# 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.

## 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)

**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)

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

| Independent variable* (reference group) | Estimate | Full Model: Odds Ratio [CI 95%] | Full Model: p-value (Chi$^2$-Test) | Final Model (after stepwise backward selection): Odds Ratio [CI 95%] | Final Model (after stepwise backward selection): p-value (Chi$^2$-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.

**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 (Chi$^2$-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).

**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 (Chi²-Test) | Odds Ratio [CI 95%] | p-value (Chi²-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 (Chi²-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 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.

**References**

1. World Health Organization. Global Recommendations on Physical Activity for Health 2010 [Available from: https://www.who.int/dietphysicalactivity/global-PA-recs-2010.pdf accessed 12 Feb 2021.
2. Bull FC, Al-Ansari SS, Biddle S, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *British journal of sports medicine* 2020;54:1451-62.