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Starting to ride an e-cycle relates to more frequent cycling: A longitudinal analysis of retrospective data

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A R T I C L E I N F O

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A B S T R A C T

Introduction: E-cycles may offer an opportunity to increase cycling levels. However, experimental findings should be complemented with longitudinal observational studies examining the effects of starting to e-cycle on cycling levels in real-life settings. The current study among Flemish and Dutch middle-aged and older adults (≥45 years) aimed to compare changes between two time points in total (conventional + e-cycling) and conventional cycling frequencies of participants who started e-cycling against participants who did not e-cycle, who e-cycled at both time points and who stopped e-cycling.
Methods: Conventional and e-cycling frequencies were assessed retrospectively using a survey and participants (n = 1420) were categorized into one of four groups; (1) not e-cycling at both time points (n = 849), (2) e-cycling at both time points (n = 553), (3) started e-cycling (n = 11) and (4) stopped e-cycling (n = 7). Non-parametric repeated measures ANOVAs were applied to examine changes in total and conventional cycling frequency according to group.
Results: A significant interaction between group and time was observed for total and conventional cycling frequencies. Total cycling frequencies significantly decreased in all groups, except among those who started e-cycling for whom a significant increase with large effect size was observed. Conventional cycling frequencies significantly decreased in all groups, except among those who stopped e-cycling for whom no significant change was observed. Sensitivity analyses on matched groups confirmed these findings.
Conclusions: E-cycles appear to boost cycling frequencies among middle-aged and older adults. Future prospective observational studies in larger samples assessing cycling frequencies and durations and overall physical activity levels are necessary to confirm current findings.

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1. Introduction

E-cycles, battery-driven bicycles with a torque or velocity sensor triggering power support when the cyclist exerts power onto the pedals, are increasingly popular and offer a healthy and sustainable transport solution (Bourne et al., 2018, 2020; Cherry and Fishman, 2021). In 2019, in Belgium and the Netherlands respectively 33 and 42% of all cycles sold were e-cycles (Stichting BOVAG-RAI Mobiliteit, 2020). When e-cycles were first introduced they were mainly used by older adults (≥65 years), but their popularity has also increased in the past years among younger age groups. In Flanders (Northern region of Belgium), the overall modal share of e-cycles is 2.9%, but it is 3.8% among 45-to-54-year-olds, 4.0% among 55-to-64-year-olds and 5.8% among those aged 65 years and older (Janssens et al., 2020).

E-cycling has been shown to be less physically intensive that conventional cycling, but sufficiently intensive to yield health benefits (Bourne et al., 2018). Since e-cycles are faster, the same trip made by e-cycle will be shorter in duration than by conventional cycle (Berntsen et al., 2017; Gojanovic et al., 2011; Sperlich et al., 2012). Therefore, to have a beneficial health impact, e-cycle use should

Table 1
Measures of socio-demographic, health and mobility characteristics and frequencies of conventional and e-cycling.

