Supplementary material

Impact of electrically-assisted bicycles on physical activity and traffic accident risk: a prospective observational study.

METHODS

General information

The Institute of Sports Medicine at Hannover Medical School in cooperation with the Institute of Biostatistics was responsible for the study design, statistical planning, inclusion of study participants, data collection and analysis, as well as the preparation of the manuscript. The Center for Health Economics Research Hannover and the Accident Research Unit contributed to the definition of the study design, assessed road traffic accidents and assisted the data analyses. The statistical report was provided to the Institute of Sports Medicine, who were responsible for data interpretation and writing the manuscript.

Questionnaires:

The SF-36 questionnaire measures QoL with eight subscales resulting in two sum scales, the mental- and physical component score of QoL. For both scales, a score of 0 points represents a minimum and a score of 100 points a maximum quality of life. The Freiburger activity questionnaire estimates the total and exercise-related physical activity of adults, both of which are specified as metabolic equivalents of task (MET)-hours per week. The medical history questionnaire included questions about general characteristics (e.g. age, workplace, and income), health status (e.g. comorbidities, musculoskeletal disorders), anthropometric data, and motion behavior (daily routines by car, bicycle, public transport etc.) The study specific user questionnaire includes general information on the bike used (bike type, purchase price, planned bike use, motive for purchase), as well as usual frequency of use, distances travelled, and transportation options. The accident sheet provided the opportunity to report traffic incidents and health-related consequences per post or online. A distinction was made between a near-accident (a critical situation in which an emergency maneuver (braking/ steering) prevented an accident) and an accident (defined as a collision or fall while cycling that resulted in injury or damage). The participant were asked to complete all documentation and return it to the study center.

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Univariate analysis and prognostic factors for reaching the physical activity target

Table S1. Univariate binary logistic regression for reaching the physical activity target

Variable	Reference group	Estimate	Effect group	Estimate	Odds Ratio [CI 95%]	p-value (Chi²-Test)
Age	>= 53 years	284/979 (29.0%)	<53 years	216/900 (24.0%)	0.77 [0.63; 0.95]	0.014
Children	>1	110/380 (28.9%)	0-1	382/1475 (25.9%)	0.86 [0.67; 1.10]	0.230
BMI	Overweight / obesity	272/1091 (24.9%)	Underweight / normal weight	227/783 (29.0%)	1.23 [1.00; 1.51]	0.050
Concomitant medication	No	418/1493 (28.0%)	Yes	59/294 (20.1%)	0.65 [0.48; 0.88]	0.005
Education	>= higher school certificate	332/1271 (26.1%)	<= secondary school certificate	167/604 (27.7%)	1.08 [0.87; 1.34]	0.484
Salary	>= 3000€	241/811 (29.7%)	< 3000€	256/1053 (24.3%)	0.76 [0.62; 0.93]	0.009
Sex	Female	130/598 (21.7%)	Male	370/1281 (28.9%)	1.46 [1.16; 1.84]	0.001
HF reducing medication	No	457/1680 (27.2%)	Yes	43/199 (21.6%)	0.74 [0.52; 1.05]	0.092
Buying motive	Other Aspects	245/815 (30.1%)	Health Improvement	233/675 (34.5%)	1.23 [0.99; 1.53]	0.067
Comorbidities	No	288/912 (31.6%)	Yes	209/940 (22.2%)	0.62 [0.50; 0.76]	<0.001
Physical disabilities/disorders	No	56/186 (30.1%)	Yes	444/1689 (26.3%)	0.83 [0.59; 1.15]	0.264
Primary bike use*	Every day use	139/508 (27.4%)	Leisure	140/472 (29.7%)	1.12 [0.85; 1.48]	0.517
			Commuting	164/429 (38.2%)	1.64 [1.25; 2.16]	0.087
			Sport	36/83 (43.4%)	2.03 [1.26; 3.27]	0.028
			Other	3/13 (23.1%)	0.80 [0.22; 2.94]	0.400
Smoking status	No	469/1730 (27.1%)	Yes	31/142 (21.8%)	0.75 [0.50; 1.13]	0.173
Sport points (physical activity questionnaire)	>= 43	275/939 (29.3%)	< 43	224/933 (24.0%)	0.76 [0.62; 0.94]	0.009
Study group	Conventional cycling	220/629 (35.0%)	E-bike	280/1250 (22.4%)	0.54 [0.43; 0.66]	<0.001

Univariate binary logistic regression to identify potential prognostic factors and confounders influencing the success rate of reaching the physical activity target of cycling 150 min at MVPA (dependent variable).

