EU Platform on Diet,
Physical Activity and Health

Working Paper on Physical Activity and Health

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1. EXECUTIVE SUMMARY

Physical activity and public health

- At least two thirds of the adult population of the European Union are estimated to be insufficiently physically active for optimal health benefits. All initiatives designed to increase physical activity are therefore urgently needed.
- The well proven health benefits of regular, moderately intense physical activity (Health Enhancing Physical Activity, HEPA), such as decreased risk of mortality from cardiovascular diseases, seem to apply to all people, regardless of their age, gender and weight.
- There is moderate evidence indicating that lower physical activity levels, or lack of high intensity exercise, are associated with greater body weight gain over time. On the other hand, recent findings strongly suggest that the amount of inactivity (i.e. time spending sitting, lying, and standing) in the population does not explain body weight.
- Current recommendations on physical activity that enhances health suggest that half an hour of moderately intense physical activity on most days of the week yields major health benefits for inactive populations. For effective prevention of overweight and obesity, up to an hour of such daily activity is recommended.
- Recent guidelines also encourage performing regular strength and flexibility training in addition to the 30 minutes of moderate intense activity, or 20 minutes of vigorous exercise three times per week. Thus, recommendations on health enhancing physical activity now approach the recommended exercise levels for developing and maintaining cardio-respiratory and muscular fitness. The message for health promotion is that "higher intensity is back"
- Thus, little is good, more is better, or, you get what you pay for.

Physical activity intervention and the Platform activities

- Public health interventions and more specifically physical activity promotion, should be based on best available evidence. However, this is historically a young field and there are no clear concepts for increasing health-enhancing physical activity on the population level.
- Priority actions for all stakeholders, including Platform members, should be identification of insufficiently inactive and vulnerable groups, and evaluating practice that can deliver measurable improvement of physical activity levels.
- Scientists and Platform actors should co-ordinate and co-operate more systematically to improve the quality of the actions and their outcome. The Platform has potential to support initiatives that are targeted towards improving the physical activity levels of specific groups .
- Improved levels of physical activity will deliver positive health gains for individuals. However, the evidence base is very limited on what types of exercise are needed, how often, at what intensity for different population groups as an effective weight reduction strategy. Therefore, when population level policy responses are sought for addressing the obesity epidemic, food intake measures are most likely to be more effective than physical activity interventions.

2. BACKGROUND: THE PLATFORM AND PHYSICAL ACTIVITY

The European Platform for Action "Diet, Physical Activity and Health" was launched in 2005. The Platform was created to provide a common forum for all interested actors at European level where

(1) they can explain their plans to contribute concretely to the pursuit of healthy nutrition, physical activity and the fight against obesity, and where those plans can be discussed; and where

(2) outcomes and experience from actors' performance can be reported and reviewed, so that over time better evidence is assembled of what works, and best ptactice more clearly defined.

Since March 2005, Platform members have made commitments and taken action to contain or reverse the current obesity trends. The Members have regularly come together to share and up-date their action plans with each other. Synopsis Commitments have been prepared and up-dated, a Platform Database has been created, and Monitoring Progress Reports have been composed. Up to the beginning of February 2007 a total of 203 commitments were available in the Database: 38 of them were scheduled to be finished in 2006, 145 of them were multi-annual and will be continued in 2007, and 20 of them will start in 2007. New commitments have been made in the course of 2007 and 2008.

Even if healthy food habits and a physically active lifestyle are cornerstones for the Platform, most actions have focused on diet. A minority, less than 25 per cent, have addressed Physical Activity and little progress has been measured or reported. It was agreed that there should be an increasing focus on Physical Activity. The topic will therefore be thoroughly discussed at the Platform meeting in September 2008.

This Working Paper summarises the current knowledge and the main messages from the physical activity and public health scientists to the policy makers, health planners and the many platform members taking actions that can help to contain or reverse the current obesity trends.

3. DEFINITIONS OF PHYSICAL ACTIVITY AND RELATED CONCEPTS

What is the difference between a) physical activity, health enhancing physical activity (HEPA), and exercise?; b) inactivity and sedentary behaviour?
What does fitness mean and what are the components ?

Physical activity

Physical activity is defined as "*any body movement produced by skeletal muscles that results in a substantial increase over the resting energy expenditure*"[1]. It refers to the movement of large muscle groups, as when moving the whole body. Physical activity's main characteristics are intensity, duration and frequency and its main settings are leisure, work, home and transport.

All kinds of physical activities, or lack of these activities, have physiological/medical consequences. Our cells in the body, organs and systems respond immediately to the stimuli caused directly and indirectly by the activity as such and adapt its structure and function accordingly. Lack of these stimuli results in tissue degeneration, lower function and disease vulnerability.

Physical inactivity and sedentary behaviour

Physical inactivity and sedentary behaviour are less clearly defined. Physical inactivity refers to low levels or the absence of physical activity. It represents the lower end of the activity spectrum. Sedentary behaviour includes a number of occupations that have in common very little energy expenditure. Watching television or videos – that is, time spent in front of a screen or, more generally, time spent sitting daily – is a commonly used indicator of sedentary behaviour.

A sedentary lifestyle may include one or more weekly sessions of intentional exercise, which may be more common among people with more education. Thus, sedentary behaviour does not represent the opposite of physical activity, but corresponds to a complementary dimension of behaviour. The distinction between physical activity and sedentary behaviour has implications for both assessing and preventing obesity and related diseases.

