

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

# Transportation Research Interdisciplinary Perspectives

journal homepage: [www.sciencedirect.com/journal/transportation-research-interdisciplinary-perspectives](https://www.sciencedirect.com/journal/transportation-research-interdisciplinary-perspectives)



## Adapting the behavioral regulation in active commuting to and from school questionnaire in Sweden: BR-ACS(SWE)

Rafael Burgueño<sup>a,d</sup>, Stina Rutberg<sup>b</sup>, Lars Nyberg<sup>b</sup>, Mascha Pauelsen<sup>b</sup>, Palma Chillón<sup>c</sup>, Anna-Karin Lindqvist<sup>b,\*</sup>

<sup>a</sup> Faculty of Education, University of Zaragoza, Zaragoza, Spain

<sup>b</sup> Department of Health, Education and Technology, Luleå University of Technology, 971 87 LULEÅ, Sweden

<sup>c</sup> PROFITH "PROMoting FITness and Health Through Physical Activity" Research Group, Sport and Health University Research Institute (iMUDS), Department of Physical Education and Sport, Faculty of Sport Sciences, University of Granada, Granada, Spain

<sup>d</sup> Health Research Centre, University of Almeria, Almeria, Spain

### ARTICLE INFO

#### Keywords:

Motivational forms  
Quality of motivation  
Self-determination continuum  
Active school transportation  
Active transport to school  
Children

### ABSTRACT

Although growing attention has been paid to motivation in explaining active travel to school among young people at the international level, no measures of motivation for active commuting to school (ACS) were found in Sweden. Guided by self-determination theory, this research aimed to adapt the Behavioral Regulation in Active Commuting to and from School (BR-ACS) questionnaire to the Swedish context and test the resulting version's psychometric properties. The purposive and cross-sectional sample included 273 students (58 % girls, aged 10–12 years) from four Swedish urban schools. Results from confirmatory factor analyses psychometrically supported the six-factor correlated model (intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation, and amotivation) and the hierarchical three-factor model (autonomous, controlled motivation, and amotivation), which were invariant across gender. Latent correlations underpinned a simplex-like pattern. Discriminant and convergent validity and reliability were gathered. Criterion validity evidence was met with positive associations from intrinsic motivation, integrated and identified regulation to ACS, and a negative relationship between amotivation and ACS. The Swedish version of the BR-ACS questionnaire is a valid and reliable measure of children's motivation toward ACS.

### Introduction

The latest global estimations reveal that most children do not live up to the recommendation of 60 min of moderate-to-vigorous physical activity daily (WHO Regional Office for Europe, 2021). The severe consequences of physical inactivity emphasize the urgency to prioritize health promotion efforts (World Health Organization, 2020). Choosing an active transport mode to school has been suggested as a promising strategy to meet the recommendations for children's physical activity since children who walk or cycle to school have higher levels of physical activity than those who don't (Faulkner et al., 2009; Larouche et al., 2020; Masoumi et al., 2020). Hence, promoting children's active commuting to school (ACS) can be a powerful strategy to increase physical activity, even cardiorespiratory fitness when cycling, and consequently, improve children's health (Campos-Sanchez et al., 2020;

Larouche et al., 2020; Lubans et al., 2009). Unfortunately, a decline in ACS among children and adolescents has occurred (González et al., 2020; Rothman et al., 2017) and among 6–15-year-old Swedish children, only 48 % and 57 % use walk or cycle to school in the winter and summer months, respectively (Swedish Transport Administration, 2018). Interventions targeting cycling and walking are needed and can play a crucial role in promoting health, mitigating climate change, and improving the environment, all of which are large societal challenges and important focuses for research and political priorities.

Prior to designing and implementing ACS promotion interventions, there is an urgent need to ascertain the potential factors of ACS behavior to develop the most effective ACS promotion strategies, as well as to monitor and evaluate the possible effects of such interventions in a more efficient way. Following the social-ecological model (Sallis et al., 2000), ACS behavior depends on various individual, social, physical

*Abbreviations:* ACS, active commuting to school; SDT, self-determination theory.

\* Corresponding author.

*E-mail address:* [anna-karin.lindqvist@ltu.se](mailto:anna-karin.lindqvist@ltu.se) (A.-K. Lindqvist).

<https://doi.org/10.1016/j.trip.2022.100721>

Received 13 September 2022; Received in revised form 28 October 2022; Accepted 7 November 2022

Available online 12 November 2022

2590-1982/© 2022 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

environmental, and policy factors. Within individual factors, motivation has been identified as an important correlate and potential determinant of behavior, although little is known about the specific role that motivation could have on active school transport (Burgueño et al., 2019; White et al., 2018). One of the most used theoretical frameworks for studying motivation in the general physical activity setting is self-determination theory (Owen et al., 2014; Ryan and Deci, 2020).

SDT is a macro theory of human motivation that considers not only the quantity of motivation a person (i.e., child) has towards behavior (i.e., ACS) but also the quality of the motivation, which yields specific outcomes (Ryan and Deci, 2017). Three main motivation qualities lie along the self-determination continuum, expressing the relative autonomy present in each of them. At a pole of the continuum stands intrinsic motivation, which concerns behaviors adopted for their own sake or inherent interest, curiosity, and pleasure. At the center of the continuum lies extrinsic motivation, which refers to behaviors adopted to an end. As extrinsic motivation can broadly vary in content depending on the internalization process (i.e., the extent to which social norms and cultural beliefs are assimilated into the self), four types of behavioral regulation are distinguished. Integrated regulation represents a full internalization, in which the person finds the behavior aligned with his/her identity and lifestyle. Identified regulation represents an almost full internalization, in which the person consciously recognizes the benefits derived from the behavior. Introjected regulation represents a partial internalization, in which the person adopts the behavior either for internal rewards of self-worth for success or the avoidance of guilt for failure. External regulation represents the full lack of internalization, in which the person adopts the behavior guided by externally imposed awards and punishments. At the opposite pole of the self-determination continuum is amotivation, which refers to the full absence of intentionality and motivation for the desired behavior.

