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Subgroups of adolescents differing in physical and social environmental preferences towards cycling for transport: A latent class analysis

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ABSTRACT

In order to be able to tailor environmental interventions to adolescents at risk for low levels of physical activity, the aim of the present study is to identify subgroups of adolescents with different physical and social environmental preferences towards cycling for transport and to determine differences in individual characteristics between these subgroups.

In this experimental study, 882 adolescents (12–16 years) completed 15 choice tasks with manipulated photographs. Participants chose between two possible routes to cycle to a friend's house which differed in seven physical micro-environmental factors, cycling distance and co-participation in cycling (i.e. cycling alone or with a friend). Latent class analysis was performed. Data were collected from March till October 2016 across Flanders (Belgium).

Three subgroups could be identified. Subgroup 1 attached most importance to separation of the cycle path and safety-related aspects. Subgroup 2 attached most importance to being able to cycle together with a friend and had the highest percentage of regular cyclists. In subgroup 3, the importance of cycling distance clearly stood out. This subgroup included the lowest percentage of regular cyclists.

Results showed that in order to stimulate the least regular cyclists, and thus also the subgroup most at risk for low levels of active transport, cycling distances should be as short as possible. In general, results showed that providing well-separated cycle paths which enable adolescents to cycle side by side and introducing shortcuts for cyclists may encourage different subgroups of adolescents to cycle for transport without discouraging other subgroups.

1. Background

According to ecological models, physical activity behaviours such as cycling for transport are determined by individual characteristics (e.g. gender, self-efficacy) as well as by the surrounding physical and social environment (Sallis et al., 2006). The physical environment can be divided into macro- and micro-environmental characteristics (Sallis et al., 2011). Macro-environmental characteristics (e.g. residential density, street connectivity) determine the distance one has to cycle to reach daily destinations which has been found to be a consistent correlate of cycling for transport among adolescents (Babey et al., 2009; Bere et al., 2008; Nelson et al., 2008; Panter et al., 2008; Schlossberg et al., 2006; Wong et al., 2011). These macro-environmental characteristics are difficult to change, especially in existing neighbourhoods. Micro-environmental characteristics (e.g. cycle path characteristics, vegetation) can be changed more rapidly and at a lower cost (Sallis et al., 2011). Unfortunately, there is only limited and inconsistent evidence regarding the association between physical micro-environmental characteristics and adolescents' cycling for transport (Dalton et al., 2011; Kerr et al., 2006; Larsen et al., 2009; Mota et al., 2007). In addition, most previous studies focused on the neighborhood environment although physical environmental characteristics along cycling routes are also likely to be important (Panter et al., 2008). In accordance with ecological models (Sallis et al., 2006), previous studies indicated the importance of social

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Table 1
Differences in socio-demographics, transport behaviour, psychosocial variables, and cycling concerns and preferences.

	Subgroup 1	Subgroup 2	Subgroup 3	p-Value[a]
Socio-demographic characteristics				
Age (yrs, M ± SD)	13.8 ± 1.6 [d]	14.1 ± 1.6 [d]	14.8 ± 1.4 [b, c]	< 0.001
Gender (% men)	51.9	62.6	65.5	0.008
SES (% higher SES)	78.7	80.4	71.8	0.505
Living environment (% rural/semi-urban/urban)	9.6/75.8/14.6	10.4/76.8/12.8	12.7/76.4/10.9	0.855
Transport behaviour				
Preferred mode of transport (% bicycle)	65.6	70.9	48.1	0.138
Participation in cycling last week (% cyclist)	79.3	89.0	69.1	0.001
Minutes cycling last week (M ± SD)	125.8 ± 169.8	147.3 ± 164.5	122.8 ± 293.8	0.341
Co-participation in cycling (/5, M ± SD)	2.8 ± 1.0 [d]	2.9 ± 1.0 [d]	2.2 ± 0.8 [b, c]	< 0.001
Cycling distance to best friend (/6, M ± SD)	3.4 ± 1.6	3.3 ± 1.7	2.9 ± 1.5	0.126
Psychosocial variables (/5, M ± SD)				
Habit	3.5 ± 1.3	3.6 ± 1.4	3.3 ± 1.4	0.321
Perceived social support	2.5 ± 1.0 [c, d]	2.8 ± 1.[b, d]	2.1 ± 0.8 [b, c]	< 0.001
Perceived social norm	2.7 ± 1.1 [c]	3.0 ± 1.1 [b, d]	2.5 ± 1.0 [c]	0.008
Perceived modelling	3.4 ± 0.9 [d]	3.4 ± 0.9 [d]	2.9 ± 0.8 [b, c]	< 0.001
Self-efficacy	3.7 ± 1.2	3.8 ± 1.3	3.7 ± 1.3	0.811
Perceived benefits	3.7 ± 1.0	3.7 ± 1.1	3.5 ± 1.0	0.625
Perceived barriers	2.3 ± 1.0	2.2 ± 1.0 [d]	2.7 ± 0.9 [c]	0.010
Cycling concerns (/5, M ± SD)				
As a cyclist I feel vulnerable in traffic	2.8 ± 1.1 [c]	2.5 ± 1.1 [b]	2.4 ± 1.1	0.001
Importance of fluorescent vest or bicycle helmet	2.5 ± 1.3 [c, d]	2.1 ± 1.1 [b, d]	1.7 ± 1.0 [b, c]	< 0.001
Cycling preferences (/5, M ± SD)				
I prefer the safest cycling route	3.6 ± 1.2 [c, d]	3.0 ± 1.2 [b]	2.6 ± 1.2 [b]	< 0.001
I prefer the shortest cycling route	3.4 ± 1.1 [c, d]	3.7 ± 1.0 [b]	4.1 ± 1.1 [b]	< 0.001
I prefer the most beautiful cycling route	2.9 ± 1.1 [c, d]	2.5 ± 1.1 [b]	2.4 ± 1.1 [b]	< 0.001
I prefer to cycle alone	2.4 ± 1.3 [c]	1.8 ± 1.1 [b, d]	2.8 ± 1.2 [c]	< 0.001