Questions	Response options and coding	Recoding and additional information
Socio-demographics		
Age: How old are you?		
Sex: What is your sex?	Woman, Man	
Living situation: What is your living situation?	Living alone, Living together	
Education: How many years of education did you receive?	0 to 6, 7 to 9, 10 to 12 or more than 12 years	Recoded into 12 years or less vs. more than 12 years
Working status: Are you retired of did you stop working?	Retired, working, stopped working (but not yet retired), never worked	Recoded into working vs. not working
Health Characteristics		
BMI What is your height? What is your weight?		BMI= (weight in kg)/(height in m)[b] and categorized into normal weight (<25.0 kg/m^2), overweight (25.0–29.9 kg/m^2) or obese (≥30.0 kg/m^2) (World Health Organization, 2018).
Self-rated health: In general, would you say your health is …	Excellent (5), Very good (4), Good (3), Fair (2), Poor (1)	RAND SF 36-questionnaire (Haywood et al., 2005; Ware et al., 1994)
Functionality: Does your health limit you during the following activities? Moderate activities (moving a table, vacuum cleaning, swimming or cycling) Climbing several flights of stairs	No, not limited at all; Yes, limited a little; Yes, limited a lot	Recoded into limited versus not limited. Participants who reported to be limited a little or a lot in moderate activities or climbing stairs were classified as 'limited'(Haywood et al., 2005; Ware et al., 1994).
Mobility characteristics		
Car driver /public transit user:		
Indicate the transport modes that you have used in the past year:		
Driver (car/motorcycle)	Not vs. driven a car in the past year	
Public transit	Not vs. used public transit in the past year	
Walking for transport		
How frequently have you walked for transport in the past 12 months?	Never (coded 0 times/month), less than 1 day per month (coded 0.5), 1 to 3 days per month (coded 2), 1 to 2 days per week (coded 6), 3 to 4 days per week (coded 14) and 5 to 7 days per week (coded 24)	
Frequencies of conventional and e-cycling[a]		
Frequency of conventional cycling		
How frequently did you ride a conventional cycle in the past 12 months: In summer[b] In spring[c]	Never (coded 0 times/month), less than 1 day per month (coded 0.5), 1 to 3 days per month (coded 2), 1 to 2 days per week (coded 6), 3 to 4 days per week (coded 14) and 5 to 7 days per week (coded 24)	
Frequency of e-cycling		
Have you used an e-cycle in the past 12 months?	Yes, No	
How frequently did you ride an e-cycle in the past 12 months[d]: In summer[b] In spring[c]	Never (coded 0 times/month), less than 1 day per month (coded 0.5), 1 to 3 days per month (coded 2), 1 to 2 days per week (coded 6), 3 to 4 days per week (coded 14) and 5 to 7 days per week (coded 24)	

[a] Only cycling for transport and recreational purposes were recorded, participants were instructed not to report competitive cycling.
[b] Corresponds to summer 2016.
[c] Corresponds to spring 2017.
[d] Question only had to be completed if participants indicated they had ridden an e-cycle in the past 12 months.

not only replace conventional cycling, but should lead to higher overall cycling levels (i.e. conventional and e-cycling combined) by replacing passive transport modes or generating new trips. A recent review concluded that the available evidence suggests that e-cycle use increases cycling frequency and distance travelled compared to conventional bicycles (Bourne et al., 2020). It also concluded that e-cycle travel particularly replaces conventional cycle trips in regions with high levels of conventional cycling, such as the Netherlands or Flanders. This review relied on experimental as well as non-experimental evidence. While experimental research enables to control for self-selection, the effects observed during an experiment may not be the same in a non-experimental/observational setting (Fishman and Cherry, 2016). None of the 40 non-experimental studies included in the review by Bourne and colleagues (Bourne et al., 2020) assessed total cycling levels before and after participants started using an e-cycle and compared these against changes in cycling levels in a control group (i.e. participants who did not e-cycle). Two more recent studies did examine changes in levels of cycling among actual e-cycle buyers. Among Norwegian e-cycle buyers distance of cycling (for a travel purpose) increased from 2.1 to 9.2 km/day while no changes were observed in a control group not using an e-cycle (Fyhri and Sundfor, 2020). Among Dutch e-cycle owners total cycling modal share doubled after e-cycle purchase, but this study did not use a control group (Sun et al., 2020).

The current observational study among Flemish and Dutch middle-aged and older adults (≥45 years) aimed to compare changes between two time points in total and conventional cycling frequencies of participants who started e-cycling against participants who did not e-cycle, who e-cycled at both time points and who stopped e-cycling.