Physical exercise, HEPA and physical fitness

Physical exercise is defined as "*a subset of physical activity that is planned, structured, systematic and purposeful physical activity*" [1], while Health Enhancing Physical Activity (HEPA) is defined as "*any form of physical activity that benefits health and functional capacity without any undue harm or risk*".

Physical fitness is "*a set of attributes that people have or achieve that relates to their ability to perform physical activity*", or a physiological state. It is clearly distinguished from physical activity and exercise, which are different types of behaviour.

[1] Bouchard C, Shepard R. Physical activity, fitness and health: the model and key concepts. In: Bouchard C, Shepard R, eds. *Physical activity, fitness and health*. Champaign, IL, Human Kinetics Publishers, 1994

Health-related physical fitness consists of the components of physical fitness that have a relationship with health. These components are favourably or unfavourably affected by physical activity habits and are related to the health status. Health-related fitness has been characterized by an ability to perform daily activities with vigour, and by traits and capacities that are associated with a low risk for the development of chronic diseases and premature death. Health-related fitness components include cardio-respiratory fitness, musculoskeletal fitness, motor fitness, and morphological fitness.

Cardio-respiratory fitness is a direct marker of physiological status and reflects the overall capacity of the cardiovascular and respiratory systems to supply oxygen during sustained physical activity, as well as the ability to carry out prolonged exercise. The maximal oxygen consumption (VO_{2max}) attained during a graded maximal exercise is considered to be an objective measure of the cardio-respiratory fitness performance.

Cardio-respiratory fitness, cardiovascular fitness, cardio-respiratory endurance, aerobic fitness, aerobic capacity, aerobic power, maximal aerobic power, aerobic work capacity, physical work capacity, and VO_{2max}, all refer to the same concept and are used interchangeably in the literature. Cardio-respiratory fitness can be expressed in terms of subject weight (ml/kg/min), according to fat free mass (ml/min/kg fat free mass), in absolute terms (l/min) and with a correction factor (ml/min/$kg^{0.7}$), or in METs.

Musculoskeletal fitness means balanced, healthy functioning of the musculoskeletal system. It requires that a specific muscle or muscle group be able to generate force or torque (measured as strength), to resist repeated contractions over time or to maintain a maximal voluntary contraction for a prolonged period of time (measured as muscular endurance), and to carry out a maximal, dynamic contraction of a single muscle or muscle group in a short period of time (measured as explosive strength, also called power).

The role of muscular strength in the performance of activities of daily living and exercise, as well as in the prevention of chronic disease, is increasingly being recognized[2].

Flexibility is another factor of the musculoskeletal component. It is the ability of a specific muscle, or a muscle group, to move freely through a full range of motion. It is of importance in a variety of athletic performances but also in the capacity to carry out the activities of daily living, which is important from a public health perspective.

Physical activity patterns over recent weeks or months partially determine cardio-respiratory fitness. Constitutional factors are also determinants: about 40% of the variation in cardio-respiratory fitness has been suggested to be attributable to genetic factors. Nevertheless, regular moderate-to-vigorous physical activity can lead to improvements in cardio-respiratory fitness at any age.

[2] Ruiz JR, et al. Association between muscular strength and mortality in men. BMJ 2008; 337:a439.

4. LINKS TO HEALTH AND RECOMMENDATIONS

How much physical activity is enough to prevent chronic diseases and to promote health. Can the dose be specified??

Physical activity and health

The seminal studies by Dr Jeremy Morris[3] in London, in the 1950s on bus-conductors and postal workers were among the first to show a link between habitual physical activity and coronary heart diseases. Research on health and the functional effects of physical activity has since then progressed.

The relationship between physical activity and health is complex. On average, and in most people, regular physical activity at a certain dose will increase health-related fitness. Such improvements in fitness are likely to have favourable effects on overall health. A large amount of data shows that some health benefits are derived from being physically active even though there may be little or no associated gain in fitness.

Cardio-respiratory fitness has been established as one of the most important independent predictors of all-cause mortality and, in particular, of cardiovascular death, irrespective of body weight. Cardio-respiratory fitness provides strong and independent prognostic information about the overall risk of illness and death in both men and women across a broad spectrum of ages, irrespective of body weight. This applies for apparently healthy individuals, and for those with diabetes mellitus, hypertension, metabolic syndrome and several types of cancer.

A large body of evidence documents the effects of regular physical activity on health, which include decreases in mortality from all causes, cardiovascular mortality and morbidity (including coronary heart disease), the risks for colon and breast cancer and type 2 diabetes[4]. This evidence-based knowledge has led to public health recommendations on physical fitness.

Recommendations

Already in the early 1970s, for example Sweden provided guidelines on physical activity (Table 1). The National Board of Health and Welfare stated: "*Do moderate physical activity daily, in combination with more intense exercise two to three times per week*". Together with the advice on improving food habits, a sentence on physical activity was included; "*Take every opportunity you have to increase lifestyle activities, such as walking, cycling, taking the stairs etc*".

Public recommendations were developed in England in the early 1990s by the Health Education Authority (HEA). They stated "*30 minutes of daily moderate intensity physical activity promotes health*".

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[3] Morris JN, Heady JA, Raffle PAB, et al. Coronary heart disease and physical activity of work. *Lancet 1953*; 265 (6795): 1053-1057.

