Adjusted for age and study area.

PAPER III



Reprinted from CANCER, Vol. 68, No. 3, August 1, 1991.

Cancer Incidence in Norwegian Seventh-Day Adventists 1961 to 1986

Is the Cancer–Life-Style Association Overestimated?

Vinjar Fønnebø, MD, MSc,* and Are Helseth, MD, PhD†

Standardized incidence ratio for cancer in Norwegian Seventh-Day Adventists compared with the general population was not significantly different from unity (men 91, women 97). Persons converting late in life had a higher incidence than those converting at an earlier age. Respiratory cancers (standardized incidence ratio [SIR] 59, 95% CI = 36 to 91) and cancers with an unspecified site (SIR 53, 95% CI = 25 to 97) were rarer and cancer of the uterine corpus (SIR 164, 95% CI = 109 to 237) was more common in Seventh-Day Adventists before the age of 75 years. Inclusion of all registered Seventh-Day Adventists regardless of religious activity and the relatively low cancer incidence rates in the Norwegian population could contribute to the nonsignificant result with regard to total cancer. Main etiologic factors in cancer development in Norway should be sought in areas where Seventh-Day Adventists do not differ from the general population.
***Cancer* 68:666–671, 1991.**

SEVENTH-DAY ADVENTISM has been regarded as a natural experiment on the role of life-style in the etiology of the major causes of death in developed countries.[1–6] This group claims abstinence from unclean foods as listed in the book of Leviticus, chapter 11, in the Old Testament of the Bible; encourages vegetarianism; and discourages the use of stimulants such as drugs, tobacco, alcohol, and caffeine-containing beverages. Members are also encouraged to practice regularity in daily life habits including exercise. Studies on the risk of cancer in Californian,[7,8] Dutch,[3] and Norwegian[5] Seventh-Day Adventists have been mortality studies. A Danish study[4] analyzed morbidity based on data in the Danish Cancer Registry. The indication that cancer survival might be better in Seventh-Day Adventists,[9] underlines the need for cancer incidence studies in Seventh-Day Adventists. The current work presents cancer incidence in Norwegian Seventh-Day Adventists relative to that of the general population.

From the *Institute of Community Medicine, University of Tromsø, Oslo, and the †Norwegian Cancer Registry, Institute for Epidemiological Cancer Research, Norway.
Supported by grant from the Aakre Fund for the Fighting of Cancer.
Address for reprints: Vinjar Fønnebø, MD, MSc, Institute of Community Medicine, University of Tromsø, Postuttaket, N-9000 Tromsø, Norway.
Accepted for publication December 11, 1990.

Materials and Methods

Name, sex, birth date, place of birth, address, date of entry into the church, and date of leaving the church were registered from the official rosters of the 73 Norwegian churches by one of the authors (V.F.). Altogether 10,602 persons were registered.

The use of an 11-digit personal identification number was introduced in Norway for all persons alive in the autumn of 1960. Some of the 10,602 Seventh-Day Adventists registered had died, moved out of the country, or left the church before the autumn of 1960. The 7451 Seventh-Day Adventists living in the country and registered to be alive January 1, 1961 or who had become Seventh-Day Adventists after that date were sought identified by the identification number in the Central Bureau of Statistics. The number was found for 7285 persons (98%). Thirty-five members lacked information on date of entry. These persons were excluded from the study. The current study thus consists of 2503 men and 4750 women contributing a total of 121,448 Seventh-Day Adventist person-years in the time period January 1, 1961 through December 31, 1986.

The reporting to the Norwegian Cancer Registry is mandatory and it thus has a virtually complete register of all solid cancers in the country.[10] The completeness of

reporting is below 95% only for lymphomas (93.5%), multiple myelomas (78.6%), and leukemia (91.6%). The death rate for all deceased citizens is also recorded in the Registry. A computer linkage was done with the Registry by the personal identification number. Expected number of cancers were calculated from national site-specific cancer incidence rates for sex, calendar year, and 5-year age groups. The highest age group was 75 years and above. Site-specific standardized incidence ratios (SIR) before and after the age of 75 years are presented separately.

Statistical Analysis

Standardized incidence ratio was calculated using the PERSON-YEARS computer program.[11] Persons were regarded at risk of cancer from entry into the church until death, leaving the church or December 31, 1986. Confidence intervals were calculated on the assumption that the incident number of cancers is distributed according to the Poisson distribution. Direct standardization was performed using a truncated standard European population as the standard.

Calculations show that about 80 expected cases are necessary to detect a SIR of 0.7 with alfa = 0.05 (*e.g.*, 5% risk of a false-positive result) and beta = 0.80 (*e.g.*, 20% risk of a false-negative result). Approximately 750 cases of cancers are expected in this study.

In testing for equality and trend of SIR across strata the chi-square tests described by Breslow and Day were used.[12]

In testing for equality and trend in crude incidence rates and crude relative rates the methods used are described by Rothman.[13]

Results

Table 1 shows a SIR for all cancers of 91 (95% CI = 81 to 103) for men and 97 (95% CI = 89 to 106) for women in Norwegian Seventh-Day Adventists in the 26-year period 1961 to 1986. For both men and women, the SIR is lowest in the age group 35 to 54 years and increases up to unity at age 75 years and older. These differences or trends, however, are not statistically significant.

No significant differences were found between men and women in SIR for any site. Site-specific SIR for cancer is therefore shown for both sexes combined in Table 2. For all sites combined the SIR was 89 (95% CI = 81 to 98) in persons below 75 years of age. Gastrointestinal cancer showed a SIR of 85 (95% CI = 69 to 103) and respiratory cancer a SIR of 59 (95% CI = 36 to 91). Cancer of the uterine corpus showed a SIR of 164 (95% CI = 109 to 237) indicating an increased risk in Seventh-Day Adventist women. Cancer incidence after the age of 75 was generally similar in Seventh-Day Adventists compared with the general population. Only hematopoietic cancer (SIR 150, 95% CI = 102 to 211) was significantly higher in Seventh-Day Adventists. Cancers with an unspecific diagnosis were less common in Seventh-Day Adventists both before and after the age of 75. The SIR was 53 (95% CI = 25 to 97) and 64 (95% CI = 36 to 105), respectively.

Table 3 shows SIR for all cancers and some important cancer sites by age at entry. Individuals entering the church at an age over 34 years of age have a significantly higher SIR than persons entering at a younger age (P less than 0.01). For gastrointestinal cancers, persons entering the church between 19 and 34 years of age have a SIR of 65, which is significantly lower than the SIR for those entering the church at a younger or older age (P less than 0.05). The same difference is present for breast cancer in women, but is not statistically significant ($P = 0.06$). For respiratory and reproductive cancer there is a nonsignificant trend showing higher SIR the later in life the person becomes a member of the church. If the analysis is restricted only to cancers occurring up to 75 years of age, the contrasts are larger and in the same direction, but insignificant due to the lower total number of cases.

No significant association was seen between duration of membership and risk of cancer for either sex.

In Table 4 the SIR for cancer is presented separately for the Seventh-Day Adventists who were members on

TABLE 1. Observed and Expected Number of Cancers in 7253 Seventh-Day Adventists in Norway 1961 to 1986 by Age Group and Sex

Age group (yr)	Men (n = 2503)					Women (n = 4750)				
	Person-years	Observed	Expected	SIR	95% CI	Person-years	Observed	Expected	SIR	95% CI
<35	12,422	5	4.2	119	38–279	15,587	10	6.9	145	70–267
35–54	11,479	13	17.8	73	39–125	19,772	41	57.4	71	51–97
55–74	12,341	104	127.3	82	67–99	30,459	216	223.3	97	85–111
75+	5,135	125	121.5	103	86–123	14,253	198	191.6	103	89–119
Total	41,377	247	270.8	91	81–103	80,071	465	479.1	97	89–106

CI: confidence interval; SIR: standardized incidence ratio.

