Temporal changes in active commuting from 2007 to 2017 among adults living in the Capital Region of Denmark

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ABSTRACT

Background: The health benefits of active commuting are well established, but little is known about the temporal changes in active commuting across sociodemographic groups.
Aim: To examine temporal changes in active commuting in the Capital Region of Denmark from 2007 to 2017 and to examine whether these changes differed across gender, age, educational attainment, BMI, distance to work/educational institution, and place of residence.
Method: The study was based on four waves of "The Danish Capital Region Health Survey (DK-CRHS)" conducted in 2007, 2010, 2013 and 2017. The pooled study sample included 102.792 individuals aged 25–79 years old.
Results: From 2007-2017 the overall prevalence of active commuters increased from 71.8% to 76.4%. Also, the Odds Ratio (OR) of being an active commuter increased significantly among men, individuals aged 25–34 and 35–44 years of age, all educational attainment groups, all BMI groups except BMI < 18.5 kg/m^2, all groups of distance to work/education > 5 km, and in all groups by place of residence (urban, suburban and rural). Survey year modified the effect of gender, age, educational attainment, distance to work/education, and place of residence, but not the effect of BMI on the probability of being an active commuter.
Conclusion: Active commuting has become more prevalent among adults living in the Capital Region of Denmark, but temporal changes from 2007 to 2017 differed between socio-demographic groups. Findings may help inform future planning and policymaking to secure targeted interventions for continuous promotion of active commuting across all socio-demographic groups.

1. Introduction

Physical inactivity is a major risk factor for obesity and non-communicable diseases such as type-2-diabetes, cardiovascular diseases and some types of cancer (Lee et al., 2012). In Denmark, 6,000 more deaths occur among physically inactive men and women each year compared to their physically active counterparts (Eriksen et al., 2016). Danish national guidelines for physical

activity among adults recommend 30 min of moderate to vigorous physical activity per day and 20 min of vigorous intensity physical activity twice per week (Danish Health Authority, 2016). Choosing active travel modes to work, typically walking or cycling, rather than motorized transportation can provide routine-based physical activity to commuters during the week and is hence a fairly easy way to meet the physical activity recommendation. Active commuting is defined as any walking or cycling to and from work, either solely or in combination with public transportation (Thern et al., 2015).

Several studies have demonstrated positive health effects of engagement in active commuting (Andersen et al., 2000; Hamer and Chida, 2008; Laverty et al., 2013; Mehrdad Tajalli, 2017; Rasmussen et al., 2016). A Danish cohort study found a 28% decreased risk of all-cause mortality from bicycling to work (Andersen et al., 2000) while other studies have found significant associations between active commuting and reduction in cardiovascular risk factors (Hamer and Chida, 2008; Mehrdad Tajalli, 2017), lower risk of Type 2 Diabetes (Mehrdad Tajalli, 2017; Rasmussen et al., 2016), and lower risk of being overweight, even when commuting by public transportation compared to car-based transportation (Laverty et al., 2013; Mehrdad Tajalli, 2017).

Bicycling is a common commuting choice in Denmark, supported by national policies and a well-developed infrastructure, that have made bicycling safe, convenient, and an attractive way to get around, particularly in the cities (Pucher and Buehler, 2008). Since 1998 till 2015 cycling has increased in Denmark, by 10% in the whole country and more than 30% in the Capital (Andersen et al., 2018). In contrast, countries like the U.S and the United Kingdom have lagged far behind in both infrastructure for bicycling and in number of active commuters (Pucher and Buehler, 2008).

The geographical area of living is crucial to the mode of commuting in Denmark (Capital Region of Denmark, 2014) and other countries alike (Scheepers et al., 2013; Thern et al., 2015). Living in urban centers has been positively linked to active commuting, whereas people are less likely to engage in active commuting in rural areas (Capital Region of Denmark, 2014; Scheepers et al., 2013). Another important predictor of travel mode is the time used for walking or bicycling (Kaczynski et al., 2012), as well as distance to work/educational institution (Bjorkelund et al., 2016; Dalton et al., 2013; DTU Transport, 2015). In Denmark, it was previously shown that when commuting distance exceeds 10 km the number of commuters who cycle all the way to work decreases considerably and car-based commuting becomes dominant (DTU Transport, 2015). Even though active commuting is very popular in Denmark, the car is by far the most frequently used means of transportation, constituting 66% of all commuting travels compared to the bicycle, which accounts for approx. 20% (DTU Transport, 2015).

