

Change in self-reported cycling habits, safety assessments, and accident experience in Norway over the last decade

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Increasing the number of cyclists and pedestrians is a climate and political priority of the Norwegian authorities. The present study examines the differences in cycling habits, perception, and experience and compares the development of cycling-related aspects over the last decade in seven municipalities in the central region of Norway. Data were collected through three surveys in 2010, 2014, and 2018. The respondents were asked if they cycle, how often they cycle, what they think about the local cycling facilities in their municipality and if they had experienced an accident and what kind of accident it was. The results show that the share of bicycle use, or commuting is not as high as expected when examining the evolution over the last decade. One of the possible explanations could be the increase of other green modes slowing down the use of bicycle. Differences between municipalities and with official statistics are examined. The share of self-reported cycling accidents is found to be half of the share reported in the national survey. This study confirms the importance for the municipalities to be more aware of the level of bicycle commuting in their own municipality and to understand the perceived barriers to bicycle use and commuting.

Keywords: Cycling behaviour, traffic accidents, traffic safety, vulnerable road users, perceived barriers.

1. Introduction

Increasing the number of cyclists and pedestrians is a national climate and political goal prioritised by the Norwegian authorities. However, cycling facilities, weather and traffic safety conditions are important factors influencing bicycle commuting. During the last ten years, SINTEF carried out for the Norwegian Public Roads Administration several studies to map the use of bicycle in many municipalities, the five regions or at national level.

We propose in the present study to examine 10-year results in the east region, region with the highest population density and to provide a general overview of the progress made to date. The east-region is considered as the central region with half of the population living in this area. The main objectives of the present study are to examine the differences in cycling habits, perceptions, and accident experience and to compare the development of various aspects

related to bicycle use and commuting over the last decade.

The specific aims of the study on which this paper is based are as follows:

- (i) To examine the change in cycling habits and seasonal variation in cycling frequency during the period.
- (ii) To examine accident experiences and accident type in the sample
- (iii) To examine the respondents' opinions about how well or poorly adapted to cycling the cycling facilities are
 - (a) in their municipality
 - (b) for the actual routes they used
- (iv) To examine those who had not cycled in the last year or cycled less than 3-4 days whether it would be relevant for them to cycle more with significant improvements in place

1.1. Cycling risk and accidents in Norway

In Norway, road safety policy is grounded in the Vision Zero project, according to which all traffic safety work should be based on a vision of no fatal or serious injury accidents (Meld. St. 33, 2016–2017, p. 14). Based on police data records, 95 cyclists were killed, and 808 cyclists were severely injured in road traffic accidents in Norway between 2010 and 2020 (TRINE 2022). When examined with respect to the cycling distance, the risk of being involved in a cycling accident in Norway is higher compared with other road users (Bjørnskau 2020). However, the road safety work is based on data collected by the police and cycling accidents are underreported in the official statistics when compared to hospital records (Melhuus 2015). The same fact is also reported in many European countries (Adminaité-Fodor and Jost 2020). To reduce the number of cycling accidents and understand the reluctance towards cycling, it is important to study the cyclists' opinions about the cycling conditions and facilities and their experience regarding accidents and how this has changed the last decade.

1.2. Measures to increase cycling activity

In the current paper, we investigate the various aspects related to bicycle use over the last decade in the central region of Norway. In addition, we compare the evolution of bicycle use in two main "cycling cities or municipalities" of the region, Sarpsborg and Fredrikstad. "Cycling cities" are defined by the authorities based on measures implemented aimed to increase the number of cycling trips in the population. The measures include physical measures like implementing new cycling infrastructure, maintenance of existing infrastructure and campaigns to inform the inhabitants and motivate them to cycle (Miljøverndepartementet, Samferdselsdepartementet, and Vegdirektoratet 1996).

Research on decision-making has moved from only focusing on cognition to include affect (Slovic et al. 2006). Feelings are more often associated with other behavioural choices than cognitive evaluation of the best action (Loewenstein et al., 2001). Consequently, in the current study we investigate the cyclists' feeling of safety and not their cognitive evaluation of risk or safety. This is in line with earlier findings on

feelings related to perceived risk, studied as a predictor of cycling frequency (Kummeneje, Ryeng & Rundmo 2019).

