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## Journal of Transport &amp; Health

journal homepage: [www.elsevier.com/locate/jth](http://www.elsevier.com/locate/jth)

# Health effects from bicycle commuting to work: Insights from participants of the German company-bicycle leasing program

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## ARTICLE INFO

### Keywords:

Active transportation  
Active commuting  
Cycling to work  
Wellbeing  
Perceived innovation characteristics  
Diffusion of innovations theory

## ABSTRACT

**Introduction:** Company-bicycle leasing programs aim to promote employees' health via the advancement of cycling to work. To date, however, empirical evidence for the effects of participation in such programs is weak. This is also true for the German program. The present study aims to assess the relationship between the five perceived innovation characteristics proposed by the Diffusion of Innovations Theory and the company-leasing bicycle commuting behavior of German employees as well as their physical and mental wellbeing. Furthermore, the study aims to find out whether the innovation characteristics relate to changes in commuting behavior, and whether these changes have a positive effect on employees' physical and mental wellbeing.

**Methods:** Perceived innovation characteristics, physical activity, and health levels of 462 employees from 62 companies were assessed in a two-wave longitudinal study. The second wave took place 40 days after the first wave. Path analyses were used for hypotheses testing.

**Results:** The results showed that compatibility (but not relative advantage, low complexity, trialability, and observability) measured in the first wave had a positive impact on cycling to work (in minutes cycled per day), which in turn increased physical and mental wellbeing (all three variables were self-reports that were measured in the second wave). There were no significant relationships using change scores for both the mediator and the health outcomes.

**Conclusions:** The findings indicate that the use of company leasing bicycles relates positively with physical and mental wellbeing. Compatibility is a significant determinant of active commuting, suggesting that company executives should endorse the perception that they share important values, lifestyles, and needs with employees. Changes in active commuting, however, did not increase health, most likely due to the short time scale under consideration. The findings help policy makers identify individual- and organization-level factors that relate to active commuting and health.

## 1. Introduction

Policy makers around the world aim to promote active commuting to work (or school). Active commuting has a vast potential to generate positive effects on the physical activity—and hence wellbeing—levels in the general population (Dinu et al., 2019; Saunders et al., 2013). Cycling is a particularly attractive means of active commuting to work, because short to medium distances can be covered in an acceptable time period (Whitt and Wilson, 1982), traffic-related problems can be reduced (e.g., less congestion, fewer parking spots needed at the work site), and on-site mobility of employees can be facilitated (Synek and Koenigstorfer, 2018).

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<https://doi.org/10.1016/j.jth.2019.100619>

Received 16 April 2019; Received in revised form 25 June 2019; Accepted 21 August 2019

Available online 31 August 2019

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In Europe, several countries have introduced programs that promote cycling to work via monetary incentives to employers and/or employees (BMF, 2012; DFT, 2011). In Germany, the so-called company-car privilege has been extended so that company-leased bicycles are also eligible for tax exemptions (BMF, 2012). Since 2012, despite a slow start of the program, more and more employers and employees have participated in the program, and the adoption drivers and barriers have been explored in a recent qualitative study (Synek and Koenigstorfer, 2018). The program offers excellent health promotion opportunities to employers and employees. Also, sales have increased in the bicycle market due to purchases of new bicycles, including s-pedelecs and e-bikes. This resulted from a reported adoption of 250,000 leasing bicycles by employees who work for an estimated 10,000 companies (ADFC, 2019).

While previous studies have considered the determinants that influence whether employees adopt the company-bicycle leasing program—that is, whether they *purchase* a new bicycle (e.g., Synek and Koenigstorfer, 2018)—to our knowledge, there are no studies that have examined what makes employees *use* their bicycles to commute to work when they participate in such a program. However, use adoption is what increases health—the mere purchase of a new bicycle is not enough (Mytton et al., 2016; Shih and Venkatesh, 2004). Thus, there is a need to study the factors that influence commuting-to-work cycling (*use*) behaviors, as well as the downstream effects of cycling to work.

