# Bicycle Helmet Assessment During Well Visits Reveals Severe Shortcomings in Condition and Fit

Gregory W. Parkinson, MD, FAAP, and Kelly E. Hike, BA

**ABSTRACT.** *Background.* **Improper bicycle helmet fit increases the risk of head injury.[1] Information on the rate of proper use of bicycle helmets is lacking. Promotion of helmet use is recommended at well-child and adolescent visits.[2] Actual helmet assessment during such visits has not been reported.**

*Objectives.* **The primary goal of this study is to measure the proportion of children whose helmets are in proper condition and can be made to fit properly by the child and/or parent. The secondary goal is to begin to assess the value and practicality of helmet inspection during well-child and adolescent visits.**

*Methods.* **The study took place at a private pediatric office in Falmouth, Massachusetts, from June 1 through August 31, 2001. Eligible children and adolescents were those aged 4 to 18 years presenting for well examination, along with siblings present at the visit. Eligible families completed a questionnaire, then had a timed attempt to fit a helmet, followed by an assessment of helmet fit and condition against a predetermined standard.**

*Results.* **Eighty-four percent (395/473) of eligible families participated. A total of 479 participants were assessed. Eighty-eight percent of participants (419/478) owned a helmet. Reported helmet use "always" or "almost always" was 73% for bicycling (317/434), 69% for in-line skating (193/279), 58% for scootering (179/310), and 50% for skateboarding (79/158). Compared with younger children, teenagers were less likely to wear helmets for all activities. Complete pass rate for every aspect of condition and fit was 4% (20/478, 95% confidence interval: 3–6). The pass rate when the parent alone fit the helmet was 0% (0/52). Three individual aspects of fit were most problematic: 1) helmet 'resting position' too high on the forehead (pass rate 249/479; 52%), 2) improper strap position (pass rate 157/476; 33%), and 3) excessive movement of the helmet from front to back of the head (pass rate 247/479; 52%). Mean time for questionnaire completion was 4 (standard deviation: ±1) minutes, and 7 (standard deviation: ±3) minutes for helmet assessment.**

*Conclusions.* **Ninety-six percent of children and adolescents wore helmets in inadequate condition and/or with inadequate fit. This occurred despite a high acceptance of helmet use by this population. Initial evidence suggests that helmet assessment during well visits may be practical and valuable.** *Pediatrics* **2003;112:320–323;** ***bicycle helmet, condition, fit, assessment.***

From Falmouth Pediatric Associates, Falmouth, Massachusetts.
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Reprint requests to (G.W.P.) Falmouth Pediatric Associates, 2 Bramblebush Park, Falmouth, MA 02540. E-mail: gparkinson@massmed.org


Head injury sustained during recreational activities continues to be a leading source of death. There are ~900 bicycle-related deaths per year in the United States; three quarters of these are attributable to head injury.[3] In 1997 there were >4000 head injuries related to in-line skating.[4] Emergency department visits from scooter injuries increased by 18 times between May and October 2000 alone;[5] of these, ~27% involved the head and face. In addition, it is estimated that in 1999 >59 000 skateboard injuries occurred,[6] ~7% of which involved the head.[7]

Helmets substantially reduce the incidence of head injury.[8] Although bicycle helmet use has increased, recent data suggests that only 12% to 15% of in-line skaters wear helmets.[4,9,10] Further, Rivara[1] et al have documented that among injured cyclists wearing helmets, poor helmet fit increases the rate of head injury. However, there are no detailed reports of the prevalence of proper helmet condition and fit. The American Academy of Pediatrics recommends promotion of helmet use as part of routine anticipatory guidance at well pediatric visits.[2] However, actual assessment of the helmet during such visits has not been reported.

The primary goal of this study was to document the prevalence of proper helmet condition and fit in a primary care setting, and the factors related to proper helmet use. The secondary goal is to investigate the value and practicality of actual helmet assessment during well visits.

## METHODS

### Experimental Design

The study was a prospective, cross-sectional assessment of the condition of children's bicycle helmets and the ability of children and/or their parents to properly fit a helmet.

### Setting and Participants

The setting was Falmouth (Cape Cod), Massachusetts, a town with a year-round population of ~30 000, which increases to >75 000 in the summer. Falmouth Pediatric Associates, LLP, is a 3-pediatrician office-based primary care practice. It is 1 of 2 pediatric practices in the area. Patients are almost exclusively year-round residents.

Data were collected between June 1 and August 31, 2001. All children and adolescents aged 4 to 18 years presenting for well visits during office hours were eligible, as were appropriate-aged siblings present at the same visit. Participants were excluded if siblings had presented on a previous day or in the presence of severe developmental delay or disability that would preclude use of bicycles, etc.

### Intervention

Families were contacted by telephone 1 or 2 business days before the well visit. The study was explained, and the family was asked to bring the child/adolescent's helmet to the visit. If contact was unsuccessful, a message was left where possible. For those not reached in advance, the study was explained at the office.

Before or after the well visit, 1 investigator (K.E.H.) met the patient/family and reexplained the study. A cover letter, which included a disclaimer, was given. This was followed by a 15-item questionnaire, including questions related to demographics, participation and helmet use patterns, helmet condition, teaching of helmet fit, and personal knowledge of a head injury victim. Only those children who participated in an activity (eg, bicycling) answered questions about helmet use for that activity.

