Helmets for Kids: evaluation of a school-based helmet intervention in Cambodia

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ABSTRACT

Objective This paper analyses helmet use before and after implementing Helmets for Kids, a school-based helmet distribution and road safety programme in Cambodia.

Methods Nine intervention schools (with a total of 6721 students) and four control schools (with a total of 3031 students) were selected using purposive sampling to target schools where students were at high risk of road traffic injury. Eligible schools included those where at least 50% of students commute to school on bicycles or motorcycles, were located on a national road (high traffic density), had few or no street signs nearby, were located in an area with a history of crash injuries and were in a province where other Cambodia Helmet Vaccine Initiative activities occur. Programme's effectiveness at each school was measured through preintervention and postintervention roadside helmet observations of students as they arrived or left school. Research assistants conducted observations 1–2 weeks preintervention, 1–2 weeks postintervention, 10–12 weeks postintervention and at the end of the school year (3–4 months postintervention).

Results In intervention schools, observed student helmet use increased from an average of 0.46% at 1–2 weeks preintervention to an average of 87.9% at 1–2 weeks postintervention, 83.5% at 10–12 weeks postintervention and 86.5% at 3–4 months postintervention, coinciding with the end of the school year. Increased helmet use was observed in children commuting on bicycle or motorcycle, which showed similar patterns of helmet use. Helmet use remained between 0.35% and 0.70% in control schools throughout the study period.

Conclusions School-based helmet use programmes that combine helmet provision and road safety education might increase helmet use among children.

BACKGROUND

RTCs are among the world's foremost public health problems with 1.24 million deaths and 20–50 million non-fatal injuries per year. Road crashes are the eighth leading cause of all deaths globally and the leading cause of death for people aged 15–29 years.[1] Without appropriate and prompt interventions, by 2030, road traffic fatalities are expected to increase to nearly 1.9 million deaths annually.[2 3] Over 90% of road traffic deaths occur in low-income and middle-income countries, and fatality risk is expected to rise as low-income countries motorise.[1 4]

RTCs are a growing public health problem in Cambodia. According to Cambodia's national Road Crash and Victim Information System, road traffic fatalities increased from 9.3 per 100 000 population in 2006 to 13.1 per 100 000 population in 2012.[5 6] The number of registered vehicles in Cambodia also increased more than 200% between 2006 and 2012, while the population increased 7.7%.[5 6]

In 2012, 1966 of the 15 615 road crash injuries in Cambodia were fatal; of these, 156 were among children under 15 years old.[5] Furthermore, thousands of people sustain severe injuries requiring hospitalisation, resulting in lost income and educational opportunities, and sometimes permanent disability. The estimated economic cost of RTCs in Cambodia in 2012 was US$329 million.[5]

In Cambodia, motorcycles are the primary means of transportation. Motorcycles comprise over 80% of Cambodia's registered motor vehicles, and account for 67% of road traffic deaths annually.[1] From 2006 to 2012, the motorcyclist fatality rate increased by 28%, from 6.99 per 100 000 to 8.96 per 100 000.[5 6] Many motorcycle-related fatalities could be prevented if motorcycle drivers *and* passengers in Cambodia wore helmets consistently and correctly. Motorcycle helmets have been shown to reduce the risk of death by 42% and head injury by 69%.[7] Cambodian law mandates helmet use for motorcycle drivers, but not passengers, including child passengers, contributing to low rates of helmet use.[8] One can legally drive a motorcycle in Cambodia at age 16, although this age restriction is not always observed in practice. Previous studies have shown that additional barriers to motorcycle helmet use include lack of access to high-quality and low-cost helmets, a belief that crash risk depends on trip length and helmet comfort.[8–10]

Although little data are available on injuries and deaths among bicyclists in Cambodia, bicyclists are also at high risk for injury and death. Like motorcyclists, bicyclists do not benefit from the protective shell of a car or from seat belts. Globally, few roads are designed with bicyclists' safety in mind, and in Cambodia, bicyclists share the same road space with cars and motorcycles.[11] Bicycle helmets have been shown to reduce the risk of head injuries by 63%–88%; therefore, increasing helmet use among bicyclists could prevent many head injuries in Cambodia.[12]