The present study aims to partly fill this void and considers the five perceived innovation characteristics proposed by the Diffusion of Innovations Theory (Rogers, 2003). The perceived innovation characteristics might be relevant in the context of the present study, because the program has only recently been established (BMF, 2012) and because consumers' evaluations of the program's features are crucial for use adoption (Shih and Venkatesh, 2004; see Nehme et al., 2016). As Synek and Koenigstorfer (2018) show in their case study, there are several innovation characteristics-like factors that influence the potential purchase and use of bicycles as part of the German taxation-policy program.

The paper is structured as follows. First, we briefly review previous studies that considered the effects of active bicycle commuting on employees' health. Second, we propose a conceptual model in reference to the Diffusion of Innovations Theory that guided our empirical study. Next, we present the methods and the results of the study, and discuss the results. We conclude by describing the limitations of our study and providing an outlook on future research.

### 1.1. Cycling to work and employees' health

Active commuting has been found to increase the levels of physical and mental wellbeing (Bize et al., 2007; Humphreys et al., 2013; Martin et al., 2014; Petrunoff et al., 2016), including reduction of cardiovascular risks (Celis-Morales et al., 2017; Hamer and Chida, 2008; Xu et al., 2013), body weight (Faulkner et al., 2009; Xu et al., 2013), perceived stress (Avila-Palencia et al., 2017), and risk of diabetes (Saunders et al., 2013). Furthermore, active commuting is associated with reduced sickness absence (Hendriksen et al., 2010; Mytton et al., 2016) and high self-reported wellbeing (Mytton et al., 2016). In agreement with these findings, bicycle commuting has been inversely associated with all-cause mortality (Andersen et al., 2000; Dinu et al., 2019) and seems to improve health-related quality of life in previously untrained healthy adults (de Geus et al., 2008).

Besides these direct health effects, active commuting has also been reported to generate positive effects for the environment, thus indirectly promoting human health. For example, active commuting helps reduce air pollution, greenhouse gas emissions, and noise—factors that provide healthier environmental contexts to all people in society (de Nazelle et al., 2011; Johan de Hartog et al., 2010).

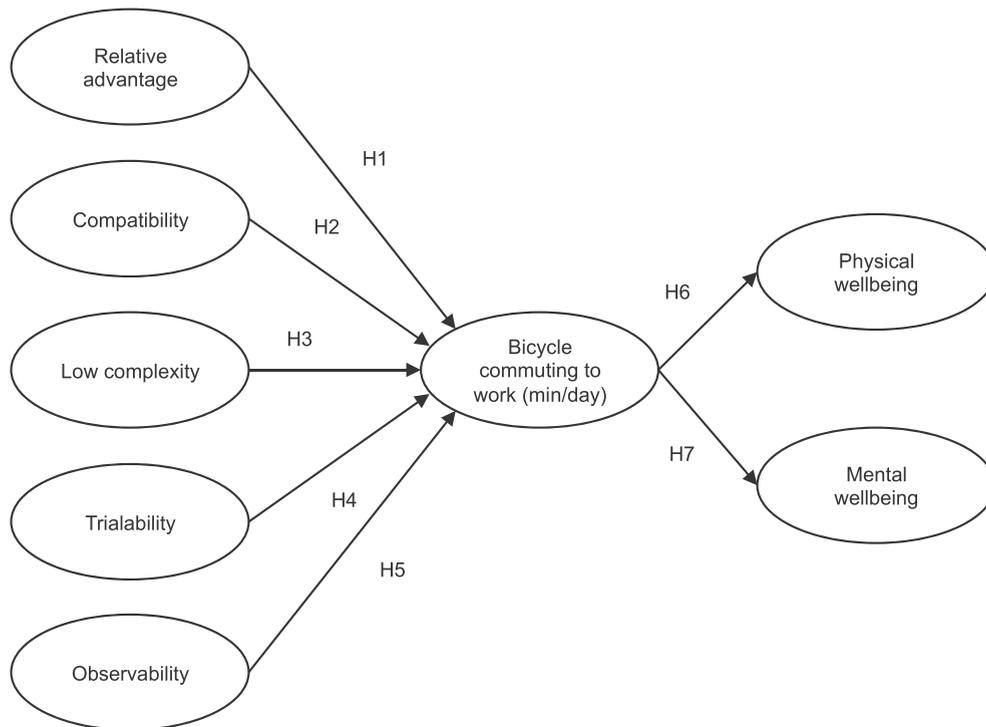
There is ample evidence that cycling to work correlates positively with physical activity and hence physical health—particularly in regard to the human cardiovascular system—and mental health. Yet, it is largely unknown what factors induce people to cycle to work more (Petrunoff et al., 2016). While many people own bicycles, they are often *not* used to commute to work, for several reasons. The main factors are: time constraints, traffic safety concerns, concerns related to distance, concerns about appearance, as well as factors such as the built environment, physical discomfort, and health problems (among others; Bopp et al., 2012; see also Synek and Koenigstorfer, 2018). In this study, we look at factors that relate to the adoption of the German company-bicycle leasing program: relative advantage, compatibility, low complexity, trialability, and observability, lending to the Diffusion of Innovations Theory (Rogers, 2003; see also Nehme et al., 2016; Synek and Koenigstorfer, 2018).

