

Electric Bicycles as a New Active Transportation Modality to Promote Health

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ABSTRACT

GOJANOVIC, B., J. WELKER, K. IGLESIAS, C. DAUCOURT, and G. GREMION. Electric Bicycles as a New Active Transportation Modality to Promote Health. *Med. Sci. Sports Exerc.*, Vol. 43, No. 11, pp. 2204–2210, 2011. Electrically assisted bicycles (EAB) are an emerging transportation modality favored for environmental reasons. Some physical effort is required to activate the supporting engine, making it a potential active commuting option. **Purpose:** We hypothesized that using an EAB in a hilly city allows sedentary subjects to commute comfortably, while providing a sufficient effort for health-enhancing purposes. **Methods:** Sedentary subjects performed four different trips at a self-selected pace: walking 1.7 km uphill from the train station to the hospital (WALK), biking 5.1 km from the lower part of town to the hospital with a regular bike (BIKE), or EAB at two different power assistance settings (EAB_{high}, EAB_{std}). HR, oxygen consumption, and need to shower were recorded. **Results:** Eighteen sedentary subjects (12 female, 6 male) age 36 ± 10 yr were included, with $\dot{V}O_{2max}$ of 39.4 ± 5.4 mL·min⁻¹·kg⁻¹. Time to complete the course was 22 (WALK), 19 (EAB_{high}), 21 (EAB_{std}), and 30 (BIKE) min. Mean % $\dot{V}O_{2max}$ was 59.0%, 54.9%, 65.7%, and 72.8%. Mean %HR_{max} was 71.5%, 74.5%, 80.3%, and 84.0%. There was no significant difference between WALK and EAB_{high}, but all other comparisons were different ($P < 0.05$). Two subjects needed to shower after EAB_{high}, 3 needed to shower after WALK, 8 needed to shower after EAB_{std}, and all 18 needed to shower after BIKE. WALK and EAB_{high} elicited 6.5 and 6.1 METs (no difference), whereas it was 7.3 and 8.2 for EAB_{std} and BIKE. **Conclusions:** EAB is a comfortable and ecological transportation modality, helping sedentary people commute to work and meet physical activity guidelines. Subjects appreciated ease of use and mild effort needed to activate the engine support climbing hills, without the need to shower at work. EAB can be promoted in a challenging urban environment to promote physical activity and mitigate pollution issues. **Key Words:** COMMUTING, EXERCISE, PHYSICAL ACTIVITY PROMOTION, MOBILITY, INTENSITY, COMMUTING

The evidence characterizing the benefits of moderate physical activity (PA) is extensive, and although most people will agree on the necessity to promote an active lifestyle on a daily basis, multiple health promotion programs featuring exercise or PA fail to show long-term sustained gains in fitness or indicators of regular PA. Many reasons can be advanced for this lack of correlation between the growing list of health benefits (26) and PA levels in the population, not the least of which are lack of time to and lack of pleasure in exercise. Advocates for exercise promotion emphasize the importance of activities not traditionally perceived as exercise, such as active transportation and maximizing steps taken every day, to include small bouts of movement in everyone's daily routine. Al-

though vigorous exercise, whether outdoors or in a gym, could procure optimal increases in fitness, the greatest relative improvements in health are obtained for people who go from inactive to moderately active (7), making a moderate level of activity the most relevant from a public health standpoint. Further benefits of more vigorous exercise have been demonstrated but are more difficult to attain and maintain, not to mention the risk of injury they carry. And as the much missed Jerry Morris, pioneer in exercise epidemiology, expressed it in 1994: "Exercise is today's best buy in public health" (19).