2. Materials and methods

2.1. Participant recruitment

The study protocol has been described in detail previously elsewhere (Schepers et al., 2020; Van Cauwenberg et al., 2019). Briefly, a cross-sectional survey study was conducted targeting Dutch and Flemish (northern region in Belgium) middle-aged and older adults (≥45 years). Dutch participants were recruited through the research panel of the National Foundation for the Elderly; 837 out of 2232 panel members completed the paper or online version of the survey (response rate = 37.5%). Flemish participants were recruited using contact details from participants in previous mobility studies (Van Cauwenberg et al., 2016) and through political, socio-cultural and leisure (senior) organizations. Forty out of 200 organizations agreed to spread the information letter (response rate organizations = 20%) and 1226 Flemish adults completed the online survey. Data were collected in June and July 2017. The study was approved by the ethical committees of the responsible University Hospitals. We excluded participants with erroneous data (e.g., participants who completed the survey twice, n = 64), younger than 45 years (n = 9) or not residing in the Netherlands or Flanders (n = 3), who had not cycled (conventional or e-cycle) in the past year (n = 490) and with missing data on cycling frequencies (n = 77). The final sample contained 1420 participants.

2.2. Measures

2.2.1. Socio-demographic, health and mobility characteristics

Participants self-reported socio-demographic, health and mobility characteristics (see Table 1).

2.2.2. Frequencies of conventional, e-cycling and total cycling and groups

Participants were asked to report their conventional and e-cycling frequencies in the past year according to season (see Table 1). For the current study, only conventional and e-cycling frequencies for the first and last recorded season were used. Since data were collected in June and July 2017, these correspond to Summer 2016 and Spring 2017. Total cycling frequency during Summer 2016 and Spring 2017 were calculated by summing corresponding conventional cycling and e-cycling frequencies. E-cycling frequencies were also used to create the variable 'group' with the following four levels; (1) not e-cycling at both time points, (2) e-cycling at both time points, (3) started e-cycling and (4) stopped e-cycling. From a question assessing the transport modes participants had used in the past year, we derived that one participant used a conventional tricycle (she was classified as not e-cycling at both time points), all other participants can be assumed to use a conventional and/or electrically-assisted bicycle.

2.2.3. Specific characteristics of e-cycle users

Participants who e-cycled at both time points or who started e-cycling were asked how long they possessed an e-cycle, what type of cycle they were riding before buying the current e-cycle (another e-cycle, conventional cycle or no cycle) and whether they cycled more or less since buying the e-cycle (less, as frequent as before, more).

2.3. Statistical analyses

Statistical analyses were performed in IBM® SPSS® Statistics version 25, except for the nonparametric repeated measures ANOVAs, which were performed in R version 3.5.2. Statistical significance was determined at $\alpha < 0.05$. An a priori power analysis in GPower version 3.1.9.2. (power = 0.80 and partial $\eta^2 = 0.14$) determined a necessary sample size of 76 participants (19 in each group).

Descriptive statistics were calculated for the total sample and the four groups. Given that the continuous variables were non-normally distributed or did not have homogenous variances across groups, Kruskall-Wallis tests (followed up by Mann Whitney U tests) were performed to examine differences in all continuous variables between groups. Given low cell counts, differences between groups in categorical variables were examined using Fisher's Exact Tests. Given the low number of participants who started (n = 11) or stopped (n = 7) e-cycling, some relevant differences did not reach statistical significance. These differences were interpreted and described in the results section without indicating them as statistically significant.

Given that total cycling frequency was non-normally-distributed, non-parametric repeated measures ANOVAs using the ARTool-package in R were applied to examine changes in total cycling frequency according to group (Wobbrock et al., 2011, 2021). A significant interaction effect was followed-up by Wilcoxon signed rank tests. Since sizes of groups differed substantially, effect sizes ($r = z/(\sqrt{\text{group size}})$) were calculated to facilitate comparison of the effects across groups. Effect sizes under 0.3 were considered small, effect sizes between 0.3 and 0.5 medium and effect sizes over 0.5 large (Field, 2005). The same approach was used for conventional cycling frequency. To examine how e-cycling frequency changed among those who e-cycled at both time points, a Wilcoxon signed rank test was used.

