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Physical activity of adults: A survey of correlates, determinants, and effects[1]

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Abstract

We survey the literature on the link of labour market related outcomes to individual physical activity and sports participation. The first part of the survey is devoted to the individual participation decision based and is based on papers from various disciplines. The second part summarizes parts of the epidemiological literature on health effects and the economic literature on the labour market effects as well as on the effects on well-being and social capital. Somewhat surprisingly, at least for studies in empirical economics, all the papers seem to agree that individual leisure sports participation and physical activity has positive effects for adults.

Keywords

Physical activity, leisure time physical activity, sports participation, labour market effects, unemployment, earnings.

JEL Classification

I12, I18, J20, J30, J68, L83.

1 Introduction

Improving the productivity of the labour force is an important policy goal of modern states. It helps to improve the position of the economy in the international competition and increases welfare and usually reduces unemployment. Many of such policies, like schooling and vocational training for younger individuals, and active labour market policies for the unemployed have been more or less thoroughly investigated by empirical economist, sometimes with rather mixed results. An aspect that has been somewhat overlooked by economists are the productivity enhancing features that are attributed to individual sports activities, as well as to individual physical activities in general. Such activities are likely to foster non-cognitive skills (as well as some cognitive ones), like self-discipline, better coping with stress, the ability to work in teams etc. Moreover, the individual's productivity also depends on his/her health status which is directly affected by the level of physical activity.

Therefore, in this survey we try to take stock of the relevant literature in economics, but also in epidemiology, sports sciences, and other social sciences.[1] The aim is to understand which individuals participate in sports and physical activities for what reasons, as well as to understand what is known about the effects of such participation. Concerning the latter, we consider those effects that can be related to productivity, namely health and well-being, social capital, and in particular labour market outcomes.

Since the literature on this topic is huge and increasing, in particular in epidemiology, we have to restrict ourselves to specific groups of individuals and specific types of individual activities. Concerning groups of individuals, we focus on adults in working age for whom

[1] Since the fields and journals where sports related papers appear are huge, we certainly have overlooked important contributions and may have misrepresenting other work (in particular, but not only, outside of economics). To all authors who rightly have reasons to complain we apologize in advance.

labour market performance can be directly measured. This does not at all mean that physical activities for children are less relevant for their later labour market productivity.[2]

Concerning physical activity, we do not restrict ourselves to individual sports participation, but include also papers that use the broader concepts of physical activity. However, those papers usually consider such activities conducted in the leisure time (leisure time physical activity, LTPA), because data on the level of physical activity on the job are very rare.

Since physical activities are considered a key determinant of individual health, various public bodies issued recommendations for minimum levels of such activities. With some institution specific variation, they recommend 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, 2011; U.S. Department of Health and Human Services, 2010; WHO, 2010), among many other national health organizations. There is also a consensus that, from the point of view of health effects, more physical activity is better. This recommended minimum level of physical activity corresponds to a daily energy expenditure of at least 1.5 kilocalories per kilogram of body weight (unit: kcal/kg, so-called MET) from all LTPAs.[3] For example, in Switzerland, which is a country with rather high activity levels, still more than a third of the adult population does not achieve this level (Hepa, 2013), which is an indication of the considerable possibilities to further increase population activity levels.

[2] The literature reviews for these groups will be referred to some other place.

[3] Individuals may meet this goal 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).

The paper proceeds with a section reviewing the factors that are associated with LTPA participation as well as considering theoretical explanations for participating. Then, the literature on the effects of LTPA on health, well-being, labour market outcomes, and social capital is discussed. Finally, we identify avenues for potential future research.

2 Determinants and correlates of participation in sports and physical activity

Bauman et al. (2002) underline the importance of distinguishing between determinants and correlates of the physical activity ('PA' henceforth). Indeed, although most of the empirical papers on physical activity agree on the list of characteristics associated with physically active individuals or with sports-friendly environments, few of these papers are able to identify a causal relationship between these characteristics and physical activity. While correlates of physical activity are interesting and worth investigating, to get a better understanding of the underlying causal mechanisms it is necessary to attempt to identify the 'determinants' of physical activity. Such understanding, for example, helps to develop policy recommendations. Below, we strive to differentiate between papers that are successful in identifying factors that are likely to causally influence participation in physical activity and papers that merely highlight correlates. In doing so, in the next subsection we first review simple stylized theoretical models that explain individual involvement in physical activity and empirical studies that test these models. In Section 2.2, we present the studies that mainly propose and analyse diverse potential correlates of physical activity without systematically relying on economic theory.

2.1 Why do individuals participate in physical activities?

Downward (2007) outlines two types of competing economic theories to explain sports participation: the 'neoclassical' theory and a set of alternative theories, which he labels as 'heterodox'. The neoclassical theory refers to the allocation of time framework (Becker 1965)

where individuals choose leisure time and consumption in order to maximize their utility. In this type of model, the main drivers of physical activity are hours of work and income. The 'heterodox' or behavioural theories draw from other sciences such as sociology and psychology. They weaken the assumption of full rationality by assuming bounded rationality instead. Individuals are subject to many non-financial influences (e.g. social pressure, learning-by-doing or spill-over effects) which modify their preferences throughout life. Therefore, sports participation is primarily determined by social relations while financial constraints, as emphasized by the neoclassical framework, are second order. However, the great majority of the sports economics literature uses nevertheless the neoclassical framework (e.g. Colman and Dave, 2013a, Humphreys and Ruseski 2007 and 2011).

The particular reason why individuals engage in physical activity is an important difference between different neoclassical models. Indeed, in these models there are two main reasons to engage in physical activities: taste for sports and desire to maintain health. In the first case physical activity is modelled as a consumption good, e.g. physical activity directly increases the level of utility without further lasting impact. In the second case, it is modelled as an intermediary (investment) good that is used to improve current and future health (Grossman, 1972). In this case, the link between physical activity and utility is indirect because individuals derive utility from health and not from physical activity directly. Of course, both characteristics of sports can be modelled simultaneously. Of course, treating all important aspects of physical activity as investment good requires a dynamic model. However, the dynamic sports participation literature is not yet well developed. Therefore, we present (only) a static framework with physical activity as consumption good, and alternatively as intermediary good. It will be seen that even such simplified model reveal the major trade-offs.

In particular, we review the seminal SLOTH model by Cawley (2004) extensively and show how the other models deviate from it.[4]

2.1.1 The SLOTH model

In Cawley (2004) **S**leep-**L**eisure-**O**ccupation-**T**ransport-**H**omeproduction model individuals' utility depends on time allocation (which gives the model its name), health, body weight, and consumption. In this model physical activity is defined as time dedicated to leisure (recreational sport) and time dedicated to commuting (active transportation such as biking and walking). The time spent on physical activities affects the level of utility directly and indirectly via its impact on health and body weight. In other words, physical activity is modelled as consumption as well as intermediary (investment) good.

Formally, the SLOTH model assumes the following utility function:

$$U = U\,(S, L, O, T, HP, F, H, W, Y).$$

The arguments of the utility function (direct effects[5] in brackets) are health (*H*, positive), weight (*W*, first positive, then negative), food intake (*F*, positive), and the composite good (*Y*, which excludes food, positive). Furthermore, (dis-)utility is derived from the following activities: sleep (*S*, positive), leisure activities (*L*, positive), paid occupation (*O*, negative), transport (*T*, negative) and home production (*HP*, negative). As already mentioned above, time spent on physical activity is included in leisure activities (*L*) and transport (*T*).

Health (*H*) depends also on the allocation of the time (physical activity increases health for example) and weight (obesity is detrimental). Therefore, the health production function can be written as follows:

[4] We choose the SLOTH model as a departure point because the great majority of the literature builds on this model.

