

Prevalence and socio-demographic correlates of active commuting to school in a nationwide representative sample of German adolescents

Anne K. Reimers^{*}, Darko Jekauc, Eliane Peterhans, Matthias O. Wagner, Alexander Woll

Department of Sport Science, University of Konstanz, Konstanz, Germany

A B S T R A C T

Objective. To assess the prevalence and socio-demographic correlates of walking and cycling to school in a nationwide representative cross-sectional sample of German adolescents.

Methods. A sample of 1828 German adolescents aged 11–17 years were examined between 2003 and 2006. Mode of commuting to school was assessed using a reliable self-report measure. Socioeconomic status, migration background and residential area were assessed as socio-demographic variables using a parent report questionnaire.

Results. Overall, 19.4% of adolescents walked and 22.2% cycled to school. Compared to girls with high socioeconomic status, girls with low socioeconomic status were more likely to walk (OR = 1.89, 95% CI = 1.23–2.89). Migration background increased the chance of walking in girls (OR = 0.47, 95% CI = 0.32–0.70) and decreased the chance of cycling in boys (OR = 2.39, 95% CI = 1.35–4.24). Compared to living in cities, living in rural areas lowered the chance of walking (girls: OR = 0.29, 95% CI = 0.18–0.50; boys: OR = 0.54, 95% CI = 0.32–0.93) and cycling (girls: OR = 0.12, 95% CI = 0.06–0.24; boys: OR = 0.34, 95% CI = 0.21–0.56), and living in medium-sized towns increased the chance of cycling in girls (OR = 1.86, 95% CI = 1.24–2.78) and boys (OR = 1.75, 95% CI = 1.20–2.56), respectively.

Conclusions. In Germany many adolescents use motorised transportation. Socio-demographic variables were associated with mode of commuting.

Keywords:
Walking
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Introduction

Physical activity plays an important role for health in adolescents (Janssen and Leblanc, 2010). However, only 17.4% of German boys and 13.1% of German girls (Jekauc et al., 2012) meet the guidelines of at least 60 min of moderate to vigorous intensity physical activity daily (WHO, 2010). Adolescents who walk or cycle to school have higher levels of daily physical activity and better cardiorespiratory fitness than passive commuters (Davison et al., 2008; Faulkner et al., 2009; Lubans et al., 2011) which has been associated with a more favourable metabolic risk profile (Ortega et al., 2008). Thus, adolescents' mode of commuting to school can affect their health.

However, in worldwide studies, prevalence of active commuting to school in children and adolescents varied widely and were some times alarmingly low (Sirard and Slater, 2008). The percentage of students who walk or bike to school has declined in recent years (Black et al., 2001; Buliung et al., 2009; McDonald, 2007; van der Ploeg et al.,

2008). Therefore, identifying risk groups with lower frequencies of active commuting behaviour is important for designing targeted intervention programs to stop or reverse decreases.

The ecological and cognitive active commuting framework (ECAC) highlights socio-demographic factors as moderators of the relationship between perceptions, availability of resources and psychosocial variables on the one hand and active commuting behaviour on the other (Sirard and Slater, 2008). Gender (Bungum et al., 2009; Chillon et al., 2010; Larsen et al., 2009; Pabayo and Gauvin, 2008), socioeconomic variables such as parental education (Chillon et al., 2009; Shi et al., 2006), income (Babey et al., 2009; Pabayo et al., 2011; Pont et al., 2009; Tudor Locke et al., 2003) and the social, physical (Kerr et al., 2006; Nelson et al., 2008) and residential (Silva et al., 2011; Wong et al., 2011) environments affect commuting behaviour. Especially, distance from home to school is a strong barrier of active commuting to school because walking or biking long distances is not feasible (Van Dyck et al., 2010).

Most previous studies were based on selective samples (e.g. solely from urban areas) (Bere et al., 2008; Chillon et al., 2009; Landsberg et al., 2008). Particularly in Germany, there are no nationwide representative studies on prevalence and socio-demographic correlates of active commuting to school in adolescents. However, results of studies from other nations are not directly transferable because of the heterogeneity of populations and locations being studied (Cooper et al.,

^{*} Corresponding author at: Department of Sport Science, University of Konstanz, Universitätsstraße 10, 78457 Konstanz, Germany. Fax: +49 7531 88 4641.

E-mail addresses: anne.reimers@uni-konstanz.de (A.K. Reimers), darko.jekauc@uni-konstanz.de (D. Jekauc), eliane.peterhans@uni-konstanz.de (E. Peterhans), matthias.wagner@uni-konstanz.de (M.O. Wagner), alexander.woll@uni-konstanz.de (A. Woll).