[4] Pedersen BK, Saltin B. Evidence for prescribing exercise as therapy in chronic disease. *Scandinavian Journal of Medicine & Science in Sports*, 2006, 16(Suppl. 1):3–63.

Two sets of physical activity and exercise recommendations are frequently referred to One is for cardio-respiratory fitness and strength training (Table 1, ACSM 1978, 1998). The other is for general health, which is mainly based upon reviews of clinical and epidemiological studies (CDC 1996). It advises adults to do 30 minutes of at least moderate intensity physical activity on most, preferably all, days of the week. The 30 minutes can be accumulated in several bouts of at least 10-minutes duration.

This recommendation has recently (August 2007) been updated by the American College of Sports Medicine (ACSM) and the American Heart Association (AHA). The update still emphasizes 30 minutes of moderate intensity physical activity to be regularly performed on at least five days per week (compared to "most, preferably all" days in the 1995 recommendation), but also that the 30 minutes of moderate intensity physical activity can be substituted by three occasions of 20 minutes of vigorous intensity activity per week. Furthermore, the new recommendation has separated healthy adults and older adults (> 64 years) or adults (50 – 64 years) with chronic conditions.

On top of these activities, ten strength-training exercises, eight to twelve repetitions of each exercise twice a week, is recommended. The recommendation also highlights that these activities are in addition to routines of daily living (such as self-care and cooking) or lasting less than 10 minutes (such as walking around home or office, walking from parking lot). Thus, the health enhancing physical activity recommendations now approach the exercise recommended for developing and maintaining cardio-respiratory and muscular fitness. "The higher intensity is back"

The recommendations on health-enhancing physical activity seem straightforward: people are supposed to be more and more active.

But, are they more and more active? For whom, and to what extent, are the recommendations valid?

The recommendations are general and new evidence about the dose-response relationship between physical activity and different chronic diseases, suggests a need for them to be modified to suit individual circumstances. For example, to prevent the transition from normal weight to overweight or obesity 45 to 60 minutes of moderate intensity daily is required and to prevent weight regain in formerly obese individuals 60 to 90 minutes of moderate intensity is required.

Table 1. Development of Physical Activity recommendations

Organisation	Year	Recommendation	Rational
National board of health and welfare, (Sweden)	1971	Be active on moderate intensity every day in combination with more intense exercise 2–3 times per week	Health and fitness
ACSM	1978 1990	3-5 times per week, 15-60 min per occasion, 60-90% HRmax on aerobic exercise In 1990, strength training was added	Maintain and improve fitness
Health Education Authority, (England)	1994	30 minutes of daily moderate intensity physical activity	Health
Pate R. et al. and CDC, Surgeon General (US)	1995 1996	30 minutes of at least moderate intensity on most, preferably all, days of the week (150 kcal per day), accumulated in several bouts of at least 10-minutes duration (Pate, 1995)	Health
ACSM	1998	3-5 times per week, 15-60 min per occasion, 55-90% HRmax on aerobic exercise plus add strength and flexibility training	Maintain or improve fitness
IASO	2003	For prevention: 45-60 minutes per day of at least moderate intensity For maintenance: 60-90 min per day	Prevent obesity or maintain weight loss
ACSM, AHA	2007	30 minutes of at least moderate intensity daily *or* 20 minutes of vigorous 3 times per week. In addition, strength training twice a week	Health and fitness

ACSM; American College of Sports Medicine [5]
CDC; Centre for Disease Control and Prevention [6]
IASO; International Association for the Study of Obesity[7]
AHA; American Heart Association [8]

[5] Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation*. 2007 Aug 28;116(9):1081-93.

[6] CDC, USDHHS, NCCDH. *Physical Activity and Health. A report from the Surgeon General*. Atlanta, GA: Centers for Disease Control and Prevention, U.S. Department of Health and Human Services, National Center for Chronic Disease Prevention and Health Promotion; 1996.

[7] Saris WH, Blair SN, van Baak MA, Eaton SB, Davies PS, Di Pietro L, et al. How much physical activity is enough to prevent unhealthy weight gain? Outcome of the IASO 1st Stock Conference and consensus statement. *Obesity Review* 2003 May;4(2):101-14

[8] Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation*. 2007 Aug 28;116(9):1081-93.

5. ASSESSMENT OF PHYSICAL ACTIVITY

Can we rely on self-reported physical activity? Is there a need for a new way of assessing physical activity?

Assessment of physical activity at population level is difficult due to the complex nature of physical activity itself. It is difficult to find an accurate instrument for it. Feasibility must be balanced with measurement accuracy.

Subjective assessment

At the population level, habitual physical activity is usually assessed using questionnaires, because these can be administered to large numbers of people at a relatively low cost. Such questionnaires can be administered by the subjects (self-report) or by trained interviewers in face-to-face meetings or by telephone. Questions pertain to predefined categories of physical activity based on the setting or intensity (moderate, vigorous). Most former questionnaires have focused on leisure-time physical activity but that is only one part of total physical activity.

To translate data on physical activity into energy-expenditure values, compendiums of energetic cost for various activities are used. The results are often expressed in metabolic equivalents (METs) – i.e. multiples of resting energy expenditure (1 MET is about 3.5 ml/kg/min oxygen). One example is brisk walking which correspond to 4.5 METs.