SDT argues that autonomous forms of motivation (i.e., intrinsic motivation, integrated regulation, and identified regulation) would lead to adaptive behavioral, cognitive and affective outcomes, while controlled forms of motivation (i.e., introjected regulation and external regulation) and amotivation would yield maladaptive outcomes (Ryan & Deci, 2020; Ryan et al., 2021). A growing body of SDT-based research on active travel has reported a positive and significant association of intrinsic motivation, integrated regulation, and identified regulation with ACS (Burgueño et al., 2019). Alternatively, the two controlled forms of motivation (i.e., introjected regulation and external regulation) and amotivation were non-significantly related to ACS among primary and secondary students (Burgueño et al., 2019; White et al., 2018).

Despite the increasing attention paid to the potential role that motivation may play in ACS behavior among young people (Burgueño et al., 2019; Niven & Markland, 2016; White et al., 2018), there is no evidence to date of SDT-based contextual instruments that assess motivation for ACS in the Swedish specific context of active school transportation. In a first attempt to measure motivation for ACS at the international level, White et al. (2018) developed the Motivation towards Active Travel to School Scale, which focused only on assessing the three main qualities of motivation (i.e., autonomous motivation, controlled motivation, and amotivation) outlined by SDT. Although this scale made a valuable contribution to motivation toward ACS, SDT-grounded research suggests the need to explore the separate distinctiveness of each of the six types of behavioral regulation to provide a better understanding of behavior (Howard et al., 2017). To examine the six types of behavioral regulation, Burgueño et al. (2019) developed the Behavioral Regulation in Active Commuting to and from School (BR-ACS) questionnaire for international use. The validation study (Burgueño et al., 2019) gathered psychometrical support for a 23-item six-factor correlated model (i.e., six types of behavioral regulation) and a hierarchical three-factor model (i.e., three qualities of motivation), which were invariant across gender and age. Evidence underpinning reliability and discriminant and criterion validity were also met (Burgueño et al., 2019). The BR-ACS questionnaire has been adapted to

the Portuguese context of ACS in children and adolescents (Marques et al., 2022), as well as to the German general of active travel in adolescents (Renninger et al., 2022). Notwithstanding the instrument's good psychometric properties, high correlations were found between the three autonomous forms of motivation and between the two controlled forms of motivation (Burgueño et al., 2019; Marques et al., 2022), as well as marginal scores for extracted variance extracted in identified regulation, introjected regulation and amotivation (Marques et al., 2022; Renninger et al., 2022).

Given the absence of psychometrically robust measures of motivation towards ACS in Sweden, this research aimed to adapt the BR-ACS questionnaire to the Swedish context and to test the psychometric properties of the resulting version named BR-ACS (SWE) with a sample of children. In line with the SDT assumptions (Ryan & Deci, 2020) and previous research on active travel (Burgueño et al., 2019; White et al., 2018), we hypothesized that intrinsic motivation, integrated regulation, and identified regulation would positively and significantly predict ACS, while introjected regulation, external regulation, and amotivation would negatively predict ACS.

## Methods

### Participants

A cross-sectional sample of 273 respondents (140 girls and 133 boys) was purposively recruited from four public schools through contact with two municipalities in Sweden. The municipalities are located about 900 km apart (latitudinal direction), covering the different weather conditions present in Sweden. The municipalities invited leaders of their schools to participate with their year 4–6 students (aged 10–12 years). All schools were in urban areas. See Table 1 for the participants' characteristics.

### Measures

#### Motivation for ACS

To assess the respondents' perception of motivation for ACS, the Swedish version of the BR-ACS Questionnaire (Burgueño et al., 2019) was used. It is made up of 23 items divided over six factors that measure intrinsic motivation (e.g., "I enjoy walking or cycling to and from school"), integrated regulation (e.g., "I consider walking or cycling to and from school to be part of my identity"), identified regulation (i.e., "I value the benefits of walking or cycling to and from school"), introjected regulation (e.g., "I feel guilty when I do not walk or cycle to and from school"), external regulation (e.g., "I feel pressured by my friends/family to walk or cycle to and from school"), and amotivation (e.g., "I think that walking or cycling to and from school is a waste of time"). The common phrase precedes the items: "I walk or cycle or would walk or cycle to school because..." and scored on a 5-point Likert scale from 0 (not true for me) to 4 (very true for me).

#### Mode of commuting to and from school

Following the recommendations set by (Chillon et al., 2017; Segura-Díaz et al., 2020), a diary-type questionnaire was developed. It allowed the respondent to register their mode of transport to and from school for 1 week, resulting in a maximum of ten separate trips.

**Table 1**  
Participant characteristics.

Sex	Girls	140
	Boys	133
Grade	Grade 4	48
	Grade 5	187
	Grade 6	38
Number of school transportations during a week	Active	1030
	Passive	697

## Procedure

The translation and adaption process followed the guidelines outlined in Wild et al. (2005). The Spanish BR-ACS questionnaire was translated to Swedish by two independent translators and discussed in a group with the translators, researchers, and teachers to find the right words for the Swedish context and the slightly lower age of the children. Then, the questionnaire was translated back to Spanish by a translator not involved earlier in the process, after which the back-translated version was discussed with the original developers. A pilot study of cognitive interviews was conducted with Swedish children aged 10–12 years, after which minor changes were made that were tested in another interview round. The process has provided validity evidence based on the instrument content used with Swedish children aged 10–12 years. This Swedish version, BR-ACS(SWE), was then used to assess the six types of behavioral regulation toward ACS.