TABLE 2. Observed and Expected Number of Cancers in 7253 Seventh-Day Adventists in Norway 1961 to 1986 by Site and Age Group

	<75 yr of age (person-years = 102,060)				≥75 yr of age (person-years = 19,388)			
	Observed	Expected	SIR	95% CI	Observed	Expected	SIR	95% CI
150–159 Gastrointestinal	98	115.9	85	69–103	110	112.3	98	80–118
151 Stomach	29	35.5	82	55–117	48	38.1	126	93–167
153 Colon	38	35.6	107	76–147	26	35.2	74	48–108
154 Rectum	14	19.5	72	39–121	16	16.1	99	57–161
Other gastrointestinal	17	25.3	67	39–108	20	22.9	87	53–135
146, 160–164 Respiratory	20	33.9	59	36–91	15	14.9	101	56–166
162 Lung	18	28.9	62	37–98	14	12.5	112	62–188
Other respiratory	2	5.0	40	4–144	1	2.4	42	0–233
170 Female breast	62	68.0	91	70–117	30	32.8	91	62–130
171–176 Female genital	70	61.5	114	89–144	20	18.5	108	66–167
171 Cervix uteri	15	19.9	75	42–124	2	3.1	65	6–232
172 Corpus uteri	28	17.1	164	109–237	4	5.0	80	22–204
175 Ovary and salpinx	21	20.7	101	63–155	10	6.5	154	74–283
Other female genital	6	3.8	158	58–345	4	3.9	103	28–262
177 Prostate gland	25	25.4	98	64–145	33	36.9	89	62–125
180–181 Urinary	23	27.8	83	53–124	27	22.0	123	81–179
190–191 Skin	15	19.2	78	44–129	25	16.2	154	100–228
206–209 Hematopoietic	33	31.1	106	73–149	32	21.4	150	102–211
199 Other unspecified diagnosis	10	18.9	53	25–97	15	23.5	64	36–105
Other specified diagnosis	33	35.1	94	65–132	16	14.6	110	62–178
All sites	389	436.8	89	81–98	323	313.1	103	92–115

CI: confidence interval; SIR: standardized incidence ratio.

January 1, 1961 and for those entering the church in the 1961 to 1986 time period. No difference is seen in SIR.

Discussion

The presented nonsignificant SIR for cancer of 91 in men and 97 in women contrast with previously published studies on cancer in Seventh-Day Adventists.[3–6,8] These studies show standardized mortality ratio (SMR) or SIR of 50 to 70 for cancer when compared with the country's general population.

After joining the church, persons in the current study had no further influence on the decision of whether or not to be included in the study. A substantial healthy volunteer bias is discussed in a report from the most recent Adventist Health Study in California.[14] One could argue that volunteers probably are religiously active and a cleaner group with regard to the Seventh-Day Adventist life-style. This view could find some support in the data from Seventh-Day Adventist participants in the Tromsø Heart Study.[15] It was here shown that religiously inactive Seventh-Day Adventists had a life-style different from their active fellow members.

A problem similar to what in screening is known as length bias can be present in prospective studies. By only including persons who are members at start of follow-up one is bound to end up with a disproportionate number of long-time members. Long-time members could be the ones following the life-style most closely and could thereby experience a different risk than short-time members. Table

TABLE 3. Standardized Incidence Ratios of Cancer in 7253 Seventh-Day Adventists in Norway 1961 to 1986 by Site and Age of Entering the Church

Age at entry (yr)	Person-years	All cancers		Gastrointestinal		Respiratory		Female breast		Female genital		Male genital		Other	
		No. patients	SIR	No. patients	SIR	No. patients	SIR	No. patients	SIR	No. patients	SIR	No. patients	SIR	No. patients	SIR
–18	41,775	86	85	22	92	2	31	15	91	13	86	4	63	29	88
19–34	39,244	192	81	45	65	11	65	20	60	29	106	15	79	72	101
35+	40,429	434	105*	141	105†	22	87	57	112	48	127	39	97	127	102

SIR: standardized incidence ratio.
Test for linear trend in SIR: $*P < 0.05$.
Test for homogeneity of SIR: $†P < 0.05$.

TABLE 4. Observed and Expected Number of Cancers in Seventh-Day Adventists in Norway 1961 to 1986 by Cohort Definition

	No. of persons	Observed	Expected	SIR
Seventh-Day Adventists January 1, 1961	4595	586	614.3	95
Seventh-Day Adventists entering 1961–1986	2658	126	135.7	93

SIR: standardized incidence ratio.

4 shows that in the current study there is no risk difference regardless of definition of the cohort.

The current study includes all persons that were registered Seventh-Day Adventists January 1, 1961 and those entering the church later. Based on the bias consideration discussed above one would expect this study to give the most conservative estimate of the SIR for cancer in a Seventh-Day Adventist population compared with the general population. The results seem to confirm this assumption.

Similar conservative estimates have, however, been presented when comparison groups other than the general population have been used. In a comparison of graduates from Loma Linda University Medical School (mainly Seventh-Day Adventists) and University of Southern California Medical School (mainly non-Seventh-Day Adventists)[7] there was no significant difference in total cancer mortality. For gastrointestinal cancer the mortality rates were higher in Seventh-Day Adventists. Differences in cancer mortality[16,17] between Seventh-Day Adventist and non-Seventh-Day Adventist participants in the American Cancer Society study were smaller than when Seventh-Day Adventists were compared with the general population.

The site-specific SIR in this study showed few significant differences between Seventh-Day Adventists and non-Seventh-Day Adventists. Although respiratory cancer was lower among Seventh-Day Adventists compared with non-Seventh-Day Adventists in age-groups younger than 75 years, the SIR point estimate of 59 was well above that found in other studies on Seventh-Day Adventists.[3,4,8] In the Tromsø Heart Study[15] it was found that 4.8% of the men and 12.8% of the women belonging to the church actually were daily cigarette smokers. If these figures are representative of Seventh-Day Adventists generally in Norway, the SIR of 59 with its wide confidence interval is not in dissonance with the smoking–respiratory cancer association that is well established.

Keeping in mind that the total number of site-specific comparisons are large in this study one would expect by chance that a few 95% confidence intervals of SIR fail to include 100. Due to the wide confidence intervals and their closeness to 100, the few other site-specific significant SIR are not discussed further.

The U-shaped distribution of SIR for gastrointestinal cancer by age at joining the church is interesting. The data seem to indicate that the optimal situation with regard to gastrointestinal cancer is not to join the church as a teen-ager but in early adult age. The study on medical school graduates[7] indicating a higher SMR for gastrointestinal cancer in Seventh-Day Adventist doctors compared with non-Seventh-Day Adventist doctors could support this line of thought in that medical graduates from Loma Linda University are likely to be lifetime Seventh-Day Adventists.

It is important to have in mind that comparing SIR can be misleading if the distribution of person-years by age is very different in the compared groups. Persons entering the church at an early age contribute mostly young person-years compared with persons entering at a later age. Analysis with directly standardized rates gave essentially the same results as the indirect method of standardization (SIR).