2005; Pabayo and Gauvin, 2008; van der Ploeg et al., 2008; Wong et al., 2011). Therefore, the purpose of the present study was to assess the prevalence of walking and cycling to school and to evaluate proposed socio demographic correlates in a nationwide representative sample of German adolescents.

Methods

Sampling and participants

We used nationwide representative data from the Motorik Modul (MoMo Study) and the German Health Interview and Examination Survey for Children and Adolescents (KiGGS). The MoMo Study is a representative study on physical fitness and physical activity in German children and adolescents and is part of the KiGGS (Kurth et al., 2008; Mewes et al., 2012; Woll et al., 2011) and both studies are representative (Kamtsiuris and Lange, 2002). A stratified multi stage probability sample with three evaluation levels was drawn (Hölling et al., 2007; Kamtsiuris et al., 2007; Kurth et al., 2008). The MoMo Study is based on a subsample of the KiGGS that includes complete data sets from 4529 children and adolescents aged 4 to 17 years. For this study, only adolescents aged between 11 and 17 years were selected from the cross sectional MoMo baseline sample ($n = 1828$), because in Germany children change from primary school to secondary schools when they are 10 to 11 years old. Subsequently, their choice of mode of commuting to school is more independent from parental or school restrictions that may not permit biking to school in elementary school children. The KiGGS and the MoMo Study were approved by the Charité/Universitätsmedizin Berlin Ethics Committee and the Federal Office for the Protection of Data and were conducted according to the Declaration of Helsinki (Kurth, 2007).

Data collection

The MoMo baseline data was collected between 2003 and 2006. Parents and adolescents gave written informed consent. The data was collected at central locations at 167 stratified sample points in Germany where parents and adolescents were examined in the presence of a qualified interviewer (Hölling et al., 2007). Socio demographic characteristics were assessed using a parent questionnaire and information on mode of commuting to school was assessed using an adolescent self report questionnaire.

Measures

Active commuting to school

Participants were asked "How do you usually get to school". Response options included on foot, by bike, by bus or train, by car, and by motorbike or motorised scooter. A new variable was calculated to discriminate between adolescents walking, cycling or using motorised commuting to get to school. Adolescents who did not have a specific main mode of commuting but used motorised transportation modes at least sometimes were categorised as motorised commuters (mixed modes). Because at the time of data collection no measure of active commuting to school with a proven reliability was available, the present measure was newly developed and evaluated and its reliability ensured ('active commuting to school': $\kappa = .92$; $p < 0.001$; Jekauc et al., in press).

Socio demographics

Socioeconomic status was calculated separately for both parents and included items on educational and professional status and total household income (Lampert et al., 2002), and the higher score was used. Adolescents with separated parents were assigned the socioeconomic status of the parent they lived with. All three aspects income, educational and professional status were scored on a scale from 1 to 7 and a sum score was created (range: 3–21) and categorised into low (3–8), medium (9–14) and high (15–21) socioeconomic status (Winkler and Stolzenberg, 2009). Migration background was assumed if the participant themselves had immigrated to Germany, at least one parent was not born in Germany, or if both parents immigrated to Germany or had no German nationality (Kurth et al., 2008; Schenk et al., 2007). The residential area variable described the size of community (rural area: <5000 residents; small town: 5000–19,999 residents; medium sized town: 20,000–99,999 residents; cities: >100,000 residents).

Statistical analysis

Data was analysed using the IBM Statistical Package for Social Science (SPSS) version 20 (IBM, New York, USA). Multinomial logistic regressions revealed that gender interacted significantly with socio economic status and residential area. Consequently, all analyses were calculated separately for both genders. Frequency distributions were calculated for mode of commuting to school and for all socio demographic correlates. Bivariate dependencies between mode of commuting to school and socio demographic variables were detected using cross tables and evaluated using chi square goodness of fit tests. The incremental power of prediction of each socio demographic variable was assessed using multinomial regression analyses. Descriptive statistics were calculated with unweighted data to describe the sample. For prevalence of modes of commuting, bivariate and multivariate analyses weighting procedures were used to enhance the representativeness of estimates (Kamtsiuris et al., 2007). The SPSS Module "Complex Samples" was used in the regression analysis to adjust p values and confidence intervals for clustering effects within the primary sampling units. Because the proportion of missing data was very low (0.6%), we used the method of list wise deletion to handle missing data.

Results

The mean age of the sample was 14.2 years ($SD = 1.9$ years; Table 1). Overall, 19.4% of adolescents reported that they usually walk and 22.2% that they usually cycle to school (Table 2). The prevalence of motorised commuting to school was similar in boys and girls (59.4% vs. 57.2%; Table 2). Boys were more likely to cycle and girls were more likely to walk to school.

