ORIGINAL ARTICLE

Factors associated with bicycle helmet use among young adolescents in a multinational sample

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Objective: To determine factors associated with variation in bicycle helmet use by youth of different industrialized countries.
Design: A multinational cross sectional nationally representative survey of health behaviors including symptoms, risk taking, school setting, and family context.
Setting: School based survey of 26 countries.
Subjects: School students, ages 11, 13, and 15 years totaling 112 843.
Outcome measures: Reported frequency of bicycle helmet use among bicycle riders.
Results: Reported helmet use varied greatly by country from 39.2% to 1.9%, with 12 countries reporting less than 10% of the bicycle riders as frequent helmet users and 14 countries more than 10%. Reported helmet use was highest at 11 years and decreased as children's age increased. Use was positively associated with other healthy behaviors, with parental involvement, and with per capita gross domestic product of the country. It is negatively associated with risk taking behaviors. Countries reported to have interventions promoting helmet use, exemplified by helmet giveaway programmes, had greater frequency of reported helmet use than those without programmes.
Conclusions: Bicycle helmet use among young adolescents varies greatly between countries; however, helmet use does not reach 50% in any country. Age is the most significant individual factor associated with helmet for helmet using countries. The observation that some helmet promotion programmes are reported for countries with relatively higher student helmet use and no programmes reported for the lowest helmet use countries, suggests the possibility of a relation and the need for objective evaluation of programme effectiveness.

In the United States, more than 70% of 5–14 year olds ride bicycles, and in England eight out of 10 children ride bicycles.[1 2] In 2001 the National Center for Injury Prevention and Control estimated that 140 000 children visit US emergency departments each year for head injuries sustained while bike riding, and 10% of all pediatric traumatic deaths in this country are due to bicycle injuries.[3 4] The Swedish Bike Helmet Initiative estimates that each year bicycle crashes result in over 40 000 injuries and 2000 hospitalizations, with an annual cost of more than $15 million in medical care.[5] The vast majority of bicycle related deaths and serious morbidity involve head injuries, and 11–15 year old youth are at greatest risk of severe injury or death from bicycle related injury.[6]

The proper use of bicycle helmets has been shown to effectively lower the rate of head injury from bicycling crashes. Thompson *et al* found that helmets were 85% effective in reducing the risk of head injury and 88% effective in reducing the risk of brain injury.[8] Despite the utility and effectiveness of bicycle helmets as an injury prevention measure for children, rates of helmet wearing by the most frequent cycling age group continue to be relatively low.[9]

In order to improve levels of helmet use among children, it is first important to understand the factors that influence whether or not they wear them. The lack of comfort, the negative social perceptions about wearing helmets, and the inconvenience of helmets have all been cited as deterrents to high levels of helmet use.[10–12] Studies have examined social and individual characteristics in an effort to explain helmet use,[13–15] and others have looked at the effectiveness of various kinds of programmes (laws, education campaigns, and so on).[16–21] However, there has been no examination of these factors on both a national and international scale.

The Health Behavior in School Children study (HBSC) is a multinational, school based survey of European and North American adolescent health behaviors that provides a unique opportunity to examine the international prevalence of helmet use. Examination of factors associated with these differences may offer important insights into the determinants of helmet use. The goal of this analysis was to examine how child helmet use varies between countries and to determine the factors that most strongly influence rates of helmet use in the countries participating in this multinational study.

METHODS

The HBSC is a multinational, school based study of young adolescents performed in collaboration with the World Health Organization Regional Office for Europe (WHO-Euro). The main purpose of the study is to ''gain new insights into and to increase our understanding of health behaviors, lifestyles, and their context in young people''.[22] The surveys are conducted every four years in a school setting in accordance with an international research protocol.[23–25] The study's target population is school children ages 11, 13, and 15. This analysis is based on the HBSC survey conducted in the academic year 1997–98. Most questions in the HBSC are adopted from standard instruments that have been previously assessed for reliability and validity. Furthermore, the

Abbreviations: GDP, gross domestic product; HBSC, Health Behaviour in School Children.

survey was pilot tested in each participating country before conducting the study in order to confirm the questionnaire's appropriateness in each location.

