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Choice of transport mode in emerging adulthood: Differences between secondary school students, studying young adults and working young adults and relations with gender, SES and living environment

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ABSTRACT

Background: Encouraging sustainable travel behavior in emerging adults is important because this transport choice might persist into adulthood. However, research on transport habits in emerging adulthood is scarce. This study aimed to examine potential differences in walking, cycling, car use and public transport use between three groups of emerging adults (secondary school students (17–18 yrs), studying young adults (18–25 yrs) and working young adults (18–25 yrs)), and to investigate differences in choice of transport modes within each of the three groups according to gender, SES and living environment.
Methods: A cross-sectional design was used to collect self-reported data via an online survey that assessed socio-demographic variables, commuting (to work or school) and transport to other destinations. 1307 emerging adults completed the questionnaire. Zero-inflated negative binomial regression models were used. The four dependent variables were minutes per week walking, cycling, car use and public transport use.
Results: Compared to the other two groups, secondary school students were most likely to cycle, studying young adults were most likely to walk and use public transport and working young adults were most likely to use a car. In each of the three groups, men were more likely to cycle than women and women were more likely to commute by car to work/school than men. Female secondary school students were also more likely to use a car to other destinations. In each of the three groups, urban emerging adults were more likely to walk and less likely to use a car than those living in rural areas. Urban studying young adults were more likely to cycle to other destinations and urban working young adults were more likely to cycle to work than their rural counterparts. Urban secondary school students were less likely to use public transport to school, although urban studying young

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adults and working young adults were more likely to use public transport than their rural counterparts. In each of the three groups, high SES emerging adults were more likely to travel by car to other destinations than those with low SES.

Conclusions: Future active transport interventions should focus on female emerging adults and on maintaining the habit of cycling after reaching the age at which it is possible to obtain a driver's license. More research on the travel behavior of working young adults is needed as this often neglected target group was least likely to use active and public transport and most likely to travel by car among the three comparison groups. Encouraging the combined use of active and public transport might help to decrease car use when travelling longer distances.

1. Background

Sustainable transport choices such as walking and cycling (i.e. active transport) offer several benefits to individuals and to the whole society. Public benefits include reduced traffic crashes and pollution emissions (Int Panis et al., 2010; Litman, 2003), reduced noise and congestion (Rabl and de Nazelle, 2012), and a reduction in the negative effect of traffic-related stress on well-being (Gee and Takeuchi, 2004). But active transport also offers individual health benefits such as lower odds of being overweight or obese (Bere et al., 2011; Gordon-Larsen et al., 2009), an overall reduction in cardiovascular risk (Hamer and Chida, 2008) and higher levels of cardiovascular fitness (Gordon-Larsen et al., 2009; Hamer and Chida, 2008; Oja et al., 2011) through more minutes of total moderate-to-vigorous physical activity (Sisson and Tudor-Locke, 2008). The latter is of great importance as in Belgium, 11.4% of all-cause mortality is associated with physical inactivity (Lee et al., 2012). Approximately 50% of Belgian youth (15–24 years) does not reach the recommended 30 min of moderate physical activity a day (Drieskens, 2014).

Emerging adulthood is a period ranging from the late teens through the twenties, and is a critical period of decision-making that might contribute to adult habits and health-related behaviors (Arnett, 2000; Bell and Lee, 2005). Within emerging adulthood, three subgroups can be distinguished: secondary school students (17–18 years, final two years of secondary school), studying young adults (18–25 years) and working young adults (18–25 years). Emerging adulthood comprises various turning points in life such as changes in education, employment or place of residence. Beige and Axhausen (2012) found strong interdependencies between these turning points and long-term mobility decisions, especially in young people. Turning points in life provide opportunities to influence travel choices because people reflect on and reconsider their travel habits and routines. Encouraging sustainable travel behavior in emerging adults is particularly important as their travel habits are not fully established yet and new travel choices might persist into adulthood and provide several long-term benefits (Beige and Axhausen, 2012; Telama, 2009).

Despite the many benefits of active transport, only 22% of 18- to 24-year-olds in Flanders (Belgium) cycle as main mode of transport, whereas for 47% driving a car or being a car passenger is their main transport mode in everyday life (Department of Mobility and civil engineering, 2012). To date, effects of interventions to promote walking and cycling were small and it was suggested that future interventions should tailor better to the needs of specific groups and settings (Ogilvie et al., 2007; Yang et al., 2010). In order to successfully target secondary school students, studying young adults and working young adults, it is necessary to have a comprehensive understanding of their travel behavior. Currently, transport habits have been primarily investigated in children, adolescents or middle-aged adults. Research on transport habits of emerging adults is scarce and mainly focused on studying young adults commuting to college or university (Molina-Garcia et al., 2010; Shannon et al., 2006; Sisson and Tudor-Locke, 2008; Titze et al., 2007). Research on studying young adults' transport modes to other destinations (e.g. friends, sports club, shops...) is lacking as well as research on transport habits to any destination in secondary school students or working young adults. Research among working young adults is scarce, presumably because they are not readily accessible through any institutional setting (Arnett, 2000).

When comparing travel behavior between secondary school students, studying young adults and working young adults, it might also be important to investigate relations with gender, socio-economic-status (SES) and living environment (urban vs. rural). Evidence has shown that in Australia and the US, men were more likely to use active transport compared to women (Babey et al., 2009; Heesch et al., 2012). In addition, Belgian adolescent boys (17–18 years) were more likely to commute actively than girls (Van Dyck et al., 2010). However, a study on travel trends in German young adults found that gender differences in car travel have largely disappeared due to the decrease in car use among young men (Kuhnimhof et al., 2012b). In addition, a review on socioeconomic inequalities of physical activity in Europe (Beenackers et al., 2012) found no clear relation between SES and active transport. Living in urban areas has been found to be positively related with active transport to school in Canadian and US adolescents (Babey et al., 2009; Robertson-Wilson et al., 2008).

