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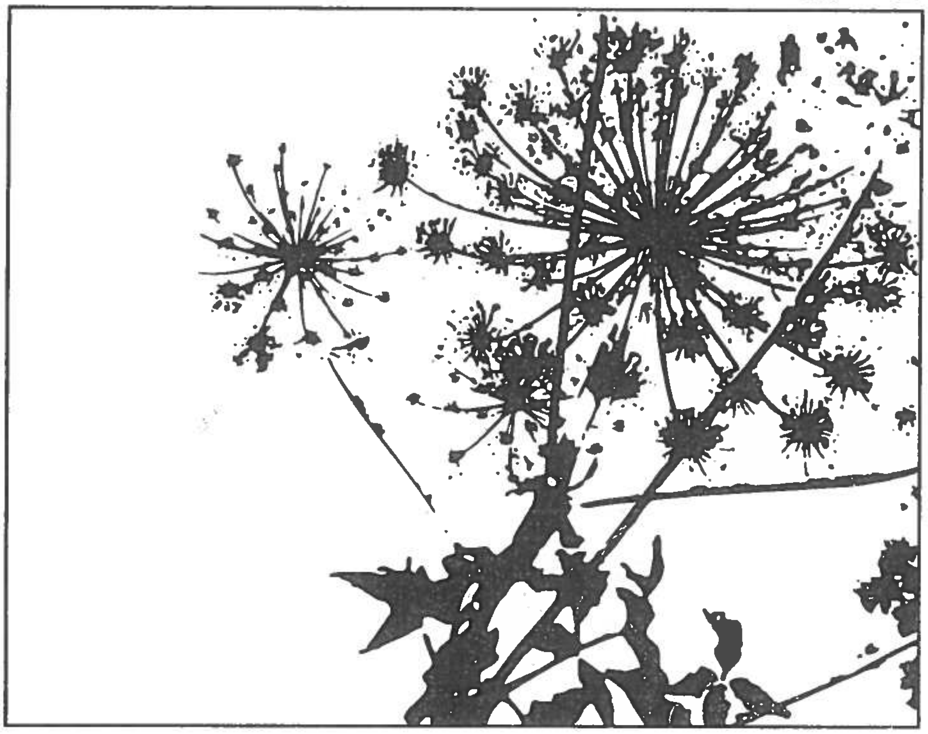

PHYSICAL ACTIVITY AND RISK OF CANCER

A population based cohort study including prostate, testicular, colorectal, lung and breast cancer

Inger Thune

Tromsø 1997

Institute of Community Medicine
University of Tromsø

The Norwegian Cancer Society

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All parts of the body which have a function, if used in moderation and exercised in labors in which each is accustomed, become thereby healthy, well developed, and age more slowly, but if unused and left idle they become liable to disease, defective in growth, and age quickly.

Hippocrates, 460-377 BC.

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Tromsø, February 1997

Inger Thune

LIST OF PAPERS

This thesis is based on the following papers, referred to in the text by their Roman numerals

I. Thune I, Lund E. Physical activity and the risk of prostate and testicular cancer: a cohort study of 53,000 Norwegian men. *Cancer Causes Control* 1994;**5**:549–556

II. Thune I, Lund E. Physical activity and risk of colorectal cancer in men and women. *Br J Cancer* 1996;**73**:1134–1140

III. Thune I, Lund E. The influence of physical activity on lung cancer risk. A prospective study of 81,516 men and women. *Int J Cancer* 1997;**70**:57-62

IV. Thune I, Brenn T, Lund E, Gaard M. Physical activity and risk of breast cancer. *N Engl J Med* 1997;**336**:1269-1275

V. Thune I, Njølstad I, Løchen M-L, OH Førde. Physical activity improves the metabolic risk profiles in men and women. A seven year follow-up study with repeated assessments of leisure time activity: The Tromsø Study. *Submitted for publication.*

CONTENTS

1 INTRODUCTION

During my childhood I was always instructed that I should be physically active in order to take care of my body, and this continued into my adulthood. The positive psychological and physiological advantages of physical activity were always emphasized. During my time at medical school and later through my contact with cancer patients, I started to wonder whether there is any relationship between physical activity and risk of cancer. In 1987, I came across an article by Frisch and colleagues[1] who had observed a lower prevalence of cancer of the breast and reproductive organs among former college athletes than among non-athletes. On completion of my medical internship, I considered whether there was any possibility of investigating further the relationship between physical activity and cancer risk. At that time, very few studies had elucidated this relationship, in contrast to many studies that were investigating the association between physical activity and cardiovascular diseases.

Strengthened by the belief that physical activity may influence cancer risk I applied for grants from the Norwegian Cancer Society in 1990. During my preparation for the application (Spring 1990), a search on Medline revealed that there were only seven studies world wide that focused on physical activity and cancer risk; this has now increased to 275 articles (Medline - December 1996).

Physical activity

Physical activity has been an important factor in the evolution of the modern human, *Homo sapiens*, 35 000 years ago.[2-3] The gene pool from which humans currently derive their individual genotypes was formed during a period of over a billion years of evolution.[4] Through a lifestyle of hunting and gathering, our genetic constitution was selected. The hunter–gatherers' way of life involves endurance activities with peak bouts of strenuous physical activity that involve considerable heat production. These patterns of physical activity continued mainly through the shift to agriculture 10,000 years ago. Such physiological adaptations suggest the importance of endurance activities in our evolutionary past; evaluation of recent preliterate populations confirms that their daily activities would have developed superior aerobic fitness.[5] The cultural changes, particularly those resulting from the Industrial Revolution, have outpaced any genetic adaptation. Consequently, a sedentary Western lifestyle could be giving modern *Homo sapiens* problems because we still carry genes for a physically active way of life. Therefore, from a genetic standpoint, humans of today are still hunters also reflected by that skeletal muscles constitutes some 40% of the body mass. The capacity to be active, whether defined by total energy expenditure or by intensity of effort, requires a state of physiological fitness. Thus, if we are sedentary and not physically active, we deteriorate. If we are active, physical activity alters the effects of other influences on our health: our cardiovascular–respiratory physiology, our musculoskeletal strength, our gastrointestinal function, and even our state of mind. Rammazzini[6] made an extraordinary observation nearly 300 years ago: sitting tailors were more sickly and paler than scurrying messengers. Thus, regular exercise is essential for optimal function of the body.[7]

Physical activity is a complex behaviour; it can be defined as 'any bodily movement produced by skeletal muscles that results in energy expenditure'.[8] Exercise is a subset of physical activity defined as 'planned, structured, and repetitive bodily movement done to improve or maintain one or more components of physical fitness', whereas physical fitness is 'a set of attributes that people have or achieve that relates to the ability to perform physical activity'.[8]

The general view is that there must be a minimum exercise intensity necessary to stimulate any improvement in physical fitness. This minimum was exemplified recently as amounting to a minimum of exercise intensity of at least 50% of the maximum oxygen uptake or at least 60% of the maximum heart rate.[9] An alternative to this minimum is the accumulation of total energy expended in exercise over a certain timespan, including not only intensity of exercise.[10] This could mean that even less time than the recommended 30 minutes of moderate physical activity daily may be enough when either the intensity is high or made up of shorter bouts with accumulated duration, whereas longer duration may be necessary for low exercise intensity to increase physical fitness.[10]

An individual' s propensity to be physically active may be inherited,[11-12] although sociocultural factors are supposed to be of greater importance in physical activity behaviour than genetic factors[12] and the genetic component has been estimated to cover about 30% of the aerobic capacity.[12] Men in the lower social classes have been observed to spend less leisure time being active and to be more active at work than men in the higher classes.[13]

Assessments of physical activity

In any scientific work, it is necessary to have precise, reliable and practical assessment of the variable being studied. More than 30 different techniques have been employed for assessing physical activity in population studies[14] and these have been described in different categories.[14-15]

A Direct

1 Questionnaire assessment

The two data collection methods used in relation to physical activity questionnaires[16] are interview[17-18] and self-administration.[19-20] The participants report varying degrees of detailed recall of activity, ranging from a recall of physical activity during one day,[21-22] to specific activity over the last week[23-24] to recall of specific activities during both work and leisure time over the past year[20, 25] or during different periods in life.[26] Questionnaires are practical means of measuring physical activity of large populations and are therefore widely used in population studies.[27-28]

Assessment of physical activity by questionnaires in different clinical and epidemiological studies has resulted in both similarities and differences across published systems. As a consequence of differences that limit the comparability of results, Ainworth et al.[29] developed *a compendium of physical activities* for calculating energy expenditure related to one specific activity, to facilitate the coding of physical activities and to promote comparability of coding across studies. All activities are assigned an intensity unit based on their rate of energy expenditure, expressed as METs where one MET is the resting metabolic rate. It is also defined as the energy expenditure for sitting quietly; for the average adult this is approximately 3.5 ml oxygen per kg body weight per min or 1 kilocalorie (kcal) per kg body weight per hour. Only data for adults are included in these calculations. In this way a physical activity index for estimating the total energy in kilocalories expended each week in activity can be obtained, by multiplying the MET score by the duration of workout, body weight in kilograms and frequency per week.

2 Diary surveys

These give detailed information about physical activity on a specific day.[14] This method has seldom been used in epidemiological studies of physical activity, although it has been used in energy balance studies. A diary may be used to compare other estimates of total daily energy expenditure, i.e. through caloric intake,[23] or in validation of a physical activity questionnaire.[23] This method is precise but time-consuming and expensive. In addition, a participant's activity pattern may easily be altered as a result of the recording process.

3 Mechanical and electronic montoring

Heart rate may reflect both intensity and duration of physical activity. It has therefore been used indirectly as a measure of physical activity in validating surveys of physical activity questionnaires.[30-31]

Motion sensors provide measurements of 'movements', primarily through pedometers, and record the acceleration and deceleration of movements. This instrument has mainly been used on a small scale, but recently Sequeria at al.[32] observed that it was important for comparison in a questionnaire of a population survey.

4 Behavioural observation

This has been developed by behaviourists, but is impractical in population studies.[14]

B Indirect

1 Calorimetry

This is measured directly through the production of heat or indirectly through the consumption of oxygen; these correlate closely with heat production but have little use in assessing physical activity in a general population.[14] Resting energy expenditure, as determined by indirect calorimetry, has, however, been used in validation studies of physical activity questionnaires.[33]

2 Caloric intake

This may be an estimate of energy expenditure and, hence, of physical activity, if one assumes that energy balance has been achieved with stable body weight. This method has therefore been used in validation of physical activity questionnaires[23, 33] However, dietary measures of physical activity are unable to identify the types, frequency, intensity or duration of physical activities.

3 Physiological markers of physical activity

Physical fitness assessment

Maximal oxygen uptake Vigorous physical activity has an influence on cardiorespiratory endurance. Hence, maximum oxygen consumption has frequently been used for estimating physical fitness[9, 11, 34] and validating self-reported physical activity.[35-36]

Maximal or submaximal work capacity This test can be performed on a bicycle that has an initial workload, with increments being made after a certain time. Physical fitness is defined as the maximum workload possible.[37-38]

Heart rate Both heart rate measured in a graded exercise test[24] and that at rest[30] have also been used as a surrogate measure of physical activity; this has the advantage of no recall or reporting bias.

Other assessments

Various others methods have been used to assess cardiorespiratory fitness, including the duration of a graded, submaximal or maximal exercise test.[39] In a technique using doubly labelled water,[14] energy expenditure over time can be measured. Participants are given water containing isotopically labelled hydrogen and oxygen atoms to drink. Then the relative proportions of metabolized and non-metabolized water provide an overall estimate of energy expenditure. In field testing, a method in which the participants are asked to walk or run for a certain time or distance, physical performance capacity is converted to aerobic capacity.[40]

4 Sports and recreational participation

This has the possibility of distinguishing between high and low levels of a specific activity; it was used by Frisch and colleagues when they compared non-college athletes with college athletes, in relation to the risk of life-time occurrence of breast and reproductive cancer.[1] Limitations are selection bias and omission of occupational physical activity, among others.

5 Job classification

Ranking jobs according to levels of physical activity has been used in many studies.[41-43] There are several limitations, because of within-job classification, selection bias and omission of leisure time activity. In addition, the variability between job categories is declining as a result of the decline in manual work.

Physiological effects

Energy balance–weight control

Physical activity correlates strongly to weight gain in the general adult population.[28] Differences in physical activity represent the largest source of variability in energy requirements, both within and between individuals. The primary components of total daily energy expenditure include resting (basal) metabolism (approximately 50–75%), physical activity (15–40%) and thermic effects of food (< 10%).[44] Basal metabolism is an almost linear function of lean body mass and is the energy expenditure measured in a resting subject after an overnight fast; it approximates to the minimum energy expenditure necessary for maintenance of critical body functions (i.e. internal work).

Total and specific cancer incidence correlated fairly well with body weight in an ecological study of 24 populations[45] and increased body mass index has been observed as a risk factor for colon cancer[17, 46] and breast cancer.[47-48] Weight gain during adult life has been observed to be a predictor of breast cancer risk.[48-49] Physical activity also influences the net available energy, and experimental studies have demonstrated that calorie restriction inhibits mammary[50-51] and colon carcinogenesis[52] and reduces proliferative activity in rodent mammary glands.[53] Consequently, any change related to energy balance can potentially disrupt the steady state of energy and macronutrient balance, inducing weight fluctuations, which are both of importance in carcinogenesis.

Bowel transit time

The normal transit time through the colon shows considerable variation among individuals[54] and between the sexes.[55] Physical activity can reduce gastrointestinal transit times.[54, 56] Consequently, exposure time of the colon mucosa and potential carcinogens in the faecal stream may be decreased by exercise.

Hormonal levels

Levels of cyclic oestrogen and progesterone seem to be related to risk of breast cancer.[57] Physical activity has been observed to reduce the cumulative exposure to both cyclic oestrogen and progesterone in women [58-59] and to influence testosterone level in men.[60-61] Hard training and moderate leisure activity may both decrease oestradiol and progesterone secretion,[62-63] as well as inducing anovulation [59, 63] or causing secondary amenorrhoea.[64]

High levels of testosterone have been observed to be important in the prostate cancer risk,[65-67] and also levels of testosterone within normal endogenous ranges have been associated with an increased risk of prostate cancer.[67] Athletes have been shown to have lower levels of testosterone [68-69] and post-exercise levels of testosterone may be temporarily lower.[60, 70]

Lung function

Physical activity improves pulmonary capacity. A measure of pulmonary function, the forced expiratory volume in one second adjusted for height (FEV_1/height), correlates positively with strenuous physical activity and duration of exercise.[71-72] Increased pulmonary ventilation and perfusion could reduce the interaction time and concentration of any carcinogenic factor in the airways.

Trauma

Physical activity may induce injury. Regeneration and increased cell division have been hypothesized as a cause of human cancer.[73] Trauma has been associated with increased risk for testicular cancer[74] and intracranial meningiomas.[75]

Immune response

In 1902, after the Boston Marathon, a leucocytosis had already been found in a small group of runners.[76] Recent studies have revealed that immune parameters are altered after an acute bout of physical activity[77-78] or result from a long-term effect[79-80] of physical activity. Moderate exercise training has been observed to increase serum globulins[81] and enhance natural killer cell activity[79-80] in trained subjects. In contrast, over-training may decrease both the resting level of immune function and the responses to acute exercise stress.[82] Exercise also results simultaneously in many other systemic changes, such as changes in neuroendocrine function and increased blood flow. Does physical activity *de novo* therefore influence the immunity or does it occur only through other physiological parameters? Recent studies may indicate a relationship of physical activity and natural immunity that is important for cancer risk.[80]

Serum lipids

Numerous cross-sectional and interventional studies have observed lower concentrations of total cholesterol and triglycerides[83-85] and higher concentration of high-density lipoprotein-cholesterol (HDL-cholesterol)[85] in physically active compared with inactive individuals. Triglycerides are known to displace oestradiol from its tight binding to sex hormone-binding globulin (SHBG), thus increasing free oestradiol. SHBG is found in low levels in obese women.[86]

Other factors

One of the most striking effects of increased physical activity, cardiovascular adjustments, may result in an increased capacity for local and central blood flow. This may in turn induce an increase in transport and removal of possible carcinogenic agents from the blood and tissues. Further high levels of physical activity may increase sensitivity to insulin[87]; recently, this has been suggested as important in carcinogenesis of the colon[47] and the breast.[88]

Cancer incidences, prognoses and geographical variations

Prostate cancer is the most frequent cancer among men in Norway, contributing 22.7% (2,236 cases) of all cancer cases diagnosed in men in 1993.[89] Comparing the age-adjusted incidence rate during 1954–58 with that of 1989–93, the incidence rate increased from 26.3 to 46.6 per 100,000 person-years. Among those diagnosed, 27.1% of the cases in 1993 were under the age of 70. The national 5-year survival rate for all ages and stages combined was 58% in 1986–90.[89] There has been an increase in cause-specific mortality, signifying a genuine increase in incidence over time, not only resulting from increased detection rates.[90] Geographical differences in incidence rates world wide demonstrate that Asia is a low-risk area, and North America and Scandinavia are high-risk areas.[91] The age-adjusted incidence rate during 1989–93 varies in the geographical regions of Norway studied, with Oslo being the high-risk area with 52.4 per 100,000 person-years and Finnmark the low-risk area with 34.2 per 100,000 person-years. Although aetiological factors are mainly unknown, these observations point to a potential role for lifestyle factors in the carcinogenesis of prostate cancer.

Testicular cancer was diagnosed in 1.9% of all cancer cases in 1993 (n = 189).[89] There has been a 2.5 times increase in the annual age-adjusted incidence rates in Norway in all age groups, from 3.3 during 1954–58 to 8.2 cases during 1989–93 per 100,000 person-years. In 1986–90, the national 5-year survival rate for all ages and stages combined was 95%.[89] Both the national[89] and the worldwide geographical variation,[92] combined with the increase in incidence over time, indicate that environmental factors could explain these patterns.

Colon cancer was diagnosed among 9.5% of cancer cases in 1993 (n for men = 817, n for women = 980).[89] The age-adjusted incidence rate increased twofold in both sexes from 1954–58 to 1989–93: from 11.4 to 23.8 per 100,000 person-years in men and from 11.0 to 20.0 per 100,000 person-years in women. Among those diagnosed in 1993, 39.5% and 33.4% of the cases were diagnosed under the age of 70 in men and women, respectively. The age-adjusted incidence rate during 1989–93 varies for the geographical regions studied, because Sogn og Fjordane and Oslo have 2.3 times higher incidence rates than Finnmark for both sexes.[89] Migration studies and geographical variation world wide points to environmental factors of importance to explain the increase in incidence rates world wide.[91,93-94] In

1986–90, the national 5-year survival rate for all ages and stages combined was 49% and 53% in men and women, respectively.[89]

Rectal cancer was diagnosed in 5.1% of all new cancer cases in 1993 (*n* for men = 533, *n* for women = 429).[89] The age-adjusted incidence rate increased from 1954–58 to 1989–93: from 7.5 to 14.9 per 100,000 person-years in men and from 5.1 to 10.0 per 100,000 person-years in women. Among those diagnosed in 1993, 42.8% and 41.3% of the cases were diagnosed under the age of 70 in men and women, respectively. In 1986-90, the national 5-year survival rate for all ages and stages combined was 48% and 53%, in men and women, respectively.[89]

Lung cancer was diagnosed in 9.2% of all new cancer cases in 1993 (*n* for men = 1,216, *n* for women = 536) and is the second most frequent cancer among men and the third most frequent in women in Norway.[89] The age-adjusted incidence rate increased from 1954–58 to 1989–93: from 11.8 to 35.3 per 100,000 person-years in men and from 3.1 to 13.7 per 100,000 person-years in women. Among those diagnosed in 1993, 51.8% and 58.4% of the cases were diagnosed under the age of 70 in men and women, respectively. There has recently been an observed shift towards adenocarcinoma as the most frequent histological type.[95] In 1986–90, the national 5-year survival rate for all ages and stages combined was 9% and 10% in men and women, respectively. The age-adjusted incidence rate during 1989–93 varies for the geographical regions studied, with Finnmark and Oslo being the high-incidence areas (41.1 and 19.6 per 100,000 person-years in men and women, respectively in Oslo), whereas Oppland is a low incidence area with 28.4 and 8.9 per 100,000 person-years in men and women respectively. World wide, lung cancer is by far the most common cancer of men.[91]

Breast cancer is the most frequent cancer among women in Norway, contributing 22.3% of all cancer diagnosed in women in 1993 (*n* = 2,035).[89] Comparing the age-adjusted incidence rate from the period 1954–58 with that of 1989–93, it increased from 43.6 to 58.6 per 100,000 person-years. Although 24% of the cases in 1993 were diagnosed under the age of 50, 61.9% of the cases in women were diagnosed under the age of 70. In 1986-90, the national 5-year survival rate for all ages and stages combined was 76% in women. Breast cancer incidence rates varied in the geographical areas studied, with Finnmark being a low-incidence area;[89] the incidence rates varies among countries with a four- to sevenfold higher incidence rate in Western countries than in Japan.[89] This points to modifiable factors that are related to lifestyle.

2 AIMS OF THE THESIS

- The overall aim of this thesis was to elucidate any association between physical activity and the subsequent risk of some major types of cancer in the general adult population of Norway: prostate, testicular, colorectal, lung and breast cancer.
- Another aim was to examine whether physical activity at work had a different association to these cancer types than physical activity in leisure time.
- To investigate whether age, sex, body mass index and hormonal status (pre- and postmenopausal), on one side, and lifestyle-related factors such as smoking and dietary factors, on the other, strengthen or reduce these observed associations.
- Could repeated assessments of physical activity induce stronger or weaker risk estimates?
- If any associations between physical activity and risk of cancer were observed, then these associations were investigated to ascertain if these could indicate a causal relationship.
- To study if changes in physical activity or sustained physical activity influence metabolic profiles to any large extent, which would support physical activity as a potent biological mediator of importance in reduction of risk for chronic diseases, e.g. cancer?

3 SUBJECTS AND METHODS

This thesis is based on population-based health surveys, originally used in screening for cardiovascular diseases, which were carried out in five geographical areas in Norway: three counties (Finnmark, Oppland and Sogn og Fjordane) and two cities (Oslo and Tromsø). The participants in this thesis were born between 1922 and 1959. The first surveys were carried out between 1972 and 1978 with repeated surveys between 1977 and 1987 in the three counties and one city.

The study population

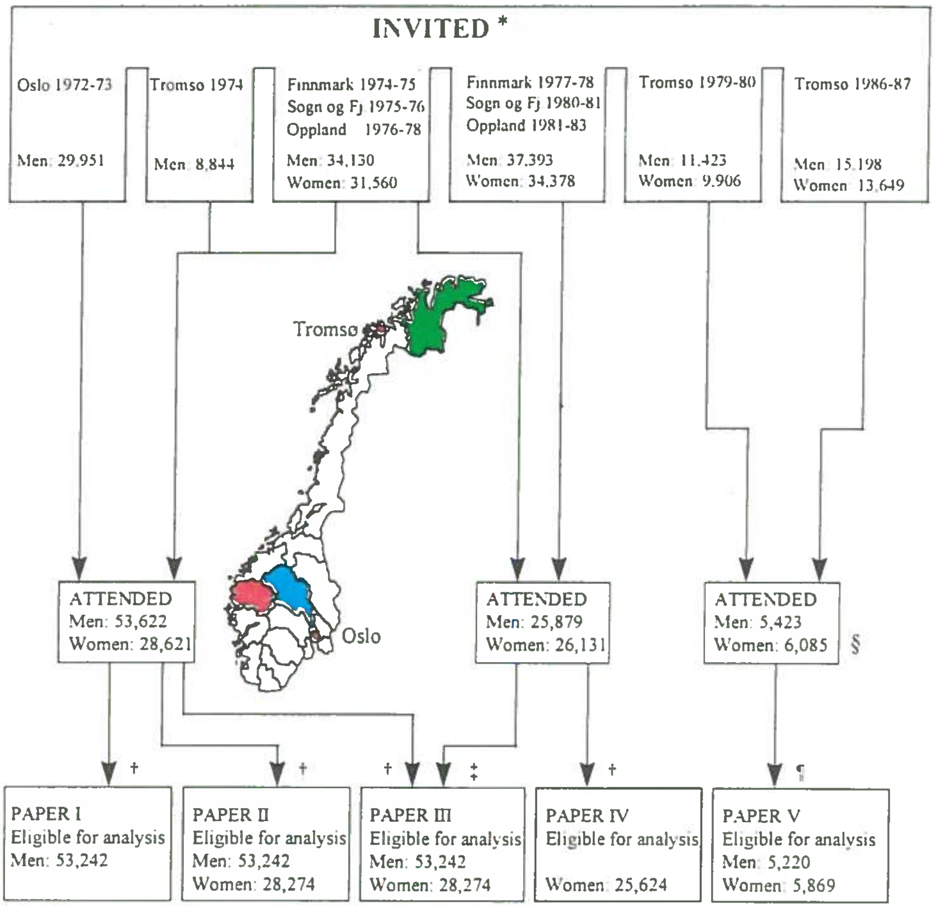
Papers I, II, III and IV

A total of 72,925 men and 31,560 women, who were residents of five geographical areas of Norway (three counties of Finnmark, Oppland and Sogn og Fjordane, and the two cities of Oslo and Tromsø) were invited to participate in a population-based health survey between 1972 and 1978 (Fig 1). In the three counties (Finnmark 1974–75, Sogn og Fjordane 1975–76 and Oppland 1976–78), all men and women aged 40–49 years, and a random sample of people aged 20–34, were invited. In four small municipalities in Finnmark, all men and women aged 20–34 were invited.[96] In Tromsø in 1974,[97] all men aged 20–49 were invited, whereas in Oslo 1972–73, men aged

40–49, plus a 7% random sample of men aged 20–39, were invited.[25]

If attendance is defined as being registered as participating, 53,622 men (attendance rate = 73.5%) and 28,621 women (attendance rate = 90.7%) attended these surveys. Paper I comprises 53,622 men only, whereas papers II and III include both sexes.

Fig. 1 The number of people invited* and eligible for analysis in papers I–V.



* Invited; included persons who appeared without invitation

† Excluded persons with a pre-existing malignancy or got a malignant disease within the first year

‡ Subcohort lung

§ Included persons aged 20-49 years at entry 1979-80 and participating at both surveys (1979-80 and 1986-87)

¶ Excluded persons with previous myocardial infarction, stroke, diabetes and those with missing information about leisure time activity

In the counties of Finnmark (1977), Sogn og Fjordane (1980) and Oppland (1982–83), 3–5 years after the first survey men and women were invited to a similar second health survey.[98] Men and women who attended both surveys in the three counties (men: *n* = 25,879; women: *n* = 26,131) represent a subcohort in paper III. A food- frequency questionnaire was given to those men and women who attended the second survey, to be completed at home and returned by mail. This food-frequency questionnaire was returned by 26,090 men and 25,892 women. Women participating in both surveys in the three counties provided the study population for paper IV.

Paper V

Paper V included men and women who were residents of Tromsø and who participated in two population surveys carried out in the municipality of Tromsø in the 1979–80 and the 1986–87 surveys.[99] In the 1979–80 survey, men aged 20–54 years and all women aged 20–49 years were included and this made up a total of 21,329, of whom 16,621 attended (78%). The total number of individuals examined at the 1986–87 surveys was 21,826, 81.3% of the eligible population. Men (*n* = 5,423) and women (*n* = 6,085) aged 20–49 years in 1979–80 and who attended both surveys were included in paper V.

Screening procedures

Surveys 1972-78

The screening procedures for the first surveys were almost identical in the five geographical areas and are described in detail elsewhere.[25, 96-97] Each person was initially contacted by mail with a cover letter and a one-page questionnaire on the reverse side (Appendix I). The participants were asked to answer the questionnaire at home and bring it to the screening examination, which then included the following elements used in the present thesis.

I A questionnaire which comprised:

A – History of cardiovascular disease, diabetes and treatment for hypertension

B – Symptoms possibly caused by coronary or peripheral athero-sclerosis

C – Physical activity during leisure time

D – Smoking habits

E – Conditions at work (physical activity) and stress in social life

F – Ethnic origin (Tromsø and Finnmark)

G – Family history of cardio-vascular disease (all counties and Tromsø)

II Measurement of height and weight performed by standardized methods

III A non-fasting blood sample.

The questionnaire was checked by trained nurses, and omissions and logical inconsistencies were corrected according to a written protocol. While checking the questionnaire, the nurses also asked everyone about the time since the last meal and women about menstrual status and pregnancy.

Follow-up surveys

The Norwegian Counties

Those participants in the counties, Finnmark (1977–78), Sogn og Fjordane (1980–81) and Oppland (1981–83), still resident in the county, together with an additional random sample aged 20–39, were invited to a similar second survey 3–5 years later (1977–83). Each person was initially contacted by mail with a cover letter and a one-page questionnaire (almost identical to the first survey; see Appendix II). Each municipality was surveyed at the same time of year as in the first survey. All attendees were given a food-frequency questionnaire to be completed at home and returned by mail (see Appendix III).

Tromsø

In the municipality of Tromsø, the 1979–80 survey of the procedures were mainly the same[99] as in the 1974 survey.[96] The main questionnaire (see Appendix II) covered the same aspects as in 1974 and, in addition, each participant was given a second questionnaire (see Appendix IV) that they were asked to complete at home and return by mail. This questionnaire was a combined food-frequency questionnaire and a questionnaire about previous and present chronic diseases, other than those covered in the first questionnaire, illness in parents and siblings, or psychosocial conditions. At screening, the main questionnaire was checked for inconsistencies by trained nurses; measurements of height, weight, blood pressure, heart rate and serum lipids have been presented (see paper V).

The 1986–87 survey was set up by the same institutions as those involved in the 1979–80 survey. The main questionnaire (see Appendix V) covered the same aspects as those in 1974 and 1979–80. In addition, each participant was given a second questionnaire (see Appendix V) that they were asked to complete at home and return by mail. At screening, the main questionnaire was checked for inconsistencies by trained nurses; measurements of height, weight, blood pressure, heart rate and serum lipids have been presented (see paper V).

The National Health Screening Service

As the service with the responsibility for tuberculosis screening since 1943, the State Mass Radiography Service, now called the National Health Screening Service (NHHS), organized the main parts of these surveys in the counties, except for the survey in Oslo; they used a mobile unit in collaboration with the County Medical Officers. They were also central in organizing the surveys in Tromsø in collaboration with the University of Tromsø and the Tromsø Health Council.

Reminder

No reminders were sent out in Oslo and, in the counties also no-one received any reminders, although the survey was backed up by the local newspapers, radio and the local health council nurse, all of whom co-operated.[96] In Tromsø one reminder was sent for each survey.

Ascertainments of variables

The main questionnaire, which also covered physical activity, was filled in at home by all subjects and checked at screening for inconsistencies; this meant that data were complete.

Participants were asked to answer the questions based on an average of performed physical activity over the last year. They marked *'yes'* for the level that fitted best.

Leisure time physical activity was divided into:

1 Reading, watching TV or other sedentary activity
2 Walking, bicycling for at least 4 hours a week
3 Participating in recreational athletics for at least 4 hours a week
4 Participating in hard training or athletics competitions, regularly, several times a week.

Work activity was divided into:

1 Mostly sedentary work, e.g. office work, watchmaker
2 Work involving a lot of walking, e.g. shop assistant, light industrial work
3 Work involving a lot of walking and lifting, e.g. postal worker, heavy industrial work
4 Heavy manual labour work, e.g. forestry work, heavy farm work.

Physical fitness was measured in a subpopulation in Tromsø and has been described previously[37] (paper V). A graded submaximal or maximal bicycle exercise test, with pedalling frequency of 60 per min, was carried out in a random subgroup in the 1986–87 survey. The initial workload was set at 25 watts(W), with a 25 W increment every minute up to a maximum of 250 W after 10 minutes. The tests were stopped prematurely if exhaustion, or symptoms such as leg pain and angina, made it necessary.[37] Physical fitness was defined as the maximum possible work load.

Heart rate is derived from the median pulse-to-pulse interval during the measurement of blood pressure. Three recordings of heart rate were made at 2-minute intervals, and the lowest measurement recorded was used (see paper V).

A semi-quantitative food-frequency questionnaire was designed by a section for dietary research at the University of Oslo; it was used in Finnmark, Oppland and Sogn og Fjordane. The questionnaire requested information on the usual consumption of 80 items. In most of the items, amount or units consumed one each occasion were requested. Among 50 questions, 31 were sufficiently specific to enable an estimation of energy and fats according to the Norwegian Food

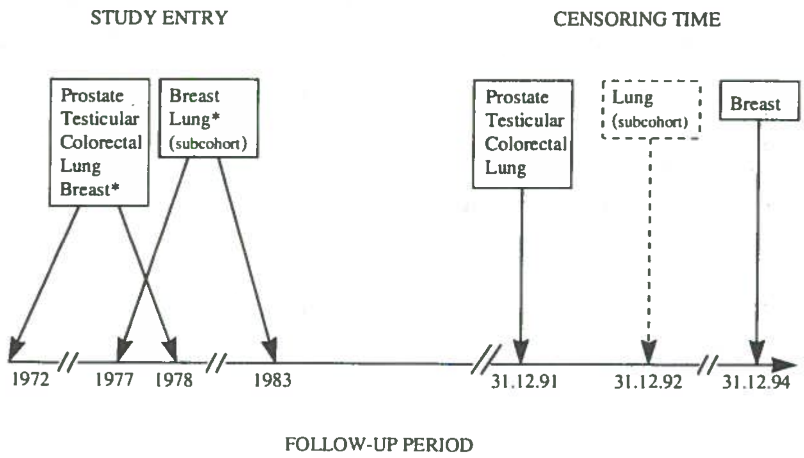
Composition table.[100] These comprised milk, potatoes, bread, spreads (cheese, meat, jam, salads), fats on bread, fat in cooking, a range of meat and fish meals, cakes, eggs, oranges, porridge, cod-liver oil and vitamin pills. The energy and fat intake for each woman was derived as the sum of all foods consumed.[101]

In Tromsø, participants answered a somewhat shorter food-frequency questionnaire comprising information about both type and quantity of bread, fruit and vegetables, type of fat used at table, the type of milk normally used, the amount of fat on each slice of bread, the number of glasses of milk and cups of coffee, and the consumption of alcohol (see Appendices IV and V).

The questionnaire used in the Oslo study had pre-set groups for number of cigarettes smoked per day and packs of pipe tobacco smoked per week (see Appendix I). Otherwise, people were asked to give their average daily consumption rather than specify a pre-set group (see Appendix I).

Height and weight were measured in light clothing with no shoes. Height was measured to the nearest centimetre and weight to the nearest half kilogram, on regularly calibrated scales. A non-fasting venous blood sample was taken for analysis.[25, 96-99]

Fig 2. The follow up period with study entry (assessment of physical activity) and censoring time of cancer (prostate, testicular, colorectal, lung and breast)



*analysing the effect of repeated assessment of leisure time physical activity

The Central Population Register at Statistics Norway has been recording the reproductive history of every women, including date of first liveborn child, which was used in paper IV. The national 11-digit personal identification number enabled linkage to Statistics Norway.

Identification of cases

In Norway there is mandatory reporting of cancer by all physicians, hospital departments and via copies of pathological reports to the Cancer Registry of Norway. This ensures almost complete registration of incident cases of cancer.[102] In addition, four times a year, all death certificates mentioning cancer are forwarded to the Cancer Registry of Norway. The national 11-digit personal identification number has enabled this linkage, resulting in close to 100% histological verification of every incident case of cancer of the prostate, testes, colon, rectum, lung and breast in the present studies.

Identification of death and emigration

In Norway all deaths are by law recorded through certification from physicians; they are further recorded at Statistics Norway. All emigrations are also recorded here, the national 11-digit personal identification number enabling linkage to Statistics Norway. Information about death and emigrations were used in papers I–IV when calculating the observation years at risk in these papers.

Statistical methods

All analyses were sex specific. Baseline characteristics were age adjusted and compared across levels of leisure and categories of work activity by analyses of co-variance.

Person-years at risk of developing cancer (Fig. 2) of the prostate, testes, colon, rectum, lung and breast were calculated as the number of years from entry into the study until the time of withdrawal (year of diagnosis of cancer, time of death or end of follow-up on 31 December 1991 for prostate/testicular/colon/rectum/lung cancer, 1992 for the subcohort of lung cancer, or 1994 for breast cancer, whichever event was the earliest).

Cox's proportional hazards analysis was used to investigate the associations of leisure, work or total physical activity with the risk of certain types of cancer in the cohort (papers I–IV). Incident cases of prostate, testicular, colon, rectal, lung or breast cancer were defined as outcome events. Confidence intervals (95%) were estimated. The fit of the models was examined by plotting the hazards; the results indicated that the application of the models was appropriate.

Analysis of co-variance was used when comparing differences and changes in serum lipids and BMI in leisure time sedentary and active attendees over the 7 years of follow-up (paper V).

All tests of significance were two sided and the significance level was chosen at 5%. These analyses were performed with the SAS Statistical package version 6.11.[103]

4 MAIN RESULTS

Paper I: *Physical activity and the risk of prostate and testicular cancer: a cohort study of 53,000 Norwegian men*

A reduced, adjusted, relative risk (RR) of prostate cancer was observed among men who walked during occupational hours and performed either moderate recreational activity (RR = 0.61; 95%CI = 0.36–1.01) or regular training (RR = 0.45; 95%CI = 0.20–1.01), relative to sedentary men (*p* for trend = 0.03). In contrast, no association was observed between physical activity and the risk of testicular cancer. However, the number of cases of testicular cancer were small, limiting the statistical power of the study.

Paper II: *Physical activity and risk of colorectal cancer in men and women*

Among women, total physical activity (work and leisure combined) was inversely associated with colon cancer risk with a dose–response relationship (*p* for trend = 0.04). The reduction in colon cancer risk in women was particularly related to recreational physical activity. This was particularly evident with cancer of the proximal colon showing a greater reduction when recreationally active women were compared with sedentary women (RR = 0.51; 95%CI = 0.28–0.93). Among men aged 45 years or over at entry to the study, an inverse dose–response effect was observed between total physical activity and colon cancer risk (*p* for trend = 0.04). This association was not observed for those men younger than 45 years at entry.

Furthermore, there was a reduced risk among recreationally active, non-obese (< 23.6 kg/m^2) women compared with sedentary non-obese (< 23.6 kg/m^2) women (RR = 0.45; 95%CI = 0.25-0.82). This study also suggests an effect modification by body mass index (BMI) among men because occupationally active men aged over 45 years at entry, in the lowest tertile of BMI (< 23.3 kg/m^2), had a reduction in colon cancer risk (RR = 0.50; 95%CI = 0.26-0.97). No association was observed between physical activity and rectal cancer in men or women.

Paper III: *The influence of physical activity on lung cancer risk: a prospective study of 81,516 men and women*

Leisure but not work activity was inversely related to lung cancer risk in men after adjustments had been made (*p* for trend = 0.01). Men who exercised at least 4 hours a week had a lower risk than men who did not exercise (RR = 0.71; 95%CI = 0.52–0.97). Reduced risk of lung cancer was particularly marked for small cell carcinoma (RR = 0.59; 95%CI = 0.38–0.94), less for adenocarcinoma (RR = 0.65; 95%CI = 0.41–1.05), with no association seen for squamous cell carcinoma. When physical activity was assessed twice in a subcohort after 3–5 years, the risk of lung cancer was particularly reduced among men who were most active at both assessments (RR = 0.39; 95%CI = 0.18–0.85). The small number of incident cases, combined with the narrow range of physical activity reported, may have limited our ability to detect an association between physical activity and lung cancer in women.

Paper IV: *Physical activity and risk of breast cancer*

Leisure time activity reduced the overall risk of breast cancer, after adjustments for age, body mass index (BMI), height, parity and geographical region; relative risk declined to 0.93 (0.71–1.22) and further to 0.63 (0.42–0.95) across increasing levels of leisure activity (*p* for trend = 0.04). Reduced risk was more pronounced in regularly exercising premenopausal relative to postmenopausal women and in younger (< 45 years at study entry) regularly exercising women (RR = 038; 95%CI = 0.19–0.79) relative to older ($\geq$ 45 years) women when compared with the respective sedentary groups. Reduced risk was particularly demonstrated in lean (lowest tertile, BMI < 22.8 kg/m^2) women who exercised at least 4 hours/week (RR = 0.28; 95%CI = 0.11–0.70). Repeated assessment of leisure time activity further confirmed this protective effect among non-obese, premenopausal women. Reduced risk was also observed in relation to work activity, especially for those who did heavy manual work compared with those whose work was sedentary (RR = 0.48; 95%CI = 0.25–0.92); there was a more pronounced effect among premenopausal than postmenopausal women.

Paper V: *Physical activity improves the metabolic risk profiles in men and women: a 7 year follow-up study with repeated assessments of leisure time activity – the Tromsø Study*

Both sustained levels and change in level of leisure time physical activity were found to influence body mass index and serum lipids in a dose–response fashion, in both sexes, after adjustments for potential con-founders. The differences of BMI and serum lipids between sustained sedentary and sustained exercising groups were consistently more pronounced after 7 years than at baseline, especially in the oldest age group. Men reporting sustained hard training, compared with sustained sedentary men, had the following: a lower concentration of Total-C (5.65 mmol/l vs 6.21 mmol/l) and triglycerides (1.34 mmol/l vs 1.85 mmol/l), a lower Total-C:HDL-C ratio by 19.0%, a lower BMI (23.9 kg/m^2 vs 25.7 kg/m^2) and higher HDL-C concentration (1.52 mmol/l vs 1.36 mmol/l). Women reporting sustained regular or hard training, compared with sustained sedentary women, had the following: a lower concentration of Total-C (5.70 mmol/l vs 5.90 mmol/l) and triglycerides (1.03 mmol/l vs 1.18 mmol/l), a lower Total-C:HDL-C ratio by 7.5%, a lower BMI (23.1 kg/m^2 vs 23.6 kg/m^2) and higher HDL-C concentration (1.73 mmol/l vs 1.66 mmol/l). An increase in leisure time activity over 7 years improved the metabolic profiles, whereas a decrease worsened them in both sexes. Heart rate and physical fitness (women) were used to validate physical activity; we observed a lower heart rate with increasing level of leisure time activity, and physical fitness increased with reported increase in activity level.