Participants who started e-cycling differed substantially on relevant baseline characteristics (i.e., region, age and gender) from participants who did e-cycle and who did not e-cycle at both time points. Therefore, a sensitivity analysis was performed, repeating the analyses described above, on a sample in which the groups not e-cycling and e-cycling at both time points were matched on region, age and gender against those who started e-cycling. Given the small number of participants who stopped e-cycling, it was not possible to match this group against those who started e-cycling and they were not included in the sensitivity analyses.

3. Results

3.1. Descriptive statistics and comparisons between groups

The majority of our sample was Flemish (66.1%) and aged 65 years or older (62.5%) (see Table 2). In comparison to the Flemish and Dutch population of those aged 45 years and older, participants aged 65 years or older and participants with more than 12 years of education were overrepresented in our sample (see Table 3).

The majority of participants did not e-cycle at both time points (n = 849, 59.8%), 553 e-cycled at both time points (38.9%), eleven participants started e-cycling (0.8%) and seven participants stopped e-cycling (0.5%) (see Table 2). While no significant differences were observed for region (p = 0.10), the prevalence of Flemish participants was substantially higher among those who started (90.9%) and stopped e-cycling (85.7%) compared to those not e-cycling (67.3%) and those e-cycling at both time points (63.5%). Those who started e-cycling tended to be younger and include more women and tended to be more likely to be working, not functionally limited and use public transport and walk more for transport. All participants who stopped e-cycling had received more than 12 years of education. Those e-cycling at both time points tended to be older, less educated and more likely to be functionally limited. Those not e-cycling at both time points had the lowest prevalence of women.

Table 2
Characteristics of the total sample and the four groups and comparisons between the four groups.

	Total sample (n = 1420)	Not e-cycling at both time points (n = 849)	E-cycling at both time points (n = 553)	Started e-cycling (n = 11)	Stopped e-cycling (n = 7)	Fisher's exact test /Kruskall Wallis H	p
Region (% Flanders)	66.1	67.3	63.5	90.9	85.7	6.1	0.10
Age (M ± SD)	66.2 ± 9.4	65.7 ± 9.8[a]	67.1 ± 8.8[b]	58.8 ± 8.4[c]	63.6 ± 9.6[a,b,c]	13.3	<0.01
Age (% 65+ years)	62.5	59.5[a]	68.2[b]	27.3[a]	28.6[a]	19.8	<0.001
Gender (% women)	50.6	47.2[a]	55.0[b]	81.8[b]	57.1[a,b]	12.5	<0.01
Living situation (% alone)	26.8	28.0	24.8	36.4	14.3	2.8	0.41
Education (% > 12 years)	73.9	76.1[a]	70.3[b]	72.7[a,b]	100.0[a,b]	7.9	0.04
Working status (% working)	26.4	28.4[a]	22.2[b]	72.7[c]	42.9[a,b,c]	18.3	<0.001
BMI (M ± SD)	26.2 ± 4.2	25.7 ± 4.1[a]	27.0 ± 4.0[b]	28.1 ± 10.3[a,b]	24.5 ± 2.4[a,b]	38.2	<0.001
Self-rated health (M ± SD)	3.1 ± 0.8	3.2 ± 0.8[a]	3.1 ± 0.7[b]	3.2 ± 0.8[a]	3.0 ± 0.8[a,b]	8.0	0.05
Functionality (% limited)[a]	40.1	34.9[a]	48.3[b]	27.3[a,b]	42.9[a,b]	25.8	<0.001
Car driving (% driving)	80.9	81.4	80.3	72.7	85.7	1.1	0.81
Public transit (% users)	51.8	55.7[a]	45.2[b]	81.8[a]	42.9[a,b]	19.0	<0.001
Walking for transport (Med (Q1-Q3))[b]	6.0 (2.0–24.0)	6.0 (2.0–24.0)[a]	6.0 (2.0–14.0)[b]	14.0 (6.0–24.0)[a,b]	6.0 (2.0–14.0)[a,b]	15.5	0.001

M = Mean, SD = standard deviation, Med = median, Q1 = quartile 1, Q3 = quartile 3.