School-based and community-based road safety programmes promoting bicycle helmet use have shown some success in high-income countries in Europe, North America and Australia.[13–32] These interventions typically included one or more of the following: mandatory helmet policies, education campaigns and free or subsidised helmets.[13–32]

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Many school-based bicycle helmet programmes report increase in helmet use, decrease in head injuries and increase in road safety knowledge, but few have followed up several months after the intervention to measure long-term effectiveness.[19] A meta-analysis of non-legislative efforts indicates that community-based interventions providing free bicycle helmets are more likely to increase helmet use than interventions providing subsidised helmets and school-based programmes.[19] Several analyses of bicycle helmet promotion interventions and policies have used helmet observations to measure effectiveness.[13 17–30] However, none of these studies evaluated helmet promotion programmes in low-income and middle-income countries where helmet use is low, and the burden of road traffic injuries is highest, particularly among bicyclists and motorcyclists.

There is little research on school-based motorcycle helmet programmes. However, a school-based motorcycle helmet promotion programme in Greece showed a significant improvement in helmet and road safety knowledge after the programme was implemented.[32] Self-reported helmet-related attitudes and practices increased for students at public and vocational schools, but not at private schools.[32]

In 2010, the Asia Injury Prevention Foundation, together with government, private sector and non-governmental organisations, launched the Cambodia Helmet Vaccine Initiative to promote motorcycle helmet wearing in Cambodia. The Cambodia Helmet Vaccine Initiative is part of the Global Helmet Vaccine Initiative, a multicountry effort to increase helmet use. The *Helmets for Kids* (*HFK*) programme, which is now a component of the Global Helmet Vaccine Initiative, was launched in Vietnam in 2000, and was first implemented in Cambodia in 2006. The school-based programme aims to increase helmet use and road safety knowledge of students and teachers at target intervention schools. With assistance from the CDC, Asia Injury Prevention Foundation began collecting evaluation data for *HFK* in Cambodia in the 2011–2012 and 2012–2013 school years. The evaluation data included school-based helmet observations and surveys of road safety knowledge and attitudes among students. This paper describes the *HFK* programme's effect on student helmet use while travelling to and from participating Cambodian schools on motorcycles or bicycles.

METHODS

Nine primary schools were selected for the *HFK* intervention over 2 years: five in school year 2011–2012 and four in 2012–2013. Four control schools were added in the 2012–2013 school year to determine whether the observed change in helmet use could be attributed, in part, to other changes in the environment, such as other Cambodia Helmet Vaccine Initiative activities (see table 1 for details of control and intervention schools).

The selection of schools for the *HFK* intervention was meant to ensure that the programme was implemented at schools where children were at high risk for road traffic injury. To determine high-risk schools, Asia Injury Prevention Foundation consulted with school officials to collect information on all primary schools located within the Cambodia Helmet Vaccine Initiative target areas. Based on this information, schools were purposively selected for the intervention using the following criteria: (1) at least 50% of students travelled to school on motorcycles or bicycles (2) school must be located on a national road (high-density traffic area), (3) school must be in an area with no or very few traffic signs and (4) school must be in a location identified as high risk based on police reports and a history of students and teachers being involved in crashes. In the second year, the four schools selected for the *HFK* intervention were matched 1:1 with control schools selected on the same criteria, and matched on size and urban/rural status.

All selected schools were primary schools with students in grades 1–5. The number of students ranged from 241 to 1883 at intervention schools and from 328 to 1132 at control schools. The road user mix of students commuting to each school varied from 53% to 85% bicyclists/motorcyclists in intervention schools and from 58% to 92% at control schools. The majority of students at intervention and control schools commuted on bicycle (see table 1).