In both genders, mode of commuting to school significantly correlated with socioeconomic status, migration background and residential area (Table 3). However, there was no significant association between age group and mode of commuting.

The results of the multinomial regression analysis for walking and cycling to school compared to motorised mode of commuting are presented in Tables 4 and 5. The proportion of explained variance determined by Nagelkerke's R^2 was 18.0% for girls and 8.4% for boys. All included variables significantly correlated with walking to school in girls (Table 4). With increasing age, the probability that girls walk to school decreased by 9% for every year of life. In girls with low socioeconomic status, the chance of walking to school was almost double that in girls with high socioeconomic status ($OR = 1.89$, 95% $CI = 1.23–2.89$). Girls with migration background were more likely to walk than those without ($OR = 0.47$, 95% $CI = 0.32–0.70$). In boys, migration background lowered the chance of cycling ($OR = 2.39$, 95% $CI = 1.35–4.24$; Table 5). Compared to city residents, adolescent girls and boys living in rural areas had a lower chance of walking (girls: $OR = 0.29$, 95% $CI = 0.18–0.50$; boys: $OR = 0.54$, 95% $CI = 0.32–0.93$).

Table 1
Frequency distributions for socio-demographic variables in German adolescents in 2003–2006.

Variable	Total ($n = 1828$) n (%)	Boys ($n = 938$) n (%)	Girls ($n = 890$) n (%)
Age group			
11–13 years	886 (48.5)	470 (50.1)	416 (46.7)
14–17 years	942 (51.5)	468 (49.9)	474 (53.3)
Socioeconomic status			
Low	475 (26.4)	230 (24.9)	245 (27.9)
Medium	898 (49.8)	473 (51.1)	425 (48.5)
High	429 (23.8)	222 (24.0)	233 (23.6)
Migration background			
Yes	201 (11.0)	91 (9.7)	110 (12.4)
No	1626 (89.0)	847 (90.3)	779 (87.6)
Residential area			
Rural area	466 (25.5)	238 (25.4)	228 (25.6)
Small town	524 (28.7)	275 (29.3)	249 (28.0)
Medium-sized town	554 (30.3)	277 (29.5)	277 (31.1)
City	284 (15.5)	148 (15.8)	136 (15.3)

Note: n = sample size.

Table 2
Prevalence of commuting to school in German adolescents in 2003–2006 (weighted %).

Commuting to school	Total (n = 1788)	Boys (n = 912)	Girls (n = 876)
Walking	19.4	16.8	22.1
Cycling	22.2	23.8	20.6
Motorised	58.3	59.4	57.2
Bus or train	45.5	46.1	45.0
Car	5.2	4.7	5.8
Motorbike or motorised scooter	1.2	3.8	0.4
Mixed modes	5.5	4.9	6.1

Note: mixed modes = adolescents who did not have a specific main mode of commuting but used motorised transportation modes at least sometimes.

or cycling (girls: OR = 0.12, 95% CI = 0.06–0.24; boys: OR = 0.34, 95% CI = 0.21–0.56) to school, respectively. Adolescent girls (OR = 1.86, 95% CI = 1.24–2.78) and boys (OR = 1.75, 95% CI = 1.20–2.56) from medium sized towns were more likely to cycle to school than their peers living in cities.

Discussion

We showed that nearly 60% of adolescents choose motorised modes of commuting to school and that fewer than one in four adolescents usually cycle to school. The prevalence of walking and cycling to school was associated with socioeconomic status, migration background and residential environment.

The prevalence of active commuting to school in our study differs from those of another German study conducted among adolescents in the city of Kiel (Landsberg et al., 2008) where only 37.4% participants were non active commuters and half of the participants cycled to school which may be explained by the high density of bike lanes in the city of Kiel. Similarly, other European studies (Bere et al., 2008; Borrestad et al., 2011; Bringolf Isler et al., 2008; Chillon et al., 2009) on urban areas also showed considerably higher prevalence of active commuting (65 to 88%) than in our study. Thus, rural urban differences may explain the discrepancies in prevalence of active commuting to school.

