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Labor Market Effects of Sports and Exercise: Evidence from Canadian Panel Data

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Abstract

Based on the Canadian National Population Health Survey we estimate the effects of individual sports and exercise on individual labor market outcomes. The data covers the period from 1994 to 2008. It is longitudinal and rich in life-style, health, and physical activity information. Exploiting these features of the data allows for a credible identification of the effects as well as for estimating dose-response relationships. Generally, we confirm previous findings of positive long-run income effects. However, an activity level above the current recommendation of the WHO for minimum physical activity is required to reap in the long-run benefits.

JEL-Code: I120, I180, J240, L830, C210.

Keywords: physical activity, Canadian National Population Health Survey, individual sports participation, human capital, labor market, matching estimation.

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Comments are very welcome.
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1 Introduction

Do the positive health effects of physical activity[1] translate into higher productivity of the labor force and thus higher earnings? Although potentially highly relevant for public policy, the answer to this question may be less obvious than it appears. Even though the medical literature agrees that more activity is always better for health,[2] it is not obvious that such health effects translate one-to-one into earnings gains. For example, on the one hand increasing physical activity is likely to take-up additional time which leads to a reduction of other leisure or working time, with an uncertain effect on earnings. On the other hand, physical activity may also build other skills, like social capital (e.g. Seippel, 2006), team skills, and self-discipline that are expected to improve productivity, and thus earnings, per se. Therefore, in this paper we investigate the effects of different levels of sports and exercise on labor market outcomes directly.

The literature on the effects of sports and exercise on labor market outcomes (for working age adults) is limited. The main reason is the lack of data that are sufficiently (large and) rich to allow identification of the respective causal effects and contain reasonably detailed information on both, labor market outcomes and sports and exercise. Recently, Kavetsos (2011) analyzes this relation using cross-section data from 25 European countries. Based on a parametric IV approach with the regional prevalence of sports participation serving as instrument, he finds positive employment effects. Rooth (2011) uses an experimental setting to show that people signaling leisure sports participation in their job application are

[1] Such effects are well established in the medical literature. See for example the literature review by Warburton, Nicol, and Bredin (2006). More recent exhaustive literature reviews are provided by U.S. Department of Health and Human Services (2008), the Annex II of EU (2013), and Reiner, Niermann, Jekauc, and Woll (2013), among several others.

[2] While Warburton, Nicol, and Bredin (2006) state that “There appears to be a linear relation between physical activity and health status, such that a further increase in physical activity and fitness will lead to additional improvements in health status” (p. 801), a recent study for Canada by Humphreys, McLeod, and Ruseski (2014) find positive, but decreasing health effects (“Increasing the intensity above the moderate level and frequency of participation in physical activity appears to have a diminishing marginal impact on adverse health outcomes”, p. 1).

more likely to be invited to a job interview. His experimental analysis is supplemented by an observational study based on Norwegian register data, which suggests long-run earnings effects to physical fitness in the range of 2 to 5%. Finally, based on a large cross-sectional database for England, using semiparametric matching methods Lechner and Downward (2013) find a positive association between different types of sport activities and earnings.

There are two related studies based on German household panel data (German Socioeconomic Panel). Cornelißen and Pfeifer (2008) use random effects regression models and find positive earnings associations for men. Lechner (2009a) uses the same panel data differently in an attempt to identify causal effects, i.e. to deal with the issue of non-random individual selection into activity levels. The main idea of his research design, which we follow closely in this paper, is to define a 'treatment' in period '0', measure the confounders in the base period '-1', and measure the outcomes in several post-treatment periods. The base period is also used to condition on pre-treatment outcomes and activity levels (by stratification), thus ensuring exogeneity of the control variables as well as controlling, similar to fixed effects, for time constant unobservables. In this design semiparametric matching estimation, used to minimize the dependence on arbitrary parametric econometric models, uncovered lasting earnings gains in the range of about 10%. Overall, it is argued that such a design used with informative variables to control for additional confounding leads to a credible and robust causal inference and avoids some of the issues that were present in the other papers mentioned above. In Lechner's study, however, samples were rather small and some important confounders that could be time varying, like detailed health information, were missing. Furthermore, the important activity measure was not detailed at all.

This paper uses the basic design of Lechner (2009a) and implements a similar estimation strategy, however, using more informative data from Canada. To be more precise, the empirical strategy consists of the following steps: The analysis is based on a population that is of age 20 to 44 in 1994 (the base year) and followed until 2008. We estimate the effects of three levels of activity ('treatment') defined in 1996 (the panel survey is biannually conducted). Covariates and pre-treatment outcomes are measured in 1994. The data are stratified according to activity level in 1994 and according to sex, since effects and participation in activities are known to be heterogeneous w.r.t. to activity level and sex. Matching estimation is performed within each stratum to estimate the effects of various outcome variables measured from 1998 to 2008. Subsequently, the strata specific results are aggregated to compute overall effects.

We attempt to contribute to the literature in several dimensions: Firstly, we improve the credibility of the actual identification of causal effects (compared to Lechner, 2009a) by using data with more informative health information which allows to control for health conditions (in 1994) in a more detailed way. Secondly, the more detailed physical activity information allows to some extent to uncover dose-response relationships, i.e. to investigate how the effects depend on the intensity of the activity. Furthermore, since the data cover a period from 1994 to 2008, effect dynamics as well as medium to long-run impacts can be estimated.

We find generally positive earnings effects of 10% to 20% (after 8 to 12 years), but no systematic effects on other labor market outcomes, like employment status or hours worked. Interestingly, an important dose-response relationship appears: To get the full benefits of sports and exercise participation, it is necessary to be in the highest of the three activity levels considered (which is above the current recommendations for minimum physical activity, e.g. World Health Organization, 2010). Thus, these results suggest that the current activity levels of large parts of the Canadian population, which are not so different compared to the activity levels observed in many other developed countries, are still far below the point for which a further increase would lead to negative returns in terms of earnings.

The structure of the paper is as follows: In the next section, we introduce the data. Section 3 discusses some general features of sports and exercise in Canada. Section 4 outlines the research design and the estimation strategy used. Section 5 contains the results and some sensitivity checks. Section 6 concludes. There are several appendices that include background information: Appendix A gives additional descriptive statistics, while Appendix B contains the results of the detailed analysis of variables confounding the activity outcome relationships within the activity-sex strata. Appendix C gives further details on the matching estimator used and the attrition analysis performed. Appendix D provides additional results covering additional outcome variables, different definitions of outcome variables used, and a heterogeneity analysis.

2 Data and sample selection

We use the *National Population Health Survey* (NPHS), which is a household survey designed to measure health status of Canadians and to expand knowledge of health determinants including sports and exercise. The survey, which was started in 1994, is longitudinal with data being collected for the same individuals every second year. In total, the survey is available for 8 cycles covering the period of 1994-2008. It is representative for the Canadian population in 1994.[3]

The data collection is interviewer based. At the beginning of each cycle, each respondent receives a letter indicating the start of data collection. The interview is conducted using a computer assisted interview system by the trained interviewers of Statistics Canada. In Cycle 1 (1994), 75% of the interviews were conducted in person (CAI) and the rest by telephone (CATI). Since Cycle 2 (1996), around 95% of the interviews are conducted by telephone. Per-

[3] For more information on survey design and methodology, see Tambay and Catlin (1995).

sonal interviews are only conducted if the respondent does not have a telephone. Interviews are comparatively long which may last up to one hour.

The survey includes variables related to labor market outcomes, general health status, chronic health conditions, as well as socio-economic and demographic factors for its participants. One of the main advantages of this data is its detailed information related to sports and exercise. Different from other household panel surveys, it includes detailed questions related to all leisure time physical activities (LTPAs).[4] For each LTPA, the respondents are asked to report their average participation and duration in each episode in the last three months.[5] The physical activity module has been administered for all survey participants 12 years and older.

In order to create our study sample, we use the 14,117 respondents who have information on their participations in sports and exercise in 1994. We then restrict the sample to the adult population aged 20 to 45 in 1994. This restriction ensures that all individuals have completed their basic education in 1994 and are not yet close to retirement in the 2008 cycle, which is the latest period used in our analysis.[6] Thus, they are in principle available to the labor force. The age restriction decreases the sample to 6,789 individuals. The econometric design used requires that information on the second cycle exists. Therefore, we exclude 507 individuals who did not respond to the survey in 1996. We exclude an additional 201 individuals who have physical mobility problems during the first two cycles of the survey, and another 36 observations due to missing information for their participation in sports and exercise in 1996. As a result, the final sample includes 6,045 individuals. Requiring furthermore hav-

[4] In the following we will use the terms LTPA and *sports and exercise* as synonyms.

[5] There are no specific questions regarding the intensity of each physical activity. Therefore, the intensity values used in the data to calculate the total energy expenditure correspond to the low intensity value for the corresponding LTPA. This approach is used since individuals tend to overestimate the intensity, frequency, and duration of their activities (Canadian Fitness and Lifestyle Research Institute, http://www.cflri.ca/).

[6] One important implication of considering only individuals fulfilling this restriction in the first period 1994 (which is required by our research design to be explained below) is that our sample will continuously age, i.e. the mean age in the last period will be 14 years higher than in the first period.

ing valid observations for all variables that we treat as confounding the relation of sports and exercise to labor market outcomes leads to the final sample size of 4,796.

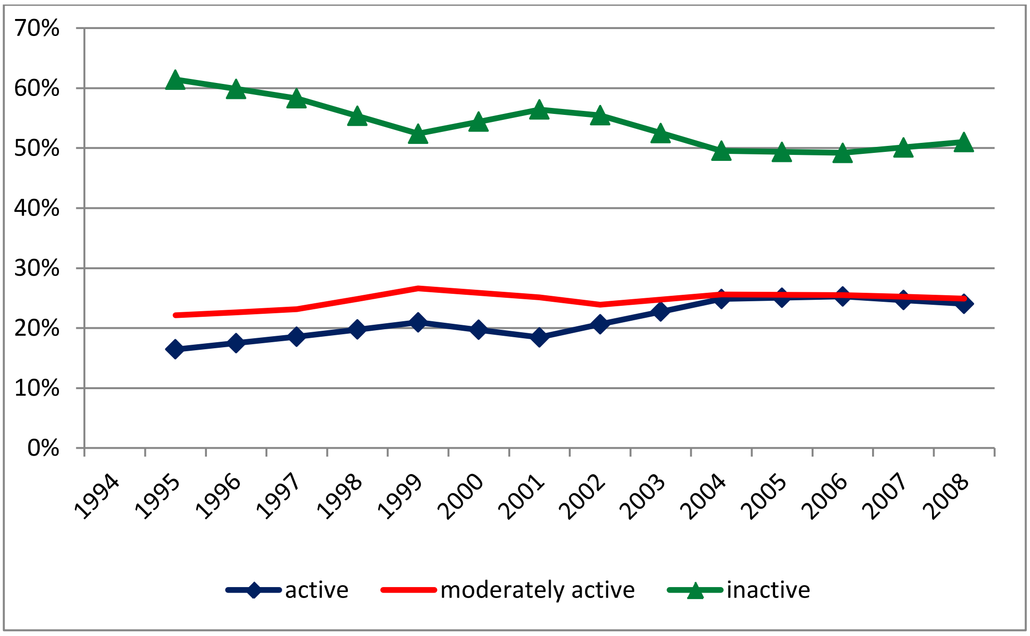
3 Sports and exercise in Canada

Despite various benefits of physical activity, individuals including children spend more time in sedentary activities and stay physically less active. This high level of insufficient physical activity is observed in all major developed countries including Canada. As a high level of inactivity becomes a substantial issue around the globe, several agencies, including the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM), emphasize the importance of a physically active lifestyle. These agencies brought together an expert panel which recommends that the individuals should "accumulate 30 minutes or more of moderate intensity physical activity on most, preferably all, days of the week" (Pate et al. 1995, p. 404). As a recent update and clarification on the 1995 recommendations, Haskell et al. (2007) state that all adults aged 18 to 65 need "moderate-intensity aerobic physical activity for a minimum of 30 minutes on five days each week" (Haskell et al., 2007, p. 1083). This is the current guideline adopted by the World Health Organization (WHO), the Canadian Society for Exercise Physiology (CSEP), and the US Surgeon General (CSEP, 2013; Benjamin, 2010; World Health Organization, 2010), among many other national health organizations. This recommended level of physical activity corresponds to a daily energy expenditure of at least 1.5 kilocalories per kilogram of body weight (kcal/kg) from all LTPAs.[7] Based on this recommendation, individuals are considered *moderately*

[7] Using information on all leisure time physical activities (LTPAs), the NPHS has a summary measure reporting total daily energy expenditure (TEE) from all leisure time physical activities. This physical activity measure for individual *i* is computed as $TEE_i = \sum_{k=1}^{K} h_k E_k$ where h_{ki} stands for hours of daily LTPA *k* of individual *i*, and E_k is the equivalent energy expenditure from the respective activity type expressed as total kilocalories (kcal) per kilogram (kg) of individual's body weight. The term E_k is calculated using the corresponding metabolic rate (MET) for each activity *k*. The METs are multiples of the resting rates of oxygen consumption during the activity. For instance, one MET represents the approximate rate of oxygen consumption of a body at rest, and the equivalent energy expenditure of 1 MET is 1 kilocalories in one hour per kilogram of individual's body weight (kcal. hr^{-1} kg^{-1}).

active if their daily energy expenditure is between 1.5 and 3 kcal/kg from all LTPAs; and they are considered physically *active* if their daily energy expenditure from all LTPAs exceeds 3 kcal/kg. Individuals whose daily energy expenditure falls below the benchmark energy expenditure[8] of 1.5 kcal/kg are considered physically *inactive*. In our study, we adopt the physical activity definition for the three levels based on these guidelines adopted by the WHO, the CSEP, and the U.S. Surgeon General, that are also used in subsequent Canadian studies (Humphreys, McLeod, and Ruseski 2014; Liu et al. 2008; Sari 2009; 2010; 2013).

Figure 3.1 Participation rates in sports and exercise for the Canadian adult population



Note: Own calculations using the NPHS for the years 1994, 1996, 1998, and 2000, and the Canadian Community Health Surveys for the years 2001, 2003, 2005, 2007, and 2008. Values for the other years are linearly interpolated. Population is between 20 and 59 in any given year.