In conclusion, previous transport studies investigating the influence of gender, SES and living environment mostly focused on either active transport or motorized transport and did not compare choice of transport mode between secondary school students, studying young adults and working young adults.

Therefore, the aim of this study is to (1) examine potential differences in walking, cycling, car use and public transport use to work or school (commuting) and to other destinations between three groups of emerging adults (secondary school students, studying young adults and working young adults), and (2) investigate relations of gender, SES and living environment with the different transport modes within each of the three target groups.

2. Methods

2.1. Participants

Secondary school students, studying young adults and working young adults were recruited respectively from random samples of secondary schools (the two final years), colleges and universities, and companies across Flanders (Belgium). A first contact was made via an e-mail sent to principals, coordinators or study councilors of secondary schools, the research department or official contact persons within colleges and universities, and to HR-managers of companies. Next, contact was made by phone. After agreement to participate, a second e-mail was sent, which contained a link to an online questionnaire (target group specific). Because of the low response rate of companies (30%) and employees (response rate not available), working young adults were also recruited face-to-face; researchers went to random commercial and retail businesses to recruit working young adults. In addition to these recruitment methods, social media was used. Within emerging adults, social media and social network sites, such as Facebook, are very popular and therefore an effective way to contact young people and send out online questionnaires (Jones et al., 2012). In total 2283 young people participated in the survey of which 1307 completed the entire questionnaire. Of those who completed the questionnaire, 613 were secondary school students, 496 were studying young adults and 198 were working young adults. The study protocol was approved by the ethics committee of the university hospital of the Vrije Universiteit Brussel.

2.2. Research procedure and measures

A cross-sectional design was used to collect self-reported data using an online survey, which was conducted between March and July 2013. The survey was based on validated questionnaires (Craig et al., 2003; de Geus et al., 2008; Ducheyne et al., 2012). The questionnaires assessed socio-demographic variables, general transport information (i.e. driver license...), commuting (to work or school) and transport to destinations other than work or school.

2.3. The socio-demographic variables

Data considering age, gender, nationality, residence (living with (grand) parents, partner, children...), living environment (countryside, village, suburb, city) and socio-economic status (SES) (education, profession and education of parents) was collected. Living environment was dichotomized into urban (suburb and city) versus rural (countryside and village). SES of secondary school students and studying young adults was dichotomized into high SES (at least one of both parents completed tertiary education) versus low SES (neither parent completed tertiary education). SES of working young adults was dichotomized into high SES (completed tertiary education) versus low SES (did not complete tertiary education) (Galobardes et al., 2006).

2.4. General transport information, commuting and transport to other destinations

General transport information, such as driver license, vehicle ownership, car availability, borrowing and sharing capability of vehicles, ownership of a public transport pass and usage of bicycle rental services was collected. All information on transport modes was subdivided in four main groups: walking, cycling, car use, and public transport (train, bus, tram and subway). The long version of the International Physical Activity Questionnaire (IPAQ-long) was developed to assess detailed information within the domains of household and yard work activities, occupational activity, active transport, and leisure-time physical activity as well as sedentary activity (Craig et al., 2003). It has been validated in Flemish adolescents and adults (Matton et al., 2007). In this study, the part about active transport was used to assess commuting behavior (to work or school) and travel behavior to destinations other than school or work. Frequency (days/week) and duration (minutes/day) of walking, cycling, car trips and public transport trips within the last seven days were assessed. If participants combined transport modes (e.g. combining public and active transport), they were asked to take both trips into account. Next, participants were asked about transport mode preference and amount of transport mode use per season.

2.5. Data analysis

To examine differences in travel behavior between secondary school students, studying young adults and working young adults (group), and to investigate relations of gender, SES and living environment with the different transport modes within each of the three target groups, zero-inflated negative binomial (ZINB) regression models were used. Fig. 1 shows the equation of a ZINB model, with location parameter μ, dispersion parameter σ and zero-inflation parameter π. The parameter μ is

$$f(y|\mu,\sigma,\pi) = \begin{cases} \pi + (1-\pi)(1+\mu\sigma)^{-(1/\sigma)}, \text{ for } y = 0 \\ (1-\pi)\dfrac{\Gamma[y+(1/\sigma)]}{\Gamma[y+1]\Gamma[1/\sigma]}\left[\dfrac{(\mu\sigma)^y}{(1+\mu\sigma)^{y+(1/\sigma)}}\right], \text{ for } y = 1, 2, \ldots \end{cases}$$

$$E(Y) = (1-\pi)\mu$$

$$Var(Y) = \mu(1-\pi)[1+\mu(\sigma+\pi)]$$

Fig. 1. Equation of a ZINB model.

the conditional mean based on the observations coming from the negative binomial distribution and not the inflating zeros. Analyses were done using R with the package 'pscl' (Jackman, 2012). ZINB models were used as the dependent variables (minutes per week walking, cycling, car use and public transport use) were positively skewed and contained a large number of zero values (Cerin et al., 2010; Slymen et al., 2006). Vuong tests supported the need to use zero-inflated regression models (Cheung, 2002) and Akaike's Information Criterion (AIC) showed that a ZINB model was preferred over a zero-inflated poisson model. ZINB models evaluate the relationships of group, gender, SES and living environment with the odds of non-participation in walking, cycling, car use and public transport use to work or school (commuting) and to other destinations (top line in Fig. 1, y = 0). Simultaneously, ZINB models estimate the relationships with minutes per week participated in these transport modes for those who did make use of these transport modes (bottom line in Fig. 1, y = 1,2,...). The zero-inflated model and the negative binomial model might differ in predictors. Hence, one ZINB model might yield two regression coefficients for the independent variables: an odds ratio (OR) (for the relationship between the independent variable and the odds of not participating in walking, cycling, using a car or using public transport) and a negative-binomial model regression coefficient (exponentiated beta coefficient representing the proportional change in minutes/week walking, cycling, using a car or using public transport with a one-unit increase in the independent variable for those who did participate in these transport modes).