### 1.2. Diffusion of Innovations Theory and perceived innovation characteristics

Rogers (2003) introduced the Diffusion of Innovations Theory in 1962. According to Rogers, persons who are interested in a new concept (or product or service) seek for, and process, information in order to reduce their uncertainty. Rogers (2003) describes five general attributes of an innovation that influence people's evaluations as part of this process. The so-called perceived innovation characteristics are: relative advantage, compatibility, complexity, observability, and trialability.

Relative advantage describes 'the degree to which an innovation is perceived as being better than the idea it supersedes' (Rogers, 2003, p. 229). Compatibility is defined as 'the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters' (Rogers, 2003, p. 15). Low complexity is 'the degree to which an innovation is perceived as relatively difficult to understand and use' (Rogers, 2003, p. 15). Observability is 'the degree to which the results (...) are visible to others' (Rogers, 2003, p. 16). Lastly, trialability reflects 'the degree to which an innovation may be experimented with on a limited basis' (Rogers, 2003, p. 16).

A number of adoption and diffusion studies have demonstrated the relevance of these innovation characteristics. They were shown to explain between 49% and 87% of the variance in the adoption rate (Sahin and Rogers, 2006). In the present study, we postulate that the five innovation characteristics would influence employees' *use adoption*, that is, to what extent employees commute



**Fig. 1.** Determinants of Physical and Mental Wellbeing of Participants of the German Company-bicycle Leasing Program.

*Notes.* The same model was postulated for changes in bicycle commuting to work (minutes per day; wave 2 minus wave 1) and changes in physical and mental wellbeing (wave 2 minus wave 1).

to work by bicycle when they are part of the program.

Fig. 1 provides an overview of the conceptual framework of the study. A set of hypotheses (H1–H5) was developed based on Diffusion of Innovations Theory. These were:

**H1–H5.** The higher the (1) relative advantage, (2) compatibility, (3) ease of use (low complexity), (4) trialability, and (5) observability of the company-bicycle leasing program (as perceived by employees), (a) the more they use their bicycle to commute to work, and (b) the more they increase their commuting behavior after the adoption of the program.

Hypotheses 6–7 postulate that the level of physical activity correlates with, and when employees become more active increases physical and mental wellbeing. The development of these hypotheses will be described next.

### 1.3. Positive health effects of active commuting to work

In agreement with the literature on positive physical and mental health effects of cycling to work (Humphreys et al., 2013; Martin et al., 2014; Petrunoff et al., 2016), we postulate that there is a positive relationship between the amount employees cycle to work and their physical and mental wellbeing. Accordingly, an increase in the amount employees cycle to work should lead to an increase in physical and mental wellbeing. The mechanisms have been researched extensively, such as an increase in fitness, a physiological adaptation that reduces cardiovascular risk factors, stress relief, and improved posture and coordination (Johan de Hartog et al., 2010; Oja et al., 2011). While we do not aim to review all the possible mechanisms in the present study, we assume the following hypotheses:

**H6a.** The more employees use their bicycle to commute to work, the higher their physical wellbeing. **H6b.** An increase in the amount employees cycle to work leads to a positive change in physical wellbeing.