5 GENERAL DISCUSSION

This very large population-based cohort study included both leisure and occupational physical activity in men and women. This gives a comprehensive consideration of total physical activity for each individual. Although prospective cohort studies have many preferences compared with case-control studies, there are some limitations. Basic questions to consider are the accuracy of the physical activity questionnaire used, in addition to the degree of association between risk for site-specific cancer and physical activity; the extent to which the observed associations may result from bias, confounding or chance, and the extent to which they may be described as causal.

Most cancers are rare diseases and even with such a large cohort the number of some site-specific cancer cases in subgroups may be small, limiting the statistical power. As a result, the possibility of observing any associations between physical activity and testicular cancer in men and lung cancer in women could not be elucidated properly.

Assessment of physical activity

Self-reported questionnaires are an appropriate and practical method for the assessment of physical activity in large populations.[15] The physical activity questionnaire used in the present thesis was originally developed for male subjects,[35] then adapted for both men and women. The observations that heart rate decreased and physical fitness increased with increasing leisure time activity level (see paper V) support the fact that the questionnaire used is adequate for ranking the individuals to levels of leisure time physical activity when related to intensity. The ranking of levels of leisure time also seems to be valid in relation to energy expenditure (Table I), strengthening the comparability with other studies.[29]

Table 1 Energy expenditure estimates related to levels of leisure time activity during 4 hours/week in a participant weighing 80 kg

Leisure time activity	Energy expenditure (kcal)
Sedentary	320
Moderate	1280
Regular exercise	2560
Hard exercise	3200

Sedentary: inactive = 1 MET value/4 hours per week (1 MET x 80 kg body weight) x (x 4 (4 @ 60 min) = 320 kcal.
Moderate: walking/bicycling = 4 MET value/4 hours per week; (4 MET X 80 kg body weight) x (x 4 (4 @ 60 min)) = 1280 kcal.
Regular exercise: skiing = 8 MET value/4 hours per week; (8 MET x 80 kg body weight) x (x 4 (4 @ 60 min)) = 2560 kcal.
Hard exercise: running = 10 MET value/ 4 hours per week; (10 MET x 80 kg body weight) x (x 4 (4 @ 60 min) = 3200 kcal.

The questionnaire used has been observed to discriminate sedentary men who were former athletes from their still active counterparts with respect to maximal oxygen uptake.[35] A correlation coefficient of 0.39 was observed between leisure time physical activity and fitness in women.[37] These two observations support the finding that intensity of leisure time activity assessed is valid in relation to the reported leisure activity levels. Further, the association between changes in levels of physical activity and changes in BMI and serum lipids also supports the reproducibility of the present questionnaire (see paper V).

Comparing eight physical activity questionnaires, Albanes and colleagues[33] observed the questionnaires to be adequate for ranking individuals related to energy expenditure, as observed in the present study. Others have observed questionnaires to be more appropriate for assessing heavy intensity physical activity as well as treadmill performance, whereas questionnaires related to light or moderate activity were less valid.[31] The present activity questionnaire also seems to cover higher intensity better than moderate activity (see paper V).

The large proportion of women reporting moderate regular leisure activity in contrast to men may indicate that also this questionnaire may have failed to include all activities relevant for women.[104]

A person may under- or overestimate the level of performed physical activity. Recall bias related to underestimates of sedentary activities and overestimates of aerobic activities have been observed.[105] We cannot exclude such a 'wish' or recall bias, but such random misclassification is anticipated as being equal in cases and non-cases as a result of the prospective design. Consequently, a non-differential misclassification may contribute to a reduced statistical significance by reducing the magnitude of the relationship in the present thesis; it cannot therefore explain the observed significant risk estimates. However, recall over a time period may provide less accurate recall. A three-month recall questionnaire can, however, give results similar to a detailed 7-day diary[23] and a questionnaire may yield a reasonable estimate of the past year.[106]

The influence of error on the results from physical activity also depends on how closely this variable has been tracked over many years. One of the advantages of a prospective design, in contrast to case-control studies, is that long-term effects of a given exposure can be provided.[107] However, any exposure variable such as the activity level at baseline may change during the follow-up, as observed in the present thesis (papers III, IV and V). Repeated assessment allows consideration of the influence on risk estimates of these changes, adjustment for changes in the level of physical activity and observation of the influence of long-term effects of physical activity (papers III, IV and V). However, combining two assessments of physical activity may also increase the precision. By comparing the observed results with those of other studies and metabolic profiles, we can elucidate whether the combination of two assessments increased the precision and/or whether continued physical activity has a different influence on risk estimates than short time activity, as observed by others.[108] Sustained higher activity level with repeated assessment showed more marked differences between sedentary and active men and women on metabolic risk profiles than one assessment (see paper V). Changes in leisure activity level influence the metabolic risk profiles in both sexes. This may indicate that consistently higher levels of leisure activity are important to reduce the risk for e.g. breast cancer and that the observed effect by combining two assessments not only can be explained by increase in the precision of our physical activity measurement.

Total physical activity can be analysed if both leisure and occupational activity are taken into account. However, variations of within-job classifications may have limited the distribution of occupational activity, for example, the large number of housewives (70% at baseline) in our cohort. Most of these housewives (76%) categorized themselves as group 2 (a lot of walking) during occupational hours. Consequently, we cannot exclude a misclassification among women related to occupational physical activity. In addition, a change in occupational physical activity may have been introduced in both sexes as a result of increases in mechanization and declines in manual work that occurred during follow-up.

In comparing physical fitness in a subgroup with the self-reported occupational physical activity level used, Løchen and Rasmussen[37] observed a decrease in physical fitness with increase in level of occupational activity for both sexes. This may be explained by the fact that occupational activity levels, as assessed in the present surveys, do not improve aerobic capacity also observed by others.[109] However, even short bouts of occupational activity need energy as indicated in paper IV, because occupationally active women have a higher level of daily energy intake which is important in carcinogenesis.

Could the observed results be explained by bias?

The collection of data, analysis and interpretation of the results may deviate from the truth because of systematic variations. Bias is not a property of the underlying population and is generally not a major problem in cohort studies.[110]

In population-based cohort studies, with attendance rates above 80%, *selection bias* is generally regarded as unlikely. However, the attendance rate in the present study showed geographical variations, about 60% in Oslo to about 90% in Sogn og Fjordane. Holme et al.[111] observed that male non-attendees in Oslo varied by social class, with the highest attendance rate among the middle class and the lowest among the lowest social class. Accordingly, low leisure time physical activity is more likely among non-attendees because men in lower social classes are more frequently sedentary during leisure time. However, repeated assessment of physical activity makes the reference category their own controls and reduces the effect of this type of selection bias (papers III, IV and V).

Furthermore, combining leisure and occupational sedentary physical activity reflects both high and low social classes.[13] Consequently, a selection bias resulting from attendance rate or social class is unlikely to explain the observed associations, especially when both occupational and recreational physical activity are taken into account. Analyses with repeated assessments of physical activity may have introduced selection bias among those with persistent sedentary and persistent active leisure time at the two assessments. However, even a change in activity over 7 years of follow-up had an influence on the metabolic profiles in both sexes (see paper V). This supports an effect from sustained activity, in addition to improved precision of the physical activity variable.

One of the advantages of prospective studies is the possibility of obtaining data on both the exposure group and the outcome group at baseline, before cancer is diagnosed. However, any preclinical disease that reduces the possibility of performing physical activity will influence the reported activity level (*information bias*). Therefore, exclusion of preclinical diseases was carried out. In addition, those who emigrated, had a pre-existing malignancy or were diagnosed with a malignant disease within the first year of attending the cohort were excluded from the analysis for all cancer types studied. Hence, both in validating the physical activity assessment used (see paper V) and in the studies related to risk of cancer (see papers I–IV), the possibility of any undiagnosed cancer influencing the reported level of physical activity is less likely. However, any other preclinical or chronic disease, such as ischaemic heart disease, was not excluded in the final analysis related to risk of cancer. When excluding people (< 1%) with reported diabetes or ischaemic heart disease at baseline, no changes in risk estimates were observed (papers I–IV).

In Norway there is compulsory reporting by hospital departments, pathology laboratories and death certificates; there is also an almost 100% histological verification of most cancer cases. This indicates no influence on risk estimates from inadequate reporting of cancer cases (*diagnostic bias*), which has often been a problem in prospective studies.[110] In addition, the unique 11-digit identification number in Norway validates the diagnosis among cohort members who have died in the cohort, who have emigrated or who are currently alive.

Physically active people are more likely to have contact with physicians than those who are physically inactive.[112] This difference would create an increased likelihood of early diagnosis of cancer in physically active men and women. If such a diagnostic bias occurred in this study, the observed estimates are likely to be an underestimate of the true strength of the association between physical activity and risk of cancer.

Appropriate adjustments for confounders?

It is important to be cautious about whether unadjusted or residual effects of certain variables affect the risk of cancer. A confounding variable must be an independent risk factor for the disease as well as being associated with the exposure under study. In addition, if a variable is included in an intermediate step between an exposure and disease, that variable is not a true confounder.[113]

No dietary data were available for the analysis related to prostate, testicular, colon, rectal and lung cancer. High intake of dietary fat has been observed to increase the risk of prostate cancer[114-115] and increased intake of vegetables and fruit is associated with reduced risk of lung cancer in men and women.[116-117] In addition, higher intake of total fat has been observed in sedentary men relative to physically active men.[118] We observed a higher intake of fruit and vegetables in participants who were active in their leisure time compared with those who were sedentary (see paper V). Consequently, dietary factors may be a potential confounder in relation to physical activity and risk of prostate and lung cancer.

A recent Norwegian prospective study, performed in part in the same study population, did not observe any association between meat, fish, fat, energy, fibre or calcium intake and risk of colon cancer.[119] Other studies have concluded that physical activity and dietary factors are independent risk factors for colon cancer.[118,120] Consequently, it is less likely that dietary intake is an important confounder in relation to the association between physical activity and risk of colon cancer.

Could any unadjusted potential confounding factor, with a strong relationship to both physical activity and risk of lung cancer, explain the protective effect of the results observed? Men in lower social classes have been observed to be less active at leisure but more active at work than men in the higher social classes.[13] However, in a recent review of differences in cancer incidence among socioeconomic groups the authors concluded that it is still unclear whether the reported associations in studies can be attributed to lifestyle related riskfactors for cancer such as smoking and nutritional habits[121] also observed in some studies.[121,122] As the population under study also consists of a relatively homogeneous social group, any residual confounding from other factors related to socioeconomic status is unlikely to be substantial. The observation that increased total physical activity reduced the overall lung cancer risk for those who were sedentary at leisure ('low social class') and work ('high social class') was used as a reference to reduce the possibility that social class is a major confounder.

There is a strong causal relationship between smoking and risk of lung cancer.[123] In addition, people active in their leisure time were less often current smokers, and more often never and ex-smokers than those who were sedentary (see paper III). However, small differences were observed related to smoking habits in different categories of occupational activity. Moreover, careful adjustments for smoking habits were performed in analyses related to lung cancer. This reduces the possibility that smoking habits could influence the association observed when related to total physical activity and risk of lung cancer. Smoking-related lung cancer risk by cell type is strongest for squamous cell carcinoma and small cell carcinoma.[124-125] The lack of a protective effect of physical activity on squamous cell carcinoma reduces a residual effect of smoking, and supports the reduced risk of lung cancer resulting from physical activity. The age-adjusted risk estimates related to physical activity and lung cancer risk changed, but not much and significant inverse associations were still observed after performing multivariate adjustments for current, past, amount and duration of smoking.

Smoking habits were also adjusted for in multivariate analysis in relation to other types of cancer: prostate , testes, colon, rectum and breast. The relative risk estimates adjusted for smoking were, in general, similar to age-adjusted risk estimates and excluded smoking as a substantial confounder.

The two cities and three counties studied have some different incidence rates of the cancer types studied,[89] and the participants were also enrolled into the study in different years. Stratified analysis by geographical areas was chosen to take care of this problem, and the relative risks, adjusted for geographical region and age at entry, were in general similar to the age-adjusted relative risk estimates. This reduced the possibility of place of residence being a substantial confounder for the association between physical activity and risk of cancer types studied.

Numerous studies have observed that body weight and weight gain during adulthood are influenced by performed physical activity (see paper V). Thus, body mass index represents an intermediate factor between diet and cancer, and not a true confounder. Comparable consideration could be given to age at menarche, as this may be influenced by physical activity – physical activity reduces weight, promotes later ovarian maturation and consequently promotes a later onset of menstruation.[64, 126]

In relation to prostate and testicular cancer, we were unable to control for some other potential risk factors which may act as confounders such as sexually transmitted disease and sexual habits, early life events (e.g prematurity)[127-128] and cryptorchidism in relation to testicular cancer.[129-130]

Is there any causality between physical activity and cancer?

Careful evaluations should be drawn before any conclusions are made about causality. Hill[131] suggested nine criteria for causality: strength, consistency, specificity, temporality, biological gradient, plausibility, coherence, experimental evidence and analogy. These criteria have been critically evaluated and found to be of importance for cause-and-effect associations.[113]

Strength of the association

Strong associations between physical activity and risk of site-specific cancer studied indicate a greater likelihood of a causal relationship. Although the observed statistical associations between physical activity and prostate and colon cancer (in men and women) may be rather weak, it should not exclude a causal relationship. However, an undetected bias could explain the modest observed associations for prostate and colon cancer (papers I and II). In papers III (lung cancer) and IV (breast cancer), the observed associations are stronger, especially when related to repeated assessment of leisure time activity.

Biological gradient: dose–response relationship

A genuine association is expected to increase with increasing level and duration of exposure. A dose–response is an important indication of causality, while the lack of such a relationship argues against causality.[107] A dose–response relationship between total physical activity and risk of prostate cancer was observed among those who walked a lot during occupational hours. A dose–response relationship was also observed between total physical activity and risk of colon cancer among women and men aged over 45 years at entry. Moreover, this pattern was observed between leisure activity and lung cancer for both one single and repeated assessments of leisure activity. An association was especially marked between occupational and leisure time physical activity and risk of breast cancer. The strongest relationship was observed between leisure time activity and cancer risk in leaner premenopausal women through repeated assessment of activity and among younger postmenopausal women. We also observed a dose–response relationship between changes in levels and sustained levels of leisure time activity and serum lipids and BMI in both sexes.

Repeated assessment of physical activity may increase precision and this could explain the observed stronger dose–response relationship between leisure activity and risk of lung and breast cancer because loss of accuracy of physical activity would diminish any dose–response relationship.

Temporality

The prospective design satisfies the criteria if physical activity precedes the development of cancer. Different times after assessment of physical activity were eliminated to assess the effect of latent disease, which may have affected physical activity level in diseased individuals. Relative risk estimates and tests for linear trend were essentially unchanged for men and women, after excluding an additional 2 or 4 years of follow-up for those cancer types studied.

Between single shot and continuous lifetime exposures, one can clearly consider a wide range of types of intermittent or limited exposure. We considered a continuous exposure of physical activity and concentrated on what appear to be two features of particular importance: the age at which exposure starts and the time period until the end of follow-up. Therefore, an age split is carried out to see if these differences interact on risk estimates. We suggest a protective effect of physical activity on prostate cancer risk only among those over 60 years, but our results are borderline and confidence intervals overlap with those younger than 60 years.

Migrant studies indicated that environmental factors operating in young adulthood may be determinants for breast cancer, whereas factors operating throughout life seem to be important for colon cancer.[94] The observed association for colon cancer in older, relative to younger, men supports colon cancer being more sensitive to lifetime physical activity. More convincing are the observations of a stronger association between physical activity and risk of breast cancer among premenopausal and younger postmenopausal women, which may indicate that breast cells are more sensitive during the early period of life when both the number of stem cells and cell differentiation are greater.[57]

Specificity and consistency

Specificity of risk to subgroups indicates a causal relationship and this was observed between leisure time activity and lung cancer, especially small cell carcinoma. Moreover, the increased risk of breast cancer in younger women, relative to older ones, supports specificity of risk to age groups.

A single study of the effect of physical activity on cancer risk seldom provides convincing evidence, but it might trigger interest and create new hypotheses. However, several studies have observed a protective effect of occupational and/or leisure time physical activity[22,132-134] and physical fitness[135] on the risk of prostate cancer. The variance observed in some studies[42,136] may be explained by methodological bias because sedentary jobs are a poor indicator[135] and college athletics is too remote in time to be important in carcinogenesis of the prostate.[42]

The observation[129-130] that lack of exercise and a sedentary lifestyle increase the risk of testicular cancer in contrast to our study. These results need to be confirmed in other studies.

The evidence for a protective influence of physical activity on colon cancer risk has consistently been observed in numerous studies in different countries world wide, related to both occupational[41,137-138] and leisure time activity.[17,41,47, 108,137-141]

The lack of association observed between physical activity and rectal cancer is supported from many others.[108, 137]

The associations between physical activity and lung cancer risk has not been studied much, but are supported with a few previous observations.[22,142] However, no other studies have analysed the association between physical activity and lung cancer risk by histological subtypes.

Since Frisch and colleagues[1] observed lower prevalence of breast cancer among former college athletes, a reduction in breast cancer risk has been observed among women resulting from leisure time[18,22, 26,143] as well as occupational physical activity.[144-145] A few others have observed inconsistent results[27,42] and these observations may be explained by the fact that college athletics is too remote an event,[42] whereas in the Framingham study most of the women were older.[27]

Coherence and biological knowledge

The association between physical activity and the cancer types studied is more plausible if the effect of physical activity supports currently known pathophysiological mechanisms.

Overall physical activity has numerous health benefits, such as improvements in the concentration of serum lipids,[85] weight control (paper V)[28] and reduction in insulin levels.[146] High circulating levels of insulin may promote the growth of tumours,[147] and recently hypothesized its importance in carcinogenesis of the colon[47] and breast.[88]

Another, important physiological effect of physical activity is related to energy balance and utilization of calories. Tannenbaum[148] was the first to observe that caloric restriction inhibits the development of spontaneous tumours (mammary and lung) in animals. Kritchevssky[52] observed that exercise halved tumour incidence in rats fed *ad libitum* and was equivalent to 25% caloric restriction. Caloric restriction reduces cellular proliferation and mitotic activity.[149] Energy restriction can also lead to enhanced DNA repair.[150]

The study of carcinogenesis through animal experiments confirms this as a multi-step process (initiation, promotion, progression) driven by carcinogen-induced genetic and epigenetic damage in suspicious cells. Thus, it is of importance to consider at what stage in the carcinogenic process physical activity may act. As recent studies have observed, adult weight gain is a risk factor for breast cancer,[117,151] so physical activity may therefore act as a late stage factor. However, influence on stem cells and mitotic activity through caloric restriction indicates that physical activity may influence initiation. Physical activity may therefore modify the carcinogenesis at different stages. In addition, both *amount* and *duration* of physical activity have been observed to be important in relation to their influence on carcinogenesis.

Carcinogenesis of the prostate seems to involve testosterone.[66-67] Hence, a role for physical activity in its development is plausible because physical activity may reduce testosterone levels.[68-69] The normal functioning of the large bowel includes a certain level of physical activity, and exercise has shown to reduce stool transit time through the large bowel. Consequently, exposure time of the colon mucosa and potential carcinogens in the faecal stream may be decreased by exercise.

Physical activity is also known to improve pulmonary capacity, and increased pulmonary ventilation and perfusion may reduce the interaction time and concentration of any carcinogenic factors in the airways. Moreover, pulmonary function has been observed as a predictor for risk of lung cancer.[152]

The specific relationship between physical activity and breast cancer may be related either to the general influence on energy balance and/or more specifically to a reduction in the cumulative exposure of both cyclic oestrogen and progesterone in physically active women relative to sedentary women.

Finally, a physically active lifestyle counteracts adverse health habits and improves the quality of life; psychological attitudes threaten the quality of living and these have recently been suggested as important for risk of cancer.[152-153]

A randomized controlled trial is the best way of showing that changes in physical activity change the risk of prostate, testicular, colon, rectal, lung and breast cancer. However, experimental studies in humans meet ethical and critical problems. Consequently, some hypothesis have first to be investigated in experimental animal studies. Animal studies have observed inhibition of mammary carcinogenesis by voluntary treadmill exercises[154] and reduction in incidence and multiplicity of colon adenocarcinomas has been observed in voluntary exercised rats.[155] This gives experimental evidence for a relationship between physical activity and carcinogenesis.

6 IMPLICATIONS AND FURTHER RESEARCH

Cultural changes have outpaced any genetic adaptation. Thus, from a genetic point of view we are still hunters and future research should focus on the suggestion that physical inactivity may act as a possible carcinogenic hazard. Even if physical activity has only a small protective effect, the prevalence of inactivity in industrialized societies is great. The attributable risk associated with inactivity may be quite high and be of importance for cancer prevention. Although numerous studies have been performed during the past five years many important questions remain and point to further studies.

- Studies in which physical activity is analysed as a dynamic process from childhood throughout the whole life are needed. Hence, repeated assessments of physical activity in cohort studies should be done. In this way, the importance of age-specific physical activity and life-time physical activity between populations and time periods could be further elaborated.
- There should be improved comparability of the physical activity assessments between different study populations and at different ages. Moreover, performed physical activity

reflecting type, intensity, duration and amount of performed physical activity is related to both age and gender. Consequently, these differences should be further focused in order to improve assessments of physical activity in epidemiological studies.

• Given the complexity of physical activity, epidemiological research should, in collaboration with clinical and laboratory medicine, focus on energy balance and biomarkers associated with different levels of physical activity and changes in physical activity, using experience from these areas of medicine.

7 CONCLUSIONS

The present work has demonstrated that sustained high levels and change from sedentary to higher levels of leisure time physical activity in adult men and women improved metabolic risk profiles; reduced weight gain and serum concentration of total cholesterol, triglycerides and increased serum concentration of high-density lipoprotein cholesterol. This confirms that the physical activity assessments used have importance for metabolic profiles at a magnitude that can influence the risk of chronic diseases.

• The inverse association between both recreational and occupational physical activity and the risk of prostate cancer may act through a combination of improved energy balance and modified hormonal influence. The evidence is still sparse but more knowledge may point to a protective role of physical activity.

• The small number of cases of testicular cancer limits the statistical power of the study and any causality remain unsolved.

• In spite of a modest association observed the overwhelming results from comparable studies support that physical activity is protective against colon but not rectal cancer in both genders.

• Our results indicate a negative dose–response association between recreational physical activity and lung cancer in men. This association was especially observed between leisure physical activity and small cell carcinoma of the lung. It is hypothesized that improved pulmonary function is sufficient to counteract carcinogenesis in groups with exposure to carcinogenic agents. However, more studies are needed before we can conclude if this is a cause-effect association.

• Our study suggests an inverse association between both leisure and work activity and the overall risk of breast cancer. Further, the leisure time effect indicates a more marked effect among premenopausal and younger postmenopausal, lean women. This is in agreement with most other studies supporting a protective role for physical activity in the prevention of breast cancer. Possible mechanisms may be hormone- and energy-dependent effects.

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Paper I

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Physical activity and the risk of prostate and testicular cancer: a cohort study of 53,000 Norwegian men

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The associations between recreational and occupational physical activity and the subsequent risk of prostate and testicular cancer were examined in a population-based cohort study of 53,242 men in Norway. Age at study entry was 19 to 50 years. Information on physical activity was based on questionnaire responses and a brief clinical examination. A total of 220 prostate and 47 testicular cancer cases were recorded in the Cancer Registry of Norway during a mean follow-up time of 16.3 years. We found a nonsignificant, reduced, adjusted relative risk (RR) of prostate cancer with increased level of physical activity at work and among those men with the greatest recreational physical activity. When occupational and recreational physical activity were combined, a reduced adjusted risk of prostate cancer was observed among men who walked during occupational hours and performed either moderate recreational activity (RR = 0.61, 95 percent confidence interval [CI] = 0.36 to 1.01) or regular recreational training (RR = 0.45, CI = 0.20 to 1.01) relative to sedentary men (test for trend, *P* = 0.03). Physically active men who were older than 60 years of age at diagnosis showed a reduced adjusted RR of borderline significance, while no association was observed for younger men. No evidence was found for any association between physical activity and testicular cancer regardless of physical activity at work and recreation. *Cancer Causes and Control* 1994, 5, 549 - 556

Key words: Cohort study, Norway, physical activity, prostate cancer, testicular cancer.

Introduction

Prostate cancer is the most frequent cancer among males in Norway, contributing 21 percent of all cancer-cases diagnosed in males in 1991; whereas testicular cancer was diagnosed in only two percent of all cancer cases in the same year.[1] Both cancer sites have shown increasing incidence rates during the last decades.[1] Carcinogenesis of the prostate and testis is still poorly understood. Since growth and tissue differentiation of both organs is related mainly to the influence of sex hormones, it has been demonstrated that these factors also may have importance for tumor development of the prostate and testis.[2-9]

Physical activity is associated with both energy balance and hormones. Athletes have been shown to have lower basal levels of circulating testosterone than do untrained men.[10-12] In addition, increased physical

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activity can decrease body fat, thereby reducing the extragonadal production of estrogens. The effect of physical activity is, therefore, of considerable interest in the study of both prostate and testicular cancer in terms of understanding the carcinogenesis of the two organs and in cancer prevention.

Previous studies have reported decreased risk of prostate cancer,[13-16] as well as increased risk or no effect in males with high physical activity.[17-21] Brownson *et al*[14] observed a decreased risk of testicular cancer with increased physical activity. Other studies have focused mainly on trauma in sports leading to increased risk of testicular cancer.[21-22]

The aim of this study is to focus on the relationship between different levels of self-reported, occupational and recreational physical activity, and the subsequent risk of prostate and testicular cancer after adjusting for some possible risk factors. Since prostate cancer is especially frequent among older males, we were interested to see whether physical activity had different influences on prostate cancer risk in younger relative to older males.

Materials and methods

Cohort

This population-based cohort was initiated as a prospective study of risk factors for cardiovascular disease. Men and women from three counties in Norway (Oppland, Sogn and Fjordane, and Finnmark) and two cities (Oslo and Tromsø) were invited to participate in a health-screening program from 1972 to 1978 organized by the National Health Screening Service. In Tromsø, all men aged 20-49 years were invited, while in Oslo, men aged 40-49 were invited plus a seven-percent random sample of men aged 20-39. In the three counties of Oppland, Sogn and Fjordane, and Finnmark, all men and women aged 35-49 and a 10-percent random sample of persons aged 20-34 years were invited. In four small municipalities in Finnmark, all men and women aged 20-34 were invited. A total of 104,485 males and females were invited, and 53,622 males (73.5 percent) and 28,621 females (90.7 percent) attended the screening.

The screening procedure used was similar in the five geographic areas. Each person was invited by mail, with a cover letter and one-page questionnaire enclosed. The participants were asked to answer the questionnaire at home and bring it with them to the clinical examination. The clinical examination comprised checking the questionnaire for inconsistency, measurements of weight, height, and blood pressure, and collection of blood samples. Heart rate and other measures of physical fitness were not assessed during the clinical examination.

The questionnaire covered the following: physical activity in recreational and occupational hours during the last year; history of chronic diseases, especially cardiovascular symptoms and diseases; and smoking habits and stress in daily life.

Self-reported physical-activity categories during recreational hours were graded from 1-4 according to which of the following categories best described the participant's usual level of recreational physical activity: R1 = reading, watching TV, or other sedentary activities; R2 = walking, bicycling, or physical activities for at least four hours a week; R3 = exercise to keep fit, participating in recreational athletics, etc., for at least four hours a week; R4 = regular hard training or exercise for competition several times a week. In the analysis, the categories R3 and R4 were merged due to few subjects in category R4 ($n = 1{,}316$).

Self-reported physical-activity categories during occupational hours were: 01 = mostly sedentary work; 02 = work with much walking; 03 = work with much lifting and walking; 04 = heavy manual work.

Identification of cases

The national 11-digit, personal identification number enabled a linkage to the Cancer Registry of Norway. This allowed for identification of every incident case of invasive prostate and testicular cancer that occurred in the cohort from the time of examination until the end of follow-up (31 December 1991). Those who emigrated or had a pre-existing malignancy or were diagnosed with a malignant disease within the first year after attending the cohort ($n = 380$) were excluded from the analyses. This reduced the possibility for any undiagnosed cancer to influence the level of physical activity. The 53,242 men eligible for analysis were then followed-up through the Norwegian Central Bureau of Statistics to identify deaths in the cohort to the end of 1991. Prostate and testicular cancers were coded according to an extended version of ICD-7.[23]

Data analysis

Cox proportional-hazards regression technique was used to analyze the simultaneous effect of physical activity and covariates on prostate and testicular cancer incidence in the cohort. Person-years at risk of developing prostate or testicular cancer were calculated as the number of years from the time of entry until the time of withdrawal (year of diagnosis, time of death, or end of follow-up). Ten percent (5,092 men) died during follow-up.

As no cases of prostate cancer were observed among men younger than age 35 years at entry, this age-group was excluded from the analyses of prostate cancer (n = 9,557). These analyses, therefore, were based on a limited number of men concerning the risk of prostate cancer (n = 43,685), but not of testicular cancer (n = 53,242). All analyses were adjusted for age at entry, geographic regions, and obesity (using body mass index [BMI] of weight/height^2). Because of missing data, the number of subjects included in the individual analyses varies slightly.

We divided the cohort in two categories of age at diagnosis in order to analyze a possible different influence of physical activity on the prostate cancer risk in younger (aged under 60 years) relative to older (60 or more years) males. Mean age at diagnosis for prostate cancer was 60.3 years and few prostate-cancer cases were older than 65 years. Other cutoff points were considered without extended information. Age at entry was adjusted for as a continuous variable in this model. The analyses were performed with the Proc Phreg procedure available in the SAS statistical package.[24]

Results

A total of 220 prostate and 47 testicular cancer-cases were diagnosed during a mean follow-up time of 16.3 years (Table 1). All testicular cancers and 99 percent of prostate cancers were histologically verified. We found strongly increasing incidence-rates of prostate cancer with increasing age at entry in contrast to decreasing incidence rates with increasing age at entry of testicular cancer. Due to the young age at entry and the relatively short follow-up, the median age at diagnosis for prostate cancer was 61.2 years (42.9-68.5 years) while testicular cancer was diagnosed in men aged 25.5-65.7 years old with a median age at diagnosis of 45.8 years.

In univariate analysis, only age and BMI were significant risk factors for prostate cancer, while a negative association was observed between age and risk of testicular cancer (Table 2). None of the variables in Table 2 gave any significant deviation from linearity by adding a second-order term (results not shown).

When calculating the crude incidence rate of prostate cancer in different occupational activity categories,

Table 1. Number of persons, person-years (PY) at risk, and prostate and testicular cancer by age at entry, Norway

Age at entry (yrs)	Number of persons	Mean follow-up (yrs)	Prostate cancer		Testicular cancer	
			No.	Incidence per 100,000 PYs	No.	Incidence per 100,000 PYs
19-24	2,648	16.9	0	0.0	6	13.4
25-29	3,459	17.0	0	0.0	7	11.9
30-34	3,450	16.7	0	0.0	3	5.2
35-39	9,436	15.8	7	4.7	10	6.7
40-44	15,930	16.5	48	18.3	12	4.6
45-49	17,629	16.1	152	53.6	9	3.2
50-54	690	15.8	13	119.1	0	0.0
Total	53,242	16.3	220	25.4	47	5.4

Table 2. Age-adjusted relative risk (RR) of prostate and testicular cancer in relation to possible risk factors; Cox proportional hazards model; Norway

Variable	Prostate cancer				Testicular cancer			
	Cases	No. of persons	RR[a]	(CI)[b]	Cases	No. of persons	RR[a]	(CI)[b]
Age at entry (per yr)	220	43,685	1.27	(1.21-1.33)	47	53,242	0.95	(0.92-0.98)
BMI (kg/m^2) per unit	217	42,851	1.25	(1.05-1.50)	46	53,242	1.32	(0.82-2.14)
Cholesterol (mmol/liter) per unit	220	43,685	0.98	(0.88-1.08)	47	53,242	1.07	(0.87-1.32)
Triglycerides (mmol/liter) per unit	220	43,685	1.05	(0.99-1.11)	47	53,242	1.05	(0.92-1.20)
Glucose (mmol/litre) per unit	220	43,685	0.98	(0.91-1.06)	47	53,242	1.08	(0.97-1.22)
Height (cm) per every 10 cm	217	42,859	0.99	(0.82-1.19)	46	52,199	1.12	(0.75-1.67)
Smoking per 10 cigarettes	211	42,067	1.08	(0.90-1.30)	46	51,532	1.20	(0.85-1.70)
Married/separated (*cf* never married)	220	43,685	1.63	(0.96-2.75)	47	53,242	0.72	(0.35-1.45)

[a] Adjusted for age at entry.
[b] CI = 95% confidence interval.

Table 3. Person-years (PY), crude incidence rates, and adjusted relative risk (RR) of prostate and testicular cancer with 95% confidence interval (CI) associated with occupational and recreational physical activity; Cox proportional hazard model; Norway

Physical activity (PhA)	PYs	Cancer cases	Crude incidence rate per 100,000 PYs	RR[a]	(CI)[b]
Prostate cancer					
Occupational PhA					
Sedentary	250,772	92	36.7	1.00	(Ref)
Walking	185,938	49	26.4	0.77	(0.54-1.09)
Lifting and walking	149,369	46	30.8	0.99	(0.69-1.42)
Heavy manual	111,533	25	22.4	0.81	(0.50-1.30)
Recreational PhA					
Sedentary	136,324	44	32.3	1.00	(Ref)
Moderately active	395,406	132	33.4	1.03	(0.73-1.45)
Regular training	169,371	41	24.2	0.87	(0.57-1.34)
Testicular cancer					
Occupational PhA					
Sedentary	309,845	13	4.2	1.00	(Ref)
Walking	225,925	6	2.7	0.60	(0.23-1.57)
Lifting and walking	189,190	13	6.9	1.38	(0.63-3.01)
Heavy manual	130,126	13	10.0	1.95	(0.86-4.41)
Recreational PhA					
Sedentary	170,718	8	4.7	1.00	(Ref)
Moderately active	471,125	26	5.5	1.22	(0.55-2.69)
Regular training	217,200	12	5.5	1.01	(0.41-2.49)

[a] Adjusted for age at entry, geographic region, and body mass index (BMI).
[b] CI = 95% confidence interval.

there was a lower incidence rate among those walking, lifting and walking combined, and, in particular, among those doing heavy manual work, compared with the sedentary group (Table 3). We observed a 25 percent lower crude incidence-rate of prostate cancer among those doing regular physical training during recreational hours compared with the sedentary and the moderately active group (Table 3). The crude incidence rate of testicular cancer was about two times higher among men with heavy manual work compared with men with sedentary work (Table 3).

We observed a nonsignificant, but consistent reduction in relative risk (RR) of prostate cancer after adjusting for age at entry, BMI, and geographic region among those walking or doing heavy manual work compared with the sedentary working-group (Table 3). A nonsignificant reduction in RR of prostate cancer also was observed among recreational-active men compared with the recreational-sedentary group (Table 3). Recreational activity did not seem to influence the adjusted RR of testicular cancer to any significant extent. However, close to twofold increased RR among men with heavy manual work was observed.

In order to study total physical activity, recreational (R) and occupational (O) activity were combined. We observed that, for prostate cancer, all physically non-sedentary groups except for one group (RR = 0.94) were at a lower risk when the overall sedentary men both at work and leisure was the reference group (Table 4). Among men walking during occupational hours combined with a low or moderate recreational physical activity, we observed a borderline significant reduced RR (RR = 0.61, 95 percent confidence interval [CI] = 0.36-1.01). Even lower relative risk (RR = 0.45, CI = 0.20-1.01) was observed in the group of men walking at work combined with high recreational physical-activity (test for trend $P = 0.03$). Performing analysis separately for R1 and R2 in the combined moderate-activity groups did not give other information than increased confidence intervals.

Men older than 60 years of age at diagnosis, who were occupationally and recreationally physically-active, had a 39 percent reduced adjusted RR of prostate cancer, while younger males only had 11 percent reduced adjusted risk compared with the most sedentary group (borderline significance) (Table 5). Including interaction terms as age-activity and age-BMI in the models, did not influence the risk estimates.

Men with heavy manual work were at about 85-95 percent increased risk of testicular cancer. However, due to small numbers, none of the estimates was statistically significant (Table 6).

Table 4. Adjusted relative risk (RR) of prostate cancer with 95% confidence interval (CI) of combined occupational and recreational physical activity among men aged 35-50 years at entry; Cox proportional hazard model; Norway

Physical activity[a]		Cases	RR[b]	(CI)	Trend test *P* value
Occupational (O)	Recreational (R)				
Sedentary (O1)	Sedentary (R1)	23	1.0	(Ref)	
Sedentary (O1)	Moderate (R2)	53	0.78	(0.47-1.27)	
Sedentary (O1)	Active (R3)	16	0.64	(0.34-1.22)	0.17
Walking (O2)	Sedentary/moderate (R1 + R2)	41	0.61	(0.36-1.01)	
Walking (O2)	Active (R3)	8	0.45	(0.20-1.01)	0.03
Lifting/walking (O3)	Sedentary/moderate (R1 + R2)	37	0.81	(0.48-1.37)	
Lifting/walking (O3)	Active (R3)	9	0.77	(0.35-1.71)	0.44
Heavy manual (O4)	Sedentary/moderate (R1 + R2)	17	0.71	(0.34-1.48)	
Heavy manual (O4)	Active (R3)	8	0.94	(0.38-2.36)	0.77

[a] R1 = Recreational sedentary; R2 = Recreational moderate active; R3 = Recreational training.
[b] Adjusted for age at entry, geographic region, and body mass index (BMI).

Table 5. Adjusted relative risk (RR) of prostate cancer in different age-groups at diagnosis according to combined occupational and recreational physical activity; Cox proportional hazard model; Norway

Age at diagnosis (yrs)	Cases	Person-years at risk	Sedentary[a] RR[a]	Moderate/active[c]	
				RR[b]	(CI)[d]
<60	84	603,518	1.0	0.89	(0.40-1.94)
60 +	128	85,755	1.0	0.61	(0.36-1.04)

[a] Sedentary during both occupation (O1) and recreation (R1).
[b] Adjusted for age at entry, geographic region, and BMI.
[c] Moderate/active = all other groups than sedentary.
[d] CI = 95% confidence interval.

Discussion

This study suggests that recreational activity in particular, but also occupational activity, may reduce the risk of prostate cancer, especially among the young elderly. When occupational and recreational physical-activity were combined, a reduced risk (nonsignificant) of prostate cancer was observed in all active groups except one group relative to the sedentary group. A significant dose-response association between physical activity and risk of prostate cancer was observed among men walking during occupational hours, with increasing level of physical activity at leisure. No obvious, significant, statistical effect of physical activity on the risk of testicular cancer was observed though a close to twofold increased risk was observed in the group with heavy manual work.

The strength of this study is the poulation-based approach and the large sample size of the cohort including more than 50,000 men. In addition, both recreational and occupational physical-activities are taken into account giving a comprehensive consideration of total physical activity of each individual. In this way, we were able to analyze a greater range of the exposure variable.

Table 6. Adjusted relative risk (RR) of testicular cancer with 95% confidence interval (CI) of combined occupational and recreational physical activity among men aged 19-50 years at entry; Cox proportional hazard model; Norway

Physical activity[a]		Cases	RR[b]	(CI)	Trend test *P* value
Occupational (O) +	Recreational (R)[a]				
Sedentary (O1)	Sedentary/moderate (R1 + R2)	10	1.0	(Ref)	
Sedentary (O1)	Active (R3)	3	0.77	(0.21-2.84)	
Walking (O2)	Sedentary/moderate (R1 + R2)	4	0.52	(0.16-1.66)	
Walking (O2)	Active (R3)	2	0.66	(0.14-3.09)	0.37
Lifting/walking (O3)	Sedentary/moderate (R1 + R2)	10	1.44	(0.59-3.55)	
Lifting/walking (O3)	Active (R3)	3	1.19	(0.31-4.47)	0.80
Heavy manual (O4)	Sedentary/moderate (R1 + R2)	9	1.85	(0.67-5.09)	
Heavy manual (O4)	Active (R3)	4	1.95	(0.55-6.94)	0.23

[a] R1 = Recreational sedentary; R2 = Recreational moderate active; R3 = Recreational training.
[b] Adjusted for age at entry, geographic region, and body mass index (BMI).

Also of importance is that the reporting and recording of all new cases of prostate and testicular cancer in Norway is based on a very strict system. This includes compulsory reporting by hospital departments, pathology laboratories, and death certificates, thus achieving a very high case-ascertainment in addition to the close to 100 percent histologic verification of the cancer cases.

However, due to the relatively young age at entry and the short follow-up, the numbers of cases of prostate cancer and especially testicular cancer are small, thereby limiting the statistical power of the study.

The questionnaire used in this study has been validated extensively for the accurate assessment of physical activity in several studies.[25-29] Based on the same questionnaire, Løchen *et al*[29] demonstrated that physical fitness increased with activity in leisure time. Physical fitness was measured as physical working capacity in a graded bicycle exercise. There is good reason to believe that the allocation of the individuals to the respective groups reflects real differences in the level of physical activity in the study population.