HFK programme

HFK provides free, high-quality tropical helmets to primary school students. Tropical helmets were developed to meet the needs of motorcyclists in hot climates: they are well ventilated and light weight.[33 34] The donated helmets are produced in

Table 1 Characteristics of *Helmets for Kids* intervention and control schools in Cambodia

School year implemented	School ID	Number of students	Number of teachers	Students commuting to school by bicycle or motorcycle (bicycle; motorcycle)	Rural/urban status
2012–2013	I1	304	20	85% (5%; 80%)	Urban
2012–2013	I2	1206	35	80% (70%; 10%)	Rural
2012–2013	I3	946	45	60% (50%; 10%)	Urban
2012–2013	I4	603	19	73% (63%; 10%)	Rural
2011–2012	I5	800	28	67% (51%; 16%)	Rural
2011–2012	I6	263	8	59% (48%; 11%)	Rural
2011–2012	I7	241	8	53% (39%; 14%)	Rural
2011–2012	I8	475	25	80% (74%; 6%)	Rural
2011–2012	I9	1883	50	69% (43%; 26%)	Urban
Control schools	**School ID**	**Number of students**	**Number of teachers**	**Students commuting to school by bicycle or motorcycle (bicycle; motorcycle)**	**Rural/urban status**
2012–2013	C1	328	20	80% (6%; 74%)	Urban
2012–2013	C2	1132	29	62% (54%; 8%)	Rural
2012–2013	C3	950	28	92% (69%; 23%)	Urban
2012–2013	C4	621	19	58% (50%; 8%)	Rural

Vietnam to meet Standard QCVN 2 2008:B.[35] The helmets are appropriate for use on motorcycles and bicycles, and are fitted to each student. *HFK* educates students and teachers on traffic safety, and asks parents to encourage their children to wear helmets (http://asiainjury.org/our-reach/cambodia/). Further, *HFK* attempts to create an environment that encourages helmet use through social norms and school policy.

At each intervention school, a handover ceremony occurred with each helmet donation. The handover ceremony served as the beginning of the programme activities. The ceremonies emphasised the importance of helmets and commitment to the *HFK* programme.

The road safety education programme included 1–2 h of in-school training and extracurricular activities facilitated by Asia Injury Prevention Foundation staff to reinforce students' road safety knowledge. The curriculum and activities were the same across all schools. The road safety curriculum emphasised the importance of wearing helmets, how to fit and properly wear a helmet (emphasising the need to strap the helmet) and how to care for helmets. Extracurricular activities included road safety games and quizzes that reinforced *HFK* messages. Murals with road safety messages were painted on the walls and fences at schools.

Among the nine intervention schools, two received the intervention in two consecutive school years. This included road safety education programmes over 2 years, a helmet donation to all students in 2011–2012 and a 'topoff' donation in the second year (2012–2013) to new students and students who had damaged or lost their helmets.

Overall, 7031 helmets were distributed, including 310 in the 'topoff' donations. Students at control schools did not receive helmets, and did not take part in any intervention activities. However, both intervention and control schools were located in provinces where provincial helmet promotion occurred. Therefore, students in control schools may have been exposed to Cambodia Helmet Vaccine Initiative television commercials, billboards or radio ads promoting helmet use.

HFK evaluation

Trained research assistants videotaped either as students arrived to or departed from school to document helmet use. Helmet observations were conducted at both intervention and control schools. Control schools were not added until the second year of the programme (2012–2013). At each school, research assistants conducted helmet observations four times per school year: 1–2 weeks before helmet distribution (pre), 1–2 weeks after the helmet distribution (post I), 10–12 weeks after helmet distribution (post II) and at the end of the school year (post III). The school year ended 3–4 months after the intervention at each school. Schools were not told in advance on which day helmet observations would occur, but knew helmet observations would occur four times throughout the school year. Schools were coded from I1 to I4 for intervention commencing school year 2012–2013, from I5 to I9 for intervention commencing 2011–2012 and from C1 to C4 for control schools.

Cameras were placed in the same position and at the same time of the day for each set of observations at a school. Individual students could not be identified in the recordings. Research assistants conducted the video observations and visited the schools in advance to identify the best camera location to capture students arriving and leaving school. Observations were typically recorded at the school's main gates under comparable weather conditions.