Attempts have been made to standardise data collection and have resulted in the International Physical Activity Questionnaire (IPAQ), and its derivate the Global Physical Activity Questionnaire (GPAQ). IPAQ has been used in Eurobarometer 2002 and 2005, and the WHO World Health Survey 2002. The data was supposed to be used for common analyses of trends, policy making, development of intervention strategies, implementation planning and evaluation of international activities. However, thus far the results from the international projects have been difficult to interpret due to varying cultural/practical circumstances (translation, definitions, data collection and cleaning, etc) in the different countries.

Common analyses of the outcome of the Platform activities regarding physical activity per se may encounter the same problem. Different actors within one and the same country may increase the difficulties further.

Objective assessment

Although the most common method used is self-reporting by questionnaires, there are also objective methods to assess physical activity, which includes motion detectors, such as pedometers and accelerometers. Pedometers are simple motion detectors that assess body movements in terms of accelerations, but not the amplitude of the acceleration. Accelerometers can be used not only to assess the body movements in terms of accelerations as such, but also to estimate the intensity of the physical activity

over time (each minute for days or weeks) (Figures 1 and 2). This methodology has now been used also for monitoring of levels of physical activity in populations[9].

Figure 1. Accelerometer placement.

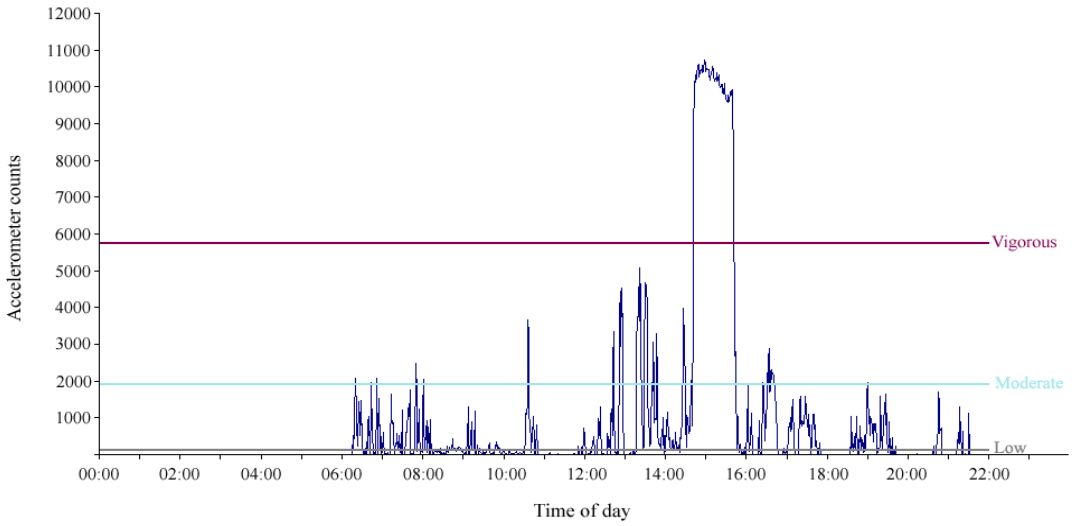

Figure 2. Sample output, provided by an accelerometer, showing physical activity over a day. Minutes between baseline and the grey line (Low) is time spent inactive, minutes above the blue line (Moderate) is time spent on moderate or vigorous intensity activities and minutes above the purple line (Vigorous) is time spent on vigorous intensity activities only. The subject whose data is shown on this graph accumulated about one hour of continuous, vigorous intensity physical activity and one hour of moderate intensity, dispersed over the day.

A set of most relevant and surprising information has been obtained from the accelerometer data. Findings from the population-based study performed in Sweden showed that:

- Objectively measured physical activity estimates estimates yielded lower values and a different activity pattern compared with those obtained by commonly used self-reporting processes.
- Fifty-two percent accumulated 30 minutes per day of at least moderate intensity physical activity.
- Only one (1) per cent achieved those 30 min from three or more bouts of at least 10 minutes (i.e. according to the current recommendations)

[9] Hagströmer M, Oja P, Sjöström M. Physical activity and inactivity among adults assessed by accelerometry. *Med Science Sports Exercise*. 2007;39:1502-1508

- Men spent more time than woman in moderate and vigorous physical activity, but there was no gender difference in average intensity (i.e. total activity).
- The variations in inactivity (e.g. time spent sitting, standing and lying) could not be explained by gender, age or Body Mass Index (BMI). Thus, younger individuals are as inactive as older, and inactivity as such is not influencing body weight (Figure 3).

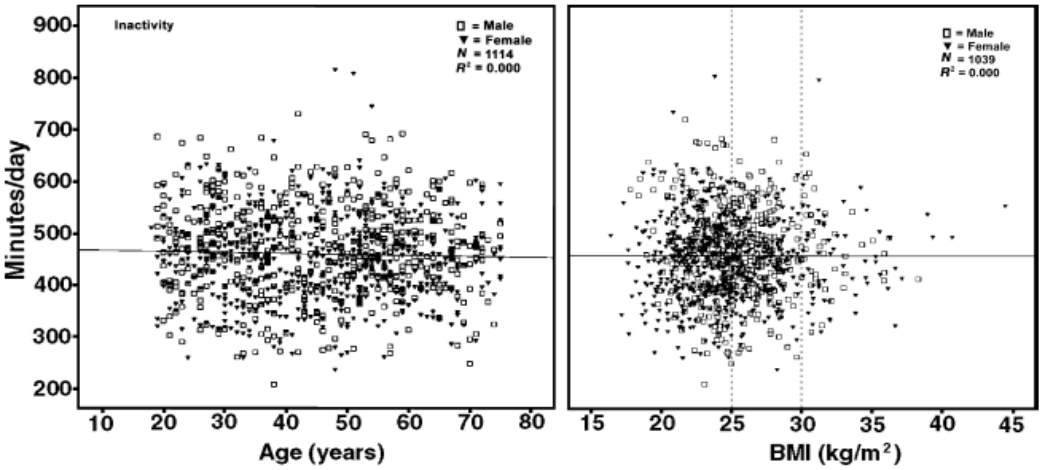

Figure 3. Time spent in inactivity, by age and BMI. (From Hagströmer et al., 2007)