Nondifferential misclassification may occur when a person describes himself as more physically active than he is. The risk estimates become closer to 1.0, contributing to a reduced statistical significance for prostate cancer. In addition, a stronger effect probably would be achieved if the evaluation of physical activity had been repeated. This was demonstrated by Lee *et al*,[15] who observed a far greater effect of physical activity when two activity assessments with 10 years' interval were combined.

Socioeconomic factors have been observed to influence the risk of both prostate and testicular cancer in some studies, but not in others.[9,30-33] No geographic or urban-rural differences were observed in our study, and adjustments for marital status did not influence the association between physical activity and risk of either prostate or testicular cancer. However, due to different age at study entry, and variation of incidence rate in the different geographic regions (results not shown), we chose to adjust for geographic region in the multivariate analysis. In addition, partly based on the same population, Holme *et al*[28] observed that higher social classes were overrepresented among men who reported sedentary work activity and that those who were sedentary at leisure were overrepresented in lower social classes. Therefore, the reference group used (the overall sedentary men when combined with recreational and occupational activity) reflects both high and low social classes. It is less likely, therefore, that social class explains the observed association.

Confounding by diet may be important, as dietary fat has been found to increase the risk of prostate cancer.[8,32] Unfortunately, dietary information was not available in this study. Obesity, measured as BMI, did not contribute to our results when this variable was adjusted for in the analysis. However, BMI independently had a positive association with the risk of prostate cancer.

Prostate cancer

The present results are in agreement of those of Albanes *et al*[13] and Lee *et al*,[15] who observed an increased risk of prostate cancer among inactive men. One reason why those men who reported walking (O2) during occupational hours combined with high recreational activity were at lowest risk (RR = 0.45) in this study may be that they perform more dynamic activity relative to the other occupational groups. The heavy manual-labor group may perform more static activity which may not influence prostate cancer risk in the same way.

The biologic implication of these findings may be related to different mechanisms. The incidence of prostate cancer is high in countries with a Western lifestyle. Obesity as the result of high caloric intake, sedentary work, and low leisure activity are important elements of this lifestyle. The bearing of physical activity on the carcinogenesis of the prostate thus may reflect the energy imbalance with decreased metabolism resulting in an increase in adipose tissue. Lew *et al*[34] found that overweight men had 30 percent increased mortality rates of prostate cancer. The increase in BMI significantly contributed to increased risk of prostate cancer with about 25 percent in univariate analysis in this study. However, in our study, the effect of physical activity on the risk of prostate cancer was independent of BMI, as this variable was adjusted for in the analysis. It is reasonable to believe that physical activity acts through additional or other mechanisms than those related merely to energy imbalance.

Any influence of physical activity on the level of sex-hormones is of special interest, with testosterone and its metabolite being particularly important. A decrease in these androgens immediately after prolonged exercise has been observed in males,[12,35] and several studies[11,36-38] have recorded lower basal levels of testosterone among trained men relative to untrained men. Black men in United States, who have a high risk of prostate cancer, have 15 percent higher levels of testosterone in serum than White men.[3] This strengthens the importance of testosterone in the pathogenesis of the disease and could be the mediator for the effect of physical activity.

We observed that the preventive effect of physical activity was higher among those older than 60 years than among younger men. This is in agreement with

Lee *et al*,[15] who observed that the protective effect of total physical activity was limited to those older than 70 years of age. Lee *et al* also argued that long-term maintenance of high levels of physical activity may be necessary for reducing the risk of prostate cancer. The fact that most men were relatively young at the end of the follow-up may explain why a stronger association with physical activity was not detected.

In contrast, Marchand *et al*[20] observed an opposite effect as they found a negative association between years spent in sedentary occupations among men aged 70 years or older, while the results for younger men were less clear. They evaluated only occupational activity, not recreational activity, which may explain the divergent results. Physical activity has probably only a weak or moderate influence on the carcinogenesis of prostate cancer. Thus, physical activity may be of greater importance among the elderly (in whom environmental and endogenous hormonal factors may be more prevailing) relative to younger men (in whom the importance of genetic predisposition may be greater and less likely to be influenced by physical activity). Further, Zumoff *et al*[39] observed that young prostate-cancer patients differed markedly in their endogenous hormonal pattern from patients aged 65 or older. The level of testosterone in serum in males declines by increasing age.[40,41] If physical activity contributes to a further suppression of the age-dependent, decreasing, testosterone-curve, this also may explain why the effect of physical activity is observed among the elderly only.

Testicular cancer

Physical activity has been suggested to act as a persistent trauma to the scrotum and thus increase the risk of testicular cancer.[21-22,42] This effect has been found for horse riding and bicycling.[21] We had no such information available and it may explain why no statistical association between physical activity and risk of testicular cancer was found in this study. It is reasonable to suggest that a true biologic effect of some types of physical activities on cancer risk probably will disappear if the effect is of minor strength or the particular activity is insufficiently represented in the study population. Another explanation for the lack of association may be the late assessment of physical activity relative to the highest cancer-risk period in this study. The assessment of physical activity was performed in males at age 20 to 49 years which also is the period with the highest incidence rate of testicular cancer. Thus, physical activity may have a decreased influence on testicular cancer risk, as the carcinogenic process may already have emerged.

The small number of testicular cancer cases limits the statistical power of the study. Also of importance may be a too-small range of variation in the assessment of physical activity which is not sensitive enough to produce statistical associations. A positive association of physical activity on the risk of testicular cancer has been demonstrated by Brownson *et al*.[14] An influence of physical activity on the risk of testicular cancer may be present also in this study although none of the risk estimates were of statistical significance. Indication for this may be a close to twofold increased risk observed among individuals performing heavy manual work.

Conclusion

Our study suggests an inverse association between both recreational and occupational physical-activity and the risk of prostate cancer. This effect may be related to energy imbalance, but more likely to be a hormonal influence on the carcinogenesis of the prostate. In contrast, no obvious statistical association between physical activity and the risk of testicular cancer was observed. Further studies are needed where the assessment of both physical activity and fitness are taken into account combined with hormonal and dietary status and metabolic measurements.

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Paper II

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Physical activity and risk of colorectal cancer in men and women

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Summary We examined the association between self-reported occupational and recreational physical activity and the subsequent risk of colorectal cancer in a population-based cohort in Norway. During a mean follow-up time of 16.3 years for males and 15.5 years for females, 236 and 99 colon cancers and 170 and 58 rectal cancers were observed in males and females, respectively, among 53 242 males and 28 274 females who attended the screening between 1972 and 1978. Physical activity at a level equivalent to walking or bicycling for at least four hours a week during leisure-time was associated with decreased risk of colon cancer among females when compared with the sedentary group (RR = 0.62, 95% CI 0.40–0.97). Reduced risk of colon cancer was particularly marked in the proximal colon (RR = 0.51, 95% CI 0.28–0.93). This effect was not observed for occupational physical activity alone, probably due to a narrow range of self-reported physical activity at work among females. However, by combining occupational and recreational physical activity we observed an inverse dose–response effect as increasing total activity significantly reduced colon cancer risk (*P* for trend = 0.04). Among males 45 years or older at entry to the study, an inverse dose–response effect was observed between total physical activity and colon cancer risk (*P* for trend = 0.04). We also found in males a stronger preventive effect for physical activity in the proximal as compared to distal colon. In addition, we found a borderline significant decrease in colon cancer risk for occupational physical activity in males 45 years or older when compared to the sedentary group (RR = 0.74, 95% CI 0.53–1.04). All results were adjusted for age, body mass index, serum cholesterol and geographic region. No association between physical activity and rectal cancer was observed in males or females. The protective effect of physical activity on colon cancer risk is discussed in regard to energy balance, dietary factors, age, social class, body mass index and gastrointestinal transit time.

Keywords: physical activity; colorectal cancer; cohort study; gender differences; subsites

Cancer of the large intestine is one of the most common neoplasms in western countries (Muir *et al.*, 1987; Engeland *et al.*, 1993). Recently, the role of exercise in the aetiology of colon carcinogenesis has drawn particular interest. A growing number of epidemiological studies have reported a protective effect of occupational physical activity on colon cancer risk (Garabrant *et al.*, 1984; Gerhardsson *et al.*, 1986; Brownson *et al.*, 1989; Peters *et al.*, 1989; Arbman *et al.*, 1993; Chow *et al.*, 1993; Fraser and Pearce, 1993). Others have observed that recreational physical activity protects against colon cancer (Wu *et al.*, 1987; Slattery *et al.*, 1988; Gerhardsson *et al.*, 1988; Severson *et al.*, 1989; Ballard-Barbash *et al.*, 1990; Lee *et al.*, 1991; Markowitz *et al.*, 1992; Giovannuci *et al.*, 1995). In contrast, the association between physical activity and risk of rectal cancer is more inconsistent (Vena *et al.*, 1985; Gerhardsson *et al.*, 1986; Fraser and Pearce, 1993).

However, few studies have analysed the association between physical activity and colon cancer risk in females or have taken gender differences, age and subsites into consideration. In addition, patients with proximal colon cancer are older than patients with distal colon and rectal cancer, and women make up a higher percentage of patients with cancer in the proximal colon (Møller Jensen, 1984; Halvorsen, 1986; Fleshner *et al.*, 1989). Furthermore, physiological differences in the proximal and the distal colon may reflect different susceptibility to neoplastic transformation (Bufill, 1990; Dubrow *et al.*, 1993).

We therefore investigated the association between self-reported physical activity both during leisure and work and the subsequent risk of colorectal cancer in a population-based, prospective study among both sexes. We further examined whether physical activity had a different effect according to age-, gender- and site-specific colorectal cancer risk.

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Material and methods

Between 1972 and 1978, 104 485 males and females from five geographical areas in Norway–Oslo, Oppland, Sogn and Fjordane, Tromsø and Finnmark–were invited to participate in a population-based health survey of risk factors for cardiovascular disease. In Tromsø, all men aged 20–49 years were invited, while in Oslo men aged 40–49 were invited plus a 7% random sample of men aged 20–39. In the three counties of Oppland, Sogn and Fjordane and Finnmark all men and women aged 35–49 and a 10% random sample of persons aged 20–34 years were invited. In four small municipalities in Finnmark all men and women aged 20–34 were invited: a total of 104 485, of whom 53 622 males (73.5%) and 28 621 females (90.7%) attended the screening.

The screening procedures were similar in the five areas. Each person was invited by mail, with a covering letter and one-page questionnaire enclosed. The participants were asked to answer the questionnaire at home and bring it to the clinical examination. The clinical examination consisted of checking the questionnaire for inconsistency, measurements of weight, height and blood pressure, and the collection of blood samples. Heart rate and other measures of physical fitness were not assessed.

The questionnaire covered the following; physical activity (PhA) during recreational (R) and occupational (O) hours in the last year; history of chronic diseases especially cardiovascular symptoms and diseases, smoking habits and stress in daily life.

Self-reported physical activity categories during recreational hours were graded from 1 to 4 according to which of the following categories best described the participant's usual level of physical activity: R1 = reading, watching TV or other sedentary activities; R2 = walking, bicycling or physical activities for at least four hours a week; R3 = exercise to keep fit, participating in recreational athletics etc. for at least four hours a week; R4 = regular hard training or participation in competitive sports several times a week.

Self-reported physical activity during occupational hours was divided into four categories; O1 = mostly sedentary work; O2 = work with much walking; O3 = work with much lifting and walking; O4 = heavy manual work.

The national 11-digit personal identification number enabled a linkage to the Cancer Registry of Norway. This allowed for identification of every incident case of colorectal cancer that occurred in the cohort from the time of examination until the end of follow-up (31 December 1991). Colorectal cancers were coded according to ICD7. In some analyses, cancers in the colon were categorised as occurring in the proximal colon (153.0 + 153.1), or the distal colon (153.2 + 153.3 + 153.4). Cases identified only incidentally at autopsy were not included. Histological confirmation was obtained in 95% of the cases and among these 96.7% were adenocarcinomas and eight cases (2.5%) were classified as malignant carcinoid tumours.

In addition all 53 622 men and 28 621 women were followed up through the Norwegian Central Bureau of Statistics to identify deaths in the cohort up to the end of 1991. Those who emigrated or had a pre-existing malignancy or developed a malignancy within the first year of the study (males, $n = 380$; females, $n = 347$) were excluded from the analyses. This reduced the possibility for any undiagnosed cancer to influence the level of physical activity. The present cohort study is restricted to males and females aged 20–69 years in the follow-up period. Included for analysis were 53 242 males (867 822 person–years) and 28 274 females (437 785 person–years).

Cox's proportional hazards regression techniques were used to analyse the simultaneous effects of physical activity and possible confounders on colon and rectal cancer incidence in the cohort. In these analyses, the categories R3 and R4 of recreational physical activity were merged due to small numbers in category R4 (males, $n = 316$; females, $n = 62$). Observation years at risk of developing colon or rectal cancer were calculated as the number of years from 1 year after study entry until the time of withdrawal (year of diagnosis of cancer, time of death or end of follow-up in December 1991, which ever was earliest). In the sex-specific analyses, we adjusted for attained age (continuous variable), geographical regions and obesity at time of measurements. As a measure of obesity, we used the body mass index (BMI) (weight height^{-2}).

To study the influence of total physical activity on colon cancer risk, occupational (O) and recreational (R) physical activity were combined. As a reference group (R1/O1 + O2), we used sedentary leisure (R1) and both sedentary (O1) and moderate (O2) activities at work in order to increase the number of persons in the reference group.

We examined models stratified by age at entry (<45 years, ⩾45 years) and BMI (median split and tertiles) to analyse if there was any effect modification by age and BMI. Other cut-off points for age were considered without extended information. These analyses were performed with the Proc Phreg procedure in the SAS statistical package (SAS Institute, 1992). Owing to missing data, the number of subjects included in the individual analyses varies slightly.

Results

A total of 236 colon and 170 rectal cancers among males and 99 colon and 58 rectal cancers among females were diagnosed in the study population during a mean follow-up time of 16.3 years and 15.5 years in males and females respectively. Median age at diagnosis for colon cancer was 58.1 years in males and 54.6 years in females. For rectal cancer the median age at diagnosis was 57.3 years and 55.4 years in males and females respectively. Of all cases of colorectal cancer, cases of proximal colon cancer were less frequent among males (23.4%) than among females (30.5%), whereas the proportion of distal colon cancer was reversed between the two sexes (31.8% *vs* 28.7%).

The grade of physical activity was differently distributed in males and females. Two-thirds of the females and 76% of the housewives reported frequent walking (O2) during occupational hours in contrast to only one-quarter among males (Table I). Fewer females than males reported sedentary work (O1). Gender differences were also observed during leisure time as only 10% of females reported regular training (R3 + R4) in contrast to 25.4% of males.

Age at entry was a significant risk factor in univariate analyses for both colon and rectal cancer in both sexes (Table II). A positive association was observed between body mass index (BMI) and colon cancer risk in males, but not in females. None of the variables in Table II significantly deviated from linearity when a second-order term was introduced (results not shown).

Total physical activity (occupational and recreational combined) showed an overall negative dose-response relationship with colon cancer risk among females (P for trend = 0.04), but not in males (Table III).

We analysed colon cancer risk in relation to a possible age effect of total physical activity by dividing the sex-specific cohort into those younger and older than 45 years at study-entry. Among males 45 years or older at study entry (median age at diagnosis = 60.0 years), we observed a negative dose-response relationship between total physical activity and colon cancer risk (P for trend = 0.04), which was not observed among males younger than 45 years at study entry (median age at diagnosis = 52.1 years) (Table IV). In addition, a borderline significant reduction on total colon cancer risk was observed among occupationally physically active males (O2, O3, O4) 45 years or older at study entry compared with the sedentary ones (RR = 0.74, 95% CI 0.53–1.04) (results not shown in Table IV). No similar age effect was observed in females.

Table I Self-reported physical activity during occupational (O) and recreational (R) hours among males and females aged 20–49 years at study entry

	Males		*Females*					
			Total		*Housewives*		*Non-housewives*	
Physical activity (PhA)	*Number*	%	*Number*	%	*Number*	%	*Number*	%
Occupational PhA								
Sedentary (O1)	18 737	35.4	3 232	11.5	690	3.4	2 542	31.4
Walking (O2)	13 990	26.4	19 192	68.2	15 221	76.0	3 971	49.0
Lifting and walking (O3)	11 804	22.3	4 462	15.9	3 049	15.2	1 413	17.4
Heavy manual (O4)	8 414	15.9	1 237	4.4	1 065	5.3	172	2.1
Recreational PhA								
Sedentary (R1)	10 640	20.0	6 336	22.4	4 625	23.0	1 711	21.1
Moderately active (R2)	29 040	54.6	19 100	67.6	13 453	66.8	5 647	69.6
Regular training (R3)	12 206	22.9	2 757	9.8	2 033	10.1	724	8.9
Regular hard training (R4)	1 316	2.5	62	0.2	31	0.2	31	0.4

Table II Age-adjusted relative risk (RR) of colorectal cancer with 95% confidence interval (CI) in relation to possible risk factors. Cox's proportional hazards model

	Colon cancer						Rectal cancer					
		Males			Females			Males			Females	
Variable	*No. of cases*	*RR*[a]	*95% CI*	*No. of cases*	*RR*[a]	*95% CI*	*No. of cases*	*RR*[a]	*95% CI*	*No. of cases*	*RR*[a]	*95% CI*
Age at entry (year)	236	1.13	(1.10–1.16)	99	1.11	(1.07–1.15)	170	1.11	(1.08–1.15)	58	1.20	(1.12–1.28)
BMI (1 g cm^{-2})	230	1.25	(1.01–1.53)	99	0.93	(0.57–1.52)	169	0.99	(0.60–1.63)	55	0.96	(0.51–1.82)
Cholesterol (1 mmol l^{-1})	236	1.02	(0.93–1.12)	99	0.96	(0.82–1.11)	170	1.00	(0.89–1.12)	58	1.04	(0.87–1.26)
Triglycerides (1 mmol l^{-1})	236	1.03	(0.96–1.10)	99	0.85	(0.67–1.07)	170	1.01	(0.92–1.11)	58	1.07	(0.86–1.33)
Height (10 cm)	224	1.13	(0.94–1.35)	99	1.08	(0.80–1.47)	169	1.02	(0.82–1.25)	55	0.88	(0.59–1.32)
Smoking (10 cigarettes)	229	0.96	(0.80–1.16)	99	1.11	(0.73–1.69)	164	1.06	(0.86–1.30)	58	0.84	(0.44–1.61)
Married/separated (ever vs never)	236	1.24	(0.80–1.91)	99	1.29	(0.52–3.16)	170	2.83	(1.39–5.78)	58	1.21	(0.38–3.88)

[a] Adjusted for age at entry. Number of cases varied slightly due to missing values for some variables.

Table III Adjusted relative risk (RR) of colorectal cancer with 95% confidence interval (CI) according to total physical activity (occupational (O) and recreational (R) combined) among males and females; Cox's proportional hazards model

	Total colon cancer				Proximal colon cancer				Distal colon cancer				Rectal cancer			
Total Physical activity	*No. of cases*	*RR*[a]	*95% CI*	*Trend test P value*	*No. of cases*	*RR*[a]	*95% CI*	*Trend test P value*	*No. of cases*	*RR*[a]	*95% CI*	*Trend test P value*	*No. of cases*	*RR*[a]	*95% CI*	*Trend test P value*
Males																
Sedentary[b]	26	1.00			10	1.00			14	1.00			18	1.00		
Moderate[c]	95	1.18	(0.76–1.82)		36	1.16	(0.57–2.34)		56	1.29	(0.72–2.33)		69	1.24	(0.73–2.08)	
Active[d]	107	0.97	(0.63–1.50)	0.49	48	0.96	(0.47–1.93)	0.64	57	0.99	(0.55–1.80)	0.53	81	1.20	(0.72–2.02)	0.63
Females																
Sedentary[b]	22	1.00			10	1.00			11	1.00			8	1.00		
Moderate[c]	17	0.97	(0.33–2.77)		10	1.22	(0.51–2.94)		7	0.84	(0.32–2.17)		6	0.96	(0.33–2.77)	
Active[d]	59	0.63	(0.39–1.04)	0.04	27	0.62	(0.30–1.28)	0.10	27	0.61	(0.30–1.23)	0.15	41	1.27	(0.59–2.72)	0.45

[a] Adjusted for age at entry, geographic region and body mass index (BMI). [b] Sedentary (R1+O1–2). [c] Moderate (R1+O3–4, O1+R3–4). [d] Active (O2–4+R2–4).

When occupational activity was examined separately, each sex showed a consistent negative adjusted reduced risk for colon cancer in the active groups compared with the sedentary group, but in neither case was this significant (Table V). Recreational activity showed no consistent reduced trend in either sex, but females with moderate recreational physical activity (R2) had an almost 40% significant reduction in the risk of total colon cancer (RR = 0.62, 95% CI 0.40–0.97). No consistent associations were observed between total physical activity, occupational or recreational physical activity and risk of rectal cancer in males or females (Table III and V).

When taking subsite into consideration, we performed site-specific analyses of the relationship between total physical activity and proximal and distal colon cancer. A negative trend for both proximal (*P* for trend = 0.10) and distal cancers (*P* for trend = 0.15) was observed in females, though this was not significant (Table III). A negative trend was observed only for proximal cancers in males older than 45 years at entry (*P* for trend = 0.08) (results not presented in Table). Further the reduction of colon cancer risk among the recreational physically active females was particularly marked in the proximal colon (RR = 0.51, 95% CI 0.28–0.93) (Table VI). No corresponding subsite differences were observed in males when taking only recreational activity into consideration.

Further, we examined models stratified by BMI (median split) to analyse if there was any effect modification related to body weight (Table VI). Among females an inverse recreational physical activity–colon cancer association was stronger among leaner females (RR = 0.45, 95% CI 0.25–0.82) compared with more obese females. Among males an inverse physical activity–colon cancer association was strongest in older and leaner males. This was observed especially by dividing BMI into tertiles, as occupationally active males 45 years or older belonging to the lowest tertile (BMI < 2.33 g cm^{-2}) had the greatest reduction in total colon cancer risk (RR = 0.50, 95% CI 0.26–0.97) (results not shown in Table VI).

To examine if the effect of physical activity on colorectal cancer differed between males and females we performed combined analyses both for total colon and for subsites. Here, we observed no significant effect of gender alone or when introducing an interaction term of gender and physical activity on colorectal cancer risk in any of the analyses (results not shown).

Discussion

In the present study an inverse dose–response relationship between total physical activity and colon cancer risk was observed in females. In males this inverse dose–response relationship was found only for those 45 years or older at study entry. An almost 40% reduction in risk of colon cancer among the moderately leisure time active compared with sedentary females was demonstrated. This reduction in cancer risk in females from recreational physical activity was particularly related to proximal colon with an almost 50%

Table IV Adjusted relative risk (RR) of colon cancer with 95% confidence interval (CI) according to total physical activity (occupational (O) and recreational (R) combined) stratified by age at entry among males and females; Cox's proportional hazards model

Total Physical activity	Males No. of cases	Males RR^a	Males 95% CI	Males Trends test P value	Females No. of cases	Females RR^a	Females 95% CI	Females Trend test P value
<45 years at entry								
Sedentary[b]	5	1.00			11	1.00		
Moderate[c]	30	2.02	(0.78–5.21)		8	0.96	(0.39–2.40)	
Active[d]	49	2.23	(0.88–5.66)	0.13	30	0.62	(0.31–1.23)	0.13
≥45 years at entry								
Sedentary[b]	21	1.00			11	1.00		
Moderate[c]	65	0.96	(0.59–1.58)		9	0.99	(0.41–2.39)	
Active[d]	58	0.66	(0.40–1.10)	0.04	29	0.66	(0.33–1.33)	0.19

[a] Adjusted for age at entry, geographic region and body mass index (BMI). [b] Sedentary (R1 + O1–2). [c] Moderate (R1 + O3–4, O1 + R3–4). [d] Active (O2–4 + R2–4).

Table V Adjusted relative risk (RR) of colorectal cancer with 95% confidence interval (CI) related to categories of occupational (O) and recreational (R) physical activity among males and females; Cox's proportional hazards model

Physical activity (PhA)		Colon cancer No. of cases	Colon cancer RR^a	Colon cancer 95% CI	Colon cancer Trend test P value	Rectal cancer No. of cases	Rectal cancer RR^b	Rectal cancer 95% CI	Rectal cancer Trend test P value
Males									
Occupational PhA									
Sedentary	(O1)	92	1.00			71	1.00		
Walking	(O2)	62	0.92	(0.67–1.28)		43	0.90	(0.61–1.31)	
Lifting/Heavy manual	(O3 + O4)	74	0.82	(0.59–1.13)	0.22	54	1.00	(0.69–1.45)	0.95
Recreational PhA									
Sedentary	(R1)	41	1.00			29	1.00		
Moderately active	(R2)	125	1.05	(0.74–1.50)		106	1.25	(0.83–1.89)	
Regular training	(R3 + R4)	64	1.33	(0.90–1.98)	0.13	34	0.98	(0.60–1.61)	0.85
Females									
Occupational PhA									
Sedentary	(O1)	12	1.00			6	1.00		
Walking	(O2)	66	0.82	(0.44–1.51)		37	0.95	(0.40–2.26)	
Lifting/Heavy manual	(O3 + O4)	20	0.69	(0.34–1.42)	0.32	12	0.88	(0.33–2.36)	0.78
Recreational PhA									
Sedentary	(R1)	30	1.00			9	1.00		
Moderately active	(R2)	57	0.62	(0.40–0.97)		40	1.51	(0.73–3.11)	
Regular training	(R3 + R4)	12	0.84	(0.43–1.65)	0.25	6	1.49	(0.53–4.22)	0.35

[a] Adjusted for age at entry, geographic region and body mass index (BMI). [b] Adjusted for age at entry, geographic region, body mass index (BMI) and civil status.

Table VI Adjusted relative risk[a] of colon cancer with 95% confidence intervals (in parentheses) related to occupational (O) and recreational (R) physical activity stratified by subsites and body mass index (BMI) in males and females; Cox's proportional hazards model

	No. of cases	*Occupational physical activity*			*No. of cases*	*Recreational physical activity*		
		Sedentary (O1)	*Active (O2–4)*			*Sedentary (R1)*	*Active (R2–4)*	
Males								
Subsites								
Proximal	89	1.00	0.89	(0.57–1.18)	90	1.00	1.05	(0.62–1.78)
Distal	127	1.00	0.82	(0.57–1.78)	128	1.00	1.19	(0.75–1.89)
BMI (g cm^{-2})								
<2.44	89	1.00	0.87	(0.56–1.35)	89	1.00	1.36	(0.74–2.51)
⩾2.44	139	1.00	0.85	(0.60–1.21)	141	1.00	1.05	(0.69–1.58)
Females								
Subsites								
Proximal	47	1.00	1.14	(0.41–3.18)	48	1.00	0.51	(0.28–0.93)
Distal	45	1.00	0.52	(0.24–1.11)	45	1.00	0.80	(0.41–1.56)
BMI (g cm^{-2})								
<2.36	48	1.00	1.43	(0.51–3.98)	48	1.00	0.45	(0.25–0.82)
⩾2.36	50	1.00	0.50	(0.23–1.06)	51	1.00	0.93	(0.49–1.74)

[a] Adjusted for age at entry, geographic region and body mass index (BMI).

reduction among active females. No association between physical activity and rectal cancer was observed in males or females.

The strength of this study beyond its prospective design, large size, broad population base and inclusion of both sexes, is a nearly complete cancer case ascertainment. Compulsory reporting by hospital departments and pathological laboratories for all new cases of cancer in Norway as well as death certificates results in very high case ascertainment. This is in addition to an almost 100% histological verification of colon cancer cases.

The accuracy of the self-reported physical activity questions used in the present analysis has been validated in several studies (Wilhelmsen *et al.*, 1976; Bjartveit *et al.*, 1981; Holme *et al.*, 1981; Løchen and Rasmussen 1992). Løchen and Rasmussen (1992) demonstrated that physical fitness among males increased with physical activity in leisure time. However, there are some limitations in using a single brief questionnaire reporting physical activity during one year without repeated assessments of physical activity and measurements of energy expenditure or dietary information. The large proportion (70%) of housewives in our cohort may have limited our ability to detect any effect of occupational activity on colon cancer risk among females. A greater variability in physical activity during leisure time rather than at work may in part explain why leisure time activity in females significantly reduced risk of colon cancer and occupational activity did not. In addition, the participants had to choose between only four occupational categories and four recreational levels of physical activity and we may therefore have underestimated the strength of physical activity for those most active.

The present findings support and extend previous results showing that physical activity is inversely related to colon cancer risk in humans (Garabrant *et al.*, 1984; Gerhardsson *et al.*, 1986; Brownson *et al.*, 1989; Peters *et al.*, 1989; Arbman *et al.*, 1993; Chow *et al.*, 1993; Fraser and Pearce, 1993; Wu *et al.*, 1987; Slattery *et al.*, 1988; Gerhardsson *et al.*, 1988; Severson *et al.*, 1989; Ballard-Barbash *et al.*, 1990; Lee *et al.*, 1991; Markowitz *et al.*, 1992; Giovannuci *et al.*, 1995) and animals (Andrianpopulos *et al.*, 1987; Reddy *et al.*, 1988).

We did not find an overall protective effect of total physical activity on colon cancer in males. This may be owing to the young age at entry and the fact that the number of cases of colon cancer are relatively small among the youngest males, thereby limiting the statistical power. The observation that only males 45 years or older at study entry had a protective effect of physical activity on colon cancer risk is consistent with similar findings in previous studies which support that age may be an effect modifier for colon cancer (Albanes *et al.*, 1989; Ballard-Barbash *et al.*, 1990; Slattery *et al.*, 1994). The observed 50% reduction in colon cancer risk among occupationally active, older and leaner males compared with sedentary males is in agreement with findings in the Framingham study in which the strongest inverse physical activity – large bowel cancer association was found among older (>50 years) and leaner males (Ballard-Barbash *et al.*, 1990). In contrast, no such age effect was found among females in the present nor in the Framingham study. An interpretation may be a somewhat different age distribution at diagnosis in females relative to males (median age at diagnosis; males, 58.1 years; females 54.6 years). Power may also be greater for males owing to the much greater number of cancer cases compared with females in both studies, thus making any age effect easier to discover in males. Consequently, physical activity as a protective factor in colon cancer risk may be of greater importance among the elderly relative to younger subjects in whom the importance of genetic predisposition may be greater. Biological mechanisms related to an age effect from physical activity on colon cancer risk have been proposed to act through improvements of the immune system among physically active elderly subjects (Shepard and Shek, 1995) or that physical activity, acting over a longer period of time in older people, is particularly important (Lee *et al.*, 1991). In spite of no significant gender differences from physical activity on colon cancer risk observed in the present study, previous studies suggest sex differences as men and women show differences under controlled experimental conditions in gastrointestinal transit time, stool bulk and bile acid production (Stephen *et al.*, 1986; Lampe *et al.*, 1993).

The inverse association between physical activity and colon cancer risk observed in the present study could be confounded. Physically active individuals may have had a diet with less saturated fat and more fibre than the inactive ones. Unfortunately, no dietary data were available for this analysis. However, other studies that examined dietary differences have concluded that physical activity and dietary factors are independent risk factors for colon cancer (Slattery *et al.*, 1988; Peters *et al.*, 1989; Gerhardsson de Verdier *et al.*, 1990; Whittemore *et al.*, 1990; Giovannucci *et al.*, 1994).

Holme *et al.* (1981), partly examining the same male cohort as followed in the present study, observed that higher social classes dominated among males who reported sedentary work, while males who were sedentary at leisure time more often represent lower social classes. Therefore, the reference group used in total physical activity reflect both high and low social classes. Social class did not influence colon cancer risk in a comparable society (Suadicani *et al.*, 1993). It is less likely, therefore, that social class explains the observed association between total physical activity and colon cancer risk.

Another observation of interest was the protective effect on proximal colon cancer incidence among physically leisure-time active females. This observation was in part also demonstrated in males 45 years or older at study entry with a particular reduction in proximal colon cancer incidence as a result of total physical activity. A possible explanation could be that exercise affects gut mobility more extensively in the proximal relative to distal colon. However, previous studies which have taken site-specific colon cancer risk into consideration have been inconsistent (Fraser and Pearce, 1993; Peters *et al.*, 1989; Gerhardsson de Verdier *et al.*, 1990; Vena *et al.*, 1985; Gerhardsson *et al.*, 1986; Brownson *et al.*, 1989).

Our study suggests that body size may modify the effect of physical activity as we observed leaner active males and females to be at a decreased colon cancer risk compared with obese subjects. This agrees with previous reports (Albanes *et al.*, 1989; Ballard-Barbash *et al.*, 1990; Giovannucci *et al.*, 1995). Body mass index (BMI) as a significant risk factor for colon cancer among males is consistent with previous studies (Marchand *et al.*, 1992; Ballard-Barbash *et al.*, 1990). The results have been more inconsistent in females (Albanes *et al.*, 1989; Ballard-Barbash *et al.*, 1990; Whittemore *et al.*, 1990). However, no direct mechanism has been suggested for the colon cancer – obesity association, but the association may indirectly be an effect of both diet and physical activity.

Several potential biological mechanisms may contribute to an observed protective effect of physical activity on colon cancer risk, including constipation which is often improved by physical activity. Walking (Holdstock *et al.*, 1970), running (Cordain *et al.*, 1986) and strength training (Koffler *et al.*, 1992), have generally been found to reduce GI transit times although not in one study (Bingham and Cummings, 1989). Contact between the colon mucosa and potential carcinogens in the faecal stream may be decreased by exercise because of shortened transit time. The fact that physical activity does not seem to lower the risk of rectal cancer accords with this 'transit time theory' as the rectum is only intermittently filled with faeces and colon peristalsis has less influence on the faecal transit time in the rectum. A decrease in the ratio of secondary to primary bile acids has been observed in obese patients after treatment with subcaloric diet and graded physical activity (Kadyrova and Shakieva, 1986). This effect of physical activity may be of importance since a high excretion of bile acids may increase the risk of colon cancer. Exercise can also elevate the production of some prostaglandins that, in turn, may influence colon cancer risk (Demers *et al.*, 1981). Physical activity may also increase colonic bloodflow so that faecal mutagens are transported away from the mucous membrane.

In conclusion, our study supports a protective effect of total physical activity on colon cancer, but not rectal cancer, in both males and females. In males this protective effect of physical activity is of greatest importance among the elderly. The stronger protective effect of physical activity on proximal rather than distal colon cancer risk supports the assumption that physical activity affects gut mobility more extensively in the proximal relative to distal colon. Further studies are needed in which repeated measurements of duration and intensity of physical activity besides energy balance, dietary factors, age, subsites and gender differences are taken into account.

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Paper III

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THE INFLUENCE OF PHYSICAL ACTIVITY ON LUNG-CANCER RISK
A prospective study of 81,516 men and women

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Physical activity is inversely related to mortality from respiratory diseases including lung cancer. Physical activity improves pulmonary function but its impact on lung-cancer risk has not been studied much. During 1972–1978, 53,242 men and 28,274 women, aged 20 to 49 years, participated in a population-based health survey and were followed until 31 December 1991. We observed a total of 413 men and 51 women with lung cancer. Leisure activity and work activity were assessed using a questionnaire in 4 categories. In a sub-cohort, physical activity was assessed twice at an interval of 3 to 5 years. Leisure but not work activity was inversely related to lung-cancer risk in men after adjustment for age, smoking habits, body-mass index and geographical residence (*p* for trend = 0.01). Men who exercised at least 4 hours a week had a lower risk than men who did not exercise [relative risk (RR) = 0.71; 95% confidence interval (CI) = 0.52–0.97]. Reduced risk of lung cancer was particularly marked for small-cell carcinoma (RR = 0.59; 95% CI = 0.38–0.94) and for adenocarcinoma (RR = 0.65; 95% CI = 0.41–1.05), with no association seen for squamous-cell carcinoma. In the sub-cohort in which physical activity was assessed twice, the risk of lung cancer was particularly reduced among men who were most active at both assessments (RR = 0.39; 95% CI = 0.18–0.85). No consistent association between physical activity and lung-cancer risk was observed among women. Our results suggest that leisure physical activity has a protective effect on lung-cancer risk in men. The small number of incident cases, combined with the narrow range of physical activity reported, may have limited our ability to detect an association between physical activity and lung cancer in women. *Int. J. Cancer,* 70:57–62, 1997.

Pulmonary function is inversely related to mortality from respiratory diseases including lung cancer (Kuller *et al.*, 1990; Nomura *et al.*, 1991; Weiss *et al.*, 1995). A measure of pulmonary function, the forced expiratory volume in one second adjusted for height (FEV_1/height), correlates positively with strenuous physical activity and duration of exercise (Kuller *et al.*, 1990; Higgins *et al.*, 1991). In a prospective study, Nomura *et al.* (1991) observed a reduction in lung-cancer risk among subjects with high levels of FEV_1. Therefore physical activity may have an influence on subsequent lung-cancer risk. No study has specifically focused on this relationship, although a few epidemiological studies have provided indications that physical activity may reduce lung-cancer risk (Albanes *et al.*, 1989; Severson *et al.*, 1989; Sellers *et al.*, 1991; Lee and Paffenbarger, 1994).

Smoking is a well-established cause of lung cancer. The fact that most smokers never develop lung cancer has prompted interest in the role of host factors in pulmonary carcinogenesis (McDuffie *et al.*, 1993). Prospective and case-control studies have shown that histological types of lung cancer vary in their respective aetiology (Vena *et al.*, 1985; Yang *et al.*, 1989; McDuffie *et al.*, 1993). Smoking has been shown to be a strong risk factor for squamous-cell carcinoma and small-cell carcinoma, but a weak risk factor for adenocarcinoma (Brownson *et al.*, 1992; McDuffie *et al.*, 1993). Adenocarcinoma is the second most frequent histological sub-type of cancer in Norway (Cancer Registry of Norway, 1995). A recent study in the USA, however, has reported that adenocarcinoma has replaced squamous-cell carcinoma as the most common histological sub-type of lung cancer for all sexes and races combined (Travis *et al.*, 1995). This may indicate a change in the aetiology and pathogenesis of this very important cancer type. To verify this, possible factors other than the effect of smoking on lung-cancer risk must be examined. We have reported earlier, from the same cohort, a protective effect of physical activity on prostate (Thune and Lund, 1994) and colon cancer (Thune and Lund, 1996), a finding that points to physical activity as a protective factor for certain cancer sites.

In this paper we hypothesize that physical activity may lower the risk of lung cancer. This hypothesis is based on the analysis of a large population-based prospective study of 81,516 men and women, in which careful adjustments for smoking habits were made. In a sub-cohort, 2 assessments of physical activity permitted the evaluation of sustained physical activity on the risk of lung cancer.

SUBJECTS AND METHODS

Cohort

Between 1972 and 1978, 104,485 men and women, aged 20 to 49 years, from 3 counties (Oppland, Sogn and Fjordane, and Finnmark) and 2 cities (Oslo and Tromsø) were invited to participate in a population-based health survey of risk factors for cardiovascular disease. In Tromsø, all men aged 20 to 49 years were invited to participate, whereas in Oslo men aged 40 to 49 were invited, together with a 7% random sample of men aged 20 to 39. In the 3 counties of Oppland, Sogn and Fjordane, and Finnmark, all men and women aged 35 to 49 and a 10% random sample of people aged 20 to 34 years were invited to participate. In 4 small municipalities in Finnmark, all men and women aged 20 to 34 were invited: a total of 104,485, of whom 53,622 men (73.5%) and 28,621 women (90.7%) attended the screening. In the 3 counties, 3 or 5 years later (1977–1983), people still resident there were invited to a similar health survey.

Screening procedures were almost identical in the 5 areas. Each person was initially contacted by mail, with a covering letter and a one-page questionnaire. The participants were asked to answer the questionnaire at home and to bring it to the clinical examination at which the questionnaire was checked for inconsistencies. Measurements of weight, height and blood pressure were made, and blood samples were taken at the examination. The questionnaire covered the following areas: physical activity (PhA) during recreational (R) and occupational (O) hours within the last year; history of chronic diseases, especially cardiovascular symptoms and diseases; smoking habits and stress in daily life.