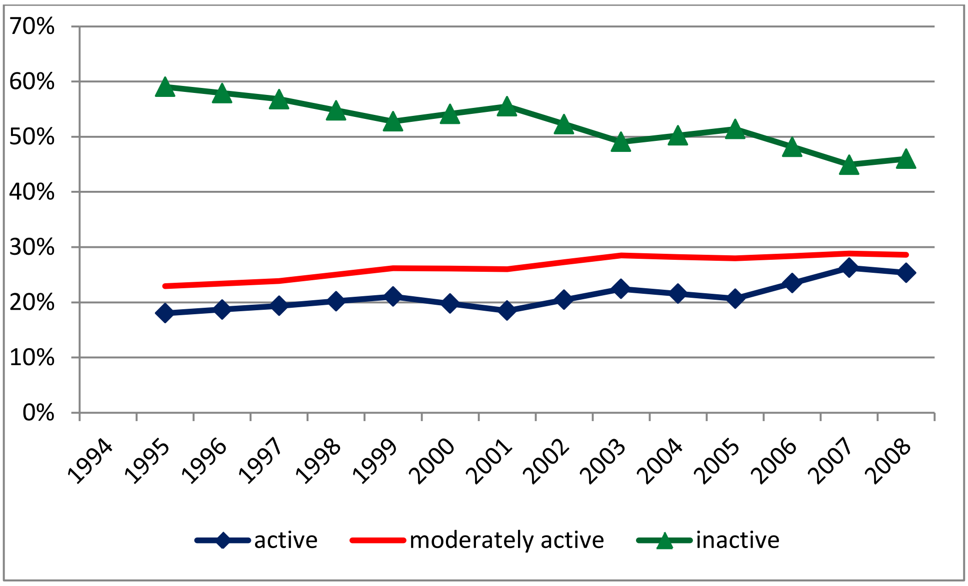
Using this definition, we illustrate the participation in sports and exercise in Canada in the period of 1994-2008. These are displayed in Figures 3.1 and 3.2. In Figure 3.1 we present the proportions of active, moderately active, and inactive Canadians aged 20 to 59 (in each year), and the same information is presented for our study sample in Figure 3.2. The vertical axis indicates the proportion of people who are physically active (green line with triangle),

[8] Individuals may meet this goal of being at least moderately active with various types and duration of sports and exercises. Examples are daily walking for 30 minutes with a speed of 2.5 miles per hour on a firm surface, or 3-times a week running for 25 minutes or longer with a speed of 5 miles per hour (for other examples, see Ainsworth et al. 2000).

moderately active (red line), or inactive (blue with diamond) while the horizontal axis shows the corresponding year for which the information is estimated.

Figure 3.1 indicates that the proportion of physically inactive adult individuals in Canada has shown a decrease in 1990s, but after 2002 it plateaued at around 50%. During the same period, the share of moderately active and active individuals increased steadily. In 1994, about 16% were active while 22% were moderately active. By the end of the study period, the shares of physically active and moderately active individuals both increased to 25%.

Figure 3.2: Participation rates in sports and exercise for the study sample



Note: Own calculations based on the study sample (age 20-45 in 1994, 22-47 in 1996, …, 34-59 in 2008).

Figure 3.2 displays the same information for the study sample. Note that the study sample is younger than the Canadian adult population in the beginning (20-45) and older in the end (34-59). Although these age differences lead to minor differences between the two figures, the general trends that are apparent for the population (Fig. 3.1) are also well reflected in the study sample, although the levels differ somewhat.

Next, we analyze which types of sports and exercises are typically done. Table 3.1 shows the participation rates in different leisure time physical activities for the study sample and the Canadian population (defined as above). First, note that the differences between those two groups are small. The second important observation is that indeed exercises are far more important than sports (involving some competition) with walking for exercise being the most important activity for men and women, followed by gardening and home exercises. The third observation is that many individuals do more than one activity, and there are some heterogeneity between men and women in terms of their choice of exercise and sports. For instance, women participates more in walking and home exercises while men participates more in gardening (surprisingly), weight training and running. Finally, note that for most activities there is an upward trend over time.

Table 3.1: Participation rates in different sports and exercises

	Canadian Population				Study sample			
	Men		Women		Men		Women	
Type of activity	1994	2008	1994	2008	1994	2008	1994	2008
Walking for exercise	42	52	55	65	41	59	54	69
Gardening	29	33	22	25	28	52	20	39
Home exercises	16	24	22	29	18	30	22	34
Weight training	10	19	6	13	13	16	8	14
Running	9	15	4	12	10	13	5	10
Cycling	12	13	10	8	13	15	11	9
Exercise classes	3	3	8	11	4	4	9	13
Swimming	8	7	9	8	7	7	10	8
Dancing	3	3	5	5	3	2	5	4
Hockey	3	6	<1	<1	4	3	<1	<1
Golfing	3	4	1	1	3	5	1	2
Others	19	21	10	13	21	20	12	13

Note: Share of those who participate at least weekly in particular activity in particular year. Own computations from the NPHS for the study sample (1994 and 2008) and the population in 1994. 2008 population numbers are computed from the Canadian Community Health Survey. Population is 20-59 in both years. Study sample is 20-45 in 1994 and 34-59 in 2008. 'Others' contains other activities with less than 1% participation rates (disaggregated numbers below 1% cannot be presented due to the data security rules of Statistics Canada).

Do more active people participate more of the same activities than less active people, just at a higher intensity, or do they do different types of activities? Table 3.2 sheds more light on this question by showing activity rates for the different groups in 1994 and 2008. Note that, not surprisingly, the higher the activity level is the higher is the participation rate in every single activity. It is also not surprising that inactive individuals do almost none of the more strenuous activities like running or weight training, but still do some walking and gardening. Among those who are at least moderately active, the major differences are again particularly apparent in the strenuous activities like running and exercise classes. The other activities show these differences as well, but less pronounced. In conclusion, moving from one activity level to a more intensive one implies ‘more of the same’ as well as more emphasis on more strenuous activities.

Table 3.2: Types of sports and exercises according to activity level in 1994 and 2008

	Men						Women					
	1994			2008			1994			2008		
Type of activity	Act	Mod	Inact	Act	Mod	Inact	Act	Mod	Inact	Act	Mod	Inact
Walking for exercise	66	58	25	85	69	36	82	79	40	90	83	52
Gardening	45	34	19	71	63	34	41	31	11	64	49	22
Home exercises	43	24	6	50	35	15	45	33	13	55	40	20
Weight training	35	18	2	36	14	5	25	15	1	29	19	4
Running	37	9	1	37	6	1	24	4	<1	29	9	2
Cycling	35	18	3	32	13	5	34	18	3	24	9	2
Exercise classes	12	5	<1	10	2	1	23	20	3	24	16	6
Swimming	14	12	3	11	10	3	29	16	4	18	9	2
Dancing	9	4	1	4	1	1	15	5	3	7	4	3
Hockey	9	6	1	8	4	<1	<1	<1	<1	1	<1	<1
Golfing	5	5	1	13	5	1	4	3	1	5	2	<1
Others	49	27	9	32	21	11	30	15	6	30	16	4

Note: Share of those who participate at least weekly in particular activity. Activity status is defined in respective year (Act: active; Mod: moderately active; Inact: inactive). Own calculations based on study sample.

4 Towards a causal analysis: empirical research design

In this section, an empirical research design is discussed that arguably allows identifying and estimating the causal effects of sports and exercise participation on labor market outcomes without having to use instrumental variables. This is a big advantage, as it seems that instruments which are at the same time valid and strong enough are not readily available in this case. In order to derive this design, it is important first to recapitulate the findings of the literature on the determinants and correlates of participation in sports and exercise.

4.1 Participation in sports and exercise

With respect to socio-economic characteristics, the literature finds that men are more likely to participate in LTPA than women (e.g. Downward, 2007; Breuer and Wicker, 2008).[9]

[9] Downward, Lera-López, and Rasciute (2011) contains a comprehensive survey of contributions of the correlates of participation in sports and exercise. The following section heavily draws on this paper as well as on Lechner and Downward (2013).

Many studies also point to the importance of age, although there is no universal agreement on the direction (and possible non-linearity) of its association with sports activities (e.g. Eberth and Smith, 2010, Garcìa, Lera-López, and Suárez, 2011; Humphreys and Ruseski, 2010; Stamatakis and Chaudhury, 2008). Higher income raises the participation rate and frequency of participation in sports and exercise (Downward and Rasciute, 2010; Humphreys and Ruseski, 2010; Lechner, 2009). The same is true for higher levels of education (e.g. Fridberg, 2010; Hovemann and Wicker, 2009). A variety of household characteristics appears to reduce participation in physical activity. These include being married and the presence of young children in the household for females (Eberth and Smith, 2010; Garcìa, Lera-López, and Suárez, 2011). Concerning employment characteristics, Downward (2004) finds a limited association of working hours on participation. Meltzer and Jena (2010) show that the intensity of exercise is positively associated with wage rates. Several studies also indicate that belonging to an ethnic minority or being an immigrant is negatively associated with participation in physical activities (e.g. Lechner, 2009a).

Further insights into the large physical activity literature are provided by the survey of Bauman, Sallis, Dzewaltowski, and Owen (2002). They show that further variables may play a role for doing sports and exercise as well. Such variables capture aspects of health, obesity, and genetic factors, as well as psychological, cognitive, and emotional factors. In addition, it seems that life style attributes associated with diet and smoking, as well as social and cultural factors play a role.

Most of the factors mentioned above should be considered as confounding the relation of sports and exercise participation and labor market outcomes. Thus, they need to be controlled for in order to arrive at estimates that can be causally interpreted. Therefore, an important question is whether the data available for this study is rich enough to approximate them.[10] Beginning with the socio-economic factors, we observe age, sex, marital status, presence of young children in the household, immigration status, income, and education. We also have proxy indicators for wealth measured as house ownership as well as size of the house (in terms of the number of bedrooms). In particular, the number of bedrooms in one's house may provide a reasonable proxy (conditional on the number of children, etc.) for wealth. These variables, therefore, cover key confounders of this group.

There are several indicators for individual labor market involvement, beyond income, which capture general features of labor market participation, like employment status, as well as particular features of the current job, like its sector or job position. A missing variable in this group relates to the time intensity of the current job (i.e. working hours which is only available in the post treatment period). Hopefully, this is captured by other variables available, in particular by the type of occupation and the income generated.

Concerning variables describing the individual life styles, besides the variables on sports and exercise, we observe alcohol consumption and smoking behavior in detail as well as the BMI (computed using self-reported height and body weight). Thus, again, it is likely that the key confounders in this group are observable. Furthermore, proxies for the intensity of physical activities in daily life, other than sports and exercise, are available and used as further control variables.

The data set used is unusually informative about health, which allows us to control for objective and subjective health measures, as well as to distinguish between physical and mental health and to take injuries into account.

Further, there are several regional indicators. The ones directly included in the analysis characterize regions by population size and density, as well as by socio-economic features,

[10] See Table A.1 in Appendix A for the details of all control variables used.

like average education and unemployment levels. Unfortunately, there is no direct information on sports facilities available.

Finally, note that our econometric approach, to be explained in the next section, requires conditioning on past activity levels (and lagged outcomes). This is also helpful for confounder control, because if there are unobservable variables that have a time constant impact on activity levels and labor market outcomes, like facilities for example, they will be captured by the lagged activity and outcome levels (similar to a fixed effect in a panel regression).

4.2 A dynamic endogeneity problem

The previous section showed that due to the informative data set used there are little concerns about unobservable confounding variables. Thus, an empirical approach using these variables as control variables, like regression or matching type estimators do, should lead to causal conclusions even when only a cross-section is used. One important condition for this to hold, however, is that these variables are not influenced by the treatment ('exogenous' in this particular sense)[11]. However, it is very likely that several, if not most, of the variables mentioned above are influenced by past sports and exercise participation. This effect could occur contemporarily and / or after some time. This problem has already pointed out by Lechner (2009a). Essentially, we follow his approach to tackle this issue by exploiting the panel structure of the data.

4.3 Outline of the research design

The central ideas of the chosen research design are the followings: Firstly, in a group of individuals who have the same activity level in a given year, by definition, this activity level cannot differentially influence other variables measured at the same time for this group. Sec-

[11] See Lechner (2008) for the necessary conditions in a non-parametric causal setting.

ondly, assuming that individuals do not decide on their sports and exercise activities according to some long-term plan, which would imply all sorts of anticipating behavior that invalidate almost any empirical analysis, future sports and exercise participation cannot have an effect on the covariates measured before activity levels are decided.

These two considerations lead to the following empirical design: (i) Past activity levels and confounders are measured in a base period (1994). (ii) Treatment is defined as the activity level in the next period available (1996). (iii) Estimation is performed within each stratum defined by the base period activity level, and the outcome variables are measured beginning from 1996. (iv) Estimates obtained for the different strata are aggregated to obtain overall effects. It is key to note that this set-up implies that within each stratum a conditional independence assumption (selection-on-observables) is assumed to hold which in turn allows using methods that control for observable confounders (see Imbens, 2004, for necessary assumptions and implications on estimation). Thus, there is no need to have instruments to identify and estimate average causal effects.

One price to pay for this simplification is that the meaning of the treatment may be somewhat different than in a standard non-dynamic or a fully dynamic setting (for which our sample is too small). The reason is that, formally speaking, we estimate a one-time causal effect of sports and exercise activity: In the base period, individuals are identical with respect to their activity level. Essentially the effect of a change in that level is exploited with this approach. However, it will be shown in the next section that the current activity level has long lasting effects on future activity levels. Therefore, the effects to be presented capture more than contemporary, short term changes in activity levels. A more sophisticated alternative is to define sequences of activity levels for several periods as the treatments. The problem of this approach is that the confounders measured in the base period are unlikely to be good determinants for decisions on activity levels several years ahead. To overcome this problem a fully developed dynamic treatment approach may be used (e.g. Robins, 1986, Lechner, 2009b, Lechner and Miquel, 2010, Lechner and Wiehler, 2013). However, such an approach when implemented semiparametrically requires much larger samples than those available for this study to get sufficiently precise estimates. Thus, it is not feasible with this data.

4.4 Implementation and descriptive statistics

We implement the basic ideas outlined above by using the three values of the activity levels (inactive, moderately active, and active) in 1994 to define the strata. Given the evidence in the literature that the selection for women and men into sports and exercise activities may differ substantially (e.g. Andersen, 1995; Pate et al., 1995; or Sari, 2011, for Canada), the activity states are interacted with sex to form six strata. Confounders are measured in 1994 while the treatment is defined as the activity status in the following period (1996).

4.4.1 Descriptive analysis

Table 4.1 shows descriptive statistics of some selected variables to better understand how active, moderately active, and inactive individuals differ with respect to their characteristics as well as later labor market outcomes (see Table A.1 in Appendix A for a comprehensive list of variables). The first observation is that, because the table shows a snapshot at the beginning of the panel data used, i.e. in 1994, individuals are on average still only about 33 years old (which is about the midpoint between 20 and 45, which defines the sample in 1994). Concerning the personal characteristics, Table 4.1 shows that being male, having fewer young children, and not being married ('married' includes having a common law partner), and having a better education is positively associated with more activity.

The positive association of education and activity is also reflected in less active individuals in a somewhat lower household income, a higher share of immigrants, and a smaller share of people living in or close to big cities. Overall, the directions of the differences in the socio-economic variables are in line, for example, with the results for Germany (Lechner, 2009a) or England (e.g. Lechner and Downward, 2013).