[5] Indirect effects via other variables in the utility function or the budget constraint are ignored in these brackets. However, when solving the model, these effects are of course of key importance.

$$H = H\,(S, L, O, T, HP, W)$$

A variation in the weight depends on the difference between calorie intake and calorie expenditure. Calorie intake ($c(F)$) is determined by the individual amount of food consumption (F). The calorie expenditure is a function of the individual's genetic heritage (G) and of her/his allocation of time. The calories expenditure is divided in two parts: a variable part and a fixed part. The fixed part corresponds to the energy required by the body's basic function ($\delta(G)\ W$). The function $\delta\,(G)$ represents the metabolic rate. The variable part of the calorie expenditure is defined by the individual's genetic heritage and by her/his allocation of time ($f\,(S, L, O, T, HP, G)$). Changes in weight are modelled with the following function:

$$\Delta W = c\,(F) - f\,(S, L, O, T, HP, G) - \delta\,(G)\ W.$$

An interesting feature of this model is that health depends directly and indirectly on physical activity. Therefore, there are five channels that link physical activity to utility: the consumption of physical activity, the increase in health due to physical activity, the decrease in weight due to physical activity, the increase in health due to a decrease in weight, as well as an effect that comes by increased (or reduced) transportation time.

The individual is constrained in terms of time, financial resources and faced fixed biological conditions. The time spent on all activities adds up to 24 hours. The amount of money available to buy goods depends on the hourly wage (w) and the time spent working (O). The price of the composite good (Y) is normalized to one and the price of the food (F) is denoted by (p_F). And as seen above, the biological factors partly determine the weight and thus the health status. In sum, the constraint maximization problem can be written as follows:

$$\text{Max } U\,(S, L, O, T, HP, F, H, W, Y),$$

$$\text{with } H = H\,(S, L, O, T, HP, W) \text{ and } W = W\,(S, L, O, T, PH, F),$$

subject to three conditions:

i. $Y + F\, p_F = w * O$,

ii. $S + L + O + T + HP = 24$,

iii. $\Delta W = c\,(F) - f\,(S, L, O, T, HP, G) - \delta\,(G)\,W$

Cawley (2004) provides no closed form solution of the above optimization program, which can be quite complex because of all the indirect linkages. Indeed, the full SLOTH model serves often as a theoretical starting point. To test concrete model predictions, researchers therefore focus on one particular motivation for physical activity engagement and derive specific predictions. We follow this approach by simplifying the SLOTH model and presenting the corresponding first order conditions. It seems reasonable to assume that the mechanisms derived from the simpler models will be at play in the more complex SLOTH model as well. Of course, it may ignore cross-effects, which may or may not be considered important in the particular case analysed.

2.1.2 Physical activity as a consumption good

One strand of the literature considers physical activity as consumption good only. Hence, individuals derive utility from physical activities directly, rather than indirectly through an intermediate factor. Hence, we use the SLOTH model as a point of departure model, but ignore the role of physical activity as an intermediary good in health and weight production. Without loss of generality, we assume that composite good, *Y*, also subsumes food, *F*. Weight and health are considered as exogenous. Therefore, health and weight production are assumed not to be influenced by physical activity. These simplifications lead to the following model:

Max $U = U\,(S, L, O, T, HP, H, W, Y)$ under the constraints:

i. $Y = w * O$,

ii. $S + L + O + T + HP = 24$

This setting corresponds to a leisure consumption model. The demand of leisure time physical activity (*LTPA*) is included one-to-one in the demand for leisure time (*L*). We derive the first order condition (FOC) and find that the demand for leisure time physical activities (*LTPA*) depends on the opportunity cost of time at work *w*, i.e. the earnings per unit of time.

FOC: $U_{LTPA} / U_Y = w$

with *LTPA = L - time dedicated to other leisure activities.*

García et al. (2011) use this type of model in order to explain participation in physical activity in Spain. In line with the above analysis, they predict that the opportunity cost of time determines the participation in physical activities. As expected, the demand for physical activity is negatively correlated to the hourly earnings. Furthermore, the relation between age and physical activity forms a U-shaped curve with a minimum at 33 years old. According to the authors, the age effect can be attributed to the fact that the opportunity cost of time varies with age (this suggest that either older people have lower opportunity cost of time or that the effects of physical activity increase with age, for example). Of course, their claim is not compatible with increasing wage-experience profiles which are frequently observed.

Humphreys and Ruseski (2011) propose a model that combines elements of the SLOTH and the so-called recreation demand model (McConnell, 1992). The main idea of the recreation demand model is to take into account the impact of travel costs on the demand for leisure. Humphreys and Ruseski (2011)'s key assumption is that engaging in physical activity has a fixed cost as well as a variable monetary cost. The fixed cost depends on the decision to engage in physical activity (extensive margin). The variable cost depends on the duration of the participation (intensive margin). The intensity of the physical activity refers to the duration of the physical activity. For example, the fixed cost comprises the yearly membership fee of a fitness club while the variable costs include expenditures for running shoes (the number of pairs needed depends on the frequency). This aspect of Humphreys and Ruseski's (2011) model is very much in the spirit of many labour supply models (see Heckman, 1993, for ex-

ample) where individuals decide first on the entry into the labour force (extensive margin) and then they choose their working hours (intensive margin). An interesting feature of their model is that they treat individuals' wages as endogenous and instrument incomes with the unemployment rate. The idea behind this strategy is that physical activity can influence incomes via health (and not potentially other channels discussed in section 3). Although allowing for a more realistic setting, it is not clear that the instrument used is valid because the unemployment rate might have a direct effect on incomes as well. Humphreys and Ruseski (2011) use the Behavioural Risk Factor Surveillance System (BRFSS) data to estimate their model and find results in line with their theoretical predictions: income has a positive and significant effect on the extensive margin but a negative and significant effect on the intensive margin.

Downward et al. (2009) suggest the use of the New Household Economics model (Becker 1974). In this model, the focus is on the interaction between the household members and their joint consumption and production. Indeed, the individual maximizes her/his utility within the household by deciding on the amount of consumption and production of goods which maximize the household utility under the household constraints (in terms of time and money). Therefore, intra-household optimization influences the choice to engage in physical activity. Moreover, the past consumption of physical activity and the consumption of the other members of the household of physical activity are relevant. If another member of the household used to go running, for example, then the costs to engage in running may be lower for the other members of the household than the costs to engage in a different physical activity. Costs relevant in this respect may be transportation costs, learning costs and informational costs, among others. Also, the utility of sharing the same activity for both members might be greater than the sum of the utility of each member doing a different activity (peer effect).

2.1.3 Physical activity as an intermediary good for health production

There is ample evidence that physical activities impact health (see Section 3.2). Hence, it appears natural to model the impact of physical activity on overall utility by letting it influence health (only). In line with the SLOTH model, Meltzer and Jena (2010) consider physical activity as an intermediary good in health production. However, they also take into account the different intensity levels in physical activity and its impact on health production. In particular, utility is assumed to depend on health (*H*), the consumption of a composite good (*Y*), and the intensity of the physical activity (*I*). The health production function depends on the intensity of the physical activity (*I*) and the number of hours spent in physical activity per day (*PA*). It is worth noting that the intensity relates to the amount of energy or effort required to engage in physical activity during a specific time unit. This differs from Humphreys and Ruseski's (2011) framework. Using the above notation, the optimization programme in the spirit of Metzler and Jena (2010) can be written as follows:

$$\text{Max } U = U(H, I, Y),$$

$$\text{with } H = H(PA, I),$$

subject to the following constraints:

i. $Y = w * O,$

ii. $O + PA = 24.$

The key difference with respect to the previous section is that health depends now on the physical activities while the SLOTH activities itself enter the utility function only indirectly via their effect on health.[6] Meltzer and Jena (2010) derive the following relationship (written here using the above notation):

[6] According to the SLOTH model individuals are physically active either during leisure time (*L*) or transport time (*T*). We use the simplification suggested by Metzler and Jena (2010) which implies that health only depends on physical activities. Therefore, we consider that time is allocated either to work or to physical activities.

FOC: $H_{PA} / H_I = w * U_Y / (- U_I)$

with H_{PA} the marginal health benefit of the time spent in physical activity and H_I the marginal health benefit of increasing exercise intensity. Hence, this framework highlights the role of physical activities in increasing health. *w* represents the cost of increasing the time engaged in physical activity which is equivalent to the opportunity cost of time. Finally, the ratio $U_Y / (- U_I)$ represents the cost of increasing intensity of the physical activity.