**H7a.** The more employees use their bicycle to commute to work, the higher their mental wellbeing. **H7b.** An increase in the amount employees cycle to work leads to a positive change in mental wellbeing.

### 1.4. Summary of the study goals and hypotheses

The purpose of the study is to, firstly, find out whether perceived innovation characteristics proposed by Rogers (2003) determine the extent to which employees use their bicycle to commute to work and to assess the relationship between company leasing bicycle commuting behavior of employees and their physical and mental wellbeing. Secondly, the study aims to find out whether perceptions

of the innovation characteristics relate to changes in commuting behavior, and whether these potential changes have a positive effect on the changes in employees' physical and mental wellbeing.

## 2. Methods

### 2.1. Research context: the German Company-bicycle leasing program

In November 2012, a fiscal reform in Germany, the so-called 1% tax rule that applies to company-leased cars (i.e., the noncash benefit amounts to 1% of the car's list price per month), was applied to bicycles, s-pedececs, and e-bikes (BMF, 2012). Since then, German companies can participate in the bicycle-leasing program that allows their employees to purchase bicycles. As the lease payment is deducted from the employees' monthly gross salary, taxable income decreases and employees can save up to 40% compared to a regular bicycle purchase (Wesp, 2015). The present study was conducted in 2017 and 2018. About 250,000 leasing bicycles (compared to 75.5 million bicycles in Germany [0.3%]; Statista, 2019a) and about 10,000 companies (compared to 3.3 million companies in Germany [0.3%]; Statista, 2019b) have adopted the program until 2018 (ADFC, 2019), which means that it can be assumed that the present study still works with early adopters (early growth stage according to Rogers, 2003).

### 2.2. Participants

Email addresses of employees from 62 German companies (all customers of JobRad, the German market leader in the leasing service provider industry; randomly selected) were provided to the authors of the present study, and the authors then—after having received the consent from the respective company representatives—contacted all the employees who had purchased a leasing bicycle via JobRad. There were no incentives provided to the participants and the participation in the study was both voluntary and anonymous. No reminders were sent out in order to avoid annoyance and to adhere to companies' communication policies.

### 2.3. Procedure

A longitudinal research design was employed in this study. The survey was administered online. The first-wave data collection took place between August 2017 and February 2018; the second-wave data collection took place between four and six weeks after the first wave.

In the first-wave survey, participants first provided their informed consent for participation in the survey. They next answered some questions capturing the five perceived innovation characteristics. Also, they reported on their levels of physical activity (in particular when commuting to work), their physical and mental wellbeing, as well as some descriptive variables and socio-demographics. The survey ended with an announcement of the second-wave survey about one month later. In the second-wave survey, participants were again asked to indicate their levels of physical activity (in particular when commuting to work) as well as their physical and mental wellbeing. Participants were fully debriefed after participation in the second wave.

### 2.4. Variables

The five perceived innovation characteristics were measured via single items, using a seven-point rating scale ranging from 1 ('I strongly disagree') to 7 ('I strongly agree'). The use of single-item measures is justified when a construct's object is concrete singular and when it is easily and uniformly imagined, as was the case for the present study (Bergkvist & Rossiter, 2007). The items were taken from Moore and Benbasat (1991) as well as Petschnig et al. (2014) and adapted to the context of the present study. The items are as follows: 'The use of a company leasing bicycle is very beneficial for me' (relative advantage); 'The use of a company leasing bicycle fits very well with my values, my lifestyle, and my needs' (compatibility); 'The use of the company-bicycle leasing program is very easy to understand' (low complexity); 'I had enough opportunities to test my company leasing bicycle before I signed the contract' (trialability); and 'The company-bicycle leasing program is highly visible in my organization' (observability).