Active commuting to and from work is an obvious choice to include some activity into everyone's busy daily professional and personal schedules and has been studied in the past decade. The natural experiments provided by the traditional cycling communities in Dutch or Danish cities have allowed researchers to make primordial observations. In a principal article in 2000, Andersen et al. (3) showed that bicycling to work was associated with a 29% reduction in mortality, independently of leisure time PA, and similar results were obtained in Chinese women by Matthews et al. (18). In addition, they showed that bicycle commuting to school was correlated with better overall fitness indexes in adolescents, compared with walking or other transport modalities (2). In adults, active commuting is also associated

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with better fitness along with cardiovascular risk profile improvement (12), and a couple of interventional studies have shown a positive effect on fitness parameters by cycling to work in previously sedentary people (14,21). In a recent review on the potential benefits of commuting, Shephard (24) describes the various amounts of energy needed to walk or cycle and states that walking would be relatively ineffective to improve fitness except in the elderly or if there is a 5% incline. As for bicycling, when riding at a comfortable speed, the effort will be sufficient to adequately stimulate fitness. Shephard (24) also calls for “a more detailed picture of the typical dose of exercise arising from such activity.” This has been partly answered by de Geus et al. (10), who measured the HR response and oxygen uptake during a typical commute ride to work in previously sedentary subjects and were able to show that it required 79% of maximal capacity to complete the trip. This corresponds to a level of effort typically sufficient to elicit gains in fitness and health-related benefits if performed on a regular basis. However, this intensity might also be too high for the commute to be really comfortable rather than strenuous.

Electrically assisted bicycles (EAB) have been developed in the last decade, with a growing public interest, especially due to energy policy and pollution concerns. Simons et al. (25) have evaluated the intensity of effort for a short simulated commute on flat terrain and concluded that EAB can elevate HR to 67% of maximal capacity, which is still in the range of training benefits.

The purpose of our study was to explore the potential to use EAB as a health-oriented and convenient commuting modality in a city with challenging topography. More specifically, our questions were, “Can we recommend EAB as an active and ecological transportation modality in sedentary subjects?” and “How does it compare with walking uphill?”

METHODS

Subjects. Eighteen subjects (12 women, 6 men) took voluntarily part in the study. Characteristics are reported in Table 1. Main inclusion criteria were not being active on a regular basis (sedentary), defined as $<150 \text{ min}\cdot\text{wk}^{-1}$ of moderate PA, and being unaccustomed to biking to work or for leisure. All subjects were free of medical conditions or chronic medication. Screening included a medical questionnaire and examination, with blood pressure and resting ECG to assess

eligibility for vigorous exercise. A signed informed consent was obtained, and the study was conducted according to the principles of the Declaration of Helsinki. The Institutional Review Board of the University of Lausanne approved the study protocol.

Experimental procedure. The experiments were carried out on three separate days, at least 48 h apart to allow for recovery between tests. After the inclusion visit, the first test was conducted in the laboratory and aimed at determining the maximal capacity, by measuring HR_{max} and maximal oxygen uptake ($\dot{V}\text{O}_{2\text{max}}$) during an incremental test on a bicycle ergometer. Women started at 50 W (men at 70 W), and resistance was increased by 20 W every minute until any of the following were reached: volitional exhaustion, cardiovascular symptoms, $\text{RER} > 1.10$, or a plateau in oxygen uptake. HR was measured using a thoracic belt and an HR monitor (Polar Vantage NVTM; Polar Electro, Kempele, Finland), and oxygen uptake was measured with a portable gas analyzer (METAMAX 3BTM; Cortex Biophysik GmbH, Leipzig, Germany). Data were analyzed and averaged every 15 s with the MetaSoft 3.8 software (Cortex Biophysik GmbH, Germany).

The field tests consisted of four different modalities, each representing an actual typical itinerary to get to the Lausanne University Hospital: WALK was a 1.7 km uphill walking test (110-m height difference, average grade of 6.5%) from the main train station. The other three were biking tests along a 5.1-km predominantly uphill course (178-m height difference, average grade of 3.4%, with maximum at 6%), on a regular city bike weighing 12 kg (BIKE), an EAB with the highest assistance (EAB_{high}), or an EAB with a moderate assistance mode (EAB_{std}). An EAB is used exactly as a regular bicycle would be, except that when putting pressure on the pedals, the engine provides additional mechanical support, producing a maximum power of 250 W. The EAB used weighed 23 kg, had a lithium-ion battery, and had a maximal assisted speed of $25 \text{ km}\cdot\text{h}^{-1}$ (FLYER C9 premiumTM; Biketec AG, Huttwil, Switzerland), and the frame was either small or medium to fit subjects’ height. To get maximal efficiency from the electrical assistance, subjects are required to pedal at a cadence of approximately 60 rpm, which is the typical cadence chosen by nonregular cyclists. Subjects were familiarized with the EAB during a 30-min accompanied test ride, where they were instructed on how to pedal at the most appropriate cadence. All subjects were quickly able within 10 min to use the EAB appropriately. The first day of field testing was started with WALK and then EAB_{std} , with a 30-min break for complete recovery in between. The second day was for EAB_{high} then BIKE. The orders were chosen so as to start with the presumed less intensive test first, to minimize fatigue for the subsequent test. Tests were conducted during the early afternoon, from 12 noon to 6 p.m., and subjects were instructed to have a light snack 90–120 min before. Weather conditions varied from 5°C to 20°C and from 70% to 80% humidity; tests were not carried out when it was raining or when roads were still wet