2. Data and Methods

2.1. Sample

The data was collected in 2010, 2014 and 2018 through telephone interviews with a representative sample of the population (13 years of age and older) in "cycling cities" of the central region. The studies were all financed by the Norwegian Public Roads Administration (NPRA). A sample of about 800 respondents were recruited in each city. In 2010, the survey included 7 cycling cities: Fredrikstad (77,591 inh.), Sarpsborg (54,029 inh.), Skedsmo (51,188 inh.), Ullensaker (32,438 inh.), Gjøvik (29,668 inh.), Hamar (29,520 inh.) and Lillehammer (27,028 inh.). New cities joined the group during the last decade and a number of 18 cycling cities was reached in 2018, included Oslo. The two largest cities in the central region (excluded Oslo) were part of the group since 2010: Fredrikstad and Sarpsborg. Table 1 presents the three periods of data collection and the number of respondents for the three surveys.

Table 1: Periods of data collection and number of respondents in 2010, 2014 and 2018.

Cities	2010	2014	2018
	20 April – 23 June	28 April – 28 June	23 April – 28 June
Fredrikstad	800	800	800
Sarpsborg	802	801	801
Skedsmo	800	800	803
Ullensaker	800	801	800
Gjøvik	800	804	800
Hamar	800	802	801
Lillehammer	800	801	803

2.2. Questionnaire and measure instrument

The questionnaires were identical in 2010, 2014 and 2018 and divided in seven parts. Only three questions were added in 2018 to investigate the reasons the respondents had for choosing to cycle and if they think that the cycling infrastructure in their municipality is well or poorly adapted to cycling, as well as if they evaluate cycling as safe in their municipality.

In the first part, the respondents were asked if they cycle, how often they cycle during the four

seasonal periods on a six-point evaluation scale ranging from "never" to "5 days a week", for which types of trips (from/to work or school, leisure or training activities), reasons to cycle (time sparing, avoid congestion, health and motion, cheap transport, for fun, trendy, environmental-friendly, etc.) and what they think about the local cycling facilities in their municipality.

In the second part, the respondents were asked about their cycling trips during the day before the interview, as well as the distances they cycled and the reasons of their trips (from/to work or school, leisure or training activities).

In the third part, the respondents were asked if they think that the cycling infrastructure on the routes they cycle and in general in their municipality are either well or poorly adapted to cycling. A five-point evaluation scale was used from "very poorly adapted" to "very well adapted".

In the fourth part, they were asked if they feel safe when cycling. A five-point evaluation scale was used from "very unsafe" to "very safe". They had also to report their experience related to accident and the type of accidents (fall, collision with pedestrian, cyclist, car, etc.).

In the sixth part, we collected the respondents' opinions about what could be done to increase to increase bicycle use and commuting (better infrastructure such as cycle lanes and ways, to feel safer to cycle, to buy a new bicycle, to have more time to cycle, better cycle facilities at work, etc.).

The questionnaires also include socio-demographic questions (age, gender, education and main occupation).

3. Results

3.1. Change in cycling habits and seasonal variation in cycling frequency

The first aim of the study was to examine change in cycling habits during the period. The results indicate that the number of respondents that had cycled at least once during the last year has decreased from 2010 to 2018 in all the seven cities, despite the implementation of new measures to increase cycling in the cities. Sarpsborg and Ullensaker have the highest decrease of 11 percentage points and Fredrikstad and Skedsmo a decrease of 9 percentage points.

Men reported to have cycled more often than women the year before in the seven cities. Sarpsborg and Fredrikstad had the largest gender differences with respectively 17 and 11 percentage points in 2018. The age group of 30-44 years old reported that they had cycled more than the other groups and the decreases for this age group are respectively of 16 and 11 percentage points for Sarpsborg and Fredrikstad.

Table 1. Percentage of reported time cycling at least once during the last year in the seven cycling cities in 2010 (N=3825), 2014 (N=3689), and in 2018 (N=3448).