## Data analysis

Data were statistically analyzed with Mplus version 8.4 (Muthén & Muthén, 2015) and Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows, version 28.0; Armonk, NY, USA).

### Confirmatory factor analysis

To gather validity evidence based on the instrument's internal structure, a confirmatory factor analysis was run. The 23-item six-factor correlated model was estimated using the Weighted Least Squares (WLSMV) estimator (Muthén & Muthén, 2015). The goodness of fit was assessed by a series of fit indexes: coefficient between  $\chi^2$  and degree of freedom ( $\chi^2/df$ ), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Standardized Root Mean Square Residual (SRMR), and Root Mean Square Error of Approximation (RMSEA) with its confidence interval at 90% (90%CI). A good fit was obtained with values up to 3 for the  $\chi^2/df$  coefficient, higher than 0.95 for CFI and TLI and lower than 0.06 for SRMR and RMSEA (Hu & Bentler, 1999). Taking into consideration that these cut-off-points are considered as too restrictive in assessing the goodness of fit by relying on results from simulation studies; Marsh et al. (2004) propose values as high as 5 for the  $\chi^2/df$  coefficient, above 0.90 for CFI and TLI in conjunction with scores below 0.080 for SRMR and RMSEA as indicative of an acceptable fit when judging results of real data from a population group. The standardized regression weights are appropriate when values are greater than 0.50 (Hair et al., 2018).

### Invariance analysis

For examination of gender invariance for the Swedish version of the BR-ACS questionnaire, tests of configural invariance (no equality constraints), weak invariance (equality constrains in item factor loadings), strong invariance (equality constraints in item factor loadings and item thresholds), and strict invariance (equality constrains in item factor loadings, item thresholds and item error variances) were conducted following the methodological approach by Putnick and Bornstein (2016). Differences in CFI of 0.010 and RMSEA of 0.015 indicate the tenability of equality constraints and, therefore, of the instrument's invariance (Putnick and Bornstein, 2016). Once the instrument's strong invariance was supported (Kline, 2016) an analysis of latent mean differences by gender was performed. For this test, the latent mean scores for the male sample were constrained to 0, whereas they were freely computed for the female sample. Significant differences among the latent means of the two groups were determined by the Z statistic (Kline, 2016).

### Convergent and discriminant validity, and reliability

The average variance extracted (AVE) was computed to provide the instrument's convergent validity evidence, showing that scores equal to 0.50 or higher are deemed suitable (Hair et al., 2018). For discriminant validity evidence, the heterotrait-monotrait ratio of correlations

(Henseler et al., 2015) and confidence interval at 95% (95%CI) of each latent correlation among factors were utilized due to high correlations found in previous validation studies (Burgueño et al., 2019; Marques et al., 2022). An acceptable level of discriminant validity is achieved when HTMT values are as high as 0.90 (Henseler et al., 2015), and the 95%CI of the latent correlation in question does not contain 1.00 (Anderson and Gerbing, 1988). To provide the instrument's reliability evidence, Cronbach's alpha ( $\alpha$ ), McDonald's omega ( $\omega$ ), and Raykov's composite reliability coefficient ( $\rho$ ) were, respectively, calculated for primary-order factors. Coefficient H was estimated for hierarchical factors. They show a good level of reliability with scores over 0.70 (Viladrich et al., 2017).

### Criterion validity

For the provision of criterion validity evidence, a linear regression analysis was run. Previously to this analysis, an inspection of the multicollinearity was conducted by estimating tolerance and variance inflation factor (VIF). Values below 1.00 for tolerance and smaller than 10 for VIF represent the absence of multicollinearity among independent variables (Hair et al., 2018). While the six types of behavioral regulation were introduced as independent variables, ACS was considered the dependent variable. As the motivational process could vary depending on the gender in physical activity settings, gender was introduced as a covariate. Lastly, descriptive statistics were computed for every variable under study.

### Ethics

The study was performed following the ethical principles of the World Medical Association's Declaration of Helsinki. The study was approved by the Ethics Review Authority, Sweden, prior to the start of the research project (Dnr: 2021-03783).

## Findings

### Confirmatory factor analysis

The 23-item six-factor correlated model obtained an acceptable fit to the observed data:  $\chi^2$  ( $df = 215$ ) = 488.375,  $p < 0.001$ ;  $\chi^2/df = 2.272$ ; CFI = 0.962; TLI = 0.955; SRMR = 0.079; RMSEA = 0.070 (90 %CI = 0.062–0.078). Fig. 1 shows standardized regression weights between 0.56 and 0.93 with each being statistically significant ( $p < 0.001$ ). Latent correlations were stronger and positive among adjacent factors, while they were weaker among faraway factors. A negative and strong correlation was also found between both poles (i.e., intrinsic motivation and amotivation). Observed latent correlations followed a symplex-like pattern.

Following previous validation studies (Burgueño et al., 2019; Marques et al., 2022), we tested the robustness of a hierarchical three-factor model comprising autonomous motivation (including intrinsic motivation, integrated regulation and identified regulation), controlled motivation (including introjected and external regulation), and amotivation. An acceptable fit was achieved:  $\chi^2$  ( $df = 222$ ) = 690.852,  $p < 0.001$ ;  $\chi^2/df = 3.112$ ; CFI = 0.934; TLI = 0.924; SRMR = 0.089; RMSEA = 0.080 (90%CI = 0.073–0.088). Structural factor loadings were 0.87 for intrinsic motivation, 0.95 for integrated regulation, and 0.97 for identified regulation on the hierarchical autonomous motivation factor, as well as 0.59 for introjected regulation and 0.92 for external regulation on the hierarchical controlled motivation factor. Negative latent correlations were found between autonomous and controlled motivation ( $r = -0.26$ ) and between autonomous motivation and amotivation ( $r = -0.44$ ). There was a positive correlation between controlled motivation and amotivation ( $r = 0.22$ ).