Data captured for each student observed on a bicycle or motorcycle included: wearing helmet (yes or no) and type of vehicle (motorcycle or bicycle). Students riding motorcycles were passengers, while students riding bicycles were drivers. Coders also attempted to capture whether or not the helmet was buckled (yes or no); however, this information was difficult to observe and less reliable than whether a student was wearing a helmet at all. A single observer watched each video three times and averaged the results.

The primary purpose of the helmet observation data was to determine the effectiveness of the programme at each school; the analytical approach stems from this purpose. We employed a basic pre–post design, and included controls in the second year to capture potential province-level effects. For each school, the percentage of students wearing helmets is reported at each observation point in the initial year of the intervention (pre, post I, post II and post III), along with the difference in helmet use between the first and last observation point. This difference is used to determine programme effectiveness for each school. As a summary measure, average helmet-wearing percentages, weighted by the number of observations, are also presented for both intervention and control schools. Difference in weighted average helmet use between intervention and control schools is also reported as a summary measure. A two-sample t test was conducted to compare weighted average helmet use at intervention and control schools at each observation period.

Schools I5 and I8 received the intervention in consecutive years; for these schools, data from both years of the intervention are presented graphically to show the extent to which helmet use was sustained across school years. The protocol was determined to satisfy the requirements of the institutional review boards of the CDC and the National Center for Injury Prevention and Control.

RESULTS

Before helmet distribution (pre), the helmet wearing rate among students was negligible: overall, only 0.46% (range 0.0%–3.30%) of the 2478 students observed commuting to and from intervention schools by motorcycle or bicycle were wearing a helmet. Similarly, baseline helmet wearing rates among the 607 students observed at the four control schools averaged 0.35% (range 0.0%–0.7%).

Observed helmet use at intervention schools increased by at least 70 percentage points at each intervention school by the end of the school year, as shown in table 2.

The observed helmet use rate at intervention schools, weighted by the number of observations per school, averaged 87.9% (range 58.9%–100.0%) at post I, 83.5% (range 52.7%–98.0%) at post II and 86.5% (range 70.7%–100.0%) at post III. This increase was consistent for both bicycle and motorcycle helmet use, as shown in figure 1. Of students wearing helmets, approximately 99% of helmets were strapped.

In table 3, helmet wearing rates at control schools did not change much over the course of the study period, with a weighted average of 0.33% at post I (range 0.0%–4.9%), 0.70% at post II (range 0.0%–3.0%) and 0.38% at post III (range 0.0%–2.1%).

Weighted average helmet use preintervention was not significantly different between intervention and control schools ($t(10) = 1.15$, $p = 0.277$). However, the weighted average helmet use of intervention and control schools was significantly different at post I ($t(10) = 306.17$, $p < 0.00001$), post II ($t(10) = 265.16$, $p < 0.00001$) and post III ($t(10) = 270.08$, $p < 0.00001$).

Table 2 Observed helmet use among students commuting on bicycles or motorcycles at each observation period in *Helmets for Kids* intervention schools in the first year of intervention in Cambodia

School ID (school year intervention commenced)	Number of students in school N=6721	Pre (1–2 weeks before intervention)		Post I (1–2 weeks after intervention)		Post II (10–12 weeks after intervention)		Post III (3–4 months after intervention)		Difference between pre and post III Percentage points
		n (obs)	% helmet	n (obs)	% helmet	n (obs)	% helmet	n (obs)	% helmet	
I1 (2012–2013)	304	60	3.3	61	75.4	81	77.8	44	85.7	82.4
I2 (2012–2013)	1206	500	0.2	589	94.5	512	97.5	473	95.3	95.1
I3 (2012–2013)	946	306	0.0	293	90.1	219	82.6	323	80.5	80.5
I4 (2012–2013)	603	224	0.0	255	91.8	192	84.4	140	82.9	82.9
I5 (2011–2012)	800	272	0.0	323	96.9	284	97.5	NA*	NA*	97.5*
I6 (2011–2012)	263	146	0.0	130	99.2	110	94.5	80	100.0	100.0
I7 (2011–2012)	241	59	0.0	103	100.0	61	90.2	36	100.0	100.0
I8 (2011–2012)	475	282	0.0	166	98.8	216	97.2	229	93.9	93.9
I9 (2011–2012)	1883	775	0.0	419	58.9	495	52.7	317	70.7	70.7
Weighted average†			0.46		87.9		83.5		86.5	

n=total number of students observed; %=percent of students observed wearing a helmet.
*NA: end of year helmet use could not be observed at school I5 because it closed unexpectedly early due to a viral illness among the students. Difference in per cent helmeted between post II and pre is reported.
†Each school's reported helmet use is weighted by the number of observations when calculating weighted average.