As required by protocol, each country administered the questionnaire to a nationally representative school based sample of students with an average age of 11.5, 13.5, and 15.5 years during the academic year 1997–98.[26] To achieve this age distribution the US conducted the survey primarily in grades 6, 8, and 10. As a school based survey, cluster sampling was used with the school or class serving as the primary sampling unit. A sufficient sample was employed to provide a 95% confidence interval of plus or minus 3% around a proportion of 50% and a design effect of 1.44. Only regional samples were employed for France (Nancy-Lorraine and Toulouse-Emdi-Pyrenees), Germany (North Rhine-Westphalia), and the Russian Federation (St Petersburg and the district, Krasnodar, and Chelyabinsk). The core protocol data from each country were compiled into an international database that was used for this analysis. For each participating country, institutional review board or equivalent ethics committee approval was obtained to administer this survey.

Variables

Each country administered the same mandatory core set of questions to collect information including demographic characteristics such as age, sex, and household composition; health related behaviors, such as tobacco, alcohol, and medication use, exercise patterns and eating patterns; perceptions of health, wellbeing, physical ailments, and psychosocial adjustment; peer relations and support; and perceptions of school and its influence. Some countries included additional optional questions as packages that focused in greater depth on school experiences, relationships with parents, socioeconomic status, body image, and violence and injuries. As a core item this survey asked participants ''How often do you wear a helmet when you ride a bicycle?'' Response choices were: ''I do not ride bicycles'', ''rarely or never'', ''sometimes'', ''often'', ''always''. Students who reported wearing helmets *often* or *always* were classified as ''helmet users'', and those who wore helmets *rarely or never* or *sometimes* were classified as ''non-helmet users''.

To determine the relations between helmet use and individual and social characteristics of HBSC respondents, we examined factors that (1) were measured in the HBSC study, and (2) could be related to bicycle helmet use. A number of variables regarding general behavior and attitudes potentially relevant to helmet use, such as risk taking and health consciousness, were measured and used in the present analysis.

The individual level characteristics examined for association with bicycle helmet use are listed and defined in table 1. In addition to age and sex, the categories of variables of interest included healthy behavior, risk taking, parent involvement, and physical activity. Each of these had multiple items that were combined into scales to facilitate analysis. Scales were developed based on grouping thematically similar items and were confirmed by factor analysis.

In addition to individual level factors or the available national variables, we attempted to identify whether there were national programmes used by participating countries that might also explain differences in helmet use between countries. It was not possible to conduct objective surveys in all of these countries to measure national differences in bicycle helmet promotion. Therefore, 12 countries were selected to represent country groups of interest with regard to helmet use: North America, users (Canada, USA), Scandinavia, users (Norway, Sweden, Denmark), United Kingdom and Ireland, users (England, Republic of Ireland), Southern Europe, user (Israel), Western Europe, non-users (France, Belgium), and Eastern Europe, non-users (Poland, Hungry). A brief subjective questionnaire was forwarded to officials in each of these countries judged by the HBSC principal investigators to be the most knowledgeable about bicycle safety for that country. The questionnaire was designed to collect qualitative data on programmes and attitudes regarding helmet use: the existence and extent of various types of helmet promotion activities (laws, campaigns, and so on) on both a national and regional level; how helmets are used in each country; perceptions about helmet use; and barriers to helmet use. The experts were asked to compile and summarize descriptive information currently available but were not required or asked to perform additional surveys or studies to collect this information.

Analytical approach

The cross national comparisons were made using an international file that contains no school or classroom identifiers, and there were no case weights. Therefore, in this analysis, all students were given a weight of 1, and country was the sole cluster. Because of the large sample sizes, many differences that are statistically significant are not considered meaningful. Our discussion and conclusions focus on results that are considered both meaningful and significant.

The primary objective of this analysis was to identify factors that predict bicycle helmet use as the dependent variable. Students who said that they used a helmet either ''often'' or ''always'' were considered to be helmet users. Students who reported that they did not ride bicycles were excluded from the analysis. Because the dependent variable was binary, a multilevel logit model was used. The log odds of ''success'' (defined as frequent bicycle helmet use) was the modeled outcome. The model was constructed with the hierarchical linear modeling program, version 4.03.[27]

An important objective of the analysis was to explore the relations between student characteristics and reported bicycle helmet use. Because the data involved a sample of students in a sample of countries, hierarchical linear modeling was

