Bicycling but not Walking Is Independently Associated With Fasting Insulin in Abdominally Obese Women

Erik Hemmingsson, Ulf Ekelund, and Joanna Udden

Background: The impact of walking and bicycling on insulin resistance (IR) in women with abdominal obesity is unclear. Methods: Pooled analysis of data from a randomized trial on physically active commuting (bicycling + walking vs walking only) in women with abdominal obesity [n = 98; age: 47.3 ± 7.6 yrs; waist circumference (WC): 103.1 ± 7.8 cm]. Bicycling and walking data were collected during 7 consecutive days by trip meters (Trelock FC-410) and pedometers (Yamax digiwalker SW-200) at baseline, 2, 4, and 6 months. Owing to a skew distribution we analyzed bicycling as a binary dummy variable with a 10 km/week cut-off. Fasting serum insulin and homeostatic model assessment – insulin resistance (HOMA-IR) were assessed at baseline and 6 months, as were body mass index (BMI), WC, and dual x-ray absorptiometry (DXA)-assessed % whole-body fat. Results: Increased bicycling by 10 km/wk was associated with reductions in fasting serum insulin at follow-up independent of age, treatment allocation, baseline phenotype, Δ walking, and Δ % body fat (β = −10.9, P = .042), but not HOMA-IR (β = −2.0, P = .13). Increased walking was not associated with fasting serum insulin (P = .33) or HOMA-IR (P = .44) at follow-up, after adjustment for the same covariates and Δ bicycling. Conclusion: Increased bicycling but not walking was associated with reduced insulin levels at follow-up. Bicycling may be more effective than walking for reducing insulin levels in abdominally obese women.

Keywords: body composition, community-based research, health promotion, intervention study, metabolic health, physical activity

Increased physical activity (PA) is critical to reduce some of the adverse health conditions associated with obesity, such as insulin resistance (IR).1–3 Physically active transport (ie, walking and cycling) has emerged as a key strategy in the promotion of PA. Part of the rationale for promotion of physically active transport are the data showing robust reductions in cardiovascular risk for women,4 and lower rates of obesity.5 Of the 2 main forms of physically active commuting (bicycling and walking), bicycling appears to provide greater cardiovascular stimulus than walking.6 Moreover, at least 2 prospective cohort studies have found that cycling to and from work is associated with reduced all-cause mortality.7,8

In a Danish study7 there was a 28% reduction of all-cause mortality in men who regularly cycled to and from work. This analysis was adjusted for a number of potential confounders, including leisure time physical activity. In a similar multivariate-adjusted analysis of women from Shanghai8 there was a 34% lower risk of all-cause mortality in women who regularly cycled to and from work.

Similar to bicycling, walking at a brisk pace for 3h per week has been associated with a 35% reduction of risk for coronary events.9 It is not clear, however, whether walking and bicycling to and from work are associated with health indicators, such as insulin resistance, independently of each other.

We therefore aimed to quantify the separate effects of walking and bicycling on fasting insulin and homeostatic model assessment – insulin resistance (HOMA-IR). We chose fasting insulin and HOMA-IR as our outcome variables since this is one of the first detectable signs of metabolic disease in populations with increased risk of diabetes and cardiovascular disease, such as unfit women with abdominal obesity. Data on walking, bicycling, and insulin resistance (HOMA-IR and fasting serum insulin) were collected from abdominally obese, middle-aged women free of diabetes, undertaking a 6-month program of physically active commuting in Stockholm, Sweden.

Methods

Study Population

The current study is a prospective cohort analysis of data from the Stockholm Bicycle Trial (Trial registration: ISRCTN04233243), a randomized trial on the promotion of bicycling and walking to and from work.10
Inclusion criteria were female gender, age 30 to 60 yrs, abdominal obesity [waist circumference (WC) ≥ 88cm], free of diabetes, working away from the home ≥ 3 days/wk, and no contraindication for PA. The women were recruited by newspaper advertisement. From 305 replies we screened 139 women of which 124 were included and randomized. After 6 months, we had complete data on PA, fasting insulin and HOMA-IR, and whole-body dual x-ray absorptiometry (DXA) scans for body composition data in 98 participants. Since the trial was only powered for between group differences in bicycling, we pooled data from both groups for increased statistical power.

