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# Active commuting from youth to adulthood and as a predictor of physical activity in early midlife: The Young Finns Study

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ABSTRACT

*Objective.* The aims of the study were to describe the stability of active commuting (AC) behavior (i.e., walking and cycling) over 27 years and examine the relationship between AC and physical activity (PA) from youth to early midlife.

*Methods.* The mode and distance of travel were assessed using a self-reported questionnaire at five consecutive measurements between 1980 and 2007, when 2072 individuals were followed up from youth (9–18 years) to adulthood (30–45 years). PA was also measured using a questionnaire.

*Results.* The prevalence of AC declined sharply with age, particularly after 12 years, while AC distances to work or place of study increased substantially. AC was concurrently and prospectively associated with PA in both men and women. Maintained AC, whether walking or cycling and short or long distances, positively predicted adult PA over time. Compared with persistently passive commuters, persistently active commuters had higher adult PA after adjustment for potential covariates. Increasing AC was independently associated with high adult PA, particularly in young adulthood.

*Conclusions.* Walking and cycling to school/work should be encouraged, as regular AC is associated with higher levels of PA over 27 years of follow-up, and thus, may contribute to a healthy and active lifestyle through the various stages of life-course.



## Introduction

Active commuting (AC) (i.e., walking and cycling) contributes to overall physical activity (PA) levels, and thus, may make an important contribution to the health benefit attributed to PA during childhood (Davison et al., 2008; Lubans et al., 2011; Sirard and Slater, 2008) and adulthood (Sisson and Tudor-Locke, 2008; Terzano and Morckel, 2011; Yang et al., 2012a). Cycling to school/work seems to be more effective in improving physical fitness and reducing cardiovascular risk factors than other means of transport in both children (Andersen et al., 2011; Cooper et al., 2008) and adults (Andersen et al., 2000; Oja et al., 1998). Children's AC to school has been in decline over time (Johansson et al., 2012; Sirard and Slater, 2008), and similar declining trends are observed in the UK (Department for Transport, 2012), the US (Brownson et al., 2005; McDonald et al., 2011), and Canada (Buliung et al., 2009). These declines are also seen in adulthood (Borodulin et al., 2008; Department for Transport, 2012). Only a few recent longitudinal studies have evaluated the effects of changes in mode of travel on PA in either children (Cooper et al., 2012; Smith et al., 2012) or adults (Sahlqvist et al., 2013), and none has shown whether these effects persist from childhood to adulthood. To the best of our knowledge, this is the first study to evaluate the longitudinal changes in mode of travel to school or work, in this instance, over a period of 27 years. The aims of the present study were to examine (1) whether AC affected PA over time, (2) whether changes in AC in youth and young adulthood predicted PA in early midlife, and (3) whether this relationship persisted when potential confounders were controlled for.

## Methods

### Study population

The Young Finns Study (Raitakari et al., 2008) is an ongoing longitudinal population-based study consisting of a series of six surveys of six cohorts born in 1962, 1965, 1968, 1971, 1974 and 1977. The participants were 3, 6, 9, 12, 15 and 18 years of age at the beginning of the study in 1980. All were randomly selected (N = 3596) from the five Finnish university cities with medical schools (Helsinki, Kuopio, Oulu, Tampere and Turku) and their surrounding communities at baseline. Follow-ups were conducted in 1983, 1986, 2001, and 2007 with 2380 (66.2%), 2384 (66.3%), 2443 (67.9%), and 2178 (60.6%)

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participants, respectively. Data were available for all participants aged 9 and up. Participants in the 3- and 6-year-old cohorts at baseline and 6-year-old cohort three years later were excluded, as no assessment of travel mode was available for them. Complete data on all variables were available for 2072 healthy adults (925 men and 1147 women). The longitudinal study design and the number of participants at each measurement are shown in Table 1. The study protocol was reviewed and approved by the ethics committee of each of the five participating universities, and informed consent was obtained from the subjects (Raitakari et al., 2008).

*Mode of transport*

The mode and distance (kilometers) of travel to school or work were elicited by a questionnaire in 1980, 1983, 1986, 2001, and 2007. Mode was coded as 1 = own car or carpool, 2 = public transport (e.g., bus, tram, or train), 3 = walking, and 4 = cycling. In 1980 and 1983, the questionnaire was administered only to the four or five oldest cohorts, aged 9–21 years. Separate questions for summer and winter were included in all the measurements, with the exception of 1980. These two variables had a positive correlation with each other, and they were then combined into one. Walking or cycling distance from home to school/workplace was determined by actual distance traveled (to the nearest 100 m). Commuters were categorized as "active" (walking and cycling) or "passive" (bus and car users). Children's questionnaire could be filled out at home with the help of their parents.

In an independent population of 60 participants, the two-week test–retest reliability of the travel mode question from the Young Finns Study Physical Activity Questionnaire, as indicated by intraclass correlation coefficients (ICC), was high in winter (ICC = 0.83) and summer (ICC = 0.98). Significant correlations between the commuting question and the pedometer step counts were also observed in adulthood (total steps: $r = 0.24$, $p < 0.001$ and aerobic steps: $r = 0.28$, $p < 0.001$) (Mansikkaniemi et al., 2012).

For this analysis, the distance of active modes was dichotomized into two groups: short-distance AC (<1 km) and long-distance AC (≥1 km).