Previous studies have suggested other underlying factors that impede or facilitate the probability of engagement in active commuting such as gender (Heinen et al., 2010; Thern et al., 2015), age (Butler et al., 2007; Laverty et al., 2013; Pucher and Buehler, 2008), and educational level (Andersen et al., 2000; Heinen et al., 2010; Scheepers et al., 2013). The results are controversial (Andersen et al., 2000; Butler et al., 2007; Heinen et al., 2010; Laverty et al., 2013; Pucher and Buehler, 2008; Scheepers et al., 2013), and to our knowledge no other studies have examined temporal changes in active commuting across sociodemographic factors. Also, the temporal change in active commuting per se is rarely investigated (Borodulin et al., 2008; Colin and Jean, 2000; Goodman, 2013). However, this is important knowledge when attempting to promote active commuting across an entire population.

The aim of this study was therefore to examine the temporal changes in active commuting in the Capital Region of Denmark from 2007 to 2017 and to examine whether these changes differed across gender, age groups, educational attainment, BMI, distance to work/educational institution, and place of residence.

2. Methods

2.1. Study design and population

This study is based on data from four waves of "The Danish Capital Region Health Survey (DK-CRHS)" conducted in the 29 municipalities constituting the Capital Region of Denmark. The largest municipality, Copenhagen, was further divided into 10 areas with each area treated as an individual municipality. The first survey was conducted from September to November 2007 (five municipalities during summer and fall 2006). The second, - third and fourth survey were conducted over three months starting from February in 2010, 2013 and 2017, respectively. The latter surveys were a part of "The Danish National Health Survey" (DK-NHS) (Christensen et al., 2012). All surveys used a random sampling design stratified on the 29 municipalities in the region. A random sample of all citizens of the region aged 25–79 years old in 2007 and 16–79 + years old in 2010, 2013 and 2017 was drawn from the Civil Registration System (CRS).

In 2007, 1800 questionnaires were sent to persons aged 25–79 years old in each municipality. In the other survey years the sample size increased as the age span was expanded to include 16–24 year olds and 79 + year olds. The sample size was 2450 persons per municipality except for one urban municipality (4500 persons), and in 2017 four municipalities additionally increased the sample size to 4900 persons. The total samples included 69,800 individuals in 2007, and 95,150 individuals in 2010 and 2013, and 104.950 in 2017, respectively. Each individual received an invitation and a questionnaire.

Response rates were 52.3% in 2007 (n = 36,472) and 2010 (n = 49,806), 43.5% in 2013 (n = 41,356), and 52,6% in 2017 (n = 55,185).

Data from all three surveys were pooled, and to obtain comparable study populations the age range was restricted to persons aged 25–79 years old. The final study population included survey participants who reported they were working or studying and had answered the question about active commuting (n = 102,792) (Fig. 1).