Meltzer and Jena (2010) emphasize the fact that a wage increase has opposing income and substitution effects. Assume that health and distaste for intense exercise are normal goods. Then, for a constant level of health, a higher wage increases the intensity of exercise. The authors use the National Health and Nutrition Survey (NHANES) to test their model predictions empirically. Their analysis suggests that higher opportunity costs of time are indeed correlated with higher intensity of exercise.

2.1.4 Physical activity in a dynamic model

This section presents a selective number of papers with study the intertemporal demand for physical activity theoretically. Unfortunately, these models are rather complex and hard to unify in a single simple framework. Hence, we review the dynamic models verbally and refer the interested reader to the respective papers for the technical details.

The most well-known dynamic framework considers physical activity as an investment in health and builds on the seminal work by Grossman (1972). Song (2011) and Moreland (2014) use this approach to explain individuals' lack of engagement in physical activity. Both authors assume that individual's time preferences are very important to explain the decision to engage in as well as the time dedicated to physical activities. Song (2011) uses the American time diary survey (ATUS) to test the hypothesis according to which smokers are less likely to invest in human capital and health. The underlying idea is that smokers have a higher preference for the present. He finds a negative correlation between smoking and

spending time on education and sport. Moreland (2014) develops a dynamic model linking physical activity and time preference. He assumes that individuals do physical activities only in order to increase their lifetime. Moreland then analyses different discount rates and shows that being physically inactive can be a rational choice for individuals with particular inter-temporal preferences for example characterised by high discount rates.

Another type of model considers physical activities as a way to signal abilities. Barron et al. (2000) show how physical activities during college or high school time can be used as a signal on the job market. Unlike Moreland (2014) and Song (2011), physical activity is assumed to be enjoyable and unrelated to health. Barron et al. (2000) develop a two period model. In the first period, the college (or high school) student allocates her/his time between leisure, physical activity, and education. These decisions determine her/his potential earnings and opportunities to study in the second period. The model predicts that the effect of physical activity on labour market earnings depends on individual's preference for the present and the ability level. In their model, firms pay a wage premium to good students that are physically active. This combination of observable characteristics –physical activity and educational attainment- serves as a signal of high ability (or lower preference for the present), i.e. individuals received high grades without spending all time on learning activities. In other words, physically active and successful students signal themselves as "good workers". Barron et al. (2000) test these predictions with the National Longitudinal Survey of Youth 1979 (NLSY1979) and the National Longitudinal Study of the high school class of 1972 (NLS-1972). They find that athletic participation in high school lead to a wage increase of 4% to 15% 10 years later.

2.1.5 Heterodox theories

As is well known, the typical neoclassical models presented in the last sections have several caveats. The aim of neoclassical theories is to build models that predict the demand of

physical activity. By contrast, heterodox frameworks are restricted to the description and explanation of the demand. The neoclassical predictions are made under a set of assumptions which imply, among others, stable preferences and rationality. Both assumptions are rather strong and might not realistically describe the individuals' decision making. The heterodox theories address these concerns by incorporating preferences that evolve over time according to consumption skills and social interactions, for example. Furthermore, a strand of research argues that individuals are not strict utility maximisers but also chose heuristically. Heterodox authors may distinguish between wants and needs and may assume that individuals are able to establish a hierarchy in their needs. In other words, bounded rationality implies that individuals choose within subsets that are ranked according to their needs (rather than choosing among all goods).

Hence, the heterodox framework allows understanding facts and believes about physical activities that are not in line with the neoclassical model predictions (as underlined by Downward, 2007). These frameworks help to shed light on various aspects previously neglected. For example, sport as a way to socialize and integrate or the effect of peers and the social environment on sports behaviours and habits. The following articles investigate similar questions with respect to the demand of physical activity using a heterodox framework.

Downward (2007) tests versions of both the neoclassical theory and the heterodox theory empirically. Using English data (General Household Survey of UK households), he estimates the probability of being engaged in physical activities. His results are in favour of the heterodox economic theory. Indeed, he finds a very small impact of income while characteristics such as participation in other leisure activities and volunteering are highly and significantly correlated with participation in physical activities.[7] He concludes that, rather than facing an income-leisure trade-off, individuals rank their needs and participate in physical activi-

[7] Education is also positively and significantly correlated with participation in physical activity.

ties once higher needs are satisfied. In order to incorporate these heterodox findings, the author's subsequent articles include variables that reflect the social environment of the individual. According to Downward et al. (2011), individuals engage in sports or physical activity in order to socialize and to "live life to the full". In this case physical activity appears to be a consumption good which involves social interactions and impacts others' satisfaction/ utility.

Downward and Riordan (2007) use cluster analysis on the General Household Survey (GHS) in order to estimate a model of social interaction. Cluster analysis is somewhat similar to matching: individuals are allocated to the cluster which fit them the best (in terms of individuals' characteristics). The number of clusters is identified from the data. It is however possible that some individuals are not allocated to any cluster (because of being too different). Downward and Riordan (2007) identify three clusters: sport, recreation and leisure. The clusters contain 2.9%, 20.7% and 76.4% of the overall sample allocated to clusters. In the next step, the authors estimate the probability to be engaged in a specific sport given the specific cluster and given the individual's characteristics. They find similar results as Downward (2007): participating in a set of activities is positively correlated to being engaged in physical activities while income as a marginal effect. These results support the heterodox theories, although the identification strategies may be subject to scrutiny.

Stempel (2005) uses U.S. data to test Bourdieu's theory applied to sports. The main idea is that members of the dominant class (in terms of cultural and economic capital) use sports as a way to distinguish themselves from the others classes. In other words, individuals choose their type of physical activity (sport) according to the class they belong to. The author estimates the probability that individual *i* does a specific type of sport given that she/he belongs to a specific class. In a second step, he uses these estimations to define which type of sport is considered as increasing the cultural capital (from the dominant class's point of view). The author argues that the dominant class engages more in strenuous aerobic activities (fitness

sport). Also, Stempel (2005) underlines the fact that the dominant class is omnivore, i.e. individuals from this class are more likely to participate in all the sports than individuals from the middle or from the lower class.[8] Last, fitness sports are relatively more favoured by the culturally dominant class while the economically dominant class invests relatively more in competitive sports.

The decision to engage in physical activity is complex. The neoclassical models propose two motivations: the taste for physical activity and the will to maintain or increase health.[9] The main cost is the opportunity cost of time. The heterodox theories underline the importance of the social environment and non-rational decision making. It turns out that that income has merely a threshold effect. The influence of education, health and demographic characteristics (e.g. age or gender) are acknowledged and studied by both theories. Both frameworks are backed by empirical support. Therefore, it seems reasonable to take into account motives for physical activity that come from the neoclassical as well as heterodox reasoning.

2.2 Who participates?

A substantial number of papers study the differences between physically active people and physically inactive ones. Several papers (e.g. Downward et al. 2011, Garcia et al. 2011) suggest disentangling the two decisions related to participation in physical activity: whether to engage in physical activity at all and for how long (and in which intensity). We distinguish different types of correlates: individual characteristics, weather conditions, neighbourhood characteristics, as well as the influence of peers, habits and commitments and the role of incentives.

[8] Stempel (2005) tests a total of 15 different sports.

[9] Given the empirical results in Section 3.3 and 3.4 below, it is somewhat surprising that these models do not address the feature that sports may also directly improve skills and thus earnings capacity.