The Recent Physical Activity Questionnaire (RPAQ) was used to assess the extent to which employees commuted to work by bicycle. Participants were first asked the following questions: 'On how many days in the past four weeks [20 working days] have you worked in your company/workplace on site?'; 'On how many days in the past four weeks [20 working days] have you used the following mode of transport as *single mode* of transport?'; 'On how many days in the past four weeks [20 working days] have you used the following mode of transport *in combination with* other modes of transport?' The options were then listed.

Participants next indicated the average time they needed for a journey to get to work and back: 'Please indicate your average daily time with this mode of transport to get to work and for the way back home.' Based on the responses, the average bicycle commuting time per working day in the past four weeks was calculated (in minutes). This variable was then used in the analysis. The validity and reliability of the scale has been shown previously (Golubic et al., 2014).

Physical and mental wellbeing were assessed via the Medical Outcomes Study Short Form Questionnaire (SF-8). The questionnaire is composed of eight questions that concern a person's wellbeing, referring to the past four weeks. Different weights are applied to each question to derive the Physical Component Summary (PCS-8) and Mental Component Summary (MCS-8) scores. We followed this procedure as described by Ware et al. (2001). The scale has been shown to be valid and reliable (Ellert et al., 2005).

## 2.5. Data analysis

Mplus 7.0 (Muthén and Muthén, 2012) was used to analyze the data. Two models were tested. In model 1, a path analysis was conducted using the five perceived innovation characteristics measured in the first wave, as well as time spent commuting to work by bicycle (per work day) and physical and mental wellbeing measured in the second wave as downstream variables (Fig. 1). Model 1 tested H1a-H7a. In model 2, a path analysis was conducted, using changes in time spent commuting to work from wave 1 to wave 2 (wave 2 minus wave 1) as the mediator and changes in physical and mental wellbeing (wave 2 minus wave 1) as the dependent variables. Model 2 tested H1b-H7b. A similar procedure that differentiates between mean scores of absolute values (here: model 1) and mean scores of change values (here: model 2) has been described by Mytton et al. (2016). We followed the approach proposed by Preacher and Hayes (2008) for the mediation analysis.

## 3. Results

### 3.1. Sample characteristics

Of the 1682 employees who were approached online to participate in the survey, 817 persons filled in the survey completely at the first wave of the study (49% response rate). In the second wave, 462 persons filled in the survey completely (equivalent to 57% of the wave-1 participants). These 462 persons were interviewed 7.8 months ( $SD = 7.0$ ) after they had signed the contract to take part in the program.

The sample consisted of 357 men (77.3%) and thus proportionately contained more men than women compared to the German population (49% men; Statistisches Bundesamt, 2018). Age, education, income, and household size distributions in our sample, however, come close to the values that have been reported for the general population in Germany (Statistisches Bundesamt, 2018). About 74.3% of the sample owned one or more bicycles ( $M = 1.20$ ,  $SD = 1.03$ ) in addition to one or more leasing bicycle(s) ( $M = 1.27$ ,  $SD = 0.52$ ). Table 1 presents an overview of the sample characteristics.

The average time difference between the first and the second wave was 39.8 days ( $SD = 4.6$ ). Importantly, all second-wave respondents filled in the survey at least four weeks after the completion of the first-wave survey. This is crucial because the reference time frame for the assessment of physical activity and wellbeing was four weeks (see 2.4 Variables).

### 3.2. Descriptive statistics and difference testing between waves

The means of the ratings of the perceived innovation characteristics (assessed in wave 1) as well as the dependent variables (bicycle commuting to work as well as physical and mental wellbeing, assessed both in wave 1 and in wave 2) are shown in Table 2. There were significant changes in bicycle commuting to work: bicycle commuting increased over time. Furthermore, we observed a decrease in physical wellbeing from wave 1 to wave 2, and no significant change in mental wellbeing during the course of the 40-day period. We note that the ratings for physical and mental wellbeing are similar to the values that have been reported for the German population ( $M_{\text{Physical}} = 50.30$  and  $M_{\text{Mental}} = 53.25$ ; Beierlein et al., 2012).