Population for analysis

All 53,622 men and 28,621 women were followed up through the Norwegian Central Bureau of Statistics to identify deaths in the cohort until the end of 1991. Those who emigrated, or who had a pre-existing malignancy, or who developed a malignancy within the first year after the survey (men, n = 380; women, n = 347) were excluded from the analyses. This reduced the possibility of

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TABLE I – AGE-ADJUSTED[1] MEAN/DISTRIBUTION (%) OF BASELINE CHARACTERISTICS ACCORDING TO LEVEL AND CATEGORY OF PHYSICAL ACTIVITY AT FIRST SCREENING, BY GENDER

Characteristics by gender	Recreational activity			Occupational activity			
	Sedentary[2]	Moderately active	Regular exercise	Sedentary	Walking	Lifting	Heavy manual
Men	(n = 10,640)	(n = 29,040)	(n = 13,522)	(n = 18,737)	(n = 13,990)	(n = 11,804)	(n = 8,414)
Age at entry (years)	42.7	43.0	41.3	42.8	42.8	41.9	42.3
BMI (kg/m^2)	25.1	24.6	24.5	24.6	24.6	24.8	25.0
Cholesterol (mmol/l)	6.92	6.83	6.61	6.72	6.77	6.87	6.86
Triglycerides (mmol/l)	2.60	2.47	2.36	2.39	2.47	2.54	2.54
Smoking habits							
Current cigarette smokers (%)	59.0	49.7	39.3	43.1	49.1	56.6	50.6
Number of cigarettes (daily)	15.0	13.4	12.2	14.2	13.4	13.3	12.8
Number of years smoked	21.0	20.3	19.8	20.1	20.3	20.7	20.7
Pipe or cigar smokers (%)	6.0	6.3	6.4	7.0	5.8	5.6	6.2
Ex-smokers (%)	18.1	22.7	24.7	25.0	22.7	19.9	18.8
Never-smokers (%)	16.7	21.0	29.2	24.5	22.2	17.4	23.9
Women	(n = 6,336)	(n = 19,100)	(n = 2,819)	(n = 3,232)	(n = 19,192)	(n = 4,462)	(n = 1,237)
Age at entry (years)	41.5	41.1	41.2	40.2	40.9	41.9	43.3
BMI (kg/m^2)	24.9	24.4	24.1	24.1	24.4	24.8	25.3
Cholesterol (mmol/liter)	6.76	6.65	6.52	6.63	6.68	6.66	6.61
Triglycerides (mmol/liter)	1.91	1.81	1.76	1.80	1.83	1.85	1.81
Smoking habits							
Current cigarette smokers (%)	42.7	38.0	33.0	41.0	39.1	39.1	22.6
Number of cigarettes (daily)	10.2	9.1	8.8	10.1	9.3	9.2	8.4
Number of years smoked	16.0	15.6	15.5	16.1	15.7	15.3	14.6
Ex-smokers (%)	11.0	13.1	14.5	14.7	13.1	11.5	8.4
Never-smokers (%)	46.1	48.7	52.2	44.1	47.6	49.2	68.7

[1]Except mean age.–[2]Number of participants for activity categories in parentheses. For some subjects, information concerning smoking status, height and body mass index (BMI) was missing.

any undiagnosed cancer influencing the level of physical activity. Included for analysis were 53,242 men (867,822 person-years) and 28,274 women (437,785 person-years).

A sub-cohort of 25,879 men and 26,131 women participating in the first (1974–1978) and the second (1977–1983) screening were followed for an additional year, until the end of 1992 (attendance rate was 85.3% of all invited). Those who emigrated, who had a pre-existing malignancy or who developed a malignancy within the first year after attending the second survey (men, n = 270; women, n = 772) were excluded from analyses. Included for analysis in the sub-cohort were 25,609 men (306,488 person-years) and 25,629 women (309,303 person-years).

Assessment of physical activity

Self-reported physical-activity categories during recreational hours in the last year was graded from 1 to 4, according to which of the following categories provided the best description of the participant's usual level of leisure activity: R1, reading, watching TV or other sedentary activities; R2, walking, bicycling or physical activities for at least 4 hr a week; R3, exercise to keep fit, participating in recreational athletics, etc., for at least 4 hr a week; R4, regular hard training or participation in competitive sports several times a week.

Self-reported physical activity during work hours in the last year was divided into 4 categories: O1, mostly sedentary work; O2, work with a lot of walking; O3, work with a lot of lifting and walking; O4, heavy manual work. At the screening, trained nurses checked the reporting of physical activity at work and leisure time for inconsistencies, and particular attention was given to housewives. This has been described in more detail elsewhere (Thune and Lund, 1996). Heart rate and other measures of physical fitness were not assessed.

Identification of cases

The national 11-digit personal identification number enabled a linkage to the Cancer Registry of Norway. This allowed identification of every incident case of lung cancer occurring in the cohort in accordance with the seventh revision of the International Classification of Diseases. Histological classification was based on the diagnoses in the pathology reports. Reporting of malignant and pre-malignant diagnoses is mandatory for all laboratories in the country. Cases identified only incidentally *post mortem* were not included. Histological confirmation was performed in 95.4% of the cases among men and 98.0% among women.

Statistical analysis

All analyses were gender-specific. In the main cohort, observation years at risk were calculated as the number of years from one year after entry into the study until the time of withdrawal (year of diagnosis, time of death or end of follow-up at 31 December 1991). In the sub-cohort, we calculated the observation time for each person from one year after second screening until the time of withdrawal (year of diagnosis, death or end of follow-up at 31 December 1992). This reduced the possibility of any undiagnosed cancer influencing the level of physical activity reported at both surveys. Baseline variables were age-adjusted and compared by analysis of co-variance. Cox's proportional-hazard regression technique was used to analyze the simultaneous effect of physical activity and co-variates on lung-cancer incidence in the cohort.

In the analyses, the R3 and R4 categories of leisure activity were merged because of the small numbers in category R4 in both screenings. We adjusted for age at entry into the screening (continuous variable), smoking habits, geographical regions and obesity at time of measurements. Smoking habits were adjusted according to ex-smoking, pipe and cigar smoking, current cigarette smoking, including number of cigarettes smoked, and years of smoking. In addition, stratified analyses by smoking behaviour were performed. As a measure of obesity, we used the body-mass index (BMI) [weight (kg)/(height [m])^2].

To study the influence of total physical activity on lung-cancer risk, occupational (O) and recreational (R) physical activity were combined. We used sedentary leisure activity (R1) and sedentary at work (O1) as the reference group (R1/O1). To account for changes over time in physical activity and smoking habits, we used information from both screenings.

The analyses were performed with the Proc Phreg procedure in the SAS statistical package. In some analyses, only cases with

TABLE II – ADJUSTED RELATIVE RISK (RR) OF LUNG CANCER WITH 95% CONFIDENCE INTERVAL (CI) RELATED TO CATEGORIES OF OCCUPATIONAL (O) AND RECREATIONAL (R) PHYSICAL ACTIVITY AT THE FIRST SCREENING (1972–78) AMONG MEN AND WOMEN

Physical activity (PhA)	Men			Women		
	Number of cases	RR[1]	95% CI	Number of cases	RR[1]	95% CI
Occupational PhA						
Sedentary (O1)	139	1.00	(Ref)	8	1.00	(Ref)
Walking (O2)	119	1.15	(0.90–1.47)	34	0.81	(0.37–1.76)
Lifting (O3)	97	1.13	(0.87–1.47)	8	0.79	(0.30–2.12)
Heavy manual (O4)	47	0.99	(0.70–1.41)	0	—	
Trend test		$p = 0.71$			$p = 0.30$	
Recreational PhA						
Sedentary (R1)	123	1.00	(Ref)	14	1.00	(Ref)
Moderate (R2)	217	0.75	(0.60–0.94)	32	0.91	(0.48–1.71)
Regular training (R3 + R4)	62	0.71	(0.52–0.97)	5	0.99	(0.35–2.78)
Trend test		$p = 0.01$			$p = 0.88$	
Total PhA (occupational + recreational)						
Sedentary (O1 + R1)	52	1.0	(Ref)	2	1.0	(Ref)
Active	349	0.73	(0.54–0.98)	48	0.87	(0.21–3.62)

[1]Adjusted for age at entry, geographical region, smoking habits [ex-smoking, pipe/cigar smoking (males only), number of cigarettes smoked, years smoked] and BMI.

histological diagnoses of squamous-cell carcinoma, adenocarcinoma and small-cell carcinoma were taken into consideration. As a result of missing data, the number of subjects included in the individual analyses varies slightly.

RESULTS

Lung cancer was diagnosed in 413 men and 51 women with median age at diagnosis of 57.3 (39.1–67.8) years and 54.2 (42.1–62.7) years in men and women, respectively, in the main cohort. Squamous-cell carcinoma was diagnosed in 128 cases (31.0%) and 10 cases (19.6%); adenocarcinoma in 88 cases (21.3%) and 17 cases (33.3%); small-cell carcinoma in 84 cases (20.3%) and 15 cases (29.4%); other types/unspecified malignancy in 94 cases (22.8%) and 8 cases (15.7%); histology not known 19 cases (4.6%) and 1 case (2.0%), in men and women, respectively.

Table I presents baseline characteristics according to type and level of activity. Approximately 25% of the men, but only 10% of the women, reported regular leisure exercise. Gender differences were also observed during occupational hours; two thirds of the women reported frequent walking, whereas in men work activity was more equally distributed among the different activity categories. Subjects reporting more leisure activity tended to be leaner and had lower serum lipids, in contrast to those subjects who had little leisure exercise and those performing heavy manual occupational activity, who had the highest BMI among both sexes. Current cigarette smokers dominated the group, with low leisure exercise, whereas ex-smokers and never-smokers reported more frequent leisure exercise.

After adjustment for age at entry, geographical region, smoking habits (ex-smoker, pipe/cigar smoking, number of cigarettes smoked, years smoked) and BMI, the risk of lung cancer decreased with increase in leisure activity among men in a dose-response manner (p for trend = 0.01) (Table II). Men who exercised for at least 4 hr a week during leisure time had a reduced adjusted relative risk (RR = 0.71; 95% CI = 0.52–0.97). No such relationship was observed among women. No statistical association was observed between work activity and lung-cancer risk among men or women.

To study total physical activity, leisure and work activity were combined (Table II). Among men we observed a 27% reduction in risk among active men (non-sedentary) compared with sedentary men (O1, R1) (RR = 0.73; 95% CI = 0.54–0.98). For women, the small number of lung-cancer cases in the reference group prevented any conclusion.

For men active in their leisure time (R2 + R3 + R4) compared with inactive men (R1), the relative risk of lung cancer was particularly reduced for small-cell carcinoma (RR = 0.59, 95% CI = 0.38–0.94) and adenocarcinoma (RR = 0.65; 95% CI = 0.41–1.05), with no significant association for squamous-cell carcinomas (Table III).

We examined the time-dependent nature of physical activity in 3 of 5 geographical areas, with initial activity assessment between 1974 and 1978 and an update after 3 to 5 years. In this sub-cohort, 142 lung-cancer cases were observed among men and 50 cases among women during a total of 615,000 person-years. Among men, median age at diagnosis was 57.0 years (41.3–66.2) whereas in women it was 55.2 years (48.7–62.7).

The impact of sustained leisure activity over time on lung-cancer risk among men is presented in Table IV. We observed the greatest reduction in lung-cancer risk among those who were active in their leisure time (R3/R4) at both screenings; the men who were inactive in their leisure time at both assessments were used as a reference group (RR = 0.39, 95% CI = 0.18–0.85; p for trend, 0.01). A weaker, but consistently reduced, lung-cancer risk was observed among the active men (R3/R4) relative to sedentary men (R1) at the first screening, whereas there was a reduction in risk of almost 40% in these men (R3/R4) at the second screening compared with the inactive men (R1) (RR = 0.62; 95% CI = 0.38–1.01). This association between activity at the second screening and lung-cancer risk was also observed in an inverse dose-response manner (p for trend, 0.05).

We also examined models stratified by smoking habits in men, to examine whether the number of cigarettes smoked influenced our results. As a consequence of the small number of lung cancer cases among never-smokers (n = 5) and among ex-smokers (n = 25), we only performed stratified analyses among current smokers by the number of cigarettes smoked (Table V). Among men smoking 15 cigarettes or more daily, we observed a reduced lung-cancer risk among active men compared with inactive men (RR = 0.59; 95% CI = 0.35–0.97). Similar results were found among men smoking less than 15 cigarettes daily, but these results did not reach significant levels (RR = 0.79; 95% CI = 0.49–1.26). The same analyses were performed for occupational activity groups, but no significant associations were observed.

DISCUSSION

In the present study we found that leisure activity reduced lung-cancer risk among men in a dose-response fashion. This protective effect was also seen for total physical activity, and was strengthened when initial and subsequent leisure activity assessments were combined.

The association between physical activity and lung-cancer risk has not been studied much. Our results however, can be compared,

TABLE III – ADJUSTED RELATIVE RISK (RR)[1] OF LUNG CANCER WITH 95% CONFIDENCE INTERVAL (CI) AMONG DIFFERENT HISTOLOGICAL SUB-TYPES ACCORDING TO RECREATIONAL (R) PHYSICAL ACTIVITY (PhA) AMONG MEN AGED 20–49 YEARS AT ENTRY IN 1972–1978 (FIRST SCREENING)

Recreational PhA	Squamous-cell carcinoma			Adenocarcinoma			Small-cell carcinoma		
	Number of cases	RR	95% CI	Number of cases	RR	95% CI	Number of cases	RR	95% CI
Sedentary (R1)	34	1.0		26	1.0		30	1.0	
Active (R2/R3/R4)	91	0.97	(0.65–1.44)	58	0.65	(0.41–1.05)	53	0.59	(0.38–0.94)

[1]Adjusted for age at entry, geographical region, smoking habits (ex-smoking, pipe/cigar smoking, number of cigarettes, years of smoking) and BMI.

TABLE IV – ADJUSTED RELATIVE RISK (RR) OF LUNG CANCER WITH 95% CONFIDENCE INTERVAL (CI) ACCORDING TO RECREATIONAL (R) PHYSICAL ACTIVITY AMONG PARTICIPATING MEN AT BOTH SCREENINGS, AGED 20–49 YEARS IN 1974–78

Recreational PhA	Years of assessment of physical activity								
	1974–78			1977–83			1974–78 and 1977–83		
	Number of cases	RR[1]	95% CI	Number of cases	RR[2]	95% CI	Number of cases	RR[3]	95% CI
Sedentary (R1)	36	1.0		38	1.0		21	1.0	
Moderate (R2)	74	0.81	(0.54–1.21)	71	0.72	(0.48–1.07)	45	0.54	(0.32–0.91)
Regular exercise (R3, R4)	28	0.84	(0.51–1.39)	29	0.62	(0.38–1.01)	10	0.39	(0.18–0.85)
Trend test		$p = 0.46$			$p = 0.05$			$p = 0.01$	

[1]Adjusted for age at entry, geographical region, smoking habits (ex-smoker, pipe/cigars, number of cigarettes, years of smoking) and BMI at first screening (1974–1978).–[2]Adjusted for age at entry, geographical region, smoking habits (ex-smoker, pipe/cigars, number of cigarettes, years of smoking) and BMI at second screening (1977–1983).–[3]Adjusted for age at entry at first screening, geographic region, smoking habits (ex-smoker, pipe/cigars, number of cigarettes, years of smoking) and BMI at second screening (1977–1983).

in part, with earlier research (Albanes *et al.*, 1989; Severson *et al.*, 1989; Sellers *et al.*, 1991; Lee and Paffenbarger, 1994). Albanes *et al.* (1989) observed, in their follow-up study of 12,500 subjects, that men in sedentary occupations had twice the risk of lung cancer of men in non-sedentary occupations. They revealed a dose-response profile, also demonstrated by others (Paffenbarger *et al.*, 1987). In contrast, increased incidence (Brownson *et al.*, 1991), as well as increased lung-cancer mortality (Garfinkel and Stellman, 1988), has been reported among physically active, as compared with inactive, men. In the first study, leisure-time activity was not assessed, whereas in the second study smoking habits were not adjusted for.

The accuracy of the self-reported recreational physical activity questions used in the present study has been validated (Wilhelmsen *et al.*, 1976; Holme *et al.*, 1981; Løchen and Rasmussen, 1992). In addition, the results for BMI and blood-lipid profiles across leisure activity groups support the validity of the assessment of physical activity. Our data also have the advantage of repeated individual estimates of total physical activity in a general population. We observed a greater protective effect of moderate and regular exercise when 2 activity assessments over a timespan of 3 to 5 years were combined. This finding may be the result of a reduction in mis-classification of physical activity, and further indicates that physical activity over a longer period is of importance. A similar effect of physical activity on risks of prostate cancer was observed in the Harvard alumni study by Lee *et al.* (1992), who observed a greater protective effect when 2 activity assessments were combined. In the ascertainment of physical activity in the present study, the questionnaire was checked for inconsistency at both screenings. It is, however, possible that reported physical exercise during leisure time is in excess of its actual occurrence (*i.e.*, "wish" bias). Based on the same questionnaire, one study demonstrated that physical fitness increased with leisure activity (Løchen and Rasmussen, 1992). Moreover, combining 2 assessments increased the precision of physical-activity measurements, and may have reduced such "wish" bias.

Another strength of this study is the completeness of data on lung-cancer cases, thanks to the compulsory reporting of all new cancer cases by hospital departments, pathology laboratories and death certificates in Norway. In addition, there was unbiased selection of participants.

One explanation of the observed association in our study could be that a pre-clinical illness resulting in inactivity could underlie the increased risk seen among sedentary men. However, the relative-risk estimates and tests for linear trend were essentially unchanged in men and women after excluding either 1, 2 or 4 years of follow-up.

The magnitude of the impact of cigarette smoking on lung-cancer risk is well documented (Doll and Peto, 1978; Risch *et al.*, 1993). One could therefore argue that our findings are residual effects of smoking which cannot be entirely eliminated by statistical adjustments. However, adjustments were made carefully for current and former smoking behaviour, ex-smoking and number of cigarettes smoked daily, as well as for years of current smoking. In addition, among men smoking 15 cigarettes or more daily, a reduced lung-cancer risk was observed among those men who were active in their leisure time compared with sedentary men. Further, it is likely that those active men who had smoked heavily had consumed about the same number of cigarettes during their lifetime

TABLE V – ADJUSTED RELATIVE RISK (RR)[1] OF LUNG CANCER WITH 95% CONFIDENCE INTERVAL (CI) AND RECREATIONAL (R) PHYSICAL ACTIVITY STRATIFIED BY NUMBER OF CIGARETTES SMOKED IN CURRENT CIGARETTES SMOKING MEN AT THE FIRST SCREENING (1972–78)

Physical activity (PhA)	<15 Cigarettes			15 Cigarettes+		
	Number of cases	RR	95% CI	Number of cases	RR	95% CI
Recreational PhA						
Sedentary (R1)	42	1.0		71	1.0	
Moderate (R2)	94	0.77	(0.53–1.11)	96	0.71	(0.52–0.96)
Regular exercise (R3, R4)	31	0.79	(0.49–1.26)	20	0.59	(0.35–0.97)
Trend test		$p = 0.28$			$p = 0.01$	

[1]Adjusted for age at entry, geographical region, pipe/cigar smoking, years of smoking and BMI.

as the sedentary men who were currently heavy smokers, because the number of reported years of smoking were the same in the 2 groups. It is plausible, therefore, that physical activity reduces lung-cancer risk, as observed in our study, and is not merely a residual effect of smoking.

In this study, we analyze the association between physical activity and lung-cancer risk by histological sub-types. We observed the inverse association between physical activity and lung cancer to be strongest for small-cell carcinoma, less marked for adenocarcinoma, with no association observed for squamous-cell carcinoma. Although cigarette smoking appears to induce lung cancer for all histological types, the magnitude of smoking-related lung-cancer risk by cell type is strongest for squamous-cell and small-cell carcinoma, and weakest for adenocarcinoma (Vena *et al.*, 1985; Brownson *et al.*, 1992; McDuffie *et al.*, 1993). However, the reliability of histological classification may be a problem, although mis-classifications will make differences in risk smaller, among different histological types, if they are non-differential. In the present study, it is probable that mis-classification is non-differential. Due to the few cases among never-smokers and ex-smokers, we could not analyze these sub-groups. In a cohort study by Lee and Paffenbarger (1994), physically active non-smokers had a reduced lung-cancer risk. When stratified by number of cigarettes smoked (more or less than 15 cigarettes), the findings of a reductive effect of leisure activity on lung-cancer risk were consistent in both groups. Overall, the data still suggest that physical activity reduces lung-cancer risk in men.

One interpretation of these observations could be that physical activity is sufficient to counteract carcinogenesis in groups with exposure to cigarette smoke or other carcinogenic agents. One plausible biological mechanism may act through the increased pulmonary function observed with increased exercise (Kuller *et al.*, 1990; Higgins *et al.*, 1991). Increased pulmonary ventilation and perfusion could reduce the interaction time and concentration of any carcinogenic agent in the airways. High or moderate levels of physical activity may thereby reduce the production of free radicals and carcinogenic metabolites produced from, for example, smoking (Tappia *et al.*, 1995; Morrow *et al.*, 1995). In our study, this supposition is supported by a positive dose-response effect with no threshold effect.

Another mechanism may be that physical activity resulting from increased pulmonary function influences particle deposition. The degree of carcinogenicity of cigarette smoke or other agents may be related to the location of particle deposition in the airways. The geometrical site of preferential particle deposition in the central airway has been demonstrated as the favoured site of cancer induction (Byers *et al.*, 1984; Yang *et al.*, 1989; Martonen, 1992). As small-cell carcinoma and, particularly, adenocarcinoma are more often located in the periphery of the lung, increased pulmonary function could be more important for these sub-types. This may explain the lack of a protective effect of physical activity observed for squamous-cell carcinoma, the protective effect for small-cell carcinoma and adenocarcinoma of the lung in our study.

The lack of association between lung cancer and physical activity among women in our study may be explained partly by the small number of cases. Further, a narrow range of variation of both occupational and leisure physical activity in women could reduce our ability to find such a relationship. An association may therefore be present but undetectable. An indication for this could be the consistent reduction in risk among occupationally active women compared with sedentary women, supported by findings in a nested case-control study in which active women had a 60% reduction in risk of lung cancer (Sellers *et al.*, 1991). A few cases in the present study exclude any conclusion regarding the association of physical activity with lung-cancer risk in women.

Occupational physical activity did not appear, in the present study, to have the same protective effect on lung-cancer risk as leisure activity. Occupational activity could reflect a more static activity, and this is supported by the observation that subjects who carry out more leisure activities are leaner and have lower serum-lipid concentrations, a pattern not observed among occupationally active subjects. Static activity may not influence lung-cancer risk through the same biological mechanism as leisure exercise. However, total physical activity reduced lung-cancer risk among active men compared with sedentary men. This indicates a weak negative or no association between occupational physical activity and lung-cancer risk in men.

CONCLUSION

The observed negative dose-response association between recreational physical activity and lung cancer in men may be explained by exercise-induced improvement of pulmonary function and reduced carcinogenic effect of any environmental factor. The observed protective effect on small-cell carcinoma and adenocarcinoma, but not on squamous-cell carcinoma, supports explanations other than a residual smoking effect. Further studies, including information on physical fitness and pulmonary function, are needed in which both gender and histological sub-types are taken into account, together with smoking habits and physical activity over time.

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Paper IV

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PHYSICAL ACTIVITY AND THE RISK OF BREAST CANCER

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ABSTRACT

Background Because physical activity may affect hormonal concentrations and energy balance, we decided to investigate whether everyday exercise is related to the risk of breast cancer.

Methods During 1974 to 1978 and 1977 to 1983, a total of 25,624 women, 20 to 54 years of age at entry, enrolled in health surveys and answered questionnaires about leisure-time and work activity.

Results During a median follow-up of 13.7 years, we identified 351 cases of invasive breast cancer among the 25,624 women in the cohort. Greater leisure-time activity was associated with a reduced risk of breast cancer, after adjustments for age, body-mass index (the weight in kilograms divided by the square of the height in meters), height, parity, and county of residence (relative risk, 0.63; 95 percent confidence interval, 0.42 to 0.95), among women who exercised regularly, as compared with sedentary women (P for trend=0.04). In regularly exercising women, the reduction in risk was greater in premenopausal women than in postmenopausal women, and greater in younger women (<45 years at study entry) than in older women (≥45 years) (relative risk, 0.38; 95 percent confidence interval, 0.19 to 0.79). In stratified analyses the risk of breast cancer was lowest in lean women (body-mass index, <22.8) who exercised at least four hours per week (relative risk, 0.28; 95 percent confidence interval, 0.11 to 0.70). The risk was also reduced with higher levels of activity at work, and again there was a more pronounced effect among premenopausal than postmenopausal women.

Conclusions Physical activity during leisure time and at work is associated with a reduced risk of breast cancer. (N Engl J Med 1997;336:1269-75.)

VIGOROUS physical training[1-5] and even moderate exercise[6-9] can interrupt the menstrual cycle, perhaps by suppressing the pulsatile release of gonadotropin-releasing hormone.[10,11] This effect of physical activity may lower a woman's cumulative exposure to estrogen and progesterone, thereby inhibiting carcinogenesis in the breast.[12-22] Energy balance might also influence the risk of breast cancer. Caloric restriction in rodents reduces the proliferative activity of the mammary glands[23] and inhibits carcinogenesis.[24,25] However, the effect of energy balance, as indicated by energy intake, body-mass index (the weight in kilograms divided by the square of the height in meters), and energy expenditure, on the risk of breast cancer has not been examined thoroughly in humans.

In this study we evaluated the influence of physical activity, both at work and during leisure time, on the risk of breast cancer in a cohort of 25,624 premenopausal and postmenopausal women. Data on parity, dietary factors, and body-mass index allowed adjustment for potentially confounding factors, and reassessment of physical activity after three to five years gave an indication of the effect of sustained physical activity on the risk of breast cancer.

METHODS

Study Population

From 1974 to 1978, the National Health Screening Service invited people in three counties in Norway (Oppland, Sogn og Fjordane, and Finnmark) to participate in a survey of risk factors for cardiovascular disease. All women who were 35 to 49 years of age and a random sample of 10 percent of those who were 20 to 34 years of age were invited. In four municipalities in Finnmark all women who were 20 to 34 years of age were invited. A comprehensive description of these populations has been published previously.[26] A total of 31,556 women were invited to participate, and 28,621 (91 percent) actually did.

All women in this survey as well as a random sample of women who were 20 to 39 years of age were invited to participate in a second survey three to five years later (1977 to 1983). Of these 34,378 women, 31,209 (91 percent) participated.[27] This second survey was used as the base line, because no information on parity and dietary factors was collected during the first survey.

Each woman received a written invitation to participate, to-

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gether with a one-page questionnaire. The participants were asked to answer the questionnaire and bring it to the clinical examination. At screening, trained nurses checked the questionnaire for inconsistencies regarding physical activity and menopausal status, measured weight and height, and collected blood samples.

During screening in the second survey, the participants were asked to fill out a food-frequency questionnaire, to be returned by mail. After one reminder, 25,892 (83 percent) returned the questionnaire. The energy and fat intakes for each woman were derived from the sum of all food consumed. The semiquantitative food-frequency questionnaire that we used has been described in detail and validated.[28,29]

Assessment of Physical Activity

Self-reported categories of physical activity during leisure hours in the year preceding each survey were assessed when the women entered the study and graded from 1 to 4 according to the participant's usual level of physical activity. A grade of 1 was assigned to those whose leisure time was spent reading, watching television, or engaging in other sedentary activities; a grade of 2 to those who spent at least four hours a week walking, bicycling, or engaging in other types of physical activity; a grade of 3 to those who spent at least four hours a week exercising to keep fit and participating in recreational athletics; and a grade of 4 to those who engaged in regular, vigorous training or participating in competitive sports several times a week. The self-reported level of physical activity during work hours in the preceding year was also graded on a four-point scale. A grade of 1 was assigned to those whose work was mostly sedentary; a grade of 2 to those whose job involved a lot of walking; a grade of 3 to those whose job required a lot of lifting and walking; and a grade of 4 to those engaged in heavy manual labor.

Two identical assessments of leisure-time activity were made at an interval of three to five years, and the results were combined for all groups. Women who reported moderate (grade 2) or regular (grade 3 or 4) exercise during leisure time in the first survey and regular exercise (grade 3 or 4) in the second survey were characterized as being consistently physically active. Women who were sedentary (grade 1) during leisure time in both surveys were characterized as being consistently sedentary. The women who were neither consistently sedentary nor consistently active during leisure time were characterized as being moderately active.

Follow-up and Identification of Cases of Breast Cancer

We followed a total of 25,707 women who had not been given a diagnosis of cancer before our base-line survey (1977 to 1983). We used the participants' national 11-digit personal identification numbers to identify every incident case of breast cancer reported to the Cancer Registry of Norway and Statistics Norway through the end of follow-up (December 31, 1994). A total of 98 percent of the cases were verified histologically. Women in whom cancer developed (n = 72) or who died (n = 11) within the first year of the study were excluded from the analyses to account for the possibility that undiagnosed cancer or severe illness might influence the level of physical activity. Through a linkage to the Central Population Register at Statistics Norway, we obtained information concerning the reproductive history of each woman, including the date of birth of each liveborn child through December 31, 1992, and deaths in the cohort through December 31, 1994.

The ultimate study cohort consisted of 25,624 women who participated in both surveys (age range, 20 to 69 years) during 359,930 person-years of follow-up.

Statistical Analysis

Base-line variables were adjusted for age and compared by analysis of covariance. Cox proportional-hazards regression analysis was carried out to investigate the simultaneous effect of physical activity and covariates on the incidence of breast cancer. To calculate the risk of breast cancer, women were observed for the development of breast cancer from entry into the study to the date of diagnosis of any cancer, the time of death, or the end of follow-up, whichever event came first. In the analysis, grades 3 and 4 of leisure-time activity were merged because of the small numbers of women with a grade of 4 in both surveys (48 women in the first survey and 57 in the second survey). As a reference group we used women who were sedentary at work or during leisure time.

In the analyses, we adjusted for age at entry (a continuous variable), county of residence, number of children, age at birth of first child, intake of total fat and energy, and body-mass index. Women who reported that they were premenopausal at base line were treated as premenopausal until they reached the age of 50 during follow-up, at which time they were considered postmenopausal. Women who reported that they were postmenopausal at base line were treated as postmenopausal.

Because there were few women with breast cancer who were sedentary both at work and during leisure time, the effect of this combination on the risk of breast cancer could not be analyzed. All significance tests were two-tailed, and the level of significance was set at 5 percent. The analyses were performed with the SAS statistical package version 6.11.

RESULTS

There were 351 incident cases of breast cancer (100 among premenopausal women and 251 among postmenopausal women) among 25,624 women. The mean length of follow-up was 14.0 years (median, 13.7), and the median age at diagnosis was 54.7 years (range, 36.3 to 68.0).

Table 1 gives the base-line characteristics of the participants. Two thirds of the women reported moderate activity during leisure time, whereas 15 percent exercised regularly. Only 14 percent reported being sedentary at work, whereas 20 percent reported lifting and 5 percent reported doing heavy manual labor. Women who reported regularly exercising during leisure time did not differ from women who were inactive during their leisure time with respect to age at entry or number of children, but they tended to be taller and to have a lower body-mass index, a relatively low ratio of total cholesterol to high-density lipoprotein (HDL) cholesterol in serum, lower serum triglyceride levels, and higher HDL cholesterol levels. Women whose work involved lifting or heavy manual labor had a higher body-mass index and more children than those engaged in sedentary work. Energy intake was positively related to physical activity, but the association was more pronounced with work activity than with leisure-time activity.

We analyzed other possible age-adjusted risk factors for breast cancer at base line and found a 28 percent increase in risk for each additional 6 cm of height and a 13 percent reduction in risk for each child. An older maternal age at the birth of a first child was associated with a borderline increase in risk, whereas body-mass index (in the group as a whole or in the subgroups of premenopausal and postmenopausal women), energy intake, and total fat intake did not influence the overall risk of breast cancer (data not shown).

Table 2 shows the relation between the level of

TABLE 1. BASE-LINE CHARACTERISTICS OF THE WOMEN ACCORDING TO THE LEVEL OF PHYSICAL ACTIVITY IN THE 1977–1983 SURVEY.*

CHARACTERISTIC	LEVEL OF ACTIVITY DURING LEISURE TIME			LEVEL OF ACTIVITY AT WORK			
	SEDENTARY (N=4410)	MODERATE (N=17,481)	REGULAR EXERCISE (N=3719)	SEDENTARY (N=3534)	WALKING (N=15,385)	LIFTING (N=5240)	HEAVY MANUAL LABOR (N=1385)
Age at entry (yr)	45.1	45.0	45.4	44.1	45.0	45.4	46.8
Body-mass index	25.5	24.8	24.5	24.3	24.8	25.2	25.6
Height (cm)	161.9	162.7	163.3	163.4	162.5	162.4	162.8
Triglycerides (mg/dl)†	139.9	127.5	124.0	125.8	130.2	130.2	122.2
HDL cholesterol (mg/dl)‡	54.5	56.1	57.3	55.7	55.7	56.5	58.0
Total cholesterol: HDL cholesterol	4.71	4.50	4.34	4.47	4.55	4.51	4.27
Parity							
No. of children	2.7	2.6	2.7	2.1	2.7	2.8	2.9
Mother's age at first birth (yr)	24.2	24.4	24.5	24.6	24.4	24.1	24.6
Daily energy intake (kJ)	5725	5761	5797	5561	5716	5854	6434
Total daily fat intake (g)	55.4	54.8	54.7	52.4	54.6	55.9	61.5
Daily smoking (%)	40.1	34.5	31.6	35.8	35.3	36.4	26.1

*All variables except age were adjusted for age. All values except those for daily smoking are means. Subjects for whom information concerning certain variables was missing are not included.

†To convert values for triglycerides to millimoles per liter, multiply by 0.01129.

‡To convert values for HDL cholesterol to millimoles per liter, multiply by 0.02586.

TABLE 2. ADJUSTED RELATIVE RISK OF BREAST CANCER ACCORDING TO THE LEVEL OF PHYSICAL ACTIVITY DURING LEISURE TIME AND AT WORK IN THE 1977–1983 SURVEY.*

LEVEL OF PHYSICAL ACTIVITY	CASES OF BREAST CANCER	RELATIVE RISK (95% CI)†	CASES OF BREAST CANCER	RELATIVE RISK (95% CI)‡
During leisure time				
Sedentary	66	1.00	65	1.00
Moderate	249	0.98 (0.75–1.28)	245	0.93 (0.71–1.22)
Regular exercise	36	0.67 (0.44–1.00)	36	0.63 (0.42–0.95)
P for trend		0.08		0.04
At work				
Sedentary	62	1.00	61	1.00
Walking	212	0.76 (0.57–1.01)	210	0.84 (0.63–1.12)
Lifting	64	0.66 (0.47–0.94)	63	0.74 (0.52–1.06)
Heavy manual labor	12	0.46 (0.25–0.86)	11	0.48 (0.25–0.92)
P for trend		0.004		0.02

*The sedentary group is the reference group. CI denotes confidence interval. Subjects for whom information concerning certain variables was missing are not included.

†Variables were adjusted for age at entry.

‡Variables were adjusted for age at entry, body-mass index, height, county of residence, and number of children.

leisure-time or work activity and the overall risk of breast cancer. After adjustment for age and with the sedentary group as the reference group, the relative risk of breast cancer was reduced among women whose jobs involved walking, lifting, or heavy manual labor. Adjustments for other factors (body-mass index, county of residence, number of children, and height) in addition to age changed the risk estimates only slightly. Further adjustments for age at first birth or dietary factors (energy intake, total fat intake, and fiber intake) did not influence our estimates of relative risk and were omitted from the final model. A 52 percent reduction in risk was observed among the women who reported doing heavy manual labor (relative risk, 0.48; 95 percent confidence interval, 0.25 to 0.92). The overall adjusted risk of breast cancer decreased in a dose–response manner with increasing activity level during leisure time

TABLE 3. ADJUSTED RELATIVE RISK OF BREAST CANCER ACCORDING TO MENOPAUSAL STATUS AND THE LEVEL OF PHYSICAL ACTIVITY IN THE 1977–1983 SURVEY.*

LEVEL OF PHYSICAL ACTIVITY	PREMENOPAUSAL WOMEN		POSTMENOPAUSAL WOMEN	
	CASES OF BREAST CANCER	RELATIVE RISK (95% CI)	CASES OF BREAST CANCER	RELATIVE RISK (95% CI)
During leisure time				
Sedentary	20	1.00	45	1.00
Moderate	68	0.77 (0.46–1.27)	177	1.00 (0.72–1.39)
Regular exercise	10	0.53 (0.25–1.14)	26	0.67 (0.41–1.10)
P for trend		0.10		0.15
At work				
Sedentary	22	1.00	39	1.00
Walking	62	0.82 (0.50–1.34)	148	0.87 (0.61–1.24)
Lifting or heavy manual labor	14	0.48 (0.24–0.95)	60	0.78 (0.52–1.18)
P for trend		0.03		0.24

*The sedentary group is the reference group. Variables were adjusted for age at entry, body-mass index, height, county of residence, and number of children. CI denotes confidence interval. Subjects for whom information concerning certain variables was missing are not included.

TABLE 4. ADJUSTED RELATIVE RISK OF BREAST CANCER ACCORDING TO BODY-MASS INDEX AND THE LEVEL OF PHYSICAL ACTIVITY DURING LEISURE TIME IN THE 1977–1983 SURVEY.*

LEVEL OF PHYSICAL ACTIVITY	BODY-MASS INDEX, <22.8		BODY-MASS INDEX, 22.8–25.7		BODY-MASS INDEX, >25.7	
	CASES OF BREAST CANCER	RELATIVE RISK (95% CI)	CASES OF BREAST CANCER	RELATIVE RISK (95% CI)	CASES OF BREAST CANCER	RELATIVE RISK (95% CI)
Sedentary	21	1.00	14	1.00	30	1.00
Moderate	104	1.12 (0.70–1.79)	73	1.09 (0.61–1.93)	68	0.70 (0.46–1.08)
Regular exercise	6	0.28 (0.11–0.70)	14	0.96 (0.45–2.01)	16	0.83 (0.45–1.53)
P for trend		0.02		0.90		0.36

*The sedentary group is the reference group. Variables were adjusted for age at entry, height, county of residence, and number of children. CI denotes confidence interval. Subjects for whom information concerning certain variables was missing are not included.

(P for trend = 0.04). Women who exercised at least four hours a week during leisure time had a 37 percent reduction in the risk of breast cancer (relative risk, 0.63; 95 percent confidence interval, 0.42 to 0.95).

When the group was divided according to menopausal status (Table 3), a consistently inverse association was observed between the level of leisure-time activity and the premenopausal risk of breast cancer; the adjusted relative risk declined to 0.77 (95 percent confidence interval, 0.46 to 1.27) and further to 0.53 (95 percent confidence interval, 0.25 to 1.14) as the level of activity increased (P for trend = 0.10). A weaker association was observed between the level of leisure-time activity and the postmenopausal risk of breast cancer. The inverse association between the level of activity at work and the risk of breast cancer was also pronounced among premenopausal women; among premenopausal women whose jobs involved lifting or heavy manual labor, the relative risk was 0.48 (95 percent confidence interval, 0.24 to 0.95).

We also divided the cohort into women who were younger than 45 years of age at entry and those who were 45 or older. Among those younger than 45 years at entry for whom data were complete (of whom breast cancer developed in 138; mean age at diagnosis, 48.3 years), the adjusted relative risk declined to 0.80 (95 percent confidence interval, 0.52 to 1.22) and further to 0.38 (95 percent confidence interval, 0.19 to 0.79) as the level of activity during leisure time increased (P for trend = 0.01). The respective adjusted relative risks were 1.03 (95 percent confidence interval, 0.72 to 1.48) and 0.84 (95 percent confidence interval, 0.51 to 1.39) (P for trend =

TABLE 5. ADJUSTED RELATIVE RISK OF BREAST CANCER ACCORDING TO BODY-MASS INDEX AND OVERALL LEVEL OF PHYSICAL ACTIVITY DURING LEISURE TIME IN THE 1974–1978 AND 1977–1983 SURVEYS.*

OVERALL LEVEL OF PHYSICAL ACTIVITY†	ALL WOMEN		BODY-MASS INDEX, <22.8		BODY-MASS INDEX, 22.8–25.7		BODY-MASS INDEX, >25.7	
	CASES OF BREAST CANCER	RELATIVE RISK (95% CI)‡	CASES OF BREAST CANCER	RELATIVE RISK (95% CI)§	CASES OF BREAST CANCER	RELATIVE RISK (95% CI)§	CASES OF BREAST CANCER	RELATIVE RISK (95% CI)§
Consistently sedentary	29	1.00	13	1.00	7	1.00	9	1.00
Moderately active	283	0.90 (0.61–1.32)	112	0.76 (0.43–1.35)	81	0.87 (0.40–1.88)	90	1.14 (0.57–2.27)
Consistently active	34	0.67 (0.40–1.10)	6	0.23 (0.09–0.60)	13	0.83 (0.33–2.09)	15	1.38 (0.60–3.17)
P for trend		0.09		0.002		0.73		0.42

*The sedentary group is the reference group. CI denotes confidence interval.

†Subjects with a consistently sedentary level of activity were classified as sedentary in both surveys (grade 1). Subjects who remained active, reporting moderate (grade 2) or regular (grade 3 or 4) exercise in the first survey and regular exercise (grade 3 or 4) in the second survey, were classified as being consistently active. Subjects were classified as moderately active if they did not meet the criteria for the other two categories.

‡Variables were adjusted for age at entry, body-mass index, height, county of residence, and number of children.

§Variables were adjusted for age at entry, height, county of residence, and number of children.

0.54) among those for whom data were complete who were 45 years of age or older at entry (of whom breast cancer developed in 208; mean age at diagnosis, 58.2 years). These values indicate that physical activity had a protective effect, particularly with respect to the risk of breast cancer before and soon after menopause.

We examined models stratified according to body-mass index (Table 4). Among lean (body-mass index, <22.8), regularly exercising women, the risk of breast cancer was reduced by 72 percent (relative risk, 0.28; 95 percent confidence interval, 0.11 to 0.70). No such association was observed in the middle or upper thirds of body-mass index among regularly exercising women. In models stratified according to both body-mass index and menopausal status, this association was seen among both premenopausal and postmenopausal lean women (data not shown).

In the second survey 61.2 percent of the participants reported the same level of leisure-time activity as in the first survey, 23.5 percent reported an increased level, and 15.3 percent reported a reduced level. By combining these two assessments of leisure-time activity, we observed that the relative risk declined to 0.23 (95 percent confidence interval, 0.09 to 0.60) as the level of sustained activity increased in lean (body-mass index, <22.8) women (P for trend = 0.002) (Table 5). This protective effect across increasing levels of sustained leisure-time activity was observed in both lean premenopausal women (relative risk, 0.23; 95 percent confidence interval, 0.06 to 0.88; P for linear trend = 0.02) and lean postmenopausal women (relative risk, 0.24; 95 percent confidence interval, 0.06 to 0.96; P for linear trend = 0.03).

