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Physical activity in groups of Swedish adults

Are the recommendations feasible?

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Abstract

Background: Successful public health programs in the area of physical activity demand a clear understanding of how, and to what extent, people are physically active. Physical activity is, however, difficult to measure accurately.
Objective: We conducted tests using various methods, including an accelerometer and the International Physical Activity Questionnaire (IPAQ).
Design: The results were applied on a feasibility sample, aged 41 ± 10 years ($N = 49$) and on random samples of a community in the Stockholm area ($N = 200$) and of the Swedish population ($N = 196$), aged 47 ± 14 years and 45 ± 13 years respectively.
Results: A majority of individuals in all samples reached the current recommendation of at least thirty minutes in total per day or more of moderate physical activity. However, based on accelerometer data this was achieved mainly through sporadic bouts of less than one minute. Few, if any, appeared to reach thirty minutes of continuous moderately intense activity or even continuous bouts of at least ten minutes three times per day.
Conclusions: This study gives new insight into how, and to what extent, people are physically active, and raises a number of issues. Which is more effective for public health purposes: reaching the total recommended time in short bouts of physical activity or reaching it on one or a few sustained periods of activity? What are the implications for promoting a physically active lifestyle? Current recommendations for physical activity need to be discussed.

Keywords: *Accelerometer*, *doubly labelled water (DLW)*, *guidelines*, *monitoring*, *physical activity*, *questionnaires*.

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Introduction

Successful public health programs targeting the promotion of physical activity and healthy eating demand a better understanding of the art and degree of physical activity in the population than what is currently available. Unfortunately, habitual physical activity is difficult to measure and its prevalence in a population is poorly understood (1). There are still many benefits to be gained by improving our understanding of this issue. Health issues can more easily be identified and described in terms of the prevalence and nature of both activity and inactivity. Better health promotion and disease prevention strategies and policies can be formulated, better plans of action and programs can be adopted, implemented and evaluated. The feasibility of the widespread recommendation for health-enhancing physical activity (2) can more easily be evaluated. Finally, the evidence base of the link between physical activity and health can be stronger and better understood.

There are therefore strong reasons to gather more accurate information on the nature and the prevalence of habitual physical activity in the population. Both subjective and objective methods are available for this purpose with varying validity and practical feasibility (3).

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Subjective methods

Questionnaires are most commonly used when acquiring data from a population set (4). They are relatively inexpensive to develop and can easily be distributed to a large sample of people. Since questionnaires often imply answering questions retrospectively, problems with accurate re-collection and over-estimation arise. In addition, inappropriately or poorly defined terms and concepts cause misunderstandings. There is a body of research on the tendency to overestimate physical activity levels when the self-report methodology is used (5). As a result the absolute validity of questionnaires is generally weak. To many people there is a large discrepancy between the ideal situation ("where I would like to be") and reality ("where I am at the moment"). Whenever a questionnaire is to be used it should be a top priority to make sure that the information obtained is both reliable and valid (6).

Another problem with questionnaires is that they are relatively easy to develop. The focus of questionnaires varies greatly measuring different modes of activities that range from sport to leisure. Many questionnaires are only used once or a few times which compromises consistency. Another issue concerns the comparison between questionnaires: Questions intended to measure the same phenomena are, in fact, very different and the data obtained is not comparable. This results in making coherent overview or discerning trends impossible.

The International Physical Activity Questionnaire (IPAQ) was primarily developed to facilitate cross-cultural comparisons and to provide estimates of prevalence of physical activity levels in populations. IPAQ consists of four different versions: short and long versions of both the self-administered and interview formats. The IPAQ was developed and tested by international researchers from approximately twenty-five centers around the world on all six continents.

In the long versions, the questions are divided into four categories covering time spent in physical activity during the last seven days, at work, during transportation, home-based activities and leisure time. The total time from the four categories gives a measure of the total amount of physical activity. Questions regarding time spent in activity from each category are divided further based on intensity. This gives valuable information as to the nature of the total physical activity. The questions also assess time spent in inactivity during the course of the day.