**Table 1**  
Sociodemographic characteristics of the sample.

Variables	Percentage or Mean ( $\pm$ SD)
Gender (female)	78.6%
Age (18–24 years)	3.0%
(25–34 years)	16.9%
(35–44 years)	23.0%
(45–54 years)	38.5%
(55–64 years)	18.5%
Gross household income (< EUR 1300)	1.3%
(EUR 1300–2599)	24.0%
(EUR 2600–3599)	29.5%
(EUR 3600–4999)	28.5%
(> EUR 4999)	16.8%
Education (9th grade [Mittelschule])	9.6%
(10th grade [Realschule])	29.9%
(High school [Hochschulreife])	11.8%
(University of Applied Sciences degree)	15.5%
(University degree or higher)	33.2%
Full time employment	90.7%
Household size	$M = 2.59$ ( $\pm 1.11$ )
BMI ( $\text{kg}/\text{m}^2$ )	$M = 27.06$ ( $\pm 4.42$ )
Distance to workplace (km)	$M = 26.41$ ( $\pm 38.71$ )

**Table 2**  
Perceived innovation characteristics, bicycle commuting to work, as well as physical and mental wellbeing.

Factors	Wave 1		Wave 2	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Physical wellbeing	51.23	7.97	50.04	8.89
Mental wellbeing	51.55	8.56	51.56	8.81
Bicycle commuting to work (min/day)	13.90	20.94	16.05	22.94
Relative advantage	5.97	1.20		
Compatibility	6.00	1.27		
Low complexity	5.20	1.97		
Trialability	3.31	1.73		
Observability	5.78	1.27		

Notes. There were significant differences between wave 1 and 2 for physical wellbeing,  $t(460) = -2.73$ ,  $p = .01$ , and bicycle commuting to work,  $t(460) = 2.58$ ,  $p = .01$ , but no significant difference for mental wellbeing,  $t(460) = 0.02$ ,  $p = .99$ .

### 3.3. Hypotheses testing for mean scores of the variables (model 1; H1a-H7a)

The correlation matrix of the variables considered in model 1 is shown in Table 3. The correlations between the variables range between 0.00 and 0.55.

The results of the path analysis for model 1 reveal that compatibility ( $b = 0.20$ ,  $SE = 0.06$ ,  $p < 0.001$ ), but not relative advantage ( $b = 0.003$ ,  $SE = 0.06$ ,  $p = 0.96$ ), low complexity ( $b = -.06$ ,  $SE = 0.06$ ,  $p = 0.32$ ), trialability ( $b = -0.06$ ,  $SE = 0.05$ ,  $p = 0.20$ ), and observability ( $b = -0.02$ ,  $SE = 0.05$ ,  $p = 0.62$ ) had a significant influence on the time spent on the bicycle commuting to work ( $R^2 = 0.04$ ). Thus, Hypothesis 2a is supported, while Hypothesis 1a as well as Hypotheses 3a-5a are not. The time spent on the bicycle commuting to work had a significant relation with both physical wellbeing ( $b = 0.12$ ,  $SE = 0.05$ ,  $p = 0.01$ ;  $R^2 = 0.01$ ) and mental wellbeing ( $b = 0.10$ ,  $SE = 0.05$ ,  $p < 0.05$ ;  $R^2 = 0.01$ ). Thus, Hypotheses 6a and 7a are supported.

A further mediation analysis (modeling the five perceived innovation characteristics as determinants of both bicycle commuting to work and the two wellbeing variables) shows that the time spent on the bicycle commuting to work fully mediates the effect of compatibility on physical wellbeing (marginal significance;  $b = 0.02$ ,  $SE = 0.01$ ,  $p = .06$ ) and mental wellbeing (marginal significance;  $b = 0.02$ ,  $SE = 0.01$ ,  $p = .07$ ). The result of the mediation analysis highlights the importance of the time spent on the bicycle for positive relation with health.