In the schools that received the intervention over two consecutive years (I5 and I8), observed helmet use remained above 50% over the course of the intervention (figure 2). An additional 310 helmets were distributed to students who were not enrolled at I5 and I8 schools in the first year and to students who had damaged or lost their helmets. Prior to the handover event for the second year, the helmet wearing rates were 86.3% and 59.9% at schools I5 and I8, and continued to remain high throughout the study period, as shown in figure 2.

DISCUSSION

HFK helped raise helmet wearing rates at intervention schools. Although the ability to observe whether helmets were buckled was difficult, nearly all (approximately 99%) students had buckled helmets, suggesting that students understood how to properly wear a helmet. In contrast, observed helmet use at the four control schools did not change significantly during the study period. These findings are similar to the implementation of *HFK* in Vietnam where helmet wearing rates increased from 25% before intervention to an average of 94% after helmet distribution and education (results presented at conference).[36] Similar programmes in high-income countries have also increased helmet use.[17] Cambodia's road traffic injury burden is high, and the majority of road users are motorcyclists or bicyclists. *HFK*, and programmes like it, may reduce childhood head injuries and deaths. Further research is needed to determine whether helmet education and provision programmes can be widely applied in low-income and middle-income countries where bicycles and motorcycles are widely used.

Previous studies have shown that children in Cambodia and elsewhere are strongly influenced by the helmet-use behaviour of their peers; therefore, programmes such as *HFK* might have a role in building a broader road safety culture in families and communities where *HFK* is implemented.[18 21 30 36 37] The Cambodia Helmet Vaccine Initiative also implements population-based interventions to encourage helmet use, such as behaviour-change communication campaigns. Messages from the community-based campaign and *HFK* are meant to be complementary to each other. The increase in helmet wearing rates might not have been as high without the community-based campaign. However, results from control schools suggest that public awareness campaigns alone are not enough to increase child helmet use. Only one control school (C1) had helmet use above 1% at any observation point. This school had a high proportion of students commuting to school by motorcycle. Helmet use may have been influenced by other local activities focused on promoting motorcycle passenger helmet use. School I1 also had a high rate of students commuting as motorcycle passengers, and was the only intervention school with recorded helmet use in the 'pre' observation period (3.30%).

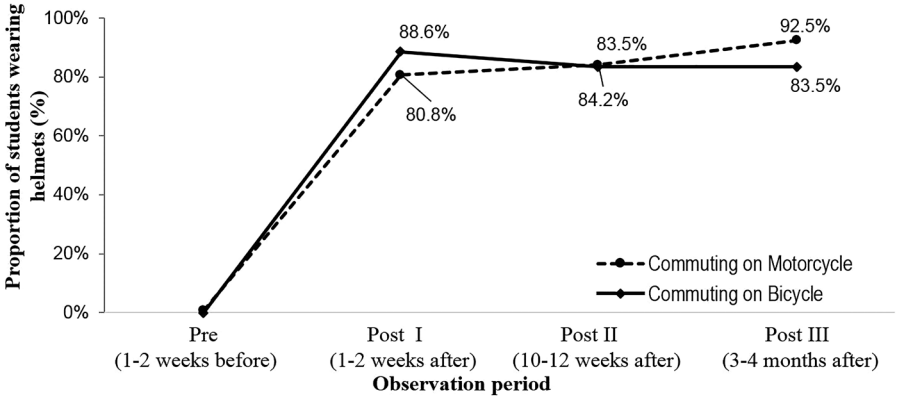

Figure 1 Average helmet use among students commuting on bicycle or motorcycle at each observation period in the nine *Helmets for Kids* intervention schools by vehicle type.