All analyses were conducted for the four dependent variables (walking, cycling, car use and public transport use) and were done separately for trips to work or school (commuting) and for trips to destinations other than work or school (resulting in eight models). To answer the first study aim (exploring differences in walking, cycling, car use and public transport use between secondary school students, studying young adults and working young adults), a basic model was estimated that included the main effects of group, SES, gender and living environment. To investigate the second aim (investigate relations of gender, SES and living environment with the different transport modes within each of the three target groups), the interaction effects between group and one of the potential moderators were first added separately to the basic model (3 separate models per dependent variable). Finally, all significant interaction effects observed in the previous step were entered simultaneously into the basic model. The results of this final model were presented. Models with trips to work or school as dependent variable were adjusted for distance to work/school. Level of significance was set at $p < 0.05$. The results were described by maintaining the interpretation of the dependent variables (odds of non-participation), but the reference categories of the independent variable (group) were altered when needed to avoid double negatives. An exact R^2 or pseudo-R^2 measure for ZINB models does not exist (UCLA: Statistical Consulting Group, 2016a, 2016b). However, as an indicative measure of goodness of fit, R^2 was reported for a regression on the non-zero data (negative binomial model) and McFadden's R^2 was reported for a binary choice model (logit model) in the table legends (Hensher and Stopher, 1979). The entire models can be found as supplementary material.

3. Results

3.1. Descriptive statistics

Descriptive statistics of the three groups are displayed in Table 1. Only few (14.5%) secondary school students had a driver license for a car, whereas more than half of the studying young adults and almost all working young adults owned a car driver license. More than half of the working young adults also owned a private car. Of the total sample, not many young people had a driver license for a moped or owned a moped, but almost all of them owned a bicycle. Almost 80% of studying young adults had a public transport pass, while less than half of the two other groups had such pass. Only 1% of secondary school students and 5% of studying young adults, but 10% of working young adults had a bicycle sharing pass. Of the total sample, more than two thirds mostly walked or cycled during summer, while this was only approximately one third during winter. Large differences were found when asked for most liked transport: in summer, more than 80% liked most to walk or cycle, whereas during winter, only about 20% liked most to do this. More than 60% of the total sample liked most to go by car or motorcycle during winter, but public transport was 'most liked' neither during summer nor winter.

Table 1
Descriptive statistics.

	Secondary school students		Studying young adults		Working young adults	
N	612		496		195	
Age (Mean ± SD)	18.0 ± 1.1		22.2 ± 2.2		24.6 ± 1.4	
Male (%)	45.3		33.3		44.1	
Belgian nationality (%)	96.2		94.4		96.9	
Rural living environment (%)	73.0		57.1		52.8	
Living with parents (%)	94.8		75.2		42.6	
Living with partner (no children) (%)	0.3		6.3		40.0	
Living with children (%)	0.0		2.2		3.6	
High SES (%)	61.3		74.0		73.3	
Driver license car (%)	14.5		61.5		86.2	
Driver license moped (%)	8.7		14.5		21.0	
Owning a car (%)	13.2		26.8		63.1	
Owning a moped (%)	8.3		6.3		2.6	
Owning a bicycle (%)	91.8		85.7		86.7	
Public transport pass (%)	48.5		77.2		39.0	
Bicycle sharing pass (%)	1.0		5.4		10.0	
km to school/work (Mean ± SD)	9.9 ± 10.4		24.2 ± 19.2		17.8 ± 17.0	
Most used transport	Summer	Winter	Summer	Winter	Summer	Winter
Walking/Cycling (%)	74.3	39.4	71.8	27.2	66.7	26.2
Car/Motorcycle (%)	15.2	36.8	16.9	43.5	30.3	62.1
Public transport (%)	9.8	23.5	11.3	29.2	3.1	11.8
Most liked transport	Summer	Winter	Summer	Winter	Summer	Winter
Walking/Cycling (%)	82.7	20.4	85.3	19.0	88.2	25.1
Car/Motorcycle (%)	13.2	60.3	11.9	61.5	11.3	64.1
Public transport (%)	3.1	19.1	2.8	19.6	0.5	10.8
Transport last 7 days (IPAQ)	Work/School	Other	Work/School	Other	Work/School	Other
Walking/Cycling						
non-participant (%)	37.4	25.7	48.2	27.6	52.3	29.7
min/*week [median (Q_1, Q_3)]* *	90.0 (50.0; 150.0)	90.0 (50.0; 180.0)	100.0 (50.8; 150.0)	100.0 (60.0; 178.8)	100.0 (60.0; 180.0)	90.0 (40.0; 150.0)
Car/Motorcycle						
non-participant (%)	72.5	49.5	68.8	30.8	43.1	16.9
min/*week [median (Q_1, Q_3)]* *	75.0 (30.0; 150.0)	80.0 (40.0; 150.0)	100.0 (45.0; 175.0)	105.0 (60.0; 195.0)	200.0 (123.8; 300.0)	130.0 (60.0; 240.0)
Public transport						
non-participant (%)	57.4	58.7	26.0	36.9	68.2	61.5
min/*week [median (Q_1, Q_3)]* *	200.0 (107.5; 300.0)	180.0 (60.0; 300.0)	300.0 (180.0; 480.0)	200.0 (90.0; 360.0)	300.0 (150.0; 480.0)	120.0 (60.0; 240.0)

* Median and quartiles (quartile 1, quartile 3) of min/week only calculated for those who did participate in the transport modes.