The covariates included gender, age, educational attainment, BMI, distance to work/educational institution, and place of residence. Information on age and gender was obtained from the CRS, while data on educational attainment was drawn from the Danish Population's Education Register (PER) and linked with questionnaire data using the CRS. Educational attainment refers to highest
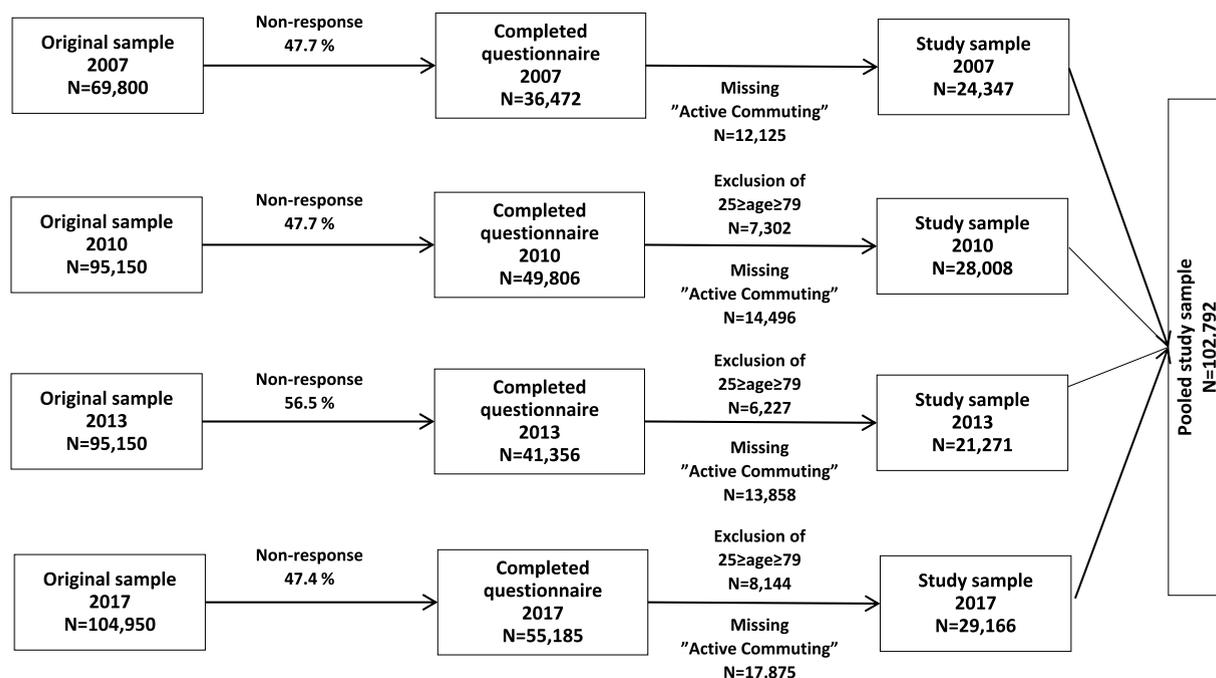
Fig. 1. Study sample.

completed education and was used as an indicator for socioeconomic position. The variable was categorized into four groups: "Primary and secondary school", "Vocational education", "Professional/academy programs" and "University degree". BMI was calculated based on self-reported height and weight and categorized following the WHO standards into < 18,5, 18,5- < 25, 25- < 30, 30+. Information about residential municipality was drawn from the CPR, and place of residence was categorized as "urban" (Copenhagen or Frederiksberg Municipality), "suburban" (The 6 municipalities around Copenhagen; Taarnby, Gentofte, Gladsaxe, Herlev, Roedovre and Hvidovre) or "rural" (The remaining 21 municipalities in the Capital Region). The categorization of "rural" should not directly be understood as farmland or countryside but covers municipalities with more green areas and less access to public transportation than the urban and suburban municipalities in the Capital Region. Distance to work/educational institution was measured as self-reported distance in kilometers and following categorized in four classes (0- < 5 km, 5- < 10 km, 10- < 20 km and 20 + km).

Active commuting was self-reported by replying to the question: "How many hours and minutes per day do you spend biking or walking during transportation to and from work or educational institution?" (Pedersen et al., 2017). All participants reporting any time spend biking or walking were categorized as active commuters.

2.2. Statistical analyses

Chi-square tests were used to examine the raw associations between active commuting and the subgroups of the covariates in 2007, 2010, 2013 and 2017. To determine whether subgroup differences in active commuting changed over time, logistic regression models were applied with active commuting (yes/no) as outcome, and with a common reference group for each covariate in 2007 except for distance to work/education where the reference was in 2010 due to lack of data from 2007. An interaction term between year and each of the covariates was added to the logistic regression models to determine whether the association of the covariates with active commuting varied over time. All models were adjusted for age and gender and weighted for non-response and survey design. The weights were computed by Statistics Denmark based on information about gender, age, municipality, educational attainment, income, civil status, and hospitalization. The analyses for BMI, distance to work/educational institution and area of residence were further adjusted for education. All analyses were performed using survey procedures in SAS statistical software (version 9.4, SAS Institute Inc., USA).

3. Results

Table 1 shows the distribution of socio-demographic and geographic characteristics in all four survey years. There were minor differences in the distribution of gender, age and BMI from 2007 thru 2017, and in distance to work/educational institution from 2010 thru 2017. From 2007 thru 2017 there were some differences in educational attainment and place of residence.

Table 2 shows the prevalence of active commuting across the covariates for all four survey years. Overall, there was an increase in

Table 1
Characteristics of the study population in 2007, 2010, 2013 and 2017.