Table 3 Observed helmet use among students commuting on bicycles or motorcycles at each observation period in the four control schools in Cambodia, 2012–2013

School ID (school year intervention commenced)	Number of students in school N=3031	Pre (1–2 weeks before intervention)		Post I (1–2 weeks after intervention)		Post II (10–12 weeks after intervention)		Post III (3–4 months after intervention)	
		n (obs)	% helmet	n (obs)	% helmet	n (obs)	% helmet	n (obs)	% helmet
C1 (2012–2013)	328	73	0.0	82	4.9	70	3.0	95	2.1
C2 (2012–2013)	1132	303	0.7	268	0.4	230	0.0	261	0.0
C3 (2012–2013)	950	62	0.0	90	0.0	88	0.0	62	0.0
C4 (2012–2013)	621	169	0.0	284	0.0	253	0.0	106	0.0
Weighted average*			0.35		0.70		0.33		0.38

n=total number of students observed; %=percent of students observed wearing a helmet.
*Each school's reported helmet use is weighted by the number of observations when calculating weighted average.

Of note, one school (I9) showed a markedly lower rate of helmet use than other intervention schools. Qualitative investigations found that teachers in this school spent less time on road safety education activities, in part due to a lack of commitment from the school principal. Although the aim was to have a helmet for each child, this school did not receive enough helmets for each student. This school demonstrates the potential challenges associated with implementing *HFK* (eg, lack of buy-in from administration, limited resources), but suggests that comprehensive school-based helmet programmes can make a significant difference in helmet use even when implementation is compromised.

This study has limitations. First, research assistants did not conduct helmet observations after the end of the school year to determine how long helmet use was maintained. However, schools I5 and I8 implemented *HFK* over 2 years. These schools maintained helmet use rates of 86.3% and 59.9%, respectively, in the weeks before the second year of activities began (figure 2). Although the proportion of helmeted students decreased during the school break, helmet use among students remained high beyond the initial intervention school year. This shows promise for long-term increases in helmet use. Helmet use was only measured when students arrived at or left school. Further research is needed to determine whether or not students exposed to the programme use helmets outside the school setting and in the years after the intervention. It would also be beneficial to determine whether or not schools receiving *HFK* continue to teach safe road behaviours, and encourage students to consistently wear a helmet after the programme ends. Last, the pre–post study design is limited. Determining the magnitude of the change in helmet use is not feasible with the current study design. The findings might not be generalisable to all schools in Cambodia as schools were selected using purposive sampling as described above. The intervention was implemented at schools where students are at high risk of crashes, and have an interest in road safety. Schools interested in participating in the programme may be more likely to have increased helmet use.