4. Differences in choice of transport mode between secondary school students, studying young adults and working young adults (Table 2)

4.1. Public transport

The logit model shows that the odds of not commuting by public transport for working young adults were 2.34 times higher than for secondary school students and 5.27 (95% CI = 3.53, 7.86) times higher than for studying young adults. In addition, the odds of not commuting by public transport were 2.25 times higher (95% CI = 1.64, 3.09) for secondary school students than for studying young adults. The negative binomial model shows that among those who did commute by public transport in the last seven days, studying young adults commuted 16% more min/week than secondary school students.

To destinations other than work or school, the odds of not using public transport were 2.30 times higher (95% CI = 1.77, 2.98) for secondary school students and 2.72 times higher (95% CI = 1.91, 3.86) for working young adults than for studying young adults. No difference was found between secondary school students and working young adults. Among those who did travel by public transport to other destinations in the last seven days, studying young adults used public transport 36% more min/week than secondary school students and 41% more min/week than working young adults (1.41; 95% CI = 1.12, 1.78).

4.2. Car use

The odds of not commuting by car were 4.80 times higher (95% CI = 3.24, 7.09) for secondary school students and 3.34 times higher (95% CI = 2.28, 4.90) for studying young adults than for working young adults. Additionally, the odds of not commuting by car were 1.44 times higher for secondary school students than for studying young adults (95% CI = 1.03,

1.99). Among those who did commute by car, working young adults commuted 76% more min/week than secondary school students and 78% more min/week than studying young adults (1.78; 95% CI = 1.44, 2.22).

Results were similar for car use to destinations other than work or school: the odds of not using a car were 5.98 times higher (95% CI = 3.90, 9.19) for secondary school students and 2.35 times higher (95% CI = 1.52, 3.63) for studying young adults than for working young adults. The odds of not using a car were also 2.55 times higher for secondary school students than for studying young adults (95% CI = 1.94, 3.34). Among those who did travel by car to other destinations, working young adults and studying young adults drove 64% and 36% more min/week than secondary school students. Working young adults also drove 21% more min/week than studying young adults (1.21; 95% CI = 1.01, 1.44).

4.3. Cycling

The odds of not commuting by bicycle were respectively 1.66 and 2.86 times higher for working young adults and studying young adults than for secondary school students, and in addition, the odds were 1.72 times higher for studying young adults than for working young adults (95% CI = 1.15, 2.57). Among those who did commute by bicycle, studying young adults cycled 27% fewer min/week than secondary school students and 26% fewer min/week than working young adults (0.74; 95% CI = 0.59, 0.94).

To destinations other than school or work, the odds of not cycling for secondary school students were 1.68 and 1.80 times higher than for working and studying young adults, respectively. No significant difference was found between working and studying young adults. Among those who did cycle to other destinations, working and studying young adults both cycled 24% fewer min/week than secondary school students.

4.4. Walking

The odds of not walking to work or school were 2.31 times higher (95% CI = 1.65, 3.23) for secondary school students and 3.03 times higher (95% CI = 1.95, 4.72) for working young adults than for studying young adults. Among those who did walk to work or school, studying young adults walked 34% more min/week than secondary school students.

Table 2
Main effects of group: differences in choice of transport mode between secondary school students, studying young adults and working young adults.

	To work or school		To other destinations	
	Logit model: OR of being non-participant[1] (95% CI)	Negative binomial model: min/week[2] (95% CI)	Logit model: OR of being non-participant[1] (95% CI)	Negative binomial model: min/week[2] (95% CI)
Public transport (Ref. = secondary school students)				
Working young adults	**2.34**[a] **(1.57, 3.49)*****	1.22[a] (0.99, 1.50)	1.18[a] (0.83, 1.67)	0.96[a] (0.75, 1.24)
Studying young adults	**0.44**[b] **(0.32, 0.61)*****	**1.16**[a] **(1.02, 1.32)***	**0.43**[b] **(0.34, 0.56)*****	**1.36**[b] **(1.15, 1.61)*****
Car use (Ref. = secondary school students)				
Working young adults	**0.21**[a] **(0.14, 0.31)*****	**1.76**[a] **(1.41, 2.20)*****	**0.17**[a] **(0.11, 0.26)*****	**1.64**[a] **(1.37, 1.97)*****
Studying young adults	**0.70**[b] **(0.50, 0.97)***	0.99[b] (0.80, 1.22)	**0.39**[b] **(0.30, 0.51)*****	**1.36**[b] **(1.17, 1.58)*****
Cycling (Ref. = secondary school students)				
Working young adults	**1.66**[a] **(1.13, 2.44)****	0.98[a] (0.79, 1.21)	**1.68**[a] **(1.19, 2.37)****	**0.76**[a] **(0.61, 0.94)***
Studying young adults	**2.86**[b] **(2.05, 3.98)*****	**0.73**[b] **(0.60, 0.89)****	**1.80**[a] **(1.39, 2.33)*****	**0.76**[a] **(0.64, 0.89)*****
Walking (Ref. = secondary school students)				
Working young adults	1.31[a] (0.83, 2.09)	1.23[a] (0.92, 1.64)	**0.56**[a] **(0.39, 0.79)*****	0.95[a] (0.77, 1.18)
Studying young adults	**0.44**[b] **(0.31, 0.61)*****	**1.34**[a] **(1.10, 1.62)****	**0.50**[a] **(0.39, 0.65)*****	**1.27**[b] **(1.07, 1.50)****

OR = odds ratio; CI = confidence interval.
All models were adjusted for gender, SES and living environment.
The model for commuting was adjusted for distance to work or school.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.
[a,b] OR with the same indices do not differ significantly ($\alpha = 0.05$).
[1] ZINB models estimate parameters associated with the odds of non-participation in using a specific transport mode to work/school or to other destinations (logit model).
[2] Simultaneously, among participants who did use that transport mode to work/school or to other destinations, ZINB models estimate parameters associated with weekly minutes using that transport mode to work/school or to other destinations (negative binomial model). This table displays selected exponentiated negative binomial model parameters, which represent the proportional increase in minutes/week among those who used public transport/car/bicycle/walked to work/school or to other destinations with a one-unit increase in the predictor.