The main result of this study is the small effect of following a life-style that is substantially different from the current Western life-style and with a diet generally advocated for the prevention of cancer.[18] The confidence intervals for the SIR for total cancer is compatible with a 19% reduction in cancer incidence in men and 11% in women. They are, however, also compatible with an increase of 3% in men and 6% in women. This could indicate that the main factors in cancer etiology in Norway are not the factors in which Seventh-Day Adventists differ from the general population. An incidence study among Mormons in Utah[19] who have no restrictions on meat intake show SMR for cancer only slightly higher than Seventh-Day Adventists in California. Gastrointestinal cancer in particular showed a SIR at the same low level as the SMR for gastrointestinal cancer in Seventh-Day Adventists. A prospective study on cancer mortality in British nuns[20] showed a SMR of 96 for all neoplasms in nuns eating no meat and 104 in nuns eating some meat when both groups were compared with the general pop-

TABLE 5. Age-Standardized Incidence Rate (per 100,000) of Malignant Neoplasms in Danish and Norwegian Men (1961–1980): Standardized to the World Health Organization European Standard Population

Yr	Denmark	Norway	Difference (%)
1961–1965	315.8	263.1	20.0
1966–1970	345.2	283.2	21.9
1971–1975	364.3	304.5	19.6
1976–1980	385.6	333.9	15.5

ulation of single women. This study concludes that dietary changes in adult life seem to have no influence on cancer risk, but the author suggests that dietary differences in childhood and adolescence might be important. Even though the current study gave a significant trend in SIR for cancer by age at entry, a closer look at the figures show that this positive trend is totally attributable to the comparably high risk in persons entering at age 35 or older. Persons who became Seventh-Day Adventists before the age of 19 had a cancer incidence very similar to persons converting between 19 and 34 years of age.

An increased interest in psychosocial factors' influence on risk of cancer and coronary heart disease has been seen. The active practice of religion has been proposed as protective for the development of cancer and coronary heart disease. The findings have, however, been conflicting[21] with methodologic difficulties in the control of possible confounding factors. If any psychosocially positive effect of religion is present in this study, the possible beneficial effect of other aspects of the life-style would be further weakened.

Could there be factors in the Seventh-Day Adventist population that actually increase the risk of cancer thereby possibly outweighing dietary benefits? In a study on breast cancer survival in Seventh-Day Adventist women[9] it was found that they had their cancer diagnosed at an earlier stage than others. The finding in the current study of a significantly lower SIR for cancers with an unspecified diagnosis could suggest that Seventh-Day Adventists also in Norway have their cancers diagnosed at an early stage resulting in a site-specific diagnosis. If this is correct, a higher than expected site-specific incidence could be found due exclusively to more accurate diagnosis. Mortality data from the same cohort (unpublished data) indicate, however, no difference in cancer mortality when compared with the general population. This indicates that the cancer survival is unaffected in this Seventh-Day Adventist group.

When comparing studies on cancer in Seventh-Day Adventists from different countries, it is important to keep in mind that the national figures used differ substantially. Similar Seventh-Day Adventist mortality or morbidity in two countries can result in a very different SIR or SMR. The only cancer incidence study so far based on comparison with the general population is the Danish study.[4] Table 5 shows that age-adjusted incidence rates for cancer in men were 16% to 22% higher in Denmark than in Norway in the study period.[22] The finding of a SIR of 70 for total cancer in men in Denmark is therefore well compatible with a SIR of 91 in Norway given Seventh-Day Adventists have the same crude rates in the two countries. Table 6 shows that except for Japan, Norway has the lowest mortality rate in the countries where cancer studies on Seventh-Day Adventists have been performed.[23] This implies that there is a smaller potential for lowering of the mortality rate among Norwegian Seventh-Day Adventists and that if the Seventh-Day Adventist mortality rates are equal in different countries, the SMR would be highest in Norway.

TABLE 6. Age-Standardized Death Rate (per 100,000) of Malignant Neoplasms in Denmark, The Netherlands, United States of America, Norway, and Japan: Standardized to the World Health Organization European Standard Population

Country	Yr	Men	Women	Total
Denmark	1987	277.3	202.0	231.9
The Netherlands	1987	311.8	166.0	224.7
United States of America	1987	246.4	160.0	194.9
Norway	1987	225.5	149.7	180.2
Japan	1988	227.6	116.0	162.8

Conclusion

Seventh-Day Adventists in Norway experienced an incidence of cancer in the time period 1961 to 1986 that was not significantly different from the general population. The inclusion of all registered Seventh-Day Adventists in the study period could contribute to the nonsignificant result. Due to the comparably low cancer incidence rates in the Norwegian population the potential for additional lowering is small. The main etiologic factors in cancer development in Norway should be sought in areas where Seventh-Day Adventists do not differ from the general population.

REFERENCES

1. Kahn HA, Phillips RL, Snowdon DA *et al.* Association between reported diet and all-cause mortality: Twenty-one-year follow-up on 27,530 adult Seventh-Day Adventists. *Am J Epidemiol* 1984; 119:775–787.

2. Jedrychowski W, Tobiasz-Adamczyk B, Olma A *et al.* Survival rates among Seventh-Day Adventists compared with the general population in Poland. *Scand J Soc Med* 1985; 13:49–52.

3. Berkel J, Waard Fd. Mortality pattern and life expectancy of Seventh-Day Adventists in the Netherlands. *Int J Epidemiol* 1983; 12:455–459.

4. Jensen OM. Cancer risk among Danish male Seventh-Day Adventists and other temperance society members. *J Natl Cancer Inst* 1983; 70:1011–1014.

5. Waaler HT, Hjort PF. Høyere levealder hos norske adventister 1960–1977: Et budskap om livsstil og helse? *Tidsskr Nor Lægef* 1981; 101:623–627.

6. Kuratsune M, Ikeda M, Hayashi T. Epidemiologic studies on possible health effects of intake of pyrolyzates of foods, with reference to mortality among Japanese Seventh-Day Adventists. *Environ Health Perspect* 1986; 67:143–146.

7. Phillips RL. Role of life-style and dietary habits in risk of cancer among Seventh-Day Adventists. *Cancer Res* 1975; 35:3513–3522.

8. Phillips RL, Garfinkel L, Kuzma JW *et al.* Mortality among California Seventh-Day Adventists for selected cancer sites. *J Natl Cancer Inst* 1980; 65:1097–1107.

9. Zollinger TW, Phillips RL, Kuzma JW. Breast cancer survival rates

among Seventh-Day Adventists and non-Seventh-Day Adventists. *Am J Epidemiol* 1984; 119:503–509.

10. Lund E. Pilot study for the evaluation of completeness of reporting to the Cancer Registry. In: Incidence of Cancer in Norway 1978. Oslo, Norway: The Cancer Registry of Norway, 1981; 11–15.

11. Coleman MP, Hermon C, Douglas A. Person-years (PYRS): A Fortran Program for Cohort Study Analysis. IARC Internal Report No. 89/006. Lyon: International Agency for Research on Cancer, 1989.

12. Breslow NE, Day NE. Statistical Methods in Cancer Research, vol. 2: The Design and Analysis of Cohort Studies. IARC Scientific Publications No. 82. Lyon: International Agency for Research on Cancer, 1987; 82–118.

13. Rothman KJ. Modern Epidemiology. Boston/Toronto: Little, Brown and Company, 1986; 221–235.

14. Beeson WL, Mills PK, Phillips RL, Andress M, Fraser GE. Chronic disease among Seventh-Day Adventists, a low risk group: Rationale, methodology, and description of the population. *Cancer* 1989; 64:570–581.

15. Fønnebø V. The Tromsø Heart Study: Coronary risk factors in Seventh-Day Adventists. *Am J Epidemiol* 1985; 122:789–793.

16. Phillips RL, Kuzma JW, Beeson WL *et al.* Influence of selection *versus* life-style on risk of fatal cancer and cardiovascular disease among Seventh-Day Adventists. *Am J Epidemiol* 1980; 112:296–314.

17. Phillips RL, Kuzma JW, Lotz TM. Cancer mortality among comparable members *versus* non-members of the Seventh-Day Adventist Church. In: Banbury Report 4: Cancer Incidence in Defined Populations. New York: Cold Spring Harbor Laboratory, 1980; 93–108.

18. Committee on Diet, Nutrition and Cancer. Assembly of Life Sciences, National Research Council. Diet, Nutrition and Cancer. Washington, DC: National Academy Press, 1982; 1–16.

19. Lyon JL, Gardner JW, West DW. Cancer incidence in Mormons and non-Mormons in Utah during 1967–1975. *J Natl Cancer Inst* 1980; 65:1055–1061.