[a,b,c] Within the same row, different subscripts indicate significant differences between groups (derived from post hoc Fisher Exact or Mann Whitney U tests).

[a] Participants who reported to be a little or severely limited by their health to perform moderate-intensity activity or to climb several stairs.

[b] Expressed in days/month in the past year, medians and quartiles were reported because of a non-normal distribution.

Table 3
Comparison of sample against national/regional statistics.

	Sample (n = 1420)	Flanders	The Netherlands
Age (% 65+ years)	62.5	41.5[a]	39.6[d]
Gender (% women)	50.6	52.0[a]	51.6[d]
Education (% > 12 years)	73.9	69.8[b]	64.5[e]
BMI (M ± SD)	26.2 ± 4.2	26.3[c]	26.5[f]

[a] Data for Flemish +45-year-olds in 2017 (Statbel, 2021a).
[b] Data for Flemish 55-to-64-year-olds in 2019 (Statbel, 2021b).
[c] Data for Flemish +45-year-olds in 2018 (Sciensano, 2021).
[d] Data for Dutch +45-year-olds in 2017 (Statline, 2021a).
[e] Data for Dutch +45-year-olds in 2020 (Eurostat, 2021).
[f] Data for Dutch 65-to-75-year-olds in 2020 (Statline, 2021b).

3.2. Specific characteristics of e-cycle users

Of the participants who used an e-cycle at both time points, 64.4% possessed their e-cycle for more than three years. Before buying their current e-cycle, 8.1% already rode an e-cycle, 88.8% rode a conventional cycle and 3.1% did not ride any cycle. Since e-cycle purchase, 2.7% reported to cycle less frequently than before, 31.6% to cycle as frequently, and 65.6% reported to cycle more frequently.

From the eleven participants who started using an e-cycle, 10 (90.9%) participants possessed their e-cycle for less than six months. Before buying the e-cycle, 10 (90.9%) participants rode a conventional cycle and one (9.1%) participant did not ride any cycle. None reported to cycle less since they bought the e-cycle, three (27.3%) reported to cycle as frequently and eight (72.7%) to cycle more frequently.

3.3. Comparison of cycling frequencies according to group

Median frequencies of conventional cycling, e-cycling and total cycling according to group and time point are presented in Table 4. For total cycling, a significant interaction between group and time was observed (see Table 5). Total cycling frequencies significantly decreased in all groups, except among those who started e-cycling for whom a significant increase with large effect size was observed.

For conventional cycling, a significant interaction between group and time was observed. Conventional cycling frequencies significantly decreased in all groups, except among those who stopped e-cycling for whom no significant change (but large effect size) was observed.

Among those e-cycling at both time points, e-cycle frequency significantly decreased over time (14 increased, 154 decreased, $z = -9.8$, $p < 0.001$, $r = -0.4$).

3.4. Sensitivity analyses

For total cycling frequency, a significant interaction effect between group and time was observed (see Appendix A). A significant increase with large effect size was observed among those who started e-cycling, but no significant changes were observed among those not e-cycling and those e-cycling at both time points.

For conventional cycling frequency, a significant interaction effect between group and time was observed. Conventional cycling frequencies did not significantly change in those not e-cycling and those e-cycling at both time points, while a significant decrease with large effect size was observed among those who started e-cycling.

Table 4
Median cycling frequencies according to group.