**Intervention**

Participants in the intervention group were randomized to a moderate intensity counseling program (physician prescription at baseline, 2, 2-hour group meetings with a health educator, and a bicycle) to promote both bicycling (primarily) and walking (secondly) to and from work. The women in the control group received a low-intensity counseling program (physician prescription at baseline, 2, 2-hour group meetings with a health educator, and a bicycle) to promote both bicycling (primarily) and walking (secondly) to and from work. Women from both groups were encouraged to compliment their physically active commuting with other types of physical activity, such as swimming, aerobics, and gardening. No specific recommendations for physical activity intensity were provided.

**Data Collection**

Bicycling distance was measured with a Trelock FC 410 trip meter (Munster, Germany) calibrated and assembled on the bicycles in the factory (Crescent CTC 670, 2005 model; Varberg, Sweden). Walking (number of steps/d) was measured with a validated Yamax digiwalker SW-200 pedometer (Yamax; Yamax Corporation, Tokyo, Japan). Daily bicycling (km/d) and walking (steps/d) data were recorded in a diary for 7 consecutive days. The mean tallies from each diary were thereafter calculated. The activity diaries were filled in at baseline, and after 2, 4, and 6 months.

Blood samples were taken during the morning at the hospital after an overnight fast, and analyzed by the hospital central laboratory. Indicators of overall IR were fasting serum insulin (β = –10.9, P = .042), independently of age, treatment allocation, % body fat, and baseline IR. The association between Δ bicycling and Δ % body fat, but not HOMA-IR at follow-up (β = –2.0, P = .13) was significant. There was no association between Δ walking and IR at follow-up (P = .33 for fasting serum insulin; P = .44 for HOMA-IR), adjusted for age, treatment allocation, baseline IR, Δ bicycling, and Δ % body fat. Figure 1 shows the levels of fasting serum insulin (estimated marginal means) at follow-up in median-stratified categories of Δ walking and Δ bicycling.

**Results**

At baseline, 47/98 (48%) were overweight and 51/98 (52%) were obese. 9/98 (9%) walked < 5000 steps/d, 27/98 (28%) walked 5000 to 7499 steps/d, 32/98 (33%) walked 7500 to 9999 steps/d, 24/98 (24%) walked 10,000 to 12,499, and 6/98 (6%) walked ≥ 12,500 steps/d. 13/98 (13%) were classified as insulin resistant (HOMA ≥ 4). None of the participants bicycled at baseline.

At baseline, walking was correlated with BMI (partial r = .27, P = .008), % body fat (partial r = .26, P = .009), but not with WC (partial r = .16, P = .120), all coefficients are age adjusted.

In prospective analysis, neither Δ walking (P = .12–.34) nor Δ bicycling (P = .13–.53) were associated with any of the 4 adiposity parameters at follow-up, after adjustment for age, treatment allocation and baseline IR.

In the main analysis (Table 1), increased bicycling by 10 km/wk was associated with reductions in fasting serum insulin (β = –10.9, P = .042), independently of age, treatment allocation, % body fat, and baseline IR. The association between Δ bicycling and Δ % body fat, but not HOMA-IR at follow-up (β = –2.0, P = .13) was significant. There was no association between Δ walking and IR at follow-up (P = .33 for fasting serum insulin; P = .44 for HOMA-IR), adjusted for age, treatment allocation, baseline IR, Δ bicycling, and Δ % body fat. Figure 1 shows the levels of fasting serum insulin (estimated marginal means) at follow-up in median-stratified categories of Δ walking and Δ bicycling.