*Physical activity*

PA during leisure time was assessed by using a self-report questionnaire from 1980 to 2007 that was used extensively in our previous research (Yang et al., 2012b). A detailed description of the development, reliability, and validity of PA has been presented elsewhere (Mansikkaniemi et al., 2012; Telama et al., 1996, 2005). The PA score was first computed as continuous and then categorized into tertiles (low ≤7, moderate >7 and <10, and high ≥10). Categories 2 and 3 represented that the participants met the national PA recommendations of at least 30 min of moderate- or high-intensity levels almost five times a week on average (Husu et al., 2011); those in category 1 did not meet the guidelines.

*Covariates*

In both youth and adult participants, body weight was measured with a Seca scale (Vogel & Halke, Hamburg, Germany) and body height with a Seca anthropometer. BMI was calculated as weight (kg) / height ($m^2$). Smoking status was assessed by a questionnaire in subjects aged 12 years or older; those who smoked daily were considered smokers. Place of residence was categorized as urban and rural areas.

Parental and participants' own socioeconomic status (SES) was self-reported according to educational and occupational levels. Education was coded into three levels: 1 = low (comprehensive school), 2 = middle (high school/vocational school), and 3 = high (polytechnic and university levels). Occupation was classified into three categories according to the criteria of the Central Statistical Office of Finland: 1 = manual (builders, metal workers, nannies, etc.), 2 = lower non-manual (civil servants, specialized and skilled workers, etc.), and 3 = upper non-manual (administrators, managers, academics, etc.). Relocation was divided into two categories (yes vs. no).

**Table 1**
The study design of participant's age (years) and cohorts at consecutive measurement years of travel mode and physical activity.

| Age (cohort) | | Baseline | | Follow-up | | |
|---|---|---|---|---|---|---|
| In 1980 | N | 1980 | 1983 | 1986 | 2001 | 2007 |
| 3 (1977) | 313 | | | **9** | 24 | 30 |
| 6 (1974) | 334 | | **9** | **12** | 27 | 33 |
| 9 (1971) | 350 | **9** | **12** | **15** | 30 | 36 |
| 12 (1968) | 381 | **12** | **15** | **18** | 33 | 39 |
| 15 (1965) | 370 | **15** | **18** | 21 | 36 | 42 |
| 18 (1962) | 324 | **18** | 21 | 24 | 39 | 45 |

Age with bold has been used in secular trend analyses.

*Statistical analyses*

The differences between active and passive commuters for the study variables were conducted using either $\chi^2$ tests or $t$ tests. Univariate analysis of variance (UNIANOVA) was used to compare the mean adult PA scores with different types of travel distance. Correlation (Spearman) was calculated to test bivariate association between categorical variables. A generalized linear mixed model with random intercepts was used to estimate the main effects of forms of travel mode (passive modes versus active modes) and travel distances (passive modes versus active mode distances) at baseline. The mode also included year of measurement (1980 corresponds to time 0 and 2007 to time 1), and AC × time interactions on adult PA at follow-up, controlling for age, place of residence, smoking status, BMI, parental and participants' own SES, and relocation.

To evaluate the effect of long-term AC in two different time periods, youth participants were grouped as "persistent active commuters" (AC in first three phases), "changing commuters" (AC in one or two phases) and "persistent passive commuters" (no AC in first three phases), and adult participants were grouped as "persistent active commuters" (AC in last two phases), "increasing active commuters" (AC in 2007 but not in 2001), "decreasing active commuters" (AC in 2001 but not in 2007), and "persistent passive commuters" (no AC in last two phases). We used logistic regression analysis to estimate the associations between changes in AC in youth and in young adulthood and later PA after adjustment for potential confounders, with persistent passive commuters as the reference group. Data analyses were stratified by gender. The level of significance was $p < 0.05$. All the statistical analyses were performed using SPSS 20.0 for Windows (SPSS Inc., Chicago, IL).

## Results

Table 2 shows that active commuters had higher PA and lower BMI levels than passive commuters. Women were more likely to actively commute than men, and participants living in urban areas were more likely to actively commute than those in rural areas. AC participants were less likely to smoke than their passive counterparts. There were no significant differences in relocation and participants' own SES.

As shown in Fig. 1, the proportion of AC declined sharply in boys (Fig. 1A) and girls (Fig. 1B) after age 12, and further decreased with age from 15 to 30, with stabilization thereafter. By age 30–45, only 25% of men engaged in AC, while the corresponding percentage of women remained high, at almost 40%. There were no secular changes of AC in 9- to 18-year-old boys and girls of the same age from 1980 to 1986.

Men who chose to actively commute either short or long distances were more likely to be physically active in adulthood, in all phases, than their passive commuters, with very few exceptions (Fig. 2A). Similar results were found in women, but significant differences between groups were observed from 1986 to 2007 (Fig. 2B).

Among men, AC was directly correlated not only with current PA, but also with PA 3 to 27 years later (Table 3). Among women, AC was associated with current PA and predicted later PA, with one exception. PA was only related to AC in two different phases, 1983 and 2001, in both genders. These correlations were significant, but relatively low.

Compared to those who traveled by passive modes, men and women who were consistently AC by walking or cycling had higher adult PA at follow-up after adjustment for age, BMI, smoking, parental and participants' own SES, place of residence, and relocation (Table 4). Significant differences between the groups were also observed for total AC ($p < 0.001$ for both genders). There were significant interactions between the AC and time in men ($p < 0.001$) and women ($p = 0.002$). Given the mean adult PA score at each time point, the differences between active and passive commuters increased across time (Fig. 3).