Thirty-year trends of physical activity in relation to age, calendar time and birth cohort in Finnish adults

Katja Borodulin¹,², Tiina Laatikainen¹, Anne Juolevi¹, Pekka Jousilahti¹,³

Background: The aim of this article was to investigate time trends 1972–2002 in leisure time, occupational and commuting physical activity across birth cohorts in Finnish adults. Methods: The study population comprised 59,028 men and women aged 25–64 years who participated in the FINRISK Study. The first birth cohort was born in 1913 and the last in 1977. Prevalence of physical activity was reported across birth cohorts and study years and change in the prevalence was tested using log-linear regression analysis. Results: The prevalence of leisure-time physical activity increased between 1972 and 2002 from 66% to 77% in men and from 49% to 76% in women. In each study year, the younger people were more active than the older ones. However, within the birth cohorts, physical activity tended to increase with age. The prevalence of physically demanding work decreased from 60% to 38% in men and from 47% to 25% in women and the prevalence of daily commuting activity decreased from 30% to 10% in men and from 34% to 22% in women, in the same time period. In the 1970s and the 80s, the older people had more physically demanding work than the younger ones, but within the birth cohorts, occupational activity decreased with age. Conclusion: During the past 30 years, the prevalence of leisure-time physical activity has increased, while the prevalence of occupational and commuting physical activity has decreased. The cross-sectional association of age with different types of physical activity was different from that assessed within the birth cohorts.

Keywords: birth cohort, epidemiologic studies, exercise, physical activity

Introduction

Physical activity enhances health and prevents many chronic diseases.¹,² The role of physical activity in reducing excess body fat and maintaining a healthy weight has become more important during the recent years, as prevalence of overweight and obesity are increasing.³,⁴ The current burden of obesity has been estimated to be caused by sedentary lifestyles and unhealthy changes in diet.³ The changes in society, such as mechanization and motorization have increased the level of physical inactivity at work and leisure time. Cars have replaced many of the trips and commuting that were before done by foot or bicycle. To understand these changes, it is important to monitor physical activity at population level in longer term and to find potential strategies to increase the physical activity of those not reaching the recommended levels.

Only few studies have reported time trends of physical activity⁵⁻⁸ and very few studies have been conducted at population level.⁹⁻¹³ Most of the previous studies were carried out in the United States, suggesting decreased occupational, transportation and home physical activity during a 10-year period¹⁰ and slight increases in the prevalence of walking between 1987 and 2000.¹¹ The percentage of persons being sedentary has also been reported to increase during a 10-year period.¹² The prevalence of leisure-time physical activity has been reported to have remained at the same level or increased at some point.¹,¹⁰,¹² There are also geographical differences between the states, as some studies report increases of leisure-time physical activity and sedentary behaviour over time, while some studies found no changes in leisure-time physical activity.¹³,¹⁴ One study carried out among the Australian adult population suggested the proportion of sufficiently physically active persons to have decreased during a 3-year follow-up.¹¹ One Canadian study suggested increases in sufficient leisure-time physical activity during a 20-year follow-up.² Similar increasing trends in leisure-time physical activity were reported in eastern Finland, while the prevalence of occupational and commuting physical activity decreased from 1972 to 1997.⁶

In addition to monitoring the trends in physical activity, it is also important to find which population subgroups have decreased their physical activity levels the most. Some cohort and retrospective studies have found that all types of physical activity decrease as one ages¹⁴,¹⁵ and particularly the participation in vigorous physical activity diminishes with age.¹⁴ Cross-sectional study is a useful design to follow the changes of physical activity in the population across time, but it is too often reported with general trend information on the prevalence of physical activity by gender or age groups. Whether the trend changes in physical activity are more related to time, birth cohorts or age, would be a fresh and interesting topic to study further.

The aim of this study was to investigate the time trends from 1972 to 2002 in leisure time, occupational and commuting physical activity in relation to age and birth cohort among the Finnish adult population. To our knowledge, no previous study has assessed the dynamics of the long-term change of different types of physical activity in relationship to age, birth cohort and calendar time in large populations.