Table 4.1: Descriptive statistics

Variable	Sex	Men			Women		
	Activity level in 1994	Active	Mod.	Inactive	Active	Mod.	Inactive
Socio-economic characteristics (1994)							
Age		32	33	33	34	33	34
Married		50	61	60	53	60	63
Number of children younger than 12		0.51	0.66	0.65	0.81	0.80	0.92
Immigrant		10	10	12	10	10	13
University or college graduate		37	41	34	38	43	36
Secondary (high) school graduate		51	44	46	49	44	48
Lower education than high school graduate		12	15	20	13	13	16
Home owned by household		62	70	67	65	66	63
Total annual household income in 1000 CAD		44	47	42	41	43	40
Employed		81	86	86	69	74	72
Living in a central metropolitan area (CMA)		63	61	54	61	58	59
Health and life style characteristics (1994)							
BMI		26	26	26	23	24	25
Avg. daily number of alcoholic drinks (last week)		0.70	0.85	0.73	0.33	0.30	0.22
Regular smoker		24	30	38	28	28	32
Self-rated health (1: worst; 5: best)		3.1	3.1	2.9	3.0	3.0	2.8
Physical activity indicators (1994)							
Total energy expenditure from sports & exercise		5.2	2.1	0.6	4.8	2.1	0.6
Active individuals		100	0	0	100	0	0
Moderately active individuals		0	100	0	0	100	0
Inactive individuals		0	0	100	0	0	100
Share of activity level (stratum) among same sex		20	24	57	16	22	61
Any injuries (past 12 months)		28	26	19	23	19	15
Activity levels (1996)							
Active individuals		52	23	18	50	27	8
Moderately active individuals		25	34	10	27	36	20
Inactive individuals		23	43	72	23	37	72
# of observations in stratum		474	562	1349	396	534	1481

Note: Sample means (for indicator variables x 100) in the strata shown.

Considering the BMI in the six strata shows that there are expected gender specific differences. However, the differences with respect to activity level appear to be minor for men, while they have the expected pattern for women. Generally, mean levels of the BMI of 26 for men and about 24 for women are an indication of the overweight and obesity problems facing western societies already in 1994. Concerning alcohol drinking and smoking, the latter is clearly negatively related to the activity level (stronger for men than for women), while the association of the former shows no clear pattern for men and a positive association with physical activity for women. Using a subjective health measure reveals the expected positive association between health and physical activity, which is also confirmed by more objective health measures (for details see Table A.1 in Appendix A).

We consider measures of physical activities in 1994 and 1996 directly. Starting with 1994, the first observation concerns the relation of the three activity levels to the individual overall expenditure of kilocalories burned due to LTPAs (as explained in Section 2). Here, in addition, we see that active men are doing somewhat more strenuous activities than active women. This is also confirmed in Section 3 based on participation differences in strenuous activities between men and women. The second observation is the positive association between injuries and activity levels, which is of course not surprising, but rarely documented (and a price to pay for doing sports and exercise).

Now, consider the overall number of individuals in the three activity levels. In 1994, about 60% of men and women are inactive, while for the remaining part there are more moderately active than active individuals. The last panels in Table 4.1 document the transition from the activity levels in 1994 to those observed in 1996. 72% of the inactive individuals remained inactive in 1996, while about 50% of the active remained active. However, while very few inactive become active in 1996 almost one fourth of the active individuals in 1994 became inactive in 1996.

Finally, the last row in Table 4.1 shows the sample sizes for each stratum, which, of course, influence the precision of the respective estimators to be discussed next.

4.4.2 Implementation

Within each stratum, propensity score matching using the estimator proposed by Lechner, Miquel, and Wunsch (2011) is applied. This estimator performed well in the large-scale simulation study by Huber, Wunsch, and Lechner (2013). It is described in detail in Appendix C. Such semi-parametric estimators are based on estimating a parametric model (e.g. probit) for the probability of belonging to one of the activity groups conditional on the above mentioned control variables. The relation between the outcomes, activity levels, and confounders, however, are left completely unspecified (non-parametric). Therefore, such estimators have the advantage of allowing for very flexible effect heterogeneity (contrary to regression models, for example).

For each outcome variable, this leads to six different estimates for each of the usual treatment effects, like the average treatment effect (ATE), the average treatment effect on the treated (ATET) and on the non-treated (ATENT). These effects can then either be used directly to describe the effects for the particular stratum or they may be aggregated to obtain average effects for the subpopulation characterized by different activity levels, or for men and women, or to obtain mean estimates for the population. The weights used here for aggregation are proportional to the respective number of treated / controls / treated plus controls, depending on whether interest is in the ATET, ATENT, or the ATE. Since there are three possible values of the treatment and since the conditional independence assumption is assumed to hold within each stratum, the sample reduction results of Lechner (2001) apply. In other words to estimate the effect of an activity status compared to another one, participants in the third state are deleted for the purpose of this particular estimation. For example, for the estimation of the effect of being active compared to being moderately active, inactive individuals play no role, therefore not included in this particular estimation.

Most of this paper will take a dose-response perspective in the sense of estimating the effect of changing the activity level from inactive to moderate and from moderate to active. This perspective is possible in this study because of the detailed activity information available in the data. Therefore, in order to implement the propensity score matching estimators for this purpose in the six strata, twelve probit estimations are required; six for analyzing the active –

moderate contrast, and another six for analyzing the inactive – moderate contrast.[12] The detailed results of these estimations are reported in Appendix B (Tables B.1 and B.2).

The specifications of the probits follow the broad categories of variables shown in Table 4.1, but they include considerably more variables. For the sake of brevity, these twelve sets of results are not discussed in detail.[13] Overall, the probit estimates confirm the results of the descriptive statistics discussed above pointing to effects of schooling, income, marriage, previous life-style, health, and activity levels as well as regional indicators as correlates of the activity level in the next period.[14]

5 Results

5.1 Dynamics of energy expenditure

The next step of the econometric analysis consists of understanding the relationship between the treatment definitions in terms of the three activity levels and the energy expenditure in the year of the treatment (1996) as well as for the later years.[15] The corresponding results are displayed in Figure 5.1. The vertical axis gives the changes in total energy expenditure, while the horizontal axis indicates the year for which the effect is estimated. There are estimates available for all odd years, which are linearly interpolated. The effects of the

[12] Appendix D contains further comparisons like active – inactive or active together with moderately active versus inactive. These comparisons require further probit estimations, which, however, we do not report for the sake of brevity.

[13] Note that the estimation of those probits is merely a technical tool to flexibly capture and remove the influence of the covariates on the comparison of the treatment states. It is not their purpose to describe selection into treatment in a way that can be readily interpreted. To that end a less flexible but easier to interpret specification might be preferable which probably would not be estimated within the strata but on the overall sample.

[14] When interpreting the results of the probit estimation keep in mind that estimation is within the six strata, so that the specifications are already conditional on sex and 1994 activity levels (similar to interacting all covariates with the six strata indicators in a joint estimation).

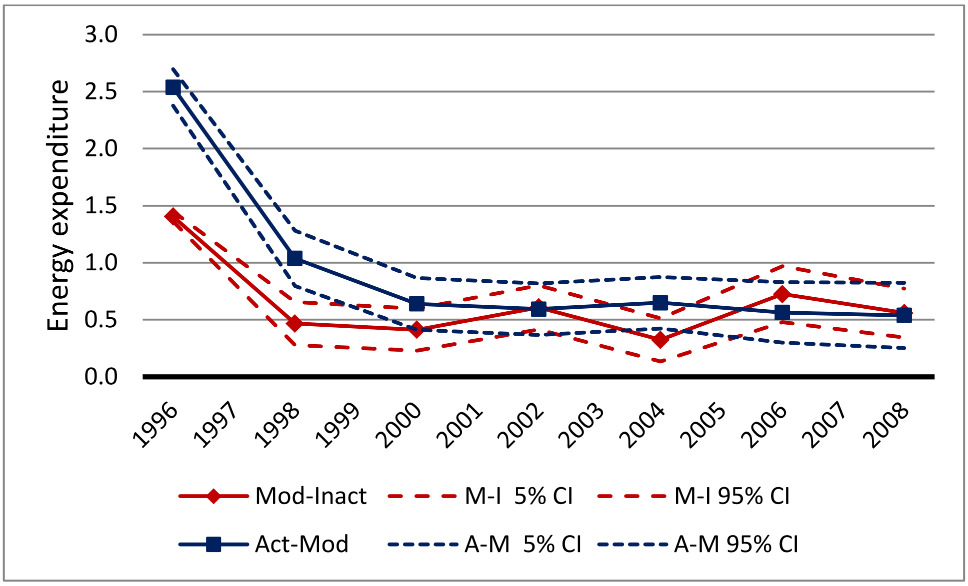
[15] Alternatively, one could define a treatment over more than one period, but this would either raise the issue of missing confounders (if confounders measured in 1994 were used as only control variables), or raise the issue of endogenous confounders (if confounders after 1994 were also used as control variables, because they might be influenced by sport and exercise activities in 1996 and later).

treatment, i.e. an increase of the activity level by one level, are depicted by a solid line, while the dashed lines show the 90% confidence bounds for the estimated effects. The effects are, of course, allowed to differ for the two different treatments considered, namely inactive to moderate (M-I; red with a rhombus) and moderate to active (A-M; blue with a square). All the following figures are considering average treatment effects (ATE) for those who were moderately active in 1994. In other words, we investigate what would happen to those moderately active in 1994 if they increase, decrease, or continue their activity level. Appendix D presents additional results for other populations and different effects that by and large confirm the findings presented in the main body of the paper.

For 1996, Figure 5.1 shows that the effect of increasing the activity level from inactive to moderate is about 1.5 kcal/kg, plus and an additional 2.5 kcal/kg when further increasing the activity level to active. This total increase of about 4 kcal/kg is a bit smaller, but in a similar range as the unadjusted differences between the active and inactive in 1994 (see Table 4.1). It is significantly larger for the moderate to active comparison than for the inactive to moderate comparison. This fact will become important later on for interpretation of the health and labor market results.

The effects get smaller over time. This is expected, as the effect of an (assigned) activity level in 1996 should have the largest effect in that very period in which the treatment is defined and less so when the distance to 1996 increases. Nevertheless, both effects remain positive and significantly different from zero until the end of the observation window in 2008. However, from 2002 onwards, both effects have similar magnitudes. Appendix D.6 presents the results for the remaining individuals, i.e. those individuals who were either active or inactive in 1994. The patterns are very similar. However, the effects for the smallest group, the active, are estimated more noisily.

Figure 5.1: Energy expenditures as effects of changes in the activity levels



Note: Average treatment effects of changing activity levels from inactive to moderately active and from moderately active to active in 1996 for individuals who were moderately active in 1994.

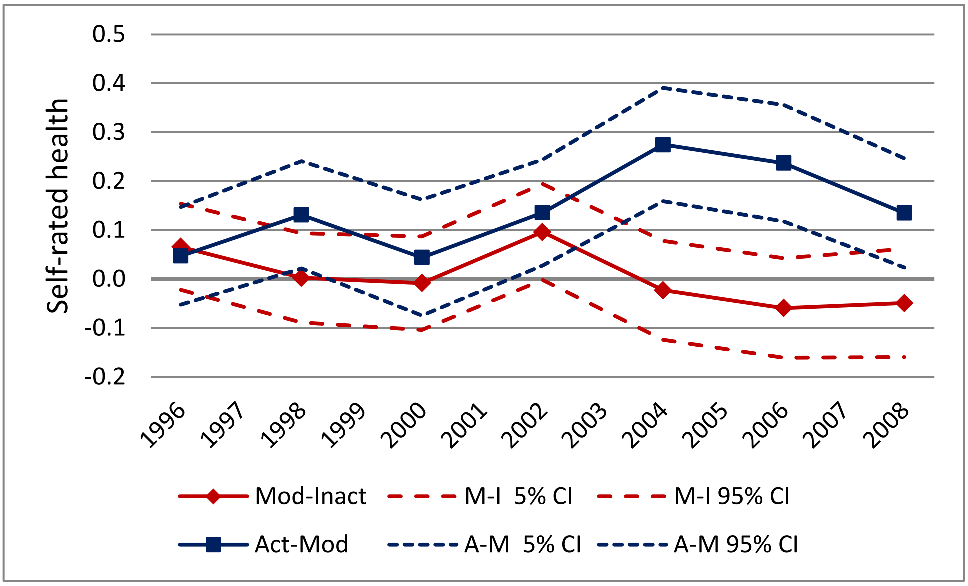
The results on the dynamics of energy expenditure over time as shown in Figure 5.1 are important for the interpretation of the following health and labor market results. Although, strictly speaking these results present the causal effect of the respective activity change in 1996 only, of course, they also capture effects of the subsequent activity changes that are due to the 1996 change.

5.2 Health effects

Although individual sports and exercise participation may have positive labor market effects through other channels than health, it would be surprising, if not disturbing, if there is no health effect given that this effect is well established in the medical literature (e.g. U.S. Department of Health and Human Services et al., 1996; Benjamin, 2010; Warburton et al. 2006; World Health Organization 2010). Therefore, it is natural to investigate the effects on health first before analyzing labor market effects. For this purpose we use a self-rated subjective health indicator that measures the health status of the participants on an ordinal rating scale of 1 (worst) to 5 (excellent). Figure 5.2 presents the average treatment effect for subjective health measure for those who are moderately active in 1994.

The results in the figure indicate that changing the activity level from inactive to moderately active has no detectable effect on subjective health. Only if the activity level is raised to the highest category ('active'), then a clear-cut long-run health effect becomes significant over time. The findings for the inactive-moderate comparison are somewhat at odds with some of the medical literature suggesting that any increase of sports and exercise activity has positive effects (for a review see U.S. Department of Health and Human Services et al., 1996, 2010; World Health Organization 2010), which is clearly not what we find for this subgroup.

Figure 5.2: Subjective health for moderately active subgroup in 1994



Note: Average treatment effects of changing activity levels from inactive to moderately active and from moderately active to active in 1996 for individuals who were moderately active in 1994.

Concerning the heterogeneity of the health effects for different activity levels in 1994, we find that the results for the (large group) of inactive (Figure D.12) aligns with the one presented for the moderately active subgroup in Figure 5.2, while the results for the small group of active in 1994 show no effect of activity level raised beyond the moderate level of activity (Figure D.11). The reasons for this result that is somewhat diverging from the general thrust of the other results remain an issue for further research. A companion paper, Sari and Lechner (2014), contains a considerably more detailed analysis of the health effects.

5.3 Labor market effects

In this section, the effects of increased sports and exercise participation on individual and household earnings as well as other labor market indicators, like working hours and employment status are discussed. The main results, i.e. the ATE for the moderately active subsample, are given within this section, while additional results are relegated to Appendix D.