The IPAQs have had acceptable reliability and validity when compared to objective methods. The World Health Organization (WHO) on both a global and regional scale, and the European Union (EU), are therefore already using, or considering the use of, the IPAQ in monitoring of health trends. The unit for preventive nutrition (PrevNut) at the Karolinska Institute has played a prominent role in the developmental process, and is one of the centers responsible for the continuing refinements and developments of the questionnaires. Collected results from the developmental work with IPAQ, and information about forthcoming studies such as the International Prevalence Study (IPS), as well as downloads of the questionnaires, are available at www.ipaq.ki.se.

Objective methods

Due to the complex task of measuring physical activity, and the difficulties in accurately recalling and reporting activities using subjective methods, there is a great need for objective methods to monitor physical activity in large groups or populations. An objective method with high validity is also the only acceptable criterion measure in the validation process of subjective methods. Doubly labelled water (DLW), heart rate monitoring, and accelerometers are the most used methods for this purpose (3).

DLW can determine the precise energy expenditure over time, but is often too expensive to be utilized in larger studies. Its inability to assess the intensity, frequency and duration of physical activity proves the need for other objective methods. Heart rate monitoring and accelerometers can both be used to determine physical activity levels and patterns and the data can easily be downloaded for further analysis. The accelerometer, a small computer carried in a plastic box around the waist, is convenient to use, and it registers minute-by-minute body movements for up to several weeks. The accelerometers most frequently used today register vertical body movements (uniaxial). The measurement, referred to as 'counts', is a direct measure of physical activity in contrast to heart rate monitoring which is a more indirect measure of the physiological response to activity.

We have tested and evaluated the validity of the most commonly used uniaxial accelerometer (formely CSA activity monitor 7164, now named MTI Actigraph AM 7164), in comparison with energy expenditure estimates from the DLW

methodology (7). We also measured its ability to accurately analyze the intensity of activities (8). The CSA has, on both accounts, proved to be valid. Among the disadvantages are the inability of accelerometers to correctly reflect the amount of energy expended while cycling, stair climbing or activities performed primarily with the arms. Furthermore they can not be used in water. Despite these limitations, the accelerometer must be regarded as a useful tool to measure the total amount of physical activity. Reflecting its popularity, accelerometry and the CSA/MTI instrument in particular, is increasingly used in studies to determine the amount and pattern of physical activity.

Aim of this study

PrevNut has collected data using both questionnaires (IPAQ) and accelerometers in order to create a platform of experiences to more extensively study the amount and pattern of physical activity in the population. Some data and conclusions are presented here from: (A) a feasibility group of fifty healthy volunteers; (B) a random sample (n = 200) from a community in the Stockholm area; and (C) a random sample (n = 196) of the Swedish population.

Material and methods

(A) Healthy volunteers

Fifty healthy adult volunteers, mean age 40.7 ± 10.3 years, most of whom exercised regularly, participated in the study (Table 1). The purpose was to examine physical activity patterns during a week using one subjective (IPAQ, long version, self-administered, last seven days) and one objective method (accelerometry/CSA). Both methods were used on forty-nine healthy adult volunteers (24 male), who all completed the study in February, 2000.

Table 1. Participant characteristics

	Study A (n = 49)	Study B (n = 200)	Study C (n = 196)
Males (n; %)	24 (49)	77 (39)	101 (52)
Age (yrs)	41 ± 10	47 ± 14	45 ± 13
Height (cm)	171 ± 9	172 ± 9	172 ± 9
Weight (kg)	70 ± 10	71 ± 9	74 ± 14
BMI	24 ± 2	24 ± 3	25 ± 4

Table 2. Total self-reported time (min/day) of physical activity as measured by IPAQ (Study A) and time in low, moderate and vigorous physical activity, respectively, and time spent in different categories of activities at moderate and vigorous activities. Mean ± SD.