E-cycle group	Frequency conventional cycling (Med (Q1-Q3))		Frequency e-cycling (Med (Q1-Q3))		Frequency total cycling (Med (Q1-Q3))	
	Summer 2016	Spring 2017	Summer 2016	Spring 2017	Summer 2016	Spring 2017
Not e-cycling at both time points (n = 849)	14.0 (6.0–24.0)	14.0 (6.0–24.0)	/	/	14.0 (6.0–24.0)	14.0 (6.0–24.0)
E-cycling at both time points (n = 553)	0.5 (0.0–14.0)	0.5 (0.0–6.0)	14.0 (6.0–24.0)	14.0 (6.0–24.0)	20.0 (14.0–24.5)	14.5 (6.5–24.0)
Started e-cycling (n = 11)	14.0 (2.0–24.0)	6.0 (0.5–14.0)	/	14.0 (14.0–24.0)	14.0 (2.0–24.0)	24.0 (20.0–30.0)
Stopped e-cycling (n = 7)	2.0 (0.0–24.0)	0.0 (0.0–6.0)	2.0 (2.0–6.0)	/	6.0 (2.0–26.0)	0.0 (0.0–6.0)

Med = median, Q1 = quartile 1, Q3 = quartile 3.

Table 5
Results of the non-parametric ANOVAs and Wilcoxon tests.

	Frequency total cycling					Frequency conventional cycling				
	Non-parametric ANOVA									
	F	p				F	p			
Main effect time	19.4	<0.001				8.3	<0.01			
Main effect group	16.0	<0.001				179.9	<0.001			
Interaction time*group	69.4	<0.001				21.2	<0.001			
	Wilcoxon test									
Group	Increase in frequency	Decrease in frequency	z	p	r	Increase in frequency	Decrease in frequency	z	p	r
Not e-cycling at both time points (n = 849)	14	182	−10.4	<0.001	−0.4	14	182	−10.4	<0.001	−0.4
E-cycling at both time points (n = 553)	16	178	−10.5	<0.001	−0.4	11	65	−5.7	<0.001	−0.2
Started e-cycling (n = 11)	11	0	−3.0	<0.01	−0.9	0	5	−2.1	0.04	−0.6
Stopped e-cycling (n = 7)	0	7	−2.4	0.02	−0.9	0	3	−1.6	0.11	−0.6

r = effect size calculated as $z/(\sqrt{(\text{group size})})$ (Field, 2005).

4. Discussion

The current observational study aimed to examine how starting to ride an e-cycle influences total and conventional cycling frequencies. Our findings showed that starting to e-cycle was associated with increases in total cycling frequency while frequencies decreased (or remained stable, i.e. in the sensitivity analyses) in the other groups. These findings occurred in a context where overall cycling modal shares decreased from 28 to 26% in Flanders and remained stable at 26% in the Netherlands between 2016 and 2017 (Janssens et al., 2018; Reumers et al., 2017; Statline, 2021c). Our findings confirm previous experimental (Bjornara et al., 2019; Cairns et al., 2017; de Kruijf et al., 2018; Fyhri and Fearnley, 2015; MacArthur et al., 2017) and non-experimental (Fyhri and Sundfor, 2020; Sun et al., 2020) studies and suggest that e-cycles may have a positive health impact by increasing overall cycling levels. In the current study we merely examined cycling frequencies and not durations. However, previous studies have reported e-cycle trips to be longer in duration compared to conventional cycle trips (Bjornara et al., 2019; Castro et al., 2019). This indicates that e-cycling may lead to higher overall cycling volumes (frequency * trip durations) compared to conventional cycling. To completely assess the potential health impact of e-cycles, future studies should compare the health impact of increased overall cycling volume against the reduced intensity of e-cycling in comparison to conventional cycling. Furthermore, e-cycles may substitute for other forms of physical activity (e.g., walking) (Cairns et al., 2017), which should also be taken into account when assessing e-cycles' overall impact on health. Currently, the evidence of the overall impact of e-cycling on metabolic and psychological health outcomes is inconclusive (Bourne et al., 2018).

