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## **Seasonal and socio-demographic determinants of school commuting**

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## **Abstract**

**Objective:** To report prevalence of commuting to school in Norway with regard to season, gender, parental education level, ethnicity and distance to school.

**Methods:** Cross-sectional questionnaire data from the Fruits and Vegetables Make the Marks project collected in 2008, including 1,339 ten to twelve-year-old children from 27 schools. The participants were categorized according to main mode of commuting to school in the three different school seasons (fall, winter and spring) and for the full school year if more than 50% of all trips were conducted by one specific mode.

**Results:** Most pupils (75%) were categorized as active commuters for the full school year. However, large seasonal variances were observed, especially for cycling. A total of 52%, 3% and 51% were categorized as cyclists in fall, winter and spring, respectively. Girls were more likely to be walkers (32% vs.24%) and less likely to be cyclist (32% vs. 41%) than boys. Children of parents with higher education were more likely to be cyclist in fall (57% vs. 42%) and spring (56% vs.40%), however, they were more likely to be walkers during winter time (71% vs.56%).

**Conclusions:** Most children reported that they were active commuters. Large seasonal variation was observed, especially regarding cycling.

**Keywords:** Children, active commuting, cycling, walking, seasonality, school

## **Introduction**

Active commuting to school provides an opportunity to increase levels of physical activity (Davison et al., 2008). Socio-demographic variables; gender, ethnicity and socio-economic status (SES) may influence children's commuting behavior. Gender differences in travel choices are noted in some studies, but the literature is inconsistent (Babey et al., 2009; Merom et al., 2006). Some studies report a positive association between children's active commuting and high SES (Bere et al., 2008; Timperio et al., 2006), other studies find no or negative associations (Babey et al., 2009; Mota et al., 2007). Ambiguous results have also been reported between active commuting and ethnicity (Babey et al., 2009; Bere et al., 2008; Harten and Olds 2004).

Distance to school appears to be a consistent predictor of children's travel behavior, with those who have a shorter distance being more likely to walk or cycle to school (McDonald 2007; Merom et al., 2006; Nelson et al., 2008). Children in Norway living more than 4.0 km from school get free public bus transportation through the whole school year by the Norwegian Government, a distance that potentially could be differentiated within the different seasons. Therefore, knowledge about commuting habits within the different seasons is important and needed.

Seasonality has received little attention as a potential environmental determinant of active commuting, maybe because it appears as a non-modifiable parameter, and we clearly cannot change the weather. However, in Norway there is a long tradition for being outdoors even during the winter, and potential problems related to active commuting might be more related to poor removal of snow and lack of proper bike lanes, than the winter in itself. Detailed knowledge on how season influence active commuting in different socio-demographic groups might contribute to the creation of effective intervention programs for promotion of active commuting throughout the year.

The objective of the present study is to assess the associations between mode of commuting to school and seasons, taking socio-demographic factors (gender, ethnicity, and parental education level) and distance to school into account.

## **Methods**

The present study is part of the project Active Transportation to school and work in Norway (ATN), and is based on data from the “cohort II” survey within the Fruit and Vegetables Makes the Marks project (FVMM) (Bere et al., 2010). The sample includes 6th and 7th graders at 27 randomly selected schools in two Norwegian counties, Hedmark and Telemark. Research clearance was obtained from The Norwegian Social Science Data Services. A total of 1,339 pupils (out of 1,712 eligible; 78%), 48% boys, 83% ethnic Norwegians completed a questionnaire in September 2008, and brought home a parent questionnaire to be completed by one of their parents. Parental data was obtained for 996 pupils.

Commuting to school was assessed with separate items to and from school for the different seasons; fall, winter and springtime; “How many days a week do you travel to/from school?”: (1) walking; (2) cycling; (3) by car; or (4) by public transport, giving a total of six responses per mode of commuting (i.e. to and from for: fall/ winter/ and springtime). The participants were categorized according to main mode of commuting to school in the three different school seasons (fall, winter and spring) and for the full school year if more than 50% of all trips were conducted by one specific mode (see Bere and Bjorkelund, 2009 for details). A number of children had not a specific main mode of commuting, and these children were classified as mixed commuters.