Year	2010	2014	2018
Municipalities	(%)	(%)	(%)
Fredrikstad	71	71	62
Sarpsborg	65	58	54
Skedsmo	69	65	60
Ullensaker	75	70	64
Gjøvik	61	60	53
Hamar	71	71	69
Lillehammer	65	65	61
Total	68	66	60

Concerning the seasonal periods, among those who reported to have cycled the year before, the share of those who reported to cycle during the summer period is the highest and the lowest for the winter period for the seven cities. Fredrikstad stands out from the group of the cycling cities with an increase of winter cycling of 4 percentage points from 2010 (11 %) to 2018 (15 %). Those who reported to practice winter cycling in Fredrikstad in 2018 are more often men (68 %) and belong to two age groups, 45–59-year group (27,4 %) and 60 years and more (27,4 %).

The respondents were also asked how often they had cycled during the time of the interview (Figure 1). No large differences are found between the cities and the cyclists mostly reported to cycle 1-2 days a week (27.5 %). Hamar and Fredrikstad are found among the cities with those who cycled more frequently, whereas Sarpsborg and Gjøvik are in the opposite group. Men also reported to cycle more frequently than women in the seven cities.

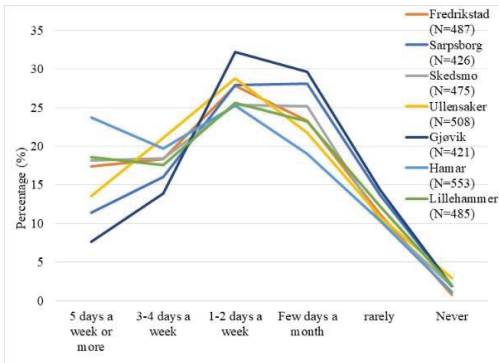


Fig 1. How often the cyclists use their bicycle during the time of the interview in April-June 2018.

Concerning the question of, in which contexts they used their bicycle (among those who had cycled one or more times the year before) it is more common to use the bicycle for leisure time and training than in connection with work or school in the seven cycling cities. In Hamar and Lillehammer they used their bicycle only 3 times more for leisure, whereas in Sarpsborg and Gjøvik it is over 4 times more. Women reported more often to use their bicycle to travel to work than for leisure or training activities compared to men.

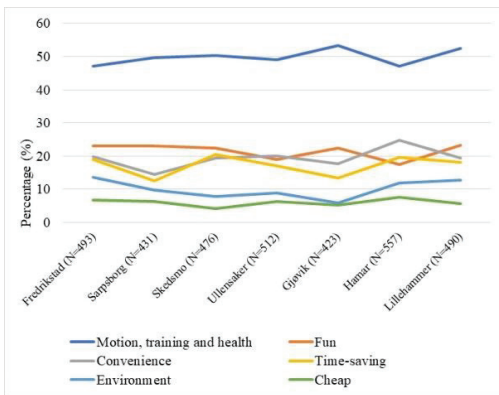


Fig 2. Reasons for choosing to cycle in the seven cycling cities in 2018.

In 2018, a question was added in the survey to investigate the main reasons the respondents had for choosing to cycle and they could select three reasons. The most common answer is found to be for motion, training and health for the seven cities, followed by for fun, convenience and time-saving. Figure 2 presents the similar answers for the cities. Except for the city of Hamar cycling for

fun is not found as a strong reason as it is for the other cities.

The respondents were asked if they had cycled the day before the interview and the results showed that in 2018, 18 % of the respondents in Hamar did it, 12 % in Fredrikstad, Skedsmo, Ullensaker and Lillehammer, 10 % in Sarpsborg and 8 % in Gjøvik. There is a general decrease of the share of respondents, who stated that they had cycled since 2014 and 2010. Figure 3 shows how the proportion of respondents who had cycled the day of registration in 2018 in the seven cities varies with the age and gender groups. Men have a higher proportion in six of the seven cities (Fredrikstad, +9 %, Lillehammer, +6 %, Skedsmo and Gjøvik, +5 %, and Sarpsborg, +4 % whereas in Hamar and Ullensaker the proportion of men and women is slightly the same (+/- 1 %). The age groups 30-44 years or 45-59 years have the highest proportion of cycling for the seven cities.