Year	2007 (n = 24,347)		2010 (n = 28,008)		2013 (n = 21,271)		2017 (n = 29,166)	
	%	n	%	n	%	n	%	n
Gender								
Women	48.7	13,108	48.4	15,314	49.0	11,650	48.1	15,444
Age								
25–34 years	28.1	5,073	28.4	5,502	27.8	3,865	29.0	5,674
35–44 years	30.5	7,071	29.5	7,736	28.4	5,183	26.5	7,043
45–54 years	23.8	6,461	24.3	7,845	25.9	6,382	25.8	8,642
55–64 year	15.9	5,171	15.6	5,961	15.4	4,789	15.8	6,381
65–79 years	1.6	571	2.3	964	2.5	1,052	2.9	1,426
Educational attainment								
Primary and secondary school	24.6	4,934	21.6	5,260	19.8	3,575	20.5	4,937
Vocational education	30.5	7,808	29.2	8,772	26.3	5,952	25.5	8,420
Professional/academy programs	28.3	7,225	29.9	8,485	31.3	6,809	30.0	8,965
University degree	16.7	3,949	19.3	5,196	22.6	4,710	24.1	6,511
BMI								
< 18.5	1.7	393	1.8	464	2.0	343	1.7	438
18.5- < 25	56.6	13,421	56.1	15,156	55.9	11,417	52.3	14,442
25- < 30	31.7	7,780	31.5	8,980	31.4	6,858	33.2	9,980
30 +	10.0	2,512	10.6	3,145	10.7	2,377	12.8	4,129
Distance to work/education*								
0- < 5 km	–		28.4	7,233	26.1	4,942	27.3	7,060
5 - < 10 km	–		24.0	6,186	24.7	4,588	23.7	6,297
10- < 20 km	–		22.6	6,612	23.2	4,954	22.1	6,922
20 + km			25.0	7,360	26.0	5,687	26.9	8,693
Place of residence								
Urban	39.6	7,155	40.2	8,402	41.8	6,381	43.3	8,064
Suburban	16.6	3,834	16.8	4,377	16.6	3,308	16.3	5,401
Rural	43.8	13,358	43.0	15,229	41.6	11,582	40.4	15,701

Number of respondents (n) and study population % (weighted for non-response and survey design).
*Information on distance to work/education was not available in 2007.

active commuting from 71.8% in 2007 to 76.4% in 2017. The proportion of active commuters was highest among women, 25-34-year olds, individuals with a university degree, BMI < 18,5 and less than 10 km to work/educational institution in every study year. Finally, the proportion of active commuters was highest among those living in urban areas followed by suburban and rural areas, respectively, also in every study year.

Generally, there was a gradual increase in the proportion of active commuters in most subgroups (Table 2). The crude pre-valence's indicate that the most pronounced changes of active commuting by percent point (pp) across the subgroups were seen for men (8,4 pp), 35–44 year olds (7,5 pp), those with BMI 25- < 30 (5,7 pp), individuals with primary and secondary school (4,7 pp), individuals with more than 20 km to work/education (6,3 pp), and among individuals living in rural areas (4,8 pp).

Table 3 shows the adjusted odds ratio (OR) for active commuting in each subgroup in 2007, 2010, 2013 and 2017. The OR for active commuting among men increased significantly from 2007 to 2017 to 1.50 compared to the reference group; men in 2007, while there was no significant change among women. For age, the OR increased significantly for the younger age groups between 2007 and 2017, while there were no significant changes among the groups above 45 years of age. In all the educational attainment groups there were significant changes in the OR's for active commuting, most notably increased for participants with a university degree from 2.01 to 2.62 compared to individuals with vocational education in 2007. There were furthermore significant changes in the OR's for active commuting in the BMI categories except for BMI < 18.5. For distance to work/education, the OR's increased significantly from 2010 to 2017 in all groups except from 0- < 5 km. Finally, the OR's for active commuting by place of residence increased significantly from 2007 to 2017, most notably for individuals living in urban areas from 3.04 to 3.68 compared to the group living in rural areas in 2007.

Tests for interaction showed that survey year modified the effect of gender, age, educational attainment, distance to work/ education and place of residence with active commuting, but not the effect of BMI (Table 3).

4. Discussion

In the present population survey, we found an overall increase in the proportion of active commuters from 2007 (71.8%), 2010 (73,1%), 2013 (74.8%) to 2017 (76.4%). Changes differed between men and women, in subgroups of age and education as well as with distance to work/education and place of residence. A recent study from 2018 by Andersen et al. (Andersen et al., 2018) confirms the increasing development in active commuting by showing that cycling has increased markedly in Denmark since 1998 (Andersen et al., 2018).