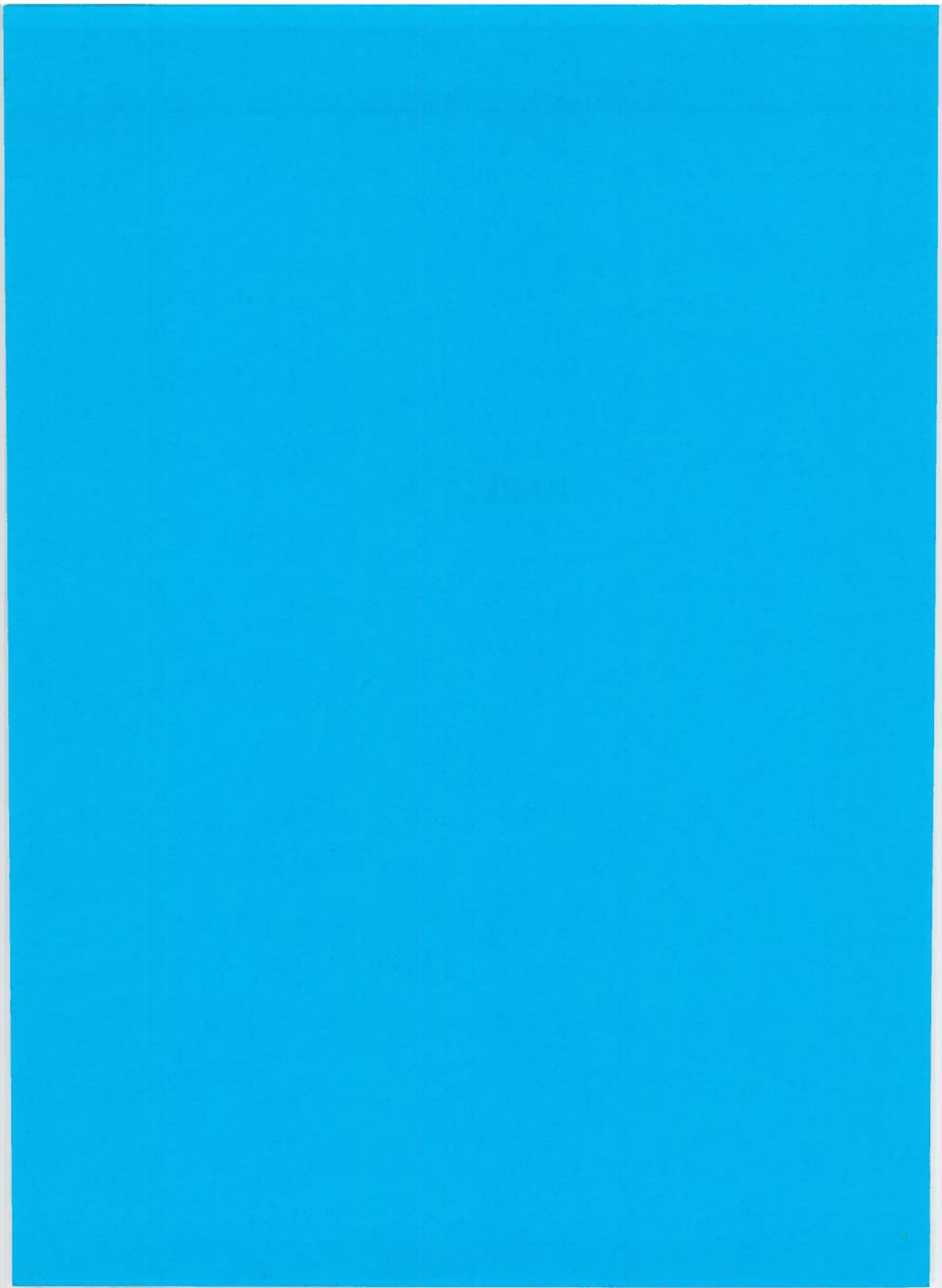
20. Kinlen LJ. Meat and fat consumption and cancer mortality: A study of strict religious orders in Britain. *Lancet* 1982; 1:946–949.

21. Jarvis GK, Northcott HC. Religion and differences in morbidity and mortality. *Soc Sci Med* 1987; 25:813–824.

22. Hakulinen T, Andersen A, Malker B, Pukkala E, Schou G, Tulinius H. Trends in Cancer Incidence in the Nordic Countries. Helsinki: The Nordic Cancer Registries, 1986; 110–111.

23. World Health Statistics Annual 1989. Geneva: World Health Organization, 1989; 386–395.

PAPER IV



MORTALITY IN NORWEGIAN SEVENTH-DAY ADVENTISTS 1962-1986.

Vinjar Fønnebø MD, MSc Epidemiology

Institute of Community Medicine

University of Tromsø

Postuttak

N-9000 TROMSØ

Norway

For communication and reprints contact Dr. V. Fønnebø

ABSTRACT

Fønnebø V. Mortality in Norwegian Seventh-Day Adventists 1962-1986.

Standardized mortality ratio (SMR) was studied in Norwegian Seventh-Day Adventists, a religious group practising a life-style regarded as protective for cancer and cardiovascular disease. Persons converting before the age of 19 had a SMR of 66 (Men) and 58 (Women). This was both significantly lower than the general population and those converting at age 35 or above ($p<0.001$). The site mainly responsible for the low SMR in young converts was cardiovascular disease (Men: 43, Women: 51). Overall SMR in Seventh-Day Adventists compared to the general population was 86 (95% CI: 80-92, $p<0.001$) in men and 98 (95% CI: 93-102, NS) in women. SMR for cancer was significantly lower only in men before the age of 75 (SMR: 78, 95% CI: 61-99, $p<0.05$). Adopting a healthful life-style early in life seems to be of decisive importance with regard to mortality, later life-style changes have a negligible effect on death risk.

Running head: Mortality in Norwegian Seventh-Day Adventists 1962-1986.

Key words: cardiovascular disease, cancer, religion, mortality, life-style, diet

INTRODUCTION

Seventh-Day Adventism has been regarded as a large-scale natural experiment on the role of life-style in the etiology of the major causes of death in Western societies [1-5]. This religious group claims abstinence from "unclean foods" as listed in Leviticus 11 of the Old Testament in the Bible, encourages vegetarianism, and discourages the use of stimulants(drugs, tobacco, alcohol, and caffeine-containing beverages). Members are also encouraged to practice regularity in daily life habits including regular exercise. Mortality studies from California [1,6], Netherlands [3], Japan [5] and a previous study from Norway [7] have indicated a substantially lower mortality in this religious group. These studies have, however, mainly been based on selected subgroups of the Seventh-Day Adventist population in the country or state(USA). The present study describes mortality in all registered Norwegian Seventh-Day Adventists in the time period January 1, 1962 to December 31, 1986.

MATERIAL AND METHODS

Name, sex, birth date, place of birth, address, date of entry into the church and date of leaving the church was registered from the official rosters of the 73 Norwegian Seventh-Day Adventist churches. Altogether 10602 persons were registered. The use of an eleven-digit personal

identification number was introduced in Norway for all persons alive in the autumn of 1960. Some of the 10602 Seventh-Day Adventists registered had died, moved out of the country or left the church before the autumn of 1960. The 7451 Seventh-Day Adventists living in the country and registered to be alive January 1, 1961 or who had become Seventh-Day Adventists after that date were sought identified by the identification number in the Central Bureau of Statistics. The number was found for 7285 persons (98%). These Seventh-Day Adventists were included in the study of cancer incidence [8] and the paper gives a more detailed description of the methods used in identifying the study population. The mortality study started follow-up from January 1, 1962 and includes 2476 males and 4697 females contributing a total of 117289 Seventh-Day Adventist person-years in the time period January 1, 1962 to December 31, 1986.

