Physically active commuting between home and work/study place in Greater Stockholm

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Abstract
One of the most often suggested strategies for enhancing public health through physical activity (PA) is to make use of the need for transportation between home and work/study place through walking or bicycling. This paper presents a study based on a questionnaire and map distributed to about 2000 physically active commuters in Greater Stockholm. Five variables are examined: distance, commuting time, velocity, perceived exertion and body mass index (BMI). The results demonstrate that most of the commuters meet the WHO physical activity recommendations. A methodological conclusion from the study is that subjective estimations of commuting distances do not give reliable values. Suggested methods for more accurate values are measuring routes drawn on maps or to use the straight-line distance between home and work/study place together with a correction factor.

1. Introduction
One of the most often suggested strategies for enhancing public health through physical activity (PA) is to make use of the need for transportation between home and work/study place through walking and bicycling (see e.g. 1). The extent to which this really is a feasible strategy within the population is however seldom addressed. For example, which proportions of the population have distances or traffic environments suitable for these forms of physical activity?

To critically analyze these matters, the Research Unit for Movement, Health and Environment at The Swedish School of Sport and Health Sciences (GIH) (www.gih.se/mhe) have launched the multidisciplinary research project “Physically active commuting in Greater Stockholm” (PACS)(www.gih.se/pacs). The general aims of the project are to illuminate:

1. what characterizes existing behavioural patterns connected to physical active commuting (PAC) to work in Greater Stockholm,
2. the potential effects of these forms of physical activity on the physical and psychological health and well-being, and
3. to what extent existing behavioural patterns are applicable within the population in Greater Stockholm under existing and enhanced circumstances.

The characterization of existing behavioural patterns of PAC includes illuminating what signifies the 1) individuals, 2) starting points – commuting routes – points of destination, 3) physical work, and 4) relationships to other modes of transportation.

This paper deals primarily with the first and second objectives, but the results will also be discussed in relation to the third objective.

Distance is a basic variable for understanding the potential effects of physically active commuting on public health and environment. And the potential in the population for commuting by feet or bicycle is often expressed in terms of feasible distances in kilometres between home and work/study place. Thus, distance is a basic variable in this context. However, different methods with potential sources of error are used to estimate the commuting distances. The first part of this study is therefore addressing that matter through illuminating the validity of different potential methods to estimate commuting distances.

After establishing a reasonable distance measurement method, the second part of the study scrutinize factors related to existing behavioural patterns of commuting through walking and/or bicycling between home and work/study place in Greater Stockholm. Our specific focus is on the constituents of WHO physical activity recommendations (time and intensity), the commuting distance and velocity as well as on the potential outcome in terms of body mass index (BMI).

2. Methods

The subjects volunteered to participate in the study after being contacted through advertisements in two large morning newspapers in Stockholm. They live in the County of Stockholm and walk and/or cycle the whole way to work/study place at least once a year. The minimum age for inclusion was 20 years. A questionnaire and individually adjusted maps were sent to 2148 persons in September 2004. The response frequency was 93 %. The variation of mean age in the different subgroups (gender and transport mode) was between 46-50 years (1 SD = 10-11). 68 % of the subjects were women. The respondents were divided into three groups dependent on their different use of transport modes. The groups are bicyclists (58 %), pedestrians (15 %) and a group of dual mode performers both walking and bicycling to work/study place (27 %). The questionnaire consisted of 35 questions primarily concerning commuting and other exercise habits.

The respondents marked their most common routes directly on the maps. There were no indications that this was difficult for the subjects. The route distances were measured and compared with the perceived distances stated by the subjects, as well as with the measured straight-line distances between home and work/study place. The subjective distance estimations were given in response to the following questionnaire request: “Estimate the length of your route from home to work/study place. State approximate distance in kilometres, and please use one decimal figure.” The variables examined in this study are map-measured route distance, estimated distance, straight-line distance, commuting time, velocity, perceived exertion and body mass index (BMI). Gender differences were evaluated statistically with the Mann-Whitney test for independent samples.
3. Results

3.1 Distances and distance measurement methods

Table 1 displays the relationships between different methods for estimating commuting distances. One-way distances (routes drawn and measured on maps) to work/study place differ between the three groups. Pedestrians of both sexes are walking a median distance of 2.5 km. Bicyclists are cycling longer distances, 9 km for men and 6.8 km for women. The group of dual mode performers covers a median distance of 3 km both walking and cycling. For comparisons between sexes, see table 2.