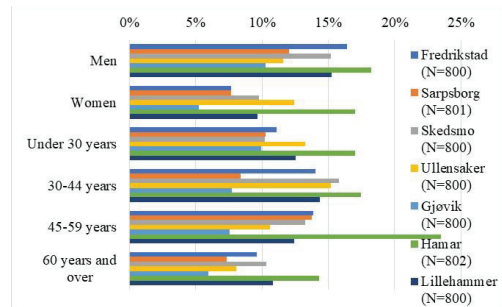


Fig. 3: Proportion of respondents who had cycled the day of registration in relation to age groups and gender.

Table 2 presents the average number of trips cycled by the respondents the day of registration in April – June 2018 for the seven cities. On average, they cycled the same number of trips per day from Monday to Friday (2.2 to 2.4 trips). The number of trips is somewhat found lower on Saturdays and Sundays (2.1 trips). The same results were found in 2010 and 2014.

With 6.2 km, Lillehammer is the city with the largest distance cycled by the respondents on the day of registration (Table 3), followed by Fredrikstad with 5.9 km. Two cities, Sarpsborg and Hamar have a constant increase from 2010 to 2018, respectively + 1.7 and + 0.8 percentage points. Skedsmo and Fredrikstad have the highest increase from 2014 to 2018, with respectively +

2.0 and + 1.5 percentage points, whereas Gjøvik, Ullensaker and Lillehammer had a large decrease (+ 1.5 and + 1.2 percentage points).

Table 2: Number of trips cycled on average by the respondents the day of registration in April- June 2018 in the seven cities.

Municipalities	Mean	N	Std. Deviation
Fredrikstad	2.32	96	1.01
Sarpsborg	2.15	79	0.87
Skedsmo	2.17	100	0.70
Ullensaker	2.18	96	0.89
Gjøvik	2.24	63	0.65
Hamar	2.33	142	0.99
Lillehammer	2.25	99	0.86
Total mean	2.24	674	0.88

Table 3: Km cycled on average by the respondents the day of registration in the seven cities in 2010 (N=1748), 2014 (N=1754) and 2018 (N=1465).

Municipalities	2018	2014	2010
Fredrikstad	5.9	4.4	5.0
Sarpsborg	5.7	5.5	4.0
Skedsmo	5.8	3.8	5.1
Ullensaker	5.8	7.0	5.9
Gjøvik	5.4	6.9	6.4
Hamar	5.0	4.6	4.2
Lillehammer	6.2	4.2	6.4
Total mean	5.7	5.7	5.3

The respondents were also asked in 2018 how they found the roads adapted for cycling during their trips. The mean values from the seven cities are presented in table 4 (Total mean = 3.90 and Std. Deviation=1.11) on a five-point scale from 5 = very well adapted to 1 = very poorly adapted).

The respondents in Gjøvik and Sarpsborg evaluated their municipalities as the less adapted to cycling, whereas Skedsmo, Ullensaker and Lillehammer were evaluated as having the most adapted roads. They also had to assess how safe they thought it was to cycle during these trips. Table 5 shows similar results for the seven municipalities (mean = 4.15 and Std. Deviation=.86) on a 5-point scale from 5 = very safe to 1 = very unsafe). Skedsmo has the highest safety mean score with 4.35 whereas Sarpsborg has the lowest with 3.93.

Five municipalities have an increase of unsafe feelings among the respondents compared to 2014, except for Skedsmo (- 4 p.p.) and

Ullensaker (- 8 p.p.). Fredrikstad has the largest increase with + 8 p.p.

Table 4: How well or poorly adapted the roads were for cycling during the respondents' cycling trips (N=1517).

Municipalities	Mean	N	Std. Deviation
Fredrikstad	3.84	225	1.20
Sarpsborg	3.73	170	1.25
Skedsmo	4.16	216	0.96
Ullensaker	4.06	209	0.96
Gjøvik	3.57	142	1.16
Hamar	3.81	331	1.13
Lillehammer	4.06	224	1.01
Total mean	3.90	1517	1.11

Table 5: How safe or unsafe for cycling were the roads used by the cyclists (N=1512).