5.3.1 Personal income

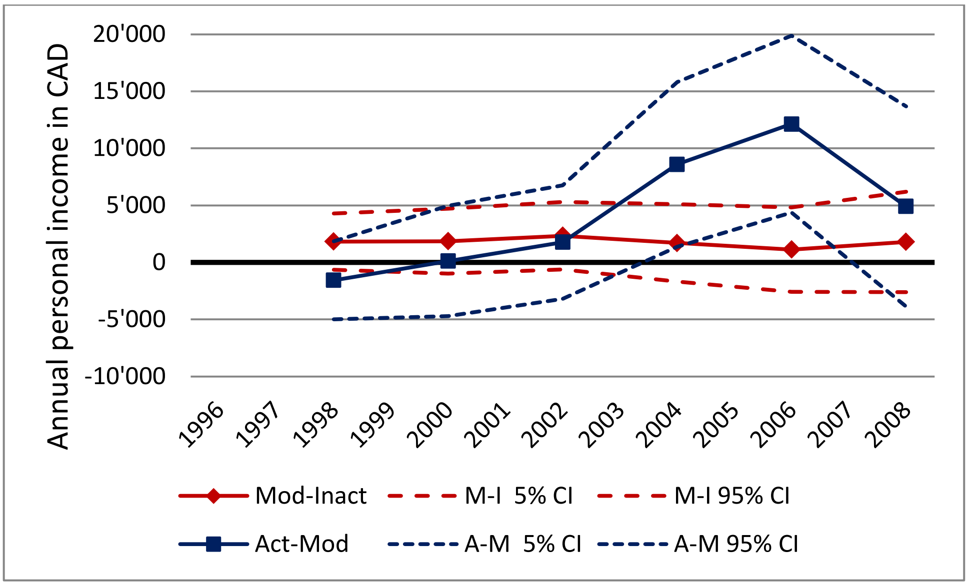
Figure 5.3 shows the results for 'annual personal income' and contains the main results of this paper: Over time, there are positive effects on earnings for an activity increase from moderate to active, but the increase from inactivity to only a moderate sports and exercise activity is too small to generate such effects. This finding is more or less in line with the effects for subjective health shown in the previous section.

Figure 5.3 suggests that it takes some time before the effects materialize (remember that treated and controls have the same distribution of activity levels in 1994), but eventually the effects become large enough to be significant. Figure D.1 in Appendix D relates the effects to the underlying levels of earnings that could be achieved under the different treatments. They are all increasing over time (and / or with age) and reach 60'000 to 65'000 CAD in 2008.[16] This suggests effects of around 10 to 20% after 8 to 12 years. This is somewhat larger than the values reported by Lechner (2009a) for Germany (but his study was based on a far less so-

[16] Note that due to sample attrition the samples get smaller over time and thus the estimates become noisier.

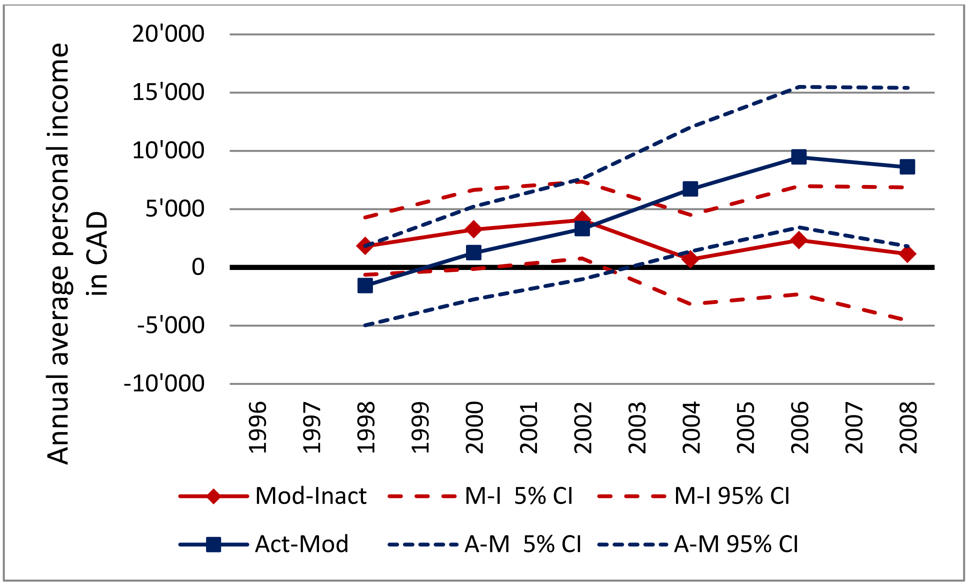
phisticated dataset). The effects for the moderate-inactive comparison are positive as well, but considerably smaller and not statistically significant.[17]

Figure 5.3: Annual personal income



Note: Average treatment effects of changing activity levels from inactive to moderately active and from moderately active to active in 1996 for individuals who were moderately active in 1994.

Figure 5.4: Annual average personal income



Note: Numbers shown in year x are the average effects over the years from 1996 to year x. Average treatment effects of changing activity levels from inactive to moderately active and from moderately active to active in 1996 for individuals who were moderately active in 1994.

[17] Note that these earnings effects are based on nominal CAD. Figure D.19 deflates the effects to 2002 CAD. The resulting differences are minor.

Instead of looking at the gain in annual earnings in every year, one may average the earnings differences from 1996 onwards to get an overall average of gains up to a particular year.[18] Figure 5.4 shows that the conclusions do not change by using this accumulated outcome variable instead. In the long run, there are average gains in personal income from increasing the activity level from moderate to active of more than 10%. These gains are considerably smaller, if positive at all, when the increase is only from inactive to moderate.

Appendices D.2 to D.7 contain heterogeneity and robustness checks for these findings. In Appendix D.2, different treatment comparisons are performed, like comparing the active directly to the inactive, and pooling the active and moderately active treatments to contrast them to the inactive (Figures D.2 and D.3). Both comparisons confirm the general findings explained above (although with less precision).

In Appendix D.3, the effects are compared for the same subpopulation. This means that instead of comparing the two ATEs (as shown above), the ATENT for the active vs. moderate contrast is compared to the ATET of the moderate vs. inactive contrast. Thus, both parameters refer to the same population of individuals who are moderately active in 1996 (and 1994). Again, the general findings (Figures D.4 and D.5) outlined above are confirmed.

Finally, instead of considering only individuals who are moderately active in 1994, the ATE's of the six strata are aggregated to obtain an overall average effect for the population (Figure D.6 in Appendix D.4). Again, the previous results are confirmed for the active-moderate comparison (although effects appear to be a little smaller). However, for the moderate-inactive comparisons, some effects for the later years could not be computed because of sample size problems in some subpopulations.

[18] Such estimation uses averages over time and individuals. Thus, it will be more precise which is reflected in the somewhat narrower confidence bounds.

Do the results differ for men and women and for the different activity states in 1994? For the active-moderate comparison (Figure D.7, D.8 in Appendix D.5), the effects for men and women are similar. The moderate-inactive comparison, however, suggests that while effects for women may be absent, for men they may be in the same range as for the active-moderate contrast. However, as before the estimations for women are subject to the sample size problems mentioned above. With respect to activity levels in 1994, there does not appear to be much effect heterogeneity, so that the qualitative general findings are again confirmed (Figures D.9 to D.14 in Appendix D.6).

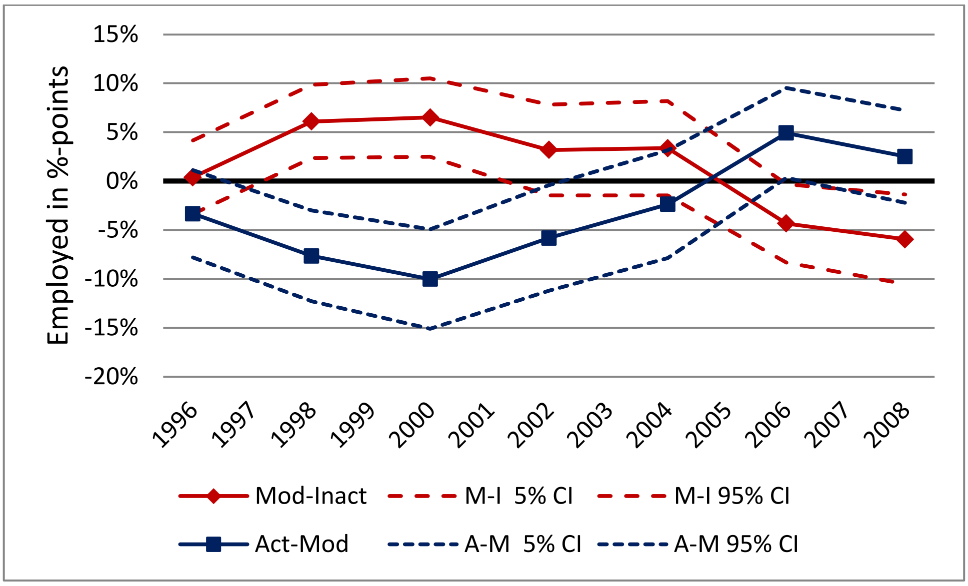
Finally, the income concept is broadened from personal income to household income (Figures D.15 and D.16 in Appendix D.7). Again, the same pattern arises although the effects seem to be somewhat larger in magnitude (perhaps due to a likely positive correlation of sport activities of the adult members of a household).

5.3.2 Employment

Next, results for variables indicating whether somebody is employed at all or full-time employed, as well as for a measure of working hours are considered.

The employment effects for the two comparisons exhibit a distinctly different dynamic pattern (Figure 5.5). For the active-moderate comparison, there is first a decline of employment followed by an increase, while for the moderate-inactive comparison the pattern is exactly opposite. This suggests that for 1998 to about 2002 changes from either active or inactive to a moderate activity level increases employment. This could be the case if a further increase of sports and exercise activities *beyond* a moderate level increases the value of leisure time (respectively, sports and exercise just take more time to conduct and is not a complete substitute with other leisure activities). This would reflect the nature of active sports and exercise participations as a consumption good complementary to leisure. Thus, rational individuals would reduce employment almost immediately and increase their leisure time while also doing more sports and exercise. It may be that after some time the investment good character of sports and exercise, which increases individual productivity, begins to dominate the consumption good character. Thus, working time becomes more valuable and employment increases with the activity level to reap in the benefits (that have been documented in the previous section). Note however that while this (rather speculative) explanation may be plausible for the active-moderate contrast, it does not explain the inverse pattern for the moderate-inactive contrast. To provide more evidence for these phenomena remains a topic for future research.

Figure 5.5: Employment

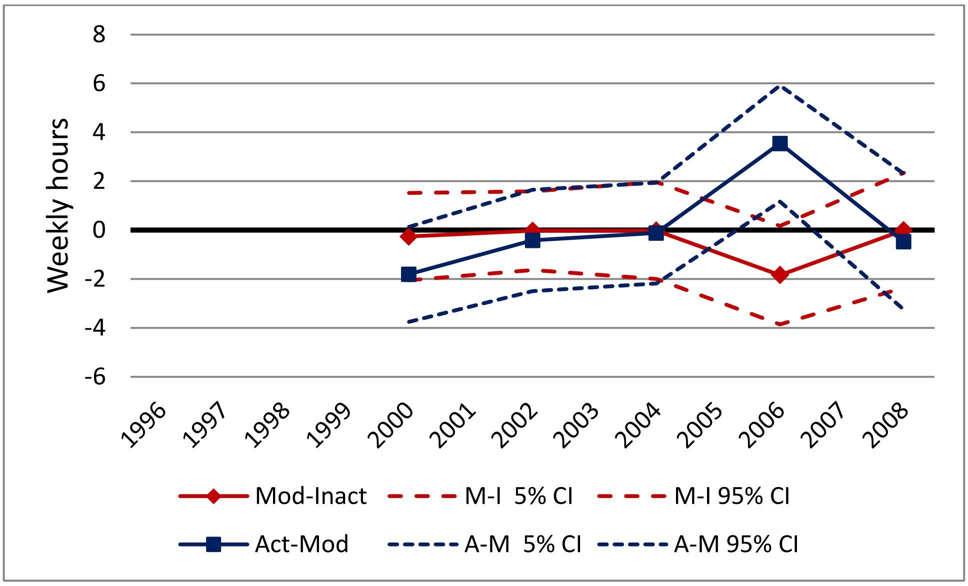


Note: Average treatment effects of changing activity levels from inactive to moderately active and from moderately active to active in 1996 for individuals who were moderately active in 1994.

When considering only full time employment (Appendix D.8) in order to rule out effects from jobs with small hours, the results are in line with these findings (from the year 2000 onwards, because there are no data on working hours before the year 2000; see Figure D.17).

The effects on working hours shown in Figure 5.6 are almost exactly zero, with the exception of one single year (2006). Again, why this happened in this year is not clear. One conjecture is that it is a statistical outlier.

Figure 5.6: Working hours



Note: Working hours are computed as annual hours / 52. Hours of non-employed workers are set to 0. Information on annual hours is available from 2000 onwards. Average treatment effects of changing activity levels from inactive to moderately active and from moderately active to active in 1996 for individuals who were moderately active in 1994.

5.4 Further sensitivity checks

The previous section already mentioned several sensitivity checks conducted with respect to the key earnings results. A further concern is the effect that attrition may have on the results presented above. As with every panel study based on survey data, there is the issue of panel attrition (on top of item non-response). If attrition is confounding, i.e. jointly related to treatment and selection, then it may invalidate the attempted causal inference. Due to the selection of the sample, the panel is balanced in the first two periods. After 1996, attrition occurs. The impact of the later attrition can be checked (to some extent) by using the full sample and estimating an effect for an additional outcome variable which is defined as one if nonresponse occurs and zero otherwise (for details see Appendix C.2). With the single exception of the year 2000, the results of this exercise (Figure C.1) reveal no evidence for selective (confounding) attrition.

A further implicit overall check of the plausibility of the chosen approach is to see whether the effects follow a plausible dynamic pattern. Given that the treatment consists of comparing different activity levels in 1996 conditional on having the same activity level in 1994 (while leaving the period after 1996 unrestricted), it would be very surprising to see immediate labor market effects (of this investment in health and social capital), other than perhaps some employment reduction due to increased value of leisure which may occur immediately. This is of course not true for subjective health which may plausibly show a short-term as well as a long term effect. Comparing the results across the various figures reveals no compelling evidence for implausible dynamic patterns. The exception is perhaps the evolvement of the employment effect which has been discussed above.

6 Conclusion

In this study we investigated the medium and long term effects of sports and exercise on labor market outcome for working age adults. The empirical analysis is based on Canadian panel data that are particularly suitable for such an analysis because they are unusually informative about sports and exercise, about potential confounding variables such as health and life style, and they contain labor market outcomes as well. The informative data set is used with a research design based on stratification and semi-parametric matching estimation that arguably allows the causal interpretation of the resulting estimates.