2.2.1 Individual characteristics

The literature on the *determinants* of physical activity broadly agrees on the same set of relevant correlates with some rare variations concerning the sign of the correlations: Women are less likely to engage in physical activity than men are, and the type of sports is gender specific (e.g. Breuer and Wicker, 2008, Downward, 2007, Lechner and Downward, 2013). Studies tend to agree on the fact that age has a non-linear effect on physical activity but there is no consensus on the exact form of the relationship. Part of the literature considers participation to increase with lower age i.e. to decrease after youth (e.g. Downward et al., 2011, Eberth and Smith, 2010, Garcìa et al., 2011, Humphreys and Ruseski, 2015). The same and other studies find an increase of physical activities with older ages (e.g. Garcìa et al., 2011, Stamatakis and Chaudhury, 2008). Garcìa et al. (2011) define the demand for physical activities as U-shaped with a minimum at 33 years of age. These results are in line with one of the predictions of the neoclassical models: demand for leisure time physical activities depends on the opportunity cost of time which varies with the employment status and thus with age. However, age is also closely related to health. Older individuals are likely to be less physically active due to relatively worse health conditions than younger individuals. Kokolakakis et al. (2012) find a negative relationship between age and physical activities. They find regional differences: the differences in the physical activity rates that are due to age are much larger among English people than among Spanish people. Wicker et al. (2009) highly recommend to study the physical activity by age band rather than globally in order to properly capture the age-specific physical activity behavioural patterns. For example, older people are more likely to walk while young adults prefer to go to fitness centres. Being married is negatively correlated to engage in physical activity (e.g. Eberth and Smith, 2010; Garcìa, Lera-López, and Suárez, 2011, Rapp and Schneider, 2013). And, women living in a household with young children are less likely to participate in physical activity (e.g. Eberth and Smith, 2010; Garcìa, Lera-López, and Suárez, 2011). Downward et al. (2011) find that

parents' participation to physical activity might affect the individual's own participation to physical activity.

The socio-economic background also plays an important role: higher incomes or earnings and higher level of education increase the probability to engage in sport (e.g. Downward and Rasciute, 2010; Fridberg, 2010; Hovemann and Wicker, 2009; Humphreys and Ruseski, 2015; Lechner, 2009; Meltzer and Jena 2010). However, higher incomes are associated with a decrease in the amount of time spent doing sport and an increase in the intensity (or the frequency) of the sport (e.g. Downward et al. 2011, Meltzer and Jena, 2010, Taks et al., 1994). Also related to the argument about opportunity costs of time, Colman and Dave (2013a) argue that a decrease in employment leads to an increase in exercise (as a leisure time physical activity) but to a decrease in physical exertion (PA done while working) which sum up to a decrease in total physical activity. In western countries, belonging to specific ethnic minorities may be associated with less sports participation (e.g. Lechner, 2009) as well. An explanation for this finding can be found in the heterodox theories in which the social environment has an important influence on the physical activity.

Finally, individuals' health is also related to their sports participation as poor health reduces participation to physical activities (e.g. Bauman, Sallis, Dzewaltowski, and Owen 2002). Participation in physical activity is negatively associated with smoking but positively associated with drinking (Downward, 2007).

2.2.2 Weather conditions (and daylight)

Weather conditions can prevent individuals to engage in physical activity by decreasing (increasing) the utility derived of being physically active. Witham et al. (2014) investigate the impact of day light and weather conditions on the physical activity of older people in Scotland (PA measured using accelerometers). They find a small positive relationship between day length and daily physical activity (1 hour more of day light leads to 1.5% more physical ac-

tivity) as well as between an increase in the minimum temperature and daily physical activity (1 additional degree Celsius translates into 0.9% additional physical activity). However, the authors do not have information on where the physical activity takes place (indoor or outdoor) and the results are, of course, specific to the particular population. Eisenberg and Okeke (2009) analyse the impact of unexpected changes in weather conditions on LTPA in 48 American states between 1993 and 2000. They find that a decrease in low range temperatures (<15.5°C) is related to a decrease in LTPA (a drop of 3°C is associated with a drop of the level of physical activity of 0.6%). They emphasise the fact that individuals with different socio-economic status (SES) have different levels of elasticity towards LTPA. Indeed, individuals with lower SES appear to be more sensitive to changes in temperatures, which can be explained by the fact that they are less able to substitute outdoor with indoor LTPA. The authors venture some further explanations according to which transport costs, schedule constraints, and preferences are different among SES. This is very relevant in terms of policy implications because it emphasises the importance of population targeted interventions.

2.2.3 Neighbourhood characteristics

Another set of characteristics, which are often presented as potential determinants of physical activity, are the ones associated with the environment where individuals live. Indeed, a substantial number of studies analyse the relationship between the presence of green spaces and sports infrastructures on individuals' physical activity. Many of them differentiate between the perceived environment (i.e. individual's perception of the environment) and more objective (external) measures of the environmental characteristics. Perceived or factual, the environment is likely to have an impact on either the monetary costs of being physically active or on the level of utility derived from being active.

Duncan et al. (2005) and Kaczynski and Henderson (2008) survey papers using the perceived environment and conclude that it is related to physical activity but only to a small ex-

tend. 40% of the papers surveyed in Kaczynski and Henderson (2008) report a statistically significant association "that is entirely or primarily positive" and according to Duncan et al. (2005) perceived environment explains 4 to 7% of the variation in physical activity. Using the Neighbourhood Environment Walkability Survey (NEWS) measured near San Diego, Saelens et al. (2003) argue that high-walkability environments positively affect individuals' physical activity (measured using an accelerometer). Huston et al. (2003) note that if some specific neighbourhood characteristics (e.g. presence of trails) are associated with higher levels of physical activity, the perceived environment and access to places for physical activity are highly correlated with race, education, and income (study based on North Carolina data): People reporting less favourable environments and less access are more likely to be Blacks or American Indians with lower income and education.

Several studies use measures of environmental characteristics either collected by the research team itself (Wicker et al., 2009, Wicker et al., 2013, Kaczynski et al., 2008, Kumagai, 2013) or from administrative data (Humphreys and Ruseski, 2007, Richardson et al., 2013). Kumagai (2013) and Richardson et al. (2013) associate the presence of green spaces or public sports infrastructures with a higher level of health (which is not entirely mediated by physical activity according to Richardson et al., 2013). They use the Japanese General Social Survey and the New Zealand Health Survey respectively. In their study about Ontario (Canada), Kaczynski et al. (2008) argue that the distance to parks and the size of parks are not related to an increase in physical activity, contrary to the presence of a trail or facilities (rather than amenities). Humphreys and Ruseski (2007) highlight a positive relationship between governmental spending on parks and *outdoor* physical activity (Behavioural Risk Factor Surveillance System, US data), while Wicker et al. (2009 and 2013) insist on the specificity of each age group concerning their use and demand for sports specific infrastructures in Germany (Stuttgart and Munich respectively). Wicker et al. (2009) pinpoint the infrastructures that matter by age: swimming pools and playground areas for the 3-18 years old, diverse sports facilities for the

19-28 years old,[10] fitness centres for the 29-35 years old, none for the 36-44 and 45-64 years old, and forests for the 65+ years old. There is some literature on the impact of the vicinity of sports infrastructures and sports clubs on children sports participation (e.g. Reimers et al., 2014, Steinmayr et al., 2011). However, few studies focus on adult participation. On the one hand, it is problematic to assume that adults choose their place of leaving independently of the infrastructures available in the area. On the other hand, many physical activities such as walking, cycling, and hiking do not require formal facilities which may be available publicly or in sports clubs. Finally, the current insufficient information on sports clubs and sports infrastructures in general in many countries prevents researchers to investigate these questions more extensively.

To sum up, there is a consensus on the fact that parks and sports infrastructures are positively related to physical activity, although this relation appears not to be too relevant. Furthermore, the literature sheds light on two important points: the perception of the environment and the requirements in terms of facilities depend on individuals' SES and on age. In particular, Wicker et al. (2009) underline the relevance of sports facilities for very young adults and the relevance of fitness centres for the 29-35 years old. Saelens and Handy (2008) provide an interesting survey about surveys and studies on that topic. They underline the fact that if the use of objective measures of the environment leads to an improvement, there is still work to do concerning the potential substitution effect between transportation walking (walking for commuting) and other forms or physical activity. They also argue that recent studies are able to associate pedestrian infrastructure with recreational walking but not with walking for commuting.