TABLE 1. Characteristics of study participants (mean and SD).

	Men (n = 6)		Women (n = 12)		Total (n = 18)	
	Mean	SD	Mean	SD	Mean	SD
Age (yr)	38.7	10.2	34.2	9.8	35.7	9.7
Height (m)	1.80	0.04	1.66	0.07	1.70	0.09
Weight (kg)	83.4	15.7	63.4	7.1	70.1	13.8
BMI ($\text{kg}\cdot\text{m}^{-2}$)	25.6	4.0	23.2	2.8	24.0	3.3
HR_{max} (bpm)	188.2	10.9	184.5	6.5	185.7	7.9
$\dot{V}\text{O}_{2\text{max}}$ ($\text{L}\cdot\text{min}^{-1}$)	3.36	0.47	2.45	0.42	2.75	0.60
$\dot{V}\text{O}_{2\text{max}}$ ($\text{mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$)	40.9	6.8	38.6	4.7	39.4	5.4

BMI, body mass index.

from previous rain. During all field tests, the portable gas analyzer system was harnessed to the subjects. Tests were conducted in real traffic, with the bike course chosen for its topography (regular slopes interspersed with flat portions to allow for recovery) and bike lanes available on approximately half of the distance. Instructions were to ride or walk at a self-selected comfortable pace, as if going to work, but not with the intent of achieving a performance. One investigator accompanied the subjects on foot for WALK or on an EAB for all biking trips, riding behind for safety reasons and assistance if necessary because of mechanical problems.

Measurements. The parameters measured were time to complete the trip, average speed, average and maximal exercise intensity (for both HR and $\dot{V}O_2$), which was expressed as percentage of maximal capacity as evaluated by the laboratory test, reported as %HR_{max} (HR/HR_{max} × 100) and % $\dot{V}O_{2max}$. We also asked subjects to rate their effort on the Borg scale for perceived exertion (6–20) (8) and whether they felt the need to shower before starting their working day after completion of the trip. We also converted exercise intensity in MET (where 1 MET = 3.5 mL O₂·kg⁻¹·min⁻¹) and total energy expenditure in MET-minutes for each modality. In some tests, highest $\dot{V}O_2$ values were attained during the BIKE field test, and these were used as reference $\dot{V}O_{2max}$ of the subject.

Statistical analysis. R 2.11 software (Team RDC, R Foundation for Statistical Computing, Vienna, Austria) was used for all analyses. Linear mixed models with the routes' modalities (EAB_{high}, EAB_{std}, BIKE, and WALK) as the within factor, subject as random effect, and a compound symmetry covariance matrix were used to assess the routes on five outcomes: percentage of HR_{max}, percentage of $\dot{V}O_{2max}$, intensity of effort (MET), energy expenditure (MET·min), and RPE (Borg scale). For the within factor, the BIKE was used as reference category. We controlled for age, sex, body mass index, HR_{max}, and $\dot{V}O_{2max}$ to verify the effect of exercise modalities on the outcome variables at the same level of covariate. There was no effect of the covariates mentioned on % $\dot{V}O_{2max}$. The only effect observed

was that for a higher $\dot{V}O_{2max}$; the %HR_{max} was lower (an increase of 1 L O₂·min⁻¹ of $\dot{V}O_{2max}$ caused a decrease in %HR_{max} of 5.8%). The final model used kept only the adjustment for baseline $\dot{V}O_{2max}$.