Table 1 Child characteristics examined as predictors of bicycle helmet use

Variable	Measures used to construct variable	Range	Descriptive statistics
Age group	Three category age group measure (11 year old *v* 13 year old *v* 15 year old)	11, 13, 15	36% age 11, 35% age 13, 29% age 15
Sex	Two category sex measure (male *v* female)	0 (male), 1 (female)	49% females, 51% males
Healthy behavior (frequency of healthy behaviors)	Scale involving seat belt use, nutritious eating habits, and tooth brushing	0 (low healthy behavior) to 4 (high healthy behavior)	Mean 2.61, SD 0.10
Risk taking (frequency of risk taking behaviors)	Scale involving alcohol use, tobacco use, skipping school, and bullying	0 (low risk taking) to 5 (high risk taking)	Mean 1.13, SD 0.14
Parental involvement (the extent of active parental involvement with children's affairs at school	Scale involving parental help with school problems, parental communication with teachers, and parental encouragement to excel at school	0 (low involvement) to 4 (high involvement)	Mean 3.35, SD 0.16

Table 2 Bicycle and helmet use among 11–15 year olds in 26 countries for 1997–98

Country	Respondents (n)	Bicycle users (%)	Wearing of helmet "often" or "always" among those who reported riding a bicycle (%)			
			11 year olds	13 year olds	15 year olds	All age groups
Norway	5026	61.0	73.0	29.2	11.3	39.1
Sweden	3802	96.2	73.5	22.6	8.2	36.2
Canada	6567	91.6	59.7	32.8	18.1	35.6
Denmark	5066	94.9	51.1	21.1	8.2	27.6
England	6373	77.7	37.5	20.0	13.3	25.4
N Ireland	3346	83.8	38.8	19.4	10.7	23.9
Greece	4299	56.6	36.0	20.6	10.4	22.1
Wales	4537	81.0	32.1	15.6	14.6	21.5
USA	5169	77.7	31.7	15.7	11.5	20.2
Germany	4792	93.7	36.9	14.5	6.6	19.6
Scotland	5632	83.0	26.8	14.5	11.9	18.9
Israel	5054	66.7	23.3	14.5	9.1	17.8
Rep of Ireland	4394	86.9	27.9	13.2	5.9	16.2
Austria	4316	94.9	26.0	9.1	4.1	13.3
Portugal	3721	84.5	11.6	4.9	6.2	7.6
Hungary	3609	87.7	12.1	5.3	2.6	7.6
Estonia	1897	81.5	12.3	6.6	4.0	7.3
Greenland	1648	79.1	12.3	5.4	4.1	7.1
Czech Republic	3703	92.4	10.0	6.0	4.5	6.8
France	4133	89.3	8.8	5.2	3.9	6.2
Poland	4861	89.8	9.1	4.6	3.5	5.8
Russia	3997	73.1	6.6	2.8	1.3	3.8
Lithuania	4513	86.9	5.9	2.1	1.8	3.3
Latvia	3775	79.8	6.5	1.4	1.6	3.3
Belgium (Flemish)	4824	96.1	5.2	1.5	1.2	2.7
Slovak Republic	3789	89.5	2.2	1.4	2.2	1.9

used.[28 29] The models incorporated child level (table 1) and country level predictors. Individual level variables were demographic factors (age, sex), variables hypothesized to be positive influences on helmet use (healthy behaviors and parental involvement) and those hypothesized to be negative influences on helmet use (risk taking). Gross domestic product (GDP) per capita, as a measure of economic wealth for each country respectively, was used as a country level predictor of helmet use. This was based on the reasoning that children in countries with greater economic resources may be better able to acquire a helmet, compared with their peers in countries with lower resources (per capita GDP), resulting in more helmet use in countries with higher per capita GDP. Per capita GDP in US dollars for 1998, the year of the survey, was used.[30]

RESULTS

Frequency of bicycle helmet use

The entire sample of all countries combined for this analysis numbers 112 843 children.* Table 2 presents the 26 of 29 participating countries that included a question about bicycle and helmet use with the core questionnaire. For the 17 countries that reported student response rates, the average response rate was 83% (57% to 95%). Five of the 17 had response rates below 80%.

As shown in table 2, the countries of the HBSC exhibited wide variation in their rates of both bicycle use and helmet use among those who rode bicycles. Bicycle use ranged from 96.2% in Sweden to 56.6% in Greece. Rates of reported helmet use in each country varied greatly, ranging from 39.1% in Norway to 1.9% in the Slovak Republic. In 12 of the 26 countries, less than 10% of the bicycle riders were frequent helmet users, whereas in 14 countries more than 10% were frequent users and in nine counties over 20% reported frequent helmet use. The highest helmet use (over 25%) was reported in the three Scandinavian countries, Canada, and England, whereas all participating Eastern European countries, along with France, Belgium (Flemish), Portugal, and Greenland, reported rates less than 10%.