The pupils also reported gender and ethnicity (categorized to be native Norwegians if both parents were born in Norway). Parents recorded their own educational level (low: no college or university education/high: having attended college or university), as an indicator of SES. Distance from home to school was calculated from the pupil’s home address using the length of the “optimal route by foot” option within <http://maps.google.no> in November 2009. Distance was categorized into living less than 4.0 km from school, and 4.0 km or more from school.

### *Statistical methods*

Unadjusted associations between main mode of commuting to school and the independent variables were analyzed with chi-square statistics using SPSS version 17.0. Multilevel logistic regression analyses, taking the clustering of pupils within schools into account, were performed with the dichotomous variables walkers (vs. non-walkers), cyclists (vs. non-cyclist), car commuters (vs. non-car commuters), bus commuters (vs. non-bus commuters),

and mixed commuters (vs. non-mixed commuters) as dependent variables, using STATA/IC 10. All models included the gender, parental educational level, ethnicity and distance to school as independent variables. Odds ratios (OR) with confidence intervals (95%) are given for each independent variable.

## **Results**

The proportions of the participants categorized as walkers, cyclists, car, and bus commuters (full school year) were 28%, 36%, 3% and 13%, respectively. A total of 16% were categorized as mixed commuters (11% were active (cycling/walking), 2% passive (car/bus), and 3% active/passive commuters) and 4% were missing (Table 1). I.e. 75% were categorized as active commuters. Large seasonal variances were observed, especially regarding cycling. A total of 52%, 3% and 51% were categorized as cyclists in fall, winter and spring, respectively.

In general for the full school year, girls were more likely than boys to be walkers (32% vs. 24%, OR=1.5; 95 % CI= 1.1-2.0), and less likely to be cyclists (32% vs. 41%, OR=0.6; 95 % CI= 0.5-0.9) (Table 2). Children of parents with higher education were more likely to be cyclists than children of parents without higher education (41% vs. 28%, OR=1.6; 95 % CI= 1.2-2.2). No significant associations were observed between mode of commuting and ethnicity. Distance to school was strongly associated with mode of commuting.

When analyzing main mode of commuting in the different seasons, children of parents with higher education were more likely than children of parents without higher education to be categorized as walkers in winter (71% vs. 56%, OR=2.1; 95 % CI= 1.5-3.0) (Table 2). In spring (25% vs. 25%, OR=0.9; 95 % CI= 0.6-1.2) and fall (23% vs. 24%, OR=0.9; 95 % CI= 0.6-1.2) no differences were found. Likewise, children of parents with higher education were more likely to be categorized as cyclists in fall (57% vs. 42%, OR=1.6; 95 % CI= 1.2- 2.2) and spring (56% vs. 40%, OR=1.6; 95 % CI= 1.2- 2.2), compared with children of parents without higher education. In winter there was no difference (2% vs. 3%, OR=0.7; 95 % CI= 0.3- 1.6).

## **Discussion**

This study shows that cycling was the dominant mode of commuting in fall and spring, and walking the dominant mode in winter. Children of parents with higher education were more

likely to be cyclists in fall and spring; however they were more likely to be walkers in winter, than children of parents without higher education.

Few studies have assessed the association between commuting to school and seasons. A recent study from Norway, representative of the population of children in Norway, reported similar but lower seasonal variations (Fyhri and Hjorthol 2009). It was reported that 40% of the children normally walked to school, 22% cycled, 23% were taken by car and 16% used public transport during summer months. During winter months, 47% walked, 12% cycled, 25% were taken by car and 17% used public transport.

The associations reported between seasons and active commuting are in line with findings from studies on general physical activity (Kolle et al., 2009; Tucker and Gilliland 2007). The climate in e.g. Norway varies highly with the seasons regarding temperature, precipitation and daylight (The Norwegian Meteorological Institute 2010). The months of winter being often characterized by periods of continuous poor and harsh weather (rain, snow and wind), which makes it more challenging to e.g. cycle to school. However, the problem related to cycling may be associated with poor removal of snow and lack of bike lanes, therefore improving cycling habits may be possible.

It is interesting that children of parents with higher education were more likely to be categorized as cyclists in general, but in wintertime more likely to be categorized as walkers, than children from low SES families. Research studying the impact of socioeconomic status on active commuting has shown diverging results in different countries (Babey et al., 2009; Bere et al., 2008; Chillon et al., 2009).