RESULTS

All participants completed the laboratory test and four field tests, but two subjects failed to complete the BIKE test because of exhaustion (abandoned after completion of 80% of the distance at the point of a maximal grade of 6%). Because of additional technical data collection issues, the final analysis included 18 WALK, 17 EAB_{high}, 17 EAB_{std}, and 16 BIKE tests. Table 2 shows the values for duration, speed, intensity, energy consumption, HR, RPE, and shower necessity.

The time to complete the course was 22 min 6 s ± 1 min 34 s for WALK, 18 min 48 s ± 2 min 16 s for EAB_{high}, 20 min 45 s ± 3 min 12 s for EAB_{std}, and 29 min 36 s ± 7 min 6 s for BIKE (*P* < 0.001 for all comparisons except WALK vs EAB_{std}, not statistically significant). Biking speeds were 16.5 ± 1.8, 15.1 ± 2.4, and 10.3 ± 2.2 km·h⁻¹ for EAB_{high}, EAB_{std}, and BIKE.

HR. Mean HR was 132.7 ± 17.4 bpm for WALK, 138.4 ± 18.0 for EAB_{high}, 149.0 ± 17.7 for EAB_{std}, and 157.0 ± 11.2 for BIKE. Relative to individual HR_{max}, this corresponded, respectively, to 71.5% ± 9.2%, 74.5% ± 8.7%, 80.3% ± 8.7%, and 84.0% ± 5.2%, all significantly different, except WALK and EAB_{high} (*P* = 0.54).

Energy expenditure. Ten of 18 subjects (56%) reached higher peak values of oxygen uptake during the BIKE test than during the laboratory test, which is not an uncommon finding in real-conditions intense effort. For those subjects, we considered this higher peak value as their $\dot{V}O_{2max}$ for subsequent analyses. The same was true for three subjects regarding HR_{max}. Mean $\dot{V}O_2$ was 1.60 ± 0.34 L·min⁻¹ for WALK, 1.50 ± 0.38 L·min⁻¹ for EAB_{high}, 1.79 ± 0.46 L·min⁻¹ for EAB_{std}, and 2.00 ± 0.44 L·min⁻¹ for BIKE, corresponding, respectively, to 59.0% ± 9.1%, 54.9% ± 11.0%,

TABLE 2. Physiological variables in the four conditions (WALK, EAB_{high}, EAB_{std} and BIKE), mean and SD.

	WALK		EAB _{high}		EAB _{std}		BIKE		<i>P</i>
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
HR									
HR _{peak_{test}} (bpm)	149.1	19.8	157.9	17.4	168.1	16.2	175.6	9.6	<i>P</i> < 0.001
HR _{mean} (bpm)	132.7	17.4	138.4	18.0	149.0	17.7	157.0	11.2	<i>P</i> < 0.001
%HR _{max}	71.5	9.2	74.5	8.7	80.3	8.7	84.6	5.2	<i>P</i> < 0.001
Energy expenditure									
$\dot{V}O_{2peaktest$ (L·min ⁻¹)	2.22	0.49	1.99	0.57	2.36	0.62	2.65	0.62	<i>P</i> < 0.001
$\dot{V}O_{2mean}$ (L·min ⁻¹)	1.60	0.34	1.50	0.38	1.79	0.46	2.00	0.44	<i>P</i> < 0.001
% $\dot{V}O_{2max}$	59.0	9.1	54.9	11.0	65.7	8.1	72.8	6.4	<i>P</i> < 0.001
METs	6.5	0.8	6.1	1.4	7.3	1.0	8.2	1.3	<i>P</i> < 0.001
Trip duration (min:s)	22:06	1:34	18:48	2:16	20:45	3:12	29:36	7:06	<i>P</i> < 0.001
Speed (km·h ⁻¹)	4.6	0.3	16.5	1.8	15.1	2.4	10.3	2.2	<i>P</i> < 0.001
MET-minutes	144.1	13.7	114.0	21.7	145.8	22.4	252.8	42.1	<i>P</i> < 0.001
Perceived effort									
RPE (Borg scale 6–20)	10.6	2.1	10.4	1.6	12.9	1.4	15.5	1.7	<i>P</i> < 0.001
Subjects needing a shower (%)	16.70		11.10		44.40		100		<i>P</i> < 0.001

HR_{mean}, mean HR attained during field test; HR_{peak_{test}}, peak HR attained during field test; $\dot{V}O_{2mean}$, mean oxygen uptake attained during field test; $\dot{V}O_{2peak_{test}$, peak oxygen uptake attained during field test.