In order to facilitate a comparison between the distance measurement methods, the estimated distances and the straight-line distances were related to the map-measured distances, which were set to 100%. Assuming that the map drawn routes are correct, estimations of distances appear to in general lead to overestimations of the distances with about 7% (range 3-13%) whereas, as could be expected, the straight-line distances are about 20% (range 18-23%) shorter than the map drawn route distance.

From the point of reliability the standard deviations of the methods are important. The mean value of the standard deviations, expressed in per cent of the mean values of each method, was for the subjective estimations 37% (range 16-86% for the different subgroups) whereas the corresponding value for the straight-line distance measurements were 14% (range 12-16%).

<table>
<thead>
<tr>
<th>Pedestrians</th>
<th>Dual mode performers (walk &amp; cycle)</th>
<th>Bicyclists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men n = 68</td>
<td>Women n = 228</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Walk</td>
<td>Cycle</td>
</tr>
<tr>
<td>Map-measured distance one-way (km, mean value)</td>
<td>2.5</td>
<td>2.4</td>
</tr>
<tr>
<td>Individual values set as 100%</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Estimated distance (% of real dist., mean value)</td>
<td>107</td>
<td>113</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>27</td>
<td>97</td>
</tr>
<tr>
<td>Standard deviation in % of the mean value</td>
<td>25</td>
<td>86</td>
</tr>
<tr>
<td>The straight-line distance (% of real dist., mean value)</td>
<td>81</td>
<td>82</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Standard deviation in % of the mean value</td>
<td>12</td>
<td>15</td>
</tr>
</tbody>
</table>

Table 1: The relationship between the map-measured, estimated and straight-line distances between home and work/study place.
3.2 Time
The commuting times were rather constant between pedestrians and bicyclists of both sexes (about 30 minutes). This was also true for the dual mode group when walking to work, whereas time length was approximately halved when bicycling to work (table 2).

3.3 Velocity
The commuting velocities differed significantly between the sexes in both the bicyclist group and the dual mode groups, whereas no sex differences were apparent between male and female pedestrians (table 2).

3.4 Perceived exertion
The perceived exertion, measured in the 15 graded (6-20) Borg scale (2), display median figures between 11 and 13 with, in general, higher figures for bicyclists and lower for pedestrians (table 2).

3.5 Body mass index
The body mass index of the commuters varied between 22.6 to 24.8 kg/m² for the different subgroups, with higher figures in men than in women (table 2).

<table>
<thead>
<tr>
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<th>Dual mode performers (walk &amp; cycle)</th>
<th>Bicyclists</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men n = 68</td>
<td>Women n= 228</td>
<td>Men n= 474</td>
</tr>
<tr>
<td>Distance one-way (km)</td>
<td>2.5 (2.1)</td>
<td>2.4 (1.9)</td>
<td>3.0 (3.3)</td>
</tr>
<tr>
<td>Commuting time</td>
<td>25 (25)</td>
<td>27 (7)</td>
<td>35 (33)</td>
</tr>
<tr>
<td>Distance one-way (km)</td>
<td>5.4 (1.1)</td>
<td>5.1 (1.0)</td>
<td>5.6* (1.0)</td>
</tr>
<tr>
<td>Velocity</td>
<td>11 (4)</td>
<td>11 (4)</td>
<td>11* (2)</td>
</tr>
<tr>
<td>Perceived exertion</td>
<td>24.8* (3.8)</td>
<td>22.8 (3.6)</td>
<td>24.0* (3.0)</td>
</tr>
<tr>
<td>Body mass index</td>
<td>22.6 (3.4)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Results are presented as medians and (interquartile ranges). Significant (p<0.05) gender differences (with both parametric and non-parametric tests) are indicated with *. The “n” represents the number of cases related to the variable distance. Some of the other variables have a few missing values.
4. Discussion

First, the methodological aspects will be discussed, thereafter the commuting behaviour in relation to the WHO recommendations.