Municipalities	Mean	N	Std. Deviation
Fredrikstad	4.00	223	1.08
Sarpsborg	3.93	168	1.04
Skedsmo	4.35	216	0.71
Ullensaker	4.26	209	0.67
Gjøvik	4.03	142	0.80
Hamar	4.23	331	0.76
Lillehammer	4.16	224	0.83
Total mean	4.15	1512	

Five municipalities had an increase of unsafe feelings among the respondents compared to 2014, except for Skedsmo (- 4 p.p.) and Ullensaker (- 8 p.p.). Fredrikstad had the largest increase with + 8 p.p.

3.2. Respondents' opinion about the general cycling facilities in their municipality

Table 6: How well or poorly adapted the seven municipalities were for cycling in 2018 (N=5603).

Municipalities	Mean	N	Std. Deviation
Fredrikstad	3.44	800	1.01
Sarpsborg	3.43	801	1.07
Skedsmo	3.48	800	1.06
Ullensaker	3.45	800	1.04
Gjøvik	3.54	800	1.00
Hamar	3.55	802	0.99
Lillehammer	3.47	800	1.05
Total mean	3.48	5603	1.03

Table 6 reveals that similar mean values were found for the appraisal of how well adapted the seven municipalities are for cycling (Mean = 3.48 and Std. Deviation=1.03) on a 5-point scale from 5 = very well adapted to 1 = very poorly adapted). Sarpsborg and Fredrikstad are municipalities assessed as the less adapted for cycling, whereas Hamar and Gjøvik were evaluated as the most adapted by their cyclists.

3.3. Cyclists' feeling of safety and experience of accidents

In 2018, the respondents evaluated how safe they thought cycling is in their municipality. Similar results were found in table 7 for the seven municipalities (Mean = 3.73 and Std. Deviation = .99) on a 5-point scale from 5 = very safe to 1 = very unsafe). Hamar has the highest safety mean score with 3.81 whereas Fredrikstad and Sarpsborg have the lowest with 3.65.

Table 7: How safe or unsafe for cycling in the seven municipalities in 2018 (N=3227).

Municipalities	Mean	N	Std. Deviation
Fredrikstad	3.65	472	0.99
Sarpsborg	3.65	416	1.01
Skedsmo	3.75	452	1.03
Ullensaker	3.69	478	1.01
Gjøvik	3.76	405	0.92
Hamar	3.81	534	1.00
Lillehammer	3.76	470	0.98
Total mean	3.73	3227	0.99

To understand the respondents' feeling of safety, they were asked if they had experienced an accident as cyclist during the last two years. When the answer was positive (N=205), they had to explain the type of accident it was and where this accident had occurred. Most of these accidents occurred on roads (47.3 %), on cycle and pedestrian paths (31.7 %) and sidewalks (21.0 %).

Table 8 indicates that Skedsmo and Hamar are the municipalities with the highest percentages of cyclists who experienced an accident, whereas Ullensaker is the municipality with the lowest percentage. Around 47 % of accidents occurred on roads and men under 30 years are the group most often involved in an accident for six of the municipalities. For Fredrikstad, men between 45 and 59 years old are the most at-risk age group.

Table 8: The share of respondents in 2018 who had experienced an accident as cyclist during the last two years (N=5390).

Municipalities	No		Yes	
	N	%	N	%
Fredrikstad	767	96.1	31	3.9
Sarpsborg	767	96.2	30	3.8
Skedsmo	766	95.9	33	4.1
Ullensaker	780	97.6	19	2.4
Gjøvik	770	96.4	29	3.6
Hamar	769	95.9	33	4.1
Lillehammer	771	96.5	28	3.5
Total	5390	96.4	203	3.6

The share of respondents who stated that they had been involved in an accident increased from 2010 to 2014 for the seven municipalities. From 2014 and 2018, only Sarpsborg (+ 89 %), Gjøvik (+ 17 %) and Hamar (+ 9 %) continued to have an increase. The other municipalities had a decrease with Fredrikstad having the highest decrease (- 37 %) followed by Skedsmo (- 12 %) and Ullensaker (- 11 %). In 2018, those who had planned to cycle more in the future (N=2083) were asked about what could be done to make them cycle more in the nearest future. Better infrastructure for cyclists and increase of cycle lanes and paths was the most chosen answer (40.3 %), among the respondents in the seven municipalities. The second answer was that they had to buy a new bicycle (15.0 %) and the third one that they need to find more time to do it (10.5 %). The fourth answer was that it should be safer to cycle (10.0 %).