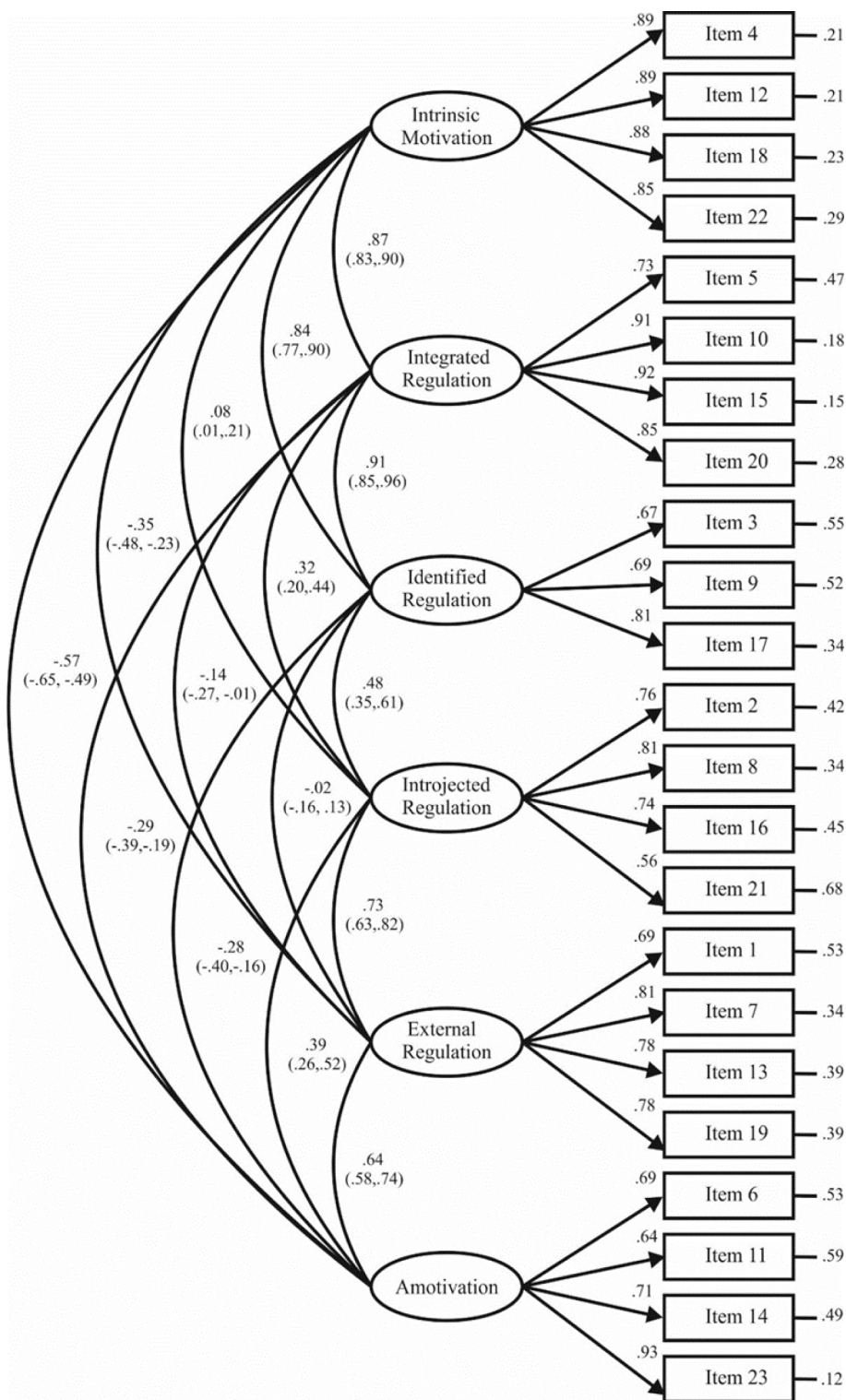


Fig. 1. Results from confirmatory factor analysis for the Swedish version of the Behavioral Regulation in Active Commuting to and from School Questionnaire.

**Table 2**  
Multigroup analysis of gender invariance.

	$\chi^2(df)$	CFI	RMSEA (90 %CI)	Models' comparison	$\Delta \chi^2(\Delta df)$	$\Delta CFI$	$\Delta RMSEA$
Configural invariance	759.23(430)	0.944	0.052(0.048–0.061)	–	–	–	–
Weak invariance	769.92(447)	0.0946	0.053(0.046–0.059)	2 versus 1	10.69(17)	0.002	0.001
Strong invariance	793.88(479)	0.946	0.052(0.045–0.058)	3 versus 2	23.96(23)	0.000	–0.001
Strict invariance	840.36(493)	0.937	0.052(0.046–0.058)	4 versus 3	46.48(23)***	0.009	0.000

Note. \*\*\*p < 0.001.



*Invariance analysis*

Table 2 displays differences as high as 0.009 in CFI values in conjunction with changes up to 0.001 in RMSEA values between each two progressively constrained models. Evidence was gathered in support of the null hypothesis of gender invariance.