* type III F-test was performed for primary bike use (p=0.0008)

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Table S2. Multiple binary logistic regression model for reaching the physical activity target

Independent variable* (reference group)	Estimate	Full Model		Final Model (after stepwise backward selection)	
		Odds Ratio [CI 95%]	p-value (Chi²-Test)	Odds Ratio [CI 95%]	p-value (Chi²-Test)
Study Group (cycling)	E-bike	0.56 [0.43; 0.72]	<0.001	0.52 [0.41; 0.66]	<0.001
Age (>=53 years)	<53 years	0.60 [0.47; 0.78]	0.001	0.58 [0.45; 0.74]	<0.001
BMI (underweight / normal weight)	Overweight / obesity	1.03 [0.80; 1.31]	0.835		
Sex (female)	Male	1.34 [1.02; 1.74]	0.033	1.37 [1.06; 1.77]	0.017
Salary (>= 3000€)	< 3000€	0.89 [0.71; 1.13]	0.344		
HF reducing medication (no)	Yes	0.90 [0.59; 1.36]	0.618		
Comorbidities (no)	Yes	0.65 [0.51; 0.83]	<0.001	0.64 [0.51; 0.80]	<0.001
Buying motive (pragmatic)	Health	1.22 [0.96; 1.55]	0.100		
Sport points in the physical activity questionnaire (>=43 pts)	< 43 pts	0.81 [0.64; 1.03]	0.083		
Primary bike use** (everyday use)	Leisure time	1.27 [0.94; 1.73]	0.125	1.26 [0.93; 1.70]	0.129
	Commuting	1.93 [1.43; 2.62]	<0.001	1.91 [1.42; 2.59]	<0.001
	Sports-related	2.18 [1.32; 3.62]	0.003	2.26 [1.37; 3.73]	0.001
	Other	0.94 [0.24; 3.62]	0.928	0.94 [0.24; 3.63]	0.932

Hosmer-Lemeshow test for the final model): $\chi^2(8) = 4.43$, p = 0.816 * multiple binary logistic regression to determine prognostic factors and confounders influencing the success rate of reaching the physical activity target of cycling 150 min at MVPA (dependent variable). After univariate analyses to detect covariables that were significantly associated with the independent variable (here included in the "Full model"), multiple regression analysis with backward selection was conducted, until only covariables with p<0.05 remained in the "Final model" as reported above.

** type III F-test was performed for primary bike use and was statistically significant before and after backward selection

(p<.001)

Sensitivity analysis for MVPA cycling activities according to the 2020 WHO guidelines for physical activity (PA)

In addition to our primary analysis relating to the "2010 WHO global recommendations on physical activity for health" [1] which stated that moderate- and vigorous-intensity activity (MVPA) should be performed in bouts of at least 10 minutes duration, we conducted a sensitivity analysis according to the recently published "2020 WHO guidelines on physical activity and sedentary behavior" [2].

In contrast to the WHO recommendation published in 2010, the 2020 WHO guideline states that now MVPA bouts of any duration count towards the calculation of MVPA minutes per week. Therefore, we reanalyzed our data and counted any cycling activity if the heart rate was above the lower individual threshold of the respective intensity level (moderate or vigorous), and present this as sensitivity analysis for the primary outcomes.

Cycling at MVPA per week, and reaching the target of cycling 150 min at MVPA per week (according to the 2020 WHO guidelines for PA)

Time spent at MVPA during cycling per week was higher for the bicycle group (bicycle: 166.4 ± 195.6 min/week; e-bike: 105.3 ± 139.0 min/week) with a mean difference between groups of 61.2 min/week [CI95% 45.8; 76.5], p<0.001. A higher proportion of conventional bicycle users (41.2%) cycled 150 min or more at MVPA per week when compared to e-bike users (27.2%) (p<0.001).

Univariate analysis and prognostic factors for reaching the physical activity target (according to the 2020 WHO guidelines for PA)

Table S3. Univariate binary logistic regression for reaching the physical activity target