Reported time (total)	572 ± 220
Low activity	508 ± 220
At least moderate activity	64 ± 82
Moderate activity	44 ± 59
Work	15 ± 34
Transport	5 ± 6
Home activities	8 ± 16
Leisure	17 ± 12
Vigorous activity	20 ± 38
Work	8 ± 29
Transport	0.3 ± 2.4
Home activities	0.9 ± 3.3
Leisure	11 ± 15

(B) Municipality sample

A total of 200 (77 males) out of 250 randomly selected households from a community in the Stockholm area participated in the study (Table 1). The individual in the household between the ages of 18 and 65 years who most recently had his/her birthday was asked to participate. Mean age: 47.1 ± 13.6 years. Physical activity was assessed by the long IPAQ telephone-interview version, last seven days, and data were collected during a week in February, 2000.

(C) National sample

In this study, 196 participants (101 males), mean age 45.0 ± 13.0 years, were randomly selected from the population register of Sweden (Table 1). Physical activity was assessed by the CSA accelerometer for one week. The accelerometers were distributed and returned using regular mail over the whole year.

Data analyses

Questionnaire data, IPAQ: For each participant, the accumulated time spent in moderately and vig-

Table 3. Time (min/day) spent in moderate and high intensity physical activity, and total time spent in at least moderate intensity as measured by accelerometers (Study C). Mean ± SD.

	Male (n = 101)	Female (n = 95)	All (n = 196)
Moderate	35 ± 26	30 ± 20	33 ± 23
High	2 ± 5	1 ± 2	2 ± 4
Total	37 ± 27	31 ± 21	35 ± 24

orous activity in the different activity domains during the day was assessed. Additionally, the total recorded time and time spent in low physical activities were recorded (Table 2).

Accelerometer data: CSA data was analyzed using a software application specially designed and written for this purpose based on Microsoft Access and Statistical Package for Social Science for Windows, 9.0, 1998 (SPSS Inc., Chicago. IL). The total registered time was recorded by the software, and also accumulated time spent in moderate and high intensity physical activity. The software could also be used to investigate the number of continuous bouts of at least moderate intensity, ranging from one to ten continuing minutes (Table 3).

The case for counts – a comment

In order to determine what constitutes moderate intensity, one needs to establish at what level the counts correspond to a valid reference point for moderate intensity. Cut-off values for the counts, reflecting low (<3 METS), moderate (3 to 6 METS), and high (>6 METS) intensities, were established according to Freedson et al (9). One MET- corresponds to a person's energy expenditure at rest (3.5 ml O_2 kg^{-1} min^{-1}), and should be considered as an approximate since specific activities may result in values over- or underestimating energy expenditure. This means that, in studies focusing on the intensity patterns of specific activities, the cut-off values may be questioned. This is less problematic if one studies the activity pattern occurring during all waking hours since the contribution of those activities, cycling for example, is relatively small.

Results

(A) Healthy volunteers

The total self-reported time using IPAQ was 9 hours and 32 minutes (572 ± 220 min) per day. Moderate activities, or higher, averaged 64 minutes per day, of which 44 minutes were moderate activity and 20 minutes were vigorous activity (Table 2). Time spent at work, in leisure activities (especially for males) and home-based activities (especially females) contributed the most to the overall time spent in moderate physical activity or higher (Table 2). The remaining time, 8 hours and 28 minutes, represented low physical activity, i.e. time spent sitting, during transportation, as well as time spent in slow walking. Nearly all, 96 per cent of the study participants reported that they had been moderately or vigorously active during leisure-time. Approximately 45 per cent of the sample reported at least 60 minutes of moderate physical activity per day, while 75 per cent reported at least 30 minutes. Nearly 60 per cent reported at least 10 minutes per day of vigorous activity.