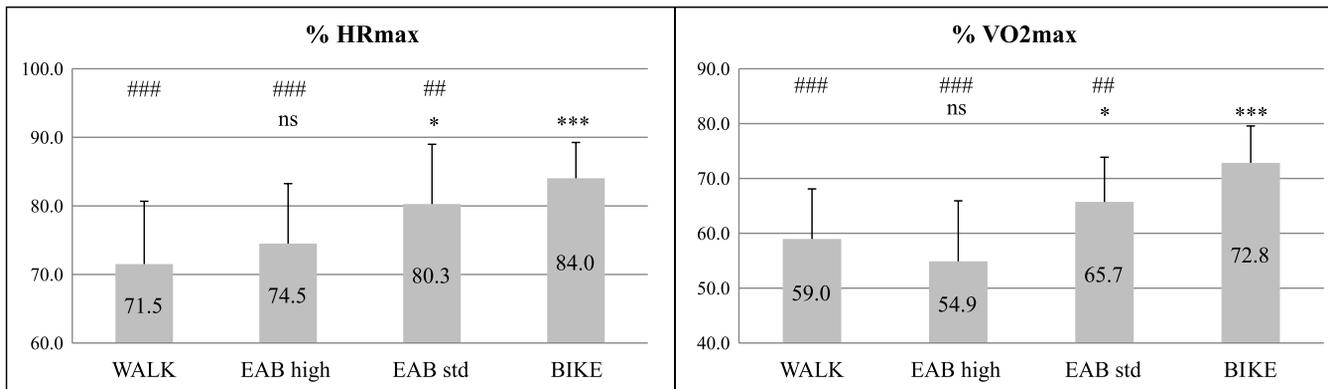


FIGURE 1—Exercise intensities for all four conditions, relative to maximal capacity (both HR_{max} and $\dot{V}O_{2max}$). Difference compared with WALK: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Difference compared with BIKE: # $p < 0.05$, ## $p < 0.01$, ### $p < 0.001$. ns = nonsignificant difference between WALK and EAB_{high}.

65.7% ± 8.1%, and 72.8% ± 6.4% of O₂max. Expressed in METs, this corresponded to 6.5 ± 0.8, 6.1 ± 1.4, 7.3 ± 1.0, and 8.2 ± 1.3. Only WALK and EAB_{high} were similar ($P = 0.97$). All subjects and all conditions elicited at least 3.0 METs (moderate intensity), whereas 72.2% (WALK), 47.1% (EAB_{high}), 88.2% (EAB_{std}), and 100% (BIKE) elicited >6.0 METs (vigorous intensity) (Fig. 1).

Perceived exertion. Borg scale at the end of the course was 10.6 ± 2.1 (WALK), 10.4 ± 1.6 (EAB_{high}), 12.9 ± 1.4 (EAB_{std}), and 15.5 ± 1.7 (BIKE), with $P < 0.001$ for all comparisons except $P < 0.01$ between WALK and EAB_{std} and no difference between WALK and EAB_{high}. The percentage of subjects who expressed the desire to take a shower upon arrival was, respectively, 16.7%, 11.1%, 44.4%, and 100%.