The latter finding is remarkable. If there is a relation at all between physical activity and body weight, it is that the lack of moderate and vigorous activity relates to overweight. The proportion of individuals in the population with almost complete lack of moderate- to vigorous activity is relatively high, approximately two thirds. This means that food consumption habits have been the major determinant of their body weight.

To conclude, the accelerometer data highlights the need to better understand the nature and measurement issues of health-enhancing physical activity, among adults as well as young individuals. This is of importance for the stakeholders involved in physical activity interventions. Subjective methods, such as questionnaires, give information of limited value, as they are hampered by low accuracy due to recall biases, differential biases, social desirability and reactivity. Objective methods using accelerometers give much more detailed and accurate information, but the cost for the equipment is high.

A number of current and planned Platform commitments should have included objective methodologies for the base-line determinations and outcome evaluation. More co-ordination or co-operation in between actors and scientists are definitively needed. The scientists and the Platform actors have a possibility to co-ordinate and co-operate more systematically to improve the quality of the actions and their outcome.

The ALPHA project

The European Commission is currently funding the ALPHA project (Assessment of Levels of Physical Activity). The aim of the project is to define the optimal methodology (accuracy and feasibility) to assess physical activity to get comparable country data within the EU and perhaps also across the world. DG SANCO's Health Information Unit will consider the methodology for use within the healthy monitoring system under development. The ALPHA project will organize its consensus meeting early autumn in 2009.

6. GLOBAL TRENDS: MINOR CHANGES, LARGE EFFECTS

Do minor changes in physical activity levels cause any effect on the population health?

The gradual increase in body weight that leads to overweight and obesity is the long-term consequence of a sustained positive energy balance, when energy intake exceeds expenditure. Changes in energy balance can result from changes in food intake and/or levels of physical activity. Even minor changes in activity and/or intake can have appreciable effects on body weight and the prevalence of obesity[10]. Identifying which specific physical activity (and diet) patterns contribute to the risk of weight gain and subsequent overweight and obesity in the population, however, is a challenge. These patterns and their changes over time may be difficult to capture with existing survey methods. The new accelerometry method may here be useful.

Societal trends

Although changes in patterns and levels of physical activity have been difficult to assess, large shifts are generally understood to have occurred in physical activity, food intake and meal patterns, particularly in the last two decades. These rapid and global changes include[11]:

- a shift away from energy-intensive occupations towards service-sector occupations;
- concurrent reductions in the level of physical activity in each occupation;
- changes towards reduced energy expenditure in the type of transportation used, leisure activity patterns, and domestic chores.

Economic analyses of time allocation over the past four decades indicate that people spend more time in leisure and travel or transportation and less in productive activities, whether at work or at home. Interestingly, these data show that leisure-time industries outpaced GDP growth for both active (such as sporting goods and gyms) and sedentary (such as spectator sports and cable television) industries, although industries associated with sedentary lifestyles displayed the fastest growth[12].

Asymmetry in appetite control

Weight gain occurs when energy intake is not reduced to match the lower energy needs of an inactive or sedentary lifestyle. Physiological research gives evidence of a powerful interaction between inactivity and energy-dense diets that produces a gain in body weight. Physically active people are more likely to have energy needs above the normal food supply, and their energy homeostasis relies on efficient hunger signals[13]. Inactive people, however, tend to have energy needs below the norm for food consumption, so their energy homeostasis relies on physiologically inefficient satiety signals. In relation to weight control, the importance of physical activity and sedentary behaviour must be viewed from the perspective of this asymmetry in appetite control, which favours passive over-consumption of energy-dense diets.

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[10] Hill JO, Wyatt HR. Role of physical activity in preventing and treating obesity. *Journal of Applied Physiology*, 2005, 99(2):765–770.

[11] Popkin BM. Using research on the obesity pandemic as a guide to a unified vision of nutrition. *Public Health Nutrition*, 2005, 8(6A):724–729

[12] Sturm R. The economics of physical activity: societal trends and rationales for interventions. *American Journal of Preventive Medicine*, 2004, 27(Suppl. 3):126–135

[13] Prentice A, Jebb S. Energy intake/physical activity interactions in the homeostasis of body weight regulation. *Nutrition Reviews*, 2004, 62(7 Pt 2):S98–S104

7. LEVELS OF PHYSICAL ACTIVITY ACROSS EUROPE

Can we compare physical activity data in between European countries?

Both the EU and the WHO are developing of surveillance systems to monitor trends within and between countries to get comparable data. Measuring physical activity at the population level, however, is difficult. Until now the lack of well-standardized measurement methodologies has impeded these efforts, but new instruments have been developed, such as the International Physical Activity Questionnaire (IPAQ)[14].