*Of the 29 HBSC participating countries, three were excluded from the analysis. The Swiss and Belgian (French) surveys did not include the question about bicycle use. Finland was excluded because an error in wording of the question caused an invalid interpretation.

Factors related to bicycle helmet use

To gain a sense of the direction and size of the associations between each predictor and helmet use, we examined unweighted bivariate relations in table 3. In most countries, helmet use decreased with age. Regarding sex, 17.1% of girls and 16.6% of boys were helmet users (not shown). Even though this difference is not considered meaningful, it is statistically significant ($\chi^2(1) = 5.45$, $p<0.05$) due to the very large sample size.

The individual items for each of the scales were examined for association with helmet use in table 3, and although significant low level associations were present, no factor stood out as explaining the pattern of helmet use. All of the relations between variables were in the predicted direction and statistically significant ($t = 8.62–67.78$, $p<0.0001$). The differences, however, are modest and vary from a maximum of 31.5% increase in the risk taking scale for non-helmet users, 11.8% increase in the healthy behavior scale for helmet

Table 3 Means of predictor variables for helmet users and non-helmet users

Helmet use	Predictor variables		
	Healthy behavior (range 0–4)	Risk taking (range 0–5)	Parental involvement (range 0–4)
Helmet users	2.84	0.89	3.52
Non-helmet users	2.54	1.17	3.29

Table 4 Twenty six country model of bicycle helmet use

Measure	Odds ratio	95% CI	*t* Ratio	p Value
Individual level predictors				
Age 13*	0.36	0.34–0.37	−45.57	0.000
Age 15*	0.20	0.19–0.21	−55.79	0.000
Female	0.81	0.78–0.84	−10.65	0.000
Parental involvement	1.09	1.06–1.11	7.03	0.000
Risk taking	0.72	0.70–0.74	−22.09	0.000
Healthy behavior	1.99	1.94–2.05	50.55	0.000
Country level predictors				
Per capita GDP	1.88	1.34–2.62	3.86	0.001

*The reference group was age 11.

users, 7.3% increase in the scale of parental involvement for helmet users, to only 2.5% increase in the physical activity scale for helmet users.

To examine the multivariate relation of predictors to helmet use, we constructed a set of models, focused on measures for all 26 of the countries included in the analyses (table 4). The odds ratios are interpreted as the change in odds of helmet use for students with a given characteristic (female and age), or the change in odds given a 1 standard deviation increase in the predictor (for the individual level scales and GDP). For the individual level predictors in table 4, age was significantly and negatively related to helmet use. In contrast to unadjusted frequencies, noted above, males were slightly but significantly more likely than females to use helmets frequently. Parental involvement and healthy behavior were positively related to helmet use, while risk taking was negatively related to helmet use.

On the country level, per capita GDP was significantly related to high levels of helmet use. GDP explained approximately 29.1% of the variation between countries in the mean frequency of helmet use.

The country policy survey pointed to some important cross national comparisons that might explain additional variation in levels of student helmet use. As shown in table 5, there were clear differences in the number and type of programmes reported in each country. Of the helmet promotion strategies listed in table 5, more strategies were reported on a regional level than on a national level. On the national level, the most commonly reported strategy involved media based campaigns aimed at changing social perceptions about bicycle helmets. On the regional level, the most commonly reported strategy was school based educational campaigns. At the time of the survey, only the USA and Canadian observers listed laws mandating helmet use, and these laws were described only on a regional basis. Sweden reported the most extensive helmet promotion efforts, with several programmes listed for both the national and regional level, while Hungary was the only country with no reported helmet promotion efforts.