DISCUSSION

In this study, we measured and determined the various components of exercise intensity during four different

commuting modalities in 18 sedentary young and middle-age subjects. Our findings indicate that electrically assisted bicycles can be used to promote PA in previously sedentary subjects and can help overcome major topographical and logistical barriers to commuter cycling. When electric bicycles are used in the high assistance mode (EAB_{high}), the effort compares to walking on a 6.5% grade at a self-selected pace and equals moderate to vigorous PA. To be considered health enhancing, active commuting should elicit, according to the American College of Sports Medicine's guidelines, intensities of at least 55%–65% of HR_{max} (22), which is accomplished by all of our subjects in all four modalities investigated. This finding is very significant because ways to promote PA for health are not easy to integrate into everyday life. Active transportation and commuting to work are one of the best options people have to be active without “losing” time in their daily schedule. In a very hilly city like Lausanne, Switzerland, obviously bicycle unfriendly, we have been able to show that electrical bicycling provides an answer to many barriers commonly encountered: intensity of effort is adapted for sedentary subjects, time to commute is very quick and

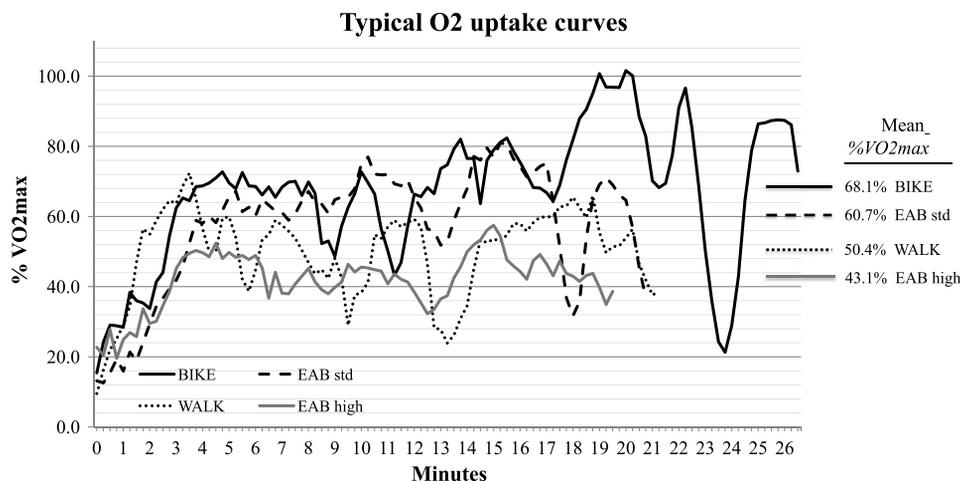


FIGURE 2—Typical example of real-time oxygen consumption in one subject (as percentage of $\dot{V}O_{2max}$) for all four trials. On the right, mean % $\dot{V}O_{2max}$ for each modality.

convenient (the same trip with a personal car would take approximately the same time, not taking into account the time and cost of parking at the workplace or the variation in traffic jam, and the use of public transportation would be almost twice as long), and finally, even sedentary people unaccustomed to riding in traffic were able to manage it safely with limited instructions (Fig. 2).

The exercise intensities measured in WALK corresponds to Ainsworth's compendium of physical activities (1) (walking uphill at $5.6 \text{ km}\cdot\text{h}^{-1} = 6.0 \text{ METs}$): we found 6.5 METs at an average speed of $4.6 \text{ km}\cdot\text{h}^{-1}$ and grade of 6.5% and a relative intensity of 59% of $\dot{V}O_{2\text{max}}$. Walking can be used as a good benchmark in this situation because of its adequate intensity as a health-enhancing PA and also the ease with which people can relate to it. The bike course chosen was meant to reproduce a realistic commute in the city of Lausanne. The university hospital is on the higher grounds of the city, whereas most of the population resides in the lower parts. At a relative intensity of 54.9% of $\dot{V}O_{2\text{max}}$ and 6.1 METs, EAB_{high} is not different from WALK and allows a greater distance to be covered faster (5.1 km at $16.5 \text{ km}\cdot\text{h}^{-1}$, average grade of 3.4%). When the EAB is used with the "standard" or middle assistance mode, the intensity becomes significantly higher but still lower than the regular BIKE, 65.7% and 72.8% of $\dot{V}O_{2\text{max}}$ (7.3 and 8.2 METs, respectively). These intensities are definitely too high to be considered as a comfortable commuting choice in untrained subjects. Previous studies by de Geus et al. (10), Oja et al. (20), and Hendriksen et al. (14) reported the intensity of commuter cycling and have consistently found that it was sufficient to provide health benefits, but they were all conducted on flat or nonspecified courses, with regular nonassisted bicycles. The only study that has compared exercise intensities on an EAB (25) reported 5.2 METs for the higher assistance mode and 6.1 METs for no electrical assistance, but their study was carried out on a 4.3-km flat course, outside of regular traffic, which explains the lower intensities observed. Direct comparison is also difficult because the EAB used were not the same (although they both produce 250 W of assistance). It is interesting to look at the overall energy required by the different commuting modalities, by expressing them in MET-minutes, which takes into consideration the time spent doing each activity. WALK elicits 144 MET-min, compared with 114 (EAB_{high}), 146 (EAB_{std}), and 253 (BIKE) MET-min. It is recommended that people accumulate 450–750 MET-min $\cdot\text{wk}^{-1}$ to enhance health (13), starting at the lower end of that range for sedentary people. This means that in our trials, subjects would need to accumulate 3.1 (WALK), 3.9 (EAB_{high}), 3.0 (EAB_{std}), and 1.8 (BIKE) one-way trips per week. Because our courses were uphill, it seems fair to assume that the return (mostly downhill) trip requires less energy, rendering estimation for two-way trips difficult in our study. Nevertheless, the return trip would definitely not amount to 0 MET-min. We can reasonably assume that three commuting trips a week with the EAB