Data were collected between March and October 2016 in Flanders (Belgium).
For continuous variables: n subgroup 1 = 573; n subgroup 2 = 188; n subgroup 3 = 49.
For categorical variables: n subgroup 1 = 616; n subgroup 2 = 211; n subgroup 3 = 55.
[a] The multivariate Wilks' lambda F = 5.7 with p < 0.001.
[b] Significant difference with subgroup 1.
[c] Significant difference with subgroup 2.
[d] Significant difference with subgroup 3.

environmental factors (e.g. cycling together with a friend) among adolescents (Carver et al., 2005; Emond and Handy, 2012; Hohepa et al., 2007; Verhoeven et al., 2016). Emond and Handy (2012) indicated that in environments which support cycling for transport, social environmental factors may play a main role regarding adolescents' cycling levels.

Since cross-sectional study designs in order to identify correlates of cycling for transport involve some methodological weaknesses, experimental studies are encouraged. Natural experiments are needed to identify causal associations between environmental characteristics and cycling for transport (Bauman et al., 2002; King et al., 2002), but introducing structural changes to real environments is ~~very~~ expensive and time-consuming. There is also a potential risk for introducing environmental changes that decrease cycling levels. In order to inform local authorities on which environmental changes should get priority, an experimental methodology using manipulated photographs has been developed. This method allowed us to simulate environmental changes under controlled conditions, relatively quickly and with minimal resources. Manipulated photographs were successfully used in a large-scale study that aimed to determine the relative importance of seven physical micro-environmental factors, cycling distance and co-participation in cycling for adolescents' preferred situation to cycle to a friend's house (Verhoeven et al., 2017). This study revealed that priority should be given to the provision of cycle paths that are well-separated from motorised traffic when aiming to promote cycling for transport among adolescents. It was confirmed that cycling distance and co-participation in cycling of friends are important factors for adolescents' cycling for transport.

In order to be able to introduce environmental changes tailored to adolescent subgroups, especially those at risk for low levels of active transport, it is important to identify subgroups with different physical and social environmental preferences towards cycling for transport based on individual characteristics. In addition, identifying subgroups may be important to avoid unintended negative effects in subgroups of the adolescent population as Sallis et al. (2011) suggested that subgroups within a population may respond differently to environmental changes. Therefore, the aim of the present study is to identify subgroups of adolescents with different physical and social environmental preferences towards cycling for transport and to determine differences in individual characteristics between these subgroups.

2. Methods

2.1. Protocol and participants

Recruitment of adolescents (12–16 years) was done via randomly selected secondary schools across Flanders (n = 103). In each participating school (n = 12), at least one class was randomly selected to participate by the principal or a staff member. This resulted in 1078 adolescents who were invited to complete a structured online questionnaire. Prior to completion of the questionnaire, passive informed consent was obtained from adolescents' parents. If parents did not agree to let their child participate, they had to sign a form. Furthermore, researchers also obtained active informed consent of adolescents. Eventually, a total of 1013 adolescents participated in the study (response rate = 94.0%) which was conducted at school under supervision of a researcher. School visits were conducted from March till October 2016. The study protocol was approved by the Ethics Committee of the