We find robust positive earnings effects that increase to more than 10% after some years, which broadly compares to the returns of one to two years of schooling (e.g. Card, 1999). Interestingly, an important heterogeneity appears in the sense that only increasing the level of sports and exercise activity to a level higher than the one recommended by national and international health organizations has this clear-cut impact. Smaller increases appear to have only a minor impact that is hard to pin with the sample sizes available in this study.

Interesting further research may address this heterogeneity issue: A possible, but of course speculative, explanation of this heterogeneity may be that activity is measured subjectively. From other studies it is known that individuals may exaggerate their physical activity (e.g. Sebastiao et al., 2012).[19] Furthermore, another interesting dimension of sports and exercise is the heterogeneity with respect to different types of activity, as different types of sports foster different skills that are valuable in the labor market.

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[19] Although, the way Statistics Canada computes the calorie expenditures takes this measurement issue to some extend into account.

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Appendix A: Descriptive statistics

Table A.1: Descriptive statistics for the strata

Variable	Men			Women		
Activity level in 1994	Active	Moderate	Inactive	Active	Moderate	Inactive
Age	31.9	33.3	33.2	33.5	33.1	33.7
Married/common law partner	0.50	0.61	0.60	0.53	0.60	0.63
Number of children of age < 12	0.51	0.66	0.65	0.81	0.80	0.92
Immigrant	0.10	0.10	0.12	0.10	0.10	0.13
University / college graduate	0.37	0.41	0.34	0.38	0.43	0.36
Secondary school graduate	0.51	0.44	0.46	0.49	0.44	0.48
Average daily # of alcohol consumption (past week)	0.70	0.85	0.73	0.33	0.30	0.22
Daily alcohol drinker (last year)	0.03	0.04	0.04	0.02	0.02	0.01
2-6 times per week alcohol drinker (last year)	0.31	0.34	0.27	0.15	0.13	0.10
Body mass index (BMI)	25.7	25.8	25.9	23.4	24.1	24.5
Regular smoker	0.24	0.30	0.38	0.28	0.28	0.32
Self-rated health (1: worst; 5: best)	3.12	3.06	2.89	3.03	3.04	2.83
Health utility index (HUI)	0.91	0.91	0.89	0.91	0.90	0.88
Depression scale	0.42	0.36	0.29	0.68	0.68	0.69
Activities prevented by pain	0.06	0.06	0.06	0.08	0.07	0.11
Distress scale	3.20	3.24	3.35	3.45	3.78	4.16
At least one of the 5 chronic conditions	0.04	0.04	0.05	0.06	0.05	0.06
Other chronic conditions	0.40	0.41	0.36	0.47	0.46	0.46
Home owned by household	0.62	0.70	0.67	0.65	0.66	0.63
Number of bedrooms in home	2.68	2.86	2.76	2.89	2.84	2.90
Total annual household income in 1000 CAD	43.8	46.8	41.7	40.7	43.3	39.8
Employed	0.81	0.86	0.86	0.69	0.74	0.72
Occupation in management, business, finance, administration, sciences	0.23	0.24	0.22	0.24	0.26	0.29
Usually sit during daily activities	0.16	0.21	0.19	0.15	0.19	0.23
Total energy expenditure from leisure time physical activities	5.15	2.10	0.56	4.80	2.07	0.57
Not biking in non-leisure time	0.80	0.88	0.93	0.86	0.91	0.96
Not walking in non-leisure time	0.43	0.43	0.50	0.31	0.32	0.38
Injuries other than repetitive strain injuries (past 12 months)	0.28	0.26	0.19	0.23	0.19	0.15
Male 25+ unemployment rate	0.09	0.09	0.10	0.09	0.09	0.10
Highest schooling rate 15+ aged: Less than grade 9	0.11	0.12	0.13	0.11	0.12	0.13
Log of regional population density	-5.98	-5.72	-5.47	-5.70	-5.64	-5.74
Central metropolitan area	0.63	0.61	0.54	0.61	0.58	0.59
Share of active 1996	0.52	0.23	0.18	0.50	0.27	0.08
Share of moderate 1996	0.25	0.34	0.10	0.27	0.36	0.20
Share of inactive 1996	0.23	0.43	0.72	0.23	0.38	0.73
Observations	474	562	1349	396	534	1481

Note: Sample means shown. If not mentioned otherwise, all variables are measured in 1994. HUI is a quality adjusted health status indicator which describes an individual's overall functional health with a single numerical value for any possible combination of levels of eight self-reported health attributes (vision, hearing, speech, mobility, dexterity, cognition, emotion, and pain and discomfort). For a detailed explanation, see Furlong, Feeny, and Torrance (1999).

Appendix B: Results of probit estimation

Tables B.1 and B.2 show the coefficients of the probit estimation for the active vs. moderate as well as the moderate vs. inactive comparisons.

Table B.1: Coefficients of probit estimations for active vs. moderately active comparison

Variable	Men			Women		
Activity level in 1994	Active	Moderate	Inactive	Active	Moderate	Inactive
Age	-0.008	-0.008	-0.003	-0.010	*-0.024*	-0.017
Married / common law partner	0.072	0.032	0.116	-0.003	0.142	0.276
Number of children of age < 12	-0.031	-0.134	0.015	-0.012	0.047	0.011
Immigrant	0.296	0.409	0.135	0.278	-0.016	0.124
University / college graduate	0.047	-0.213	-0.201	-0.312	0.142	-0.176
Secondary school graduate	-0.293	0.025	-0.118	-0.393	-0.275	-0.234
Average daily # of alcohol consumption (past week)	-0.150	-0.093	-0.001	-0.003	-0.039	*0.225*
2-6 times or daily per week alcohol drinker (last year)	-0.251	0.023	0.105	**0.548**	-0.260	-0.084
BMI	-0.004	-0.012	0.007	-0.017	-0.030	-0.024
Regular smoker	-0.028	-0.105	-0.022	-0.267	***0.497***	0.108
Self-rated health	-0.056	-0.031	0.000	-0.075	-0.117	0.007
Health utility index	-0.906	-0.770	-0.376	-0.217	-0.594	0.437
Depression scale	-0.014	*0.113*	0.021	0.033	-0.050	-0.076
Activities prevented by pain	-0.090	0.189	-0.032	0.018	0.149	0.340
Distress scale	-0.042	-0.025	0.029	-0.017	0.016	0.010
At least one of the 5 chronic conditions	-0.120	-0.381	*-0.670*	-0.355	-0.356	-0.238
Other chronic conditions	-0.018	0.076	-0.172	-0.009	-0.137	0.075
Home owned by household	0.095	-0.283	-0.092	*0.342*	-0.156	0.033
Number of bedrooms in home	0.012	*0.161*	0.011	-0.121	0.021	0.085
Total household income/10000	-0.003	-0.054	0.002	0.078	-0.006	-0.060
Employed	**0.433**	-0.047	-0.023	0.336	-0.365	0.106
Not in labor force	-	-	-	0.003	-0.439	0.057
Occupation in management, business, finance, administration, sciences	0.224	0.235	-0.093	-0.020	-0.194	-0.128
Usually sit during daily activities	0.165	-0.155	**-0.428**	-0.193	-0.246	0.102
Total energy expenditure from leisure time physical activities	***0.156***	0.192	0.173	*0.079*	0.293	0.255
Not biking in non-leisure time	-0.309	0.018	-0.048	-0.085	-0.246	-0.039
Not walking in non-leisure time	0.014	-0.150	-0.070	-0.001	-0.250	-0.259
Injuries other than repetitive Strain injuries (past 12 months)	0.197	-0.030	***0.048***	0.594	0.173	0.029
Male 25+ unemployment rate	1.197	0.587	0.723	3.322	1.513	***-4.222***
Highest schooling rate 15+ aged: Less than grade 9	2.388	-0.285	0.774	-1.695	*-3.196*	0.369
Log of regional pop. density	-0.019	-0.050	-0.006	-0.015	0.025	0.070
Central metropolitan area	0.284	0.109	0.109	-0.326	-0.299	0.232
Efron's Pseudo R^2 in %	13.8	10.2	5.1	12.8	15.0	9.0

Note: All covariates are measured in 1994. Numbers in ***bold italics*** / **bold** / *italics* denote significance at the 1% / 5% / 10% level. All specifications include a constant term. Dependent variable is 'active in 1996'. Sample consists of active and moderately active individuals (1996).

Table B.2: Coefficients of probit estimations for the moderate vs. inactive comparison

Variable	Men			Women		
Activity level in 1994	Active	Moderate	Inactive	Active	Moderate	Inactive
Age	*0.023*	0.001	-0.005	-0.001	-0.012	-0.004
Married / common law partner	-0.035	-0.155	0.043	**-0.525**	-0.079	**-0.205**
Number of children of age < 12	0.018	-0.006	0.012	0.010	-0.040	-0.046
Immigrant	-0.074	-0.119	-0.136	-0.394	0.292	**-0.301**
University / college graduate	0.487	0.046	-0.083	0.213	0.053	-0.185
Secondary school graduate	**0.752**	-0.136	0.066	-0.040	0.247	0.049
Average daily # of alcohol consumption (past week)	-0.100	-0.014	-0.043	0.176	-0.087	-0.011
2-6 times or daily per week alcohol drinker (last year)	0.132	-0.115	-0.126	-0.359	0.067	0.190
BMI	-0.006	-0.013	-0.003	-0.007	0.001	-0.002
Regular smoker	-0.340	-0.031	-0.005	0.156	-0.232	0.010
Self-rated health	**0.328**	-0.014	0.019	**0.296**	0.095	0.013
Health utility index	-1.239	0.603	0.194	*1.464*	*1.449*	0.304
Depression scale	-0.103	**-0.110**	*-0.082*	-0.068	-0.013	0.009
Activities prevented by pain	-0.263	-0.052	*0.392*	0.612	*0.790*	-0.158
Distress scale	-0.005	0.004	0.002	0.008	-0.006	-0.011
At least one of the 5 chronic conditions	0.474	0.053	0.028	0.109	0.078	-0.226
Other chronic conditions	0.110	0.091	0.022	0.223	0.059	-0.055
Home owned by household	0.043	*0.489*	0.114	-0.052	0.228	0.068
Number of bedrooms in home	-0.070	**-0.163**	-0.055	-0.095	0.010	-0.049
Total annual household income/10000	0.030	**0.070**	0.022	0.007	0.003	**0.048**
Employed	-0.167	0.153	-0.081	-0.209	0.270	0.201
Not in labor force	-	-	-	0.160	0.076	*0.354*
Occupation in management, business, finance, administration, sciences	-0.260	-0.194	-0.102	**0.564**	-0.119	0.040
Usually sit during daily activities	0.034	0.009	0.152	0.452	-0.238	0.000
Total energy expenditure from leisure time physical activities	-0.018	*0.433*	*0.649*	-0.017	0.079	*0.612*
Not biking in non-leisure time	0.097	0.001	-0.005	-0.382	0.022	0.143
Not walking in non-leisure time	-0.290	-0.072	*-0.150*	-0.038	-0.116	0.021
Injuries other than repetitive Strain injuries (past 12 months)	-0.028	-0.153	0.006	-0.361	0.013	**0.236**
Male 25+ unemployment rate	-0.020	-1.595	0.112	-2.469	-1.651	0.328
Highest schooling rate 15+ aged: Less than grade 9	-3.188	-0.690	-1.129	-2.835	1.978	-0.543
Log of regional population density	0.047	0.028	*-0.042*	0.075	0.016	*-0.046*
Central metropolitan area	-0.052	0.005	*-0.187*	0.041	0.185	-0.136
Efron's Pseudo R^2 in %	14.0	10.1	6.5	18.0	7.8	6.5

Note: All covariates are measured in 1994. Numbers in ***bold italics*** / **bold** / *italics* denote significance at the 1% / 5% / 10% level. All specifications include a constant term. Dependent variable is 'moderately active in 1996'. Sample consists of moderately active or inactive individuals (1996).

Appendix C: Econometric issues

Appendix C.1: The matching estimator

Table C.1 gives the detailed matching protocol used. See Huber, Lechner, and Wunsch (2013) and Huber, Lechner, and Steinmayr (2012) for further details on the implementation and the properties of this estimator, including trimming and common support rules.

Table C.1: Matching protocol for the estimation of a counterfactual outcome and the effects

Step A-1	Choose one observation in the subsample defined by *d*=1 and delete it from that pool.
Step B-1	Find an observation in the subsample defined by *d*=0 that is as close as possible to the one chosen in step A-1) in terms of $(x), \tilde{x}$. 'Closeness' is based on the Mahalanobis distance.
Step C-1	Repeat A-1) and B-1) until no observation with *d*=1 is left.
Step D-1	Compute the maximum distance (*dist*) obtained for any comparison between a member of the reference distribution and matched comparison observations.
Step A-2	Repeat A-1).
Step B-2	Repeat B-1). If possible, find other observations in the subsample of *d*=0 that are at least as close as $R * dist$ to the one chosen in step A-2). Do not remove these observations, so that they can be used again. Compute weights for all chosen comparisons observations that are proportional to their distance. Normalise the weights such that they add to one.
Step C-2	Repeat A-2) and B-2) until no participant in *d*=1 is left.
Step D-2	D-2) For any potential comparison observation, add the weights obtained in A-2) and B-2).
Step E	Using the weights $w(x_i)$ obtained in D-2), run a weighted linear regression of the outcome variable on the variables used to define the distance (and an intercept).
Step F-1	Predict the potential outcome $y^0(x_i)$ of every observation using the coefficients of this regression: $\hat{y}^0(x_i)$.
Step F-2	Estimate the bias of the matching estimator for $E(Y^0\|D=1)$ as: $\sum_{i=1}^{N} \frac{(1-d_i)w_i\hat{y}^0(x_i)}{N_0} - \frac{d_i\hat{y}^0(x_i)}{N_1}$.
Step G	Using the weights obtained by weighted matching in D-2), compute a weighted mean of the outcome variables in *d=0*. Subtract the bias from this estimate to get $E(Y^0\|D=1)$.

Note: *R* is set to 150%. Age is used as additional matching variable ($\tilde{x}$). The weight of the propensity score coming from the Mahalanobis metric is multiplied by 5. Control observations with weights larger than 5% are removed.

Table C.1 shows how to compute the average treatment effects on the treated (ATET). The average treatment effects on the non-treated (ATENT) are computed in the same way but the role of treated and controls are reversed in the algorithm. The average treatment effect (ATE) is computed by aggregating both effects using the treatment share (*ATE = ATET x P(D=1) + ATENT x P(D=0)*). These estimations are performed for each of the six subsamples separately. The weights used to aggregate these estimates over specific groups or the population are proportional to the number of treated (for the ATET) / controls (ATENT) / populations (ATE) in the respective subsamples.