**Discussion**

In this prospective cohort analysis of middle-aged women with abdominal obesity at risk for type 2 diabetes, we found that increased bicycling to and from work was associated with fasting insulin levels, whereas walking was not. This suggests that bicycling to and from work may be more important than walking for reducing hyperinsulinemia. Using alternative adiposity covariates (BMI, WC or % trunkal fatness) or different cut-offs for bicycling did not materially change these findings. In contrast to reduced percent body fat (P = .04), neither bicycling (P = .13) or walking (P = .44) were associated with HOMA-IR at follow-up in multivariate-adjusted analyses.

Data on the health effects of physically active commuting are accumulating. A Finnish study found that physically active commuting for 30 min/d or more was associated with a 36% reduction in incident type 2 diabetes. Two other studies have also quantified the impact of...
Table 1  Associations ($\beta$-Coefficients, 95% CI) Between Changes in Walking and Bicycling (Exposure Variables) and Markers of IR (Fasting Serum Insulin and HOMA-IR) at Follow-Up as Outcome Variables in Abdominally Obese Women Participating in a Program of Physically Active Commuting ($n = 98$)

<table>
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<th>Fasting serum insulin</th>
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<th>HOMA-IR</th>
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<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 1</td>
<td>Model 2</td>
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<tr>
<td>$\Delta$ Walking, ksteps/d</td>
<td>0.7 (–0.9; 2.3)</td>
<td>0.8 (–0.8; 2.4)</td>
<td>0.1 (–0.3; 0.5)</td>
<td>0.2 (–0.2; 0.6)</td>
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<tr>
<td>$\Delta$ Bicycling, 10 km/d*</td>
<td>–12.2 (–22.8; –1.6)*</td>
<td>–10.9 (–21.4; –0.4)*</td>
<td>–2.4 (–5.0; 0.3)</td>
<td>–2.0 (–4.7; 0.6)</td>
</tr>
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</table>

Note. Model 1: adjusted for age, baseline phenotype, treatment allocation, and the other outcome variable. Model 2: adjusted for age, baseline phenotype, treatment allocation, change in DXA-assessed $\Delta$% body fat, the other outcome variable.

Abbreviations: $\Delta$, change between baseline and 6 months.
*A Analyzed as a binary dummy variable where $<$10km/wk increase was coded as 1, and $\geq$10 km/wk increase was coded as 2.

$^a P < .05$.

bicycling on all-cause mortality. Andersen et al studied bicycling to and from work in Danish men and women and found a 28% decreased risk of all-cause mortality (covariates included leisure time physical activity). Moreover, a study by Matthews et al on Chinese women found that women who cycled for transportation had a 34% decreased all-cause mortality risk whereas the protective effects of walking were less clear. Since bicycling may be more effective than walking in promoting health, we suggest this is reflected in initiatives to promote physically active transport.

The following limitations exist. Since we included 30- to 60-year-old women with a WC $\geq$ 88cm, still relatively free of metabolic disease, the findings may not be generalizable to other populations such as those already diagnosed with diabetes. In terms of data quality, the women in the control group ($n = 48$) of the trial self-reported bicycling levels, whereas the intervention group ($n = 50$) used trip-meters. Since self-report of PA tends to be higher than measured data, it is possible that control participants bicycled less than what they reported. However, only 8/48 (17%) of control participants reported bicycling levels at or above the 10 km/week cut-off, compared with 42/50 (84%) of the intervention group participants. Furthermore, we adjusted for treatment allocation in the multivariate models (in effect adjustment for whether bicycling was assessed by trip-meter or self-report).
Strengths of the study include repeated measurements of walking and bicycling, and the use of a validated pedometer. Trip meters were calibrated and fitted by the bicycle manufacturer on identical bicycles delivered directly from the factory. We would like to stress, however, that trip meters are susceptible to bias from changes in tire air pressure and body weight variation, which have been found to result in deviations of about 5% (personal communication with Trelock, the trip meter manufacturers).

To summarize, we found that bicycling to and from work was independently associated with fasting insulin, whereas no such effect was found for walking. Bicycling may therefore be more effective than walking in reducing hyperinsulinemia in abdominally obese women.

Further research is needed to tease out the underlying mechanisms for why bicycling may be more effective than walking in reducing insulin levels.

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References