can help reach the minimum of 450 MET-min required for health in sedentary subjects.

One aspect that is frequently mentioned by people who have tried to commute actively in our hilly environment is the necessity to change clothes or shower due to perspiration upon arrival at the workplace. Indeed, when advocating for active commuting, experts agree that it is important to provide employees a place to change and shower at the workplace (9). Although we understand this proposal and agree on its principle, we often have to face logistical difficulties expressed by employers to meet these recommendations. Also, practical problems exist for the supplemental time spent changing and showering at work. We addressed this issue by asking our subjects to state whether they felt the need to shower at the end of the course and found without surprise that all BIKE trials needed it. But it was also surprising to find that 16.7% of WALK trials wanted to shower, whereas only 11.1% of EAB_{high} wanted to do so. One has to consider the fact that they were carrying the gas analysis system harnessed to their back, which accounted for some of the perspiration, as expressed by most subjects. Nonetheless, EAB_{high} was the least likely to induce perspiration. This is an important argument when approaching employers with the aim of implementing new mobility strategies for their employees. For example, at our institution, with expanding buildings and employee numbers (currently 9000), while facing parking shortage or reallocation, our investigation has convinced hospital management to negotiate with retailers and subsidize the purchase of EAB. We believe that this type of collaboration with the employer could lead to increases in active commuting.

The strengths of our study are in the comprehensive objective and subjective evaluation of exercise intensity and the real-life setting of our evaluation. The exercise intensities were reported as a percentage of each subject's own maximal capacity tested in a laboratory setting, which gives more weight to our data. For comparison, the only other study that evaluated EAB (25) reported intensities based on theoretical maximal capacity for HR ($\text{HR}_{\text{max}} = 220 - \text{age}$) and only absolute values for oxygen uptake. Our subjects were sedentary and not accustomed to active commuting. The courses chosen are typically used by people employed at our university hospital and hence highly representative of what people actually do in reality. The BIKE course was very difficult for the participants as shown by RPE scores (15.5, "hard" to "very hard"), even after discarding the two subjects who maxed out on the effort and quit before the end of the course.

Limitations consist of the limited amount of subjects, especially men, but our results are definitely solid across all subjects. In Switzerland, 65% of EAB buyers are middle-age women, which corresponds to our study population. Although we could not find similar data to compare with our findings, the intensities we observed were rather high. This can be explained by the eagerness of observed subjects to do well in the trial, despite instructions to adopt a