DISCUSSION

Our results support the idea that physical activity protects against breast cancer, particularly among premenopausal and younger postmenopausal women. Activity during both leisure time and work reduced the overall risk. There was a significant inverse dose–response relation between leisure-time activity and the risk of breast cancer. The protective effect was evident among lean premenopausal and postmenopausal women, and repeated assessment emphasized the preventive effect of physical activity.

The overall reduction in the risk of breast cancer among active women is consistent with findings in other cohort[15-17] and case–control[19-22] studies, but at variance with the findings of a few others.[30,31] In one of these discrepant studies,[31] most of the women were older than in the present study and breast cancer was diagnosed mainly among postmenopausal women. In the other,[30] physical activity at college was assessed 35 to 70 years before the diagnosis of breast cancer, and no adjustments were made for potential confounding factors. Our finding of a protective effect of work-related activity on the risk of breast cancer is also in agreement with other studies.[18,32,33]

Precise assessment of physical activity is difficult in a population-based cohort. The accuracy of the levels of leisure-time activity reported on the questionnaire that we used has been validated previously.[34-36] Since the level of leisure-time activity correlates with the degree of physical fitness,[34,36] our observation that recreationally active women tended to be leaner than inactive women and had serum lipid profiles associated with regular exercise strengthens the validity of our assessments. Energy intake was also positively related to both leisure-time and work activities, particularly work activities.

Repeated assessment of leisure-time activity is important in any analysis of the effect of sustained activity on the risk of breast cancer. The protective effect was notable among lean women who were consistently active during their leisure time. In combining the two assessments for each woman, we may also have increased the precision of our assessment of physical-activity levels, but we cannot differentiate the effect of sustained activity from any misclassification.

The population-based approach and the high participation rate in our study reduced selection bias. The almost complete reporting of incident cases of breast cancer also strengthens our results. Age at menarche was not available and could have confounded our results, but this is not likely, since an increased risk of only 4 percent was observed for each year of earlier age at menarche in a similar study population in Norway.[37]

Information about the use of hormonal contraceptives was not available, although recent meta-analyses suggest that there is only a small increase in the risk of breast cancer among the youngest women who commonly use hormonal contraceptives.[38] It is probable that this information would not have confounded our results to any large extent.

How does physical activity influence the development of breast cancer? The propensity to be physically active may be inherited,[39] so the genotype may influence both physical activity and the predisposition to breast cancer. Social and cultural influences on exercise and energy balance seem to be more important than genetic factors,[39,40] which points to leisure-time activity as an independent and modifiable variable with regard to its effect on the risk of breast cancer.

A reduction in the cumulative exposure to cyclic estrogens and progesterone may in part explain the preventive effect of both leisure-time and work activity. Over the long term, vigorous training and moderate leisure-time activity may decrease estradiol and progesterone secretion,[3,6,41] reduce the length of the luteal phase,[10,42] induce anovulation,[7,8,41,43] delay menarche,[4,5] and cause secondary amenorrhea.[2,12]

Physical activity influences energy balance, and experimental studies have shown that calorie restrictions inhibit mammary carcinogenesis.[24,25,44] Anthropometric measures such as height, body-mass index, and weight gain have been used as biomarkers of caloric intake, and increased values have been reported to be risk factors for breast cancer in humans.[45-48] A diet involving a high energy intake has also been associated with early age at menarche,[5,49] and this finding supports the hypothesis that increased net energy may increase the cumulative hormonal levels that are of importance for carcinogenesis of the breast. Women who were active during leisure time reported only a slightly higher total energy intake than sedentary women, and they tended to be leaner, indicating that their net available energy was lower. The greater protective effect of leisure-time activity against breast cancer in lean women indicates that there may be an optimal energy balance that inhibits mammary carcinogenesis.

Triglycerides are known to displace estradiol from its tight binding to the sex hormone–binding globulin, which is found in low levels in obese women,[50] and thus triglycerides increase levels of free estradiol. Serum levels of triglycerides were higher in sedentary women than in women who were more active during their leisure time; thus, exposure to estrogen may be greater in inactive women. This underscores the importance of avoiding obesity if physical activity is to have an optimal inhibitory effect on the risk of breast cancer.

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Paper V

PHYSICAL ACTIVITY IMPROVES THE METABOLIC RISK PROFILES IN MEN AND WOMEN

A seven-year follow-up study with repeated assessments of leisure time activity: The Tromsø Study

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***Objective*.–To examine effects of leisure time physical activity on the metabolic profiles.**

***Design*.– Population-based cohort study, following subjects attending two surveys (1979–80 and 1986–87) with repeated assessments of self-reported leisure time physical activity**

***Participants*.– 5220 men and 5869 women, aged 20–49 years at entry.**

***Main Outcome Measures*.– Measurements of body mass index (BMI in kg/m^2), triglycerides, total cholesterol (Total-C), high-density-lipoprotein cholesterol (HDL-C) related to four levels of physical activity.**

***Results*.– There was a dose-response relationship between serum lipids and BMI, and levels of physical activity in both sexes after adjustments for potential confounders. These differences of BMI and serum lipids between sedentary and sustained exercising groups were consistently more pronounced after 7 years than at baseline, especially in the oldest age group. Men reporting sustained hard training compared with sedentary men, had a lower concentration of Total-C (5.65 mmol/l vs 6.21 mmol/l), triglycerides (1.34 mmol/l vs 1.85 mmol/l), Total-C:HDL-C ratio by 19.0% and BMI (23.9 kg/m^2 vs 25.7 kg/m^2), and a higher HDL-C concentration (1.52 mmol/l vs 1.36 mmol/l). Women reporting sustained regular or hard training compared with sedentary women, had a lower concentration of Total-C (5.70 mmol/l vs 5.90 mmol/l), triglycerides (1.03 mmol/l vs 1.18 mmol/l), Total-C:HDL-C ratio by 7.5% and BMI (23.1 kg/m^2 vs 23.6 kg/m^2), and a higher HDL-C concentration (1.73 mmol/l vs 1.66 mmol/l). An increase in leisure time activity over the 7 years improved metabolic profiles, whereas a decrease worsened them in both sexes.**

***Conclusions*.– Sustained high levels and change from sedentary to higher levels of physical activity improved the metabolic risk profile in both sexes. The differences observed are sufficiently large to have a beneficial effect on the risk of certain chronic diseases.**

INTRODUCTION

Physical activity strengthens the musculoskeletal system, improves cardiovascular capacity and, pulmonary function,[1] influences the cumulative exposure to certain hormones,[2] enhances the immune system[3] and increases insulin sensitivity.[4] It also represents the largest source of variability in energy requirements,[5-6] influencing body weight[6-7] The benefits of physical activity and fitness have been associated with decreased overall mortality[8-10] and reduced incidence of cardiovascular diseases,[11-12] non-insulin-dependent diabetes mellitus[7,12-13] and certain types of cancer such as colon cancer[14-15] and breast cancer.[16]

Serum lipids are important biological risk markers for chronic diseases, particularly cardiovascular diseases,[11,17-18] that can be modified by physical activity.[19-24] In addition, obesity increases the risk of cardiovascular diseases,[25-26] diabetes[4,27] and certain types of cancer.[14,28]

Changes in the level of physical activity can result in weight gain or weight loss if there is no calorie compensation. Weight gain in adult life may be a marker of a new metabolic steady state, which may have serious health consequences.[4,26,28-29] This emphasizes the importance of age and body mass index (BMI) in the evaluation of the influence of physical activity on metabolic risk profiles.

Few population-based prospective studies have evaluated the importance of both sustained and change in level of physical activity over time on weight gain and lipids, taking age into account. Most studies are of men, less is known about women.[20,30-32]

The aim of the present study was to elucidate the impact of physical activity on the metabolic risk profile over a certain timespan. This was done in a population-based study of 5220 men and 5869 women with two self-reported assessments of leisure time physical activity with a 7-year interval. Biological markers of a metabolic risk profile were defined by BMI, triglycerides, total cholesterol, high-density-lipoprotein cholesterol (HDL-C) and the ratio of total cholesterol to HDL cholesterol (Total-C:HDL-C). Data on smoking habits, menopausal status, dietary factors, consumption of alcohol and coffee, and use of hormonal contraceptives allowed for adjustment of use and change in potentially confounding factors during follow-up. Heart rate and physical fitness (in women only), made a validation of self-reported physical activity possible.

MATERIAL AND METHODS

Study subjects

The study subjects are men and women who participated in two population surveys carried out with a 7-year interval in the municipality of Tromsø, northern Norway. In the 1979–80 survey, all men aged 20–54 years and all women aged 20–49 years, registered in the municipality, were invited and 16 621 subjects attended, i.e. 78% of the invited population. The total number of individuals examined at the 1986–87 survey was 21 826 subjects, 81.3% of the eligible population. Eligible for the present study were those 11 508 subjects (5423 men and 6085 women) who were 20-49 years at baseline (1979-80) and attended both surveys (88.3% of those invited to both surveys).We excluded subjects who reported previous myocardial infarction, stroke, angina pectoris, diabetes mellitus and taking antihypertensive medications, (192 men, 207 women) at baseline (1979–80), and those with missing information about leisure time activity at either surveys (11 men, 9 women). Hence, the present cohort consisted of 5220 men and 5869 women aged 20–49 years in 1979–80.

Screening procedures

The methods and questionnaires used in the two surveys were almost identical and are described in detail elsewhere.[33] The screening comprised administration of a main questionnaire about disease, symptoms and smoking. At the two surveys, trained nurses checked the questionnaire for inconsistencies and asked about time since last meal, menopausal status, use of oral contraceptives and hormonal replacement therapy (1986–87). Height was measured to the nearest centimetre and weight to the nearest half-kilogram on regularly calibrated scales. As a measure of obesity, we used the body mass index (BMI) (weight (kg)/[height (m)]^2.

In the 1979/80 survey, blood pressure was measured by personnel trained according to tape recordings produced by the London School of Hygiene and Tropical Medicine. In the 1986-87 survey, an automatic device (Dinamap, Criticon, Tampa) was used. Heart rate is derived from the median pulse-to-pulse interval during the time of the blood pressure measurement. Three recordings of heart rate were made at 2-minute intervals, and the lowest measurement recorded was used in the present study.

A non-fasting blood sample for lipid analyses was taken. Total serum cholesterol was measured directly by the enzymatic oxidase method. HDL-cholesterol was assayed by the same procedure after precipitation of low-density lipoproteins with heparin and manganese chloride. Triglycerides were enzymatically determined as glycerol.

A second questionnaire, given to the participants at both surveys, was a combined food frequency questionnaire and a questionnaire about chronic diseases and drug use. The nutritional part covered type and quantity of table fat, milk, coffee drinking, vegetables, fruit and alcohol habits. It was filled in at home and returned by 88% and 92% of the participants at the 1979–80 and 1986–87 surveys, respectively. Energy or fat intake for each individual could not be calculated because of insufficient information about nutritional habits.

Assessment of physical activity and physical fitness

The main questionnaire covering physical activity was filled in at home and checked at the screening for inconsistencies and incomplete data. Physical activity in leisure time was graded from I to IV: level I: reading, watching TV or other sedentary activities; level II: walking, bicycling or physical activities for at least 4 hours a week; level III: exercises to keep fit for at least 4 hours a week; and level IV: regular hard training or exercise for competition several times a week.

Physical fitness was assessed by a graded submaximal or maximal bicycle exercise test with a pedalling frequency of 60/min in a random subgroup in the 1986–87 survey.[34] The initial workload was set at 25 watts, with a 25-W increment every minute, up to a maximum of 250 W after 10 min. Physical fitness was defined as the maximum workload performed. As a result of incomplete testing in men – about 75% reached the maximum workload – only measurements of 220 women could be used in analyses.

Statistical analysis

All analyses were sex specific. The primary aim was to analyse differences and changes in metabolic risk factors (serum lipids and BMI) in leisure time sedentary and active attendees over the 7 years of follow-up. Baseline characteristics were age adjusted and compared, based on the four reported levels of leisure time activity using analysis of co-variance. In the analysis of changes in BMI, cholesterol, HDL-cholesterol, triglycerides and Total-C:HDL-C ratio, comparison groups were defined as:

- ≤ -2 changes – those who reduced at least two levels of leisure time activity
- –1 change – those who reported one level reduction in leisure activity between surveys
- Unchanged – those who reported the same activity level after 7 years of follow-up
- +1 change – those who reported one level increase in activity
- $\geq +2$ change – those who increased at least two levels of leisure time activity.

We adjusted, for age at entry into the 1979–80 survey, use and change in smoking habits, coffee drinking, type of table fat used and menopausal status, when analysing the effect of sustained and change in physical activity in metabolic profiles, respectively. Time since last meal was included as a co-variate only in the analyses of triglyceride levels. Analysis of covariance were used for adjustments. Because very few women reported regular hard exercise (level IV), levels III and IV were merged in some analyses.

We examined models stratified by age at entry (20–29, 30–39 and 40–49 years) and BMI (tertiles) to analyse whether there was any effect modification by age and BMI of leisure time activity. As a result of missing data, the number of subjects included in the separate analyses varied slightly. Tests for linear trends were performed by linear regression. All significance tests were two-tailed and the significance level was chosen at 5%. SAS statistical package version 6.11was used.

RESULTS

At baseline the mean age was 34.4 years and 33.7 years in men and women, respectively. Sedentary leisure time activity was reported by 19.4% of men and 21.9% of women; regular exercise was reported in 29.3% of men and 12.2% of women; hard exercise was performed by 6.3% of men and 1.0% of women (Table 1).

Men reporting higher levels of daily leisure time activity at baseline tended to be slightly leaner, to have an increased daily intake of fruit and vegetables and low fat milk, to have lower diastolic blood pressure, to smoke less, to consume fewer cups of coffee and to have a lower daily alcohol and saturated table fat intake compared with sedentary men (Table 1). Men who performed regular hard

Table 1. Baseline characteristics* (mean/distribution (%)) according to level of leisure time physical activity in men and women, aged 20-49 years at entry at survey 1979-80.

	LEISURE TIME PHYSICAL ACTIVITY							
	Men				Women			
CHARACTERISTICS	Sedentary (n=1015)†	Moderate (n=2344)	Regular (n=1532)	Hard (n=329)	Sedentary (n=1284)	Moderate (n= 3811)	Regular (=715)	Hard (n=59)
Age at entry (years)	34.4	35.2	34.3	29.6	32.9	33.9	34.4	27.7
BMI (kg/m^2)	24.5	24.2	24.1	24.0	22.6	22.7	22.4	22.3
Height (cm)	176.6	177.1	177.2	177.2	163.5	163.6	164.5	165.1
Systolic blood pressure (mmHg)	129.4	129.6	129.3	130.2	121.3	121.2	119.3	119.3
Diastolic blood pressure (mmHg)	81.7	81.8	80.9	80.5	77.9	78.0	77.7	77.1
Dietary intake (%)								
unsaturated table fat	71.3	72.2	74.4	75.8	71.8	75.3	75.4	67.1
low fat milk	12.1	13.7	17.2	21.0	17.7	26.7	33.2	33.2
fruit/vegetables (daily)	31.8	40.6	47.5	48.5	52.7	65.4	74.4	67.2
Coffee consumption (% $\geq$5 cups/daily)	68.1	61.0	59.1	46.2	55.8	50.5	47.4	35.5
Alcohol (% $\geq$ 2-3 times weekly)	17.8	13.7	13.6	11.7	4.4	3.9	4.8	6.6
Daily smoking (%)	59.8	48.6	41.5	25.7	54.2	44.9	41.9	37.4
Use of oral contraceptives (%)					8.4	7.3	7.0	11.1
Premenopausal (%)					95.2	95.8	96.5	90.1

* Age-adjusted

† Number of participants for activity categories in parentheses. For some subjects, information concerning certain variables was missing.

Table 2. Changes in serumlipids and body mass index (BMI) according to changes in the level of leisure time physical activity after 7 years of follow-up (1986-87)

Characteristics*	Baseline†	1986-87†	CHANGE IN LEVEL OF LEISURE TIME ACTIVITY					
	Mean ±SD	Mean ±SD	≤−2	−1	0	1	2≥	*p* for trend
MEN			(*n*=261)‡	(*n*=1337)	(*n*=2681)	(*n*=823)	(*n*=118)	
Cholesterol								
(mmol/l)	5.93±1.26	6.05 ± 1.23	0.32	0.14	0.12	0.05	0.09	0.0002
[mg/dl]	[229±49]	[234±48]	[12]	[5[	[5]	[2]	[3]	
Triglycerides								
(mmol/l)	1.63 ±0.96	1.67 ± 1.07	0.14	0.08	0.03	0.04	-0.16	0.14
[mg/dl]	]144±85]	[148±95]	[12]	[7]	[3]	[4]	[-14]	
HDL chol.								
(mmol/l)	1.45±0.45	1.37± 0.35	-0.11	-0.09	-0.09	-0.07	0.01	0.16
[mg/dl]	[56±17]	[53±14]	[-3]	[-3]	[-3]	[-3]	[0.4]	
Tot.-C:HDL-C	4.36 ±1.46	4.71± 1.63	0.59	0.40	0.35	0.22	0.02	0.0001
BMI (kg/m^2)	24.2 ±2.8	24.9 ± 2.9	1.0	0.8	0.7	0.6	0.2	0.0001
WOMEN			(*n*=134)	(*n*=1147)	(*n*=3604)	(*n*=917)	(*n*= 67)	
Cholesterol								
(mmol/l)	5.73 ±1.19	5.83 ± 1.26	0.30	0.15	0.09	0.04	-0.08	0.004
[mg/dl]	[222±46]	[225±49]	[12]	[6]	[3]	[2]	]-3]	
Triglycerides								
(mmol/l)	1.09 ±0.61	1.15 ± 0.66	0.13	0.06	0.06	0.01	0.03	0.14
[mg/dl]	[97±54]	[102±58]	[12]	[5]	[5]	[1]	[3]	
HDL chol.								
(mmol/l)	1.75 ±0.42	1.66 ± 0.39	-0.10	-0.10	-0.09	-0.07	-0.05	0.05
[mg/dl]	[68±16]	[64±15]	[-4]	[-4]	[-3]	[-3]	[-2]	
Tot.-C:HDL-C	3.43 ±1.03	3.69 ± 1.19	0.35	0.31	0.26	0.19	0.04	0.0013
BMI (kg/m^2)	22.6 ±3.2	23.5 ± 3.5	1.2	1.0	0.9	0.7	0.4	0.001

* Adjusted for age at baseline and change in: smoking habits, table fat, coffee drinking, menopausal status (women)
†Values are presented as means ± SD
‡ Number of participants for activity categories in parentheses. For some subjects, information concerning certain variables was missing.

exercise tended to be younger. Leisure time active women tended to be taller, to have a lower systolic blood pressure and a higher daily. intake of low fat milk, to consume fewer cups of coffee and to smoke less than sedentary women. Only 7.5% of the women were current users of oral contraceptives

After 7 years, more individuals reported decreased (men: 30.6%, women: 21.8%) rather than increased physical activity (men: 18.0%, women: 16.8%). There was a decline in level of physical activity with increasing age. By comparing the regular exercise groups at follow-up survey, with the groups who are 10 years older at baseline, there was, however, a decline by 3–5% in subjects who trained regularly; this was not related to the average age effect in the cohort (results not presented).

There was an overall increase in BMI, triglycerides, cholesterol and Total C:HDL-C ratio, and a decrease in HDL-C in both sexes after 7 years in the cohort relative to baseline values (Table 2). After adjustment for age at entry there was a highly significant inverse dose–response pattern from most reduced to most increased changes in activity level in both sexes for serum cholesterol concentration, Total-C: HDL-C ratio and BMI. Adjustment for change in smoking habits, dietary fat intake, coffee drinking and menopausal status did not change these results. Comparing the two extremes in the change of physical activity level during follow-up ($\leq$ 2 levels decrease vs $\geq$2 levels increase), there was a significant difference also in triglycerides and HDL-C for both sexes. Further adjustments for present use of or change in fruit/vegetable, use of oral contraceptives or alcohol consumption did not influence this association and were omitted from the final model.

To analyse the influence of sustained leisure activity on metabolic risk factors over time, we focused on men and women who maintained their activity after 7 years of follow-up. After multivariate adjustments the differences in the level of serum lipids and BMI, between the sedentary and exercising groups (regular and hard), were consistently more pronounced after 7 years than at baseline (Table 3). This was especially marked among those who sustained activity compared with all participants. This was true for both men and women. Men reporting sustained hard training had reduced levels, compared with sustained sedentary men, of: Total-C by 9.0%, triglycerides by 27.6% and Total-C:HDL-C ratio by 19.0%; there was also an increase in HDL-C of 13.2% plus a 7.0% smaller BMI. Women who were regular and hard trainers in their leisure time had a reduced concentration, compared with sedentary women, of: Total-C by 3.4%, triglycerides by 12.7% and Total-C:HDL-C ratio by 7.5%; they also had an increase in HDL-C of 4.0% plus a 2.1% smaller BMI. All tests for linear trend with increasing physical activity showed a highly significant dose–response effect ($p < 0.001$) for men and for women (except HDL-C).

The effect of sustained physical activity on metabolic profiles in different age groups of men is demonstrated in Figure 1. First, the differences in BMI, and the levels of cholesterol, triglycerides, HDL-C and Total-C: HDL-C, when compared for the sedentary and hard exercise group, were more pronounced in the oldest (40–49 years) than in the youngest (20–29 years) age groups; this effect increased after 7 years of follow-up. Second, the average levels of the metabolic profiles were consistently higher after 7 years in the sedentary and moderately active individuals of all ages. It is possible to reduce the levels of BMI, cholesterol and triglycerides below the baseline level by regular and hard training after 7 years, but this occurs mainly in the oldest segment of the cohort. Similar effects were seen for women, although to a lesser extent (Figure 2). This indicate an important effect of sustained physical activity on metabolic profiles.

A possible effect modification of weight was elucidated by stratified analyses of BMI. Leisure time activity had the same effect on the serum lipids in all three tertiles of BMI in both sexes (Figure 3). Within each tertile of BMI, the serum concentration of Total-C and

Table 3. Serum lipids* and BMI* at baseline among all participants and after 7 years of follow-up among men and women who sustained† activity across levels of leisure time physical activity

	LEISURE TIME PHYSICAL ACTIVITY									
	All participants survey 1979/80					Sustained activity survey1986/87				
Characteristics	Sedentary	Moderate	Regular	Hard	*p* for trend	Sedentary	Moderate	Regular	Hard	*p* for trend
MEN	(*n*=1015)§	(*n*=2344)	(*n*=1532)	(*n*=329)		(*n*=499)	(*n*=1485)	(*n*=616)	(*n*=81)	
Cholesterol										
(mmol/l)	6.09	5.93	5.90	5.69	0.0001	6.21	6.13	5.96	5.65	0.001
[mg/dl]	[235]	[229]	[228]	[220]		[240]	[237]	[230]	[218]	
Triglycerides										
(mmol/l)	1.73	1.62	1.59	1.48	0.0001	1.85	1.69	1.54	1.34	0.0001
[mg/dl]	[153]	[143]	[141]	[131]		[164]	[150]	[119]	[136]	
HDL chol.										
(mmol/l)	1.43	1.45	1.46	1.52	0.007	1.36	1.36	1.39	1.52	0.0014
[mg/dl]	[55]	[56]	[56]	[59]		[53]	[53]	[54]	[59]	
Tot.-C:HDL-C	4.58	4.38	4.28	3.95	0.0001	4.84	4.80	4.56	3.92	0.0001
BMI (kg/m^2)	24.5	24.2	24.1	23.9	0.0001	25.7	25.0	24.5	23.9	0.0001
WOMEN‡	Sedentary	Moderate	Regular/Hard			Sedentary	Moderate	Regular/Hard		
	(*n*=1284)§	(*n*=3811)	(*n*=774)			(*n*=581)	(*n*=2832)	(*n*=213)		
Cholesterol										
(mmol/l)	5.74	5.74	5.62		0.07	5.90	5.85	5.70		0.05
[mg/dl]	[222]	[222]	[217]			[228]	[226]	[220]		
Triglycerides										
(mmol/l)	1.15	1.09	1.01		0.03	1.18	1.14	1.03		0.007
[mg/dl]	[102]	[97]	[89]			[105]	[101]	[91]		
HDL chol.										
(mmol/l)	1.73	1.75	1.79		0.22	1.66	1.67	1.73		0.09
[mg/dl]	[67]	[68]	[69]			[64]	[65]	[67]		
Tot.C:HDL-C	3.47	3.44	3.30		0.07	3.75	3.69	3.47		0.009
BMI (kg/m^2)	22.6	22.7	22.3		0.14	23.6	23.5	23.1		0.03

*Adjustments were done for age at baseline and current; smoking habits, coffee drinking, table fat, menopausal status (women) and time since last meal (triglycerides) at 1979-80 or 1986-87 survey, respectively.

†Sustained activity level; men and women who reported the same level of leisure time activity in 1979-80 and in 1986-87.

‡Regular and hard exercise are combined in women

§ For some subjects, information concerning certain variables was missing.

Table 4. Mean values of heart rate (beats/min)* at survey 1986/87 in both sexes by level and changes of leisure time physical activity at survey 1979/80 and 1986/87 combined.

Change in leisure time physical activity 1979/80 to 1986/87	Leisure time physical activity 1986/87				
	Sedentary	Moderate	Regular exercise	Hard exercise	*p for trend*
MEN					
Increased (n = 941)	-	71.5	68.4	63.3	$p < 0.0001$
Sustained(n = 2 676	72.8	71.6	66.2	56.8	$p < 0.0001$
Decreased (n= 1 598)	72.8	69.1	62.6	-	$p < 0.0001$
WOMEN					
Increased (n = 984)	-	75.5	72.5	69.4	$p < 0.0001$
Sustained (n = 3 604)	77.6	75.0	71.1	69.4	$p < 0.0001$
Decreased (n = 1 281)	75.8	73.3	70.0	-	p= 0.0002

* Adjusted for age at baseline (1979-80)

Table 5. Physical fitness and heart rate in relation to leisure time physical activity among 220 women at survey 1986/87.

Leisure time physical activity	Number	Physical fitness (Watts) ± SEM	Heart rate (beats/min) ± SEM
Sedentary	55	144.1 ± 4.59	78.2 ± 1.74
Moderate	148	158.7 ± 2.80	75.4 ± 1.06
Regular/Hard exercise	17	186.1 ± 8.25	69.0 ± 3.13
p for trend		$p < 0.0001$	$p = 0.02$

Values are presented as age-adjusted means ± SEM

triglycerides, and the Total-C:HDL-C ratio were reduced and HDL-C was increased with increasing leisure time activity.

The impact of physical activity on metabolic profiles in non-smokers did not differ from the results presented for smokers and non-smokers combined (results not presented).

A highly significant lower heart rate with increasing physical activity level was demonstrated (Table 4) for both sexes in all groups (p for linear trend < 0.0001). When comparing those who increased or decreased their activity level with those who sustained their activity level between the two surveys, a lower heart rate among those who increased and a higher heart rate among those who decreased their activity level was found. The lowest heart rate was observed among those who reported the highest level of leisure time physical activity in both surveys in both sexes, indicating high correlation between physical activity and heart rate.

Physical fitness, assessed in a small random sample of 220 women, increased with increasing level of leisure time activity ($p < 0.0001$) (Table 5), and heart rate was also reduced with increasing level of leisure activity ($p = 0.02$).

DISCUSSION

With the steady decline in occupational physical activity, exercise at leisure time has become more important for determining metabolic and health-related effects of physical activity. About 36% of the men and 13% of the women in our study performed regular exercise at baseline, which dropped to 26% and 9%. This implies both an age-dependent decline in level of physical activity in the cohort, and a general decrease in activity in the population, independent of age.

The large sample size, and repeated assessment of physical activity, made it possible to test for the influence of both sustained and change in physical activity on weight and serum lipids in an adult population. Sustained physical activity at leisure time reduced the age-related weight gain and improved lipid profiles across all BMI strata. Maintenance of a high level of physical activity after 7 years strengthened the associations observed at baseline. Men and women reporting sustained regular or hard training had significant improvement of serum lipids and BMI, compared with sedentary men and women. We were also able to demonstrate that an increase in leisure time activity over the 7 years improved the metabolic profiles, whereas a decrease in activity worsened the metabolic profile in both sexes.

Self-reports of physical activity provide a possibility for under- or over-estimating activity levels.[35] A lower heart rate and higher physical fitness (women), with increasing physical activity, support real differences in the level of physical activity among groups. Additionally, the physical activity assessment used has previously been validated, [34, 36-37] and exclusion of subjects with chronic diseases improves the quality of the physical activity data in the study.

An individual's propensity to be physically active may be inherited.[38-39] Lower Total-C and higher HDL-C concentrations at baseline may be markers for men and women who are genetically endowed with muscle

Fig 1. Age-adjusted mean values of body mass index (BMI) and serum lipids* across levels of leisure time physical activity at 1979-80 ●—● and 1986-87 O---O in different age-groups among men who sustained the same activity level at both surveys.
*Triglycerides were adjusted for time since last meal

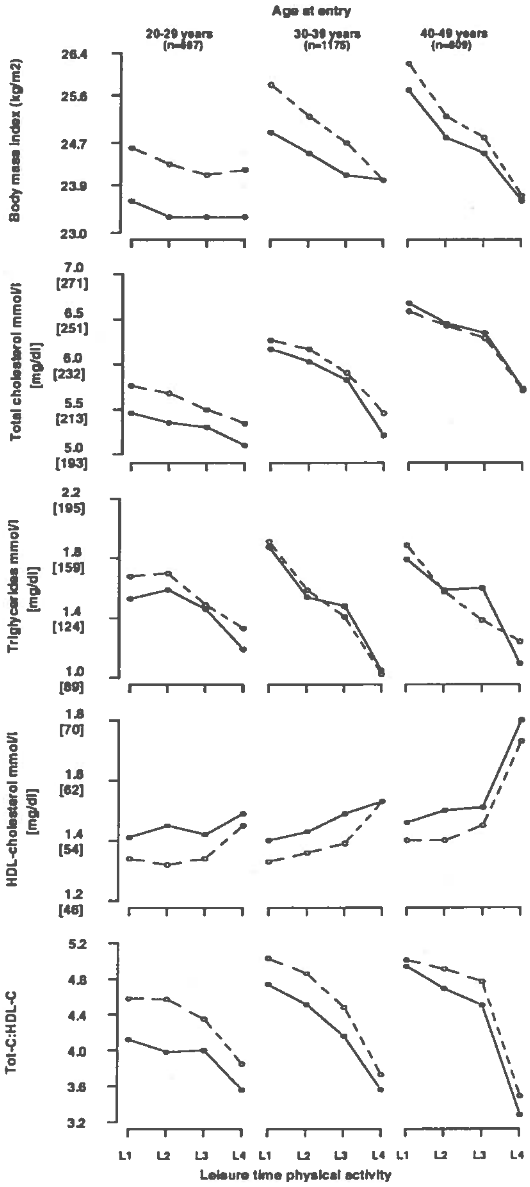


Fig 2. Age-adjusted mean values of body mass index (BMI) and serum lipids* across levels of leisure time physical activity at 1979-80 ●—● and 1986-87 o---o in different age-groups among women who sustained the same activity level at both surveys.
*Triglycerides were adjusted for time since last meal

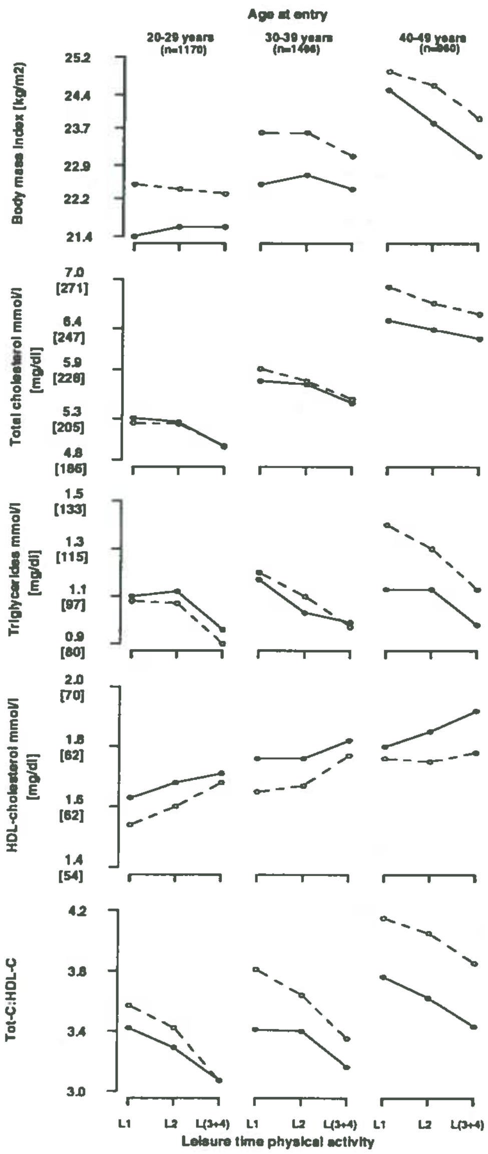
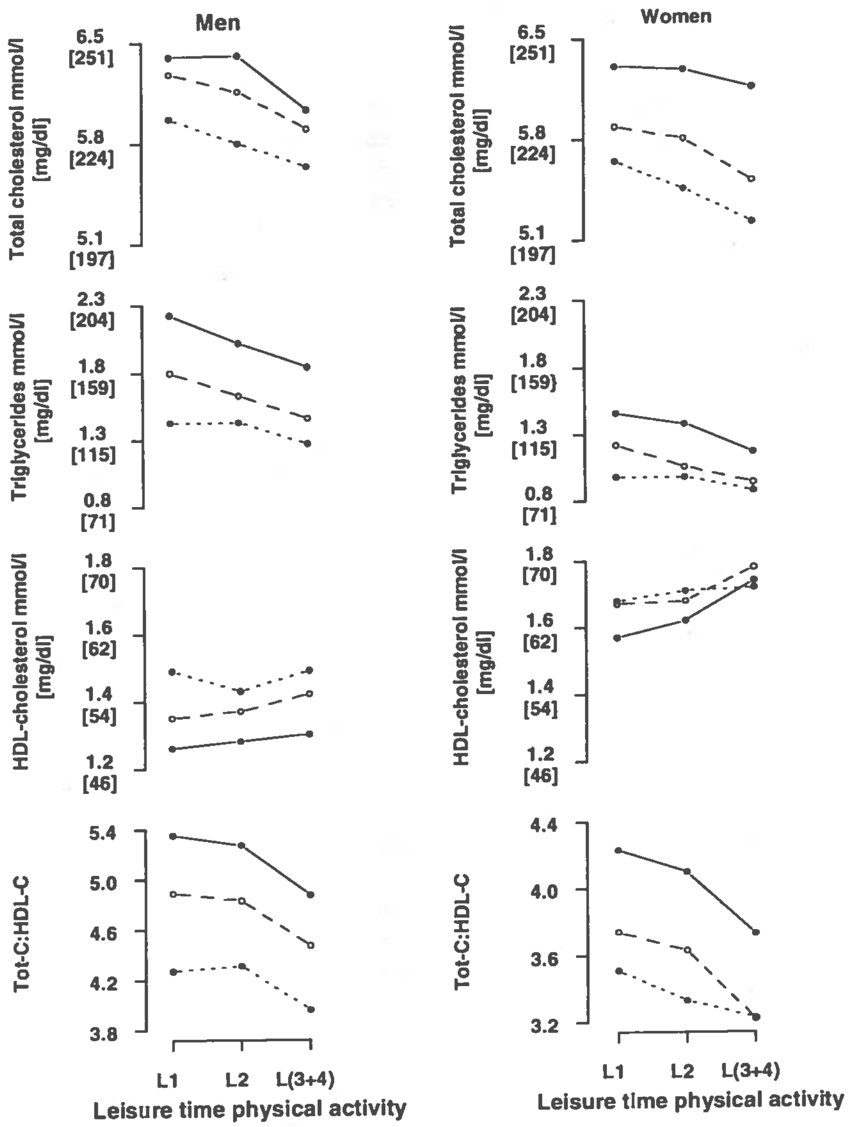


Fig. 3. Age-adjusted mean values of serum lipids* across levels of leisure time physical activity stratified by tertiles of body mass index (1986-87) among men; BMI < 23.5 kg/m^2 ●·····●, BMI 23.5-25.9 kg/m^2 o---o, BMI > 25.9 kg/m^2 ●—● and women; BMI < 21.7 kg/m^2 ●·····●, BMI 21.7-24.2 kg/m^2 o---o, BMI > 24.2 kg/m^2 ●—●, who sustained the same activity level at both surveys
*Triglycerides were adjusted for time since last meal



fibre types that make physical activity easier. Changes in the level of physical activity, however, influenced both body weight and lipid profiles in this study, and has been observed by others.[40] These changes indicate true metabolic effects of physical activity, not merely a genetic predisposition.

The population-based approach and high attendance rate reduce any selection bias in this study. It could be argued that the improvement of metabolic profiles could result from a residual effect among smokers. However, in separate analyses of non-smokers, the impact of physical activity on the estimates and tests for linear trends of the metabolic factors studied was no different from that in the total cohort.

It is possible that physically active subjects in this study may have under- or over-estimated the amount of certain foods consumed to a greater extent than inactive subjects. Due to incomplete information about nutritional habits, total energy or fat intake for each individual could not be calculated. Only certain items could be used as markers for foods generally consumed. Thus, a residual effect of diet composition, a cluster of healthy habits can not be excluded. However, regular exercise in overweight men and women improves the plasma lipoprotein levels in the present study and is additional to the effect of nutrition.[41]

Weight

Physical activity is an important component of long-term weight control. The inverse association between physical activity and body weight at baseline corroborates previous cross-sectionally observations.[14-15] The increase in BMI between sedentary and exercising groups, in those who maintained their activity level, is particularly interesting. This finding is consistent with a recent prospective study,[6] in which American male adults in the lowest category of leisure activity weighed, on average, 1.1 kg/m^2 more than men in the highest category. In our study we observed that sedentary men weighed, on average, 1.8 kg/m^2 more than exercising men at the follow-up survey. This difference was most marked in the oldest age group, with 2.5 kg/m^2 low vs high physical activity; it supports the finding that inactivity results in more weight gain in older than in younger individuals.[7] Even in those who sustained hard training, some weight gain was observed after 7 years of follow-up. This "age effect" could be explained by an age-dependent metabolic change in calorie utilization or a reduction in physical activity within, but not between, each level of activity. It could also be related to changes in nutrition.

It has been suggested that leisure time activity may also be a consequence of weight change.[6] People can put on weight because their weight makes it more difficult to exercise. Women who decreased their physical activity over the follow-up period weighed, on average, 1.2 kg/m^2 more after 7 years, whereas those women who increased their activity level had only a 0.4 kg/m^2 weight gain. Comparable results were observed for men; this points to the possibility of changing physical activity behaviour during adult life, independent of weight. Our study demonstrates a strong relationship between physical activity and weight gain in adult life, and supports the hypothesis that physical activity is a main determinant of body weight throughout adulthood. The effects of physical activity on body weight are mediated through the mechanisms of direct energy expenditure during exercise, preserving fat-free mass, increasing resting metabolic rate[42-43] and the thermic effect of food,[42] and inducing a decreased dietary intake.[44] Even if a person has not gained much weight, the mass of adipose tissue may have increased with a concomitant reduction in muscle mass as a result of physical inactivity.

Serum lipids

Cross-sectional and interventional studies have found lower concentrations of Total-C and triglycerides[19, 21, 40] and higher concentrations of HDL-C[24, 34, 45] in physically active compared with inactive individuals. We found more pronounced differences in the concentrations of cholesterol, triglycerides and HDL-C, and Total-C:HDL-C between sedentary and exercising men and women at follow-up; we are not aware of any other population-based study that demonstrates this effect on lipid profiles using repeated assessment of physical activity. These findings indicate an important effect of sustained physical activity on lipid profiles in the general population. This effect was most pronounced among the oldest members of the cohort.[21, 40, 46]

A certain intensity and duration of physical activity are necessary to achieve the desired effects on lipid metabolism.[23,47] Regular exercise for at least 4 hours a week, as in the present study, may include both the intensity and timespan needed to improve certain metabolic profiles. We found an inverse dose–response relationship between both sustained and increased physical activity levels and total cholesterol during follow-up, indicating that even moderate physical activity influences the level of total cholesterol. This was not the case with HDL-C and triglycerides because no significant dose–response relationship was observed between increase in the level of physical activity over 7 years and these lipids in men. By comparing the extremes in changes of activity (reduction versus increased), the HDL-C concentration was improved significantly in both men and women. This indicates that improvement in levels of triglycerides and HDL-C requires a high level of physical activity. This may also explain the weaker association of serum lipids and physical activity in population-based studies,[21] because these studies may have had a smaller distribution of activity than intervention studies.[24, 31, 40]

High BMI values have often been

associated with higher levels of serum cholesterol and triglycerides,[21, 48] as was observed in this study. Differences in body weight are therefore frequently cited as the reason for differences in serum cholesterol, triglyceride and HDL levels between physically active and inactive people.[41, 49] However, in the present study we observed an effect of physical activity on lipid profiles across all BMI values. This supports an influence of physical activity on lipid profiles independent of the metabolic effect of weight gain or loss.[50-52]

The increase in aerobic metabolism, oxygen uptake and increase in fatty acid use for muscular energy provides significant control parameters for lipid metabolic processes that occur during training.[19, 22, 45, 47] These mechanisms may explain why physical activity is able to bring about a reduction in concentration of serum triglycerides and serum cholesterol, and an increase in serum HDL-C.[22, 45, 47] It also supports the assumption that exercise over a long period (common in leisure time activity) has more impact than exercise over a short period – static exercise (common in occupational activities) – on lipid profiles;[53] this underlines the importance of leisure time activity over work activity.