*Analysis of convergent validity, discriminant validity, and reliability*

Table 3 shows AVE scores between 0.52 and 0.74. Discriminant validity was met by values ranging from -0.46 to 0.90 for the HTMT ratio of correlations, as well as 95 % CIs of every latent correlation that did not exceed 1.00 (see Fig. 1). On the other hand, Table 3 displays scores between 0.72 and 0.89 for Cronbach’s alpha, between 0.75 and 0.89 for McDonald’s omega and between 0.76 and 0.92 for Raykov’s composite reliability coefficient. Additionally, values of 0.97 and 0.92 were obtained for hierarchical factors of autonomous motivation and controlled motivation.

*Linear regression analysis*

Before linear regression analysis, the absence of multicollinearity among independent variables was verified. Table 4 also shows that, after controlling for gender, intrinsic motivation ( $\beta = 0.16, p = 0.019$ ), integrated regulation ( $\beta = 0.20, p = 0.002$ ) and identified regulation ( $\beta = 0.16, p = 0.019$ ) positively and significantly predicted ACS, whereas amotivation predicted it negatively ( $\beta = -0.14, p = 0.042$ ). The total variance explained was 11 %.

*Descriptive statistics and latent mean differences by gender*

Table 5 presents mean scores greater than the midpoint of the measurement scale in intrinsic motivation, integrated regulation, identified regulation, and ACS. Conversely, introjected regulation, external regulation, and amotivation obtained mean values smaller than the midpoint of the measurement scale. After providing evidence supporting the instrument’s strong invariance, latent mean differences by gender were analyzed, revealing that, although male and female students obtained similar scores in the six types of behavioral regulation, female students scored significantly higher than male students in ACS.

**Discussion**

The purpose of this research was to adapt the BR-ACS questionnaire to the Swedish context and to examine the psychometric properties of the resulting version using a sample of young people. The results gathered validity and reliability evidence for using the Swedish version of the BR-ACS questionnaire to assess the children’s perception of SDT-based motivation toward ACS.

Consistent with both the original version of the BR-ACS questionnaire (Bргуeño et al., 2019) and the Portuguese instrument’s version (Marques et al., 2022), the results from the CFA provided psychometric evidence in support of the 23-item six-factor correlated model in the Swedish context of ACS. Values from 0.56 to 0.93 for standardized regression weights indicated that every item adequately represented the

**Table 3**  
Reliability and convergent and discriminant validity of the Swedish version of the BR-ACS questionnaire.

	$\alpha$	$\omega$	$\rho$	AVE	1	2	3	4	5	6
Intrinsic motivation	0.89	0.89	0.92	0.76	–					
Integrated regulation	0.87	0.87	0.91	0.73	0.87	–				
Identified regulation	0.72	0.75	0.76	0.52	0.81	0.90	–			
Introjected regulation	0.80	0.81	0.81	0.53	0.14	0.35	0.47	–		
External regulation	0.81	0.82	0.85	0.59	–0.32	–0.14	–0.02	0.62	–	
Amotivation	0.82	0.82	0.84	0.56	–0.46	–0.22	–0.18	0.35	0.63	–

Note. Numbers below diagonal show heterotrait-monotrait ratio of correlations.

**Table 4**  
Predictive relationships between the six types of behavioural regulation and active commuting to and from school in Swedish students.

	Active commuting to and from school					
	B(SE)	$\beta$	t	Tol	VIF	R <sup>2</sup>
(constant)	0.13(0.20)	–	0.67	–	–	0.11
Gender	–0.09 (0.05)	–0.10	–1.73	0.99	1.01	
Intrinsic motivation	0.09(0.03)	0.16*	2.37	0.38	2.64	
Integrated regulation	0.11(0.04)	0.20**	3.11	0.32	3.16	
Identified regulation	0.08(0.03)	0.16*	2.37	0.43	2.34	
Introjected regulation	–0.01 (0.04)	–0.02	–0.20	0.71	1.41	
External regulation	0.04(0.04)	0.07	0.90	0.70	1.44	
Amotivation	–0.09 (0.04)	–0.14*	–2.04	0.76	1.31	

Note: Tol = Tolerance; VIF = Variance inflation factor. \*\* p < 0.01, \* p < 0.05.

target factor to be measured. Stronger and positive scores were found for latent correlations among more adjacent factors, while weaker correlations were observed between progressively more distant factors and a negative correlation between intrinsic motivation and amotivation. Akin to previous research on active travel to school (Bргуeño et al., 2019; Renninger et al., 2022), these correlation patterns drew a simplex-like structure (Ryan & Connell, 1989), which gathered further evidence in favor of the self-determination continuum (Ryan & Deci, 2020) in the ACS context. Furthermore, this study also provided psychometric support for a hierarchical three-factor model consisting of autonomous motivation, controlled motivation, and amotivation, in line with previous research (Bргуeño et al., 2019; Marques et al., 2022; White et al., 2018). These findings empirically underpinned the SDT theoretical assumption concerning three distinguishable types of motivation according to their quality (Ryan & Deci, 2020). From a methodological view, they could also be of great practical use when examining differentiated effects of motivation for ACS on behavioral, cognitive, and affective outcomes in complex structural models. When performing intervention research, it is essential to not only measure an outcome of the intervention. It is equally important to evaluate “the black box” i.e how and why an intervention was successful (or unsuccessful) at improving outcomes and which specific elements or components of the intervention, if any, led to an improvement in outcome (i.e. what are the mediating factors). Questionnaires like BR-ACS(SWE) are important tools in this process.

The results from the multi-group analysis gathered evidence underpinning the gender invariance assumption of the BR-ACS(SWE), which aligned with prior research (Bргуeño et al., 2019; Marques et al., 2022; Renninger et al., 2022). These findings pointed out that the instrument performs equally for Swedish male and female children, which allowed us to analyze the potential differences by gender regarding every motivational form. To our knowledge, this was the first study that examined motivation toward ACS depending on gender, showing the absence of significant gender differences in each of the six types of behavioral regulation for ACS. This suggests that boys and girls display similar levels of the different motivational forms involved in ACS.