Another aspect of the neighbourhood, which could also have an impact on the participation to physical activity, is safety. Janke et al. (2013) analyse the impact of violence on

[10] The authors explain that this age group is more likely to participate in regular sport activity that requires a supply of gymnasia, sports fields, public playgrounds and fitness centres.

physical activity in England by using a difference-in-difference framework (DiD) based on pooled cross-sections of 0.9 million individuals observed quarterly over 6 years (22 periods) in 323 local authorities. They argue that self-reported physical activity (for the last 4 weeks) is negatively correlated with the quarterly rate of violent crimes with injury (recorded by the police in the last 4 quarters before the interview). They also use the Riots in August 2011[11] as a natural experiment and still find a deterring effect for women. However, surprisingly, they find the opposite effects for men. According to them, the men's answer to local crime is to "man up" by going out more and exercise more.[12] Caruso (2011) studies the interactions between sports and crime rates in Italy and finds negative correlations between sports participation and the crime rate concerning property and juvenile crime and a positive correlation between sports participation and violent crime.

Finally, there are also features of the individuals' surroundings determined at the aggregate level. Ruseski and Maresova (2014) suggest that government's sports policies and success of the national team could also influence individual's physical activity in a given country. In a study using a cross section of 34 countries, they analyse the impact of the success of the national team at the Olympics (in Athens) and of hosting sports mega-events on individuals' physical activity. According to their results, both are negatively correlated with the participation in physical activity. Their interpretation is that elite sports have ousted mass sports participation in terms of provision of resources and use of sports facilities (in countries hosting sports mega-events or being successful at the Olympics). The authors also investigate the role of economic freedom (using the related index) and the position of women in society (using female labour force participation rates and women's suffrage year). They argue that institutional structures which favour gender equality and economic freedom are positively

[11] 6 days of riots happened after a man was shot dead by the police in London. The riots spread very quickly to other cities and towns in England and led to looting, arson, and a mass deployment of police.

[12] This explanation holds for the riots and not for the regular quarterly variation in local crime rate.

related to higher individuals' participation to physical activity. These findings are supported by Kokolakakis et al. (2012) who argue that although sports participation correlates appear to be the same for England and Spain, their influence is country specific and due to differences in institutions and culture. Indeed, education is a more important driver in Spain than in England and the impact of gender in Spain is twice its impact in England.[13] Conversely, age appears to matter more in England than in Spain meaning that sports participation in England decreases faster with age. This result is in contradiction with García et al. (2011) who find an increase of physical activity with age (after the age of 33 years old) in Spain. Kokolakakis et al. (2012) also underline other differences that they consistently interpret as consequences of the culture and institutions.[14]

2.2.4 Peers

There is a growing recent literature on peer effects. The theoretical link between the individual demand of physical activity and peers can be established by extending the concept of a household in the context of the New Household Economics (NHE), or by relying on the heterodox theory. According to the NHE, the consumption of physical activity is easier if another member of the individual's household already participated in such physical activity, for example. If the individual's peers are considered as part of an extended household and are physically active they directly impact the individual's level of physical activity. 'Heterodox theory' also takes into account social pressure, social interaction and desire of integration in ones' consumption choices. Therefore, if the peers are physically active it is very likely that the individual will also be physically active, and vice-versa. In contrast to the previous stud-

[13] Higher levels of education lead to higher sports participation rates and men are more likely to do sport than women are.

[14] For example, the fact that –relatively to workers- being a student has a positive impact on PA in Spain but not in England is because the great majority of the students in England work while attending college.

ies, many of those papers are based on an experimental design. In many cases, although not in all, this implies that the reported correlates are most likely to have a causal interpretation.

Carrel et al. (2011) uses the randomised assignment of college students of the US Air Force Academy to squadrons to analyse the impact of peers on individual fitness. They find that the effect of the initial fitness levels of the peer is about 40 to 70% as large as the effect of the own initial individual fitness level. Furthermore, according to their results, individuals in such groups tend to converge towards their less fit peers.

Babock and Hardman (2010) and Leslie and Norton (2012) find similar results in their experiments: individuals tend to converge towards the lowest individual level of physical activity. In their pay-to-exercise experiment, Babock and Hardman (2010) find that paid-to-exercise college students (i.e. treated students) who have relatively more non-treated friends exercise less than treated college students who have relatively more treated friends (University of California). These results suggest that by selecting a group of peers with a higher number of physically active people than inactive ones the individual will exercise more. Leslie and Norton (2012) randomly assigned people to solo, duo or quintet groups and gave them information about the other members of the group performance (except for solo). They observe that in duos and quintets the physical activity decreases (converges) towards the level of activity of the less active group member. However, Leslie and Norton (2012) highlight the fact that information on the peers' behaviour can be strategically used in order to reach the desirable results (increase physical activity participation). In their experiment, they choose to give information on all the group members' performance and they argue that the top-performers prevent the group to decline towards the lowest individual level. Therefore, they suggest that sharing information concerning only the top-performance might have a very different impact on the group members' performances. These two experiments lead to believe that selective information sharing in the peer group and peer group structure (share of physically active

members) can be used to increase individuals' physical activity. However, it is important to recall that these are results from experiments conducted on specific samples (i.e. there is no external validity).

Johannesson et al. (2010) set up an experiment in a Swedish hospital in order to observe the impact of contests and symbolic rewards on physical activity. The contest is a step contest: individuals have to wear a step counter and report their number of steps for a certain period of time. The best performers (teams or individuals) are entitled to receive a price or to be part of a lottery. Former studies underline the fact that step contests per se increase physical activity participation (e.g. Bravata et al. 2007). For their experiment, Johannesson et al. (2010) build different groups to which they gave different rewards and also different amounts of information with respect to the performance of the others. They find that step contests with symbolic rewards are an even larger incentive to exercise than regular step contests. They do not comment on the potential existence of a peer effect leading to downward convergence.

Rapp and Schneider (2013) investigate the different types of partnership between couples on the physical activity and suggest three channels. On the one hand, being in a relationship should be associated with a decrease in the partners physical activity level because of "being released from the pressure of the marriage market" and because both partners experience a reduction in their discretionary time. On the other hand, they argue that the partner can exert social control and social support of healthy behaviours and thus increases her partner's level of physical activity. Using the German Socio-Economic Panel, (GSOEP) they find that, for men, the negative correlation between physical activity and marriage becomes positive when they get older (for women the correlation remains negative but decreases with age). In Ruseski et al. (2014), the authors use the "sense of belonging to the community" as an instrument for physical activity arguing that it is positively correlated to individual's physical activity.

Wilcox et al. (2000) underline the fact that rural older women report more barriers to leisure time physical activity than urban older women do. They associate it with the lack of physically active role model in rural areas. Finding important differences according to the ethnicity they also argue that cultural norms on physical activity might influence individual physical activity. Mutter and Pawlowski (2013) investigate the impact of role models in Germany and find a positive correlation between the success of the national German soccer team and the motivation to do sports for young amateur soccer players (males and females). This result concerns only the *motivation* to do sports and also it refers only to people who are already engaged in sports participation.

2.2.5 Habits, commitment, and economic incentives

Several papers observe the role of commitment and habits of participation in physical activity. The underlying idea is that the demand of physical activity as an investment good depends on time preferences. People with high preference for the present are less likely to engage in physical activity. Habits or commitment directly affects the time preference of the individual by creating external / artificial constraints (et vice versa) and, thus, affect physical activity. DellaVigna and Malmandier (2006) use monthly panel data from health clubs over three years to test the predictions of the profit-maximization contract according to which the consumer chooses the utility-maximising contract under rational expectations about her future consumption frequency. Those predictions do not correspond to the data: they observe that the individuals buy inadequate contracts in term of length and gym attendance frequency. In order to explain this phenomenon they suggest that people overestimate their future self-control or future efficiency when buying health clubs' contract. This explains why it seems that

individuals do not act rationally when they face contracts with immediate costs and delayed benefits.[15]

At least three experiments have been done subsequently in order to highlight the link of participation in physical activity and commitment and habits. First, Charness and Gneezy (2009) run two experiments with university students (University of Chicago and University of California at San Diego) in which they investigate the effects of two different forms of pay-to-exercise incentives. In one experiment the students are paid $100 if they go eight times to the gym within four weeks. In the other experiment the students that meet the requirements are paid $175. In this second experiment, for one group the requirement is to go to the gym at least once within a month, for the other group the requirement is to go at least eight times within a month. The results suggest that students who were financially encouraged to exercise at least eight times within four weeks – and who were not regular gym attendants before - increase their participation to physical activity during the experiment and also during some weeks after the experiment. This increase in physical activity is associated with an improvement in various biometric indicators such as body-fat and pulse rate. The variation in body-fat is more than 2 percentage points lower and the variation of the pulse rate is higher by 5.15 beats per minute for the control group (when comparing with the -intensively- treated group).