Total time registered per day with the CSA accelerometer averaged 14 hours and 20 minutes (860 ± 355 min). Participants averaged 71 ± 21 minutes per day in moderate intensity activities and 10 ± 4 minutes in activities of high intensity. Every second person (49 per cent) fulfilled 60 minutes per day of activity of at least moderate intensity, while nearly all, 99 per cent, were active for at least 30 minutes per day at that intensity level. Sixty per cent reached one bout and two per cent at least three bouts per day of continuous 10-min periods of moderate or high physical activity intensity.

(B) Municipality sample

The subjects reported through IPAQ 11 hours 18 minutes (678 ± 385 min) of total activity per day of which 187 ± 164 minutes were at least moderate physical activity. Of these, 30 ± 56 minutes were vigorous activity. Time spent at work and in leisure activities and home-based activities (especially females) contributed the most to the overall time spent in moderate physical activity or higher (Fig. 1). The remaining time, 8 hours and 11 minutes, was time spent sitting, during transportation, and in slow walking. The percentage of subjects reporting moderate and vigorous activities during leisure-time was 45 per cent. About 85 and 80 per cent of the sample reported at least 30 or 60 minutes per day of moderate activities per day respectively, and about 35 per cent reported at least 10 minutes of vigorous activity per day (Fig. 2).

(C) National sample

The total registered CSA time was 13 hours and 20 minutes (800 ± 88 min) per day. Physical activity corresponding to at least moderate intensity averaged 35 minutes per day (Table 3). On average, males and females accumulated 2 and 1 minute, respectively, of high intensity activity daily. About 50 per cent of the individuals accumulated 30 minutes of at least moderate intensity physical activity, and 12 per cent accumulated 60 minutes (Fig. 3). Only 15 per cent of the sample achieved at least one 10 minute bout of moderate intensity physical activity, whereas one per cent achieved three bouts per day. Five per cent of the individuals accumu-

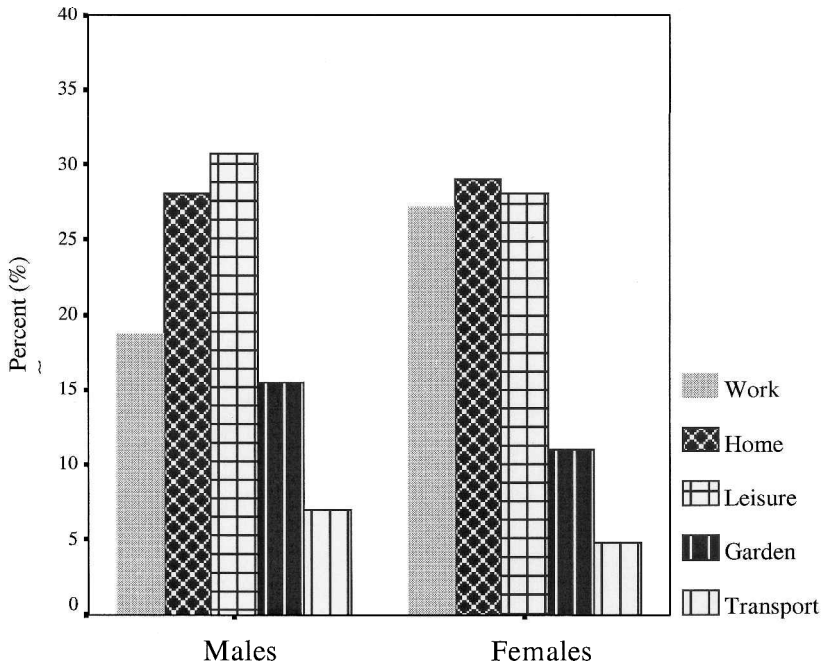

Fig. 1. The percentage of total time spent in physical activity of different categories according to gender (Municipality study, Study B).

lated at least 10 minutes of high intensity. Thus, 50 per cent of the sample was physically active according to the current recommendation for health enhancing physical activity if all minutes of activity at this level were encountered, while only about one per cent was active according to the recommendations for 30 consecutive minutes, or 3×10 minutes.