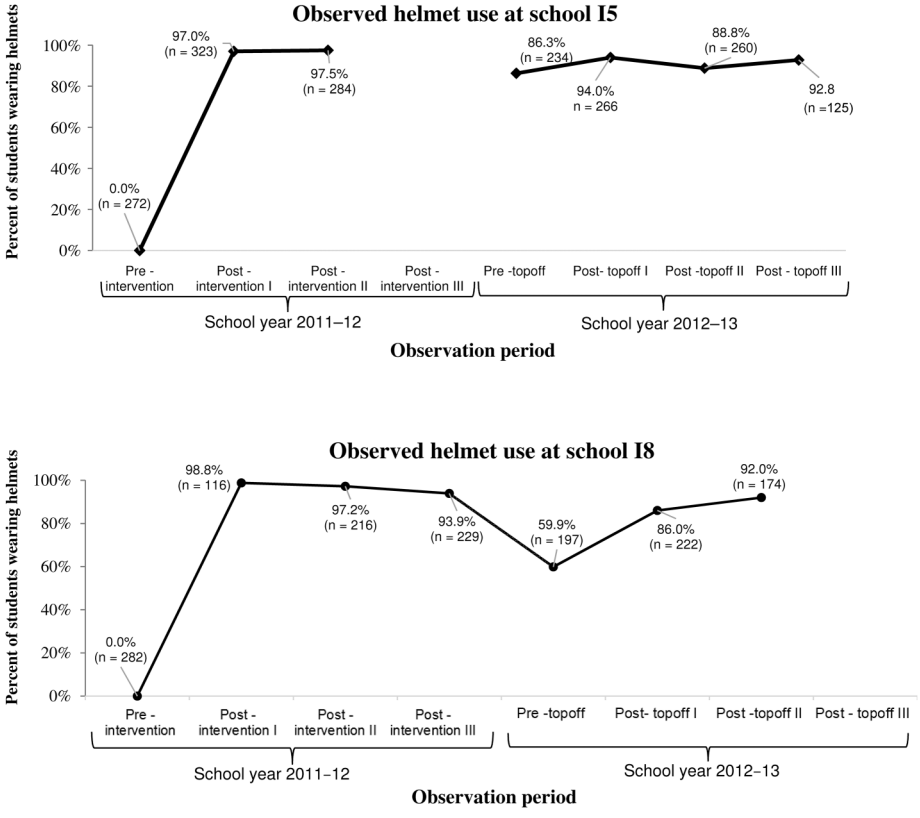

Figure 2 Observed helmet use in two Cambodian schools (15 and 18) that received *Helmets for Kids* over two consecutive years. The postintervention II observation for I5 coincided with the end of the school year. No further observations were made. School I5 did not conduct postintervention III helmet observations because the school ended classes early in 2011–2012 due to illness. The post-topoff II helmet observation for I8 coincided with the end of the school year. School I8 did not conduct the post-topoff III helmet observation because helmets were distributed late.

In future evaluations, it would be useful to implement more rigorous evaluation such as a randomised controlled trial. Further evaluations may also compare helmet use in schools that receive the full *HFK* intervention against control schools with educational activities only and control schools that receive only helmet provision without educational activities. This would help quantify which components increase helmet use most and by how much. Future evaluations could also test the importance of providing helmets for free compared with subsidised helmets. Evidence from high-income countries suggests that free helmet programmes are more likely to increase helmet use than programmes offering discounted helmets.[17]

This study contributes new evidence for programmes that aim to increase child helmet use in low-income and middle-income countries, and specifically for school-based programmes that combine helmet provision and education. Evaluation data from Vietnam have demonstrated *HFK*'s ability to increase helmet use,[36] but this is the first time that control schools have been included for an *HFK* programme. This study is also important given the current increasing burden of road traffic injury in low-income and middle-income countries, and the pressing need for effective interventions to decrease motor vehicle injuries and deaths and increase road safety.

What is already known on the subject?

- Vulnerable road users, including motorcyclists and bicyclists, suffer a disproportionate burden of road traffic injuries and deaths in low-income and middle-income countries.
- Helmet use is low among Cambodian children.
- Motorcycle and bicycle helmet use reduces the risk of head injury in children.

What this study adds?

- School-based helmet programmes that include helmet distribution and education can increase child helmet use during school commutes.
- Helmet use increases can be sustained throughout the school year.

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Contributors All authors reviewed the manuscript and provided revisions several times. DJE, TVB and EMP were primarily responsible for drafting, revisions and analysis. MS, PK and SS were primarily responsible for implementing the programme and data collection. MFB, DRR and MJF conceptualised and designed the evaluation, and helped interpret the data. All authors approved the submission for publication.

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Competing interests Asia Injury Prevention Foundation authors are reporting on evaluation results of a programme they developed as part of the Cambodia Helmet Vaccine Initiative.

Ethics approval Institutional Review Board of the C DC.

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Preventing concussions

To reduce concussions, the American Academy of Pediatrics' Council on Sports Medicine and Fitness has proposed restricting body checking among youth ice hockey players. As well, US Soccer stated it will restrict the use of headers in players under age 10, and limit its use in practice among 11 to 13 year-olds. Some believe neck muscle strengthening may help prevent some concussions in youth sports but this remains unproven.

Dangers of cheerleading

As we reported previously, cheerleading ranks high among dangerous sports. Head injuries and concussions comprise about 5% of all cheerleading injuries. They increased by 26% each year from 1998 to 2008.

Helmets for Kids: evaluation of a school-based helmet intervention in Cambodia

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