Inference is based on the ‘approximate’ asymptotic standard errors as explained and investigated in Lechner (2002). The basic idea is that the matching weights are treated as non-stochastic. In Lechner (2002), this approach appears to lead to conservative inference. Unfortunately, the infrastructure of the RDC (with which all computations had to be performed due to data security concerns for the particular data used) did not allow us to obtain bootstrap inference based on a sufficiently large number of bootstrap replications. For the active and moderate subsample of men in the active-inactive comparison, we did however obtain 99 bootstrap replications. Comparing standard errors estimated from the 99 bootstraps suggests that the approximate asymptotic standard errors are not far off, sometimes being somewhat smaller or somewhat larger than the (still rather noisily estimated) bootstrap standard errors.

Appendix C.2: Panel attrition

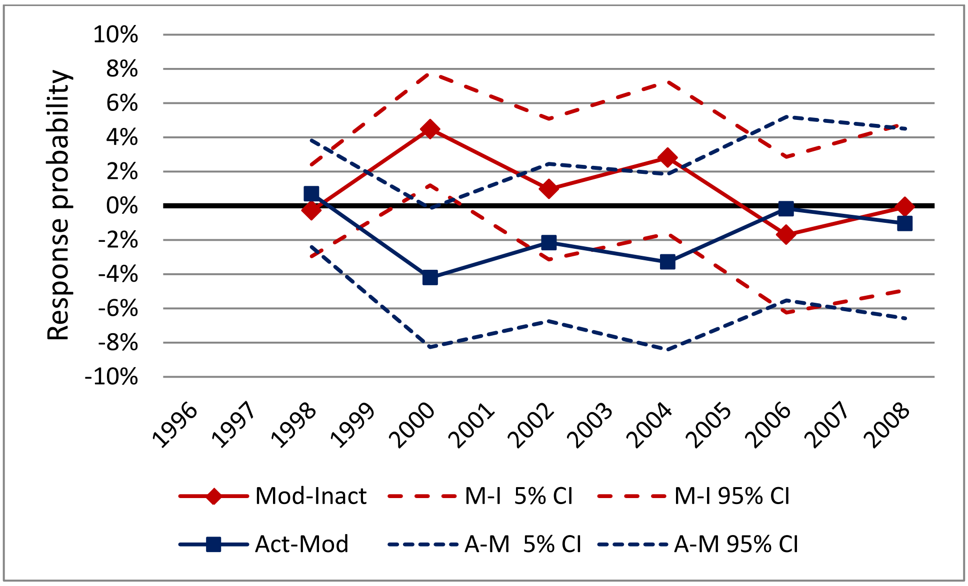
The sample used is an unbalanced panel for which we require complete answers to all variables used by the probit, i.e. only for the years 1994 and 1996. The results presented for the later years are based on those cases with valid information for the particular outcome variable shown.

The number of people answering the survey decreases from one cycle to the next due to attrition caused by non-response (refusals, individuals that were untraceable or partial response; deceased or institutionalized persons are counted as a response for longitudinal purposes). Out of 17,276 individuals in Cycle 1, the gross panel response rate is 93.6% in Cycle 2, 88.9% in Cycle 3, and decreased to 77.6% in Cycle 6, and further to 70.7% in Cycle 8.

Refusal is the largest source of non-response in the NPHS. Based on surveys that were sent out to panel members, the refusal rate increased from 3.1% in Cycle 2 to 6.3% in Cycle 4. However, it stabilized around 8% for the remaining Cycles of the NPHS. After refusal, the failure to trace a longitudinal panel member is the second most important source of non-response. As a share of surveys sent out to panel members, it increased from 1.7% in Cycle 2 to 3.1% in Cycle 4, and then to 4.5% in Cycle 5. The cumulative unable-to-trace rate is rising with the passing cycles, and reached to 5.9% in Cycle 6, and to 7.5% in Cycle 8.

One way to check whether non-response may have an effect on our results is to check whether the treatment leads to selective attrition. For this purpose, we create a binary outcome variable that is one for a particular individual if there is any missing information in any variable of interest for this particular individual (otherwise zero). Figure C.1 shows the results for the active vs. moderately active and moderately active vs. inactive comparisons (ATE, moderate subsample), which feature prominently in the main part of the paper.

Figure C.1: Effect of treatment on survey response



Note: ATE based on those moderately active in 1994.

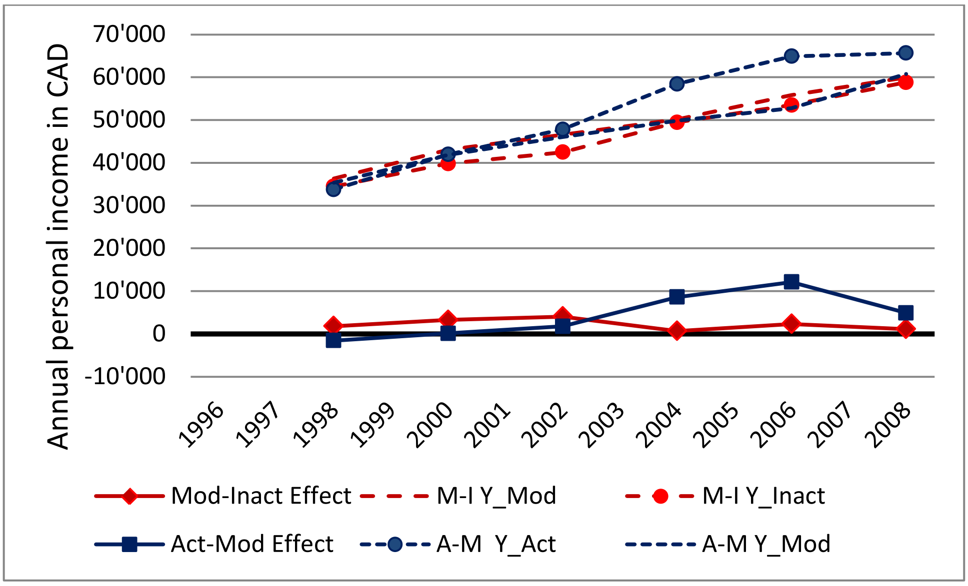
Figure C.1 shows that, with one exception in the year 2000 for the moderate-inactive comparison, there is no concern about selective (confounding) attrition.

Appendix D: Further results

Appendix D.1: Level of the personal income variable

To put the size of the results into perspective, Figure D.1 shows the levels of the potential outcomes for the personal income for the respective ATE (corresponding to Figure 4.2 in the main text). Note that in addition to the effects this figure shows the personal income active and moderately active individuals could expect on average when being active (A-M Y_Act) or when being only moderately active (A-M Y_Mod). Furthermore, the figure shows the expected earnings of moderate activity among the population of moderate and inactive individuals (M-I Y_Mod) as well as the expected income for a member of this population of being inactive (M-I Y_Inact). Note that the values of Y_Mod for the two different populations are almost identical. Generally, there is an upward trend for all (potential) outcomes which is due to inflation and the fact that the sample ages over time.

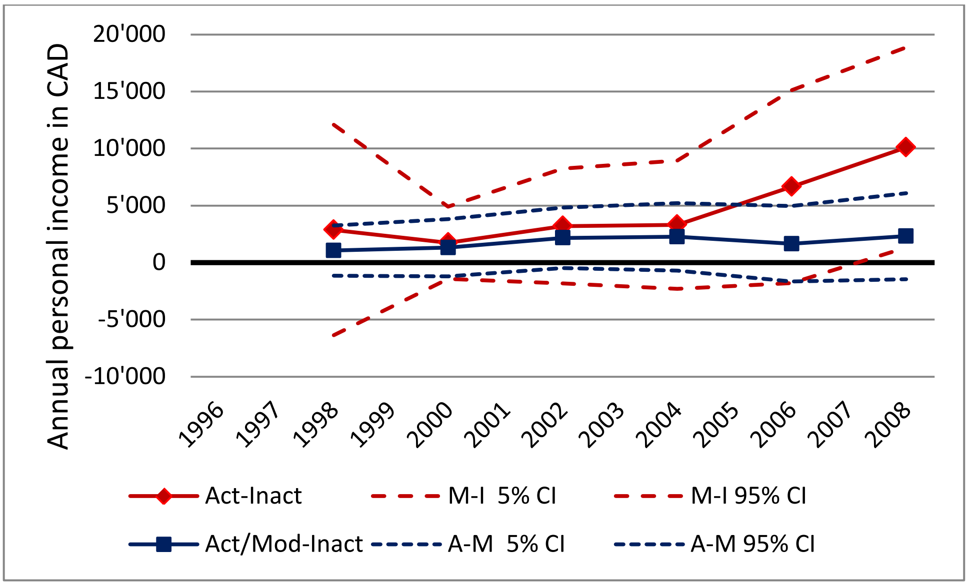
Figure D.1: Estimated potential outcomes and effects for annual personal income



Note: ATE based on subsample of moderately active individuals in 1994.

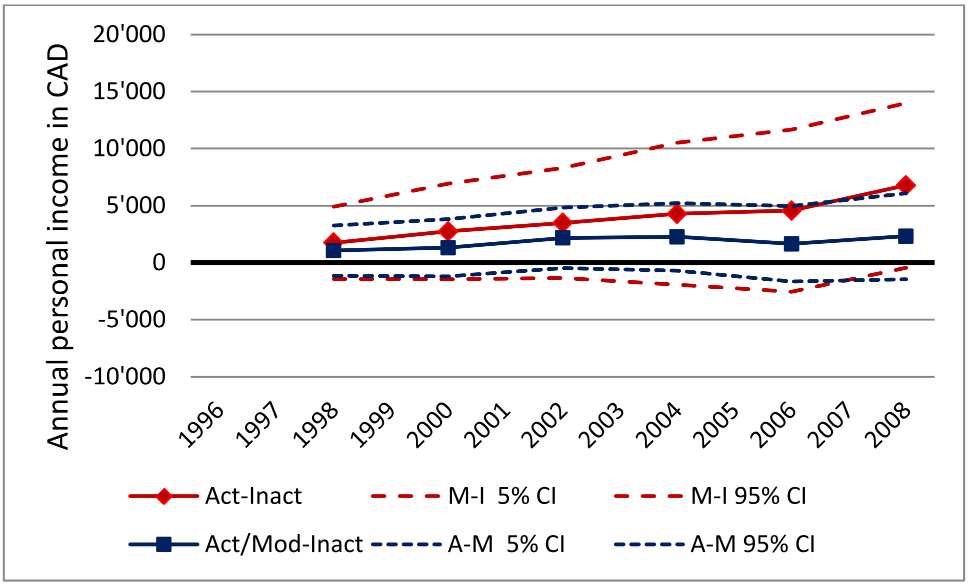
Appendix D.2: Results aggregated over different activity states in period 1

Figure D.2: Annual personal income: Active vs. inactive and active & moderate vs. inactive



Note: ATE based on subsample of moderately active individuals in 1994.

Figure D.3: Average annual personal income: Active vs. inactive and active & moderate vs. inactive



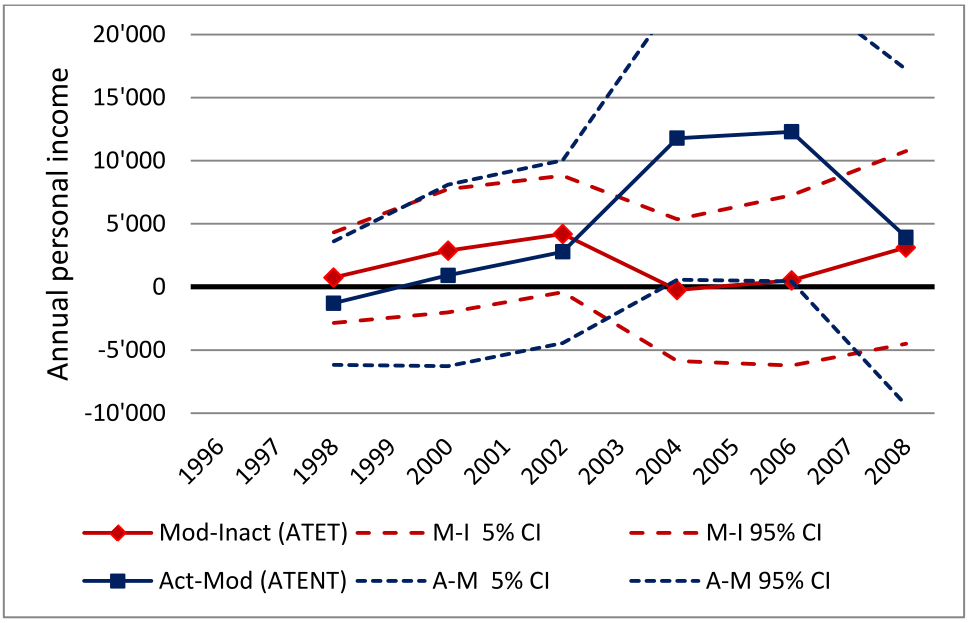
Note: ATE based on subsample of moderately active individuals in 1994.

Figure D.2 shows the results for the ATE of personal income when active and moderate activities are compared to inactivity and when being active is directly compared to being inactive. Effects are positive in both cases. However, they are only at the boarder of being significant. As expected the effects for the active-inactive comparison are somewhat larger, but also less precisely estimated. The conclusions are confirmed when considering average outcomes over time (Figure D.3).

Appendix D.3: Effects for the same subpopulation

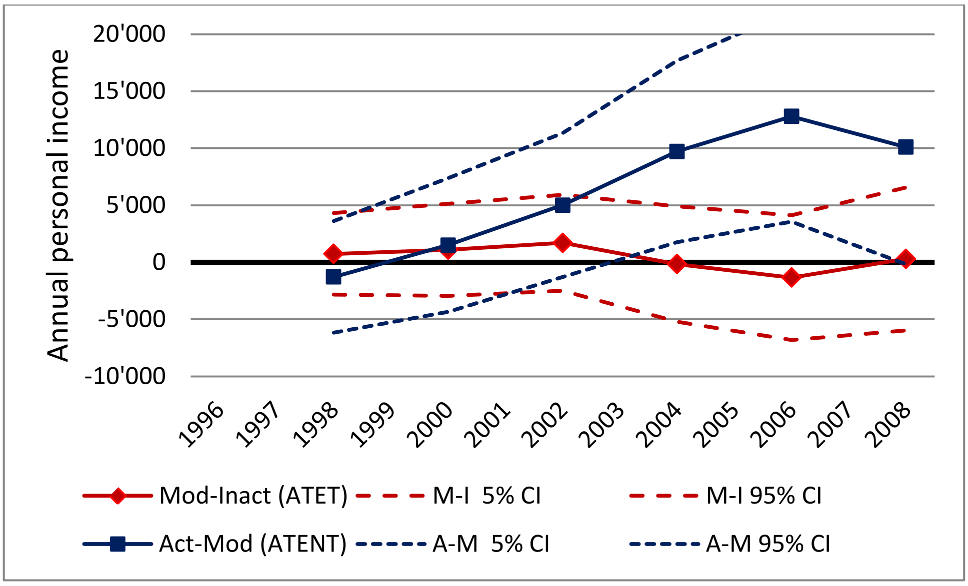
The main text focused on a comparison of the ATE of the active-moderate and moderate-inactive contrasts. If results differ for the two contrasts, then such difference might be due to the fact that those ATEs are computed for different subpopulation (if individual effect heterogeneity is present). Therefore, this subsection presents results for the ATENT of the active-moderate comparison (i.e. the moderately active in 1996) as well as for the ATET of the moderate-inactive comparison (again, the moderately active in 1996). As in the main text, the analysis is based on the subpopulation of moderately active people in 1994.