To other destinations, the odds of not walking for secondary school students were 1.99 times (95% CI = 1.54, 2.58) and 1.79 times (95% CI = 1.27, 2.53) higher than for studying and working young adults. Among those who did walk to other destinations, studying young adults walked 27% more min/week than secondary school students and 33% more min/week than working young adults (1.33; 95% CI = 1.09, 1.63).

5. Moderation effects of gender, SES and living environment

5.1. Public transport (Table 3)

For commuting, significant interaction effects were found between group and SES and group and living environment. The odds of not commuting by public transport were 2.49 times higher for secondary school students with high SES than for those with low SES. SES did not relate to public transport use among studying and working young adults. For working young adults living in rural areas, the odds of not commuting by public transport were 2.44 times higher than for those living in urban areas (95% CI = 0.21, 0.81). Living environment did not relate to commuting by public transport among studying young adults.

For public transport to destinations other than work or school, significant interaction effects were found between group and SES and between group and living environment. The odds of not using public transport were 1.79 times higher for secondary school students with high SES than for those with low SES. SES did not relate to public transport use among studying young adults and working young adults. In rural areas, the odds of not using public transport were respectively 3.23 times (95% CI = 0.21, 0.46) and 4.35 times (95% CI = 0.12, 0.42) higher for studying and working young adults than in urban areas. Living environment did not relate to public transport use among secondary school students. Among those who did use public transport, male secondary school students travelled 24% more minutes/week than their female counterparts.

Table 3
Associations between group, the potential moderators and the interaction terms with public transport.

	To work or school		To other destinations	
	Logit model: OR of being non-participant[1] (95% CI)	Negative binomial model: min/week[2] (95% CI)	Logit model: OR of being non-participant[1] (95% CI)	Negative binomial model: min/week[2] (95% CI)
Group (Ref. = secondary school students)				
Working young adults	**7.01 (3.10, 15.84)*****	1.22 (0.99, 1.50)	**4.50 (2.03, 10.01)*****	0.96 (0.75, 1.24)
Studying young adults	1.54 (0.85, 2.80)	**1.16 (1.02, 1.32)***	0.79 (0.47, 1.32)	**1.36 (1.15, 1.61)*****
Potential moderators				
Gender (Ref. = female)	1.27 (0.96, 1.66)	1.04 (0.92, 1.16)	1.23 (0.97, 1.58)	**1.24 (1.06, 1.44)****
SES (Ref. = low SES)	**2.49 (1.66, 3.73)*****	0.96 (0.85, 1.08)	**1.79 (1.24, 2.58)****	0.87 (0.74, 1.03)
Living environment (Ref. = rural)	**2.07 (1.31, 3.27)****	0.93 (0.83, 1.05)	1.17 (0.79, 1.75)	0.89 (0.76, 1.03)
Interaction terms				
Working young adults*SES	0.48 (0.20, 1.13)		**0.39 (0.17, 0.88)***	
Studying young adults*SES	**0.30 (0.15, 0.57)*****		0.76 (0.43, 1.37)	
Working young adults*living environment	**0.20 (0.09, 0.45)*****		**0.19 (0.09, 0.40)*****	
Studying young adults*living environment	**0.31 (0.16, 0.59)*****		**0.26 (0.15, 0.46)*****	

OR = odds ratio; CI = confidence interval.
The model for commuting was adjusted for distance to work or school.
For the logit model, as an indication of goodness of fit, the McFadden's R^2 for using public transport was 0.15 to work or school and 0.08 to other destinations.
For the negative binomial model, as an indication of goodness of fit, the R^2 for a linear regression among those using public transport was 0.21 to work or school and 0.04 to other destinations.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.
[1] ZINB models estimate parameters associated with the odds of non-participation in public transport to work/school or to other destinations (logit model).
[2] Simultaneously, among participants who did use public transport to work/school or to other destinations, ZINB models estimate parameters associated with weekly minutes public transport use to work/school or to other destinations (negative binomial model). This table displays selected exponentiated negative binomial model parameters, which represent the proportional increase in minutes/week among those who used public transport to work/school or to other destinations with a one-unit increase in the predictor.

5.2. Car use (Table 4)

In each of the three groups separately, the odds of not commuting by car were 1.35 and 2.63 times higher for men and those living in urban areas than for women and those living in rural areas.

Regarding car travel to other destinations, significant interaction effects between group and gender and group and living environment were found. The odds of not using a car were 1.70 times higher for male than for female secondary school students. Gender did not relate to car travel among studying and working young adults. The odds of not using a car were 2.65 and 2.64 times higher for studying and working young adults living in urban areas than for those living in rural areas. Living environment did not relate to car travel among secondary school students. In each of the three groups separately, the odds of not using a car were 1.59 times higher for young people with low SES than for those with high SES. Among those who did travel by car to other destinations, men drove 27% more min/week than women in each of the three groups separately. An interaction effect found between group and SES showed that secondary school students and studying young adults with high SES drove 34% and 35% (0.65; 95% CI = 0.51, 0.82) fewer min/week by car to other destinations than those with low SES. SES was not related to min/week car travel among working young adults.

Table 4
Associations between group, the potential moderators and the interaction terms with car use.