Given that the observed effects tend to be temporary only, Royer et al. (2012) and Acland and Levy (2012) started experiments that focus on the 'after-treatment period' of the previous studies. In other words, they try to understand why people do not continue exercising and how to encourage them to do so even when payments ended. Royer et al. (2012) set up a structure in which an own self-funded commitment contract has been coupled with an initial

[15] Goldhaber et al. (2010) study the impact of nudges and anchoring on individual's decision concerning the type of exercise commitment contract by making an experiment in the US. They find that the default values of duration influence the length of the contract especially for first time users (information on financial stake does not). Interestingly, this change in the contract duration does not seem to impact the frequency of the participation to physical activity. However, they do not evaluate compliance with the exercise commitments.

incentive programme (in a Fortune 500 company in the Midwest of the USA). The own self-funded commitment contract is similar to the pay-to-exercise incentive except that the participant use her own money. The participant chooses the amount of her own money that she will gain (loose) by complying (not complying) with the contract requirements.[16] They underline the fact that while initially individuals might have issues with time consistency, this type of joint intervention does improve the long-term effect of the pay to exercise programme.

Acland and Levy (2012) build an experiment similar to the one proposed by Charness and Gneezy (2009) but with a much longer follow-up period and focusing exclusively on people who do not regularly attend the gym before the experiment (university students from Berkeley). They also model habit formation including naivety arguing that the individuals are biased concerning their habit formation and also they are naïve with respect to this bias. In other words, the students overestimate their change of behaviour towards physical activity and they are overoptimistic concerning the realisation of their predictions.

This literature allows us to gain a better understanding of individuals' decision to engage in physical activity and the impact of commitment and structure of the physical activity offer. It is worth noting that naivety and over-confidence towards capacity or will to change physical activity behaviours seem to be well-spread among individuals who are not physically active. Therefore, counselling, encouragement and supervision appear to be appealing interventions.

Active transportation is a way to engage in physical activity while commuting from by walking or cycling, for example. Some studies focus on diverse ways to encourage active transportation (and thus physical activity) and physical activity via different types of incentives. Brockman and Fox (2011) analyses the evolution of active transportation among Bristol university staff between 1998 and 2007 while the university reduced the parking opportuni-

[16] The commitment is fixed to "not missing more than 14 days in a row at the gym".

ties. They find that during this period - and contrary to national trends - the share of people who reported that they walked and cycled to work increased (from 19 to 30% and from 7 to 12% respectively). Furthermore, those 70% of the people walking or cycling to the university achieved more than 80% of the recommended levels of physical activity according to the official guidelines for physical activity by doing so.

Davis and Jones (2007) report on the success of incentives given by companies to increase physical activity (and productivity) among their employees. They find evidence in the literature that health promotion programmes and exercise programmes do increase physical activity. Also, physical activity counselling sessions are associated with higher self-reported levels of physical activity and higher observed fitness in the short term. They conclude that employer supported interventions –at the workplace or elsewhere- do increase physical activity level among their employees. Sockoll et al. (2009) review a large number of papers analysing the effectiveness of workplace health promotion and prevention. They highlight the fact that physical activity programmes do increase – to a limited extent – workers' physical activity. Aside to physical exercise courses and counselling, low-cost interventions such as motivating signs for encouraging stair use, initiation of jogging groups or substituting personal visits instead of using a telephone positively influence employees' physical activity.

Sen (2012) is interested in the effect of changes in the gasoline price (due to Hurricane Katrina) on physical activity in the US (using the American Time Use Survey which allows calculating the MET). Indeed, two effects can be figured out: the substitution effect (people opt for active transportation rather than motorized one) and the income effect (people stop part of their leisure activities because of budget restrictions). Sen (2012) finds that an increase in gasoline price is associated with an increase in both: participation to physical activity and duration of physical activity. However, the concerned physical activity is moderately energy intense and corresponds to housework. Furthermore, physical activity of individuals with the lowest and highest SESs is not influenced. Therefore, the author concludes the income effect

is nonlinear. While middle SES groups stop hiring housekeepers (domestic help) and do their moderately intensive housework themselves, individuals with low SES did not have any housekeeper, and individuals with high SES can still afford to have some. Therefore, he suggests that taxes on gasoline price are not an efficient way to increase physical activity of all SES groups.

3 Returns of physical activity for working age adults

According to the theories on the individual demand for physical activity, involvement in physical activities may be motivated by a desire to increase utility directly, a desire to maintain and improve health, a desire to build and or at least to signal some specific skills, and/or a desire to be socially integrated. In this section we consider the corresponding outcome variables, beginning with the attempt to measure changes in utility directly by various indicators for individual happiness. Health can also be analysed by different sets of objective and subjective indicators. The presence of a skill related signal is usually tested by job application experiments sending out CV's with and without that information. Skill effects may be approximated by measuring long term labour market outcomes. Social inclusion, however, is a more complex concept that is mainly studied from a qualitative perspective.

3.1 Happiness

Van Hoecke et al. (2013) implement an experiment in order to evaluate the impact of need-supportive physical activity counselling on physical well-being of Flemish sedentary adults who are to be motivated to engage in physical activity. They find a positive relationship, which increase with the level of physical activity. They also conclude that it is relevant for individuals to be advised and supported by experts with respect to their own decision concerning physical activity in order to increase their well-being. This explanation relates to the

Self-Determination Theory (e.g. Deci and Ryan, 2002), which takes into account individuals' self-motivation and self-determination in order to explain their behaviour.

Using the Behavioural Risk Factor Surveillance System data (BRFSS), Huang and Humphreys (2012) estimate a positive relationship between participation in physical activity and self-reported life satisfaction. According to their results, this effect is partially mediated by an improvement in health and the overall impact is greater for men. To obtain their results (based on 1.5 million individuals) they use an instrumental variable approach for the participation to physical activity. The instrument is the number of sports facilities in the county where the individual lives. In Ruseski et al. (2014), the authors also have recourse to IV estimations in order to measure the impact of physical activity on well-being for a sample of individuals living in Rheinberg (Germany). They use two instruments: the distance to sports facilities (computed using geo-codes) and the answer to a question asking whether participating in physical activity is important. They include an indicator of disability in their estimations but no further information on the individual health status. They argue that physical activity has a positive impact on well-being.

Rasciute and Downward (2010) analyse the link between physical activity and happiness using data from the English Taking Part Survey. They insist on the fact that happiness and health are interdependent and they differentiate the impact of physical activity by type and motivation. In particular, they distinguish cycling and walking from other physical activities. According to them, physical activity for recreation or health does have a positive impact on health and well-being while cycling for the same reasons (or used as a mean of transportation) is negatively correlated to well-being and positively correlated to health. They suggest that the disutility of cycling might be due to safety issues on the roads.

3.2 Health

In this section, we survey papers analysing the effect of physical activity by health outcomes: specific conditions (e.g. diabetes mellitus, cardiovascular diseases - CVD henceforth), health costs, and self-reported health status. Most of the studies look at short terms effect and are able to compute the metabolic equivalent task (MET). The MET values are used to build categories such as inactive, moderately and active for example.[17] The positive impact of physical activity on health is well established in the medical literature (e.g. Warburton et al., 2006), in the sports science literature (e.g. Reiner et al., 2013), as well as in economics (e.g. Humphreys et al., 2014, Sari, 2009 and Sari, 2013).