#### *Study limitations*

Only two of Norway's 19 counties were included in the study, ethnicity is clearly not as homogenous as the two classified groups. Further, SES is not only dependent on parental education level. The strength of the present study is the rather comprehensive questionnaire for assessing the main mode of commuting to school, allowing us to assess seasonal variations (Bere and Bjorkelund 2009).

## **Conclusion**

Most children reported to be active commuters to school. Seasonal variation and significant associations with gender, parental education level, and distance were observed.

## **Competing interests**

The authors declare that they have no competing interest.

## **Authors' contributions**

EB conceived the FVMM project. All authors designed the present study. LABB collected and analyzed the data, and drafted the manuscript. LBA and EB revised the manuscript critically. All authors have read and approved the final manuscript.

## **Acknowledgement**

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**Table 1** Description of mode of commuting and the unadjusted association between mode of commuting and the socio demographic variables, collected in two Norwegian counties in 2008.

	n (%)	Walkers		Cyclist		Car Commuter		Bus Commuter		Mixed Commuters		Missing	
		%	(95 %CI)	%	(95 %CI)	%	(95 %CI)	%	(95 %CI)	%	(95 %CI)	%	(95 %CI)
<b>Full school year</b>	1339 (100%)	28	(26-30)	36	(34-39)	3	(2-4)	13	(11-15)	16	(14-18)	4	(2-4)
<b>Fall</b>	1339 (100%)	24	(21-26)	52	(49-55)	4	(3-5)	13	(11-15)	6	(5-7)	1	(1-3)
<b>Winter</b>	1339 (100%)	65	(62-67)	3	(2-4)	8	(7-10)	15	(13-17)	8	(6-9)	1	(1-2)
<b>Spring</b>	1339 (100%)	25	(23-27)	51	(48-53)	3	(2-4)	12	(10-14)	8	(6-9)	1	(1-3)
<b>Gender</b>													
<b>Boys</b>	630 (48 %)	24	(20-27)	41*	(37-45)	3	(2-5)	15*	(12-18)	15	(12-17)	2	(1-4)
<b>Girls</b>	684 (52%)	32*	(29-36)	32	(29-36)	4	(2-5)	11	(9-13)	18	(15-20)	3	(2-6)
<b>Parental education</b>													
<b>Low</b>	341 (37 %)	28	(23-32)	28	(23-33)	4*	(2-7)	19*	(15-23)	18	(15-22)	3	(1-5)
<b>High</b>	578 (63 %)	28	(25-32)	41*	(37-49)	2	(1-4)	11	(9-14)	15	(12-18)	3	(1-3)
<b>Ethnicity</b>													
<b>Not native Norwegian</b>	229 (17 %)	36*	(30-43)	33	(27-39)	5*	(2-8)	10	(6-14)	12	(8-17)	4	(1-6)
<b>Native Norwegian</b>	1110 (83 %)	26	(24-29)	37	(34-40)	3	(2-4)	14	(12-16)	17*	(15-19)	3	(2-4)
<b>Distance</b>													
<b>Less than 4 km</b>	1021 (85%)	34*	(31-37)	42*	(39-45)	2	(1-3)	3	(2-4)	16	(14-19)	3	(2-4)
<b>4 km or more</b>	176 (15 %)	11	(7-16)	16	(10-21)	7*	(3-11)	46*	(38-53)	16	(10-21)	4	(1-7)

\* Significant differences between groups (chi-square statistics,  $p < 0.05$ )

**Table 2** Odds ratios for being a walker, cyclist, car commuter, bus commuter or mixed commuter for full school year and within the different seasons, collected in two Norwegian counties in 2008.