Representative studies showed that 71.4% of school children in Switzerland and 12.9% of students in the United States were active commuters (Grize et al., 2010; McDonald, 2007). Approximately 20% of secondary school students were active commuters to and 30% from school in Ontario (Canada) and in Australia (van der Ploeg et al., 2008; Wong et al., 2011). These discrepancies in mode of commuting to school between countries suggest that other factors including environmental and geographical characteristics may play a role in

determining whether adolescents do or do not commute actively to school. In addition, some studies reported different prevalences of active commuting to and from school (Bullung et al., 2009; Pabayo and Gauvin, 2008; van der Ploeg et al., 2008; Wong et al., 2011), and hence differences between travel modes before and after school should not be neglected. Because students using city busses presumably walk to and from bus stops and hence might have higher overall physical activity levels than students using school busses (Pabayo et al., 2012), cars or motorbikes, future studies should account for these possible effects of these types of transportation.

The finding that boys were more likely to cycle and girls were more likely to walk to school is supported by the results of previous studies (Bere et al., 2011; Chillon et al., 2011; Nelson et al., 2008; Timperio et al., 2006). While the causes for the differing prevalence in boys and girls are unknown, it is possible that higher safety concerns deter females from cycling (Garrard et al., 2008; Twaddle et al., 2010). Further, concerns about physical appearance when wearing safety helmets, weather conditions or sweating might be barriers to cycling in girls (Bungum et al., 2009) which presumably are particularly important in the age range of adolescents.

In Germany, adolescents with migration background and low socioeconomic status more frequently attend a "Hauptschule" which are secondary schools of the tripartite German school system with the lowest academic level (Klieme, 2010). The density of "Hauptschulen" is higher than the density of other secondary school types in Germany. Thus, besides other social and physical environmental factors a shorter distance to school may explain the higher prevalence of walking in these girls with low socioeconomic status and migration background.

Frequency of cycling to school was significantly reduced in boys with migration background. Because migration background and low socioeconomic status correlate with lower income, these results may be explained by less financial resources for purchasing bicycles in these demographic groups. In addition, low relevance and acceptance of cycling as a mode of commuting in other cultures may play a role. Moreover, migration has been shown to be associated with living in hazardous areas (Burmman, 2008). Hence, higher safety risks may lead to lower uses of bicycles as a transportation mode.

Adolescents from rural areas were less likely to walk or cycle to school (Babey et al., 2009; Silva et al., 2011; Wong et al., 2011) presumably because of lower school density in rural areas and thus greater distances from an adolescent's home to school. Distance from home to school is the most common barrier to active commuting to school because it is the primary factor in the parents' decision making process for or against allowing their child to walk or cycle to school (Sirard and Slater, 2008) because it is not feasible to walk or cycle to school if the distance is too far (Nelson et al., 2008; Sirard

Table 3
Distribution of different modes of commuting to school by socio-demographic variables for adolescents in Germany, 2003–2006 (n = 1828).

	Girls (n = 890)				Boys (n = 938)			
	Walking	Cycling	Motorised	p	Walking	Cycling	Motorised	p
Age group				0.30				0.93
11–13 years	23.3	22.2	54.5		16.9	24.3	58.8	
14–17 years	21.3	19.6	59.1		16.7	23.5	59.8	
Socioeconomic status				<0.01				0.01
Low	32.7	17.2	50.2		20.3	18.0	61.7	
Medium	17.5	19.6	62.9		13.6	25.1	61.3	
High	17.4	26.3	56.3		18.0	27.2	54.7	
Migration background				<0.01				<0.01
Yes	41.4	15.1	43.5		28.4	12.1	59.6	
No	18.4	21.7	59.9		15.2	25.4	59.4	
Residential area				<0.01				<0.01
Rural area	11.7	4.1	84.2		11.6	11.6	76.8	
Small town	23.8	16.4	59.8		17.4	22.0	60.7	
Medium-sized town	21.7	34.2	44.2		18.4	34.4	47.2	
City	29.5	21.5	49.0		18.6	23.2	58.2	

Note: data are shown as weighted percentages.

Table 4
Multinomial logistic regressions of correlates of walking and cycling to school in German girls in 2003–2006 (n = 864).

		Regression coefficient	SE	p	adj OR	95% CI for adj OR	
						Lower	Upper
Walking*	Age (in years)	0.09	0.04	0.02	0.91	0.84	0.99
	Socioeconomic status						
	Low	0.63	0.22	<0.01	1.89	1.23	2.89
	Medium	0.13	0.21	0.54	0.88	0.59	1.32
	High (ref.)				1.00		
	Migration background						
	No	0.75	0.20	<0.01	0.47	0.32	0.70
	Yes (ref.)				1.00		
	Residential area						
	Rural area	1.22	0.27	<0.01	0.29	0.18	0.50
	Small town	0.29	0.21	0.17	0.75	0.50	1.13
	Medium-sized town	0.05	0.21	0.81	0.95	0.63	1.44
	City (ref.)				1.00		
Intercept	1.15	0.63	0.07				
Cycling*	Age (in years)	0.07	0.04	0.10	0.94	0.87	1.01
	Socioeconomic status						
	Low	0.20	0.23	0.39	0.82	0.53	1.28
	Medium	0.33	0.19	0.08	0.72	0.50	1.04
	High (ref.)				1.00		
	Migration background						
	No	0.32	0.26	0.21	1.38	0.83	2.28
	Yes (ref.)				1.00		
	Residential area						
	Rural area	2.15	0.38	<0.01	0.12	0.06	0.24
	Small town	0.47	0.23	0.04	0.63	0.40	0.98
	Medium-sized town	0.62	0.21	<0.01	1.86	1.24	2.78
	City (ref.)				1.00		
Intercept	1.29	0.64	0.04				