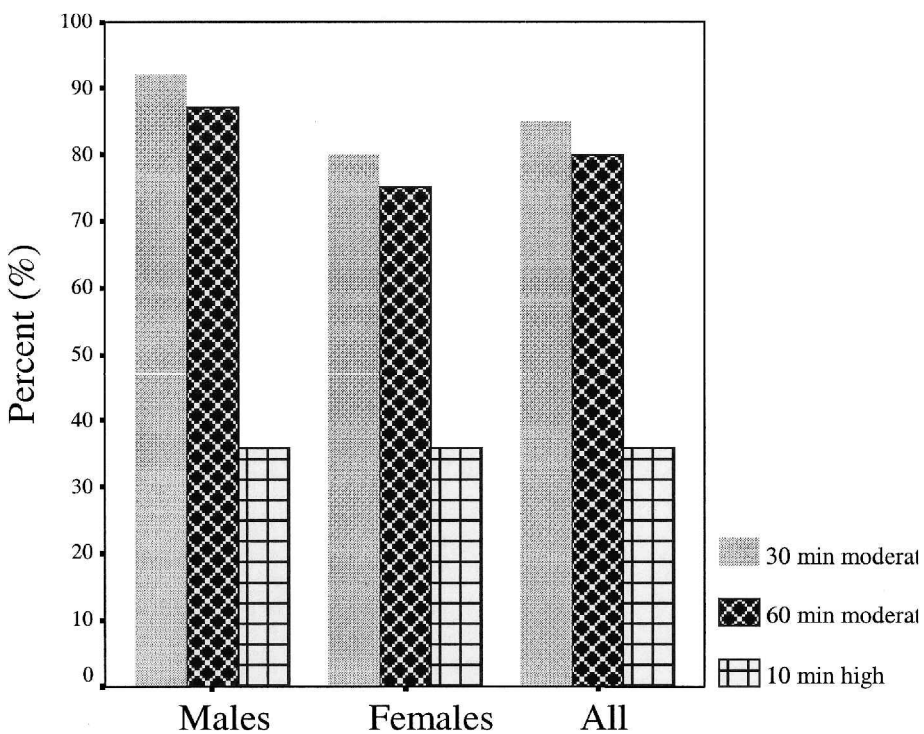

Fig. 2. The relative number of participants in the Study B (using IPAQ) reaching at least 30 and 60 minutes respectively of moderate physical activity per day, as well as at least 10 minutes of vigorous activity.