We found that the probability of men taking part in active commuting increased significantly from 2007 thru 2017. In contrast,

Table 2
Prevalence of active commuting in 2007, 2010, 2013 and 2017.

Year	2007		2010		2013		2017	
	%	95% CI	%	96% CI	%	95% CI	%	95%CI
Active commuting overall	71.8	(71.2–72.4)	73.1	(72.5–73.7)	74.8	(74.2–75.5)	76.3	(75.8–76.8)
		$p < 0.0001$		$p < 0.0001$		$p < 0.0001$		$p < 0.0001$
Gender		(n = 24,347)		(n = 28,008)		(n = 21,271)		(n = 29,166)
Women	77.3	(76.5–78.1)	77.9	(77.2–78.6)	78.6	(77.7–79.4)	77.8	(77.1–78.5)
Men	66.5	(65.5–67.5)	68.6	(67.7–69.5)	71.2	(70.2–72.3)	74.9	(74.1–75.7)
		$p < 0.0001$		$p < 0.0001$		$p < 0.0001$		$p < 0.0001$
Age		(n = 24,347)		(n = 28,008)		(n = 21,271)		(n = 29,166)
25–34 years	79.6	(78.4–80.8)	82.2	(81.1–83.2)	83.6	(82.3–84.9)	85.9	(84.9–86.9)
35–44 years	69.1	(67.9–70.3)	70.1	(69.0–71.2)	73.6	(72.3–75.0)	76.6	(75.5–77.7)
45–54 years	68.8	(67.5–70.1)	68.8	(67.6–69.9)	69.8	(68.5–71.0)	70.5	(69.4–71.6)
55–64 year	68.9	(67.4–70.4)	70.3	(69.0–71.6)	71.2	(69.7–72.7)	70.4	(69.1–71.7)
65–79 years	59.1	(54.1–64.1)	63.7	(60.0–67.3)	65.3	(61.6–68.9)	61.6	(58.6–64.6)
		$p < 0.0001$		$p < 0.0001$		$p < 0.0001$		$p < 0.0001$
Educational attainment		(n = 23,916)		(n = 27,713)		(n = 21,046)		(28,833)
Primary and secondary school	70.4	(69.0–71.8)	74.3	(73.0–75.6)	74.2	(72.6–75.9)	75.1	(73.8–76.5)
Vocational education	65.2	(64.0–66.4)	64.7	(63.6–65.9)	66.5	(65.1–67.8)	67.4	(66.3–68.5)
Professional/academy programs	74.9	(73.8–76.0)	76.3	(75.3–77.3)	77.0	(75.9–78.1)	78.0	(77.1–79.0)
University degree	79.5	(78.1–80.9)	78.8	(77.6–80.0)	80.5	(79.3–81.8)	83.9	(82.9–84.9)
		$p < 0.0001$		$p < 0.0001$		$p < 0.0001$		$p < 0.0001$
BMI		(n = 24,106)		(n = 27,745)		(n = 20,995)		(n = 28,989)
< 18.5	78.7	(74.0–83.4)	80.3	(76.3–84.3)	83.7	(79.7–87.8)	84.0	(80.2–87.9)
18.5- < 25	75.3	(74.5–76.2)	76.9	(76.2–77.7)	78.7	(77.8–79.5)	79.7	(79.0–80.4)
25- < 30	67.2	(66.1–68.4)	68.6	(67.5–69.7)	70.0	(68.8–71.3)	72.9	(71.9–73.9)
30 +	65.0	(62.9–67.2)	64.8	(62.8–66.7)	67.6	(65.3–69.8)	70.1	(68.5–71.7)
		$p < 0.0001$		$p < 0.0001$		$p < 0.0001$		$p < 0.0001$
Distance to work/education				(n = 27,391)		(n = 20,171)		(n = 28,972)
0- < 5 km	–		81.4	(80.4–82.4)	82.6	(81.4–83.8)	83.1	(82.1–84.0)
5 - < 10 km	–		81.3	(80.3–82.4)	83.9	(82.7–85.1)	83.5	(82.5–84.5)
10- < 20 km	–		68.2	(66.9–69.5)	72.1	(70.6–73.5)	72.4	(71.1–73.6)
20 + km			60.0	(58.7–61.3)	61.2	(59.7–62,6)	66.3	(65.1–67.5)
				$p < 0.0001$		$p < 0.0001$		$p < 0.0001$
Place of residence		(n = 24,347)		(n = 28,008)		(n = 21,271)		(n = 29,166)
Urban	84.2	(83.3–85.2)	85.9	(85.1–86.7)	87.5	(86.5–88.4)	87.1	(86.3–87.9)
Suburban	70.9	(69.3–75.5)	70.3	(68.8–71.9)	73.0	(71.2–74.7)	73.9	(72.5–75.2)
Rural	60.9	(59.9–61.8)	62.2	(61.3–63.1)	62.9	(61.9–63.9)	65.7	(64.9–66.5)
		$p < 0.0001$		$p < 0.0001$		$p < 0.0001$		$p < 0.0001$