### 3.4. Hypotheses testing for mean change scores of the variables (model 2; H1b-H7b)

Model 2 used difference scores instead of wave-2 scores for the mediator and the dependent variables. The testing of model 2 reveals that there were no significant relationships between any of the five perceived innovation characteristics and the change in commuting behavior ( $b$ 's between  $-0.07$  and  $0.05$ ,  $p$ 's  $> 0.14$ ). Also, the change in minutes spent on the bicycle commuting to work did not cause changes in physical wellbeing ( $b = 0.08$ ,  $SE = 0.05$ ,  $p = 0.11$ ) or mental wellbeing ( $b = 0.04$ ,  $SE = 0.05$ ,  $p = 0.44$ ;  $R^2$  for each = 0.01).

## 4. Discussion

### 4.1. Theoretical and managerial contribution

The purpose of the study was to assess the relationship between company leasing bicycle commuting behavior of employees and their physical and mental wellbeing, as well as to find out whether perceived innovation characteristics proposed by Rogers (2003) determine the extent to which employees use their bicycle to commute to work. Another purpose was to find out whether perceptions of the innovation characteristics relate to changes in commuting behavior, and whether these changes have a positive effect on

**Table 3**  
Correlations between the variables (model 1).

Factors	1	2	3	4	5	6	7	8
1. Physical wellbeing	1.00							
2. Mental wellbeing	0.13	1.00						
3. Bicycle commuting to work	0.12	0.09	1.00					
4. Relative advantage	0.06	0.09	0.06	1.00				
5. Compatibility	0.07	0.10	0.16	0.55	1.00			
6. Low complexity	0.04	0.10	0.00	0.49	0.41	1.00		
7. Trialability	-0.04	0.17	-0.06	0.25	0.14	0.34	1.00	
8. Observability	0.07	0.14	-0.02	0.24	0.18	0.23	0.20	1.00

changes in both physical and mental wellbeing. The results of the study show that the amount spent on the bicycle commuting to work relates positively with health, and that compatibility is the only determinant of the bicycle commuting to work. None of the determinants of the changes in the amount spent on the bicycle commuting to work and health outcomes was significant. This is not surprising, as the employees considered in the present study did only marginally increase their cycling-to-work behavior after the adoption of the leasing-bicycle program (considering a time frame of 40 days after the initial assessment). The slight change in commuting to work by bicycle did not relate to a change in physical and mental wellbeing.

The study contributes to the literature on active commuting to work by (1) considering the use (rather than the mere adoption) of the company-bicycle leasing program; (2) revealing that compatibility—that is, the match between what a company does and what an employee feels with regard to values, lifestyles, and needs—relates to bicycle commuting to work considered after a specified time window (here: 40 days); and (3) modeling changes in physical and mental wellbeing that might have been due to an increase in cycling to work, using a longitudinal design. The particular consideration of change variables in the model shows that the variables included in the model do not explain the changes in physical or mental health. In what follows, we explain the contributions and limitations.

First, the study extends previous work that considered purchase adoption determinants (e.g., Synek and Koenigstorfer, 2018) to account for *use* adoption determinants. The use concept is important, because positive health and environmental effects from commuting to work are triggered by the continuous use of the bicycle (and not the mere purchase of a bicycle; Shih and Venkatesh, 2004). While it might be important that companies and employees adopt programs to promote cycling, and make bicycles more available and affordable, the usage by employees will determine the successful contribution to societal goals. Our results thus add to the descriptive findings from the Cyle to Work Alliance, which administered a one-time survey but did not study any relationships between variables (C2WA, 2011; Swift et al., 2016).