4. Discussion

The current study confirmed that despite a large political strategy to increase the number of cyclists, the cycling frequency has decreased in most of the municipalities, defined as “cycling cities” in the east region. One explanation for this disappointing result could be, to a small extent the increase of other green modes in 2018 such as electric cars (around 200,000 electric cars registered in 2018) and city electric scooters, slowing down the use of bicycle. However, compared to the Norwegian population the share of cycling trips is relatively higher in cycling cities (or municipalities) than other cities. According to the national travel survey conducted in 2018, only four percent of all trips are cycling

trips. This number has been relatively stable since 2000 (Grue, Landa-Mata & Flotve, 2021). Even though the share of cycling trips did not significantly increase in the “cycling cities” during the last 10-year period, the introduction of new cycling-related measures in these municipalities may have avoided a decline in the share of cyclists.

An explanation of the relatively low number of reported cycling accidents in the cycling cities, compared to the Norwegian population, could be the ‘Safety in Numbers effect’. This effect explains the non-linear statistical relationships between the number of cyclists and the number of injuries for the same group. It is argued that an individual is less likely to be involved in an accident when part of a large group of cyclists (Elvik & Bjørnskau 2017). Based on this assumption, the risk of being involved in an accident as a cyclist may be reduced if the cycling frequency continues to progress and becomes high enough to produce the ‘Safety in Numbers effect’.

Furthermore, the cyclists’ feeling of safety was found as the highest in the municipalities where the cyclists used roads that they perceived to be most adapted for cycling. The share of cyclists which had experienced an accident when cycling during the last two years was low in all the municipalities compared to research on the whole Norwegian population. Kummeneje & Rundmo (2018) found in a study among a representative sample of the Norwegian population that eight percent of the sample had experienced an accident as cyclist during the last two years. In the present study, this percentage was between 2.4 and 4.1 for the cycling cities. Based on these results, we conclude that well adapted roads are important for cyclists’ safety and their perception of safety. The cyclists selected better infrastructure for cyclists and increase of cycle lanes and paths are the most important measures to increase cycling and make them to cycle more.

The present study investigated gender and age differences in cycling habits. According to the national travel survey in 2018 among the youngest age group (13-17 years), individuals with low income and no access to car, was found to cycle the most. There are either small or nonsignificant gender differences in the national travel survey, and both men and women stated that they used their bicycle mostly to and from

work (Grue, Landa-Mata & Flotve, 2021). In the current study, men reported to cycle more frequently than women. However, women reported more often to use their bicycle to travel to work compared to men. This is in contrast to studies from Australia and United States where women were found to be more often recreation cyclists than men, and men more often commuter cyclists (Australian Sport Commotion 2010; Pucher, Garrard and Greaves 2011; Pucher et al. 2010 in Gerrard, Handy and Dill 2017). The measures to increase cycling in the cycling municipalities, may have influenced women’s travel patterns to work. Unsafe cycling environment are argued to be a factor influencing gender differences in bicycle use (Garrard, Handy & Dill 2017). However, a recent Canadian study did not find differences in safety perception between men and women (Graystonea, Mitraa & Hessb 2022). This is in line with the current study for most of the municipalities.

5. Conclusion

The present study establishes that the share of bicycle use, or commuting is unfortunately not as high as expected by the municipalities despite their continuous efforts in implementing cycling measures over the last decade to increase the number of cyclists. However, the share of bicycle use is relatively stable over time. There are some differences between the cycling municipalities included in the current study and the official statistics. The share of self-reported cycling accidents in the studies municipalities in 2018 was found to be half or less of the share reported in the national survey. This study confirms the importance for the municipalities to be aware of the level of bicycle commuting in their own municipality and to understand the perceived barriers to bicycle use such as the lack of safe infrastructure and cycling facilities.

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