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Children's cycling skills: Development of a test and determination of individual and environmental correlates

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ABSTRACT

Introduction: Children's ability to perform cycling skills was found to play an important role in cycling accidents. Therefore, this study developed a test to gain a detailed insight into the cycling skills of 9–10 year old children and evaluated individual and physical environmental correlates of cycling skills.
Methods: Children ($n = 93$) took a cycling test consisting of 13 test stations. In addition, parents completed a questionnaire on school commuting behavior. An exploratory factor analysis was conducted to investigate the factor structure of the cycling test and ICC's were calculated to examine interrater reliability. Descriptive statistics were executed on children's cycling skill scores. Regression analyses were conducted to evaluate individual and environmental correlates of cycling skills.
Results: Three factors were extracted: the 'during-cycling skills', the 'before/after-cycling skills' and a 'transitional-cycling skills' factor. These factors accounted for 56.74% of the total variance. Furthermore, intraclass correlation coefficients ranged from 0.75 to 0.98. For all cycling skill, except two, 50% of children scored higher than 7.5/10. Additionally, 18.4% of children scored lower than 3/10 on at least two cycling skills. Parental perceived motor competence of the child explained 10% of the variance in cycling skills ($\beta = 0.33$), residential density explained 12% of the variance ($\beta = -0.37$).
Conclusions: In order to get an overall picture of the cycling skills of children, the 'during-cycling skills', the 'before/after-cycling skills' and the 'transitional-cycling skills' need to be examined. Furthermore, Flemish children of the 4th grade scored well on cycling skills. However, cycle training programs should focus more on one-handed skills and those children scoring lower than 3/10 on one or more cycling skills.

1. Introduction

Cycling is an enjoyable and accessible form of physical activity (Roberts et al., 1996). For children, the use of a bicycle is often the only way to cover greater distances at faster speeds. This is probably one of the reasons why most children commonly prefer cycling rather than walking (Shephard, 2008). Furthermore, among youth regular cycling has also been shown to be related to higher rates of physical activity (Sirard et al., 2004; Heelan et al., 2005; Cooper et al., 2005; Sirard et al., 2005) and higher cardiovascular fitness (Cooper et al., 2006; Voss and Sandercock, 2010). These health benefits are linked with reduced risk for cardiovascular disease, stroke, coronary disease and cancer (Blair et al., 2001).

However, bicycle-related accidents are among the most common causes of children's physical injuries (Briem et al., 2004; Lammar, 2005; Klin et al., 2009). Especially, children in the last years of primary school are at risk (Lammar, 2005; Tin Tin et al., 2010). Researchers investigating child cyclist injuries found that most children become injured near their home (Petch and Henson, 2000) and that most injuries did not result from interactions with motor vehicles, pedestrians, animals or other cyclists (Lammar, 2005; Heesch et al., 2011). Most commonly reported cycling accident is falling off the bicycle (Lammar, 2005). Bad road surfaces also cause cycling accidents (Lammar, 2005; Heesch et al., 2011). Additionally, the ability of children to perform cycling skills (Corden et al., 2005) was found to play an important role in bicycle-related injuries. This argues for taking cycling skills into consideration when encouraging children to cycle for transportation or in leisure time.

The ability of children to perform cycling skills depends on the child's capability to control for several motor components such as steering, balancing, pedaling, braking, and cognitive elements such

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as attention and decision making skills during cycling. This capability depends mainly on the physical and mental developmental abilities of the child (Corden et al., 2005). These developmental aspects are strongly related to age (Maring and van Schagen, 1990), which is found to be a major predictive factor for the performance of cycling skills (Arnberg et al., 1978). A study conducted by Hansen et al. (2005) stated that children at the age of four have immature psychomotor skills to handle their bicycle safely in traffic. Similarly, a study examining children's cycling competence showed that children from the second grade, aged about eight, had rudimentary cycling skills (Briem et al., 2004). According to Strickland (2001), 9–10 year olds should be able to cycle based on the development of their motor and cognitive abilities. However, this age group is also more involved in bicycle accidents (Lammar, 2005; Tin Tin et al., 2010), whereby human errors play an important role (Corden et al., 2005) and research is needed to confirm that these children have sufficient cycling skills to cycle safely in traffic. Moreover, from this age, independent mobility starts to change (Alexander, 2005), as children might get parental allowance to cycle to school. Whether other individual factors, like motor competence or independent cycling mobility, predict children's cycling competence is not known, yet of interest.