	To work or school		To other destinations	
	Logit model: OR of being non-participant[1] (95% CI)	Negative binomial model: min/week[2] (95% CI)	Logit model: OR of being non-participant[1] (95% CI)	Negative binomial model: min/week[2] (95% CI)
Group (Ref. = secondary school students)				
Working young adults	**0.21 (0.14, 0.31)*****	**1.76 (1.41, 2.20)*****	**0.15 (0.07, 0.32)*****	1.01 (0.71, 1.43)
Studying young adults	**0.70 (0.50, 0.97)***	0.99 (0.80, 1.22)	**0.40 (0.26, 0.59)*****	**1.39 (1.03, 1.86)***
Potential moderators				
Gender (Ref. = female)	**1.35 (1.02, 1.77)***	0.98 (0.82, 1.18)	**1.70 (1.20, 2.40)****	**1.27 (1.11, 1.46)*****
SES (Ref. = low SES)	1.13 (0.84, 1.51)	0.93 (0.77, 1.12)	**0.63 (0.48, 0.83)*****	**0.66 (0.52, 0.85)****
Living environment (Ref. = rural)	**2.63 (1.94, 3.57)*****	0.83 (0.68, 1.02)	1.40 (0.95, 2.06)	0.94 (0.81, 1.08)
Interaction terms				
Working young adults*gender			0.69 (0.30, 1.62)	
Studying young adults*gender			**0.53 (0.30, 0.91)***	
Working young adults*SES				**1.89 (1.25, 2.84)****
Studying young adults*SES				0.98 (0.70, 1.38)
Working young adults*living environment			1.89 (0.77, 4.63)	
Studying young adults*living environment			**1.90 (1.09, 3.32)***	

OR = odds ratio; CI = confidence interval.
The model for commuting was adjusted for distance to work or school.
For the logit model, as an indication of goodness of fit, the McFadden's R^2 for using a car was 0.08 to work or school and 0.09 to other destinations.
For the negative binomial model, as an indication of goodness of fit, the R^2 for a linear regression among those using a car was 0.25 to work or school and 0.04 to other destinations.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.
[1] ZINB models estimate parameters associated with the odds of non-participation in car use to work/school or to other destinations (logit model).
[2] Simultaneously, among participants who did use a car to work/school or to other destinations, ZINB models estimate parameters associated with weekly minutes car use to work/school or to other destinations (negative binomial model). This table displays selected exponentiated negative binomial model parameters, which represent the proportional increase in minutes/week among those who used a car to work/school or to other destinations with a one-unit increase in the predictor.

5.3. Cycling (Table 5)

The odds of not commuting by bicycle were 1.32 times higher for women than for men in each of the three groups separately. Significant interaction effects were found between group and SES and group and living environment. The odds of not commuting by bicycle were 2.56 times higher for secondary school students with low SES than for those with high SES. SES was not related to bicycle commuting among studying and working young adults. In rural areas, the odds of not commuting bicycle were 2.50 times higher for working young adults than in urban areas (95% CI = 0.21, 0.78), but living environment

was not related to cycling among the two other groups. Among those who did commute by bicycle, living in urban areas resulted in 18% fewer min/week cycling compared to living in rural areas in each of the three groups separately.

Regarding cycling to destinations other than work or school, the odds of not cycling were 1.47 times higher for women than for men in each of the three groups separately. Significant interaction effects were found between group and SES and group and living environment. For secondary school students with low SES, the odds of not cycling were 2.63 times higher than for those with high SES. There was no effect of SES among studying and working young adults. The odds of not cycling were 2.00 times higher for studying young adults living in rural areas than for those living in urban areas (95% CI = 0.34, 0.73), although living environment was not related to cycling among the two other groups. Among those who did cycle to other destinations, being male was associated with 21% more min/week cycling than being female in each of the three groups separately.

Table 5
Associations between group, the potential moderators and the interaction terms with cycling.

	To work or school		To other destinations	
	Logit model: OR of being non-participant[1] (95% CI)	Negative binomial model: min/week[2] (95% CI)	Logit model: OR of being non-participant[1] (95% CI)	Negative binomial model: min/week[2] (95% CI)
Group (Ref. = secondary school students)				
Working young adults	1.98 (0.81, 4.83)	0.98 (0.79, 1.21)	1.72 (0.81, 3.64)	**0.76 (0.61, 0.94)***
Studying young adults	1.58 (0.82, 3.04)	**0.73 (0.60, 0.89)****	1.12 (0.67, 1.90)	**0.76 (0.64, 0.89)*****
Potential moderators				
Gender (Ref. = female)	**0.76 (0.58, 0.99)***	1.12 (0.97, 1.29)	**0.68 (0.53, 0.86)****	**1.21 (1.05, 1.39)****
SES (Ref. = low SES)	**0.39 (0.26, 0.58)*****	1.04 (0.88, 1.23)	**0.38 (0.26, 0.56)*****	1.01 (0.85, 1.20)
Living environment (Ref. = rural)	0.97 (0.63, 1.49)	**0.82 (0.70, 0.96)***	1.43 (0.96, 2.12)	1.09 (0.93, 1.27)
Interaction terms				
Working young adults*SES	1.36 (0.55, 3.33)		1.48 (0.67, 3.27)	
Studying young adults*SES	**2.49 (1.24, 4.98)***		**3.15 (1.77, 5.60)*****	
Working young adults*living environment	**0.41 (0.19, 0.91)***		**0.43 (0.21, 0.87)***	
Studying young adults*living environment	0.71 (0.38, 1.36)		**0.35 (0.20, 0.60)*****	

OR = odds ratio; CI = confidence interval.
The model for commuting was adjusted for distance to work or school.
For the logit model, as an indication of goodness of fit, the McFadden's R^2 for cycling was 0.11 to work or school and 0.05 to other destinations.
For the negative binomial model, as an indication of goodness of fit, the R^2 for a linear regression among those cycling was 0.05 to work or school and 0.03 to other destinations.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.
[1] ZINB models estimate parameters associated with the odds of non-participation in cycling to work/school or to other destinations (logit model).
[2] Simultaneously, among participants who did cycle to work/school or to other destinations, ZINB models estimate parameters associated with weekly minutes cycling to work/school or to other destinations (negative binomial model). This table displays selected exponentiated negative binomial model parameters, which represent the proportional increase in minutes/week among those who cycled to work/school or to other destinations with a one-unit increase in the predictor.