Methods

This study was part of the National FINRISK Study, which monitors the levels of chronic disease risk factors in Finland.
and has been conducted in 1972, 1977, 1982, 1987, 1992, 1997 and 2002. In 1972 and 1977, the study was carried out in eastern Finland, after which new survey areas have been added in the subsequent years: in 1982, Turku and Loimaa regions in south-western Finland, in 1992, the capital area of cities of Helsinki and Vantaa and in 1997, the province of Oulu in north-western Finland. In each study year, an independent random sample was drawn from the national population register. In 1972 and 1977, the random sample comprised 6.6% of the population born in 1913–49. In the later surveys, a sex and 10-year age group stratified random sample was drawn for each area. The first and second study samplings included participants aged 30–59 years and the later studies aged 25–64 years. The sample sizes for each study from 1972 to 2002 were 9882, 10 012, 8665, 6029, 5964, 7619 and 11 944, totalling up to 60 115 individuals. The participation rates have been slightly higher among women than among men and have varied between 70% and 96% in women and between 60% and 94% in men. The leisure-time physical activity analysis included 59 028 individuals, after the exclusions of missing information on physical activity (n = 1087 for all study years). The occupational physical activity analysis included 44 836 individuals, after the exclusions of missing information on physical activity (n = 847 for all study years) and occupation (n = 959 for all study years) and the exclusion of the unemployed, housewives and the retired (n = 13 473 for all study years). The commuting physical activity analysis included 43 518 individuals, after the exclusions of missing information on physical activity (n = 1741 for all study years) and occupation (n = 1809 for all study years) and the exclusion of the unemployed, housewives and the retired (n = 13 047 for all study years). The analyses on the occupational distribution comprised 58 306 participants after the exclusion of missing information the occupation (n = 1809 for all study years). The exact sample sizes across the study years are reported in the tables. The study protocol in 1972–97 followed the WHO MONICA protocol and the 2002 Study the European Heart Risk Monitoring Project. The study protocols have been kept as similar as possible to ensure comparable data across the years. The sampling procedure and information on the sample sizes have been published elsewhere.

Physical activity, divided into leisure time, occupational and commuting physical activity, was assessed using self-administered questionnaires. The questionnaire was created for middle-aged men in Sweden and has been validated in this population, showing that more physically active men had a higher predicted maximal oxygen uptake. This questionnaire has widely been used in health-related studies. Leisure-time physical activity was assessed with a question: how much do you exercise and stress yourself physically in your leisure time? The four response options were: (i) In my leisure time I read, watch TV and work in the household with tasks which do not make me move much and which do not physically exhaust me, (ii) in my spare time I walk, cycle or exercise otherwise at least 4 h/week. This includes walking, fishing and hunting, light gardening, etc. but excludes travel to work, (iii) in my spare time I exercise to maintain my physical condition, e.g. running, jogging, skiing, gymnastics, swimming, playing ball games or I do heavy gardening or the like for at least 3 h/week and (iv) in my spare time I regularly exercise several times a week, competitive sports such as running, orienteering, skiing, swimming, playing ball games or other heavy sports. The responses were dichotomized to physically inactive (Category 1) and physically active (Categories 2–4). Occupational physical activity measured how physically demanding the work was and the four response options varied from very light (mostly sitting) to very demanding (forest and farm work). The responses were dichotomized into physically inactive and physically active work. The two-way commuting trip was assessed in minutes spent walking, biking or otherwise exercising and was further dichotomized into low-commuting physical activity (0–29 min daily) and high-commuting physical activity (more than 30 min daily).

**Statistical methods**

The participants were divided into birth cohorts by the following birth year groups: 1913–22, 1923–32, 1933–42, 1943–52, 1953–62, 1963–72 and 1973–77. The prevalence of physical activity was calculated as the percentage of those being physically active for each type of physical activity. Log-linear regression analysis was carried out to study the change of the prevalence in physical activity across calendar time (study year) and birth cohort. In the log-linear regression analysis models, dependent variable was the dichotomous variable of physical activity and independent variables were the categorical birth cohorts and the study years. The strength of the association is reported with beta values, their 95% confidence intervals (95% CI) and P-values. The positive beta values denoted that the prevalence of physical activity increased by increasing calendar time or birth cohort. Interaction tests of calendar time and birth cohorts were carried out to study whether the change in the prevalence of physical activity differed across birth cohorts in the study years.

The analyses were adjusted for geographical area. Separate analyses were implemented for different types of physical activity. The unemployed, retirees and housewives were excluded in the analyses of occupational and commuting physical activity. Men and women were analysed separately. For the change of the occupational status over time, Chi-squared tests were employed. The SAS statistical software package (1999 SAS Institute Inc., Cary, NC, USA) was used to carry out the analyses.