Variable	Reference group	Estimate	Effect group	Estimate	Odds Ratio [CI 95%]	p-value (Chi^2-Test)
Age	>= 53 years	341/979 (34.8%)	<53 years	258/900 (28.7%)	0.75 [0.62; 0.91]	0.004
Children	>1	129/380 (34.0%)	0-1	461/1475 (31.3%)	0.88 [0.70; 1.12]	0.315
BMI	Overweight / obesity	328/1091 (30.1%)	Underweight / normal weight	270/783 (34.5%)	1.22 [1.01; 1.49]	0.043
Concomitant medication	No	494/1493 (33.1%)	Yes	71/294 (24.2%)	0.64 [0.48; 0.86]	0.003
Education	>= higher school certificate	413/1271 (32.5%)	<= secondary school certificate	185/604 (30.6%)	0.92 [0.74; 1.13]	0.418
Salary	>= 3000€	276/811 (34.0%)	< 3000€	318/1053 (30.2%)	0.84 [0.69; 1.02]	0.079
Sex	Female	164/598 (27.4%)	Male	435/1281 (34.0%)	1.36 [1.10; 1.68]	0.005
HF reducing medication	No	547/1680 (32.6%)	Yes	52/199 (26.1%)	0.73 [0.53; 1.02]	0.067
Buying motive	Other Aspects	300/815 (36.8%)	Health Improvement	271/675 (40.2%)	1.15 [0.93; 1.42]	0.187
Comorbidities	No	337/912 (37.0%)	Yes	258/940 (27.5%)	0.65 [0.53; 0.79]	<.001
Physical disabilities/disorders	No	58/186 (31.2%)	Yes	541/1689 (32.0%)	1.04 [0.75; 1.44]	0.815
Primary bike use*	Every day use	183/508 (36.0%)	Leisure	161/472 (34.1%)	0.92 [0.71; 1.20]	0.089
			Commuting	191/429 (44.5%)	1.43 [1.10; 1.85]	0.200
			Sport	39/83 (47.0%)	1.57 [0.99; 2.51]	0.175
			Other	5/13 (38.5%)	1.11 [0.36; 3.44]	0.894
Smoking status	No	562/1730 (32.5%)	Yes	37/142 (26.1%)	0.73 [0.50; 1.08]	0.116
Sport points (activity questionnaire)	>= 43	324/939 (34.5%)	< 43	273/933 (29.3%)	0.79 [0.65; 0.95]	0.015
Study group	Conventional cycling	259/629 (41.2%)	E-bike	340/1250 (27.2%)	0.53 [0.44; 0.65]	<.001

Univariate binary logistic regression to identify potential prognostic factors and confounders influencing the success rate of reaching the physical activity target of cycling 150 min at MVPA (dependent variable). * type III F-test was performed for primary bike use (p=0.007)

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Table S4. Multiple binary logistic regression model for reaching the physical activity target

Independent variable* (reference group)	Estimate	Full Model		Final Model (after stepwise backward selection)	
		Odds Ratio [CI 95%]	p-value (Chi²-Test)	Odds Ratio [CI 95%]	p-value (Chi²-Test)
Study Group (cycling)	E-bike	0.54 [0.42; 0.69]	<0.001	0.51 [0.40; 0.65]	<0.001
Age (>=53 years)	<53 years	0.53 [0.42; 0.68]	<0.001	0.52 [0.41; 0.67]	<0.001
BMI (underweight / normal weight)	Overweight / obesity	1.00 [0.79; 1.27]	0.968		
Sex (female)	Male	1.30 [1.01; 1.67]	0.044	1.30 [1.02; 1.66]	0.035
Salary (>= 3000€)	< 3000€	0.97 [0.78; 1.22]	0.818		
HF reducing medication (no)	Yes	0.84 [0.57; 1.25]	0.400		
Comorbidities (no)	Yes	0.68 [0.54; 0.86]	0.001	0.67 [0.53; 0.83]	<0.001
Buying motive (pragmatic)	Health	1.15 [0.92; 1.45]	0.219		
Sport points (physical activity questionnaire) (>=43 pts)	< 43 pts	0.88 [0.69; 1.10]	0.261		
Primary bike use** (every day use)	Leisure time	1.00 [0.75; 1.34]	0.974	1.00 [0.75; 1.33]	0.984
	Commuting	1.71 [1.28; 2.29]	<0.001	1.70 [1.27; 2.27]	<0.001
	Sports-related	1.75 [1.06; 2.88]	0.027	1.79 [1.10; 2.93]	0.020
	Other	0.92 [0.26; 3.22]	0.900	0.94 [0.27; 3.27]	0.922

Goodness-of-fit (Hosmer-Lemeshow test for the final model): $\chi^2(8) = 7.72$, p = 0.461, * multiple binary logistic regression to determine prognostic factors and confounders influencing the success rate of reaching the physical activity target of cycling 150 min at MVPA (dependent variable). After univariate analyses to detect covariables that were significantly associated with the independent variable (here included in the "Full model"), multiple regression analysis with backward selection was conducted, until only covariables with p<0.05 remained in the "Final model" as reported above.

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Univariate and multiple analysis for prognostic factors for having at least one road traffic accident or near-accident

First, univariate binary logistic regression models were used to identify potential prognostic factors and confounders (p<0.1) influencing the success rate of having at least one road traffic accident (Table S5) or near-accident (Table S7), respectively. Then, potential prognostic factors were included in multiple binary logistic regression analysis and backward selection was used to drop independent variables with the highest p-value until only covariates and factors remained in the model that were significantly associated (p<0.05) with having at least one road traffic accident (Table S6) or near-accident (Table S8), respectively.