Eurobarometer Study 2002 and 2005

An Eurobarometer study collected data on the 15 EU countries in 2002 and 25 in 2005 (data remains to be analysed) using the IPAQ[15]. The prevalence of sufficient total activity, based on the recommendations on health-enhancing physical activity, shows that nearly 69% of the countries are at the low end of the physical activity scale, thus inactive. The most active were the Netherlands and Germany, the least active, Sweden.

Further, the results show that regular walking was most prevalent in Spain, Denmark, Finland, Germany and Ireland. The prevalence of sitting for six hours or more a day was highest in Denmark (56%) and lowest in Portugal (24%). Of the seven most active countries, based on the prevalence of sufficient activity (the Netherlands, Germany, Greece, Luxembourg, Denmark, Portugal), five showed relatively high rates of sitting.

The study also provided information on socio-demographic variables related to levels of physical activity (Table 2). Males were 1.6 times more likely than females to be active sufficiently, according to total weekly activity and slightly more likely to sit for at least six hours a day. There was no gender difference in regular walking. The relationship between age and sufficient activity varied across the outcome measures. The likelihood of sufficient activity decreased with age, while that of sitting for six hours or more a day was highest in the middle-aged group. There was no age relationship with walking.

In addition, intermediate educational level was related to a higher likelihood of being sufficiently active physically than was low and high educational level. The size of the residential community was related to all activity measures. People living in large towns were less likely to be sufficiently active than those living in small towns, towns and cities. Regular walking increased with increasing size of towns, and sitting increased in a dose–response manner with the size of town.

In summary, the Eurobarometer study provides unique cross-country comparisons of population levels of health-enhancing physical activity by using a new measurement tool designed for the purpose. The findings suggest that two thirds of the adult populations of EU countries in 2002 were insufficiently active for health benefits. These observations indicate a need for urgent action to promote health-enhancing physical activity across European countries and particularly in the least active. The lack of EU-wide data on health-related fitness is also remarkable.

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[14] Craig CL et al. International physical activity questionnaire: 12-country reliability and validity. *Medicine and Science in Sports and Exercise*, 2003, 35(8):1381–1395

[15] Sjöström M et al. Health-enhancing physical activity across European Union countries: the Eurobarometer study. *Journal of Public Health*, 2006, 14:291–300

Table 2. Association between sociodemographic variables and physical activity (adjusted odds ratios (OR) with 95% CI) in the EU, 2002

Sociodemographic variable	Sufficient total activity		Sedentary		Walking for 30 minutes 5 times a week		Sitting for 6 hours a day	
	Adjusted OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI
Gender								
Female	–	–	–	–	–	–	–	–
Male	1.57	1.46–1.68	0.82	0.76–0.88	0.97	0.91–1.04	1.17	1.09–1.25
Age								
15–29 years	–	–	–	–	–	–	–	–
30–54 years	0.78	0.72–0.85	1.26	1.14–1.38	1.02	0.94–1.11	0.64	0.59–0.70
> 55 years	0.42	0.37–0.46	1.99	1.79–2.21	1.03	0.93–1.13	0.88	0.80–0.97
Education								
≤15 years	–	–	–	–	–	–	–	–
16–19 years	1.18	1.06–1.30	0.76	0.69–0.84	1.13	1.03–1.24	1.11	1.01–1.22
≥ 20 years	1.03	0.92–1.15	0.76	0.68–0.84	1.08	0.98–1.20	1.68	1.51–1.86
Location								
Small town	–	–	–	–	–	–	–	–
Town	0.95	0.86–1.05	0.96	0.87–1.06	1.18	1.07–1.30	1.09	0.99–1.20
Large town	0.83	0.74–0.92	1.05	0.95–1.17	1.13	1.02–1.24	1.42	1.28–1.57
City	0.93	0.84–1.02	0.87	0.78–0.95	1.25	1.14–1.38	1.63	1.49–1.79
Country								
Belgium	1.07	0.87–1.33	2.83	2.30–3.48	1.00	–	1.95	1.59–2.40
Denmark	1.75	1.43–2.15	1.24	0.99–1.55	2.72	2.24–3.31	3.04	2.47–3.74
Germany	2.27	1.89–2.72	1.31	1.08–1.59	2.10	1.77–2.49	2.08	1.72–2.50
Greece	2.00	1.63–2.45	1.89	1.53–2.35	1.59	1.31–1.94	1.61	1.31–1.98
Italy	1.14	0.92–1.41	2.22	1.80–2.75	1.98	1.63–2.41	2.68	2.19–3.28
Spain	1.09	0.87–1.35	1.82	1.46–2.26	3.20	2.63–3.89	1.61	1.31–1.98
France	1.01	0.82–1.25	3.37	2.74–4.15	1.26	1.03–1.53	1.31	1.06–1.62
Ireland	1.23	1.00–1.52	2.34	1.89–2.90	2.02	1.67–2.45	1.39	1.13–1.72
United Kingdom	1.31	1.08–1.60	2.49	2.04–3.04	1.50	1.25–1.81	1.47	1.21–1.79
Luxembourg	1.92	1.51–2.43	1.40	1.09–1.81	1.75	1.39–2.20	2.19	1.74–2.76
Netherlands	2.62	2.14–3.20	1.00	–	1.11	0.91–1.36	2.55	2.08–3.13
Portugal	1.59	1.28–1.98	1.58	1.26–1.97	1.30	1.06–1.60	1.00	–
Finland	1.61	1.31–1.97	1.30	1.05–1.62	2.25	1.86–2.73	2.44	1.99–2.99
Sweden	1.00	–	2.10	1.70–2.60	1.57	1.29–1.91	2.32	1.89–2.85
Austria	1.12	0.90–1.39	2.27	1.83–2.81	1.69	1.39–2.06	1.76	1.43–2.17

Note. Rows with missing data are the reference groups. In the country analysis, the reference country was the one with the lowest prevalence for each activity measure.