**Table 5**  
Descriptive statistics and latent mean differences by gender.

	Total sample				Boys	Girls	Z-value	p-value
	Range	M(SD)	$\gamma_1$	$\gamma_2$				
Intrinsic motivation	0–4	2.92(1.04)	–0.72	–0.45	2.83(1.04)	3.01(1.03)	1.31	0.189
Integrated regulation	0–4	2.23(1.25)	–0.14	–1.17	2.15(1.19)	2.31(0.131)	1.34	0.181
Identified regulation	0–4	2.34(1.04)	–0.21	–0.70	2.28(1.09)	2.40(1.01)	1.10	0.270
Introjected regulation	0–4	0.58(0.67)	1.44	1.56	0.59(0.71)	0.57(0.64)	1.16	0.247
External regulation	0–4	0.52(0.70)	1.84	1.94	0.57(0.74)	0.47(0.67)	0.94	0.348
Amotivation	0–4	0.70(0.86)	1.31	1.45	0.76(0.90)	0.64(0.81)	0.92	0.356
ACS	0–10	6.88(4.22)	–0.80	–1.18	6.34(4.50)	7.40(3.87)	15.94	<0.001

Note. ACS: Active commuting to and from school.

Similar to the results from Burgueño et al. (2019) and contrasted with those from Marques et al. (2022) and Renninger et al. (2022) who reported marginal values for identified regulation, introjected regulation and amotivation, this research displayed AVE scores between 0.52 and 0.74. They met convergent validity evidence for the BR-ACS(SWE), implying that items comprising each factor suitably captured and well retained the meaning of each motivational form intended for measurement. As in previous research (Burgueño et al., 2019; Marques et al., 2022) this research also found high correlations among the three autonomous forms of motivation, suggesting that children could have a slight difficulty in differing between intrinsic, integrated, and identified reasons. However, HTMT scores up to 0.90 in conjunction with 95% CIs for each latent correlation that did not exceed the unit, in any case, gathered evidence supporting the good level of discrimination among the instrument's six motivational forms. Moreover, this study provided reliable evidence of BR-ACS(SWE) for the six order-primary factors (this is, the different types of behavioral regulation) and for the two hierarchical factors of autonomous motivation and controlled motivation. They were congruent with those reported in prior validation studies (Burgueño et al., 2019; Marques et al., 2022).

In line with the SDT assumptions (Ryan and Deci, 2020) and previous research on active transport (Burgueño et al., 2019; Niven and Markland, 2016; White et al., 2018; Renninger et al., 2022), the results of the linear regression analysis met criterion validity evidence for the Swedish instrument's version. Specifically, the intrinsic motivation, integrated and identified regulation were positively and significantly associated with ACS. A plausible explanation would rest on the fact that when children perceive ACS as a fun and challenging activity (intrinsic motivation), include it into their lifestyle (integrated regulation), and acknowledge its benefits (identified regulation), they tend to actively travel to school. Conversely, our results show that amotivation was negatively and significantly related to ACS in children. It is likely that when children experience inefficacy, futility, and undervaluation regarding ACS (amotivation), they fail to adopt an active mode to commute to school.

### Limitations

Although these results underpin the applicability of the BR-ACS questionnaire to the Swedish context of ACS, there are limitations. The factor model of the Swedish instrument's version was tested using a purposive and small sample of primary students. Future research is needed to test the instrument with a more varied sample of students (including middle and high secondary students and undergraduates) to ensure that this version is a valid and reliable measure of motivation for ACS in the Swedish context. A second limitation is the use of a cross-sectional design that has not allowed us to determine causal-effect relationships between motivation and ACS. Additional longitudinal and experimental studies are required to deeply analyze the effects of the different types of motivation on ACS among students.

### Practical implications

Evaluating and promoting children's use of healthy mobility requires interdisciplinarity, where relevant research questions are addressed by combining and integrating skills from multiple disciplines and cross-sectorial perspectives, where the research integrates perspectives from for example the social, health and education sectors. The availability of a valid and reliable measure of students' perceptions of motivation toward ACS in the Swedish context implies a series of practical applications. Thus, BR-ACS(SWE) might be used to gain a deeper insight into the Swedish children's motivational processes in active travel to school. Particularly, the instrument could be utilized not only to determine changes in students' perceptions of behavioral regulation for ACS during a single academic course but also to analyze their motivational trajectories toward ACS throughout different educational levels (i.e., primary education, secondary education, and higher education) in the Swedish context. Further, this instrument will enable teachers, families, and researchers to develop a more accurate detection of those students who might be at a motivational risk to actively travel to school at any point of the academic course. Moreover, the results of this research open the way for developing a potentially effective intervention programme, stating that increased students' levels of autonomous forms of motivation would tend to improve their rate of ACS. This will help researchers and policymakers develop more adapted motivational strategies for the more effective promotion of adaptive motivational patterns toward ACS among Swedish students. To illustrate this, researchers and policymakers should design strategies based on intrinsic motivation that focus on the selection of those routes that are safe, spacious, and adapted to the children's and adolescents' level of fitness and motor skills to turn active travels to school into an enjoyable and stimulating activity favoring their personal achievement. Strategies based on integrated regulation are also recommended to facilitate that children and adolescents include active travels to school into their daily life. Furthermore, strategies based on identified regulation are advised to sensitize children and adolescents on the benefits derived from active travels to school through advertising campaigns on social networks and media.