Next to age, cycling experience may influence cycling skills. General cycling experience has been shown to be related to children's cycling skills (Arnberg et al., 1978). Children may gain cycling experience by cycling to school for example. Predictors of cycling to school are widely investigated. Commuting distance and parental safety concerns such as crime and traffic have been negatively associated with cycling to school (Timperio et al., 2004; Cooper et al., 2005; McMillan, 2007; Yeung et al., 2008; Trapp et al., 2011). Also, physical environmental factors have been widely investigated and were found to be related to cycling to school (Kerr et al., 2006; Timperio et al., 2006; Titze et al., 2008). For children, street connectivity and land use mix of the neighborhood were positively associated with cycling to school (Kerr et al., 2006). Also, residential density was mentioned as an important positive predictor of cycling to school (Kerr et al., 2006). Whether these predictors directly or indirectly relate to the cycling skills of children is unknown.

The aims of the present study were to (1) develop a test to gain a detailed insight into the cycling skills of 9–10 year old children; (2) to investigate the relative contribution of individual and physical environmental correlates in explaining variance in their cycling skills.

2. Method

2.1. Sample and procedure

All 4th graders (n = 122) from a random sample of five primary schools in Flanders were invited to participate in the present study, which was conducted during the winter of 2010. Through a letter to the parents, children were asked to bring their bicycle to school to participate in a cycling skills test. Participating children also received a parental questionnaire to fill out at home. The children were asked to hand the questionnaire to one of their parents and to bring the completed questionnaire back to school. A total of 114 children (participating rate = 93.4%) took the cycling skills test and 100 parents (response rate = 82%) completed the questionnaire. This resulted in a study sample of 93 children (mean age = 9.17 years; SD = 0.524; 50.5% girls) who took the cycling skills test and whose parents filled out the questionnaire. Ethical approval was granted, by the Ethics Committee of the Ghent University. Informed consent from all participating children and their parents was obtained.

2.2. Instruments

2.2.1. Cycling test

The cycling test was developed based upon existing cycling tests described in the literature (Cooper, 1999; Stichting Vlaamse Schoolsport, 2005; Vlaamse Stichting Verkeerskunde, 2009; Belgisch Instituut voor de verkeersveiligheid, 2009) and the advice from an expert panel with large experience in cycling skills and general motor testing in children. The basic cycling skills that children should accomplish to cycle safely in right-hand traffic (Stichting Vlaamse Schoolsport, 2005; Vlaamse Stichting Verkeerskunde, 2009; Belgisch Instituut voor de verkeersveiligheid, 2009) were selected. The cycling test consisted of 13 test stations (see Table 1 and Fig. 1). The tests were carried out on an asphalt surface on the playground of the school. Children were instructed how to perform the tests, but were not allowed to practice. If a child was not able to bring his or her own bicycle to school, he/she was allowed to use a bicycle from a class mate. Three researchers were trained on the scoring procedure of all test stations during four hours. Each child was scored for the entire test by one researcher. To perform testing of all the children within a maximum of two lesson times per class group, three children took the cycling skills test simultaneously. For each test a 5-point scale was used to assess the general performance of the skill. The speed and fluency of the performance as well as the ability to keep balance and to perform the test without interruptions were taken into account when scoring the general performance. Furthermore, for 11 tests, the researchers additionally indicated if the child was able to fulfill some specific points of interest. For each specific point of interest that was fulfilled, one point was added to the general performance score. This sum score (sum of the general performance score and the points of interest) was then converted to a score on ten. Furthermore, the researchers also indicated whether the child was using his/her own bicycle to perform the tests ('yes' or 'no'). The sum of the scores on the different tests, converted to a score of 100, was used as the dependent variable (=overall cycling skill score). Furthermore, interrater reliability for each test station was examined in a subsample (n = 20).

2.2.2. Questionnaire

The parental questionnaire was based on the literature (Timperio et al., 2006; Bringolf-Isler et al., 2008; Hume et al., 2009; Panter et al., 2010) and supplemented with questions assessing specific cycling factors. The questionnaire was first pilot tested in a sample of 20 parents to identify lack of clarity of the questions and the items. Modifications were made if necessary.

2.2.2.1. Individual predictor variables. *Demographics*. Parents reported their child's age and gender. To calculate body mass index (BMI), parents also reported the height and weight of their child.

Child characteristics. Parents' perceptions of the children's motor competence was assessed with a single item namely "in general, compared to other children of your child's age, how would you rate your child's motor competence?". A five-point Likert scale with response options ranging from "not good at all" to "excellent" was provided. Furthermore independent mobility of the child was assessed by the question 'How far is your child allowed to leave home with the bicycle when he/she is alone?'. Response options were (1) not, (2) 0–500 m, (3) 500–1 km, (4) 1–3 km, (5) 3–5 km, (6) 5–10 km, and (7) more than 10 km.

Behavioral factors. Sports participation was evaluated by asking which sports (up to three) their child participate in during leisure time and how frequently (h per week). The time spent in each sport was summed, and the average hours per day spent in sports participation were calculated. This part of the questionnaire was based on the Flemish Physical Activity Questionnaire, which is found to