Sex

It has been suggested that women have different physiological responses to physical activity than men in terms of BMI[54] and lipid profiles.[20, 31] We observed almost identical effects on BMI across all physical activity levels and in those who sustained their activity level during the follow-up. This supports common physiological responses to weight of physical activity in both sexes.

Our data also contradict the assumption that the generally higher HDL-C concentrations in women compared with men limit the potential for any further increase with exercise.[20] It has been observed that there is a smaller increase in HDL-C concentration in exercising women relative to men in some studies,[20] but not in others.[24] This may result from a smaller distribution in the level of physical activity in women and may not be related to true differences in biological effect between the sexes. The larger difference observed in heart rate according to level of leisure time activity in men than in women further emphasizes the larger range of physical activity carried out by men. Similarly, in this study, women, particularly in the oldest age group, reported hard exercise less frequently than men. This may also explain the smaller effect of physical activity on HDL-C concentration in women. However, women have to perform comparable levels of physical activity at a comparable intensity to achieve the same improvements as men in the concentrations of lipids.

Implications for chronic diseases

Not only are large weight gains during adulthood associated with increased morbidity or mortality of chronic diseases; [55, 56] even a modest weight gain in a normal weighted population is associated with increased risk of coronary heart disease,[29] non-insulin-dependent diabetes mellitus[4, 7] and breast cancer.[28] The importance of the dose–response association between recent weight gain and breast cancer risk[28] underlines the importance of adult weight control in women. The improvement of lipid profiles by 9.0–27.6%, as achieved in men who carried out sustained hard training, may represent, from previous studies,[57, 58] a reduction in morbidity and mortality from coronary heart disease of 20% and 25%, respectively. The reduction in triglyceride levels may be important as a risk factor for cardiovascular diseases[17] and breast cancer.[59]

The benefits of physical activity to risk and mortality from chronic diseases[7-8, 10-12] may be hypothesized as acting through a common link. Weight gain during adulthood and physical inactivity[4, 7, 54] may give a diminished sensitivity to insulin, which is associated with increased risk for non-insulin-dependent diabetes mellitus and cardiovascular diseases;[60] they have recently also been suggested to be important in carcinogenesis of the colon[14] and breast.[61]

Conclusion

This population-based prospective study has demonstrated that sustained physical activity over 7 years reduces the age-related weight gain, in a dose–response pattern, and improves lipid profiles across all BMI values in both sexes. A change from sedentary to higher levels of physical activity during adulthood improves metabolic profiles whereas a reduction in activity worsens the profiles. However, only sustained regular or hard exercise gives metabolic effects that are sufficient to compensate for the age-dependent worsening of metabolic profiles. Women have similar metabolic effects to men, but, as a result of a narrower distribution in the level of physical activity, there are more limited effects on lipids and BMI. These observations strengthen the importance of leisure time physical activity as a preventive factor against certain chronic diseases.

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Appendix I

Questionnaire; Oslo 1972-73
Finnmark 1974-75
Tromsø 1974
Sogn og Fjordane 1975-76
Oppland 1976-78

English translation of the questionnaire used in the cardiovascular disease study in Norwegian counties 1977-83 (Finnmark, Sogn og Fjordane, Oppland) and Tromsø 1979-80

English translation; Mrs. Anne Clancy and Mr. Kevin McCafferty

Tick "yes/no" or "yes", as appropriate.

Part A

Have you, or have you had:
- a heart attack?
- angina pectoris (heart cramp)?
- any other heart disease?
- arteriosclerosis of the legs?
- a cerebral stroke?
- diabetes?

Are you being treated for:
- high blood pressure?

Do you use:
- nitroglycerine?

Part B

Do you have pain or discomfort in the chest when:
- walking up hills or stairs, or walking fast on level ground?
- walking at normal pace on level ground?

If you get pain or discomfort in the chest when walking, do you usually:
(1) stop?
(2) slow down?
(3) carry on at the same pace?

If you stop or slow down, does the pain disappear:
(1) within 10 minutes?
(2) after more than 10 minutes?

Do you have pain in the calf while:
- walking?
- resting?

If you get pain in the calf, then:
- does the pain increase when you walk faster or uphill?
- does the pain disappear if you stop?

Do you usually have:
- cough in the morning?
- phlegm chest in the morning?

Part C

Exercise and physical exertion in *leisure time.* If your activity varies much, for example between summer and winter, then give an average. The questions refer only to the last twelve months.

Tick "YES" beside the description that fits best:
(1) Reading, watching TV, or other sedentary activity?
(2) Walking, cycling, or other forms of exercise at least 4 hours a week? (including walking or cycling to place of work, Sunday-walking, etc.)
(3) Participation in recreational sports, heavy gardening, etc.? (note: duration of activity at least 4 hours a week).
(4) Participation in hard training or sports competitions, regularly several times a week?

Part D

Do you smoke daily at present?
If "Yes":
Do you smoke cigarettes daily? (handrolled or factory made)

If you do not smoke cigarettes at present:
Have you previously smoked cigarettes daily?

If "Yes", how long is it since you stopped?
(1) Less than 3 months?
(2) 3 months to 1 year?
(3) 1 to 5 years?
(4) More than 5 years?

For those who smoke or have smoked previously:
How many years altogether have you smoked daily? *Number of years* ....

How many cigarettes do you, or did you, smoke daily? Give number of cigarettes per day (handrolled + factory made)
Number of cigarettes ....

Do you smoke tobacco products other than cigarettes daily?
- cigars or cigarillos?
- a pipe?

If you smoke a pipe, how many packs of tobacco (50 grams) do you smoke per week?
Give average number of packs per week.
Number of tobacco packs ....

Part E

Do you usually work shifts or at night?
Can you usually come home from work:
- every day?
- every weekend?

Are there periods during which your working days are longer than usual? (e.g.: fishing season, harvest)

During the last year, have you had: (Tick "YES" beside description that fits best):
(1) mostly sedentary work? (e.g., office work, watchmaker, light manual work)
(2) work that requires a lot of walking? (e.g., shop assistant, light industrial work, teaching)
(3) work that requires at lot of walking and lifting? (e.g., postman, heavy industrial work, construction)
(4) heavy manual labour? (e.g., forestry, heavy farmwork, heavy construction)

During the last 12 months, have you had to move house for work reasons?
Is housekeeping your main occupation?
Have you within the last 12 months received unemployment benefit?
Are you at present on sick leave, or receiving rehabilitation allowance?
Do you receive a complete or partial disability pension?

Part F (alternatives: yes, no, don't know)

Have one or more of your parents or sisters or brothers had a heart attack (heart wound) or angina pectoris (heart cramp)?

In Finnmark and Tromsø only:
Are two or more of your grandparents of Finnish origin?
Are two or more of your grandparents of Lapp origin?

Part G

Has anyone in your household (other than yourself), been called in to a doctor for further medical examination after the previous cardiovascular disease survey?

Original questionnaire, Tromsø 1974

Identical in; Finnmark 1974-75
Sogn og Fjordane 1975-76
Oppland 1976-78

TROMSØUNDERSØKELSEN 1974

Innkallings brev

UNDERSØKELSE AV RISIKO FOR HJERTE- OG KARSYKDOMMER

Hjerte- og karsykdommer er mer utbredt i Nord-Norge enn i andre landsdeler. Vi vil nå be om Deres samarbeid i kampen mot disse sykdommer.

Med sikte på å sette i verk forebyggende tiltak, vil det i løpet av 1974 bli gjennomført en undersøkelse av samtlige menn i Tromsø i alderen 20—49 år.

Undersøkelsen utføres av Universitetet i Tromsø og Tromsø helseråd. Undersøkelsen er frivillig, men forutsetningen for at den skal få verdi, er at alle møter opp.

UNDERSØKELSENS GJENNOMFØRING

1. Vennligst fyll ut vedlagte spørreskjema.
2. Ta med dette skjema og møt fram til undersøkelse i Poliklinikkbygget, Sentralsykehuset ca. 1 uke etter at dette brev er mottatt. Poliklinikken er åpen mandag, tirsdag, onsdag, torsdag og fredag, kl. 08.30—18.00.

   Undersøkelsen vil omfatte:

   a. Måling av blodtrykk.
   b. Gjennomgåelse av det utfylte skjema, samt utfylling av tilleggsskjema.
   c. Måling av høyde og vekt.
   d. Blodprøve.

Undersøkelsen vil ta ca. 30 minutter. Opplysningene behandles konfidensielt.

En del av dem som blir undersøkt, vil etter bestemte regler bli innkalt til undersøkelse på et senere tidspunkt.

Hvis undersøkelsen gir holdepunkter for at De kan ha nytte av behandling, vil De bli henvist til lege for videre kontroll.

Dersom det er vanskelig for Dem å møte fram ca. 2 uker etter at dette brev er mottatt, vennligst ring telefon 81 100.

TROMSØUNDERSØKELSEN 1974

Vi håper på et godt samarbeid og 100 % frammøte. På forhånd takk.

Hilsen

Arne Nordøy prof.dr.med.	Hans Anstad stadslege

A

JA | NEI

Har De, eller har De hatt:

- Hjerteinfarkt? 33
- Angina pectoris (hjertekrampe)? 34
- Annen hjertesykdom? 35
- Åreforkalkning i bena? 36
- Hjerneslag? 37
- Sukkersyke? 38

Er De under behandling for:

- Høyt blodtrykk? 39

Bruker De:

- Nitroglycerin? 40

B

JA | NEI

Får De smerter eller ubehag i brystet når De:

- Går i bakker, trapper eller fort på flat mark? 41
- Går i vanlig takt på flat mark? 42

Hvis De får smerter eller ubehag i brystet ved gange, pleier De da å:

1. Stanse? 43
2. Saktne farten? . . . .
3. Fortsette i samme takt? . . . .

Hvis De stanser eller saktner farten, forsvinner smertene da:

1. Etter mindre enn 10 minutter? 44
2. Etter mer enn 10 minutter? . . . .

Får De smerter i tykkleggen når De:

- Går? 45
- Er i ro? 46

Hvis De får leggsmerter, besvar da:

- Forverres smertene ved raskere tempo eller i bakker? 47
- Gir smertene seg når De stopper? . . 48

Har De vanligvis:

- Hoste om morgenen? 49
- Oppspytt fra brystet om morgenen? . . 50

C

JA

Bevegelse og kroppslig anstrengelse i Deres **fritid**.
Hvis aktiviteten varierer meget f.eks. mellom sommer og vinter så ta et gjennomsnitt.

Spørsmålet gjelder bare det siste året.

Sett kryss i den ruten hvor „JA" passer best.

1. Leser, ser på fjernsyn eller annen stillesittende beskjeftigelse? 51
2. Spaserer, sykler eller beveger Dem på annen måte minst 4 timer i uken? . . (Her medregnes også gang eller sykling til arbeidsstedet, søndagsturer m.m.)
3. Driver mosjonsidrett, tyngre hagearbeid e.l.? . . . . (Merk at yirksomheten skal vare minst 4 timer i uken.)
4. Trener hardt eller driver konkurranseidrett, regelmessig og flere ganger i uken? . . . .

D

JA | NEI

Røyker De daglig for tiden? 52

Hvis svaret var „JA" på forrige spørsmål, besvar da:

- Røyker De sigaretter daglig? . . . . 53 (håndrullede eller fabrikkframstilte)

Hvis De ikke røyker sigaretter nå, besvar da:

- Har De røykt sigaretter daglig tidligere? . 54

Hvis De svarte „JA", hvor lenge er det siden De sluttet?

1. Mindre enn 3 måneder? 55
2. 3 måneder - 1 år? . . . .
3. 1 - 5 år? . . . .
4. Mer enn 5 år? . . . .

Besvares av dem som røyker nå eller har røykt tidligere:

- Hvor mange år tilsammen har De røykt daglig? . . . . 56-57 Antall år:
- Hvor mange sigaretter røyker eller røykte De daglig? Oppgi antall pr. dag (håndrullede + fabrikkframstilte) 58-61 Ant. sigaretter

Røyker De noe annet enn sigaretter daglig?

- Sigarer eller sarutter/cigarillos? . . . 62
- Pipe? 63

Hvis De røyker pipe, hvor mange pakker tobakk (50 gram) bruker De i pipa pr. uke?

- Oppgi gjennomsnittlig antall pakker pr. uke. 64-66 Ant. tobakkpk

E

JA | NEI

Har De vanligvis skiftarbeid eller nattarbeid? 67

Kan De vanligvis komme hjem fra arbeidet:

- Hver dag? 68
- Hver helg? 69
- Har De i perioder lengre arbeidsdager enn vanlig? . . . . 70 (f.eks. under sesongfiske, annenarbeid)

Har De i løpet av siste året hatt:

Sett kryss i den ruten hvor „JA" passer best.

1. Overveiende stillesittende arbeid? . . 71 (f.eks. skrivebordsarb., urmakerarb., montering)
2. Arbeid som krever at De går mye? . . (f.eks. ekspeditørarb., lett industriarb., undervisn.)
3. Arbeid hvor De går og løfter mye? . . (f.eks. postbud, tyngre industriarb., bygningsarb.)
4. Tungt kroppsarbeid? . . . . (f.eks. skogsarbeid, tungt jordbruksarb., tungt bygningsarb.)

- Har De i løpet av de siste 12 mnd måttet flytte fra hjemstedet på grunn av forandring i arbeidssituasjonen? 72
- Er husmorarbeid Deres hovedyrke? 73
- Har De i løpet av de siste 12 mnd fått arbeidsledighetstrygd? 74
- Er De for tiden sykmeldt, eller får De attføringspenger? 75
- Har De full eller delvis uførepensjon? . . 76

F

JA | NEI | VET IKKE

- Har en eller flere av foreldre eller søsken hatt hjerteinfarkt (sår på hjertet) eller angina pectoris (hjertekrampe)? . 77
- Er to eller flere av Deres besteforeldre av finsk ætt? 78
- Er to eller flere av Deres besteforeldre av samisk ætt? 79

Original questionnaire, Oslo 1972-73

OSLO HELSERÅD

INNKALLING TIL SKJERMBILDEFOTOGRAFERING

FRAMMØTESTED: St. Olavs pl. 5 II.

FRAMMØTETID: Mandag, tirsdag: Menn A-L. Kl. 8.15 - 11.30 og kl. 13.00 - 14.30
Torsdag, fredag: Menn M-Å. Kl. 8.15 - 11.30 og kl. 13.00 - 14.30
De kan også møte mandag, tirsdag og torsdag kl. 15.30 - 18.00, men da må De vennligst ringe 20 10 70 linje 660 og 661 kl. 8.30 - 14.30 for å avtale tid.

De bes møte innen en uke etter at De har mottatt denne innkalling.
Vennligst ta med tuberkulinkort om De har.

NB: Møt helst om formiddagen.

UNDERSØKELSE AV RISIKO FOR HJERTE - KARSYKDOMMER

Samtidig med skjermbildefotograferingen ber vi Dem om - på helt frivillig grunnlag - å medvirke i en stor befolkningsundersøkelse blant menn i Oslo rettet mot hjerte - infarkt og lignende tilstander.

Dersom De er villig, må De på forhånd, så godt som mulig, krysse av svarene på baksiden. Ta skjemaet med ved frammøtet.

Hjerteundersøkelsen vil omfatte:

Måling av høyde og vekt.
Kontroll av skjemaet, med anledning til å drøfte tvilsspørsmål ved utfyllingen.
Måling av blodtrykk.
Blodprøve (ca. 10 ml blod fra vene).

Blodprøven vil bli analysert på Ullevål sykehus.

Som hovedregel gjelder at opplysninger om funnene hos enkeltpersoner ikke gis - heller ikke til den undersøktes lege.
Men en del av dem som blir undersøkt i Oslo Helseråd, vil etter bestemte regler bli innkalt til en etterundersøkelse ved Ullevål sykehus, vanligvis i løpet av 1 - 3 uker.

Hvis etterundersøkelsen på Ullevål gir som resultat at en mann vurderes som sannsynlig behandlingstrengende, vil han bli henvist til lege for videre kontroll og eventuelt behandling.

Hvis etterundersøkelsen gir som resultat at mannens risiko for hjerte - karsykdom ligger i et nærmere definert grenseområde, vil han bli spurt om han er villig til å delta i et vitenskapelig forsøk på å senke risikoen. Slike forsøk må gå over flere år, og fordelingen av mennene på behandlings - og kontrollgruppe vil skje ved loddtrekning.

Vennlig hilsen
OSLO HELSERÅD

HJERTE - KARSYKDOMMER

SPØRRESKJEMA

JA NEI

Har De, eller har De hatt:

- Hjerteinfarkt? 13
- Angina pectoris (hjertekrampe)? 14
- Annen hjertesykdom? 15
- Åreforkalkning i bena? 16
- Hjerneslag? 17
- Sukkersyke? 18

Er De under behandling for:

- Høyt blodtrykk? 19

Bruker De:

- Nitroglyserin? 20

JA

Bevegelse og kroppslig anstrengelse i Deres arbeid.
Spørsmålet gjelder bare det siste året.
Sett kryss i den ruten hvor „JA" passer best.

Har De:

- Overveiende stillesittende arbeid? 21
  (f.eks. skrivebordsarbeid, urmakerarbeid, montering)
- Arbeid som krever at De går mye? 22
  (f.eks. ekspeditørarb., lett industriarb., undervisning)
- Arbeid hvor De går og løfter mye? 23
  (f.eks. postbud, tyngre industriarb., bygningsarbeid)
- Tungt kroppsarbeid? 24
  (f.eks. skogsarbeid, tungt jordbruksarb., tungt bygg arb.)

JA

Bevegelse og kroppslig anstrengelse i Deres fritid.
Hvis aktiviteten varierer meget f.eks. mellom sommer og vinter så ta et gjennomsnitt.
Spørsmålet gjelder bare det siste året.
Sett kryss i den ruten hvor „JA" passer best.

- Leser, ser på fjernsyn eller annen stillesittende beskjeftigelse? 25
- Spaserer, sykler eller beveger Dem på annen måte minst 4 timer i uken? 26
  (Her medregnes også gang eller sykling til arbeidsstedet, søndagsturer m.m.)
- Driver mosjonsidrett, tyngre hagearbeid e.l.? 27
  (Merk at virksomheten skal være minst 4 timer i uken.)
- Trener hardt eller driver konkurranseidrett, regelmessig og flere ganger i uken? 28

JA NEI

- Har De i det siste året følt Dem merkbart mere anspent eller irritabel enn før? 29
- Regner De Dem selv for å være en person som presser Dem selv og ofte velger et høyt tempo? 30
- Eller regner De Dem selv for en person som gir avkall på slik innsats, for heller å ha ro og fredelige dager? 31
- Mener De at det er mere enn vanlig press på tidsfrister i Deres arbeidssituasjon? 32

72 CS

JA NEI

- Røker De daglig for tiden? 33

Hvis svaret var „JA" på forrige spørsmål, besvar da:

- Inhalerer De? 34
- Røker De sigaretter daglig? 35
  (håndrullede eller fabrikkframstilte)
- Bruker De mest filtersigaretter? 36

Hvis De ikke røker daglig nå, besvar da:

- Har De røkt sigaretter daglig tidligere? 37

Hvis De svarte „JA", hvor lenge er det siden De sluttet?

- Mindre enn 3 måneder? 38
- 3 måneder – 1 år? 39
- 1 – 5 år? 40
- Mere enn 5 år? 41

Hvor mange sigaretter røker eller røkte De daglig?
(håndrullede + fabrikkframstilte)

- 1 – 4? 42
- 5 – 9? 43
- 10 – 14? 44
- 15 – 19? 45
- 20 – 24? 46
- 25 eller flere? 47

Røker De noe annet enn sigaretter daglig?

- Sigarer eller senutter/cigarillos? 48
- Pipe? 49

Hvis De røker pipe, hvor mange pakker pipetobakk (50 gram) bruker De pr. uke?

- 1/2 pakke eller mindre pr. uke? 50
- 1/2 – 2 pakker pr. uke? 51
- Mere enn 2 pakker pr. uke? 52

JA NEI

Får De smerter eller ubehag i brystet når De:

- Går i bakker, trapper eller fort på flat mark? 53
- Går i vanlig takt på flat mark? 54

Hvis De får smerter eller ubehag i brystet ved gange, pleier De da å:

- Stanse? 55
- Sakte farten? 56
- Fortsette i samme takt? 57

Hvis De stanser eller sakter farten, forsvinner smertene da:

- Etter mindre enn 10 minutter? 58
- Etter mere enn 10 minutter? 59

Får De smerter i tykkleggen når De:

- Går? 60
- Er i ro? 61

Hvis De får leggsmerter, besvar da:

- Forverres smertene ved raskere tempo eller i bakker? 62
- Gir smertene seg når De stopper? 63

Appendix II

Questionnaire; Finnmark 1977-78
Sogn og Fjordane 1980-81
Oppland 1981-83
Tromsø 1979-80 - Questionnaire I

English translation of the questionnaire used in the cardiovascular disease study in Oslo* 1972-73, Norwegian counties 1974-78 (Finnmark, Oppland and Sogn og Fjordane) and Tromsø 1974.

English translation; Mr. Kevin McCafferty

Tick "yes/no" or "yes", as appropriate.

Part A

Have you, or have you had:
- a heart attack?
- angina pectoris (heart cramp)?
- any other heart disease?
- hardened arteries in the legs?
- a cerebral stroke?
- diabetes?

Are you being treated for:
- high blood pressure?

Do you use:
- nitroglycerine?

Part B

Do you have pain or discomfort in the chest when:
- walking up hills or stairs, or walking fast on level ground?
- walking at normal pace on level ground?

If you get pain or discomfort in the chest when walking, do you usually:
(1) stop?
(2) slow down?
(3) carry on at the same pace?

If you stop or slow down, does the pain disappear:
(1) within 10 minutes?
(2) after more than 10 minutes?

Do you have pain in the calf while:
- walking?
- resting?

If you get pain in the calf, then:
- does the pain increase when you walk faster or uphill?
- does the pain disappear if you stop?

Do you usually have:
- cough in the morning?
- phlegm chest in the morning?

Part C

Exercise and physical exertion in *leisure time.* If your activity varies much, for example between summer and winter, then give an average. The questions refer only to the last twelve months.

Tick "YES" beside the description that fits best:
(1) Reading, watching TV, or other sedentary activity?
(2) Walking, cycling, or other forms of exercise at least 4 hours a week? (including walking or cycling to place of work, Sunday-walking, etc.)
(3) Participation in recreational sports, heavy gardening, etc.? (note: duration of activity at least 4 hours a week).
(4) Participation in hard training or sports competitions, regularly several times a week?

Part D*

Do you smoke daily at present?
If "Yes":
Do you smoke cigarettes daily? (handrolled or factory made)

If you do not smoke cigarettes at present:
Have you previously smoked cigarettes daily?

If "Yes", how long is it since you stopped?
(1) Less than 3 months?
(2) 3 months to 1 year?
(3) 1 to 5 years?
(4) More than 5 years?

For those who smoke or have smoked previously:

How many years altogether have you smoked daily? Number of years ....

How many cigarettes do you, or did you, smoke daily? Give number of cigarettes per day (handrolled + factory made)

Number of cigarettes ....

Do you smoke tobacco products other than cigarettes daily?

- cigars or cigarillos?
- a pipe?

If you smoke a pipe, how many packs of tobacco (50 grams) do you smoke per week?

Give average number of packs per week.

Number of tobacco packs ....

Part E

Do you usually work shifts or at night?

Can you usually come home from work:

- every day?
- every weekend?

Are there periods during which your working days are longer than usual? (e.g.: fishing season, harvest)

*In Oslo preset groups of cigarettes smoked per day and packs of pipe tobacco smoked per day (see original questionnaire)

During the last year, have you had: (Tick "YES" beside description that fits best):

(1) mostly sedentary work? (e.g., office work, watchmaker, light manual work)

(2) work that requires a lot of walking? (e.g., shop assistant, light industrial work, teaching)

(3) work that requires at lot of walking and lifting? (e.g., postman, heavy industrial work, construction)

(4) heavy manual labour? (e.g., forestry, heavy farmwork, heavy construction)

During the last 12 months, have you had to move house for work reasons?

Is housekeeping your main occupation?

Have you within the last 12 months received unemployment benefit?

Are you at present on sick leave, or receiving rehabilitation allowance?

Do you receive a complete or partial disability pension?

Part F (alternatives: yes, no, don't know)

Have one or more of your parents or sisters or brothers had a heart attack (heart wound) or angina pectoris (heart cramp)?

In Finnmark and Tromsø only:

Are two or more of your grandparents of Finnish origin?

Are two or more of your grandparents of Lapp origin?

MELDING OM SKJERMBILDEFOTOGRAFERING OG HJERTE-KARUNDERSØKELSE

(Gjelder bare den person brevet er adressert til)

Skjermbildefotograferingen kommer nå til Deres distrikt.

Tid og sted for Deres frammøte vil De finne nedenfor.

Også denne gangen vil en del av befolkningen få tilbud om hjerte-karundersøkelse. De tilhører denne gruppe. En orientering om undersøkelsen er gitt i vedlagte brosjyre.

Vennligst fyll ut sporreskjemaet på baksiden og ta det med til undersøkelsen. Ta også med tuberkulinkort eller helsebok, om De har.

Fravær bes eventuelt meldt på vedlagte seddel.

Med hilsen

HELSERÅDET FYLKESLEGEN
STATENS SKJERMBILDEFOTOGRAFERING

Født dato Personnr. Kommune Kretsnr.

Møtested Kjønn Første bokstav etternavn Dag og dato Klokkeslett

SKRIV IKKE HER!

T. S. M. 17 M. 18 19 / 24 25 / 30 31 32

A/S HECOS OSLO

A

JA | NEI

Har De, eller har De hatt:

- Hjerteinfarkt? 33
- Angina pectoris (hjertekrampe)? 34
- Annen hjertesykdom? 35
- Åreforkalkning i bena? 36
- Hjerneslag? 37
- Sukkersyke? 38

Er De under behandling for:

- Høyt blodtrykk? 39

Bruker De:

- Nitroglycerin? 40

B

JA | NEI

Får De smerter eller ubehag i brystet når De:

- Går i bakker, trapper eller fort på flat mark? 41
- Går i vanlig takt på flat mark? 42

Hvis De får smerter eller ubehag i brystet ved gange, pleier De da å:

1 Stanse? 43
2 Saktne farten?
3 Fortsette i samme takt?

Hvis De stanser eller saktner farten, forsvinner smertene da:

1 Etter mindre enn 10 minutter? 44
2 Etter mer enn 10 minutter?

Får De smerter i tykkleggen når De:

- Går? 45
- Er i ro? 46

Hvis De får leggsmerter, besvar da:

- Forverres smertene ved raskere tempo eller i bakker? 47
- Gir smertene seg når De stopper? 48

Har De vanligvis:

- Hoste om morgenen? 49
- Oppspytt fra brystet om morgenen? 50

C

JA

Bevegelse og kroppslig anstrengelse i Deres **fritid**.
Hvis aktiviteten varierer meget f.eks. mellom sommer og vinter så ta et gjennomsnitt.

Spørsmålet gjelder bare det siste året.

Sett kryss i den ruten hvor „JA" passer best.

1 Leser, ser på fjernsyn eller annen stillesittende beskjeftigelse? 51
2 Spaserer, sykler eller beveger Dem på annen måte minst 4 timer i uken?
(Heri medregnes også gang eller sykling til arbeidsstedet, søndagsturer m.m.)
3 Driver mosjonsidrett, tyngre hagearbeid e.l.?
(Merk at virksomheten skal vare minst 4 timer i uken.)
4 Trener hardt eller driver konkurranseidrett, regelmessig og flere ganger i uken?

G

JA | NEI

Har noen i Deres husstand (utenom Dem selv) vært innkalt til nærmere undersøkelse hos distriktslegen etter forrige hjerte-kar undersøkelse? 80

D

JA | NEI

Røyker De daglig for tiden? 52

Hvis svaret var „JA" på forrige spørsmål, besvar da:

- Røyker De sigaretter daglig? 53
(håndrullede eller fabrikkframstilte)

Hvis De ikke røyker sigaretter nå, besvar da:

- Har De røykt sigaretter daglig tidligere? 54

Hvis De svarte „JA", hvor lenge er det siden De sluttet?

1 Mindre enn 3 måneder? 55
2 3 måneder - 1 år?
3 1 - 5 år?
4 Mer enn 5 år?

Besvares av dem som røyker nå eller har røykt tidligere:

- Hvor mange år tilsammen har De røykt daglig? 56-57 Antall år:
- Hvor mange sigaretter røyker eller røykte De daglig? Oppgi antall pr. dag 58-61 Ant. sigaretter:
(håndrullede + fabrikkframstilte)

Røyker De noe annet enn sigaretter daglig?

- Sigarer eller serutter/cigarillos? 62
- Pipe? 63

Hvis De røyker pipe, hvor mange pakker tobakk (50 gram) bruker De i pipa pr. uke?

- Oppgi gjennomsnittlig antall pakker pr. uke. 64-66 Ant. tobakkpk.:

E

JA | NEI

Har De vanligvis skiftarbeid eller nattarbeid? 67

Kan De vanligvis komme hjem fra arbeidet:

- Hver dag? 68
- Hver helg? 69
- Har De i perioder lengre arbeidsdager enn vanlig? 70
(f.eks. under sesongfiske, onnearbeid)

Har De i løpet av siste året hatt:

Sett kryss i den ruten hvor „JA" passer best.

1 Overveiende stillesittende arbeid? 71
(f.eks. skrivebordsarb., urmakerarb., montering)
2 Arbeid som krever at De går mye?
(f.eks. ekspeditørarb., lett industriarb., undervisn.)
3 Arbeid hvor De går og løfter mye?
(f.eks. postbud, tyngre industriarb., bygningsarb.)
4 Tungt kroppsarbeid?
(f.eks. skogsarbeid, tungt jordbruksarb. tungt bygningsarb.)

Har De i løpet av de siste 12 mnd måttet flytte fra hjemstedet på grunn av forandring i arbeidssituasjonen? 72

Er husmorarbeid Deres hovedyrke? 73

Har De i løpet av de siste 12 mnd fått arbeidsledighetstrygd? 74

Er De for tiden sykmeldt, eller får De attføringspenger? 75

Har De full eller delvis uførepensjon? 76

F

JA | NEI | VET IKKE

Har en eller flere av foreldre eller søsken hatt hjerteinfarkt (sår på hjertet) eller angina pectoris (hjertekrampe)? 77

Er to eller flere av Deres besteforeldre av finsk ætt? 78

Er to eller flere av Deres besteforeldre av samisk ætt? 79

Appendix III

Questionnaire; Food frequency questionnaire

Food frequency questionnaire

Prepared by the Section for Dietary Research

University of Oslo

English version in: Gaard M. *Nutritional aspects of cancer of the breast and colon*
An epidemiological study. Thesis Oslo, 1997

Questionnaire

In connection with the present examination, we would like to ask some questions about your dietary habits.
Please, fill inn the questionnaire and return it in the envelope provided. The postage is paid by the recipient.
If several in your household have received a questionnaire, each one is asked to fill it in.
All information that you give will be regarded as strictly confidential.

With regards

The Board of Health *County Medical Officer of Health*

Section for Dietary Research
University of Oslo

National Health Screening Service

Guidance

Answer each question by checking the most appropriate box.
If it is difficult to give an accurate answer, then answer in accordance with your best judgement. Perhaps there will be questions which you cannot answer at all. Leave these questions, and answer as many as possible of the other questions.

14 Do you live on a diet?
1 ☐ Yes 2 ☐ No
If you are on a regimen, try to fill in the questionnaire, nevertheless.

15 How many slices of bread do you usually eat daily?
1 ☐ Less than 2 slices a day
2 ☐ 2-4 slices a day
3 ☐ 5-6 slices a day
4 ☐ 7-8 slices a day
5 ☐ 9-12 slices a day
6 ☐ 13 or more slices a day

16 What type of bread do you eat most frequently?
1 ☐ Factory made
2 ☐ Home made

17 If factory made bread, what type do you eat most often?
1 ☐ White bread
2 ☐ Medium brown bread
3 ☐ Brown bread

18 If home made bread, how much whole meal flour is used?

1 □ Do not use whole meal flour
2 □ Less than 1/4 whole meal flour
3 □ 1/4-1/2 whole meal flour
4 □ More than 1/2 whole meal flour

19 What type of fat do you usually spread on bread?

1 □ Nothing
2 □ Butter
3 □ Margarine

20 If you spread margarine on your bread, what brand do you usually use?

....

21 Check the appropriate package

1 □ Packet
2 □ Beaker

22 Which sandwich spreads do you usually use? Check all the appropriate boxes.

22 □ White cheese
23 □ Whey cheese
24 □ Honey, syrup, sugar
25 □ Jam, marmalade
26 □ Other sweet spreads
27 □ Mayonnaise, salads
28 □ Liver paste
29 □ Cold cuts, bologna
30 □ Sardines, pickled herring

31 How many glasses/cups of milk do you usually during daily?

1 □ Do not drink milk, or drink less than 1 glass/cup a day
2 □ 1 glass/cup a day
3 □ 2 glasses/cups a day
4 □ 3 glasses/cups a day
5 □ 4 glasses/cups a day
6 □ 5 or more glasses/cups a day

32 What type of milk do you usually drink?

1 □ Do not drink milk
2 □ Whole milk, sweet or sour
3 □ Skim milk, sweet or sour
4 □ Hand-skimmed milk
5 □ Both whole and skimmed milk

33 How many cups of coffee do you usually drink daily?

1 □ Do not drink coffee or less than 1 cup a day
2 □ 1-2 cups a day
3 □ 3-4 cups a day
4 □ 5-6 cups a day
5 □ 7-8 cups a day
6 □ 9 or more cups a day

34 How much sugar do you use with/in your coffee?

1 □ Do not drink coffee
2 □ Do not use sugar
3 □ 1-2 lumps per cup
4 □ 3-4 lumps per cup
5 □ 5-6 lumps per cup
6 □ 7 lumps per cup

35 How many eggs (boiled, fried) do you usually eat during a week?

1 ☐ Do not eat, or less than 1 egg a week
2 ☐ 1 egg a week
3 ☐ 2 eggs a week
4 ☐ 3-4 eggs a week
5 ☐ 5-6 eggs a week
6 ☐ 7 or more eggs a week

36 How many oranges do you usually eat during a week?

1 ☐ Do not eat, or less than 1 orange a week
2 ☐ 1 orange a week
3 ☐ 2 oranges a week
4 ☐ 3-4 oranges a week
5 ☐ 5-6 oranges a week
6 ☐ 7 or more oranges a week

37 How often do your main meal contain fish?

1 ☐ Less than once a week
2 ☐ 1-2 times a week
3 ☐ 3-4 times a week
4 ☐ 5-6 times a week
5 ☐ 7 times a week

38 How often do your main meal contain meat (dishes with blood and/or offal included)?

1 ☐ Less than once a week
2 ☐ 1-2 times a week
3 ☐ 3-4 times a week
4 ☐ 5-6 times a week
5 ☐ 7 times a week

39 How often do your main meal contain other dishes like porridge, pancakes etc.?

1 ☐ Less than once a week
2 ☐ 1-2 times a week
3 ☐ 3-4 times a week
4 ☐ 5 or more times a week

40 How often do you use melted fat (butter, margarine, bacon fat etc.) on or with meat dishes?

1 ☐ Never, or less than once a week
2 ☐ 1-2 times a week
3 ☐ 3-4 times a week
4 ☐ 5 or more times a week

41 How often do you use melted fat (butter, margarine, bacon fat etc.) on or with fish dishes?

1 ☐ Never, or less than once a week
2 ☐ 1-2 times a week
3 ☐ 3-4 times a week
4 ☐ 5 or more times a week

42 How often do you eat fish liver (when fish liver is available)?

1 ☐ Never, or less than once a week
2 ☐ 1-2 times a week
3 ☐ 3-4 times a week
4 ☐ 5 or more times a week

43 How often do you eat potatoes with your main meal in the course of an ordinary week?

1 ☐ Less than 3 times a week
2 ☐ 3-5 times a week
3 ☐ 6-7 times a week

44 How many potatoes do you usually eat per dinner?

1 ☐ Less than one per meal
2 ☐ 1 potato per meal
3 ☐ 2 potatoes per meal
4 ☐ 3-4 potatoes per meal
5 ☐ 5 or more per meal

45 How often do you drink soft drinks during an ordinary week?

1 ☐ Never, or less than once a week
2 ☐ 1-2 times a week
3 ☐ 3-4 times a week
4 ☐ 5-6 times a week
5 ☐ 7 or more times a week

46 How often do you eat cakes, cookies etc. during an ordinary week?

1 ☐ Never, or less than once a week
2 ☐ 1-2 times a week
3 ☐ 3-4 times a week
4 ☐ 5-6 times a week
5 ☐ 7 or more times a week

Do you use some of these products during an ordinary week? Check the appropriate boxes.

47 ☐ Potato chips
48 ☐ Chocolate, candy
49 ☐ Wine, liquor
50 ☐ Beer
51 ☐ Cod liver oil
52 ☐ Vitamin supplements

HOW MANY TIMES PER MONTH DO YOU USE ANY OF THE FOLLOWING TYPES OF DISHES WITH YOUR MAIN MEAL?

53 Poached or fried sausages etc.?

1 ☐ Never, or less than once a month
2 ☐ 1-2 times a month
3 ☐ 3-4 times a month
4 ☐ 5-8 times a month
5 ☐ More than 8 times a month

54 Meat balls, hamburgers, rissoles etc.

1 ☐ Never, or less than once a month
2 ☐ 1-2 times a month
3 ☐ 3-4 times a month
4 ☐ 5-8 times a month
5 ☐ More than 8 times a month

55 Meat stews?

1 ☐ Never, or less than once a month
2 ☐ 1-2 times a month
3 ☐ 3-4 times a month
4 ☐ 5-8 times a month
5 ☐ More than 8 times a month

56 Fried or roast meat?

1 ☐ Never, or less than once a month
2 ☐ 1-2 times a month
3 ☐ 3-4 times a month
4 ☐ 5-8 times a month
5 ☐ 9-16 times a month
6 ☐ More than 16 times a month

57 Poached fish?

1 ☐ Never, or less than once a month
2 ☐ 1-2 times a month
3 ☐ 3-4 times a month
4 ☐ 5-8 times a month
5 ☐ 9-12 times a month
6 ☐ 13-16 times a month
7 ☐ More than 16 times a month

58 Fish cakes, fish balls, processed fish?

1 ☐ Never, or less than once a month
2 ☐ 1-2 times a month
3 ☐ 3-4 times a month
4 ☐ 5-8 times a month
5 ☐ More than 8 times a month

59 Fried fish?

1 ☐ Never, or less than once a month
2 ☐ 1-2 times a month
3 ☐ 3-4 times a month
4 ☐ 5-8 times a month
5 ☐ 9-12 times a month
6 ☐ 13-16 times a month
7 ☐ More than 16 times a month

60 Fruit soups, stewed fruit?

1 ☐ Never, or less than once a month
2 ☐ 1-2 times a month
3 ☐ 3-4 times a month
4 ☐ 5-8 times a month
5 ☐ 9-12 times a month
6 ☐ 13-16 times a month
7 ☐ More than 16 times a month

61 How many times do you usually eat per day? (Include coffee breaks)

1 ☐ 2 times per day
2 ☐ 3 times per day
3 ☐ 4 times per day
4 ☐ 5 times per day
5 ☐ 6 or more times per day

62 At what time do you eat or drink for the first time in the morning?

1 ☐ Before 6 a.m.
2 ☐ Between 6 a.m. and 8 a.m.
3 ☐ Between 8 a.m. and 10 a.m.
4 ☐ At 10 a.m. or later

63 How many bread meals do you usually have per day?

1 ☐ Do not eat bread
2 ☐ Once a day
3 ☐ 2-3 times a day
4 ☐ 4 or more times a day

64 Do you have a household on your own or with others?

1 ☐ Private household alone
2 ☐ Private household with other adults
3 ☐ Private household with adults and children
4 ☐ Usually eat in a canteen

65 The drawings below show cubes of butter or margarine in a true scale. *
Mark the cube with which best resembles the amount you spread on a slice of bread. If in doubt, try buttering a slice.
* (see original questionnaire)

1 □ Do not use
2 □ 3 grammes
3 □ 5 grammes
4 □ 8 grammes
5 □ 12 grammes

66 Do you make any attempts to change your body weight?

1 □ Yes 2 □ No

I forbindelse med den undersøkelsen De er med på, vil vi stille Dem noen spørsmål om Deres kosthold og endringer av dette de siste 3 årene.
Vi vil også spørre om endringer av den fysiske aktivitet i fritiden og av røykevaner.

Vennligst fyll ut dette spørreskjemaet og returner det i den vedlagte svarkonvolutt. Portoen vil bli betalt av mottakeren.

Om det skulle være flere i Deres husstand som har fått spørreskjema, ber vi om at hver enkelt fyller det ut.

Opplysningene De gir vil bli behandlet strengt fortrolig.

Med hilsen

Helserådet — Fylkeslegen

Avdeling for kostholdsforskning
Universitetet i Oslo

Statens skjermbildefotografering

VEILEDNING FOR UTFYLLING AV SPØRRESKJEMAET.