The surveys on the impact of physical activity on health find evidence of the existence of a positive relationship (e.g. Hillman et al. 2008, Reiner et al. 2013, Shephard 1996, Sockoll et al. 2009, Warburton et al. 2006). According to Warburton et al. (2006), physical activity is effective in the primary and secondary prevention of a substantial number of physical conditions (e.g. CVD, diabetes mellitus, osteoporosis, breast and colon cancer).[18] They also underline the fact that if the relation between physical activity and health is linear, the highest improvement in health is observed when people who are least fit become physically active. Hillman et al. (2008) review studies which analyse the relationship between physical activity (and more specifically aerobic fitness training) and brain function and cognition. They find positive results but underline the lack of precision with respect to the optimal design of the exercise intervention (e.g. type, duration, and schedule over the lifespan).

Sari (2009, 2013) uses Canadian data (Canadian Community Health Survey -CCHS- and National Population Health Survey -NPHS- respectively) which allow him to calculate the MET and analyses the corresponding healthcare use. He finds that being moderately

[17] The use of 3 categories is the most common in the presented studies.

[18] Primary prevention is health promotion and specific protection while secondary prevention consists in dealing with latent disease and preventing progression of disease (or preventing asymptomatic disease to become symptomatic).

active rather than inactive has a greater impact in reducing healthcare use than being active rather than moderately active. More precisely, the length of a hospital stay decreases by 35 to 41% (Sari, 2013). The impact is larger for women and also for people who have a chronic disease (i.e. diabetes, heart disease, cancer; stroke or high blood pressure). Results concerning outpatient services are similar: inactive individuals use 12% more nurse services, 5% more family physicians, and 13% more physician services than active people (Sari 2009). Furthermore, moderately active people compared to active people use 2.4 to 9.6% more physician (family and other respectively) services. Dunnagan et al. (1999) study the impact of worksite based fitness programming on health-related costs. Using the University of Kentucky Wellness Program (UKWP) they build an experiment in order to compare individuals who are part of the program with individuals who are not. They argue that regular exercise reduces health care costs. Unfortunately, their sample contains less than hundred individuals and suffers from selection (selection of the participants and attrition).

Humphreys et al. (2014) look at the impact of physical activity on the self-reported health status and several chronic conditions using the CCHS. They find the same pattern as Sari (2009) and Sari (2013): being moderately active rather than inactive is more rewarding than being active rather than moderately active. This results hold for the level of self-reported health as well as for diabetes, arthritis and high blood pressure. Colman and Dave (2013b) analyse the same outcomes using the National Health and Nutrition Examination Survey (NHANES1). They are not able to compute the MET but they take into account the total physical activity as well as recreational physical activity instead of focusing on the latter like many other papers. According to their results, both types of physical activity have a protective effect on health via a reduction of the risk factors (BMI, high blood pressure and resting heart rate). A decrease in high recreational exercise and other physical activities explains 10 to 33% of an increase in BMI and hypertension, 2 to 8% increase in diabetes and heart disease and 10 to 20% in the increase of noted risk factors and illness conditions.

In addition, Schulkind (2013) uses the so-called Title IX to evaluate the impact of physical activity on the intergenerational transmission of health. Title IX is a law amendment introduced in 1972 in the US. Its main purpose was to prohibit gender discrimination in federally funded activities such as education. Its compliance required a substantial increase in the supply of female high school and collegiate athletics. Schulkind (2013) uses the increase in female physical activity required to comply with Title IX regulations as an instrument and performs IV in order to estimate the impact of an increase in women's athletic participation (instrumented) on her child's birth weight. According to her results, an increase by 20% in girls' athletic participation in 1970's translates into 6 (12) %-points reduction in low (very low) birth weight births. She attributes this effect to a change in the mothers' physical activity behaviours.

The literature provides evidence supporting the hypothesis according to which physical activity improve health, self-reported health, and well-being. It is worth noting that most studies suggest that greater short term effects on health come from an increase from inactive to moderately active. By contrast, Lechner and Sari (2014) -who focus on long term effects- find that only an increase from moderately active to active has a positive and significant impact on health.

The next relevant question concerns the transferability of the positive health effects of physical activity to the individual's human capital and labour market productivity. There is a consensus on the fact that more physical activity is always better for health, therefore individuals should spend more time engaging in physical activity.[19] Since the time is a limited resource dedicating more time to physical activity requires an adjustment (reduction) of either leisure or work time. This change in the allocation of time has consequences on earnings.

[19] This is a simplification of reality. Indeed, as mentioned before physical activity is also defined in terms of intensity suggesting that duration and intensity are substitutes to some extend (WHO guidelines). However, the material costs are different and the risk of injury higher, not everyone can use / benefit from such substitution.

However, spending more time investing and maintaining health also leads, for example, to fewer sick days, which in turn increases the amount of time available for work and leisure. Moreover, physical activity may also build other skills (cognitive and non-cognitive skills) and facilitate social inclusion (e.g. Seippel, 2006, Frost, 2013). Non-cognitive skills such as team skills, self-discipline, and tenacity are associated with sports participation and higher level of productivity and thus, higher earnings. Thus, we continue this review by presenting papers on labour-market outcomes and social capital.

3.3 Labour market outcomes

In this section, we present empirical economic papers analysing the relationship between LTPA and labour market outcomes. The literature on this topic is limited, mainly because the data needed to analyse this topic is relatively poor. Indeed, while positive health effects are very well established by the literature, the evidence on labour market effects is more limited.

We start with presenting the results concerning employability followed by the effects on the earnings and wages.[20] Rooth (2011) performs an experiment in Sweden and finds that the applicants who include a statement about being active in sports in their job application increase their call-back rate by 2%-points. The design of the experiment is such that more than 8000 applications were sent to 3821 employers in different sectors for 13 different occupations with different skills requirement and degree of costumer contact.

In a non-experimental setting, Cabane (2013) uses the German Socio-Economic Panel (GSOEP) to investigate the impact of physical activity on unemployment duration. She finds a positive correlation between physical activity (at least once a week) and exit from unemployment to employment for women who have at least 3 years of working experience. How-

[20] The literature on the characteristics of the jobs performed by physically active people focuses on adolescent physical activity and is therefore excluded from this survey.

ever, she argues that it might reflect lower psychological barriers to job search (such as bounded self-control) rather than an actual effect of being physically active. Kavetsos (2011) studies the relationship between physical activity and employment using the Eurobarometer survey of 2004 (a cross-section including 25 European countries). He runs IV estimations using the regional prevalence of sports participation as instrument. He finds that individuals who are physically active are more likely to be employed and that the probability of employment increases with the frequency of exercise. It is likely that the exclusion restriction for the instrument variable is violated. Indeed, the assumption tested in the paper suggests that the regional prevalence of sports participation is related to the labour market situation. Interestingly, Lechner and Downward (2013) analyse the impact of sports participation on employment among different age groups. The authors use semi-parametric matching methods on a large representative cross-sectional database for England to adjust for major covariates. They also find a negative correlation between physical activity and unemployment for men. Moreover, they also observe a positive relationship between physical activity and youth employment for 26 to 45 years old individuals. Although causal relationship cannot be strictly established in Lechner and Downward (2013), the amount of information on the individuals and their physical activity, as well as the results of a substantial formal sensitivity analysis suggest that the impact of endogeneity due to confounders is somewhat limited.

Another part of the literature on physical activity and earnings focuses on the short and long run effects of adults' participation to physical activity on their current earnings. Cornelissen and Pfeifer (2008) perform an analysis using the GSOEP and a random effect regression strategy. They find that men who practise sport at least weekly earn 5% more than men who do not (around 3% more than men who do participate but less often). They test the impact of youth sport on earnings and find significant results. Women who declare having been involved in sports competition when they were 15 years old earn about 6% more. Lechner (2009) has similar results using the same database (the GSOEP) but adopting a dif-

ferent strategy (semi-parametric matching estimation using informative panel data in a specific way). He finds an increase by 1200 euros p.a. over a 16-year period for adults who practise sports at least monthly (with respect to physically inactive or less active people). Lechner and Downward (2013) estimate the gain of different sports on annual household income between 4300 and 6500 GBP p.a. for 26 to 45 years old men and between 3400 to 5300 GBP p.a. for women of the same age (it varies according to type of sport). They find that for men outdoor sports and then fitness sports appear to have the highest association to earnings while it is racquet sports and then team sport for young women (26 to 45 years old), and outdoor sports for older women (46 to 64 years old) showing lowing positive associations.