A computer linkage was done with the national Death registry. The eleven-digit personal identification number was used to identify the persons in both computer files. Expected number of deaths were computed from national site-specific mortality rates for sex, calendar year and five-year age groups. The highest age-group for site-specific mortality was 75 years and above.

For directly age-adjusted rates in table 2 the person-years distribution of the total Seventh-Day Adventist population

was used. Elsewhere direct standardization was performed using a truncated standard European population as the standard.

Standardized mortality ratios (SMR) were calculated using the PERSON-YEARS computer program [9]. Persons were regarded at risk of death from entry into the church until leaving the church or December 31, 1986. Confidence intervals were calculated on the assumption that the incident number of deaths is distributed according to the Poisson distribution.

Power calculations show that in a comparison with population rates approximately 80 expected deaths are necessary to detect a SMR of 0.7 with alpha=0.05 and beta=0.80. With approximately 118000 person-years in this study, 2000 deaths are expected. The study is thus large enough for rendering statistically significant a result similar to the other mortality studies in Seventh-Day Adventists.

In testing for homogeneity and trend of SMR across strata the chi-square tests described by Breslow and Day were used [10].

In testing for homogeneity and trend in crude incidence rates and crude relative rates the methods used are described by Rothman [11].

Cause-specific mortality analysis was done separately for age-groups under and over 75 years of age. This was done because diagnostic certainty with regard to cause of death could be lower in the highest age groups.

RESULTS

Total mortality

Table 1 shows sex and age-specific all-cause mortality in Norwegian Seventh-Day Adventists in the period 1962-1986. Standardized mortality ratios (SMR) are presented in table 2 using the general population as the reference population. Seventh-Day Adventist men had a significantly low SMR of 86 (95% CI: 80-92, $p>0.001$), while the SMR for women was 98 (95% CI: 93-102, NS). There was a significant trend showing lower SMR in young men. In women the SMR was similar in all age-groups.

Entering the church before the age of 19 is in table 3 shown in men to be associated with an SMR of 66 compared to 96 for those entering at age 35 or above. The trend is significant both for all age groups combined ($p<0.001$) and for the age-groups 55-64 ($p<0.05$) and 65-74 ($p<0.01$). In 45-54 year-olds there is a non-significant reverse trend. In women the trend of a lower SMR when entering the church early in life is even stronger than in men (Table 4). Late enterers had a SMR

of 108 compared to 58 in those entering before 19 years of age (Trend test: $p<0.001$). This trend was present with a varying degree of significance in all age groups except the youngest.

Persons entering the church before the age of 19 are often brought up in a Seventh-Day Adventist home. The association of duration of membership and SMR is therefore analyzed only for those entering the church at age 19 or above (Table 5). In men there was a significant downward trend in SMR with increasing duration of membership ($p<0.05$). The SMR showed a slight excess in mortality in the first 14 years of membership turning to a 20% deficit after 20 years of membership. No such trend was present in women.

Table 6 shows life expectancy from age 20 for Seventh-Day Adventists compared to the general Norwegian population. An increased life expectancy of 3.1 years in men ($p<0.001$) and 0.7 years in women ($p>0.05$) was observed when all church members were included in the analysis. Restricting the analysis to persons entering before 19 years of age gives a substantially higher life expectancy increase. Men increased their life expectancy by 5.2 years ($p<0.001$) and women by 5.7 years ($p<0.001$).

Cause-specific mortality

Seventh-Day Adventist men below the age of 75 had a total mortality significantly lower than the general population (SMR: 72, 95% CI: 64-80, $p<0.001$)(Table 7). Both cancer (SMR: 78, 95% CI: 61-99, $p<0.05$), cardiovascular disease (SMR: 65, 95% CI: 55-77, $p<0.001$) and respiratory disease (SMR: 30, 95% CI: 11-65, $p<0.001$) mortality was significantly lower. Gastrointestinal disease mortality was low (SMR: 51, 95% CI: 16-119, NS), but as for the other infrequent causes of death the wide confidence interval includes both a possible substantial mortality deficit and an excess. For those aged 75 years and above no significant differences in mortality were found for any site.

In women the 95% confidence interval for SMR before the age of 75 indicates a possible 14% deficit in mortality (Table 8), but allows also for a three percent excess mortality in Seventh-Day Adventist women (SMR: 94, 95% CI: 86-103, NS). The only site that has an SMR significantly different from 100 is gastrointestinal disease (SMR: 42, 95% CI: 15-91, $p<0.02$).

When examining specific cardiovascular disease sites, table 9 shows that coronary heart disease and sudden death are the sites responsible for the low cardiovascular mortality in men below 75 years of age (SMR=55, 95% CI: 43-69, $p<0.001$).

Cerebrovascular and other cardiovascular mortality were only slightly lower than expected. In older men no significant differences were found between Seventh-Day Adventists and the general population. No SMR for any cardiovascular site is significantly different from 100 in women.

Table 10 shows SMR for cardiovascular diseases, cancer and other causes by age at entry into the church. For both cancer and cardiovascular mortality the SMR showed an increasing trend with age at entry into the church. When entering the church before 19 years of age, cardiovascular mortality is reduced by 57% ($p<0.001$) in men and 49% ($p<0.01$) in women (Test for trend: Men: $p<0.01$, Women $p<0.001$). For cancer the contrasts were smaller (Test for trend: Men: $p<0.05$, Women $p<0.01$) and no difference was seen between the two lowest entry age groups. For other causes, women entering the church before 19 had a lower SMR than women entering later ($p<0.05$).

Table 11 shows that the person-year contribution of leavers after leaving the church increases the number of expected deaths by 112. The number of observed deaths, however increases by 228 indicating an SMR of over 200 for this group after leaving the church. Starting follow-up one or ten years after entry into the church seems to have no effect on the total SMR estimate.

DISCUSSION

The presented SMR of 86 in men and 98 in women indicate a smaller difference between Seventh-Day Adventists and the general population than seen in previously published mortality studies in Seventh-Day Adventists [1-3,5,7]. A substantial lower mortality is, however, seen in members entering the church before 19 years of age.

Bias and analytical considerations

The church rosters have no information on the life-style of the individual member. Basing the analyses on roster information has ensured an almost complete follow-up of all registered members, but leaves uncertainty with regard to compliance with church-advocated life-style. A previously published study by the author [12] shows that religiously active Seventh-Day Adventists follow the recommended life-style, whereas the thirty percent classified as religiously inactive had a life-style similar to non-Seventh-Day Adventists. The inclusion in this study of these non-complying Seventh-Day Adventists could give a biased estimate of the possible health effect of the recommended Seventh-Day Adventist way of life. Inclusion of all registered members, however, excludes healthy volunteer bias which has been shown to be substantial in the Californian

Adventist Health Study [13]. When no suitable "volunteer" reference group is available, a comparison between a "volunteer" Seventh-Day Adventist group and an unselected general population could be misleading. After joining the church, persons in the present study had no further influence on the decision to be included in the study or not. They thus represent an unselected population of Seventh-Day Adventists including some members who no longer follow the recommended life-style, and are in this study compared with the unselected general population.

The present study includes both persons who are members at start of follow-up and those entering the church in the follow-up period, thus avoiding a possible length bias. This bias can arise by only recruiting persons who are members at start of follow-up thereby including a disproportionate number of long-time members. One reason for short membership is death and a prospective study will run the risk of being slightly biased if only long-time members are included.

Based on the bias considerations discussed above one would expect this study to give the most conservative estimate of SMR in a Seventh-Day Adventist population compared to the general population. The results seem to confirm this assumption.

Total mortality in the present study seems to contrast with the previously published Norwegian study on mortality in

Seventh-Day Adventists [7] showing an all-cause SMR of 72 in men and 84 in women. More noteworthy is this discrepancy when the two studies actually are based on many of the same persons. Persons who in the population census of 1960 reported that they belonged to the Seventh-Day Adventist Church were included and followed from January 1, 1961 through 1977 in the previous study. This method could probably include disproportionally many long-time members and also select members with the closest adherence to the Seventh-Day Adventist life-style. When these two important differences in study design are considered a discrepancy of 14 in SMR for both sexes could be explained.