Besvar de enkelte spørsmål ved å sette kryss i den ☐ som passer.
Hvis De ikke kan gi et helt nøyaktig svar, vennligst svar da etter beste skjønn.
Det kan forekomme spørsmål som De finner at De i det hele tatt ikke er i stand til å besvare. La disse spørsmål stå åpne, og besvar så mange som mulig av de øvrige.

14 Er De på diett (spesiell kost) nå?

1 ☐ Ja   2 ☐ Nei

Om De er på diett, så prøv likevel å fylle ut skjemaet.

15 Hvor mange brødskiver spiser De vanligvis pr. dag?

1 ☐ Mindre enn 2 skiver pr. dag
2 ☐ 2 - 4 skiver pr. dag
3 ☐ 5 - 6 skiver pr. dag
4 ☐ 7 - 8 skiver pr. dag
5 ☐ 9 - 12 skiver pr. dag
6 ☐ 13 eller flere skiver pr. dag

16 Hva slags brød spiser De oftest?

1 ☐ Kjøpt
2 ☐ Hjemmebakt

17 Hvis kjøpt brød, hva slags oftest?

1 ☐ Loff
2 ☐ Fint (lyst) brød
3 ☐ Grovt (mørkt) brød

18 Hvis hjemmebakt brød, hvor stor andel av melet er grovt (mørkt)?

1 ☐ Bruker ikke grovt mel
2 ☐ Mindre enn 1/4 grovt mel
3 ☐ 1/4 - 1/2 grovt mel
4 ☐ Mer enn 1/2 grovt mel

19 Hva pleier De vanligvis å smøre på brødet?

1 ☐ Bruker ikke noe
2 ☐ Smør (meierismør)
3 ☐ Margarin

20 Hvis De bruker margarin på brødet, hvilket merke bruker De vanligvis?

....

21 Kryss av for den aktuelle pakning.

1 ☐ Pakke
2 ☐ Bordpakning (beger)

22 Hvilke påleggslag bruker De vanligvis?
30 Kryss av i alle ruter som er aktuelle.

22 ☐ Hvit (gul) ost
23 ☐ Brun ost
24 ☐ Honning, sirup, sukker (på brød)
25 ☐ Syltetøy, marmelade
26 ☐ Andre søte påleggslag (sunda, sjokade, banos, nøtte m.v.)
27 ☐ Majones, salater
28 ☐ Leverpostei
29 ☐ Spekepølse (salt pølse) og annet kjøttpålegg
30 ☐ Sardiner, sursild, speket fisk og annet fiskepålegg

31 Hvor mange glass eller kopper melk drikker De vanligvis pr. dag?

1 ☐ Drikker ikke, eller mindre enn 1 glass eller kopp pr. dag
2 ☐ 1 glass eller kopp pr. dag
3 ☐ 2 glass eller kopper pr. dag
4 ☐ 3 glass eller kopper pr. dag
5 ☐ 4 glass eller kopper pr. dag
6 ☐ 5 eller flere glass eller kopper pr. dag

e.s.trykk

32 Hva slags melk drikker De vanligvis?

1 Drikker ikke melk
2 Melk (helmelk), søt, sur
3 Skummet melk, søt, sur
4 Håndskummet melk
5 Både helmelk og skummet melk

33 Hvor mange kopper kaffe drikker De vanligvis pr. dag?

1 Drikker ikke, eller mindre enn 1 kopp pr. dag
2 1 - 2 kopper pr. dag
3 3 - 4 kopper pr. dag
4 5 - 6 kopper pr. dag
5 7 - 8 kopper pr. dag
6 9 eller flere kopper pr. dag

34 Hvor mye sukker bruker De vanligvis til eller i kaffen?

1 Drikker ikke kaffe
2 Bruker ikke sukker til/i kaffen
3 1 - 2 biter/teskjeer pr. kopp
4 3 - 4 biter/teskjeer pr. kopp
5 5 - 6 biter/teskjeer pr. kopp
6 7 eller flere biter eller teskjeer pr. kopp

35 Hvor mange egg (kokte eller stekte) spiser De vanligvis i uken?

1 Spiser ikke, eller mindre enn 1 egg i uken
2 1 egg i uken
3 2 egg i uken
4 3 - 4 egg i uken
5 5 - 6 egg i uken
6 7 eller flere egg i uken

36 Hvor mange appelsiner spiser De vanligvis i uken?

1 Spiser ikke, eller mindre enn 1 appelsin i uken
2 1 appelsin i uken
3 2 appelsiner i uken
4 3 - 4 appelsiner i uken
5 5 - 6 appelsiner i uken
6 7 eller flere appelsiner i uken

37 Hvor ofte består middagsmåltidet av fisk eller retter med fisk?

1 Sjeldnere enn én gang i uken
2 1 - 2 ganger i uken
3 3 - 4 ganger i uken
4 5 - 6 ganger i uken
5 7 ganger i uken

38 Hvor ofte består middagsmåltidet av kjøtt eller retter med kjøtt (også retter med blod og innmat)?

1 Sjeldnere enn én gang i uken
2 1 - 2 ganger i uken
3 3 - 4 ganger i uken
4 5 - 6 ganger i uken
5 7 ganger i uken

39 Hvor ofte består middagsmåltidet av andre typer retter, som grøt, pannekaker m.v.?

1 Sjeldnere enn én gang i uken
2 1 - 2 ganger i uken
3 3 - 4 ganger i uken
4 5 eller flere ganger i uken

40 Hvor ofte bruker De fett (smør, margarin, kjøttfett eller fleskefett) til eller på kjøtt?

1 Aldri eller sjeldnere enn én gang i uken
2 1 - 2 ganger i uken
3 3 - 4 ganger i uken
4 5 eller flere ganger i uken

41 Hvor ofte bruker De fett (smør, margarin, kjøttfett eller fleskefett) til eller på fisk?

1 Aldri eller sjeldnere enn én gang i uken
2 1 - 2 ganger i uken
3 3 - 4 ganger i uken
4 5 eller flere ganger i uken

42 Hvor ofte spiser De fiskelever (i perioder fiskelever er å få)?

1 Aldri eller sjeldnere enn én gang i uken
2 1 - 2 ganger i uken
3 3 - 4 ganger i uken
4 5 eller flere ganger i uken

43 Hvor ofte spiser De poteter til middag i løpet av en vanlig uke?

1 Sjeldnere enn 3 ganger i uken
2 3 - 5 ganger i uken
3 6 - 7 ganger i uken

44 Hvor mange poteter spiser De vanligvis til middag?

1 Mindre enn én potet pr. måltid
2 1 potet pr. måltid
3 2 poteter pr. måltid
4 3 - 4 poteter pr. måltid
5 5 eller flere poteter pr. måltid

45 Hvor ofte drikker De saft, brus eller andre søte drikker i løpet av en vanlig uke?

1 Aldri eller sjeldnere enn én gang i uken
2 1 - 2 ganger i uken
3 3 - 4 ganger i uken
4 5 - 6 ganger i uken
5 7 eller flere ganger i uken

46 Hvor ofte spiser De kaker, kjeks, vafler eller lefser i løpet av en vanlig uke?

1 Aldri eller sjeldnere enn én gang i uken
2 1 - 2 ganger i uken
3 3 - 4 ganger i uken
4 5 - 6 ganger i uken
5 7 eller flere ganger i uken

47 Bruker De noe av de følgende varer i
52 løpet av en vanlig uke?
Kryss av i alle ruter som er aktuelle.

- 47 ☐ Potetgull (potetchips)
- 48 ☐ Sjokolade, konfekt, drops eller pastiller
- 49 ☐ Vin, brennevin
- 50 ☐ Øl (uansett type)
- 51 ☐ Tran
- 52 ☐ Vitaminpiller eller vitamin-preparat

HVOR MANGE GANGER I MÅNEDEN SPISER DE NOEN AV DE FØLGENDE RETTER TIL MIDDAG?
Gjelder spørsmålene 53-60.

53 Kokte eller stekte pølser

- 1 ☐ Aldri eller sjeldnere enn én gang i måneden
- 2 ☐ 1 - 2 ganger i måneden
- 3 ☐ 3 - 4 ganger i måneden (inntil én gang i uken)
- 4 ☐ 5 - 8 ganger i måneden (inntil 2 ganger i uken)
- 5 ☐ Mer enn 8 ganger i måneden (mer enn 2 ganger i uken)

54 Kjøttkaker, karbonader og liknende

- 1 ☐ Aldri eller sjeldnere enn én gang i måneden
- 2 ☐ 1 - 2 ganger i måneden
- 3 ☐ 3 - 4 ganger i måneden
- 4 ☐ 5 - 8 ganger i måneden
- 5 ☐ Mer enn 8 ganger i måneden

55 Kokt kjøtt, fårikål, kjøttsuppe, lapskaus

- 1 ☐ Aldri eller sjeldnere enn én gang i måneden
- 2 ☐ 1 - 2 ganger i måneden
- 3 ☐ 3 - 4 ganger i måneden
- 4 ☐ 5 - 8 ganger i måneden
- 5 ☐ Mer enn 8 ganger i måneden

56 Stekte kjøttretter (koteletter, småstek m.v.)

- 1 ☐ Aldri eller sjeldnere enn én gang i måneden
- 2 ☐ 1 - 2 ganger i måneden
- 3 ☐ 3 - 4 ganger i måneden
- 4 ☐ 5 - 8 ganger i måneden
- 5 ☐ 9 - 16 ganger i måneden
- 6 ☐ Mer enn 16 ganger i måneden

57 Kokt fisk

- 1 ☐ Aldri eller sjeldnere enn én gang i måneden
- 2 ☐ 1 - 2 ganger i måneden
- 3 ☐ 3 - 4 ganger i måneden
- 4 ☐ 5 - 8 ganger i måneden
- 5 ☐ 9 - 12 ganger i måneden
- 6 ☐ 13 - 16 ganger i måneden
- 7 ☐ Mer enn 16 ganger i måneden

58 Fiskekaker, fiskepudding, fiskeboller

- 1 ☐ Aldri eller sjeldnere enn én gang i måneden
- 2 ☐ 1 - 2 ganger i måneden
- 3 ☐ 3 - 4 ganger i måneden
- 4 ☐ 5 - 8 ganger i måneden
- 5 ☐ Mer enn 8 ganger i måneden

59 Stekt fisk

- 1 ☐ Aldri eller sjeldnere enn én gang i måneden
- 2 ☐ 1 - 2 ganger i måneden
- 3 ☐ 3 - 4 ganger i måneden
- 4 ☐ 5 - 8 ganger i måneden
- 5 ☐ 9 - 12 ganger i måneden
- 6 ☐ 13 - 16 ganger i måneden
- 7 ☐ Mer enn 16 ganger i måneden

60 Søtsuppe, fruktsuppe, fruktgrøt, kompott

- 1 ☐ Aldri eller sjeldnere enn én gang i måneden
- 2 ☐ 1 - 2 ganger i måneden
- 3 ☐ 3 - 4 ganger i måneden
- 4 ☐ 5 - 8 ganger i måneden
- 5 ☐ 9 - 12 ganger i måneden
- 6 ☐ 13 - 16 ganger i måneden
- 7 ☐ Mer enn 16 ganger i måneden

61 Hvor mange ganger spiser De vanligvis pr. dag (tell også med kaffemåltider)?

- 1 ☐ 2 ganger pr. dag
- 2 ☐ 3 ganger pr. dag
- 3 ☐ 4 ganger pr. dag
- 4 ☐ 5 ganger pr. dag
- 5 ☐ 6 eller flere ganger pr. dag

62 Når spiser eller drikker De første gang om morgenen?

- 1 ☐ Før kl. 0600
- 2 ☐ Mellom kl. 0600 og kl. 0800
- 3 ☐ Mellom kl. 0800 og kl. 1000
- 4 ☐ Kl. 1000 eller senere

63 Hvor mange ganger om dagen spiser De brødmat?

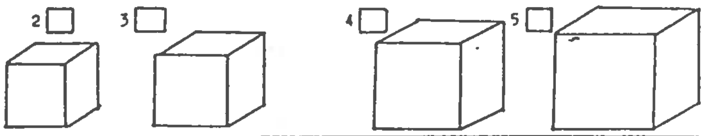
- 1 ☐ Spiser ikke brød
- 2 ☐ 1 gang pr. dag
- 3 ☐ 2 - 3 ganger pr. dag
- 4 ☐ 4 eller flere ganger pr. dag

64 Har De husholdning alene eller sammen med andre?

- 1 ☐ Har privat husholdning alene
- 2 ☐ Har privat husholdning sammen med voksne
- 3 ☐ Har privat husholdning sammen med voksne og barn
- 4 ☐ Spiser hovedsaklig i messe, kantine (storhusholdning)

65 Nedenstående tegninger forestiller terninger av smør eller margarin i naturlig størrelse. Kryss av for den terning som likner mest på den mengde De bruker til en skive brød. Er De i tvil, forsøk å prøvesmøre en skive.

1☐ Bruker ikke   2☐   3☐   4☐   5☐



66 Gjør De noe forsøk på å forandre kroppsvekten Deres?

1☐ Ja   2☐ Nei

Dette spørreskjemaet er utarbeidet av Avdeling for kostholdsforskning, Universitetet i Oslo for bruk i Statens Skjermbildefotograferings hjerte- kar-undersøkelser. For bruk i Finnmark II ble skjemaet også oversatt til samisk.
Siden skjemaet belyser spesielle sider av kostholdet er det ikke uten videre egnet til å gi en generell beskrivelse. Vi ber om at andre grupper som måtte være interessert i å bruke skjemaet eller deler av det, først kontakter oss, og at det blir gitt kilde-henvisning.

Avdeling for kostholdsforskning
Universitetet i Oslo

Appendix IV

Questionnaire; Tromsø 1979-80 - Questionnaire II

ADDITIONAL QUESTIONS FOR PERSONS ATTENDING THE MASS X-RAY EXAMINATION IN TROMSØ.

English translation; Mrs. Anne Clancy and Mr. Kevin McCafferty

Together with the invitation to attend you received a questionnaire from the National Mass Radiography Service. You delivered this questionnaire at the examination.

Cardiovascular diseases are, however, a complex group of diseases. The causes are still partly unknown. In Tromso we are therefore trying to obtain a more complete description of factors which may be of importance for the course of these diseases, such as diet, psychological pressure ("stress"), social conditions, and occurrence of disease in relatives. We hope you will take the trouble to complete this questionnaire as well, and return it to the Tromso Board of Health in the enclosed envelope.

All information in connection with the mass x-ray examination will be treated as strictly confidential.

I YOUR OWN DIET

1. What type of bread do you usually eat?

Tick the most appropriate box;	*Yes*
White bread (e.g. French bread)	☐
Ordinary bread (light texture)	☐
Whole meal (brown) bread	☐
Home-made (brown) bread	☐

2. What type of butter or margarine do you usually eat?

Tick the most appropriate box;	*Yes*
Butter	☐
Ordinary margarine	☐
Plant margarine	☐
Soft margarine spread	☐

3. How many slices of bread do you usually eat daily ?

Tick the most appropriate box;	*Yes*
Less than two slices	☐
2-6 slices	☐
7-12 slices	☐
13 or more slices	☐

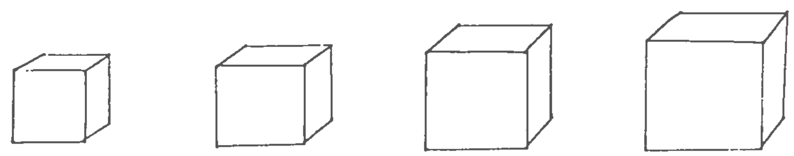
4. What type of milk do you usually drink?

Tick the most appropriate box;	*Yes*
Do not drink milk	☐
Full cream milk: ordinary type or curdled	☐
Skimmed milk: ordinary type or curdled	☐
Mixture of full cream and skimmed milk	☐

5. The drawings below show cubes of butter or margarine(actual size).
Tick the box above the cube which best resembles the amount you spread on a slice of bread.
If in doubt, try buttering a slice.

Do not use butter or margarine ☐

1. ☐ 2. ☐ 3. ☐ 4. ☐



6. How many glasses/cups of milk do you usually drink daily?

Tick the most appropriate box	*Yes*
Do not drink milk, or drink less than 1 glass /cup	☐
1-2 glasses	☐
3-4 glasses/cups	☐
5 or more glasses/cups	☐

7. How many cups of coffee do you usually drink daily?

Tick the most appropriate box	*Yes*
Do not drink coffee or drink less than 1 cup	☐
1 - 4 cups	☐
5 - 8 cups	☐
9 or more cups	☐

8 . Are you a teetotaller? *Yes* ☐ *No* ☐

If *"No"* :

How often do you usually drink beer?

Tick the most appropriate box	*Yes*
Never or just a few times a year	☐
Once or twice a month	☐
About once a week	☐
2-3 times a week	☐
More or less daily	☐

How often do you usually drink wine?

Tick the most appropriate box	*Yes*
Never or just a few times a year	☐
Once or twice a month	☐
About once a week	☐
2-3 times a week	☐
More or less daily	☐

How often do you usually drink spirits?

Tick the most appropriate box	*Yes*
Never or a just few times a year	☐
Once or twice a month	☐
About once a week	☐
2-3 times a week	☐
More or less daily	☐

9. Approximately how often during the past 12 months have you drunk so much wine, beer or spirits that you got drunk?

Tick the most appropriate box	*Yes*
Have never been drunk, or have not been drunk during the past year	☐
A few times during the last year	☐
Once or twice a month	☐
Once or twice a week	☐
3 or more times a week	☐

10. How often does your main meal consist of fish or fish dishes?

Tick the most appropriate box	*Yes*
Less than once a week	☐
Once or twice a week	☐
3 - 4 times a week	☐
5 - 6 times a week	☐
7 days a week	☐

11. How often do you eat fruit or vegetables?

Tick the most appropriate box	*Yes*
Never eat fruit or vegetables	☐
A few times a year	☐
Once or twice a month	☐
About once a week	☐
2 to 3 times a week	☐
More or less daily	☐

12. How many times a month do you eat boiled sausages or fried meat balls, processed meat, etc.?

Tick the most appropriate box	*Yes*
Never or less than once a month	☐
Once or twice a month	☐
3 - 4 times a month (up to once a week)	☐
5 - 8 times a month (up to twice a week)	☐
More than 8 times a month, (more than twice a week)	☐

13. Have you made any changes in your diet during the last 5 years as regards the following food items?

Tick each item in the appropriate box

	As before	More now	Less now
Ordinary margarine or butter:	☐	☐	☐
Skimmed milk :	☐	☐	☐
Lean meat:	☐	☐	☐
Full cream milk:	☐	☐	☐
Soya margarine (soft):	☐	☐	☐
Fatty meat:	☐	☐	☐

II. OWN ILLNESSES PAST OR PRESENT

Tick the appropriate box "Yes" or "No"

14. Have you ever had ? *Yes No*
- Sudden paralysis or numbness on one side of your face or body, in your hand or foot ☐ ☐
-Sudden loss of ability to speak ☐ ☐
-Sudden loss of eyesight, complete or partial, or sudden onset of double vision ☐ ☐

15. Have you had a peptic ulcer? *Yes No* ☐ ☐

Do you often have a gnawing pain in the upper part of your stomach? ☐ ☐

Do you suffer much from heartburn or regurgitation of gastric juices? ☐ ☐

Do you suffer much from wind and rumbling in your stomach? ☐ ☐

Do you often get cramps in your stomach ? ☐ ☐

Have you ever had your large intestine x-rayed? ☐ ☐

Have you ever had gall stones? ☐ ☐

16. Have you had kidney stones or stones in the urinary tract? Yes *No* ☐ ☐

If yes, how many times ? ....
and
When did you have your last attack? *Year:*.....

17. Have you ever had cancer? *Yes No*
If "yes", in what year was the disease discovered? ☐ ☐ *Year:* ....

18. Do you have, or have had you the skin disease psoriasis? *Yes No* ☐ ☐

19. Have you had allergy-induced eczema on your hands during the last 12 months? *Yes No* ☐ ☐

20. Have you been on sick leave, or been unable to work due to allergic eczema on your hands at any time during the past 3 years? *Yes No* ☐ ☐

21. Have you ever had arthritis? (chronic rheumatoid arthritis) *Yes No* ☐ ☐

22. Have you suffered from back pain during the past 12 months lasting for more than 4 weeks? *Yes No* ☐ ☐

If *"Yes"* did the back pain improve if you exercised? *Yes No* ☐ ☐

23. Have you suffered from morning stiffness in your back lasting more than 30 minutes? *Yes No* ☐ ☐

24. Have you suffered from pains lasting more than 3 months, in the joints listed below during the last 3 years? *Yes No*
Knees: ☐ ☐
Elbows: ☐ ☐
Innermost finger joints: ☐ ☐
Other joints: ☐ ☐

If "*Yes*", did you suffer from stiff joints in the mornings lasting more than 30 minutes? *Yes No* ☐ ☐

25. Have you had any infectious disease during the past 14 days? (influenza , common cold , vomiting, diarrhoea, etc.) *Yes No* ☐ ☐

26. Have you taken iron tablets during the past 14 days? *Yes No* ☐ ☐

27. How often do you take painkillers such as Globoid, Novid, Dispril, Albyl, etc.?
Tick the appropriate box *Yes*
1 - 3 times a week ☐
1 - 3 times a month ☐
Seldom or never ☐

Have you used such painkillers during the past 14 days? *Yes No* ☐ ☐

28. Have you changed the amount of physical exercise you take in leisure during time the last five years?
Tick the most appropriate box. *Yes*
As before ☐
More than before ☐
Less than before ☐

III ILLNESS IN PARENTS AND SIBLINGS

29. Have any of these relatives had:	mother	father	sister	brother
Cerebral stroke or brain haemorrhage	☐	☐	☐	☐
Diabetes	☐	☐	☐	☐
Arthritis (chronic rheumatoid arthritis)	☐	☐	☐	☐
Cancer	☐	☐	☐	☐
Kidney stones or stone in urinary tract	☐	☐	☐	☐
Psoriasis	☐	☐	☐	☐
Peptic ulcer	☐	☐	☐	☐
None of the above-mentioned illnesses	☐	☐	☐	☐

IV SOCIAL CONDITIONS AND PSYCHOLOGICAL PRESSURE ("STRESS")

30. How many years schooling have you had? (including secondary and folk high schools) number of years ....

31. What was your family's financial situation when you were growing up?

Tick the appropriate box	*Yes*
Very good	☐
Good	☐
Poor	☐
Very poor	☐

32 .Do you suffer from sleeplessness?	*Yes*	*No*
	☐	☐

If *"yes"*, at what time of the year do you suffer from sleeplessness?

Tick the appropriate box	Yes
No particular time	☐
Especially during the 'dark time'	☐
Especially during the arctic summer (midnight sun)	☐
Especially in spring and autumn	☐

What form your sleeplessness take?

Tick the most appropriate box	*Yes*
Difficult to fall asleep at night?	☐
Wake up a lot during the night ?	☐
Wake up very early in the morning?	☐

33. Have you had difficulty sleeping in the past couple of weeks?

Tick the most appropriate box	*Yes*
Not at all	☐
No more than usual	☐
Rather more than usual	☐
Much more than usual	☐

34. Have you felt unhappy and depressed during the past couple of weeks?

Tick the appropriate box	*Yes*
Not at all	☐
No more than usual	☐
Rather more than usual	☐
Much more than usual	☐

35. Have you felt unable to cope with your difficulties during the past couple of weeks?

Tick the appropriate box	*Yes*
Not at all	☐
No more than usual	☐
Rather more than usual	☐
Much more than usual	☐

ETIKETT

TILLEGGS-SPØRSMÅL FOR DEM SOM HAR VÆRT TIL SKJERMBILDEUNDERSØKELSE I TROMSØ

Sammen med innkallingen fikk De et spørreskjema fra Statens Skjermbilde-fotografering. Dette leverte De ved undersøkelsen.

Hjertekarsykdommene er imidlertid en mangeartet sykdomsgruppe med tildels dårlig kjente årsaksforhold. I Tromsø vil vi derfor forsøke å få en mer fullstendig kartlegging av forhold som kan være av betydning for sykdommens forløp, f.eks. kosthold, psykisk press ("stress"), sosiale forhold og sykdomsforekomst blant slektninger. Vi håper De vil være brydd med å fylle ut også dette skjema, og sende det tilbake til Tromsø Helseråd i den utleverte konvolutt.

Alle opplysninger i forbindelse med skjermbildeundersøkelsen vil bli behandlet strengt konfidensielt.

I EGET KOSTHOLD

1. Hva slags brød spiser De oftest?
Sett kryss i den ruten der „JA" passer best.

	JA
Loff 1	☐
Fint (lyst) brød, alminnelig brød 2	☐
Grovt (mørkt) brød, kneipp o.l. 3	☐
Hjemmebakt (grovt) brød 4	☐

2. Hva slags smør eller margarin bruker De oftest?
Sett kryss i den ruten der „JA" passer best.

	JA
Meieri eller fjellsmør 1	☐
Vanlig margarin 2	☐
Plantemargarin 3	☐
Myk (soft) margarin 4	☐

3. Hvor mange brødskiver spiser De vanligvis daglig?
Sett kryss i den ruten der „JA" passer best.

	JA
Mindre enn 2 skiver 1	☐
2-6 skiver 2	☐
7-12 skiver 3	☐
13 skiver eller flere 4	☐

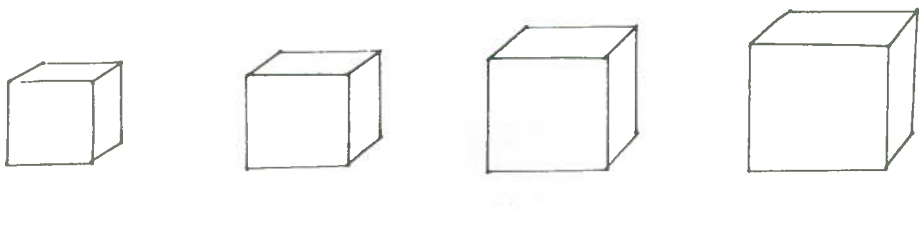
4. Hva slags melk drikker De vanligvis?
Sett kryss i den ruten der „JA" passer best.

	JA
Drikker ikke melk 1	☐
Melk (helmelk), søt, sur 2	☐
Skummet melk, søt, sur 3	☐
Blanding av skummet og helmelk 4	☐

5. Tegningen nedenfor forestiller terninger av smør eller margarin i naturlig størrelse.
Kryss av for den terning som likner mest på den mengde De bruker til 1 skive brød.
Er De i tvil, forsøk å prøvesmøre en skive.

Bruker ikke smør eller margarin .... ☐

1. ☐ 2. ☐ 3. ☐ 4. ☐



6. Hvor mange glass/kopper melk drikker De vanligvis daglig?

Sett kryss i den ruten der „JA" passer best.

	JA
Drikker ikke, eller mindre enn et glass/en kopp	1
1-2 glass/kopper	2
3-4 glass/kopper	3
5 eller flere glass/kopper	4

7. Hvor mange kopper kaffe drikker De vanligvis daglig?

Sett kryss i den ruten der „JA" passer best.

	JA
Drikker ikke, eller mindre enn en kopp	1
1-4 kopper	2
5-8 kopper	3
9 eller flere kopper	4

8. Er De totalavholdsmann/kvinne? ...... JA NEI

Hvis nei,

— Hvor ofte pleier De å drikke øl?

Sett kryss i den ruten der „JA" passer best.

	JA
Aldri, eller noen få ganger i året	1
1-2 ganger i måneden	2
Omtrent 1 gang i uken	3
2-3 ganger i uken	4
Omtrent hver dag	5

— Hvor ofte pleier De å drikke vin?

Sett kryss i den ruten der „JA" passer best.

	JA
Aldri, eller noen få ganger i året	1
1-2 ganger i måneden	2
Omtrent 1 gang i uken	3
2-3 ganger i uken	4
Omtrent hver dag	5

— Hvor ofte pleier De å drikke brennevin?

Sett kryss i den ruten der „JA" passer best.

	JA
Aldri, eller noen få ganger i året	1
1-2 ganger i måneden	2
Omtrent 1 gang i uken	3
2-3 ganger i uken	4
Omtrent hver dag	5

9. Omtrent hvor ofte har De i løpet av de siste 12 måneder drukket så mye øl, vin eller brennevin at De har vært beruset?

Sett kryss i den ruten der „JA" passer best.

	JA
Har aldri vært beruset eller ikke vært beruset i løpet av siste år	1
Noen få ganger i året	2
1-2 ganger i måneden	3
1-2 ganger i uken	4
3 eller flere ganger i uken	5

10. Hvor ofte består middagsmåltidet av fisk eller retter med fisk?

Sett kryss i den ruten der „JA" passer best.

	JA
Sjeldnere enn 1 gang i uken	1
1-2 ganger i uken	2
3-4 ganger i uken	3
5-6 ganger i uken	4
7 ganger i uken	5

11. Hvor ofte bruker De frukt eller grønnsaker?

Sett kryss i den ruten der „JA" passer best.

	JA
Bruker aldri frukt eller grønnsaker	1
Noen få ganger i året	2
1-2 ganger i måneden	3
Omtrent 1 gang i uken	4
2-3 ganger i uken	5
Omtrent hver dag	6

12. Hvor mange ganger i måneden spiser De kokte eller stekte pølser, kjøttkaker eller annen opplaget kjøttmat?

Sett kryss i den ruten der „JA" passer best.

	JA
Aldri eller sjeldnere enn 1 gang i måneden	1
1-2 ganger i måneden	2
3-4 ganger i måneden (inntil 1 gang i uken)	3
5-8 ganger i måneden (inntil 2 ganger i uken)	4
Mer enn 8 ganger i måneden, (mer enn 2 ganger i uken.)	5

13. Har De i løpet av de siste 5 årene forandret Deres kosthold når det gjelder disse varene?
Sett ett kryss for hver enkelt vare.

	Som før	Mer nå	Mindre nå
Vanlig margarin eller smør			
Skummet melk			
Magert kjøtt			
Helmelk			
Soya (soft) margarin			
Kjøtt med mye fett			

II TIDLIGERE/NÅVÆRENDE EGNE SYKDOMMER

	JA	NEI
14. Har De noen gang hatt?		
Plutselig lammelse eller nummenhet i en side av kropp eller ansikt, i en hånd eller fot		
Plutselig tap av taleevnen		
Plutselig tap av synet helt eller delvis, eller plutselig dobbeltsyn		
15. Har De hatt magesår?		
Har De ofte sugende smerter øverst i magen?		
Har De mye plager med sure oppstøt eller halsbrann?		
Er De mye plaget av oppblåsthet og rumling i magen?		
Har De ofte knipsmerter i magen?		
Har De noen gang tatt røntgenbilde av tykktarmen?		
Har De hatt gallestein?		

	JA	NEI
16. Har De hatt nyresteinsanfall (nyregrus) eller stein i urinveier?		
Hvis ja, hvor mange ganger?	ANTALL GANGER:	
og når hadde De siste anfall?	ÅRSTALL:	

	JA	NEI
17. Har De noen gang hatt kreftsykdom?		
Hvis ja, hvilket år ble sykdommen oppdaget?	ÅRSTALL:	

	JA	NEI
18. Har De, eller har De hatt hudsykdommen psoriasis?		
19. Har De i løpet av de siste 12 måneder hatt allergisk eksem på hendene?		
20. Har De i løpet av de siste 3 år vært sykemeldt eller arbeidsufør p.g.a. allergisk eksem på hendene?		
21. Har De, eller har De hatt leddgikt? (Kronisk reumatisk artritt)		

	JA	NEI
22. Har De i løpet av de siste 12 måneder vært plaget av smerter i ryggen som har vart lenger enn 4 uker?		
Hvis ja, bedrer ryggsmertene seg dersom De beveger Dem?		
23. Har De vært plaget av stivhet i ryggen om morgenen som varte lenger enn 30 minutter?		

	JA	NEI
24. Har De i løpet av de siste 3 år vært plaget av smerter i noen av de følgende ledd i mer enn 3 måneder?		
Kneleddene		
Albuleddene		
De innerste fingerleddene		
Andre ledd		
Hvis ja, merket De stivhet i leddene om morgenen av mer enn 30 minutters varighet?		

	JA	NEI
25. Har De hatt noen infeksjonssykdom de siste 14 dagene? (Influensa, forkjølelse, "ræksjuka," el.l.)		
26. Har De brukt jerntabletter de siste 14 dagene?		

27. Hvor ofte bruker De smertestillende midler som Globoid, Novid, Dispril, Albyl el.l.?
Sett kryss i den ruten der „JA" passer best.

	JA	NEI
1-3 ganger i uken 1		
1-3 ganger i måneden 2		
Sjelden eller aldri 3		
Har De brukt slike smertestillende midler de siste 14 dagene?		

28. Har De endret mengden av fysisk aktivitet i fritiden de siste 5 årene?
Sett kryss i den ruten der „JA" passer best.

	JA
Som før 1	
Mer enn før 2	
Mindre enn før 3	

III SYKDOMMER HOS FORELDRE OG SØSKEN

29. Har noen av disse slektninger hatt:

	Mor	Far	Søstre	Brødre
Hjerneslag eller hjerneblødning				
Sukkersyke				
Leddgikt (kronisk reumatisk artritt)				
Kreft				
Nyrestein eller stein i urinveier				
Psoriasis				
Magesår				
Ingen av nevnte sykdommer				

IV SOSIALE FORHOLD OG PSYKISK PRESS ("STRESS")

30. Hvor mange års skolegang har De? (Medregnet folkeskole og ungdomsskole.) .... ANTALL ÅR:

31. Hvordan var de økonomiske forhold i familien under Deres oppvekst?
Sett kryss i den ruten der „JA" passer best.

	JA
Meget gode 1	
Gode 2	
Vanskelige 3	
Meget vanskelige 4	

32. Hender det at De er plaget av søvnløshet?
Hvis ja, når på året pleier De å være plaget?
Sett kryss i den ruten der „JA" passer best.

	JA	NEI
Hender det at De er plaget av søvnløshet?		
Ingen spesiell tid 1		
Særlig i mørketiden 2		
Særlig i midnattsoltiden 3		
Særlig høst og vår 4		

Hvordan arter søvnløsheten seg?

	JA
Vanskelig å sovne om kvelden 1	
Våkner ofte i løpet av natten 2	
Våkner tidlig om morgenen 3	

33. Har De i de siste par ukene hatt vansker med å sove?
Sett kryss i den ruten der „JA" passer best.

	JA
Ikke i det hele tatt 1	
Ikke mer enn vanlig 2	
Heller mer enn vanlig 3	
Mye mer enn vanlig 4	

34. Har De i de siste par ukene følt Dem ulykkelig og nedtrykt (deprimert)?
Sett kryss i den ruten der „JA" passer best.

	JA
Ikke i det hele tatt 1	
Ikke mer enn vanlig 2	
Heller mer enn vanlig 3	
Mye mer enn vanlig 4	

35. Har De i de siste par ukene følt Dem ute av stand til å mestre Deres vanskeligheter?
Sett kryss i den ruten der „JA" passer best.

	JA
Ikke i det hele tatt 1	
Ikke mer enn vanlig 2	
Heller mer enn vanlig 3	
Mye mer enn vanlig 4	

Appendix V

Questionnaire; Tromsø 1986-87 - Questionnaire I
Tromsø 1986-87 - Questionnaire II

QUESTIONNAIRE I, TROMSØ SURVEY 1986-87

English translation; Mrs. Anne Clancy and Mr. Kevin McCafferty

A FAMILY

Have one or both of your parents, or any of your siblings (brothers and sisters) had a heart attack or angina pectoris (heart cramp)?

Yes	*No*	*Don't know*
☐	☐	☐

B OWN ILLNESSES

Have you, or have you had:	*Yes*	*No*
A heart attack?	☐	☐
Angina pectoris (heart cramp) ?	☐	☐
A cerebral stroke?	☐	☐
Diabetes?	☐	☐

Are you receiving treatment for:	*Yes*	*No*
High blood pressure?	☐	☐
Do you use nitroglycerine?	☐	☐

C SYMPTOMS

Do you get pain or discomfort in the chest, when:	*Yes*	*No*
Walking up hills, stairs or walking fast on level ground?	☐	☐
Walking at ordinary pace on level ground?	☐	☐

If you get pain or discomfort in your chest when walking, do you usually :

	Yes
Stop	☐
Slow down	☐
Carry on at the same pace	☐

If you stop or slow down, does the pain disappear:

	Yes
After less than 10 minutes?	
After more than 10 minutes?	

D EXERCISE

Exercise and physical exertion in leisure time. If your activity varies much, for example between summer and winter, then give an average. The questions refer only to the last twelve months.

Tick "yes" in the most appropriate box:

	Yes
- Reading , watching TV or other sedentary activity?	☐
- Walking, cycling or other forms of exercise at least 4 hours a week? (including walking or cycling to place of work, Sunday walking ,etc.)	☐
- Participation in recreational sports, heavy gardening, etc.? (Note: duration of activity at least 4 hours a week)	☐
- Participation in hard training or sports competitions regularly several times a week?	☐

E SALT/ FAT

How often do you use salted meat or salted fish for dinner?

Tick the appropriate box	*Yes*
Never or less than once a month	☐
Once a week or less	☐
Twice a week or less	☐
More than twice a week	☐

How often do you add extra salt to your dinner ?

Tick the appropriate box	*Yes*
Rarely or never	☐
Sometimes or often	☐
Always or nearly always	☐

What type of margarine or butter do you usually use on your bread?

Tick the most appropriate box	*Yes*
Do not use margarine or butter on bread	☐
Butter	☐
Margarine	☐
Soft (soya) margarine spread	☐
Butter/ margarine mixtures	☐

What type of cooking fat do you normally use in your household ?

Tick the appropriate box.	*Yes*
Butter or hard margarine	☐
Soft (soya) margarine or oil	☐
Butter/ margarine mixtures	☐

F SMOKING

Do you smoke daily at present? *Yes* *No*
If "*Yes*": ☐ ☐
Do you smoke cigarettes daily? ☐ ☐
(hand-rolled or factory made)
If you do not smoke cigarettes at present:
Have you previously smoked cigarettes on a daily basis? *Yes* *No* ☐ ☐

If "*Yes*", how long is it since you gave up smoking ? *Yes*
More than 3 months? ☐
3 months to 1 year? ☐
1 - 5 years? ☐
More than 5 years? ☐

The following questions are to be answered by those who smoke at present or who have smoked previously.
How many years altogether have you smoked on a daily basis: ....

How many cigarettes do you smoke or did you smoke daily: ....
(hand-rolled + factory made)

Do you smoke anything else other than cigarettes daily? *Yes*
Cigars, cigarillos, cheroots ? ☐
Pipe? ☐
If you smoke a pipe, how many packets of tobacco (50 gr.) do you smoke in a week? Give the average number of packets a week: ....

G COFFEE

How many cups of coffee do you usually drink daily?
Tick the most appropriate box *Yes*
Do not drink coffee, or less than one cup ☐
1 - 4 cups ☐
5 - 8 cups ☐
9 or more cups ☐

What type of coffee do you usually drink daily?
Coarse ground coffee for brewing (boiled) ☐
Finely ground filter coffee ☐
Instant coffee ☐
Caffeine free coffee ☐
Do not drink coffee ☐

H EMPLOYMENT

Have you received unemployment benefit within the past 12 months? *Yes* *No* ☐ ☐

Are you at present on sick leave, or receiving rehabilitation allowance? ☐ ☐

Are you on a full time or partial disability pension? *Yes* *No* ☐ ☐
Do you usually work shifts or do night work? ☐ ☐

During the past year have you had :
Tick the most appropriate box. *Yes*
- Mostly sedentary work? (office work, watchmaker, light manual work) ☐
- Work requiring a lot of walking? (shop assistant, light industrial work, teaching) ☐
- Work requiring a lot of walking and lifting? (postman, heavy industrial work, construction) ☐
- Heavy manual labour? (forestry, heavy farmwork, heavy construction) ☐

Is house-keeping your main occupation? *Yes* *No* ☐ ☐

I FOLLOW - UP EXAMINATION

Has any one in your household (other than yourself) been called in to a doctor for further medical examination after the previous cardiovascular disease survey? *Yes* *No* ☐ ☐

If as a result of this survey you need further medical examination, which general practitioner do you wish to be referred to ?
Write the doctor's name here:
....

No particular doctor ....

HELSEUNDERSØKELSEN I TROMSØ

(Gjelder bare den person som brevet er adressert til.)

Helseundersøkelsen kommer nå til Deres distrikt.

Tid og sted for frammøte vil De finne nedenfor.

De finner en orientering om undersøkelsen i den vedlagte brosjyren.

Vi ber Dem vennligst fylle ut spørreskjemaet på baksiden og ta med dette til undersøkelsen.

Vi ber Dem eventuelt melde fra om fravær på den vedlagte fraværsmeldingen.

Med hilsen

KOMMUNEHELSETJENESTEN I TROMSØ
FYLKESLEGEN I TROMS UNIVERSITETET I TROMSØ
STATENS HELSEUNDERSØKELSER

Født dato	Personnr.	Kommune	Kretsnr.