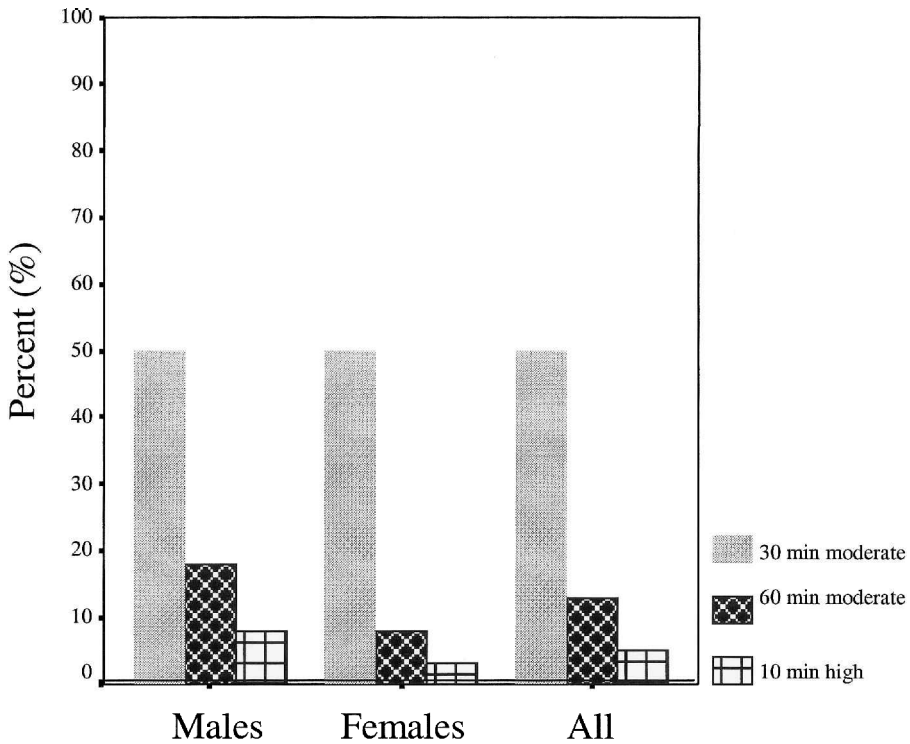

Fig. 3. The relative number of participants in Study C (using CSA accelerometers) reaching at least 30 and 60 minutes respectively of moderate intensity physical activity per day, as well as at least 10 minutes of high intensity.

Discussion

The current guideline for the amount of physical activity necessary to promote health and prevent disease in a population is based on a recommendation formulated 1995 by representatives for the Center for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM) (1). The rationale behind the recommendation was the growing public health concern regarding physical inactivity, and the need for public health programs to promote physical activity in large segments of the population. In addition, several studies mainly published in the early 1990's provided the scientific rationale for this new guideline, which emphasized the importance of moderate intensity activity (10). It was therefore of utmost importance to formulate a clear, valid, and easily understood recommendation that explicitly stated the amount and nature of physical activity required to promote health. Similar recommendations focusing on moderate intensity physical activity were published in Sweden even as early as the 1960's (11).

The physical activity recommendation, has had a strong impact all over the world, and was defined as: "Every adult should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week [...] intermittent bouts of physical activity, as short as 8 to 10 minutes, totaling 30 minutes or more on most days provide beneficial health and fitness effects".

Within the recommendation, the most common definition of physical activity was included-"any bodily movement produced by skeletal muscles that results in energy expenditure" (12).

Thus, physical activity entails all activities performed on a daily basis, such as during transport, in the home, and during leisure-time. The latter category includes activities such as exercise and training. Exercise implies planned, structured and repetitive activities done to maintain or improve fitness (12). Traditionally, this type of activity has received by far the greatest attention. However, other types of activities performed on a daily basis normally constitute the greater part of the total daily physical activities. Consequently, the interest from researchers, public health educators and other groups promoting physical activity are increasingly focusing on these lifestyle-based activities. The magnitude and nature of the link between low or moderate-intensity activity and health is relatively unknown.

The recommendation of 30 minutes of daily moderate activity is partly based on experimental data, partly on extrapolates of available results, mainly epidemiological data. A new feature com-

pared to older recommendations was that similar health effects could be obtained with 3–4 daily 8–10-minute bouts of physical activity as with a single longer bout of 30 minutes. However, the scientific evidence for this statement is weak at closer inspection.

Taken together, there is almost no data in the literature on population estimates regarding habitual physical activity. There is some knowledge regarding the extent of exercise habits and its determinants, but there is no data available of the physical activity patterns in the population. Moreover, there is limited data about its distribution according to gender, age, socio-economic conditions, etc. Neither the nature nor the main components of physical activity – the intensity, the duration, and frequency – are known. Thus, the underlying evidence behind the recommendation is not as strong as it should be.

More recent recommendations (13, 14) have a more stable scientific platform, although data on amount and pattern of activity are still lacking. Both the EURODIET Report and a recent report from the National Academy of Sciences (USA) conclude that 30 minutes of daily moderate activity is insufficient to prevent weight gain, and recommend 60 minutes or more (up to 80 minutes) of such activity.

The results from the municipality study, obtained by a subjective method (questionnaire), and the on-going national study using an objective method (accelerometer), provide an interesting, and perhaps surprising, picture of the physical activity pattern in the population. In addition to a methodological discussion, the results should give rise to a discussion regarding the feasibility of the current guideline.