Data shown are weighted % (95% Confidence intervals) and p-values for χ^2.

there has been no significant change in active commuting among women. Several aspects may explain the observed gender difference. A so-called ceiling effect may partly explain the lack of increase in active commuting among women; i.e. a large proportion of women were already active commuters in 2007 (77.3%) leaving less room for further increase. Nevertheless, women had a higher probability of active commuting in every study year compared to men. Working hours and distance to work may also partly explain the observed findings. In all years between 2007 and 2017 men have had around 5 h longer working week (StatBank Denmark, 2019) as well as longer commuting distance compared to women (Wandsøe-Isaksen and Bonde, 2018). Men may therefore be more likely to use the family car to save time. In support of the diminished gender difference over time, there has been a relative change in commuting distance between men and women from 2008 to 2018; in 2008 men had a 49% longer commuting distance than Danish women compared to a 43% longer commuting distance than women in 2018 (Wandsøe-Isaksen and Bonde, 2018). Altogether, both working habits and commuting habits may explain some of the gender differences observed in this study. Finally, Heinen and Maat suggest that the impact of gender is country specific; in countries with low cycling rates men tend to cycle more; while women cycle more in countries with high cycling rates (Heinen et al., 2010).

For the age groups significant increase in the probability of active commuting over time was only found among 25–34 year olds and 35–44 year olds. Furthermore, the youngest individuals between 25-34 years of age had the highest probability of active commuting in every study year, which is likely explained by a high prevalence of students who cannot afford a car yet as also suggested by studies from Canada and England (Butler et al., 2007; Laverty et al., 2013). For every study year, we also found that the probability of active commuting decreased with age. This pattern is likely a result of the life cycle phases. A study by Pooley et al. from 2018 (Pooley et al., 2018) on narrative life histories suggests that throughout the later twentieth century changes in family responsibilities significantly influence the decisions about everyday travel. Particularly, the impact of having children increases car use even for people who had previously engaged and enjoyed active commuting (Pooley et al., 2018).

We found a significant increase in the probability of active commuting in all educational attainment groups from 2007 thru 2017. Andersen et al. emphasizes that high safety in cycling has been a main priority in Denmark which has contributed to cycling being socially desirable in all socio-economic strata (Andersen et al., 2018). However, we found that the increase was most notable among

Table 3

Odds ratio (OR) of active commuting in 2007, 2010, 2013 and 2017.