### Conclusions

The present study gathered a substantial basis of psychometric evidence for using the BR-ACS questionnaire in the Swedish context of active travel to school. The findings from this research showed that the validity and reliability of the scores from the BR-ACS questionnaire were suitable and psychometrically robust, suggesting that adapting the BR-ACS questionnaire to the Swedish context could be used in future research among children who travel to school.

### CRedit authorship contribution statement

**Rafael Burgueño:** Conceptualization, Formal analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing.  
**Stina Rutberg:** Conceptualization, Funding acquisition, Writing –

review & editing. **Lars Nyberg**: Data curation, Validation, Writing – review & editing. **Mascha Pauelsen**: Conceptualization, Data curation, Investigation, Methodology, Writing – original draft. **Palma Chillón**: Validation, Writing – review & editing. **Anna-Karin Lindqvist**: Conceptualization, Data curation, Funding acquisition, Project administration, Writing – original draft, Writing – review & editing.

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Data availability

The data that has been used is confidential.

### Acknowledgement

We are grateful to the children who participated in the study. We would also like to thank Annie Palstam and Mathias Andersson for their assistance with part of the data collection.

### Funding

This work was supported by Vinnova, Sweden innovation agency [grant number 2018-04174]. In addition, Rafael Burgueño was particularly supported by a Margarita Salas postdoctoral fellowship (grant number: RR\_A\_2021\_02) from the Spanish Ministry of Universities.