It is important to have in mind that comparing SMR's can be misleading if the distribution of person-years by age is very different in the compared groups. Persons entering the church at an early age contribute mostly "young" person-years compared to persons entering at a later age. The analysis of the data using directly standardized rates gave, however, similar results as with the indirect method of standardization (SMR).

Cancer

Cancer mortality in Seventh-Day Adventists was significantly lower only in men under 75 years of age. This difference is, however, considerably smaller than other cancer mortality studies [2,3,5] in Seventh-Day Adventists have reported.

Although the SMR was significantly highest in the persons entering the church at 35 years of age or above, no significant difference was found between entering below 19 or between 19 and 34.

In Waaler's Norwegian study [7], the SMR for cancer in all males was 69 and in all females 90. If restricted to ages under 75, however, the male SMR in Waaler's study was 75 compared to 78 in the present study and the female SMR was 92 compared to 94 in the present study. These small discrepancies are well within the limits of chance findings, and indicate that the possible selection in Waaler's study did not affect the results with regard to cancer mortality.

SMR's for cancer in the present study are well in accordance with incidence figures in the same population [8]. Almost identical figures for SIR and SMR are found in the two studies. This indicates that prognosis given a cancer disease does not differ between Seventh-Day Adventists and the general population.

When discussing differences in cancer mortality one must keep in mind that cancer mortality in the Norwegian population is relatively low [14]. If Seventh-Day Adventist cancer mortality is similar in different countries one would expect a smaller difference between Seventh-Day Adventists and the general population in Norway than in other Western countries.

Cardiovascular disease

This study shows that when entering the church before 19 years of age, cardiovascular mortality is reduced by 57% in men and 49% in women. The greatly reduced risk in women is particularily noteworthy since women in the general population already have a low risk. This finding has previously only been reported for both sexes combined [15]. For all members of the church combined the findings in this study of a low SMR in men and an SMR in women similar to the general population seem to be well in accordance with results from other Seventh-Day Adventist studies [1,3,5].

Other causes of death

In both sexes mortality from gastrointestinal diseases was low before the age of 75, although statistically significant only in women. The number of deaths is very low and caution must be applied with regard to conclusive remarks. In men a lower SMR for respiratory diseases other than lung cancer is well compatible with the recommended abstinence from smoking.

Mortality according to age of entry

The main result of the present study is a lower total SMR and SMR for cardiovascular disease in both men and women entering the church in early age. The large contribution of person-years by elderly women entering the church at 35 years and above masks this important finding in the analysis of total SMR in women.

Establishing a healthy life-style in childhood and early teen-age seems to be of substantial importance for later cardiovascular death risk. This finding is supported by the CHD incidence study in Hawaiian Japanese [16]. The investigators state that "exposure to Japanese culture during childhood appears to protect against CHD in adulthood". Similarities in Seventh-Day Adventist and Japanese childhood life-styles should be sought for in that they seem to result in similar adult mortality rates (Table 12). From a preventive perspective the findings in this study strongly support the idea that the target point in the postponement of cardiovascular death should be childhood.

Converting after the age of 35 seems, however, to be associated with little benefit in mortality. Realizing that life-style changes accompany church entry, this seems to weaken the belief that life-style changes in middle-age are decisive in the prevention of premature death. Several intervention studies concentrating on life-style changes in middle age [17-21] have also failed to show any benefit in

total mortality for the intervention groups. The interpretation of the results have often been to blame "contamination" in the control groups [18]. Contamination of the general population with Seventh-Day Adventist beliefs and life-style is not likely in a degree to explain the results in the present study. One could, however, still argue that persons converting in adult age are a high-risk group before entry and "come down" to the general population mortality level. Table 5 showed a weak trend only in male SMR by duration of membership and table 11 shows that analysis of the data with a one- or ten-year delay in start of follow-up results in a negligible alteration in the SMR estimate. This does not support the theory of "high-risk person" recruitment of adult members, again underlining the need for the early establishment of a healthy life-style.

Other factors' influence on mortality

Could there be other characteristics of Norwegian Seventh-Day Adventists' way of life than diet and alcohol and tobacco abstinence that could possibly explain the low mortality? Whether Seventh-Day Adventists are a genetically self-selected low-mortality group has previously been discussed by Phillips [22]. It is difficult to clarify this issue, but the present study showing a death risk in middle-age converters similar to the general population suggests that the church does not recruit low-risk persons. Waaler

[7] looked at census information with regard to educational background and geographical distribution of the church members. He found that the older Seventh-Day Adventist generation (contributing most of the deaths) had a lower than national average educational level and lived in high-risk areas of the country.

In the last decade an increased interest in psychosocial factors' influence on risk of cancer and coronary heart disease has been seen. The active practice of religion has been proposed as protective for the development of cancer and coronary heart disease [23]. The findings have, however, been conflicting with methodological difficulties in the control of possible confounding factors. If any beneficial effect of religion as such is present in this study, this would further weaken the possible beneficial effect of other aspects of the life-style. If on the other hand religion should have a deleterious influence on death risk, possible beneficial effects of life-style would be masked.

CONCLUSION

Seventh-Day Adventists in Norway entering the church before the age of 19 experienced a 50% reduced mortality in the time period 1962-1986 compared to the general population. The Seventh-Day Adventist life-style when adopted in early

age seems to be of particular importance with regard to cardiovascular disease. For cancer the effect seems to be smaller. A change in life-style in a Seventh-Day Adventist direction after the age of 35 has in this study been shown to be associated with no lower death risk than that experienced by the general population.

REFERENCES

1. Phillips RL, Lemon FR, Beeson WL, Kuzma JW. Coronary heart disease mortality among Seventh-Day Adventists with differing dietary habits: a preliminary report. Am J Clin Nutr 1978;31:S191-8.

2. Phillips RL, Garfinkel L, Kuzma JW, Beeson WL, Lotz T, Brin B. Mortality among California Seventh-Day Adventists for selected cancer sites. J Natl Cancer Inst 1980;65:1097-107.

3. Berkel J, de-Waard F. Mortality pattern and life expectancy of Seventh-Day Adventists in the Netherlands. Int J Epidemiol 1983;12:455-9.

4. Kahn HA, Phillips RL, Snowdon DA, Choi W. Association between reported diet and all-cause mortality. Twenty-one-year follow-up on 27,530 adult Seventh-Day Adventists. Am J Epidemiol 1984;119:775-87.

5. Kuratsune M, Ikeda M, Hayashi T. Epidemiologic studies on possible health effects of intake of pyrolyzates of foods, with reference to mortality among Japanese Seventh-Day Adventists. Environ Health Perspect 1986;67:143-6.

6. Phillips RL. Role of life-style and dietary habits in risk of cancer among seventh-day adventists. Cancer Res 1975;35:3513-22.

7. Waaler HT, Hjort PF. Høyere levealder hos norske adventister 1960-1977: Et budskap om livsstil og helse? Tidsskr Nor Laegeforen 1981;101:623-7.

8. Fønnebø V, Helseth A. Cancer incidence in Norwegian Seventh-Day Adventists. Is the cancer - life-style association overestimated? Cancer 1991 (In press).

9. Coleman MP, Hermon C, Douglas A. Person-years(PYRS). A Fortran program for cohort study analysis. IARC Internal report No. 89/006. Lyons: IARC, 1989.

10. Breslow NE, Day NE. Statistical methods in cancer research. Volume II - The design and analysis of cohort studies. IARC Scientific Publications No. 82. Lyons: IARC, 1987:82-118.