Lechner and Sari (2014) analyse the impact on the earnings of Canadian adults changing from being inactive to being moderately active and from being moderately active to active based on an informative and long Canadian health panel. The method used is the same as in Lechner (2009) however, the data is much more informative and therefore the identification strategy which relies on the conditional independence assumption together with a type of semi-parametric fixed effects approach is more credible. In Lechner and Sari (2014) it appears that the change from inactivity to a moderate level does not lead to a significant increase in the earnings over time. However, the increase from a moderate to more active level positively affects earnings by 10 to 20% in the longer run (8-12 years). Kosteas (2012) analyses the same question and runs matching estimations on the NLSY79. According to his results, practising sport at least weekly increases the wage of 33 to 41 years old men and women by 6 to 11%, respectively.

In their report on “PA, absenteeism and productivity”, Davis and Jones (2007) analyse the success of the firms as providers of incentives for physical activity. They find evidence that absenteeism can be substantially decreased (and physical activity increased) by introducing workplace health promotion programmes in which individuals commit for at least 12

months and also by offering workplace exercise intervention programmes (interventions above 1 hour per week can decrease absenteeism by one third to one half). Effects are larger for people who are inactive.

There is another channel (in addition to health and human capital) which could explain the link between success on the labour market and physical activity: physical attractiveness. Indeed, several papers show that physical attractiveness (or beauty) is positively correlated to earnings (e.g. French 2002, Hamermesh and Biddle, 1994, and Mobius and Rosenblat 2006) and also to employment (Pfeifer, 2012). Sports participation is related to physical attractiveness in many ways. First, it is generally admitted that healthier people 'look better' in terms of skin and body shape (fitness). Second, according to the Special Eurobarometer 412 (2014) 24% of the people are engaged in physical activity in order "to improve [their] physical appearance". This is the fifth most cited reason joint with "to control your weight" which is also about physical appearance. This channel is rarely put forward and to our knowledge the relationship between physical activity and physical attractiveness has not yet been studied in economics.

As discussed in section 2, the reasons to engage in physical activity might vary with a large set of individual characteristics. It would therefore be interesting to investigate the heterogeneity of the effect of being physically active on the labour market according to educational background, gender or age for example. Gender heterogeneity is the most commonly studied.

3.4 Social capital

As outlined before, social environment and peers influence individuals' participation in physical activity. Indeed, a substantial share of the physical activity involves social interactions, either directly, like in team sports, or indirectly when individual sports are done in sports centres, for example. Therefore, it can be a way to socialize. Also, the sport world is

supposed to be discrimination free and its rules are usually in line with accepted rule of social behaviour. In other words, sports clubs and centres are open to everybody and sports rules promote collaboration, solidarity, fair play etc. This suggests that sports could be used to integrate people and improve social inclusion. However, according to Stempel (2005), the dominant class works on differentiating itself from the other and uses sport for that purpose. If this is the case, physical activity cannot be used to improve social inclusion among different SES groups. Nevertheless, rightly or wrongly sports is celebrated for its inclusive values, but, to the best of our knowledge, most of the literature on this topic is qualitative in nature.[21] In Krouwel et al. (2006) and in Frost et al. (2013) the authors use the opinions of survey respondents about sports and social inclusion in the Netherlands and in Australia, respectively. Krouwel et al. (2006) focus on the question of minorities and different ethnical groups. They ask four different social groups in Rotterdam about their preferences and motivation for physical activity (mainly why they do it and with whom they want to do it). They conclude that, at least for adults' leisure time, physical activity is not necessarily the best method to increase integration of the minorities. Indeed, according to the survey, while young individuals enjoy being in mixed ethnicity sport clubs, adults prefer not to be mixed. Frost et al. (2013) analyse the role of rural football clubs in social inclusion of population who are living in remote Australian rural areas (in Victoria). Their data come from reports presented to the Parliament of Victoria Rural and Regional Services and Development Committee in 2004 at the occasion of the Inquiry into Country Football. The reports claim that rural football clubs are beneficial to social inclusion in these areas.

Delaney and Kearney (2005) and Seippel (2006) analyse the link between involvements in sports and trust in society. The underlying question is whether the values associated with

[21] An entire segment of the literature is dedicated to sports and violence but also sport and social inclusion among youth but since the focus of this paper is on adults we do not present this literature here (e.g. Hartmann and Depro, 2006, Meek and Lewis, 2014, Van Hout and Ohelam, 2014).

sports participation (such as solidarity, responsibility, and trust) translate into political or societal involvement. Seippel (2006) uses data from the Norwegian part of the Johns Hopkins Comparative Non-profit Sector Project (a survey) to study the impact of participating in voluntary sport organizations – among other organizations – on trust and political commitment. He argues that being a member of a voluntary sport organization is positively related to generalized trust, political interest and voting, but not to politicians' trustworthiness. Delaney and Kearney (2005) compute descriptive statistics using several data sets (European Social Survey 2002, 2000 UK Home Office Survey, 2000 Time Usage Survey and polls from the website MORI) in order to analyse the situation in the UK and also to characterise the position of the UK within the European countries. They emphasise the fact that after controlling for individuals' socio-demographic characteristics, sports participation is closely related to political trust, wellbeing and the frequency of socializing and meeting with friends. They suggest using sports in order to build up community networks and relationships. Both papers find a positive relationship between being engaged in sport (or sports related activities) and political trust but none is able to empirically identify a causal relationship.

In summary, it is not clear yet which kind of effects physical activity has on social capital and trust among adults. Indeed, the studies presented here do not plausibly identify causal relationships and differ in their conclusions.

4 Conclusions

This paper reviewed parts of the vast literature on the effects, determinants, and correlates of physical activity. Although, there seems to be a strong consensus in the literature that, with very few exceptions, being physically active improves almost all aspects of life, still many interesting questions remain unanswered.

Let us take the example of labour market outcomes to consider a couple of open issues. The first issue is how exactly the different types of physical activities affect the different labour market outcomes (e.g. 1 h of cycling vs. 1 h of football). This issue is also related to the question on the how the effects come about. Which part is due to a health effect, which is due to increased physical attractiveness, additional social capital and so on? The current studies treat these issues mainly as a black box to obtain an estimate of the overall effect. This is so not because they are not interested in doing so, but mainly because it is very difficult to find existing data large and informative enough to be able answer such important questions.

In a similar vein, while the epidemiological literature seems to indicate that more physical activity is always better, this is not an appealing point of view for an economist. Since time is a limited resource, time devoted to physical activity cannot be devoted to other activities that also increase current or future utility (and consumption possibilities). Thus, since at some level the returns to physical activity should become smaller (jogging 24 h a day cannot be healthy), it will usually not be optimal to live a life that consists only of sleeping, eating, and daily 16h workouts. Unfortunately, close to nothing is known so far where this optimum is and how it varies with individual characteristics, like education and time preference rates for example. To understand such issues, we expect that developing theoretical models explicitly taking into account the dynamic nature of consuming and investing in physical activity will shed more light on mechanisms, expected heterogeneities, and (heterogeneous) optimal behaviour.

Finally, developments in the dimensions outlined above should form the basis for any reliable and robust investigation of the large amount of public subsidies spent and their returns to society (or the taxpayer) in general.[22]

[22] For example, Pawlowski and Breuer (2013) estimate the annual level of (net) public subsidies directed to the sports sector in Germany to be around 8 bn EUR.

Overall, this indicates that the link between sports and labour economics is an under researched field which would benefit from additional high quality data and the (hopefully) resulting reliable empirical studies as well as from a profound theoretical analysis, and of course, the metamorphosis of the two.

We like to conclude that the large positive effects of physical activity with respect to almost all dimensions analysed (social integration may be the exception), in particular labour market performance, appears to indicate that increasing physical activity among workers and unemployed may offer a yet not fully explored avenue to raise their productivity, and thus make individual unemployment, for worker as well as for older individuals, less likely.

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