Source: Eurobarometer data Sjöström M et al. (2006), Health-enhancing physical activity across European Union countries: the Eurobarometer study. *Journal of Public Health* 14(5), 291.300.

8. ACTIONS THAT CAN HELP TO CONTAIN OR REVERSE CURRENT OBESITY TRENDS

What can be done to contain or reverse the obesity trends? Is it worth the effort? Can promotion of physical activity help to reverse the current obesity trends?

Effects on body weight; Ecological, European and longitudinal studies

Ecological data are scarce in the literature. In one widely cited study, the increasing prevalence of obesity in the UK from 1950 to the mid-1990s was observed in parallel with increasing levels of indicators of sedentary behaviour, such as the number of cars per household or hours spent viewing television. However, limited causal inference can be drawn from this type of data[16].

Very few EU-wide population surveys have assessed physical activity/inactivity levels in relation to weight outcomes. In a series of papers from a pan-European survey, using self-reports, which included representative samples of about 1000 adult subjects from the EU 15, low participation in leisure-time physical activity was inversely associated with the prevalence of obesity, while the amount of time spent sitting during leisure was positively associated with BMI, independent of leisure-time physical activity. Two different definitions of sedentary lifestyle were used: 1) spending less than 10% in leisure activities over 4 METs; and 2) no leisure-time physical activity reported and being over the median (6 hours a week) for time spent sitting during leisure. Both indicators of sedentary behaviour were positively associated with obesity. The number of hours spent sitting at work was also found to be positively associated with obesity[17].

In various population groups, a large number of cross-sectional studies show an inverse (and expected) association between habitual physical activity and indicators of obesity[18]. People who are overweight or obese display lower levels of cardio-respiratory fitness than those of normal weight. The few longitudinal cohort studies suggest that higher levels of physical activity may limit weight gain over time. In quantitative terms, one additional hour of brisk walking per day was associated with a decrease of about 25% in the risk of obesity (BMI over 30 kg/m^2), as indicated by a six-year follow-up of women from the Nurses' Health Study. Considering activities from daily living, a five-year follow-up study in men showed an inverse association between walking or cycling to work and weight gain over time. Whether there is a gender difference in the relationship between low levels of physical activity and body weight gain, remains insufficiently documented[19].

Inactivity and weight gain: no simple relationship

Although thinking that physically inactive people are more likely to gain weight over time is intuitively appealing, the direction of causality can be questioned, as overweight people may find physical activity to be more difficult, uncomfortable or embarrassing. A Danish study recently documented that increases in body weight preceded an increase in leisure-time physical inactivity[20]. The direction of the relationship between physical activity and weight gain is therefore less easy to

[16] Prentice AM, Jebb SA. Obesity in Britain: gluttony or sloth? *BMJ*. 1995 Aug 12;311(7002):437-9

17 Martinez JA, Kearney JM, Kafatos A, Paquet S, Martinez-Gonzalez MA. Variables independently associated with self-reported obesity in the European Union. *Public Health Nutrition.* 1999 Mar;2(1A):125-33

[18] Wareham NJ et al. Physical activity and obesity prevention: a review of the current evidence. *Proceedings of the Nutrition Society*, 2005, 64(2):229–247

[19] Saris WH et al. How much physical activity is enough to prevent unhealthy weight gain? Outcome of the IASO 1st Stock Conference and consensus statement. *Obesity Reviews*, 2003, 4(2):101–114

20 Petersen L, Schnohr P, Sorensen TI. Longitudinal study of the long-term relation between physical activity and obesity in adults. *International Journal of Obesity and Related Metabolic Disorders*. 2004 Jan;28(1):105-12

demonstrate than might commonly be thought. In addition, very few studies have used an objective assessment of physical activity, such as that provided by accelerometers or heart-rate recordings. Such measures would indeed be needed to address in more detail the issue of dose (of physical activity) and response (weight gain).

Few studies of obesity and physical activity levels have taken account of dietary intakes. A six-year prospective study[21] of Swedish women demonstrated an interaction between habitual physical activity and energy or fat intake, with greater weight gain being associated with greater energy or fat intake only in the less active group. The amount of physical activity needed to prevent gaining or regaining weight obviously depends on the habitual food intake among the population in question. This means that the nutritional context must be considered. Recommendations about physical activity made, for example, for North American populations might therefore not be directly applicable to Europeans. This is not because the physiology of exercise would differ between different populations, but because energy output takes place at a different level of intake.

Evidence from prospective studies documents the importance of the amount of time dedicated to sedentary occupations, as a separate behaviour from physical activity or inactivity, in relation to weight gain. In women from the Nurses' Health Study two hours of additional television viewing was associated with a 25% increased risk of becoming obese during six years of follow-up[22]. This association was independent not only of habitual physical activity but also food intake. Part of the influence is likely to be mediated through associations of sedentary pursuits with other health behaviours, such as smoking and alcohol intake, which tend to cluster.