If assuming that the commuters are able to correctly draw their routes on maps, and that these route distances are correctly measured of our research team, the results demonstrate that the method of letting the respondents estimate their distances in a questionnaire is not a reliable way to find out the individual route distances of pedestrians and/or bicyclists. For all subgroups the results indicate that the straight-line distance is a more reliable method to use than the subjective estimation of the distance. This is true under the condition that correction is made for the underestimation of 20 % of real distances. The reason for that is the finding of smaller relative deviations from average values with the straight-line distance method (14 %) compared to subjective estimations of the respondents (37 %). Thus, one conclusion from this study is that evaluations of individual walking and cycling route distances, aiming to be accurate, should preferably include a map on which the respondents draw their own exact routes which thereafter are measured. If that is not possible, we recommend the procedure of measuring the straight-line distance and use that together with a correction factor of 1.25.

The WHO recommendations on physical activity (PA) consist of two time limits. One is 30 minutes of accumulated PA per day, which is to give much of the potential health benefits of PA. Another is 60 minutes of accumulated PA per day which is supposed to secure weight control (1). From this study it is clear that a great majority (89-91%) of the pedestrians and bicyclists reach a commuting time of more than the physical activity recommendations of 30 minutes of moderate physical activity per day, given that they commute both to work/study place and back home on the same day. Furthermore, about half of the pedestrians and bicyclists have commuting times that meets the time limit of 60 minutes. Within the dual mode group, however, lower figures are noted if they chose to cycle rather than to walk the whole distance to work.

The perceived exertion values (Borg scale) of 11 in pedestrians and 13 in bicyclists and 11-13 in the dual mode group correspond to the verbal expressions of “fairly easy” and “somewhat hard” (2), respectively, which reasonably well correspond to the expression “moderate intensity” in the WHO recommendations. Thus, the intensity demand set by WHO is also met in this form of PA.

The body mass index (BMI) indicates that the majority of the physically active commuters are of normal weight, but that a considerable proportion of the male pedestrians and bicyclists are overweight. However, in comparison with the same age groups in the population in the County of Stockholm (3), the BMI of the commuters appear to be lower. This indicates that these forms of physical activity might be key elements in avoiding obesity and thereby enhancing public health. However, more facts are needed about socio-economic status of the subjects, a possible confounding factor.

Gender differences exist primarily in the bicyclist group. Notable are the longer distances in men compared to women. Interestingly, no such differences appear among pedestrians. Possibly the gender differences among bicyclists depend on different physical work capacity and/or differences in spatial distributions of work places. The lower velocities of the female bicyclists might reflect a lower physical work capacity in this group compared to the men. This is now subject in our further investigations.

At last some reflections concerning the extent to which these existing behavioural patterns can be applicable within the population. For example, as asked in the Introduction; “which
proportions of the population have distances or traffic environments suitable for these forms of physical activity?” It is beyond the scope of this text to further this matter in depth. However, let us indicate the potential through comparing the estimated distances from home to work by people living in suburbs close to the inner urban area of Stockholm. 61% of the respondents within the adult population estimated that their distances to work were less than 10 km (4). Assuming a slight overestimation of distances, as indicated by this study, we can draw the conclusion that at least in this group of the population a majority have distances that are clearly possible to reach with a bicycle. Thus, available evidence suggest that the strategy of making use of transportations needs from home to work/study place in a metropolitan area place can be of a clear value from the perspective of public health.

This is further supported by our conclusion that the studied existing behavioural patterns of physical active commuting in Greater Stockholm meet the health related physical activity recommendations by WHO.

5. References