Note: data was weighted using the complex sample procedure. $-2 \log \text{Likelihood} = 1999.3$; Nagelkerkes $R^2 = .180$; *ref: motorised; SE = standard error; df = degrees of freedom; adj OR = adjusted odds ratio; CI = confidence interval; ref. = reference value.

and Slater, 2008) a reasonable walking and biking distance of Belgium older adolescents are 2.0 km and 8.0 km, respectively (Van Dyck et al., 2010). However, the distance from home to school is difficult to measure especially in large scale studies (Chillon et al., 2009; Pabayo

and Gauvin, 2008). Nevertheless, future studies should focus on distance as a confounder.

We showed that in cities with 100,000 and more residents, the chance of cycling to school decreases dramatically compared to that

Table 5
Multinomial logistic regressions of correlates of walking and cycling to school in German boys in 2003–2006 (n = 900).

		Regression coefficient	SE	p	adj OR	95% CI for adj OR	
						Lower	Upper
Walking*	Age (in years)	0.03	0.04	0.53	0.97	0.90	1.06
	Socioeconomic status						
	Low	0.07	0.23	0.76	0.93	0.59	1.47
	Medium	0.39	0.20	0.05	0.68	0.46	1.00
	High (ref.)				1.00		
	Migration background						
	No	0.38	0.24	0.12	0.68	0.43	1.10
	Yes (ref.)				1.00		
	Residential area						
	Rural area	0.61	0.28	0.03	0.54	0.32	0.93
	Small town	0.00	0.23	0.99	1.00	0.64	1.58
	Medium-sized town	0.28	0.23	0.22	1.32	0.85	2.05
	City (ref.)				1.00		
Intercept	0.35	0.68	0.61				
Cycling*	Age (in years)	0.02	0.04	0.65	0.98	0.92	1.06
	Socioeconomic status						
	Low	0.28	0.22	0.20	0.75	0.49	1.17
	Medium	0.11	0.17	0.50	0.89	0.64	1.24
	High (ref.)				1.00		
	Migration background						
	No	0.87	0.29	<0.01	2.39	1.35	4.24
	Yes (ref.)				1.00		
	Residential area						
	Rural area	1.08	0.26	<0.01	0.34	0.21	0.56
	Small town	0.17	0.21	0.42	0.85	0.57	1.27
	Medium-sized town	0.56	0.19	<0.01	1.75	1.20	2.56
	City (ref.)				1.00		
Intercept	1.29	0.64	0.04				

Note: data was weighted using the complex sample procedure. $-2 \log \text{Likelihood} = 2088.5$; Nagelkerkes $R^2 = .084$; *ref: motorised; SE = standard error; df = degrees of freedom; adj OR = adjusted odds ratio; CI = confidence interval; ref. = reference value.

in medium sized towns possibly because of higher traffic density and greater safety risks accompanied by better public transportation in cities. Future research should address the impact of physical and social environmental determinants of active commuting behaviour such as safety, presence of sidewalks and bicycle lanes and availability of infrastructure to verify this hypothesis in German adolescents.

Strengths and limitations

The major strength of this study is that it is based on representative data for Germany with an age spectrum from 11 to 17 years and the use of a reliable measure for mode of commuting. Gender specific risk groups of motorised modes of commuting were identified. However, this study did not provide information on the distances to school, which may be a confounder and has been shown to be a strong predictor of active commuting to school (Nelson et al., 2008). Further, we did not consider social or physical environmental variables as confounders or distinguish between travel to and from school. Finally, the results were based on self report data on mode of commuting, migration background and socioeconomic status.

Conclusions

The results of this study indicate that many German adolescents do not actively commute to school. Different socio demographic variables correlate with commuting behaviour in boys and in girls. Before designing intervention programs for identified risk groups in Germany, impacts of social and physical environmental factors that may be changed should be investigated.

Conflict of interests statement

The authors declare that they have no conflict of interests.

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