Møtested	Kjønn	Første bokstav i etternavn	Dag og dato	Klokkeslett

HOYDE VEKT ANM 70	M P O KODE 75	AVVIK ARM MAN APP.NR TSM 82
MÅLING 1	**MÅLING 2**	**MÅLING 3**
MAR 85 S 88	MAR 91 S 94	MAR 97 S 100
HR 103 D 106	HR 109 D 112	HR 115 D 118

A FAMILIE

Har en eller flere av foreldre eller søsken hatt hjerteinfarkt (sår på hjertet) eller angina pectoris (hjertekrampe)? 12

JA | NEI | VET IKKE

B EGEN SYKDOM

Har De, eller har De hatt:

JA | NEI

Hjerteinfarkt? 13
Angina pectoris (hjertekrampe)? 14
Hjerneslag? 15
Sukkersyke? 16

Er De under behandling for:

Høyt blodtrykk? 17

Bruker De:

Nitroglycerin? 18

C SYMPTOMER

Får De smerter eller ubehag i brystet når De:

JA | NEI

Går i bakker, trapper eller fort på flat mark? 19
Går i vanlig takt på flat mark? 20

Dersom De får smerter eller vondt i brystet ved gange, pleier De da:

Stoppe? .... 21 — 1
Saktne farten? .... — 2
Fortsette i samme takt? .... — 3

Dersom De stopper eller saktner farten, går da smertene bort:

Etter mindre enn 10 minutter? .... 22 — 1
Etter mer enn 10 minutter? .... — 2

Har De vanligvis:

JA | NEI

Hoste om morgenen? 23
Oppspytt fra brystet om morgenen? 24

D MOSJON

Bevegelse og kroppslig aktivitet i Deres fritid. Dersom aktiviteten varierer mye, f.eks. mellom sommer og vinter, så ta ett gjennomsnitt. Spørsmålet gjelder bare det siste året.

Sett kryss i den ruten som passer best.

Leser, ser på fjernsyn eller annen stillesittende beskjeftigelse? .... 25 — 1

Spaserer, sykler eller beveger Dem på annen måte minst 4 timer i uken? .... — 2
(Her skal De også regne med gang eller sykling til arbeidsstedet, søndagsturer m.m.)

Driver mosjonsidrett, tyngre hagearbeid e.l.? .. — 3
(Merk at aktiviteten skal vare i minst 4 timer i uken.)

Trener hardt eller driver konkurranseidrett regelmessig og flere ganger i uken? .... — 4

E SALT/FETT

Hvor ofte bruker De salt kjøtt eller salt fisk til middag?

Sett kryss i den ruten som passer best.

Aldri eller sjeldnere enn en gang i måneden .... 26 — 1
Inntil en gang i uken .... — 2
Inntil to ganger i uken .... — 3
Mer enn to ganger i uken .... — 4

Hvor ofte pleier De å strø ekstra salt på middagsmaten?

Sett kryss i den ruten som passer best.

Sjelden eller aldri .... 27 — 1
Av og til eller ofte .... — 2
Alltid eller nesten alltid .... — 3

Hva slags margarin eller smør bruker De vanligvis på brødet?

Sett kryss i den ruten som passer best.

Bruker ikke smør eller margarin på brød .... 28 — 1
Smør .... — 2
Hard margarin .... — 3
Myk (Soft) margarin .... — 4
Smør/margarin blanding .... — 5

Hva slags fett blir vanligvis brukt til matlaging i husholdningen Deres?

Sett kryss i den ruten som passer best.

Smør eller hard margarin .... 29 — 1
Myk (Soft) margarin eller olje .... — 2
Smør/margarin blanding .... — 3

F RØYKING

JA | NEI

Røyker De daglig for tida? 30

Dersom svaret er «JA», svar da på dette:

Røyker De sigaretter daglig? 31
(håndrullede eller fabrikkfremstilte)

Dersom De ikke røyker sigaretter nå, svar da på dette:

Har De røykt sigaretter daglig tidligere? 32

Dersom De svarte «JA», hvor lenge er det da siden De sluttet?

Mindre enn 3 måneder? .... 33 — 1
3 måneder – 1 år? .... — 2
1–5 år? .... — 3
Mer enn 5 år? .... — 4

Skal besvares av de som røyker nå eller som har røykt tidligere:

Hvor mange år til sammen har De røykt daglig? .... 34 — År

Hvor mange sigaretter røyker eller røykte De daglig?
Gi opp antallet sigaretter daglig .... 36 — Sigaretter
(håndrullede + fabrikkframstilte)

Røyker De noe annet enn sigaretter daglig?

Sigarer eller serutter/sigarillos? 40
Pipe? 41

Dersom De røyker pipe, hvor mange pakker tobakk (50 gram) bruker De i pipen på en uke?

Gi opp gjennomsnittlig tall på pakker i uken .... 42 — Tobakkspk.

G KAFFE

Hvor mange kopper kaffe drikker De vanligvis hver dag?

Sett kryss i den ruten som passer best.

Drikker ikke kaffe, eller mindre enn en kopp .... 45 — 1
1 – 4 kopper .... — 2
5 – 8 kopper .... — 3
9 eller flere kopper .... — 4

Hva slags kaffe drikker De vanligvis hver dag?

Kokekaffe 46
Filterkaffe 47
Pulverkaffe 48
Koffeinfri kaffe 49
Drikker ikke kaffe 50

H ARBEID

JA | NEI

Har De i de siste 12 månedene fått arbeidsledighetstrygd? 51

Er De for tiden sykemeldt, eller får De attføringspenger? 52

Har De full eller delvis uførepensjon? 53

Har De vanligvis skiftarbeid eller nattarbeid 54

Har De i det siste året hatt:

Sett kryss i den ruten som passer best.

For det meste stillesittende arbeid? .... 55 — 1
(f.eks. skrivebordsarb., urmakerarb., montering)
Arbeide som krever at De går mye? .... — 2
(f.eks. ekspeditørarb., lett industriarb., undervisn.)
Arbeide der De går og løfter mye? .... — 3
(f.eks. postbud, tyngre industriarb., bygningsarb.)
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(f.eks. skogsarb., tungt jordbruksarb., tungt bygningarb.)

JA | NEI

Er husmorarbeid hovedyrket Deres? 56

I ETTERUNDERSØKELSE

Har noen i husstanden Deres (utenom Dem selv) vært innkalt til nærmere undersøkelse hos lege etter den siste hjertekarundersøkelsen? 57

Dersom denne helseundersøkelsen viser at De bør undersøkes nærmere: Hvilken almenpraktiserende lege ønsker De da å bli henvist til?

Skriv navnet på legen her

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Ikke skriv her

Ikke skriv her

ADDITIONAL QUESTIONS THE TROMSØ HEALTH SURVEY, 1986 - 87.

English translation; Mrs. Anne Clancy and Mr. Kevin McCafferty

Cardiovascular heart and circulatory diseases, on which the surveys of 1974 and 1979-80 focused, are a very varied category of diseases whose causes are still partly unknown. In Tromso we are therefore trying to obtain a more complete description of factors which may be important for the course of these diseases, such as diet, psychological pressure, "stress", social conditions and the occurrence of disease in relatives. Such a description is also important in the search for factors that contribute to cancer, a group of diseases which we will also be trying to combat in the coming years.

When you were called in, you received a questionnaire which you handed in at the survey. The present questionnaire asks for further information about your health and includes questions on various diseases and physical and psychological complaints. We have included questions on pregnancy, birth and menstruation.

In addition, we are interested in obtaining information on the public use of medical services in order to find out how to improve the health service.

We hope that you will take the trouble to fill in yet another questionnaire and return it to "Tromso Board of Health" in the enclosed envelope. All information will be treated in strict confidence. If you have any comments to make on the survey, you may write them down in the space provided on the last page of the questionnaire.

Yours sincerely

Tromso Board of Health	*Department of Medicine, University of Tromso*

GENERAL STATE OF HEALTH

How is your health?

Tick the appropriate box.	*Yes*
Very bad	☐
Bad	☐
Neither good nor bad, "middling"	☐
Good	☐
Excellent	☐

ILLNESS

Have you/ have you had: Tick "*yes*" or "*no*" for each question.	*Yes*	*No*
The skin disease psoriasis?	☐	☐
Asthma?	☐	☐
Allergic eczema?	☐	☐
Hay fever?	☐	☐
Chronic bronchitis?	☐	☐
Stomach ulcer?	☐	☐
Duodenal ulcer?	☐	☐
Your appendix removed?	☐	☐
An operation for a stomach ulcer?	☐	☐
Chronic rheumatoid arthritis?	☐	☐
Cancer?	☐	☐
Epilepsy?	☐	☐
Migraine?	☐	☐

INFECTIONS

How many times in the last 6 months have you had infections like a cold, influenza (flu) diarrhoea/vomiting, or similar illnesses ? *Number of times* :.............

	Yes	*No*
Have you had one of these infection in the past 14 days?	☐	☐

ILLNESS IN PARENTS OR SIBLINGS

Tick the appropriate box for relatives that have, or have had the following illnesses:

	Mother	Father	Brother	Sister
Cerebral stroke or brain haemorrhage:	☐	☐	☐	☐
Diabetes:	☐	☐	☐	☐
Rheumatoid arthritis:	☐	☐	☐	☐
Cancer:	☐	☐	☐	☐
Psoriasis:	☐	☐	☐	☐
Stomach or duodenal ulcer:	☐	☐	☐	☐
Asthma:	☐	☐	☐	☐

	Yes	*No*
Tick the appropriate box if neither your parents nor siblings have or have had any of the above illnesses.	☐	☐

MEDICINES

	Yes	*No*
Have you during the last year used tablets/ sprays or had injections for asthma or allergies?	☐	☐

Have you used any of the following medicines in the past 14 days?	*Yes*	*No*
Painkillers:	☐	☐
Antipyretics (to reduce fever):	☐	☐
Eczema ointment:	☐	☐
Blood pressure medication:	☐	☐
Heart medication:	☐	☐
Sleeping tablets:	☐	☐
Nerve tablets:	☐	☐
Migraine medication:	☐	☐
Epilepsy medication:	☐	☐
Other medicines:	☐	☐

CONTACT DUE TO OWN HEALTH OR ILLNESS

How many visits have you made during the past year due to your own health or illness ?

	Number of visits
To a GP(general practitioner):	....
To a specialist, (non hospital):	....
Emergency GP	....
Medical officer at work :	....
Physiotherapist:	....
Chiropractor:	....
Nature healer(homeopath etc.):	....
Hospital outpatient department	....
Number of hospital admissions in the past year:	....

DIET

How many slices of bread do you usually eat daily ?

Tick the most appropriate box.	*Yes*
Less than 2 slices	☐
2 - 4 slices	☐
5 - 6 slices	☐
7 -12 slices	☐
13 or more slices	☐

What type of milk do you usually drink?

Tick the most appropriate box.	*Yes*
Do not drink milk	☐
Full cream milk (ordinary or curdled)	☐
Light milk	☐
Skimmed milk (ordinary or curdled)	☐

How many glasses/cups of milk do usually drink daily?

	Yes
Less than 1 glass/cup	☐
1 - 2 glasses/cups	☐
3 - 4 glasses/cups	☐
5 or more glasses/cups	☐

FISH

How often do you eat cod, coal fish, red snapper or other lean fish for dinner or in a sandwich?

Tick the most appropriate box	*Yes*
Less than once a week	☐
Once a week	☐
Twice a week	☐
3 or more times a week	☐

How often do you eat cod/pollock or other lean fish for dinner or in a sandwich?

Tick the most appropriate box.	*Yes*
Less than once a week	☐
Once a week	☐
Twice a week	☐
3 or more times a week	☐

How often do you eat fat fish, such as herring, halibut, mackerel, salmon or trout for dinner or in a sandwich?

Tick the most appropriate box	*Yes*
Less than once a week	☐
Once a week	☐
Twice a week	☐
3 or more times a week	☐

Do you take cod liver oil regularly?

Tick the most appropriate box	*Yes*
No	☐
'Dark-time'(mid-winter)	☐
All year	☐

BREAKFAST

	Yes	*No*
Do you usually eat breakfast every day?	☐	☐

DINNER

How often do you eat meat for dinner?

Tick the appropriate box	*Yes*
Less than once a week	☐
Once or twice a week	☐
3 - 4 times a week	☐
5 or more times a week	☐

How often do you use fat like butter, margarine, mayonnaise, etc. with your dinner?

Tick the most appropriate box	*Yes*
Less than once a week	☐
Once or twice a week	☐
3 - 4 times a week	☐
5 or more times a week	☐

	Yes	*No*
Do you usually eat vegetables with your dinner?	☐	☐

FRUIT

How often do you usually eat fruit ?

Tick the appropriate box.	
Less than once a week	☐
About once a week	☐
2 - 3 times a week	☐
4 - 5 times a week	☐
More or less	☐

ALCOHOL

	Yes	*No*
Are you a teetotaller?	☐	☐

If "*not*", how often do you drink beer?

Tick the most appropriate box	*Yes*
Never or just a few times a year	☐
Once or twice a month	☐
About once a week	☐
2 - 3 times a week	☐
More or less daily	☐

How often do you drink wine ?

Tick in the most appropriate box	*Yes*
Never or just a few times a year	☐
Once or twice a month	☐
About once a week	☐
2 - 3 times a week	☐
More or less daily	☐

How often do you drink spirits ?

Tick the appropriate box	*Yes*
Never or just a few times a year	☐
Once or twice a month	☐
Approximately once a week	☐
2 or 3 times a week	☐
More or less daily	☐

Approximately how often in the past year have you drunk alcohol corresponding to at least 5 small bottles of beer, a bottle of wine, or a quarter bottle of spirits?

Tick the most appropriate box	*Yes*
Not at all the past year	☐
A few times	☐
Once or twice a month	☐
3 or more times a week	☐

PHYSICAL ACTIVITY

How often do you take part in physical activity lasting at least 20 minutes, which makes you perspire or become breathless?

Tick the appropriate box.	*Yes*
Rarely or never	☐
Weekly	☐
Several times a week	☐
Daily	☐

If you usually take part in this type of activity at least weekly, how much time do you spend exercising?

Tick the most appropriate box.	*Yes*
Less than 30 minutes a week	☐
Between 30 minutes and one hour weekly	☐
Between 1 and 2 hours a week	☐
More than 2 hours a week	☐

CHANGE IN DIETARY HABITS AND OTHER HABITS

Have you changed any of the following habits during the last 5 years?

Tick the appropriate box.	*Use now*		
	More	*As before*	*Less*
Dietary fat	☐	☐	☐
Soya margarine or oil	☐	☐	☐
Skimmed or low fat milk	☐	☐	☐
Coffee intake	☐	☐	☐
Alcohol intake	☐	☐	☐
Physical activity	☐	☐	☐

MARRIAGE / PARTNER

	Yes	*No*
Are you married or 'living together?	☐	☐

How old were you when you first married or moved in with a partner? *age:* ....

HOUSEHOLD

How many persons live in your household ?
Number of persons : ....

	Yes	*No*
Is anyone in your household 10 years or younger?	☐	☐
Does anyone in your household need special care/assistance? *(Other than the children)*	☐	☐

SCHOOLING

How many years schooling have you had? (include secondary and folk high schools)
Number of years : ....

EMPLOYMENT

Have you had paid work this past year?

Tick the appropriate box	*Yes*
Full-time work	☐
Part-time work	☐
Unpaid work	☐

How much house work do you normally do yourself ?

Tick the appropriate box	*Yes*
All or almost all	☐
At least half	☐
More than a quarter	☐
Less than a quarter	☐

BACK AND JOINTS CONDITIONS

	Yes	*No*
During this last year have you suffered from backache that has lasted longer than 4 weeks ?	☐	☐
If "*yes*", does the pain improve when you exercise?	☐	☐
Have you suffered from morning stiffness in your back lasting more than 30 minutes?	☐	☐

During the past 3 years have you suffered from pain in any of the following joints lasting more than 30 minutes ?

	Yes	*No*
Knees	☐	☐
Elbows	☐	☐
Innermost finger joints	☐	☐
Other joints	☐	☐

	Yes	*No*
If "*yes*", have you suffered from stiff joints in the mornings lasting more than 30 minutes?	☐	☐

NECK HEAD AND SHOULDER COMPLAINTS

How often do you suffer headache?

Tick the appropriate box	*Yes*
Rarely or never	☐
Once or twice a month	☐
Once or twice a week	☐
Daily	☐

How often do you suffer pain in the neck or shoulder?

Tick the appropriate box	*Yes*
Rarely or never	☐
Once or twice a month	☐
Once or twice a week	☐
Daily	☐

Do these complaints inhibit your ability to work?

Tick the appropriate box.	*Yes*
Little or no effect	☐
To some degree	☐
To a large degree	☐
Cannot do ordinary work	☐

Have your back, shoulders, and /or neck ever been x-rayed? *Yes* ☐ *No* ☐

SLEEPLESSNESS / LOSS OF CONSCIOUSNESS

Have you ever suffered from sleeplessness? *Yes* ☐ *No* ☐

If "*yes*", at what time of the year do you usually suffer from sleeplessness?

Tick the appropriate box	*Yes*
No particular time	☐
Especially during the 'dark time'	☐
Especially during the arctic summer (midnight sun)	☐
Especially in spring and autumn	☐

Have you at any time during the last 12 twelve months suffered from tiredness that has affected your work performance? *Yes* ☐ *No* ☐

Have you suffered from sudden loss of consciousness in the past year? *Yes* ☐ *No* ☐

Have you noticed sudden changes in your pulse rate or heartbeat in the past year? *Yes* ☐ *No* ☐

REACTION TO PROBLEMS

If you have major personal problems, do you expect to get help and support from your spouse or family? *Yes* ☐ *No* ☐

In the last year, have you long felt a need to seek help with personal problems, without doing so? *Yes* ☐ *No* ☐

During the past 2 weeks have you felt unable to cope with your problems?

Tick the appropriate box	*Yes*
Seldom or never	☐
Sometimes	☐
Often	☐
Nearly always	☐

During the past 2 weeks have you felt unhappy or depressed?

Tick the appropriate box	*Yes*
Seldom or never	☐
Sometimes	☐
Often	☐
Nearly always	☐

Do you ever feel lonely?

Tick the appropriate box	*Yes*
Very often	☐
Sometimes	☐
Rarely or never	☐

THE REMAINING SECTION OF THE QUESTIONNAIRE APPLIES TO WOMEN ONLY.

MENSTRUATION

How old were you when you started menstruating? *age:* ....

When did you start your last period? (*date, month, year*) ....

How many days usually pass from the first day of one period to the first day of your next period (the time lapsed between the start of two periods)?
Number of days: ....

Do/did you menstruate regularly? *Yes* ☐ *No* ☐

Do you usually need pain-killers during menstruation? *Yes* ☐ *No* ☐

PRE-MENSTRUAL TENSION

Do you have any of the following complaints before your period?

Are you depressed or irritable?

Tick the appropriate box	*Yes*
Hardly at all	☐
Noticeably	☐
Very much so	☐

Are your breasts painful?

Tick the appropriate box	*Yes*
Hardly at all	☐
Noticeably	☐
Very much so	☐

Do you have swollen hands/feet, put on weight, or feel bloated?

Tick the appropriate box.	*Yes*
Hardly at all	☐
Noticeably	☐
Very much so	☐

Do the complaints disappear when you get your period? *Yes* ☐ *No* ☐

What type of medication do you use for these complaints?

Tick the appropriate box.	*Yes*
Diuretics	☐
Other medicines	☐

PREGNANCY

How many children have you had?
Number of children : ....

How old were you when you got pregnant for the first time? *Age*: ....

CONTRACEPTION

Do you now use or have you ever used the contraceptive pill or an intrauterine device? *Yes* ☐ *No* ☐

If *"yes"*, for how many years altogether have you used: *Number of years*

The pill: ....

An intrauterine device: ....

How old were you when you started using:

The pill: *age:* ....

An intrauterine device: *age:* ....

If you stopped taking the pill, did 6 months or more pass without menstruating (having a period), without your being pregnant? *Yes* ☐ *No* ☐

Did you have to stop taking the pill due to high blood pressure? *Yes* ☐ *No* ☐

CERVICAL SMEAR TEST

How many times have you had a cervical smear test in the last 3 years?
Number of times: ....

How many years is it since you had your last cervical smear test ?
Number of years: ....

Comments

....

....

Thank you for your help! Remember to post the questionnaire today!
The Tromso survey 1986-1987.

Tilleggsspørsmål til Helseundersøkelsen i Tromsø 1986-87.

Hjerte-karsykdommene, som Hjerte-karundersøkelsene i 1974 og 1979-80 spesielt tok opp, er en mangeartet sykdomsgruppe med tildels dårlig kjente årsaksforhold. I Tromsø vil vi derfor forsøke å få en mer fullstendig kartlegging av forhold som kan være av betydning for sykdommens forløp, f.eks. kosthold, psykisk press *«stress»*, sosiale forhold og sykdomsforekomst blant slektninger. En slik kartlegging er også viktig for å finne fram til sykdomsskapende forhold for kreftsykdommene, som er en sykdomsgruppe vi også vil prøve å bekjempe i årene som kommer.

Sammen med innkallingen fikk De et spørreskjema som De leverte ved undersøkelsen. Dette spørreskjema kartlegger helseforholdene bedre og inkluderer spørsmål om noen forskjellige sykdommer og fysiske/psykiske plager. Spesielt er det tatt med spørsmål vedrørende svangerskap, fødsel og menstruasjon.

Dessuten er vi interessert i å få oversikt over hvordan folk bruker helsetjenesten, for å få kunnskap om hvordan helsetjenesten kan bedres.

Vi håper De vil være brydd med å fylle ut også dette skjemaet, og sende det tilbake til Tromsø Helseråd i den utleverte konvolutt. Alle opplysninger i forbindelse med Helseundersøkelsen vil bli behandlet strengt konfidensielt. Har De noen kommentarer til undersøkelsen kan De skrive dem i kommentarfeltet på siste side.

Med hilsen

Tromsø Helseråd   Fagområdet medisin

HELSETILSTAND

Hvordan er Deres helsetilstand?
Sett kryss i den ruten der «Ja» passer best.

		Ja
Meget dårlig	12	☐ 1
Dårlig		☐ 2
Hverken god eller dårlig, middels		☐ 3
Bra		☐ 4
Utmerket		☐ 5

SYKDOM

Har De, eller har De hatt
Kryss av «Ja» eller «Nei» for hvert spørsmål

		Ja	Nei
Hudsykdommen psoriasis	13	☐	☐
Astma	14	☐	☐
Allergisk eksem	15	☐	☐
Høysnue	16	☐	☐
Kronisk bronkitt	17	☐	☐
Sår på magesekken	18	☐	☐
Sår på tolvfingertarmen	19	☐	☐
Blindtarms-operasjon	20	☐	☐
Magesårs-operasjon	21	☐	☐
Leddgikt (kronisk revmatoid artritt)	22	☐	☐
Kreftsykdom	23	☐	☐
Epilepsi (fallesyke)	24	☐	☐
Migrene	25	☐	☐

INFEKSJON

Hvor mange ganger har De hatt infeksjon slik som forkjølelse, influensa, «ræksjuka» og lignende siste halvår? 26 Antall ☐

Har De hatt slik infeksjon siste 14 dager? 27 Ja ☐ Nei ☐

SYKDOM HOS FORELDRE OG SØSKEN

Kryss av for de slektningene som har eller har hatt noen av sykdommene:

		Mor	Far	Bror	Søster
Hjerneslag eller hjerneblødning	28	☐	☐	☐	☐
Sukkersyke	32	☐	☐	☐	☐
Leddgikt (revmatoid artritt)	36	☐	☐	☐	☐
Kreft	40	☐	☐	☐	☐
Psoriasis	44	☐	☐	☐	☐
Magesår eller tolvfingertarmsår	48	☐	☐	☐	☐
Astma	52	☐	☐	☐	☐

Kryss av dersom slektningene ikke har eller har hatt noen av disse sykdommene 56 Ja ☐ Nei ☐

MEDISINER

Har De siste år brukt tabletter, sprøyter eller astmaspray mot astma eller allergi 60 Ja ☐ Nei ☐

Har De brukt følgende medisiner siste 14 dager?

		Ja	Nei
Smertestillende	61	☐	☐
Febersenkende	62	☐	☐
Eksemsalve	63	☐	☐
Blodtrykksmedisin	64	☐	☐
Hjertemedisin	65	☐	☐
Sovemedisin	66	☐	☐
Nervemedisin	67	☐	☐
Migrenemedisin	68	☐	☐
Medisin mot epilepsi (fallesyke)	69	☐	☐
Annen medisin	70	☐	☐

KONTAKT PGA. EGEN HELSE ELLER SYKDOM

Hvor mange besøk har De hatt siste år på grunn av egen helse eller sykdom?

		Antall besøk
Hos vanlig lege	71	☐
Hos spesialist utenfor sykehuset	72	☐
På legevakta	85	☐
Hos bedriftslege	87	☐
Hos fysioterapeut	89	☐
Hos kiropraktor	81	☐
Hos naturmedisiner (homeopat, soneterapeut o.l.)	83	☐
På sykehusets poliklinikk	85	☐

Antall innleggelser på sykehus siste år .... 87 ☐

KOSTHOLD

Hvor mange brødskiver spiser De vanligvis daglig?
Sett kryss i den ruten der «Ja» passer best

		Ja
Mindre enn 2 skiver	88	☐ 1
2 – 4 skiver		☐ 2
5 – 6 skiver		☐ 3
7 – 12 skiver		☐ 4
13 eller flere skiver		☐ 5

Hva slags melk drikker de vanligvis?
Sett kryss i den ruten der «Ja» passer best.

		Ja
Drikker ikke melk	89	☐ 1
Melk (helmelk), søt, sur		☐ 2
Lettmelk		☐ 3
Skummet melk, søt, sur		☐ 4

Hvor mange glass/kopper melk drikker De vanligvis daglig?

		Ja
Mindre enn ett glass/kopp	90	☐ 1
1 – 2 glass/kopper		☐ 2
3 – 4 glass/kopper		☐ 3
5 eller flere glass/kopper		☐ 4

FISKEMAT

Hvor ofte spiser De torsk/sei eller annen mager fisk til middag eller som pålegg?
Sett kryss i den ruten der «Ja» passer best.

		Ja
Sjeldnere enn en gang i uken	91	☐ 1
1 gang i uken		☐ 2
2 ganger i uken		☐ 3
3 eller flere ganger i uken		☐ 4

Hvor ofte spiser De fet fisk som sild, kveite, uer, makrell, laks, ørret til middag eller som pålegg?
Sett kryss i ruten der «Ja» passer best.

		Ja
Sjeldnere enn en gang i uken	92	☐ 1
1 gang i uken		☐ 2
2 ganger i uken		☐ 3
3 eller flere ganger i uken		☐ 4

Bruker De tran regelmessig?
Sett kryss i ruten der «Ja» passer best.

		Ja
Nei	93	☐ 1
I mørketida		☐ 2
Hele året		☐ 3

FROKOST

		Ja	Nei
Spiser De vanligvis frokost daglig?	94	☐	☐

MIDDAGSMAT

Hvor ofte spiser De vanligvis kjøtt til middagen?
Sett kryss i ruten der «Ja» passer best.

		Ja
Sjeldnere enn en gang i uken	95	☐ 1
1 – 2 ganger i uken		☐ 2
3 – 4 ganger i uken		☐ 3
5 eller flere ganger i uken		☐ 4

Hvor ofte bruker De fett (smør, margarin, remulade, majones og lignende) til eller på middagsmaten?
Sett kryss i ruten der «Ja» passer best.

		Ja
Sjeldnere enn en gang i uken	96	☐ 1
1 – 2 ganger i uken		☐ 2
3 – 4 ganger i uken		☐ 3
5 eller flere ganger i uken		☐ 4

		Ja	Nei
Bruker De vanligvis grønnsaker som del av middagsmaten?	97	☐	☐

FRUKT

Hvor ofte spiser De vanligvis frukt?
Sett kryss i ruten der «Ja» passer best.

		Ja
Sjeldnere enn en gang i uken	98	☐ 1
Omtrent en gang i uken		☐ 2
2 – 3 ganger i uken		☐ 3
4 – 5 eller flere ganger i uken		☐ 4
Omtrent daglig		☐ 5

ALKOHOL

	Ja	Nei
Er De total avholdsmann/-kvinne	☐	☐

Hvis nei,
– Hvor ofte pleier De å drikke øl?
Sett kryss i ruten der «Ja» passer best.

		Ja
Aldri, eller noen få ganger i året	100	☐ 1
1 – 2 ganger i måneden		☐ 2
Omtrent 1 gang i uken		☐ 3
2 – 3 ganger i uken		☐ 4
Omtrent hver dag		☐ 5

Hvor ofte pleier De å drikke vin?
Sett kryss i ruten der «Ja» passer best.

		Ja
Aldri, eller noen få ganger i året	101	☐ 1
1 – 2 ganger i måneden		☐ 2
Omtrent 1 gang i uken		☐ 3
2 – 3 ganger i uken		☐ 4
Omtrent hver dag		☐ 5

– Hvor ofte pleier De å drikke brennevin?
Sett kryss i ruten der «Ja» passer best.

		Ja
Aldri, eller noen få ganger i året	102	☐ 1
1 – 2 ganger i måneden		☐ 2
Omtrent 1 gang i uken		☐ 3
2 – 3 ganger i uken		☐ 4
Omtrent hver dag		☐ 5

Omtrent hvor ofte har De i løpet av siste år drukket alkohol tilsvarende minst 5 halvflasker øl, en helflaske vin eller ¼ flaske brennevin?
Sett kryss i ruten der «Ja» passer best.

		Ja
Ikke siste år	103	☐ 1
Noen få ganger		☐ 2
1 – 2 ganger i måneden		☐ 3
3 eller flere ganger i uken		☐ 4

FYSISK AKTIVITET

Hvor ofte utfører De fysisk aktivitet av minst 20 minutters varighet og som fører til at De blir svett eller andpusten?
Sett kryss i ruten der «Ja» passer best. — 104

	Ja
Sjelden eller aldri	☐ 1
Ukentlig	☐ 2
Flere ganger i uka	☐ 3
Daglig	☐ 4

Dersom De vanligvis utfører slik aktivitet minst en gang i uka, hvor mye tid bruker De ukentlig til slik aktivitet?
Sett kryss i ruten der «Ja» passer best. — 105

	Ja
Mindre enn 30 minutter i uka	☐ 1
Mellom 30 minutter og 1 time i uka	☐ 2
Mellom 1 og 2 timer i uka	☐ 3
Mer enn 2 timer i uka	☐ 4

VANE- OG KOSTENDRINGER

Har De endret Deres vaner/kosthold i løpet av de siste 5 år når det gjelder:(Sett kryss for hvert spørsmål)

		Bruker nå mer	som før	mindre
Fett i kosten	106	☐	☐	☐
Soyamargarin eller matoljer	107	☐	☐	☐
Skummet melk eller lettmelk	108	☐	☐	☐
Kaffe-forbruk	109	☐	☐	☐
Alkohol-forbruk	110	☐	☐	☐
Fysisk aktivitet	111	☐	☐	☐

EKTESKAPS-/SAMBO-FORHOLD

		Ja	Nei
Er De gift eller samboende	112	☐	☐

Hvor gammel var De da De første gang giftet Dem eller innledet et samboerforhold? ... 113 ☐ år

HUSSTAND

Hvor mange personer bor det i deres husstand? ... 115 Antall ☐

		Ja	Nei
Er noen i Deres husstand 10 år eller yngre?	117	☐	☐
Trenger noen i Deres husstand spesielt tilsyn/pleie – *utenom barna?*	118	☐	☐

SKOLEGANG

Hvor mange års skolegang har De (ta også med folkeskole og ungdomsskole)? ... 119 ☐ år

ARBEID

Har De hatt lønnet arbeid hele siste år?
Sett kryss i ruten der «Ja» passer best. — 121

	Ja
Fulltidsarbeid	☐ 1
Deltidsarbeid	☐ 2
Ikke lønnet arbeid	☐ 3

Hvor stor del av det daglige arbeid i hjemmet gjør De vanligvis selv?
Sett kryss i ruten der «Ja» passer best. — 122

Alt eller nesten alt	☐ 1
Minst halvparten	☐ 2
Mer enn en fjerdedel	☐ 3
Mindre enn en fjerdedel	☐ 4

RYGG- OG LEDDPLAGER

		Ja	Nei
Har De i løpet av siste år vært plaget av smerter i ryggen som har vart lenger enn 4 uker?	123	☐	☐
Hvis ja, bedrer ryggsmertene seg dersom De beveger Dem?	124	☐	☐
Har De vært plaget av stivhet i ryggen om morgenen som varte lenger enn 30 minutter?	125	☐	☐

Har De i løpet av siste 3 år vært plaget av smerter i noen av de følgende ledd i mer enn 3 måneder?

		Ja	Nei
Kneleddene	126	☐	☐
Albueleddene	127	☐	☐
De innerste fingerleddene	128	☐	☐
Andre ledd	129	☐	☐
Hvis ja, merket De stivhet i leddene om morgenen av mer enn 30 minutters varighet	130	☐	☐

PLAGER I HODE, NAKKE OG SKULDRE

Hvor ofte er De plaget av hodepine?
Sett kryss i ruten der «Ja» passer best. — 131

	Ja
Sjelden eller aldri	☐ 1
En eller flere ganger i måneden	☐ 2
En eller flere ganger i uken	☐ 3
Daglig	☐ 4

Hvor ofte er De plaget av smerter i nakke eller skuldre?
Sett kryss i ruten der «Ja» passer best. — 132

	Ja
Sjelden eller aldri	☐ 1
En eller flere ganger i måneden	☐ 2
En eller flere ganger i uken	☐ 3
Daglig	☐ 4

Reduserer plagene i hodet, nakken eller skuldrene Deres arbeidsevne?
Sett kryss i ruten der «Ja» passer best. — 133

	Ja
Aldri, eller i ubetydelig grad	☐ 1
I noen grad	☐ 2
I betydelig grad	☐ 3
Klarer ikke vanlig arbeid	☐ 4

		Ja	Nei
Har De noen gang fått røntgenundersøkt ryggen, nakken og/eller skuldre	134	☐	☐

SØVNLØSHET/BEVISSTLØSHET

		Ja	Nei
Hender det at De er plaget av søvnløshet	135	☐	☐

Hvis ja, når på året er De mest plaget?
Sett kryss i ruten der «Ja» passer best. — 136

	Ja
Ingen spesiell tid	☐ 1
Særlig mørketiden	☐ 2
Særlig i midnattsoltiden	☐ 3
Særlig høst og vår	☐ 4

		Ja	Nei
Har De gjennom hele siste år vært plaget av søvnighet slik at det går ut over arbeidsevnen?	137	☐	☐
Har De siste år hatt anfall med plutselig tap av bevissthet?	138	☐	☐
Har De merket anfall med plutselig endring i pulsen eller hjerterytmen siste år	139	☐	☐

REAKSJONER PÅ PROBLEMER

Hvis De får store personlige problemer, regner De da med å få hjelp og støtte fra ektefelle, samboer eller familie? 140 — Ja ☐ Nei ☐

Har De i lengere tid følt behov for å oppsøke noen på grunn av personlige problem siste år, uten at De har tatt slik kontakt? 141 — Ja ☐ Nei ☐

Har De i de siste 14 dager følt Dem ute av stand til å takle Deres vanskeligheter?
Sett kryss i ruten der «Ja» passer best. 142 — Ja
- Aldri eller sjelden ☐ 1
- Av og til ☐ 2
- Ofte ☐ 3
- Nesten hele tida ☐ 4

Har De i de siste 14 dager følt Dem ulykkelig og nedtrykt (deprimert)?
Sett kryss i ruten der «Ja» passer best. 143 — Ja
- Aldri eller sjelden ☐ 1
- Av og til ☐ 2
- Ofte ☐ 3
- Nesten hele tida ☐ 4

Hender det ofte at De føler Dem ensom?
Sett kryss i ruten der «Ja» passer best. 144 — Ja
- Meget ofte ☐ 1
- Av og til ☐ 2
- Aldri eller nesten aldri ☐ 3

RESTEN AV SKJEMAET BESVARES BARE AV KVINNER

MENSTRUASJON

Hvor gammel var De da De fikk menstruasjon første gang? 145 ☐ år

Når begynte Deres siste menstruasjon? 147 dag / mnd. / år

Hvor mange dager er/var det vanligvis fra menstruasjonens 1. blødningsdag til neste menstruasjons 1. blødningsdag (= tiden mellom to menstruasjoners begynnelse)? 153 ☐ dager

Pleier/pleide menstruasjonen å være regelmessig 155 — Ja ☐ Nei ☐

Bruker De vanligvis smertestillende tabletter under menstruasjonen? 156 — Ja ☐ Nei ☐

PLAGER FOR MENSTRUASJON

Har De før menstruasjon noen av disse plagene:

– Er De nedtrykt (deprimert) eller irritabel?
Sett kryss i ruten der «Ja» passer best 157 — Ja
- Ubetydelig ☐ 1
- Merkbart ☐ 2
- Plagsomt ☐ 3

– Har De smertefulle bryst?
Sett kryss i ruten der «Ja» passer best 158 — Ja
- Ubetydelig ☐ 1
- Merkbart ☐ 2
- Plagsomt ☐ 3

– Har De hovne hender/føtter, vektøkning, eller følelse av å «ese ut»?
Sett kryss i ruten der «Ja» passer best 159 — Ja
- Ubetydelig ☐ 1
- Merkbart ☐ 2
- Plagsomt ☐ 3

Forsvinner plagene når menstruasjonen kommer? 160 — Ja ☐ Nei ☐

Bruker De mot slike plager: — Ja / Nei
- vanndrivende tabletter? 161 ☐ ☐
- andre medisiner? 162 ☐ ☐

SVANGERSKAP

Hvor mange barn har De født? 163 Antall ☐

Hvor gammel var De første gang De var gravid? 164 ☐ år

PREVENSJON

Bruker eller har De brukt P-piller eller spiral? 166 — Ja ☐ Nei ☐

Hvis ja, hvor mange år har De tilsammen brukt:
- P-piller? 167 ☐ år
- Spiral? 169 ☐ år

Hvor gammel var De da De begynte med
- P-piller? 171 ☐ år
- Spiral? 173 ☐ år

Hvis De har sluttet med P-piller, uteble da menstruasjonen i mer enn 6 måneder uten at De var gravid? 175 — Ja ☐ Nei ☐

Har de måttet slutte med P-piller fordi De fikk høyt blodtrykk? 176 — Ja ☐ Nei ☐

KREFTPRØVE

Hvor mange ganger har De fått tatt kreftprøve (celleprøve) fra livmorhalsen siste 3 år? 177 Antall prøver ☐

Hvor mange år siden er det siden siste prøve? 178 ☐ år

Deres kommentarer: 179

Takk for hjelpen! Husk å postlegge skjemaet idag!
Tromsøundersøkelsen 1986-7

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.

21. The Healthy Faith. Pregnancy outcome, risk of disease, cancer morbidity and mortality in Norwegian Seventh-Day-Adventists.
Av Vinjar Fønnebø, 1992.

22. Aspects of breast and cervical cancer screening.
Av Inger Torhild Gram, 1992.

23. Population studies on dyspepsia and peptic ulcer disease: Occurrence, aetiology, and diagnosis. From The Tromsø Heart Study and The Sørreisa Gastrointestinal Disorder Studie.
Av Roar Johnsen, 1992.

24. Diagnosis of pneumonia in adults in general practice.
Av Hasse Melbye, 1992.

25. Relationship between hemodynamics and blood lipids in population surveys, and effects of n-3 fatty acids.
Av Kaare Bønaa, 1992.

26. Risk factors for, and 13-year mortality from cardiovascular disease by socioeconomic status. A study of 44690 men and 17540 women, ages 40-49.
Av Hanne Thürmer, 1993.

27. Utdrag av medisinalberetninger fra Sulitjelma 1891-1990.
Av Anders Forsdahl, 1993.

28. Helse, livsstil og levekår i Finnmark. Resultater fra Hjerte-karundersøkelsen i 1987-88. Finnmark III.
Av Knut Westlund og Anne Johanne Søgaard, 1993.

29. Patterns and predictors of drug use. A pharmacoepidemiologic study, linking the analgesic drug prescriptions to a population health survey in Tromsø, Norway.
Av Anne Elise Eggen, 1994.

30. ECG in health and disease. ECG findings in relation to CHD risk factors, constitutional variables and 16-year mortality in 2990 asymptomatic Oslo men aged 40-49 years in 1972.
Av Per G. Lund-Larsen, 1994.

31. Arrhythmia, electrocardiographic signs, and physical activity in relation to coronary heart risk factors and disease. The Tromsø Study.
Av Maja-Lisa Løchen, 1995.

32. The Military service: mental distress and changes in health behaviours among Norwegian army conscript.
Av Edvin Schei, 1995.

33. The Harstad injury prevention study: Hospital-based injury recording and community-based intervention.
Av Børge Ytterstad, 1995.

34.* Vilkår for begrepsdannelse og praksis i psykiatri. En filosofisk undersøkelse.
Av Åge Wifstad, 1996. (utgitt Tano Aschehoug forlag 1997)

35. Dialog og refleksjon. Festskrift til professor Tom Andersen på hans 60-års dag, 1996.

36. Factors affecting doctors´ decision making.
Av Ivar Sønbø Kristiansen, 1996.

37. The Sørreisa gastrointestinal disorder study. Dyspepsia, peptic ulcer and endoscopic findings in a population.
Av Bjørn Bernersen, 1996.

38. Headache and neck or shoulder pain. An analysis of musculoskeletal problems in three comprehensive population studies in Northern Norway.
Av Toralf Hasvold, 1996.

39. Senfølger av kjernefysiske prøvespreninger på øygruppen Novaya Semlya i perioden 1955 til 1962. Rapport etter programmet "Liv". Arkangelsk 1994.
Av A.V. Tkatchev, L.K. Dobrodeeva, A.I. Isaev, T.S. Podjakova, 1996.

40. Helse og livskvalitet på 78 grader nord. Rapport fra en befolkningsstudie på Svalbard høsten 1988.
Av Helge Schirmer, Georg Høyer, Odd Nilssen, Tormod Brenn og Siri Steine, 1997.

De som er merket med * har vi dessverre ikke flere eksemplar av.