Table S5. Univariate binary logistic regression for having at least one traffic accident

Variable	Reference group	Estimate	Effect group	Estimate	Odds Ratio [CI 95%]	p-value (Chi²-Test)
Age	>= 53 years	47/979 (4.8%)	<53 years	55/900 (6.1%)	1.29 [0.86; 1.93]	0.212
Sex	female	32/598 (5.4%)	male	70/1281 (5.5%)	1.02 [0.67; 1.57]	0.919
Overall cycling time	<= 110 min/wk	35/941 (3.7%)	> 110 min/wk	67/938 (7.1%)	1.99 [1.31; 3.03]	0.001
Cycling frequency	<= 3 trips/wk	37/924 (4.0%)	> 3 trips/wk	65/955 (6.8%)	1.75 [1.16; 2.65]	0.008
Study group	Conventional cycling	26/629 (4.1%)	E-bike	76/1250 (6.1%)	1.50 [0.95; 2.37]	0.080

Univariate binary logistic regression to identify potential prognostic factors and confounders influencing the probability of having at least one accident (dependent variable).

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Table S6. Multiple binary logistic regression model for having at least one traffic accident

Independent variable* (reference group)	Estimate	Full Model		Final Model (after stepwise backward selection)	
		Odds Ratio [CI 95%]	p-value (Chi^2-Test)	Odds Ratio [CI 95%]	p-value (Chi^2-Test)
Study Group (cycling)	E-bike	1.63 [1.02; 2.58]	0.039	1.59 [1.00; 2.51]	0.048
Overall cycling time (<= 110 min/wk)	> 110 min/wk	1.74 [0.96; 3.17]	0.069	2.05 [1.35; 3.13]	0.001
Cycling frequency (<= 3 trips/wk)	> 3 trips/wk	1.26 [0.69; 2.28]	0.451		

Goodness-of-fit (Hosmer-Lemeshow test for the final model): $\chi^2(2) = 1.66$, p = 0.437, * multiple binary logistic regression to determine prognostic factors and confounders influencing the probability of having at least one accident (dependent variable). After univariate analyses to detect covariables that were significantly associated with the independent variable (here included in the "Full model"), multiple regression analysis with backward selection was conducted, until only covariables with p<0.05 remained in the "Final model" as reported above.

Table S7. Univariate binary logistic regression for having at least one near-accident

Variable	Reference group	Estimate	Effect group	Estimate	Odds Ratio [CI 95%]	p-value (Chi^2-Test)
Age	>= 53 years	57/979 (5.8%)	<53 years	77/900 (8.6%)	1.51 [1.06; 2.16]	0.022
Sex	female	33/598 (5.5%)	male	101/1281 (7.9%)	1.47 [0.98; 2.2]	0.065
Overall cycling time	<= 110 min/wk	38/941 (4.0%)	> 110 min/wk	96/938 (10.2%)	2.71 [1.84; 3.99]	<0.001
Cycling frequency	<= 3 trips/wk	35/924 (3.8%)	> 3 trips/wk	99/955 (10.4%)	2.94 [1.98; 4.37]	<0.001
Study group	Conventional cycling	48/629 (7.6%)	E-bike	86/1250 (6.9%)	0.89 [0.62; 1.29]	0.550

Univariate binary logistic regression to identify potential prognostic factors and confounders influencing the probability of having at least one near-accident (dependent

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variable).

Table S8. Multiple binary logistic regression model for having at least one near-accident

Independent variable* (reference group)	Estimate	Full Model		Final Model (after stepwise backward selection)	
		Odds Ratio [CI 95%]	p-value (Chi²-Test)	Odds Ratio [CI 95%]	p-value (Chi²-Test)
Study Group (cycling)	E-bike	1.12 [0.77; 1.64]	0.548		
Overall cycling time (<= 110 min/wk)	> 110 min/wk	1.71 [1.00; 2.92]	0.051	1.74 [1.02; 2.98]	0.043
Cycling frequency (<= 3 trips/wk)	> 3 trips/wk	2.02 [1.16; 3.51]	0.013	1.97 [1.14; 3.41]	0.015
Sex (female)	Male	1.45 [0.96; 2.18]	0.078		
Age (>=53 years)	<53 years	1.61 [1.12; 2.33]	0.010	1.57 [1.10; 2.25]	0.014

Goodness-of-fit (Hosmer-Lemeshow test for the final model): $\chi^2(4) = 1.689$, p = 0.793, * multiple binary logistic regression to determine prognostic factors and confounders influencing the probability of having at least one near-accident (dependent variable). After univariate analyses, multiple regression analysis with backward selection was conducted, until only covariables with p<0.05 remained in the "Final model" as reported above.

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