comfortable pace (as if they were actually going to work in the morning). For the biking trips, the high intensity can also be accounted for by the stress generated by being in regular traffic, especially when looking at HR levels, which were relatively more elevated than oxygen uptake. For example, in WALK, %HR_{max} was 71.5% and % $\dot{V}O_{2max}$ was 59%, compared with 74.5% and 54.9% in EAB_{high}. This apparent discrepancy can be explained by the additional stress of biking and also by the fact that biking involves more resistance-type activity than walking, with the known higher dissociation between HR and $\dot{V}O_2$ in this type of exercise playing a role (16). Also, our subjects were not accustomed to the task they were evaluated for; hence, the intensities might overestimate the actual values obtained after a few weeks of utilization of EAB and traffic stress control. But we feel that there is a comfortable margin available, and even if intensity did go down after regular use, it would still be within a moderate-intensity range for EAB_{high}. In the study by Simons et al. (25), subjects were for the most part habitual bicycle commuters and still had to produce a sufficient effort, although they were on flat grounds. We also acknowledge a limitation in the design of our study, in that subjects performed two tests on the same day because of time constraints and logistics. This introduced a systematic bias, and the optimal design would have been to perform each test on a separate day, in randomized order. We believe that the 30-min pause between tests allowed sufficient recovery and that the chosen order had minimal effect on the subsequent second test because the first one was at a lower and moderate intensity. This level of exercise intensity is habitually used during warm-up before any type of exercise testing for $\dot{V}O_2$ or HR ($\dot{V}O_{2max}$, or steady-state measurements), and it is commonly accepted in a laboratory setting. We felt confident that the first exercise would not last long enough (18–22 min in effect) and be intense enough to induce abundant sweating, dehydration, or important muscle fatigue, all of which could influence subsequent measures. One reason to couple two tests per day was to allow for weather conditions to be as similar as possible between tests.

It remains to be investigated whether long-term commuting with EAB can provide benefits for health as has already been shown for regular bicycle commuting. De Geus (11) conducted a 1-yr intervention where middle-age men and women were commuting to work by regular bike, on average, 3.9 times per week. They observed an improvement in maximal power generated and $\dot{V}O_{2max}$ at 6 and 12 months, compared with a control noncommuting group. Although they showed only small differences, the effect is present and is also dose dependent. It also seems that women need less cumulated activity to get the same fitness benefits as men, which would encourage us to promote this activity in women even more. Further steps include longitudinal data collection in EAB users, to ascertain its benefits in the long term.

Active transportation may give PA advocates the “biggest bang for their buck,” provided common barriers to walking

or cycling are addressed. Ease of effort and self-efficacy in the accomplishment of the commute are paramount, as are also safety concerns for cyclists. We already know that more cyclists on the roads will diminish the risk of motorist collision (17,23), but more bike lanes are necessary as is education of cyclists and motorists alike. We know that people are more likely to change their travel behavior if they get up-to-date and tailored information, and a recent survey in Geneva (6) found that the motivation to acquire an EAB is for sustained mobility and development. Very few people mention health benefits. It is fair to assume that the health benefits of EAB use are unknown to them at the present time and that the spreading of such information could contribute to changes in transportation choices. We foresee one significant drawback with the market for EAB expanding: manufacturers are able to make bicycles with better battery autonomy while providing ever more assistance to pedaling. Some two-wheelers already exist where the pedals do not need to be activated (or pressed on) to engage the electric support, which would annihilate health-enhancing characteristics of PA in such a commute (the pedals are actually there only to allow the vehicle to be registered legally as a “bicycle,” avoiding motor vehicle taxes and laws). Hopefully, the health benefits will remain a concern and selling arguments for manufacturers and retailers. Major health issues are at stake, with ever increasing chronic diseases, obesity, and diabetes worldwide. Another potential benefit of bicycling to work lies in the improved oxygenation of painful neck/shoulder muscles, as shown by Andersen et al. (4). Because neck/shoulder pain is a risk factor for long-term sickness absence among sedentary workers (5), initiatives to increase bicycling in this population—e.g., by electric bicycles—seem imperative. Electric bicycles can provide a safe, fast, comfortable, and acceptable means of commuting to work, not to mention pollution and energetic issues. In a recent series on “Energy and Health” in the *Lancet*, Woodcock et al. (27) state that, “Active transport offers the greatest potential to improve health and lower transport energy use. These modes increase PA, are nonpolluting, pose little danger to others, and are socially inclusive.” We could not agree more, and the EAB seems to fit nicely into the picture. Although the electric motor cannot be considered as entirely “green,” it most certainly produces no direct emission of CO₂ (15), except the one exhaled by the exercising rider sitting on it.

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