Our findings were obtained in two regions with a strong cycling culture, which may imply that e-cycling has replaced conventional cycling more frequently than they would have in regions with weaker cycling cultures (Bourne et al., 2020). Therefore, the effects of e-cycles on total cycling frequency may be even more pronounced in regions with weaker cycling cultures. On the other hand, a stronger cycling culture and a potentially strong cycling history of our participants may have led to frequently using the e-cycle. Our participants who started using an e-cycle had a mean age of 59 years and the majority of them were working, which may imply that they used the e-cycle mainly for commuting purposes (Bourne et al., 2020). Research among older and retired individuals should confirm whether e-cycles stimulate cycling frequency to a similar degree in that target group.

This was one of the few studies examining the effects of starting to use an e-cycle on cycling levels in a non-experimental set-up. A second strength is that we compared changes in cycling frequencies across four groups, including a group who stopped e-cycling. To our knowledge, no previous study examined the effect of e-cycle use cessation on overall cycling levels. A last strength is that we performed sensitivity analyses to examine whether our findings were not confounded by differences in baseline characteristics between the groups. Despite these strengths, several limitations should be taken into account. First, the groups who started (n = 11) and stopped (n = 7) e-cycling were small resulting in insufficient power to detect significant differences between the groups. This was counteracted by the presentation of effect sizes to facilitate interpretation of the effects. The small group sizes also prevented the examination of potential moderators (e.g., gender, age, or region). Second, cycling frequencies were assessed retrospectively, which may result in recall bias (Vanparijs et al., 2015). There is a need for prospective observational studies examining the effects of e-cycles on cycling levels. Third, we had no information on exactly how long ago participants started using their e-cycle, which may imply that the observed large effects on total cycling frequency may be attributable to a novelty effect. However, in an experimental study among Norwegian adults it was shown that e-cycle use increased the longer participants possessed the e-cycle (Fyhri and Fearnley, 2015). It should be noted that participants maximally possessed the e-cycle for 64 days. Future studies with exact information on how long participants possess an e-cycle and longer follow-up periods are necessary to examine how e-cycle use affects cycling levels over time.

To conclude, e-cycles appear to boost cycling frequencies among middle-aged and older adults. Future prospective observational studies in larger samples assessing cycling frequencies and durations and overall physical activity levels are necessary to confirm current findings.

Author statement

All authors contributed to the conceptualization and design of the study. JVC, PS and BdG organized the data collection. JVC performed the analyses and drafted the paper. PS, BD and BdG reviewed and edited the paper.

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Appendix. sensitivity analyses

Descriptive statistics and comparisons between matched groups

To increase the comparability of the groups, participants not e-cycling and e-cycling at both time points were matched on region, age and gender against those who started e-cycling. After matching, there were no longer statistically significant differences between these three groups (see Table A1).

Comparison of cycling frequencies according to group

Median conventional cycling, e-cycling and total cycling frequencies according to group are presented in Table A2. For total cycling frequency, a significant interaction effect between group and time was observed (see Table A3). Total cycling frequencies did not significantly change in those not e-cycling (medium effect size) and those e-cycling at both time points (small effect size), while a significant increase was observed among those who started e-cycling (large effect size).

For conventional cycling frequency, a significant interaction effect between group and time was observed. Conventional cycling frequencies did not significantly change in those not e-cycling and those e-cycling at both time points (medium effect sizes), while a significant decrease was observed among those who started e-cycling (large effect size).

Among those e-cycling at both time points, e-cycle frequency did not significantly change over time (1 increased, 0 decreased, $z = -1.0$, $p = 0.32$, $r = -0.3$).