11. Rothman KJ. Modern Epidemiology. Boston/Toronto: Little, Brown and Company, 1986:221-35.

12. Fønnebø V. The Tromsø Heart Study: coronary risk factors in Seventh-Day Adventists. Am J Epidemiol 1985;122:789-93.

13. Beeson WL, Mills PK, Phillips RL, Andress M, Fraser GE.

Chronic disease among Seventh-day Adventists, a low-risk group. Rationale, methodology, and description of the population. Cancer 1989;64:570-81.

14. World Health Statistics Annual 1987. Geneva: WHO, 1989:342-349.

15. Snowdon DA, Phillips RL, Kuzma JW. Age at Baptism into the Seventh-day Adventists church and risk of death due to ischemic heart disease. Banbury Rep 1982;11:1-8.

16. Yano K, Blackwelder WC, Kagan A, Rhoads GG, Cohen JB, Marmot MG. Childhood cultural experience and the incidence of coronary heart disease in Hawaii Japanese men. Am J Epidemiol 1979;109:440-50.

17. WHO European Collaborative Group. European collaborative trial of multifactorial prevention of coronary heart disease: final report on the 6-year results. Lancet 1986;i:869-72.

18. Wilhelmsen L, Berglund G, Elmfeldt D, et al. The multifactor primary prevention trial in Gçteborg, Sweden. Eur Heart J 1986;7:279-88.

19. Multiple Risk Factor Intervention Trial Research Group. Multiple risk factor intervention trial. Risk factor changes and mortality results. JAMA 1982;248:1465-77.

20. Miettinen TA, Huttunen JK, Naukkarinen V. Multifactorial primary prevention of cardiovascular diseases in middle-aged men. JAMA 1985;254:2097-102.

21. Salonen JT, Puska P, Mustaniemi H. Changes in morbidity and mortality during comprehensive community programme to control cardiovascular diseases during 1972-7 in North Karelia. Br Med J 1979;2:1173-8.

22. Phillips RL, Kuzma JW, Beeson WL, Lotz T. Influence of selection versus lifestyle on risk of fatal cancer and cardiovascular disease among Seventh-day Adventists. Am J Epidemiol 1980;112:296-314.

23. Jarvis GK, Northcott HC. Religion and differences in morbidity and mortality. Soc Sci Med 1987;25:813-24.

Table 1. Observed and expected number of deaths in 7173 Seventh-Day Adventists in Norway 1962 to 1986 by age group and sex.

	Men n=2476					Women n=4697				
Age group	Obs.	Exp.	SMR	95% CI	p	Obs.	Exp.	SMR	95% CI	p
<45	24	25.2	95	61-142	NS	17	15.7	108	63-173	NS
45-54	19	31.8	60	36- 93	<.02	30	31.6	95	64-135	NS
55-64	60	93.3	64	49- 83	<.001	97	104.5	93	75-113	NS
65-74	172	234.4	73	63- 85	<.001	313	334.8	93	84-104	NS
75+	540	563.2	96*	88-104	NS	1204	1216.0	99	94-105	NS
All age groups	815	947.9	86	80- 92	<.001	1661	1702.6	98	93-102	NS

Test for trend in SMR:
* :p<0.01

Table 2. Mortality(per 100,000 person-years) by sex and age-group in 7173 Norwegian Seventh-Day Adventists 1962-1986.

Age group	Men n=2476		Women n=4697	
	Person-years	Mortality rate	Person-years	Mortality rate
<45	17656	135.9	23385	72.7
45-54	5412	351.1	10539	284.7
55-64	6021	996.5	13982	693.7
65-74	5940	2895.6	15377	2035.5
75+	5037	10720.7	13940	8637.0
Total	40066	2034.1	77223	2150.9
Age-adjusted		2526.2		1949.8

Table 3. Crude mortality and SMR by age-group and age at entry into the church in 2476 Norwegian Seventh-Day Adventist men 1962-1986.

	Age at entry into the church								
Age group	<19 years n=866			19 to 34 years n=743			35 years and above n=867		
	Person-years	Mortality rate	SMR	Person-years	Mortality rate	SMR	Person-years	Mortality rate	SMR
<45	12619	126.8	98	4643	150.8	89	394	253.7	101
45-54	1461	479.0	84	2732	329.4	56	1218	246.3	40
55-64	927	755.3	51	2756	725.6	47	2337	1411.9	89*
65-74	586	1195.3	31	2000	2449.8	64	3355	3458.0	86**
75+	281	8547.4	77	1252	9664.1	87	3504	11272.0	101
Total	15874	384.3	66	13384#	1539.1	73	10808	5070.3	96***

#: The number of person-years in each age-group do not sum up to exactly the total figure due to rounding of the person-years in each age-group.

Test for linear trend in SMR:
* :p<0.05
** :p<0.01
***:p<0.001

Table 4. Crude mortality and SMR by age-group and age at entry into the church in 4697 Norwegian Seventh-Day Adventist women 1962-1986.

Age group	Age at entry into the church								
	<19 years n=1298			19 to 34 years n=1357			35 years and above n=2042		
	Person-years	Mortality rate	SMR	Person-years	Mortality rate	SMR	Person-years	Mortality rate	SMR
<45	16301	61.3	106	6353	94.4	113	731	136.8	99
45-54	3278	61.0	21	4401	295.4	98	2860	524.5	167**
55-64	2631	456.2	65	5312	564.8	76	6040	910.7	118*
65-74	1623	1170.4	60	5057	1720.4	81	8696	2380.3	106**
75+	886	4626.5	55	3652	7640.5	89	9402	9402.2	107***
Total	24720#	339.8	58	24774#	1675.1	86	27729	4190.6	108***

#: The number of person-years in each age-group do not sum up to exactly the total figure due to rounding of the person-years in each age-group.

Test for linear trend in SMR:
* :p<0.05
** :p<0.01
***:p<0.001

Table 5. SMR by sex and duration of membership in 5009 Norwegian Seventh-Day Adventists entering the church at age 19 or above. 1962-1986.

	Men n=1610		Women n=3399	
Duration of membership	Number of deaths	SMR	Number of deaths	SMR
<5 years	72	111	84	110
5- 9 years	70	106	88	97
10-14 years	68	107	89	81
15-19 years	61	93	127	98
20-24 years	57	79	160	117
25-29 years	59	80	147	104
30-34 years	68	81	149	96
35-39 years	64	73	160	98
40+ years	235	85*	573	103

Test for linear trend in SMR:
* :p<0.05

Table 6. Life expectancy at age 20 for Seventh-Day Adventists 1962-86 compared to the Norwegian population.

	Men	Women
Norway 1961-1985	53.4	59.0
All Seventh-Day Adventists 1962-1986	56.5***	59.7
Seventh-Day Adventists joining the church before the age of 19 1962-1986	58.6***	64.7***

Table 7. Site-specific standard mortality ratios in 2476 Norwegian Seventh-Day Adventist men 1962-1986 classified by age-group.

ICD				Age at death									
				Below 75 years					75 years and above				
7	8	9	Cause of death	Obs	Exp	SMR	95% CI of SMR	p	Obs	Exp	SMR	95% CI of SMR	p
140-205	140-203	140-208	Cancer	69	87.9	78	61- 99	<.05	98	91.6	107	87-130	NS
330-334 400-468 782.4 795.2-241 470-527	390-458 782.4 795 460-519	390-459 798.1 460-519	Cardiovascular diseases	136	207.8	65	55- 77	<.001	307	321.5	95	85-107	NS
			Respiratory diseases	6	20.1	30	11- 65	<.001	64	67.1	95	73-122	NS
530-587	009.1-009.9 520-577	520-579	Gastrointestinal diseases	5	9.8	51	16-119	NS	9	14.0	64	29-122	NS
590-637	580-629	580-629	Urogenital diseases	8	5.6	143	63-282	NS	12	16.1	75	39-130	NS
800-999	800-999	800-999	Accidents and violent deaths	24	29.9	80	52-119	NS	18	15.9	113	67-179	NS
			All other causes	27	23.6	114	75-167	NS	32	37.4	86	59-121	NS
			All causes	275	384.6	72	64- 80	<.001	540	563.3	96	88-104	NS

Table 8. Site-specific standard mortality ratios in 4697 Norwegian Seventh-Day Adventist women 1962-1986 classified by age-group.