Second, the study provides novel insights into the importance of the five perceived innovation characteristics to promote bicycle commuting to work and health. The study thus adds to the findings from Synek and Koenigstorfer (2018), who used a case study approach taking into account documents and interviews to postulate that the five perceived innovation characteristics might be relevant for the adoption and use of the program. While other authors have used different theoretical groundings (e.g., the trans-theoretical model of behavior change; Mutrie et al., 2002; social practice theory; Guell et al., 2012), the general assumption that employee-perceived characteristics influence the adoption and implementation of the program is similar. The findings from the present study indicate that compatibility is important in order to persuade employees to use their company leasing bicycles to commute to work. Thus, shared values, lifestyles, and needs between employers and their employees are relevant (see Nehme et al., 2016), and activities to promote them should be encouraged. This mostly relates to organizational culture, that is, the values and beliefs within an organization that provide the contextual setting for interactions and behaviors of individuals (Schein, 1985). We note that the explanatory power of the model was quite low for physical activity ( $R^2 = 0.04$ ) and wellbeing ( $R^2 = 0.01$ ). This is typical for studies that look at use behaviors (particularly episodes of behaviors) and health, where habits and other external factors have a strong influence (e.g., Nigg et al., 2008).

Last, the study is among the few studies in the cycling-to-work literature that applied a longitudinal design to study the mechanisms of how the perceived characteristics (particularly compatibility, as shown in the analysis) associate with health. Positive relations (but no health effects explained by increased cycling to work) were found for physical and mental wellbeing. Both findings—the significant ones and the non-significant ones—are in agreement with Mytton et al. (2016). The evidence for full mediation (regarding the relation of compatibility with wellbeing via bicycle commuting to work) is particularly interesting. It indicates that those employees who spent more time on their bicycle reported better health. This makes sense, because the mere purchase of a company leasing bicycle might induce a feel-good effect at maximum; only the usage relates positively with wellbeing. The change in usage, however, did not relate to changes in health over the course of 40 days (as shown in the present study).

#### 4.2. Limitations and outlook

As with any empirical study, our work is not free of limitations. First, time spent on the bicycle commuting to work as well as both physical and mental wellbeing were measured using self-reports. While the validity and reliability of these measures have been shown before, we cannot rule out that these variables were subject to over- or underestimation. Future studies may use objective criteria to strengthen the level of evidence.

Second, the sample is not representative for all leasing bicycle program adopters. Currently, there is no database specifying which companies or which employees have adopted the program. Thus, the general population of adopters is unknown. The generalizability of the results might therefore be limited. We feel that this limitation is acceptable, because the main focus of our work was to contribute to theory and provide process evidence of how health outcomes can be explained or increased using a longitudinal design. The dropout rate of 43% between the two waves is common for this type of longitudinal research (Mytton et al., 2016).

Third, it would be interesting to find out whether an intervention study with a control group could replicate our findings. The addition of a control group allows the researcher(s) to calculate the effect of the program's implementation on the main dependent variables considered in the present study: bicycle commuting to work as well as physical and mental wellbeing. Besides adding a control group, the time frame under consideration might be extended. The time frame considered in the present study might have been too short to capture changes in wellbeing.

Last, we note that we cannot explain why compatibility, but not the other four perceived innovation characteristics, influenced the time spent on the bicycle. Relative advantage is typically a strong indicator for the use adoption of new concepts, products, or services (Rogers, 2002, 2003). In our study, however, the impact of relative advantage on the self-reported time spent on the bicycle

commuting to work was nonsignificant. Future studies may reveal whether this result is replicated for other cycle-to-work programs and what the reasons might be. In addition, other factors that were not be considered in this study but might influence cycling to work could be modeled in future research, such as differences in incentives (incentives for purchasing vs. incentives for active commuting) and differences in employer characteristics (e.g., provision of parking, showers, and other infrastructure). Future work might also be interested in finding solutions to better predict changes in variables. Similarly to Mytton et al. (2016), the present study could not explain changes in health via changes in bicycle commuting to work.

## 5. Conclusion

Many countries struggle to reduce their citizens' dependency on cars and promote cycling instead. Company-bicycle leasing programs are one policy instrument to promote cycling to work. The present study shows that the time spent 'in the saddle' relates positively with health of employees who participated in the German bicycle leasing program. It remains a challenge to motivate not only these people, but all employees, to use sustainable commute-to-work options and thus contribute to the Sustainable Development Goals brought forward by the United Nations. At least for participants of the program, shared values, lifestyles, and needs between employers and employees seem important when applied to the context of cycling to work.

## Financial disclosure

The authors did not receive any specific funding for this work.

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