		Fall		Winter		Spring		Full school year	
		OR	(95 % CI)	OR	(95 % CI)	OR	(95 % CI)	OR	(95 % CI)
<b>Walkers</b> n= 375	<b>Gender</b> (girls vs. boys)	1.2	(0.9-1.7)	1.4	(1.0-1.9)	1.2	(0.9-1.7)	1.5*	(1.1-2.0)
	<b>Ethnicity</b> (native Norwegian vs. Non Norwegian)	1.0	(0.6-1.6)	1.3	(0.8-2.2)	0.8	(0.5-1.4)	1.0	(0.6-1.6)
	<b>Parental education</b> (high vs. low)	0.9	(0.6- 1.2)	2.1*	(1.5-3.0)	0.9	(0.6-1.2)	1.0	(0.7-1.3)
	<b>Distance</b> ( $\geq$ 4km school/home vs. <4 km school/home)	0.2*	(0.1-0.4)	0.1*	(0.0-0.1)	0.3*	(0.1-0.5)	0.3*	(0.1-0.5)
<b>Cyclist</b> n= 482	<b>Gender</b> (girls vs. boys)	0.8	(0.6- 1.1)	0.4*	(0.2-1.0)	0.7*	(0.5-0.9)	0.6*	(0.5-0.9)
	<b>Ethnicity</b> (native Norwegian vs. Non Norwegian)	1.3	(0.8- 2.0)	3.0	(0.4-22.5)	1.2	(0.8-1.9)	1.14	(0.7-1.8)
	<b>Parental education</b> (high vs. low)	1.6*	(1.2- 2.2)	0.7	(0.3-1.6)	1.6*	(1.2-2.2)	1.6*	(1.2-2.2)
	<b>Distance</b> ( $\geq$ 4km school/home vs. <4 km school/home)	0.2*	(0.1- 0.3)	0.2	(0.0-1.7)	0.2*	(0.1-0.3)	0.2*	(0.1-0.4)
<b>Car commuters</b> n= 40	<b>Gender</b> (girls vs. boys)	1.2	(0.5-2.5)	0.6	(0.4-1.1)	1.7	(0.7-4.0)	1.1	(0.5-2.6)
	<b>Ethnicity</b> (native Norwegian vs. Non Norwegian)	1.6	(0.4-7.0)	1.2	(0.5-2.8)	1.5	(0.4-6.6)	0.9	(0.2-2.9)
	<b>Parental education</b> (high vs. low)	0.4*	(0.2-0.8)	0.5*	(0.3-0.9)	0.7	(0.3-1.6)	0.5	(0.2-1.2)
	<b>Distance</b> ( $\geq$ 4km school/home vs. <4 km school/home)	2.9*	(1.3-6.5)	1.5	(0.8-2.9)	2.2	(0.9-5.6)	2.9*	(1.2-7.1)
<b>Bus commuters</b> n= 174	<b>Gender</b> (girls vs. boys)	0.8	(0.4-1.4)	0.9	(0.5-1.5)	1.0	(0.6-1.8)	0.8	(0.5-1.4)
	<b>Ethnicity</b> (native Norwegian vs. Non Norwegian)	0.5	(0.2-1.3)	0.7	(0.3-1.8)	0.5	(0.2-1.4)	0.5	(0.2-1.4)
	<b>Parental education</b> (high vs. low)	0.7	(0.4-1.3)	0.6*	(0.4-1.1)	0.6	(0.4-1.1)	0.7	(0.4-1.3)
	<b>Distance</b> ( $\geq$ 4km school/home vs. <4 km school/home)	36.0*	(19.8-65.9)	25.3*	(14.9-43.0)	36.8*	(20.0-69.0)	31.8*	(17.7-56.9)
<b>Mixed commuters</b> n= 214	<b>Gender</b> (girls vs. boys)	1.3	(0.7-2.3)	1.0	(0.6-1.8)	1.5	(0.9-2.7)	1.2	(0.8-1.8)
	<b>Ethnicity</b> (native Norwegian vs. Non Norwegian)	0.7	(0.3-1.5)	0.6	(0.3-1.2)	1.2	(0.5-2.9)	1.1	(0.6-1.9)
	<b>Parental education</b> (high vs. low)	0.7	(0.4-1.2)	0.6	(0.4-1.1)	0.6	(0.4-1.0)	0.8	(0.5-1.1)
	<b>Distance</b> ( $\geq$ 4km school/home vs. <4 km school/home)	2.8*	(1.5-5.2)	2.1*	(1.1-4.0)	2.6*	(1.4-4.7)	1.0	(0.6-1.6)

\* Significant differences between groups (multilevel logistic regressions,  $p < 0.05$ )