ICD				Age at death									
				Below 75 years					75 years and above				
7	8	9	Cause of death	Obs	Exp	SMR	95% CI of SMR	p	Obs	Exp	SMR	95% CI of SMR	p
140-205	140-203	140-208	Cancer	142	150.8	94	79-111	NS	155	147.1	105	89-123	NS
330-334 400-468 782.4 795.2	390-458 782.4 795	390-459 798.1	Cardiovascular diseases	209	233.0	90	78-103	NS	695	717.0	97	90-104	NS
241 470-527	460-519	460-519	Respiratory diseases	29	26.0	112	75-160	NS	146	149.4	98	83-115	NS
530-587	009.1 009.9 520-577	520-579	Gastrointestinal diseases	6	14.4	42	15- 91	<.02	47	36.7	128	94-170	NS
590-637	580-629	580-629	Urogenital diseases	8	7.5	107	47-211	NS	13	17.8	73	39-125	NS
800-999	800-999	800-999	Accidents and violent deaths	15	18.4	82	46-134	NS	52	49.0	106	79-139	NS
			All other causes	48	36.7	131	96-173	NS	96	98.8	97	79-119	NS
			All causes	457	486.8	94	86-103	NS	1204	1215.8	99	94-105	NS

Table 9. Site-specific cardiovascular standard mortality ratios in 2476 Norwegian Seventh-Day Adventist men 1962-1986 classified by age-group.

ICD				Age at death									
				Below 75 years					75 years and above				
7	8	9	Cause of death	Obs	Exp	SMR	95% CI of SMR	p	Obs	Exp	SMR	95% CI of SMR	p
330-334	430-438	430-437	Cerebrovascular disease	30	33.7	89	60-127	NS	92	97.1	95	76-116	NS
420	410 412.0-412.3 413	410-414	Coronary heart disease and sudden death	76	138.3	55	43- 69	<.001	121	128.6	94	78-112	NS
782.4 795.2	782.4 795	798.1											
			Other cardiovascular	30	35.8	84	56-120	NS	94	95.8	98	79-120	NS
			All cardiovascular	136	207.8	65	55- 77	<.001	307	321.5	95	85-107	NS

Table 10. SMR of cancer, cardiovascular and other deaths in 7173 Seventh-Day Adventists in Norway 1962 to 1986 by sex and age of entering the church.

	Men							Women						
		Cancer		Cardiovascular disease		Other			Cancer		Cardiovascular disease		Other	
Age at entry	Person-years	No. dead	SMR	No. dead	SMR	No. dead	SMR	Person-years	No. dead	SMR	No. dead	SMR	No. dead	SMR
<19	15874	16	88	19	43	26	88	24720	26	75	36	51	22	57
19-34	13384	38	67	121	77	47	68	24774	73	79	207	79	135	107
35+	10808	113	107*	303	92**	132	96	27729	198	116**	661	107***	303	105†

Test for linear trend in SMR:
* :p<0.05
** :p<0.01
***:p<0.001

Test for homogeneity of SMR:
† :p<0.05

Table 11. Observed and expected number of deaths by type of follow-up. Seventh-Day Adventists in Norway in the time period 1962 to 1986.

Study design	Obs.	Exp.	SMR
Follow-up from entry, censoring when leaving the church	2476	2650.5	93
Follow-up from one year after entry, censoring when leaving the church	2442	2623.5	93
Follow-up from entry, leavers not censored before death	2704	2762.5	98
Follow-up from 10 years after entry, censoring 10 years after leaving the church	2228	2371.2	94

Table 12. Mortality rate in Norway(1985), Norwegian Seventh-Day Adventists(1962-1986) and Japan(1986) by sex and age-group.

Age group	Norway 1985	All Seventh-Day Adventists 1962-1986	Seventh-Day Adventists entering church before 19 years of age 1962-1986	Japan 1986
Men:				
45-54	544.0	351.1	479.0	478.5
55-64	1474.9	996.6	755.3	1052.5
65-74	3743.5	2895.5	1195.3	2749.9
Women:				
45-54	270.2	284.7	61.0	226.4
55-64	677.1	693.7	456.2	500.4
65-74	1793.4	2035.5	1170.4	1431.0

ISM SKRIFTSERIE - FØR UTGITT:

1. Bidrag til belysning av medisinske og sosiale forhold i Finnmark fylke, med særlig vekt på forholdene blant finskættede i Sør-Varanger kommune.
Av Anders Forsdahl, 1976. (nytt opplag 1990)

2. Sunnhetstilstanden, hygieniske og sosiale forhold i Sør-Varanger kommune 1869-1975 belyst ved medisinal-beretningene.
Av Anders Forsdahl, 1977.

3. Hjerte-karundersøkelsen i Finnmark - et eksempel på en populasjonsundersøkelse rettet mot cardiovasculære sykdommer. Beskrivelse og analyse av etterundersøkelsesgruppen.
Av Jan-Ivar Kvamme og Trond Haider, 1979.

4. The Tromsø Heart Study: Population studies of coronary risk factors with special emphasis on high density lipoprotein and the family occurrence of myocardial infarction.
Av Olav Helge Førde og Dag Steinar Thelle, 1979.

5. Reformer i distriktshelsetjenesten III: Hypertensjon i distriktshelsetjenesten.
Av Jan-Ivar Kvamme, 1980.

6. Til professor Knut Westlund på hans 60-års dag, 1983.

7. Blodtrykksovervåkning og blodtrykksmåling.
Av Jan-Ivar Kvamme, Bernt Nesje og Anders Forsdahl, 1983.

8. Merkesteiner i norsk medisin reist av allmennpraktikere - og enkelte utdrag av medisinalberetninger av kulturhistorisk verdi.
Av Anders Forsdahl, 1984.

9. "Balsfjordsystemet." EDB-basert journal, arkiv og statistikksystem for primærhelsetjenesten.
Av Toralf Hasvold, 1984.

10. Tvunget psykisk helsevern i Norge. Rettsikkerheten ved slikt helsevern med særlig vurdering av kontrollkommisjonsordningen.
Av Georg Høyer, 1986.

11. The use of self-administered questionnaires about food habits. Relationships with risk factors for coronary heart disease and associations between coffee drinking and mortality and cancer incidence.
Av Bjarne Koster Jacobsen, 1988.

12. Helse og ulikhet. Vi trenger et handlingsprogram for Finnmark.
Av Anders Forsdahl, Atle Svendal, Aslak Syse og Dag Thelle, 1989.

13. Health education and self-care in dentistry - surveys and interventions.
Av Anne Johanne Søgaard, 1989.

14. Helsekontroller i praksis. Erfaringer fra prosjektet helsekontroller i Troms 1983-1985.
Av Harald Siem og Arild Johansen, 1989.

15. Til Anders Forsdahls 60-års dag, 1990.

16. Diagnosis of cancer in general practice. A study of delay problems and warning signals of cancer, with implications for public cancer information and for cancer diagnostic strategies in general practice.
Av Knut Holtedahl, 1991.

17. The Tromsø Survey. The family intervention study. Feasibility of using a family approach to intervention on coronary heart disease. The effect of lifestyle intervention of coronary risk factors.
Av Synnøve Fønnebø Knutsen, 1991.

18. Helhetsforståelse og kommunikasjon. Filosofi for klinikere.
Av Åge Wifstad, 1991.

19. Factors affecting self-evaluated general health status - and the use of professional health care services.
Av Knut Fylkesnes, 1991.

20. Serum gamma-glutamyltransferase: Population determinants and diagnostic characteristics in relation to intervention on risk drinkers.
Av Odd Nilssen, 1992.