Children and adolescents

The available evidence indicated that data from prospective studies suggest that increased physical activity and decreased sedentary behaviour protect against weight gain in childhood and adolescence. The magnitude of the effects identified, however, was considered small. Interestingly, there is some indication that physical activity in childhood and adolescence may be associated with body composition in adulthood. Regarding fitness, there is strong evidence indicating that: higher levels of cardio-respiratory fitness at childhood and adolescence are associated with healthier cardiovascular profile later in life. Furthermore, improvements in muscular strength from childhood to adolescence can act as a counterweight to increased body fat in adulthood. The evidence is moderate for the association between changes in cardio-respiratory fitness and cardiovascular disease risk factors, and between cardio-respiratory fitness and the risk of developing metabolic syndrome, and arterial stiffness. All these findings suggest that preventive measures should begin early in life.

Effects independent of body weight: prevention

Type 2 diabetes and the metabolic syndrome. A major health consequence of obesity is type 2 diabetes. A comprehensive lifestyle intervention, including advice for regular physical activity, has been shown to delay the onset of type 2 diabetes in people at risk. A more recent analysis of this intervention study[23] indicated that moderate physical activity alone is associated with a substantial reduction in the risk of diabetes. These findings suggest that an increase in lifestyle physical activities can substantially reduce the disease burden of populations.

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[21] A prospective study watches for outcomes, such as the development of a disease, during the study period and relates this to other factors such as suspected risk or protection factor(s). The study usually involves taking a cohort of subjects and watching them over a long period. Prospective studies usually have fewer potential sources of bias and confounding than retrospective studies.

[22] Hu FB, Li TY, Colditz GA, Willett WC, Manson JE. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA*. 2003 Apr 9;289(14):1785-91

23 Laaksonen DE, Lindstrom J, Lakka TA, Eriksson JG, Niskanen L, Wikstrom K, et al. Physical activity in the prevention of type 2 diabetes: the Finnish diabetes prevention study. *Diabetes*. 2005 Jan;54(1):158-65

Low cardio-respiratory fitness was recently shown to be a strong and independent predictor of new cases of metabolic syndrome in both men and women, which could be one of the mechanisms for an increased risk of cardiovascular disease with low fitness level. Moreover, cardio-respiratory fitness seems to be associated with decreased mortality, regardless of the level of body weight or the presence of metabolic syndrome, in men.

Cardiovascular diseases. The health benefits of at least moderate-intensity physical activity seem to apply to all people, regardless of their weight. Data from several studies indicate that overweight or obese people who are physically active or have moderate-to-high levels of fitness have decreased risks of death from all causes and cardiovascular diseases, compared with those who are inactive and unfit. Regular physical activity may thus increase longevity in overweight or obese people, independent of their weight status or loss.

Management of overweight

Although physical activity is recognized as a major component of the management of overweight or obesity, the importance or magnitude of the beneficial effects of physical activity in this context differs according to the outcome examined. Physical activity appears essential for weight maintenance after diet-induced weight loss, rather than for weight loss per se. It is also important for the preservation of fat-free mass during weight loss. Physical activity has beneficial effects on fitness and reducing obesity-related complications, such as cardiovascular diseases and diabetes. Most data suggest that total volume of physical activity, rather than its intensity, is important for managing weight. Since the emerging evidence on physical exercise shows that it has limited effect for weight loss, this is more effectively treated as a clinical health issue with professional attention to diet and nutrition. From a public health perspective, the focus should be on preventing of weight regain after weight loss.

Prevention of weight gain, and regain

Primary prevention. There is no definite consensus on the amount of physical activity required to prevent weight gain at the population level, and the shape of the dose–response curve is not clear. This is a complex issue, especially in view of the difficulty of matching energy intake with energy expenditure in times of readily available food and low levels of habitual physical activity[24]. A 2003 consensus statement by the International Association for the Study of Obesity acknowledged the important contribution of 30 minutes of moderate daily physical activity to health, even in overweight or obese people. Nevertheless, this dose might be insufficient to prevent weight gain over time by some people. For them, additional physical activity (with increased duration and/or intensity) or decreased energy intake is recommended.

Secondary prevention. While consensus is lacking on the amount of physical activity needed to prevent weight regain, there is an indication that adults would need 60–90 minutes per day of moderately intense activity, or smaller amounts of vigorously intense activity, to avoid regaining weight.

The next steps; Monitoring physical activity and obesity

Monitoring physical activity at the population level is a major part of the public health response to current concerns about the obesity epidemic. Standardised methods of surveillance are required, however, to make better assessments of current physical activity levels and trends over time, better

[24] Blair SN et al. The evolution of physical activity recommendations: how much is enough? *American Journal of Clinical Nutrition*, 2004, 79(5):913S–920S

plans for public health interventions using physical activity and better monitoring of their effects in preventing and controlling obesity. Such monitoring systems should allow the identification of vulnerable groups, such as people of low socioeconomic status, that are at increased risk of low cardio-respiratory fitness, low physical activity levels and increased rates of obesity.

In addition, environmental factors that encourage greater physical activity must be better understood and described. Large-scale use of objective monitoring of physical activity needs to be further explored, for the better delineation of the dose-response curve of body weight outcomes. Moreover, research is required to define the value of implementing a health-related fitness assessment in the framework of European health monitoring systems. Finally, steps should be taken to provide comparable data on food intake and physical activity levels, given the evidence that both contribute to the obesity epidemic, so that the interaction between the two can be assessed in more detail.