5.4. Walking (Table 6)

The odds of not commuting by foot were 2.50 times higher for those living in rural areas than for those living in urban areas in each of the three groups separately. Among those who did walk to work or school, an interaction effect was found between group and living environment. Urban studying young adults walked 19% fewer min/week than rural studying young adults (0.81; 95% CI = 0.65, 1.00). There was no effect of living environment among the two other groups.

For walking to other destinations, the odds of not walking were 2.04 times higher for those living in rural areas than for those living in urban areas. A significant interaction effect was found between group and SES. For secondary school students with high SES, the odds of not walking were 1.46 times higher than for those with low SES. In addition, the odds of not walking were 2.72 times higher for working young adults with low SES than for those with high SES (95% CI = 0.23, 0.87). SES was not related to walking in studying young adults. Among those who did walk to other destinations in, men walked 32% more min/week than women in each of the three groups separately. A significant interaction effect was found between group and SES. High SES secondary school students walked 31% fewer min/week than their counterparts. SES was not related to min/week walking among the two other groups.

Table 6
Associations between group, the potential moderators and the interaction terms with walking.

	To work or school		To other destinations	
	Logit model: OR of being non-participant[1] (95% CI)	Negative binomial model: min/week[2] (95% CI)	Logit model: OR of being non-participant[1] (95% CI)	Negative binomial model: min/week[2] (95% CI)
Group (Ref. = secondary school students)				
Working young adults	1.31 (0.82, 2.09)	**1.71 (1.09, 2.68)***	1.31 (0.68, 2.52)	0.95 (0.59, 1.52)
Studying young adults	**0.43 (0.31, 0.61)*****	**1.58 (1.22, 2.04)*****	**0.60 (0.37, 0.97)***	0.97 (0.71, 1.32)
Potential moderators				
Gender (Ref. = female)	0.94 (0.70, 1.26)	0.99 (0.84, 1.16)	1.17 (0.92, 1.49)	**1.32 (1.14, 1.54)*****
SES (Ref. = low SES)	1.25 (0.92, 1.71)	0.95 (0.79, 1.14)	**1.46 (1.01, 2.12)***	**0.69 (0.54, 0.88)****
Living environment (Ref. = rural)	**0.40 (0.30, 0.54)*****	1.15 (0.86, 1.53)	**0.49 (0.38, 0.63)*****	1.16 (0.90, 1.50)
Interaction terms				
Working young adults*SES			**0.30 (0.14, 0.65)****	1.36 (0.83, 2.23)
Studying young adults*SES			0.77 (0.43, 1.36)	**1.51 (1.07, 2.13)***
Working young adults*living environment		**0.55 (0.30, 0.90)***		0.66 (0.43, 1.01)
Studying young adults*living environment		2.17 (1.85, 2.55)		0.97 (0.69, 1.35)

OR = odds ratio; CI = confidence interval.
The model for commuting was adjusted for distance to work or school.
For the logit model, as an indication of goodness of fit, the McFadden's R^2 for walking was 0.08 to work or school and 0.06 to other destinations.
For the negative binomial model, as an indication of goodness of fit, the R^2 for a linear regression among those walking was 0.06 to work or school and 0.04 to other destinations.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.
[1] ZINB models estimate parameters associated with the odds of non-participation in walking to work/school or to other destinations (logit model).
[2] Simultaneously, among participants who did walk to work/school or to other destinations, ZINB models estimate parameters associated with weekly minutes walking to work/school or to other destinations (negative binomial model). This table displays selected exponentiated negative binomial model parameters, which represent the proportional increase in minutes/week among those who walked to work/school or to other destinations with a one-unit increase in the predictor.

6. Discussion

The aim of this study was twofold: to investigate differences in walking, cycling, car use and public transport use between three groups of emerging adults (secondary school students, studying young adults and working young adults) and to investigate relations of gender, SES and living environment with the different transport modes within each of the three groups. Results showed that, when promoting sustainable travel behavior in emerging adults, interventions should be adapted to specific subgroups and focus should be more on female emerging adults and on maintaining the habit of cycling after reaching the age at which it is possible to obtain a driver's license.

Secondary school students were more likely to cycle and less likely to travel by car than the two other groups because many of them do not have a car driver license yet. It is very important that emerging adults maintain the habit of cycling after reaching the age at which it is possible to obtain a driver's license. However, secondary school students were least likely to walk among the three groups, especially to destinations other than school, and less likely to use public transport than studying young adults.

Studying young adults, on the other hand, were most likely to walk and most likely to use public transport among the three groups, and they did this more min/week than the other groups. It might be that studying young adults walked most because many of them live in student residences during the week, which are often nearby or on college or university campuses and nearby or in city centers with plenty of destinations (Shannon et al., 2006; Zhou, 2012). Furthermore, more than half of the studying young adults had a driver's license, but only 27% owned a car while 77% owned a public transport pass. The availability and access to transport modes might explain their frequent use of public transport and many studying young adults might not have the money to afford a car. Compared to secondary school students, studying young adults were more likely to use a car, although they were less likely to use a car than working young adults. Studying young adults were less likely to cycle and cycled fewer minutes/week than secondary school students.

Working young adults seemed to be the group with the least favorable travel behavior: they were less likely to cycle than secondary school students, less likely to walk and use public transport than studying young adults and more likely to use a car than the two other groups, both to work/school and to other destinations. In line with public transport use of studying young adults, car use of working young adults might be explained by the access to the transport mode since many working

young adults had a driver license and owned a private car. Previous research showed that access to a personal car is a strong barrier to active transport (Molina-Garcia et al., 2010; Simons et al., 2014) and is strongly associated with car use (Brand et al., 2013). Nevertheless, although working young adults did not report longer commuting distances, nor were they living more in rural environments, they travelled more by car than the other two groups. Working young adults might have a more constrained travel time budget or use their travel time budget differently compared to the two other groups (Mokhtarian and Chen, 2004; Saarloos et al., 2009), possibly because of different individual and household characteristics (long working hours, cohabiting, having children). Therefore, future interventions in working young adults should focus on maintaining cycling and/or walking habits, for example by emphasizing the speed (in urban areas), flexibility and convenience of AT (no traffic jams, always parking spots, shortcuts...). Public transport can be encouraged additionally, to complement active transport for travelling longer distances.