Table 5 Countries' policies regarding bicycle helmet use

	Countries, n (out of 12 completing survey)	Countries, % (out of 12 completing survey)
National helmet promotion efforts		
Laws	0	0
School based educational campaigns	3	25
Media based educational campaigns on the efficacy of helmets	3	25
Media based campaigns aimed at changing social perceptions about bicycle helmets	6	50
Helmet giveaways	4	33
Regional helmet promotion efforts		
Laws	2	17
School based educational campaigns	7	58
Media based educational campaigns on the efficacy of helmets	4	33
Media based campaigns aimed at changing social perceptions about bicycle helmets	5	42
Helmet giveaways	5	42

DISCUSSION

Although the majority of young adolescents in participating countries report that they ride bicycles, this study documents that there is considerable variation in rates of bicycle helmet use in these countries. Furthermore, the overall helmet use rates among young adolescents remains fairly low despite the public health importance of preventing head injury in bicycle crashes. In all of the HBSC countries during 1997–98, over half of the children rode bicycles, but in only three countries—Canada, Sweden, and Norway—did more than a third of the bicycle riders report regular bicycle helmet use.

Some of the between-child variation in bicycle helmet use is related to children's characteristics. Age was the single strongest predictor of helmet use, and this trend was consistent across countries. Younger students exhibited more helmet use, perhaps because they are more likely to comply with pro-safety messages from their parents or other adults.[8] Others have suggested that higher rates of usage in younger age groups may be due to the fact that helmet usage programmes are often targeted towards these groups.[31] This finding suggests that policy makers may need to specifically target older adolescents in order to increase their rates of use.

Certain behavior patterns (for example, health orientation and risk taking) are also predictive of helmet use. Further, parental involvement was a significant predictor of helmet use. This is consistent with past findings that social encouragement and parental rules both play a role in safety behaviors.[32 33]

Countries with higher per capita GDP showed higher rates of helmet use even after important child characteristics were taken into account. This association may result from it being financially easier for children in wealthier countries to acquire helmets. In addition or alternatively, wealthier nations may be more willing and able than less wealthy nations to dedicate resources to certain types of public health interventions, such as helmet promotion. However, the association with GDP explained only 29% of the variation among countries after adjustment for other individual factors.

For clues to possible explanation of the cross country variation, this study identified various helmet promotion strategies on a national level and even more diverse strategies on a regional level. In general the reported use of programmes within countries to promote bicycle helmet use corresponded to the student reported use of helmets, and for the countries where observers reported no programmes to promote helmet use, very few students reported use of helmets. The most frequently observed strategy related to reported helmet use was regional helmet giveaways. However, the informal survey we employed regarding helmet use promotion in selected participating countries was not an objective, representative survey. Therefore, the collected information does not permit a quantitative comparison of the effectiveness of different helmet promotion strategies, and this may just be an indication of the degree of national interest in bicycle helmet use.

There are additional limitations of this analysis that should be noted. First, the HBSC is a broadly focused study regarding the health behaviors of middle and high school aged children. For this reason, more in-depth information

might have been available from a study focused primarily on bicycle helmets. This study relied on self reporting from students about whether or not they wore helmets. Self reporting of behaviors in adolescents has been examined in several studies which have demonstrated a high level of reliability and validity of self report by adolescents about risk behaviors, although the reliability of this reporting decreases with increasing sensitivity of subject matter.[34–37] Compared to topics such as drug use or sexual activity, bicycle helmet use is not a particularly sensitive topic for teenagers, suggesting that in this instance self report may be a more dependable measure.

While we had expected to see stronger relations between individual or social characteristics of the HBSC students and their levels of helmet use, this study does indicate several factors, such as age and parental involvement, which should be integrated into planning for helmet promotion efforts. Furthermore, this study suggests that a wide variety of helmet promotion efforts are being used, and their relative effectiveness should be further explored in objective cross national comparisons. This study also demonstrates the feasibility of conducting an international comparison of factors influencing helmet use, and that such an analysis can be valuable for evaluating the effectiveness of various approaches to helmet promotion.

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Key points

- Helmet use decreases as adolescent age increases across all countries and is modestly associated with parent involvement and other healthy behaviors.
- Cross national frequencies of bicycle helmet use among young adolescents vary greatly between developed countries that is partly (29.1%) explained by per capita GDP.
- Countries with the highest rates of bicycle helmet use also report some intervention programmes to promote helmet use.

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Phone driver jailed for killing two policemen

A Swiss woman has been jailed for two and a half years for killing two French policemen in a road accident 2 years ago. The 34 year old woman was sending a text message as she drove down a motorway at 180 km/h with her children in the back seat. She ploughed into a police van, killing two officers and seriously injuring two others. The driver had just driven 1300 km from Spain and had only passed her driving test 3 months earlier. In addition to the prison sentence, she was fined €1300 and has been banned from driving for 5 years.

Contributed by Ian Scott, from WRG FM website.