Year	2007		2010		2013		2017		P-values
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	
Gender (n = 102,792)									< 0.0001[a]
Women	1.72	(1.61–1.83)	1.78	(1.67–1.89)	1.85	(1.73–1.98)	1.77	(1.66–1.88)	0.2256[b]
Men	1.00		1.10	(1.03–1.17)	1.25	(1.17–1.33)	1.50	(1.41–1.60)	< 0.0001[b]
Age (n = 102,792)									< 0.0001[a]
25–34 years	1.74	(1.58–.1.91)	2.06	(1.87–2.26)	2.28	2.04–2.54	2.72	(2.47–3.01)	< 0.0001[b]
35–44 years	1.00		1.05	(0.97–1.13)	1.25	(1.14–1.37)	1.46	(1.35–1.59)	< 0.0001[b]
45–54 years	0.98	(0.91–1.07)	0.98	(0.91–1.06)	1.03	(0.95–1.12)	1.07	(0.99–1.15)	0.1234[b]
55–64 year	0.99	(0.91–1.08)	1.06	(0.97–1.15)	1.10	(1.00–1.21)	1.06	(0.98–1.16)	0.1914[b]
65–79 years	0.65	(0.52–0.80)	0.78	(0.66–0.92)	0.84	(0.71–1.00)	0.72	(0.62–0.82)	0.1988[b]
Educational attainment (n = 101,293)									0.0011[a]
Primary and secondary school	1.20	(1.10–1.31)	1.48	(1.36–1.62)	1.51	(1.36–1.67)	1.58	(1.44–1.73)	< 0.0001[b]
Vocational education	1.00		0.99	(0.92–1.06)	1.08	(0.99–1.17)	1.15	(1.06–1.24)	0.0002[b]
Professional/academy programs	1.44	(1.33–1.56)	1.56	(1.44–1.68)	1.62	(1.49–1.76)	1.72	(1.59–1.86)	0.0005[b]
University degree	2.01	(1.81–2.22)	1.90	(1.73–2.08)	2.14	(1.93–2.36)	2.62	(2.39–2.88)	< 0.0001[b]
BMI (n = 100,692)									0.8187[a]
< 18.5	1.03	(0.77–1.37)	1.11	(0.86–1.44)	1.27	(0.93–1.73)	1.32	(0.99–1.78)	0.5915[b]
18.5- < 25	1.00		1.07	(1.01–1.14)	1.16	(1.08–1.24)	1.22	(1.15–1.31)	< 0.0001[b]
25- < 30	0.80	(0.74–0.86)	0.86	(0.80–0.92)	0.89	(0.83–0.96)	1.02	(0.95–1.09)	< 0.0001[b]
30 +	0.75	(0.67–0.83)	0.72	(0.66–0.80)	0.80	(0.72–0.90)	0.92	(0.83–1.01)	0.0004[b]
Distance to work/education (n = 75,822)									0.0003[a]
0- < 5 km	–		2.92	(2.68–3.18)	3.10	(2.81–3.43)	3.20	(2.93–3.49)	0.1499[b]
5 - < 10 km	–		2.78	(2.54–3.04)	3.21	(2.89–3.57)	3.12	(2.85–3.42)	0.0211[b]
10- < 20 km	–		1.44	(1.33–1.56)	1.68	(1.53–1.84)	1.71	(1.57–1.86)	0.0001[b]
20 + km	–		1.00		1.01	(0.92–1.10)	1.31	(1.21–1.41)	< 0.0001[b]
Place of residence (n = 101,626)									0.0157[a]
Urban	3.04	(2.80–3.31)	3.46	(3.19–3.75)	3.89	(3.53–4.27)	3.68	(3.38–4.00)	0.0068[b]
Suburban	1.56	(1.43–1.71)	1.48	(1.36–1.61)	1.63	(1.48–1.80)	1.77	(1.63–1.92)	0.0001[b]
Rural	1.00		1.05	(1.00–1.11)	1.06	(1.00–1.13)	1.22	(1.15–1.29)	0.0001[b]

All models are adjusted for age and gender and weighted for non-response and survey design. The analyses for BMI, distance to work/educational institution and area of residence are further adjusted for education. Data shown are OR (95% Confidence intervals), p-values are a) from type 3 tests of interaction between covariates and survey year and b) from test for effect of covariate subgroup over time.
Men (2007), 35–44 year olds (2007), vocational education (2007), BMI: 18.5- < 25 (2007), 20 + km distance to work/education (2010) and living in rural municipalities (2007) were reference categories.

individuals with a university degree who also had the highest probability of active commuting in every study year compared to individuals with shorter duration of education. This is not surprising, as it is well established in the literature that education level is a robust and strong determinant for physical activity and for health behaviors in general (O'Donoghue et al., 2018).

With respect to BMI we also found a significant increase in active commuting from 2007 thru 2017 for all groups except for the underweight BMI group < 18.5. It should be noticed that the BMI group < 18.5 is very small with less than 500 participants in every study year and results should therefore be interpreted with caution. Although, the results show that individuals with high BMI are less likely to use active commuting in all study years they still had increased probability of active commuting over time, as did their normal weight counterparts. This indicates that higher BMI may not impede engagement in active commuting which is an important message for planning of targeted public health interventions.