Figure D.4: Annual personal income for moderates in 1994 that are still moderately active in 1996



Note: ATET / ATENT for the moderate-inactive / active-moderate comparison. Estimation is based on subsample of moderately active individuals in 1994.

Figure D.5: Average annual personal income for moderates in 1994 that are still moderately active in 1996



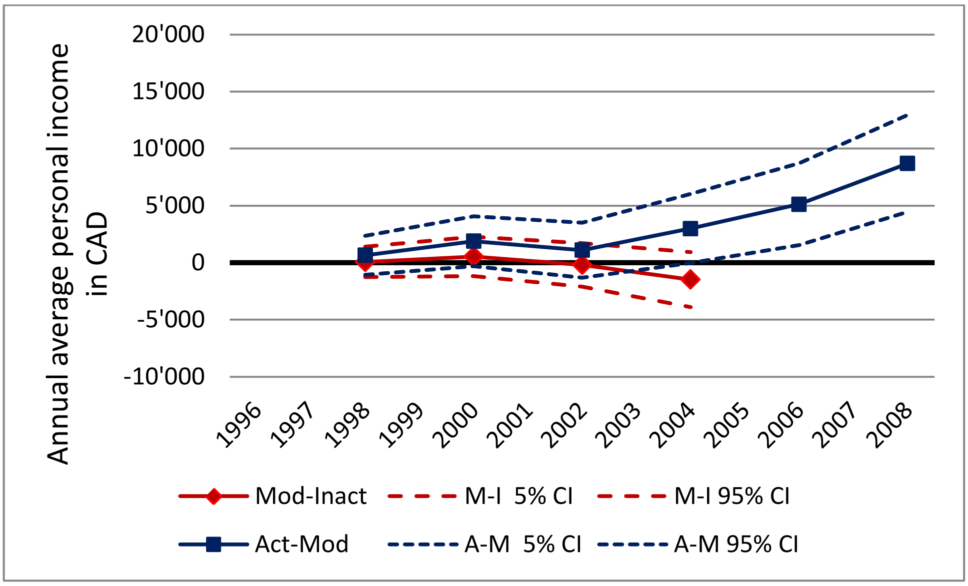
Note: ATET / ATENT for the moderate-inactive / active-moderate comparison. Estimation is based on subsample of moderately active individuals in 1994.

Qualitatively, the results reflect the same patterns as for the ATE shown in the main body of the paper.

Appendix D.4: Averages over all subpopulations

Most of the results presented so far focused on the population with a moderate activity level in 1994. Figure D.6 presents the results aggregated over all 1994 activity levels. It appears that the effects become stronger for the active-moderate comparisons, while no effects are detectable for the moderate-inactive comparison.

Figure D.6: Annual personal income: ATE aggregated over activity states in 1994

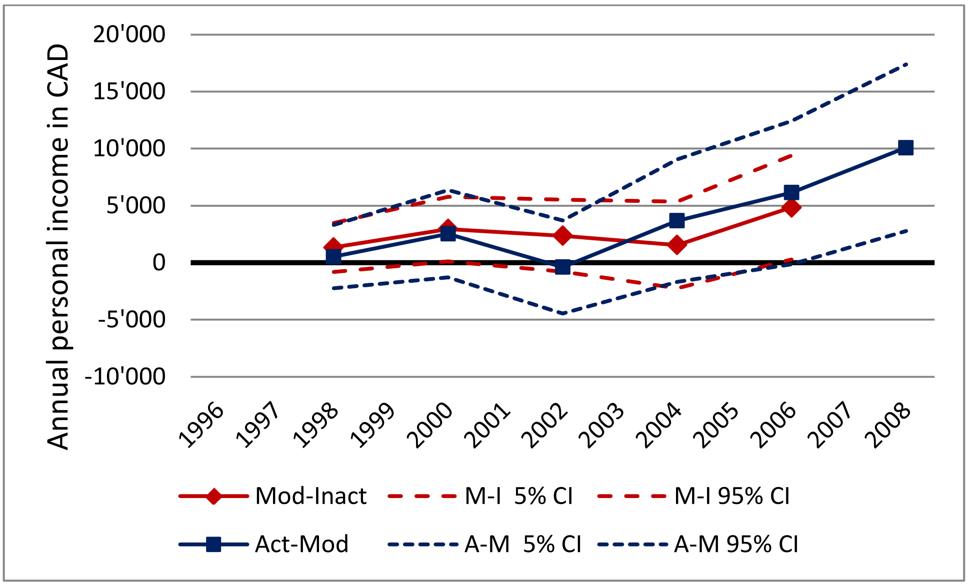


Note: The results for the moderate-inactive comparison extend only to 2004, because the female active (1994) subpopulation responding to this income question and observed to be inactive is too small afterwards.

Appendix D.5: Gender heterogeneity

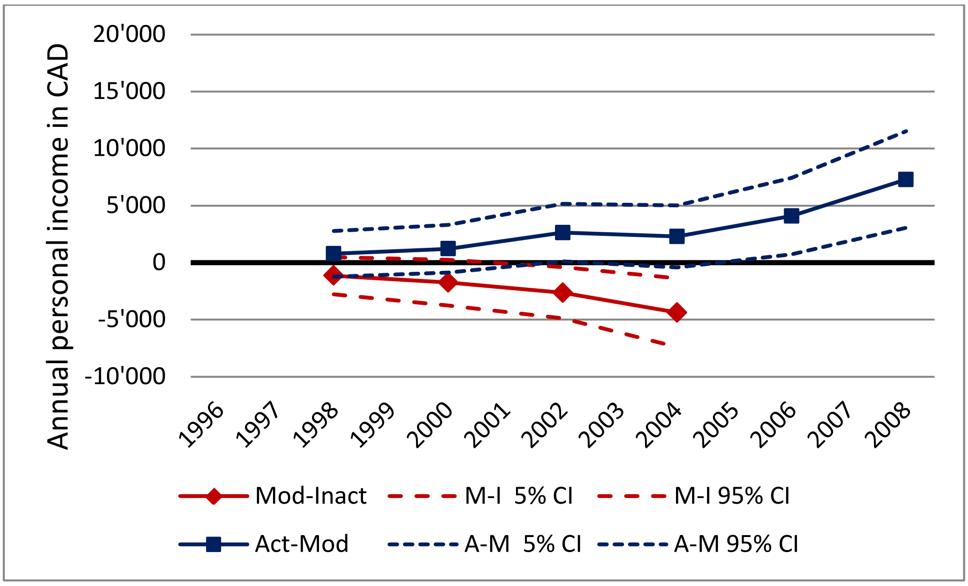
Figure D.7 and D.8 show gender difference based on the ATE aggregated over all 1994 activity populations. The results suggest that the effects for men are somewhat more pronounced than for women, although the differences between the point estimates are hardly significant.

Figure D.7: Annual personal income - men



Note: The results for the moderate-inactive comparison extend only to 2006, because the male active subpopulation responding to this income question became too small afterwards.

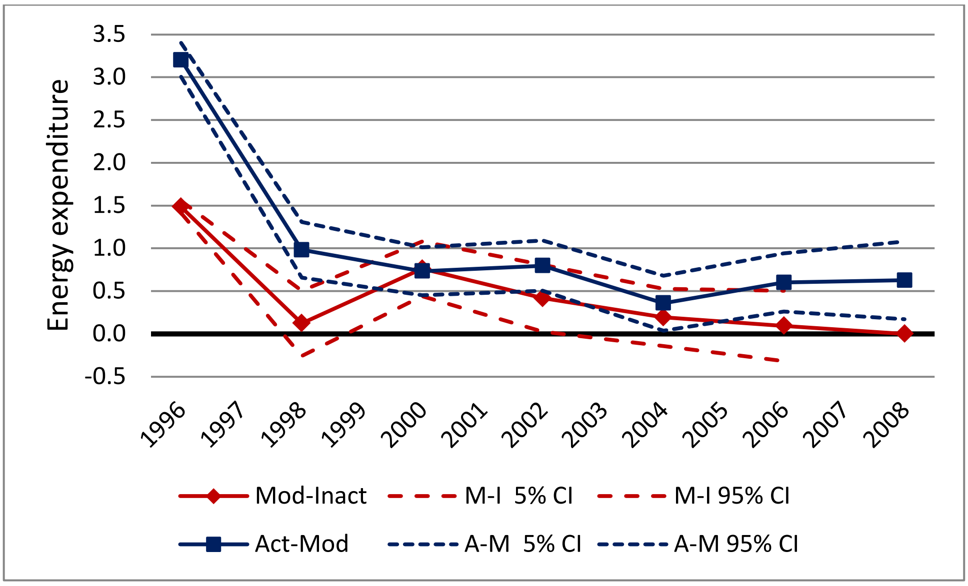
Figure D.8: Annual personal income - women



Note: The results for the moderate-inactive comparison extend only to 2004, because the female active subpopulation responding to this income question became too small afterwards.

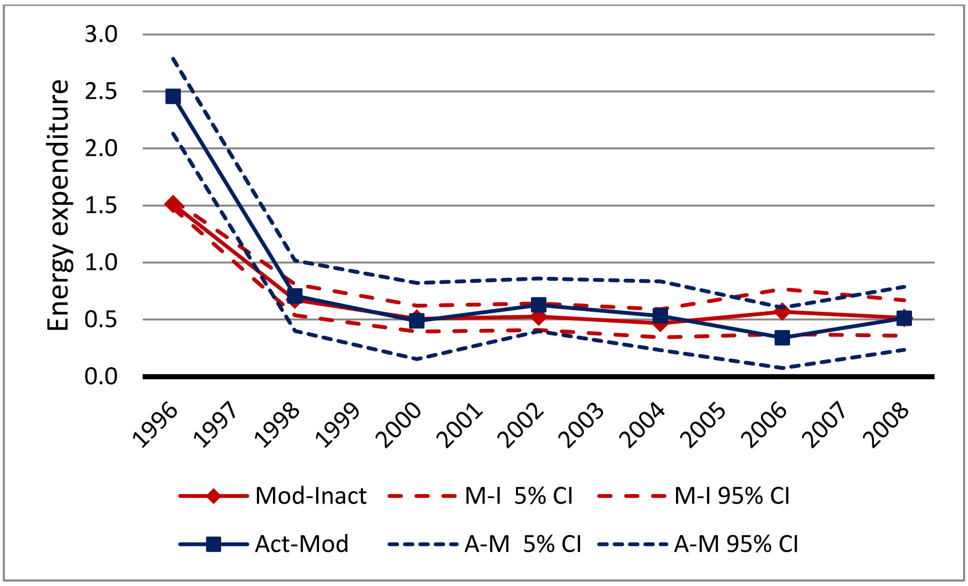
Appendix D.6: Heterogeneity with respect to activity states in 1994

Table D.9: Effects on energy expenditure for individuals active in 1994



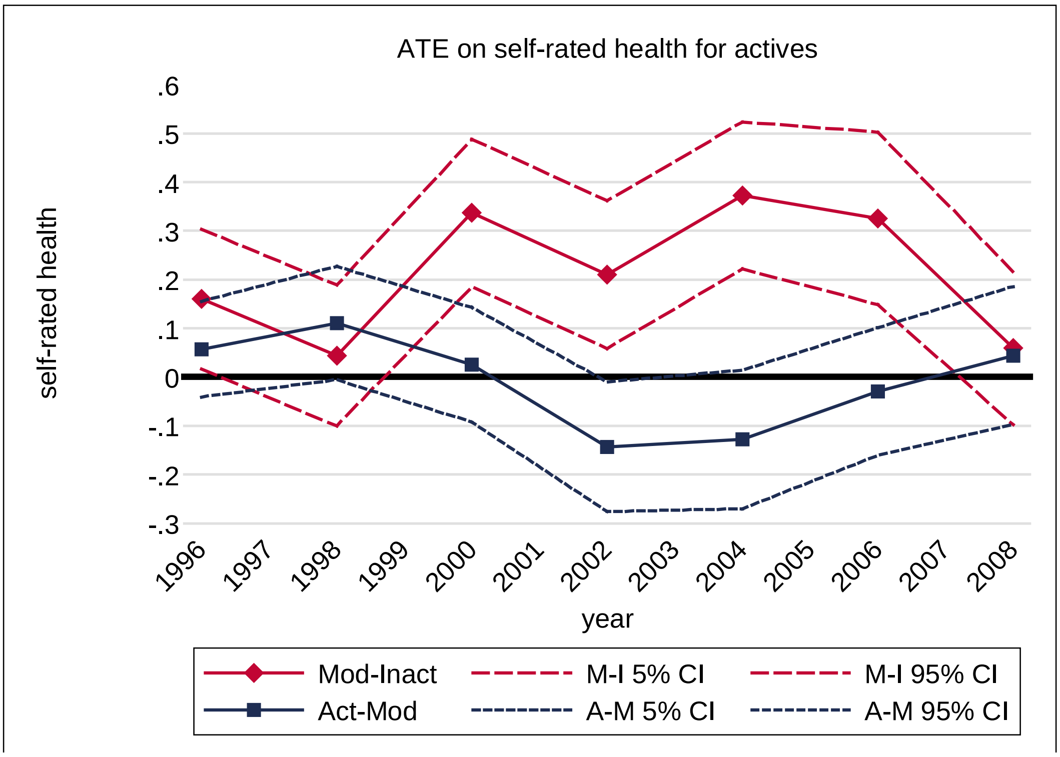
Note: ATE based on subsample of active individuals in 1994.