**Results**

The prevalence of leisure-time physical activity increased between 1972 and 2002 from 66% to 77% in men (beta value from linear regression analysis 0.14, 95% CI 0.10–0.18, P < 0.001) and from 49% to 76% in women (beta 0.32, 95% CI 0.28–0.36, P < 0.001, figure 1 and table 1). During the time period of 1972–87, the younger people were physically more active at leisure than the older ones, while in 1992–2002, the older people were slightly more active (table 1). However, within the birth cohorts, physical activity tended to increase with age (beta 0.056, 95% CI 0.04–0.08, P < 0.001 in men and beta 0.12, 95% CI 0.10–0.14, P < 0.001 in women). This trend was particularly strong among those who were born between 1933 and 1952 (beta −0.026, 95% CI −0.04 to −0.02, P < 0.001 for interaction between birth cohort and calendar time in men and beta −0.05, 95% CI −0.06 to −0.04, P < 0.001 in women). In men born after 1953 and women after 1963, the participation in leisure-time physical activity has remained somewhat at the same level.

Between 1972 and 2002, the prevalence of physically demanding work decreased from 60% to 38% in men and from 47% to 25% in women (beta −0.14, 95% CI −0.2 to −0.08, P < 0.001 in men and beta −0.16, 95% CI −0.24 to −0.09, P < 0.001 in women, figure 1 and table 2). In the 70s and the 80s, the older people had more physically demanding work than the younger ones (table 2). Occupational physical activity decreased across time within the birth cohorts (beta −0.05, 95% CI −0.07 to −0.03, P < 0.001 in men and beta −0.23, 95% CI −0.27 to −0.20, P < 0.001 in women) with
an exception of women born between 1953 and 1962 whose occupational physical activity increased during the study years. The decreasing trend in occupational physical activity was particularly strong among men born before 1952 and women born before 1942 (beta 0.02, 95% CI 0.01–0.03, P < 0.001 for interaction between birth cohort and calendar time in men and beta 0.05, 95% CI 0.03–0.07, P < 0.001 in women). The decreases in occupational physical activity are clearly related to the changes in occupational status, as can be seen in table 3, which describes the change of occupational status over the study period. In men, agricultural work decreased significantly (P < 0.001, Chi square test), while the largest increases were visible for office and service work (P < 0.001, Chi square test). Similarly in women, agricultural work decreased (P < 0.001, Chi square test) together with increasing prevalence of office and service work (P < 0.001, Chi square test). The largest change in women’s occupation, however, was the significant decrease in the number of housewives (P < 0.001, Chi square test). Furthermore, the proportions of retired and unemployed persons increased during the study period both in men and women (P < 0.001, Chi square test).

During the study years, participation in daily commuting activity of a minimum of 30 min decreased significantly from 30% to 10% in men (beta −0.45, 95% CI −0.56 to −0.34, P < 0.001), whereas the decrease in women from 34% to 22% was not significant (beta −0.01, 95% CI −0.09 to −0.08, P = 0.87) (figure 1 and table 4). The largest decreases in commuting physical activity were observed in the 70s and the 80s, while the decrease levelled off in the 90s. The younger birth cohorts had lower participation in commuting physical activity than older cohorts throughout the study years (beta −0.24, 95% CI −0.28 to −0.20, P < 0.001 in men and beta −0.04, 95% CI −0.08 to −0.01, P = 0.014 in women, table 4). Men born between 1913 and 1932 decreased their commuting physical activity more than other birth cohorts across the study years (beta 0.05, 95% CI 0.02–0.08, P < 0.001 for interaction between birth cohort and calendar time).

**Discussion**

These large population-based data on Finnish adults suggest that during the past 30 years, the prevalence of leisure-time physical activity has increased, while the prevalence of occupational and commuting physical activity has decreased. The largest changes in the prevalence of different types of

![Figure 1](https://academic.oup.com/eurpub/article-abstract/18/3/339/518507) The 30-year trends of leisure time, occupational and commuting physical activity in men (upper panel) and women (lower panel)

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⁠Beta values (B) with 95% confidence intervals (95% CI) and significance levels (P) from linear regression model, adjusted for geographical area.
The trends in physical activity were different across birth cohorts, as the older cohorts increased their leisure time and decreased their occupational and commuting physical activity more than the younger cohorts. Somewhat controversial to our findings, two retrospective cohort studies in women have suggested decreased vigorous and overall physical activity during a follow-up period.14,15 We found no previous studies reporting occupational or commuting physical activity by birth cohorts and gender across calendar time.