### References

- Anderson, J.C., Gerbing, D.W., 1988. Structural equation modeling in practice: A review and recommended two-step approach. *Psychol. Bull.* 103 (3), 411–423. <https://doi.org/10.1037/0033-2909.103.3.411>.
- Burgueño, R., González-Cutre, D., Sevil-Serrano, J., Herrador-Colmenero, M., Segura-Díaz, J.M., Medina-Casabón, J., Chillón, P., 2019. Understanding the motivational processes involved in adolescents' active commuting behaviour: Development and validation of the behavioural regulation in active commuting to and from school (BR-ACS) questionnaire. *Transport Res. F. TRAF* 62, 615–625. <https://doi.org/10.1016/j.trf.2019.02.016>.
- Campos-Sanchez, S.F., Javier Abarca-Alvarez, F., Molina-Garcia, J., Chillón, P., 2020. A GIS-based method for analysing the association between school-built environment and home-school route measures with active commuting to school in urban children and adolescents. *Int. J. Environ. Res. Public Health* 17 (7). <https://doi.org/10.3390/ijerph17072295>.
- Chillón, P., Herrador-Colmenero, M., Migueles, J.H., Cabanas-Sanchez, V., Fernandez-Santos, J., Veiga, O.L., Castro-Pinero, J., 2017. Convergent validation of a questionnaire to assess the mode and frequency of commuting to and from school. *Scand. J. Public Health* 45 (6), 612–620. <https://doi.org/10.1177/1403494817718905>.
- Faulkner, G.E.J., Buliung, R.N., Flora, P.K., Fusco, C., 2009. Active school transport, physical activity levels and body weight of children and youth: A systematic review. *Prevent. Med.* 48 (1), 3–8. <https://doi.org/10.1016/j.ypmed.2008.10.017>.
- González, S.A., Aubert, S., Barnes, J.D., Larouche, R., Tremblay, M.S., 2020. Profiles of active transportation among children and adolescents in the global matrix 3.0 initiative: A 49-country comparison. *Int. J. Environ. Res. Public Health*. <https://doi.org/10.3390/ijerph17165997>.
- Hair, J.F., Babin, B.J., Anderson, R.E., Black, W.C., 2018. *Multivariate Data Analysis*, 8th ed. Cengage Learning EMEA, Hampshire, UK.
- Henseler, J., Ringle, C., Sarstedt, M., 2015. A new criterion for assessing discriminant validity in variance-based structural equation modeling. *J. Acad. Market Sci.* 43 (1), 115–135. <https://doi.org/10.1007/s11747-014-0403-8>.
- Howard, J.L., Gagné, M., Bureau, J.S., 2017. Testing a continuum structure of self-determined motivation: A meta-analysis. *Psychol. Bull.* 143 (12), 1346–1377. [10.1037/bul0000125](https://doi.org/10.1037/bul0000125); [10.1037/bul0000125.supp](https://doi.org/10.1037/bul0000125.supp) (Supplemental).
- Hu, L., Bentler, P.M., 1999. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Lawrence Erlbaum Modeling, United States*. Retrieved from <http://proxy.lib.ltu.se/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=edsbl&AN=RN054352694&lang=sv&site=eds-live&scope=site>.
- Kline, R.B., 2016. *Principles and practice of structural equation modeling*, 4th ed. Guilford Press, New York.
- Larouche, R., Barnes, J.D., Blanchette, S., Faulkner, G., Riazi, N.A., Trudeau, F., Tremblay, M.S., 2020. Relationships among children's independent mobility, active transportation, and physical activity: A multisite cross-sectional study. Retrieved from *Pediatric Exercise Sci.* 32 (4), 189–196. <http://proxy.lib.ltu.se/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=146363696&lang=sv&site=eds-live&scope=site>.
- Lubans, D.R., Morgan, P.J., Tudor-Locke, C., 2009. A systematic review of studies using pedometers to promote physical activity among youth. *Prev. Med.* 48 (4), 307–315. <https://doi.org/10.1016/j.ypmed.2009.02.014>.
- Marques, A., Santos, T., Demetriou, Y., Schönbach, D., Peralta, M., Lagestad, P., Gouveia, É.R., 2022. Adaptation of the behavioural regulation in active commuting to school (BR-ACS) questionnaire in portuguese youth. *Children* 9 (182), 182. <https://doi.org/10.3390/children9020182>.
- Marsh, H.W., Hau, K.T., Wen, Z., 2004. In search of golden rules: Comment on hypothesis-testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing hu and bentlers (1999) findings. *Lawrence Erlbaum Associates, Inc., United States*. Retrieved from <http://proxy.lib.ltu.se/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=edsbl&AN=RN150839943&lang=sv&site=eds-live&scope=site>.
- Masoumi, H., Martin, R., & Grzegorz Sierpiński. (2020). Children's independent mobility to school in seven European countries: A multinomial logit model. *Int. J. Environ. Res. Public Health*, 17(9149), 9149. doi:10.3390/ijerph17239149.
- Muthén, L. K., & Muthén, B. O. (2015). *Mplus user's guide th ed*. Los Angeles: Muthén & Muthén.
- Niven, A.G., Markland, D., 2016. Using self-determination theory to understand motivation for walking: Instrument development and model testing using bayesian structural equation modelling. *Psychol. Sport Exerc.* 23, 90–100. <https://doi.org/10.1016/j.psychsport.2015.11.004>.
- Owen, K., Smith, J., Lubans, D.R., Ng, J.Y.Y., Lonsdale, C., 2014. Self-determined motivation and physical activity in children and adolescents: A systematic review and meta-analysis. *Prev. Med.* 67, 270–279. <https://doi.org/10.1016/j.ypmed.2014.07.033>.
- Putnick, D.L., Bornstein, M.H., 2016. Measurement invariance conventions and reporting: The state of the art and future directions for psychological research. *Dev. Rev.* 41, 71–90. <https://doi.org/10.1016/j.dr.2016.06.004>.
- Renninger, D., Kelso, A., Demetriou, Y., Reimers, A.K., Marzi, I., Beck, F., Standage, M., 2022. Motivation and active travel in adolescent girls and boys in Germany – findings from the ARRIVE study. *Transport. Res. Part F: Traffic Psychol. Behav.* 90 (425) <https://doi.org/10.1016/j.trf.2022.09.015>.
- Ryan, R. M., Deci, E. L., 2017. *Self-determination theory. basic psychological needs in motivation, development and wellness* Guilford Press. doi:<https://doi.org/10.7202/1041847ar>.
- Rothman, L., Macpherson, A.K., Ross, T., Buliung, R.N., 2017. The decline in active school transportation (AST): A systematic review of the factors related to AST and changes in school transport over time in north america. *Prev. Med.* <https://doi.org/10.1016/j.ypmed.2017.11.018>.
- Ryan, R.M., Deci, E.L., 2020. Intrinsic and extrinsic motivation from a self-determination theory perspective: definitions, theory, practices, and future directions. *Contemp. Educ. Psychol.* 61 <https://doi.org/10.1016/j.cedpsych.2020.101860>.
- Ryan, R.M., Deci, E.L., Vansteenkiste, M., Soenens, B., 2021. Building a science of motivated persons: Self-determination theory's empirical approach to human experience and the regulation of behavior. *Motivation Sci.* 7 (2), 97–110. <https://doi.org/10.1037/mot0000194>.
- Sallis, J.F., Owen, N., Fotheringham, M.J., 2000. Behavioral epidemiology: A systematic framework to classify phases of research on health promotion and disease prevention. *Society of Behavioral Medicine, United States*. Retrieved from <http://proxy.lib.ltu.se/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=edsbl&AN=RN092250131&lang=sv&site=eds-live&scope=site>.
- Segura-Díaz, J.M., Rojas-Jiménez, Á., Saucedo-Araujo, R., Aranda-Balboa, M., Herrador-Colmenero, M., Chillón, P., Murillo-Pardo, B., 2020. Feasibility and reliability of a questionnaire to assess the mode, frequency, distance and time of commuting to and from school: The paco study. *Int. J. Environ. Res. Public Health* 17 (14), 1–15. <https://doi.org/10.3390/ijerph17145039>.
- Swedish Transport Administration. (2018). Attityundersökning barns skolvägar (children's routes to school). Retrieved from <https://www.trafikverket.se/contentassets/799dec75057b45069c9621f395ac39ee/rapport-barns-skolvagar-2018.pdf>.
- Viladrich, C., Angulo-Brunet, A., Doval, E., 2017. A journey around alpha and omega to estimate internal consistency reliability. *Anales De Psicología*. 33 (3), 755–782. <https://doi.org/10.6018/analesps.33.3.268401>.
- White, R.L., Parker, P.D., Lubans, D.R., MacMillan, F., Olson, R., Astell-Burt, T., Lonsdale, C., 2018. Domain-specific physical activity and affective wellbeing among adolescents: An observational study of the moderating roles of autonomous and controlled motivation. *Int. J. Behav. Nutr. Phys.* 15 (1), 1–13. <https://doi.org/10.1186/s12966-018-0722-0>.
- WHO Regional Office for Europe. (2021). *2021 physical activity factsheet for the European Union member states in the WHO European Region*. Retrieved from <https://www.who.int/europe/publications/i/item/WHO-EURO-2021-3409-43168-60449>.
- Wild, D., Grove, A., Martin, M., Eremenco, S., McElroy, S., Verjee-Lorenz, A., Erikson, P., 2005. Principles of good practice for the translation and cultural adaptation process for patient-reported outcomes (PRO) measures: Report of the ISPOR task force for translation and cultural adaptation. *Value Health* 8 (2), 94–104.
- World Health Organization. (2020). WHO guidelines on physical activity and sedentary behaviour. Retrieved from <https://apps.who.int/iris/bitstream/handle/10665/336656/9789240015128-eng.pdf>.