Table A1
Characteristics of the matched groups and comparisons

	Not e-cycling at both time points (n = 11)	E-cycling at both time points (n = 11)	Started e-cycling (n = 11)	Fisher's exact test /Kruskall Wallis H	p
Region (% Flanders)	90.9	90.9	90.9	/	/
Age (M ± SD)	58.8 ± 8.4	58.8 ± 8.4	58.8 ± 8.4	/	/
Age (% 65+ years)	27.3	27.3	27.3	/	/
Gender (% women)	81.8	81.8	81.8	/	/
Living situation (% alone)	45.5	9.1	36.4	3.8	0.24
Education (% > 12 years)	81.8	63.6	72.7	1.0	0.88
Working status (% working)	54.5	63.6	72.7	0.9	0.90
BMI (M ± SD)	26.6 ± 3.2	26.5 ± 6.3	28.1 ± 10.3	0.6	0.76
Self-rated health (M ± SD)	3.2 ± 0.6	2.8 ± 0.8	3.2 ± 0.8	1.9	0.39
Functionality (% limited)[1]	27.3	45.5	27.3	1.1	0.72
Car driving (% driving)	72.7	72.7	72.7	0.2	1.00
Public transit (% users)	45.5	54.5	81.8	3.3	0.29
Walking for transport (Med (Q1-Q3))[2]	6.0 (2.0–24.0)	6.0 (2.0–24.0)	14.0 (6.0–24.0)	1.3	0.53

M = Mean, SD = standard deviation, Med = median, Q1 = quartile 1, Q3 = quartile 3.
/no statistical tests were performed since the three groups were matched on these variables.
1Participants who reported to be a little or severely limited by their health to perform moderate-intensity activity or to climb several stairs.
2Expressed in days/month in the past year.

Table A2
Median cycling frequencies according to group

(continued on next page)

Table A2 (*continued*)

E-cycle group	Frequency conventional cycling (Med (Q1-Q3))		Frequency e-cycling (Med (Q1-Q3))		Frequency total cycling (Med (Q1-Q3))	
	Summer 2016	Spring 2017	Summer 2016	Spring 2017	Summer 2016	Spring 2017
E-cycle group	Frequency conventional cycling (Med (Q1-Q3))		Frequency e-cycling (Med (Q1-Q3))		Frequency total cycling (Med (Q1-Q3))	
	Summer 2016	Spring 2017	Summer 2016	Spring 2017	Summer 2016	Spring 2017
Not e-cycling at both time points (n = 11)	14.0 (6.0–24.0)	14.0 (6.0–24.0)	/	/	14.0 (6.0–24.0)	14.0 (6.0–24.0)
E-cycling at both time points (n = 1)	0.5 (0.0–6.0)	0.0 (0.0–6.0)	14.0 (6.0–24.0)	14.0 (6.0–24.0)	24.0 (12.0–24.5)	24.0 (14.0–24.0)
Started e-cycling (n = 11)	14.0 (2.0–24.0)	6.0 (0.5–14.0)	/	14.0 (14.0–24.0)	14.0 (2.0–24.0)	24.0 (20.0–30.0)

Med = median, Q1 = quartile 1, Q3 = quartile 3.

Table A3
Results of the non-parametric ANOVAs and Wilcoxon tests

	Frequency total cycling		Frequency conventional cycling	
	Non-parametric ANOVA			
	F	p	F	p
Main effect time	18.1	<0.001	24.2	<0.001
Main effect group	0.5	0.60	5.7	<0.01
Interaction time*group	19.0	<0.001	11.0	<0.001

E-cycle group	Wilcoxon test Increase in frequency	Decrease in frequency	z	p	r	Increase in frequency	Decrease in frequency	z	p	r
Not e-cycling at both time points (n = 11)	0	1	−1.0	0.32	−0.3	0	1	−1.0	0.32	−0.3
E-cycling at both time points (n = 11)	1	1	−0.4	0.66	−0.1	0	1	−1.0	0.32	−0.3
Started e-cycling (n = 11)	11	0	−3.0	<0.01	−0.9	0	5	−2.1	0.04	−0.6

r = effect size calculated as $z/(\sqrt{(\text{group size})})$ (Field, 2005).

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