The largest changes in all types of physical activity have taken place in the 70s and the 80s. It is clear that some of the changes can be explained by the changes occurring in the society; physically demanding occupations, such as farming, have been replaced with light office work, mechanization has resulted in physically less demanding work tasks and increased commuting and leisure-time physical activity. One of the most observable changes has been the increasing trend in leisure-time physical activity. This decrease can be

<p>| Table 2 Prevalence (%) of high occupational physical activity by birth cohort and study year in men and women. The unemployed, retired, and housewives excluded |</p>
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<th>1972 (n = 5141)</th>
<th>1977 (n = 4810)</th>
<th>1982 (n = 3912)</th>
<th>1987 (n = 2426)</th>
<th>1992 (n = 2224)</th>
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| Table 3 Occupational distribution of the study population from 1972 to 2002 |
|-------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Birth cohort | 1972 (n = 5414) | 1977 (n = 5611) | 1982 (n = 4538) | 1987 (n = 3099) | 1992 (n = 2839) | 1997 (n = 3365) | 2002 (n = 3195) |
| Men         |                |                |                |                |                |                |                |
| Agriculture work | 30 | 21 | 18 | 16 | 8 | 7 | 5 |
| Factory and construction work | 32 | 31 | 34 | 29 | 26 | 23 | 27 |
| Office and service work | 28 | 29 | 33 | 32 | 42 | 37 | 43 |
| Student | 0 | 0 | 1 | 1 | 3 | 3 | 3 |
| Retired | 10 | 16 | 12 | 18 | 17 | 17 | 15 |
| Unemployed | 2 | 3 | 2 | 3 | 5 | 12 | 8 |
| Women       |                |                |                |                |                |                |                |
| Agriculture work | 21 | 15 | 12 | 10 | 5 | 5 | 3 |
| Factory and construction work | 8 | 9 | 12 | 10 | 7 | 6 | 5 |
| Office and service work | 35 | 38 | 46 | 51 | 58 | 54 | 61 |
| Student | 0 | 0 | 1 | 2 | 3 | 4 | 5 |
| Housewife | 29 | 21 | 15 | 10 | 7 | 7 | 6 |
| Retired | 6 | 15 | 12 | 15 | 16 | 13 | 12 |
| Unemployed | 1 | 2 | 2 | 3 | 4 | 11 | 7 |

a: Chi-square test

The data suggest that the prevalence of leisure-time physical activity increased during the 30-year observation period among Finns. Similar findings were reported in Canada and eastern Finland, whereas the findings from the USA and Australia have indicated unchanged or decreased levels of leisure-time physical activity. The comparisons with previous studies may not always be applicable as the study designs, methods and follow-up periods vary between the different studies. Nevertheless, the increasing trend in leisure-time physical activity seems to be somewhat controversial finding in the western societies.
these self-reports are accurate enough for epidemiological studies on health.2,22–24 Moreover, our questionnaire does not allow the calculation of overall physical activity, which could have given a net value of the change in all physical activities over the time. In general, the estimation of metabolic cost of all activities would be desirable in health-related studies.29

Simultaneously, the amount of leisure time has increased. The physically lighter working day has left individuals with additional strength to engage in leisure-time physical activity and adopt new physical activity hobbies. Leisure-time physical activity increased in each birth cohort with age, suggesting that people may be too occupied at younger age with small children or that physical activity becomes more important as ones ages. Furthermore, the general health consciousness has increased, which may have affected the older generations more than the younger ones. The women’s large increase in leisure-time physical activity may be partially explained by new household equipment, such as washing machines and refrigeration devices that left spare time to do physical activity.

During the past 30 years, remarkable positive changes have occurred in Finland in terms of health behaviour and cardiovascular health.25–27 The North Karelia Project,28 a community-based intervention in the 70s, concentrated only on reducing smoking and eating heart-healthy, low-saturated, low-sodium and high-fibre food. During the intervention times, overweight and obesity were not a public health problem, as people consumed a considerably high amount of energy in their daily work. Physical activity was not included in the aimed lifestyle changes in the North Karelia Project. Nevertheless, perhaps the increased prevalence of leisure-time physical activity should be counted as part of the positive health changes, although it has been less studied than the traditional risk factors. Clearly, the association of increased leisure-time physical activity with health over the time deserves more research in the future.

The limitations of this study are related to self-reported questionnaires on physical activity. Self-reports are prone to recall bias, which may have affected our findings by classifying the individuals into incorrect activity class. In the previous reports using this dataset, the associations of different types of physical activity with cardiovascular morbidity and mortality have provided a protective effect on health, suggesting that these self-reports are accurate enough for epidemiological

### Acknowledgement

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Conflicts of interest: None declared.
Key points
During the past 30 years in Finland, the prevalence of leisure-time physical activity has increased, while the prevalence of occupational and commuting physical activity has decreased
The largest changes in different types of physical activity have taken place in the 70s and the 80s and have happened among men and women born before 1953
The younger age groups have generally had lower levels of occupational and commuting physical activity and higher levels of leisure-time physical activity throughout the study years
The encouraging message from our results is that middle-aged and elderly people were able to increase their leisure-time physical activity with age
The target groups to increase physical activity should include all age groups and both genders and the type of activity should include both leisure time and commuting physical activity

References