Across all survey years it was evident that active commuting was substantially more likely when distance to work was below 10 km compared to distances above 10 km. This is consistent with several studies. For example, studies from Norway and the United Kingdom which show that distance to work is a very important predictor of travel mode (Bjorkelund et al., 2016; Dalton et al., 2013), and results from a Danish report on transportation habits demonstrating a 50% reduction of active commuting trips (80%–40%) when commuting distance increased from a maximum of 5 km to 10–20 km (DTU Transport, 2015). Likewise, an American study found that students living more than 20 min from their campus were much less likely to walk or bike (Kaczynski et al., 2012). In Denmark, the average commuting distance has increased by 2.4 km from 2008 to 2016: it is the group of commuters who have a distance > 20 km that has grown whereas the group of commuters with a distance < 20 km has become smaller (Statistics Denmark, 2016). Since the economic crisis in 2008 there has been a geographical change of the job offering in Denmark where more jobs have moved to the larger cities, and due to the economic state of the market it has become increasingly expensive to live in the city (Baes-Jørgensen, 2014). This has forced many people to live further away from their working place and commute distances have consequently increased (Baes-Jørgensen, 2014). Our results show that the probability of active commuting increased by 30% for those with 20 + km to work/education from 2010 to 2017 and no significant changes were observed for those with short distance (0- < 5 km). A contributing explanation could be the implementation of a structural change in 2010 allowing Danes to bring their bike for free in the train (Politikken, 2011). This may have resulted in more commuters who combine active travel with public transportation when going to and from work. Finally, the implementation of the 'Cycle superhighways' in the Capital Region of Denmark offers a better infrastructure for cyclists that makes it healthy, easy and safe to choose the bike for commuting distances above 5 km (Cycle superhighways, 2019).

For place of residence we found that the probability of active commuting significantly increased from 2007 to 2017 among citizens living in both urban-suburban and rural areas. It was evident across survey years that people living in urban areas were much more likely to use active commuting, and the most notable increase in the probability of being active commuter was also seen among urban residents. This is in line with the Regional Cycling Report showing an increase in the number of bicycling trips in the capital city, Copenhagen, from 2007 thru 2016 (Capital Region of Denmark, 2014, 2016). In contrast our results for suburban areas are not completely in line with the decreasing to stable level found for the areas in the Regional Cycling Report (Capital Region of Denmark, 2016). Research from the Netherlands and Sweden have also reported active commuting to be more frequent among individuals living in urban areas (Scheepers et al., 2013; Thern et al., 2015) possibly because urban areas are characterized by a more developed public transportation system and an infrastructure that encourages citizens into active commuting (Djurhuus et al., 2014; Scheepers et al., 2013). Andersen et al. also points out that in Denmark, especially the Capital has invested heavily in cycle infrastructure during the last two decades and during this time cycling has increased more than 30% (Andersen et al., 2018).

Main strengths of the present study are the large study samples from four survey years and the use of similar questions across the four surveys as well as the exploration of subgroups. Furthermore, the stratification for the sampling design, the adjustments and weights used for non-response have strengthened the generalizability of the study results. Some limitations should be emphasized and it should be noted that it is difficult to compare results from studies examining active commuting as the methods for assessing active commuting are not consistent across studies (Thern et al., 2015). One important limitation is that we were unable to take duration of commuting into account which may have contributed to the very high prevalence of active commuters found in this study. On the other hand we have excluded the youngest individuals, 16–24 years old, hence leaving out the age group in Denmark with the highest prevalence of active commuters as 93% and 92% of 16–24 year olds were walking or bicycling to work/education in 2013 (Robinson et al., 2014) and 2017 (Lau et al., 2018), respectively. Furthermore, we were unable to distinguish between walking and bicycling. These aspects of active commuting should be investigated in more detail in future studies. Finally, a well-known limitation is the possibility of social desirability and recall bias due to self-reported data on active commuting. However, self-reported time spent on active commuting appears likely to perform well and give valid answers as it is a recurring daily activity that most people are able to assess fairly accurately by self-report (Panter et al., 2014).

In conclusion, from 2007 to 2017 there has been an overall increase in commuting among adults in the Capital Region of Denmark from 71,8%–76.3%. The 10-year increase in active commuting differs between men and women, in subgroups of age and education as well as with distance to work/education, and place of residence. More research including qualitative methods is needed to elucidate explanations of the temporal changes in active commuting found in this study. Findings from such studies may inform future policies, interventions and programs aiming to promote and maintain active commuting. As this study shows marked subgroup differences in ten-year changes of active commuting, future interventions should consider targeting specific population subgroups and potentially applying different promotion strategies for active commuting in different subgroups. One example of a structural and political initiative to promote active commuting among people with rural residence and long distance to work/education could be establishment of a public infrastructure that makes it inexpensive and easy to combine active travel with public transportation.

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