Table D.10: Effects on energy expenditure for individuals inactive in 1994



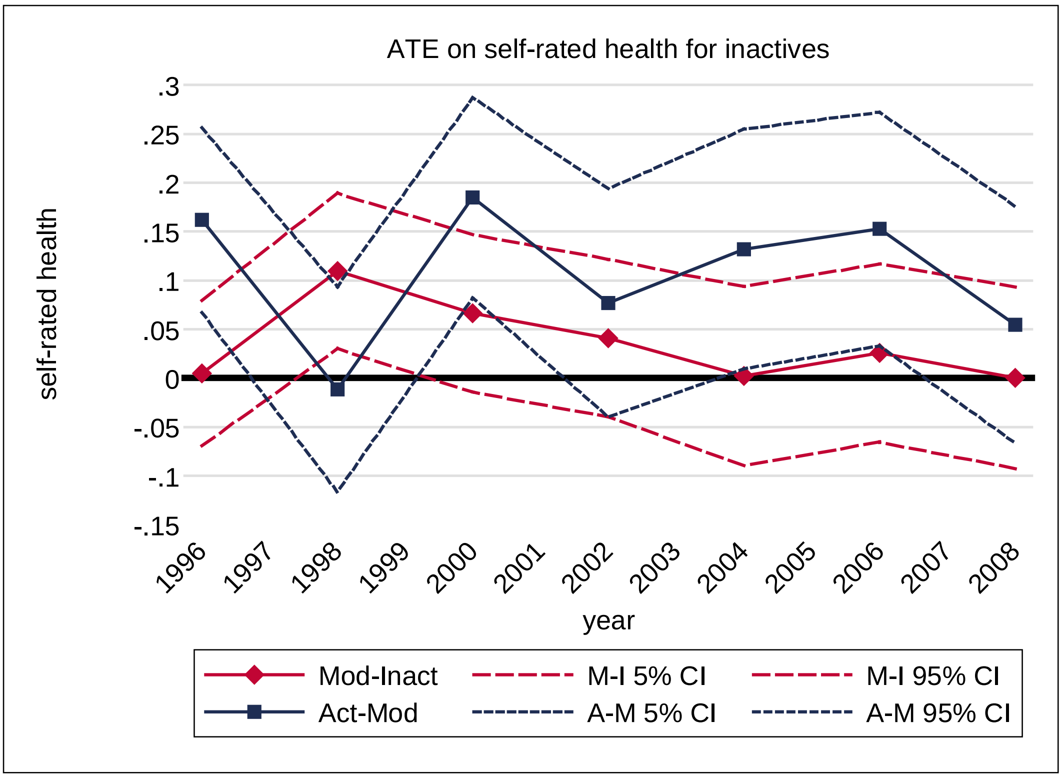
Note: ATE based on subsample of inactive individuals in 1994.

Figure D.11: Effects on subjective health for individuals active in 1994



Note: ATE based on subsample of active individuals in 1994.

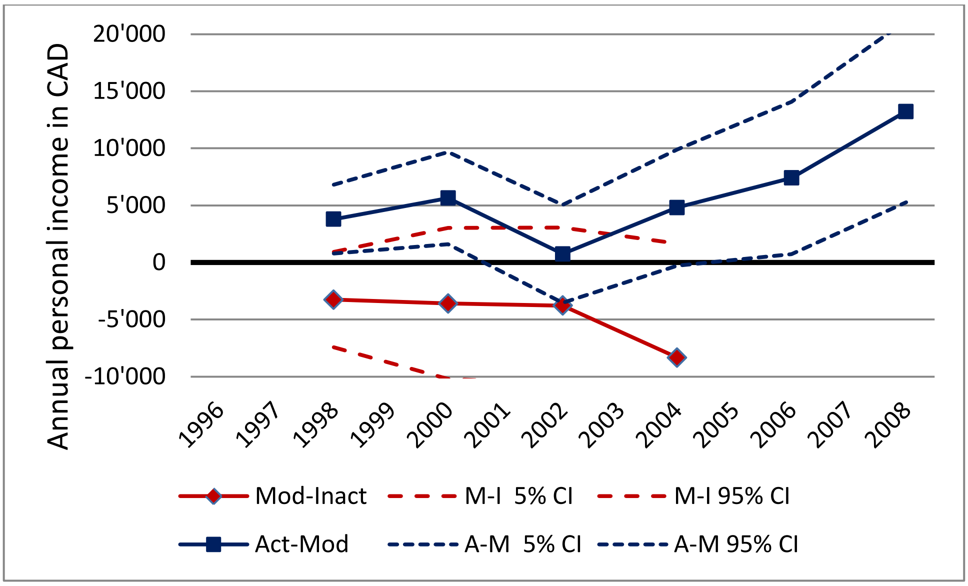
Figure D.12: Effects on subjective health for individuals inactive in 1994



Note: ATE based on subsample of inactive individuals in 1994.

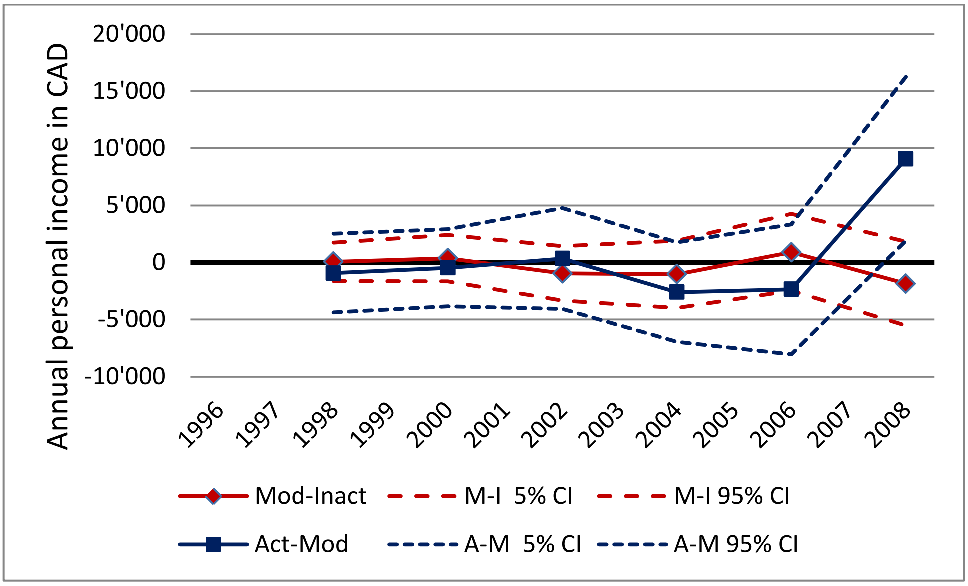
Considering the effects for the different subsamples (Figures D.13, D.14, 5.3) confirms the view that it is difficult to detect any effect from becoming moderately active, but that there is a large gain from changing from being moderately active to being active. However, comparing the effects over the three activity states in 1994 does not reveal much heterogeneity (taking into account sampling uncertainty).

Figure D.13: Effects on annual personal income for individuals active in 1994



Note: ATE based on subsample of active individuals in 1994.

Figure D.14: Effects on annual personal income for individuals inactive in 1994

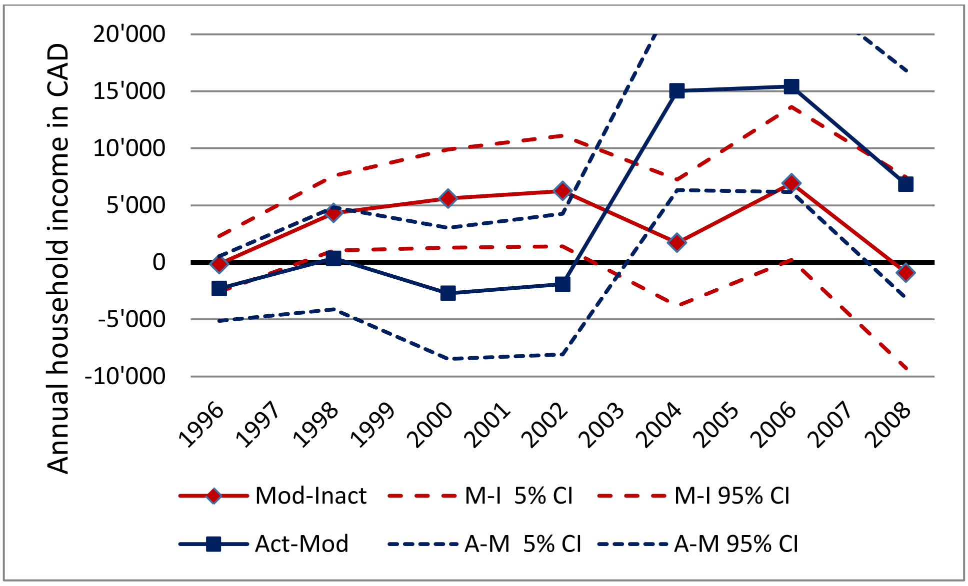


Note: ATE based on subsample of inactive individuals in 1994.

Appendix D.7: Annual household income

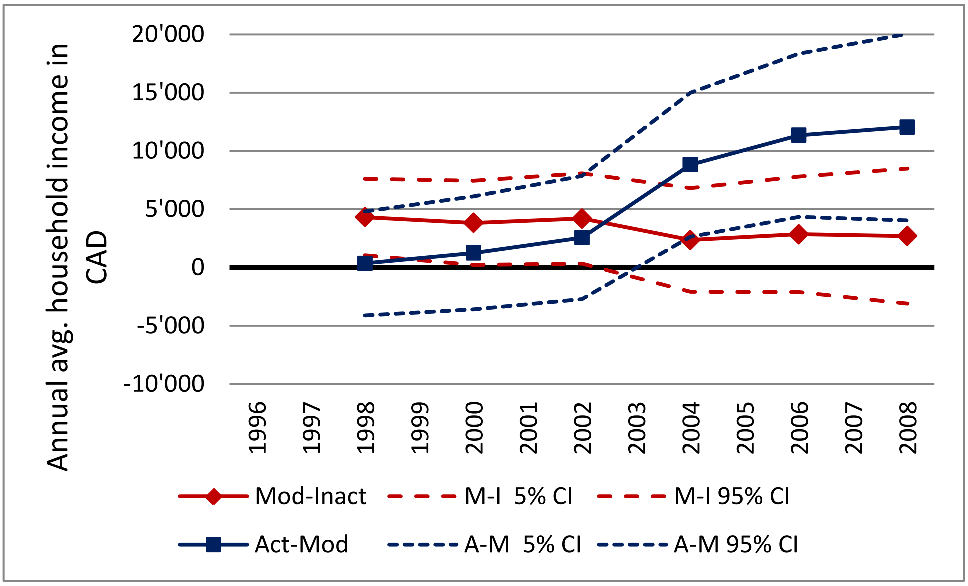
This section presents ATEs for the subsample of moderately active in 1996 using a broader income concept, namely annual household income. We provide the ATEs for annual household income and average annual household income computed over the years from 1996 to the corresponding year. Although the results below are somewhat larger than for annual personal income, the qualitative conclusions remain the same.

Figure D.15: Annual household income



Note: Average treatment effects for individuals who were moderately active in 1994.

Figure D.16: Annual average household income

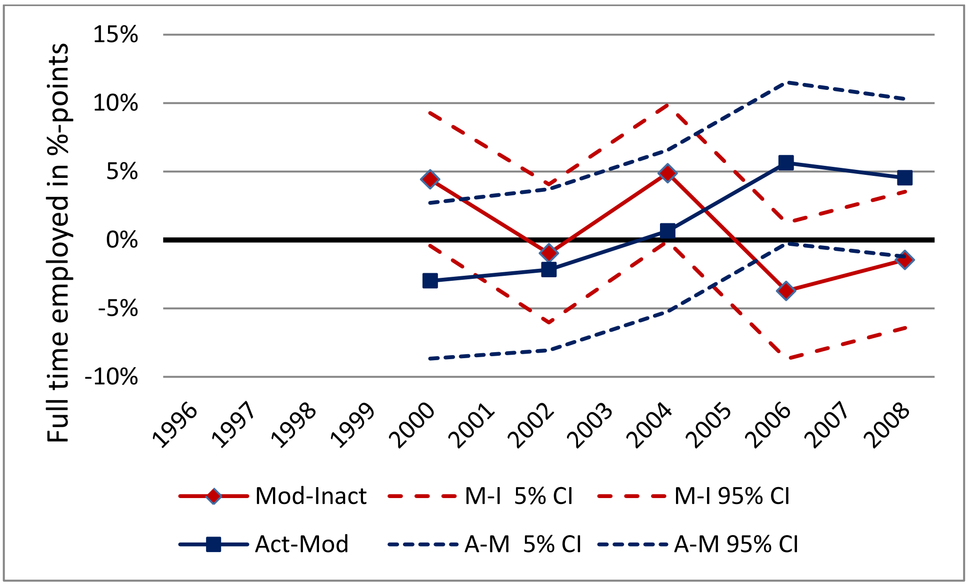


Note: Numbers shown in year x are the average effects for the outcomes over the years from1996 to year x. Average treatment effects for individuals who were moderately active in 1994.

Appendix D.8: Full time employment

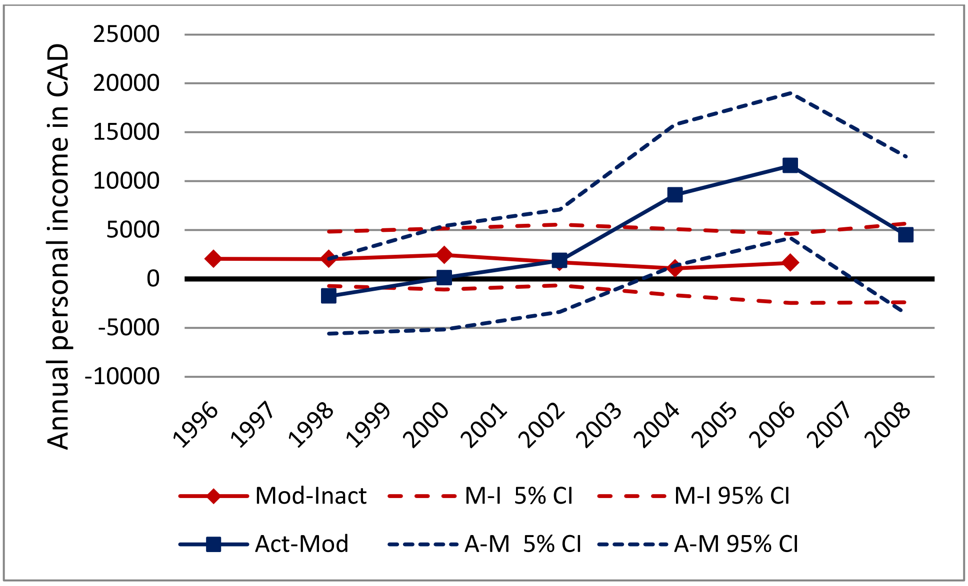
This section presents ATEs for the subsample of moderately active in 1994 for full time employment (defined as annual hours / 52 larger than 35; Figure D.17). The information on annual working hours is not available before 2000. For 2000 and later, the patterns roughly coincide with those observed for employment, which are discussed in the main body of text.

Figure D.17: Full time employment



Note: Full time employment is defined as working more than 35 hours. Information on annual hours is available from 2000 onwards. Average treatment effects for individuals who were moderately active in 1994.

Figure D.18: Annual personal income in 2002 CAD



Note: Deflated using the GDP price deflator with base year 2002. Average treatment effects for individuals who were moderately active in 1994