It has been known for quite some time that people over-report the extent to which they are physically active – a fact that should apply to most studies conducted in the past that used questionnaires. Study A, using both questionnaire and accelerometer, showed that the difference in between the methods in total physical activity and the time spent in moderate activity and higher are relatively small. Having said this, the differences obtained if comparing the results from Study B and Study C illustrate the difficulties in comparing studies with different methodological approaches.

The results presented here clarify the need for identical or at least similar methodology to make data comparisons possible, within and between countries. Of the methods available today, the questionnaires (IPAQ) and the accelerometer (CSA) may be among the best available methods to obtain relevant and valid information regarding the extent and nature of physical activity. Work is currently conducted on an international level to continue to develop the instruments.

Some of the differences in registered activity between the studies may be explained by the fact that the sample in Study A most likely was more active than the rest of the population. Similarly, the participants in the municipality study (Study B) are expected to be more active than the population as a whole since a higher proportion of the sample were from higher socio-economic groups (85% lived in private houses). Finally data collection was carried out during February a time when participation in outdoor activities reach a minimum.

This may partly explain why home-based moderate activities were as prevalent as activities performed during leisure, especially for women (Fig. 2). Barely half the sample (45%) reported moderate activities during leisure-time. Although a large proportion of the sample was mostly sedentary, the majority of participants were regularly moderately, or above, active for 30 minutes or more per day. Similar experiences have been made in studies on activity level among elderly individuals (15).

The result is thought provoking. Home-based activities, assumed to bring important health-benefits to the individual, may have a significant impact on the public health. As mentioned earlier, previous studies investigating the extent of participation in physical activity have often defined physical activity as planned and structured exercise. Consequently, they have overlooked the contribution of home-based daily activities. The confusion related to the definitions of different common concepts and terms is a problem.

The participants in Study C accumulated approximately 35 minutes of moderate or higher intensity physical activity per day as assessed by the accelerometer. Of these 35 minutes, only 8 minutes were bouts, which last for 2 minutes or more. The remaining 27 minutes were activities of one-minutes bouts. The analyses conducted so far indicate that those sporadic activities are spread throughout the day, and most likely include short bouts of transportation from one place to another and other intermittent daily movements.

The current recommendation stresses that 30 minutes of moderate activities on most, preferably all, days of the week can have significant and

positive health effects, and that the activities can be accumulated by shorter bouts each lasting around 10 minutes. Only one participant out of one hundred in Study C reached three 10-minute bouts of moderate-intensity physical activity. Only a few reached one continuous 10-minute bout per day.

In the municipality study (Study B), 85 per cent of participants reached, according to IPAQ-data, the current recommendation of 30 minutes of moderate activity per day, and 75 per cent reported that they accumulated 60 minutes. The corresponding figures in Study C (using accelerometers) were 50 and 13 per cent respectively (Fig. 3). Only a small proportion of the subjects from the two studies were active corresponding to high intensity physical activity for a total of at least 10 accumulated minutes per day. One may assume that regular exercise a few times per week, for example jogging, would easily maintain an average of at least 10 minutes of high intensity physical activity per day. This gives some indication of the extent and nature of physical activity habits in the studied population.

And so the questions remain: How active is the population in reality? Is the recommendation feasible? According to this study, a large proportion of the population appeared to reach the daily 30 minutes of physical activity per day as outlined in the current recommendation, but only a few subjects accumulated 3×10 minutes of continuous bouts of moderate intensity of physical activity, especially the exercise-type of activities.

This study has managed to capture some of the complex issues involved in measuring physical activity, and to some extent increased our understanding of the amount and pattern of physical activity in a population. As indicated in this study, there are several issues that need to be examined further. For example we don't know whether it is the total amount of activity accumulated during the day, or whether the activity needs to be performed in continuous bouts in order to achieve health benefits. There is a great need for further experiences and better understanding of measuring physical activity as well as more research investigating the link between activity and health, and the therapeutic and preventive effects of physical activity.

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