Our results showed that men were more likely to cycle than women in each of the three groups. Previous research in adolescents and adults also found that men were more likely to cycle for transport than women (Babey et al., 2009; Heesch et al., 2012; Van Dyck et al., 2010). Furthermore, women were more likely to commute by car than men and female secondary school students were also more likely to use a car to other destinations. This is in line with studies in six countries that found a recent decrease in driver licenses, car availability and car travel distance, particularly for young men compared to young women (Kuhnimhof et al., 2012a; Kuhnimhof et al., 2012b).

Secondary school students with low SES were less likely to cycle, but more likely to travel by public transport to all destinations and more likely to walk to other destinations than those with high SES. On the other hand, working young adults with low SES were less likely to walk to other destinations. Beenackers et al. (2012), did not find a consistent pattern between SES and active transport in a review on socioeconomic differences among European adults. However, the included studies all targeted adults, ranging from 15 to 93 years, without looking in detail to subgroups such as emerging adults. The influence of SES on active and public transport seems to be very subgroup-specific. The influence of SES on car travel is clearer. Emerging adults with high SES were more likely to travel by car to other destinations than those with low SES. This result confirms previous research in adults indicating that car use is higher among high SES groups (Brand et al., 2013; Goodman, 2013).

Emerging adults living in urban areas were more likely to walk to work/school and to other destinations than those living in rural areas. Urban studying young adults were more likely to cycle to other destinations and urban working young adults were more likely to commute by bicycle than their rural counterparts. These results are in line with several studies stating that the use of active travel is higher in urban areas than in rural areas, both in Flanders (Boussauw, 2011; de Vos, 2015; Van Dyck et al., 2011) and in other parts of the world (Ewing and Cervero, 2001, 2010; Panter et al., 2008). Urban secondary school students were less likely to travel by public transport to school, although urban studying young adults were more likely to travel by public transport to other destinations and urban working young adults were more likely to travel by public transport to work and to other destinations than their rural counterparts. It was found in Australian studies that it is important for employed adults to have public transport infrastructure both near home and near workplaces in order to use public transport (Badland et al., 2014), but that those living in more suburban neighborhoods had a lower density of public transport stop available than those living in more urban areas (Badland et al., 2012). Emerging adults living in rural areas were more likely to commute by car than those living in urban areas. Rural studying young adults and working young adults were also more likely to travel by car to other destinations. Longer distances in rural areas are a barrier for active transport. Distance was one of the most consistent predictors of active transport in several studies (Babey et al., 2009; Nelson et al., 2008; Panter et al., 2008). Therefore, it is important to provide options to shorten car trips such as park-and-ride areas near cities where people can switch from car to public transport or to cycling by using bicycle sharing schemes.

Study limitations include the use of self-reported questionnaires. Since the data is cross-sectional, it cannot provide information on changes in travel behavior, but can only give information on travel behavior of three groups of emerging adults. Next, since Belgium, and specifically Flanders, has good geographical and climatological conditions for cycling and a real 'cycling culture', caution should be taken when extrapolating the results (Vandenbulcke et al., 2009). Moreover, because of the good cycling conditions in Flanders, the decrease in cycling among working young adults in this sample is even more worrying. This indicates the need to investigate the changes in cycling behavior in places with less favorable cycling conditions. Although a mixture of sampling methods, including snowball sampling, was used, we managed to obtain a sample that appears to be representative on several key variables, of young people in Flanders. In this study, 45% of secondary school students was male with 61% having high SES. This is in accordance with a sample of 1445 randomly recruited secondary school students in a previous Belgian study (Deforche et al., 2010) who found that 44% were boys with 63% having high SES. Furthermore, an average of 45% studying young adults and working young adults owned a private car in this study. This is in accordance with the most recent transport data of the Flemish Government, which state that 43% of 18-to-24 year olds own a car (Department of Mobility and civil engineering, 2012). Next, this study included a relatively small number of working young adults.

Strengths of this study first include the large study sample. Second, the study was executed among secondary school students, studying young adults and working young adults. Few other studies have investigated travel behavior in emerging adults, and we have no knowledge of other studies comparing these subgroups. This is important since emerging adulthood is a critical period. Third, walking, cycling, car use and public transport use were questioned and analyzed separately but are all part of a single study, which allows to see broader patterns. Most previous studies solely focused on one of these transport

modes or combined them as active and passive transport. Investigating the relations of gender, SES and living environment with the different transport modes is a final strength of this study.

7. Conclusions

Future interventions promoting sustainable travel behavior in emerging adults should be adapted to specific subgroups such as secondary school students, studying young adults and working young adults. They should focus on maintaining the habit of cycling after reaching the age at which it is possible to obtain a driver's license, especially when owning a car. They should also pay attention to female emerging adults, since they were less likely to cycle and more likely to commute by car than their male counterparts. More in-depth research on the travel behavior of working young adults is needed as this often neglected target group was least likely to use active and public transport and most likely to travel by car among the three groups. Because of the need to travel longer distances, it is important to promote a multimodal lifestyle in order to encourage the combined use of active and public transport. Bicycle sharing schemes might be promising in the light of multimodality. Lastly, future research in emerging adults investigating change in travel behavior longitudinally, as they transition from one life stage to another, would be very valuable to better understand transport choices in this target group.

Competing interests

The authors declare that they have no competing interests.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.tra.2017.05.016.

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