Subsequently, an attempt to fit the helmet as well as possible was made by the patient/parent; this was done using the child/adolescent's helmet if present or, if not, using a helmet borrowed from our stock of several brands. For preteens, the parent was required to complete the questionnaire and to at least supervise the helmet fitting, while teens could do both, with or without their parents. This design was an attempt to simulate real life conditions.

Helmet fit and condition was then assessed by the same investigator (K.E.H.), according to a protocol, modified from Thompson et al.[11] Four broad categories were used for assessment: 1) condition, 2) stability, 3) room, and 4) strap (see Table 1 and Fig 1). Each category had from 2 to 5 subcomponents (14 total).

The duration of questionnaire completion, helmet-fitting, and assessment were measured and recorded. Finally, a handout on bicycle helmet fit was given and explained.

### Pass Criteria

To be considered a "pass", all 14 subcomponents from the 4 categories assessed had to be passed. Participants who used one of our new helmets were not assessed for condition; these helmets were required to pass the 9 subcomponents from the stability, room, and strap categories.

### Data Analysis

Data were entered into the *EpiInfo 6.04 Y2K Update* and *EpiInfo 2000*[12] with data cleaning at the time of entry and duplicate data review to reduce error. The relationship between variables was examined via $2 \times 2$ tables and $\chi^2$.

### Ethical Approval and Consent

The study was ethically reviewed and approved by a committee from Falmouth Hospital, the local acute care health care facility. Parental consent was required for all minors; 18-year-olds could give their own consent.

## RESULTS

This data indicates that only 4% (20/479) of children and parents passed the entire evaluation of condition and fit. There were 3 main difficulties encountered: 1) helmet resting position too high on the forehead, 2) improper strap position (failure of the straps to make a 'V' around the ears), and 3) excessive movement of the helmet from front to back of the head. The details of the results will now be explained.

A total of 479 children from 395 families took part. Four hundred seventy-three eligible families were scheduled for well visits during the study period, giving an assessment rate of 84% (395/473). Seventy

**TABLE 1.** Helmet Assessment Data

| Category | Number (%) | 95% Confidence Interval |
|---|---|---|
| 1) Condition | | |
| Proper certification* | 227/256 (89) | 84–92 |
| No history of helmet injury | 376/419 (90) | 87–92 |
| Helmet age <10 y | 388/390 (99) | 98–100 |
| Acceptable helmet wear | 185/267 (69) | 64–75 |
| Plastic cover present | 263/267 (99) | 96–100 |
| Plastic cover intact (hairline crack acceptable) | 231/267 (87) | 82–90 |
| Total pass Condition | 141/255 (55) | 49–61 |
| 2) Room | | |
| Space for <2 finger breadths in front of helmet | 472/479 (99) | 97–99 |
| Space for <2 finger breadths in side of helmet | 468/479 (97) | 96–99 |
| Correct size† | 250/372 | 62–72 |
| Total pass Room | 247/372 (66) | 61–71 |
| 3) Strap | | |
| Strap 'V' around ear; clip below ear | 157/476 (33) | 29–37 |
| Helmet front pulls down over forehead when mouth opened. | 231/477 (48) | 44–53 |
| Total pass Strap | 101/474 (21) | 18–25 |
| 4) Stability | | |
| Resting position <2 finger breadths above brow | 249/479 (52) | 48–56 |
| Side-to-side movement ≤1 in§ | 350/479 (73) | 69–77 |
| Front-to-front movement ≤1 in | 247/479 (52) | 47–56 |
| Rotational movement ≤1 in | 366/478 (77) | 73–80 |
| Total pass Stability | 97/478 (20) | 17–24 |
| Total pass Overall | 20/479 (4) | 3–6 |

* Consumer Product Safety Commission, Snell, American Society for Testing and Materials, American National Standards Institute, or Canadian Standards Association; although the accepted standard in the United States has been the Consumer Product Safety Commission since 1999, because many helmets would be more than 2 years old it was felt more reasonable to be flexible in type of certification.

† Head circumference measured and reference chart for appropriate size used. For 108 (22%), size couldn't be definitively determined because of loss of sticker.

§ See Fig 1.

Note that small differences in denominators are accounted for by missing data. Large differences relate to the nonapplicability of certain questions to those that tried on our new helmets (eg, they were not assessed for helmet condition).


**Fig 1.** Photograph of directions to assess helmet movement: 1, "front to back"; 2, "rotation"; and 3, "side to side."

families did not arrive for a scheduled visit or did not have appropriate consent, and 8 refused participation. The mean participant's age was 10 years (standard deviation: ±4 years). Sixty-one percent of participants (292/479) were 12 years or younger and 39% (187/479) were 13 years or older. Ninety-four percent (452/479) were accompanied by a parent. Ninety-one percent of participants who responded (394/434) were white (see Table 2).

Participation rates for activities within the previous year were 91% for bicycling, 58% for in-line skating, 65% for scootering, and 33% for skateboarding.

Eighty-eight percent of participants owned a bicycle helmet, 56% actually brought their helmet to the visit, and 44% used a helmet that we provided. Helmet use data are shown in Table 3. Self- (or parent)-reported helmet use "always" or "almost always" was 73% for cyclists, 69% for in-line skaters, 58% for scooter riders, and 50% for skateboarders. For all groups, helmet use was higher for preteenagers than for teenagers ($P < .001$). Ninety percent of participants felt that it was "easy" or "pretty easy" to fit a helmet.

Helmet pass rates are shown in Table 1. The pass rates for individual categories were as follows: 55% for condition, 20% for stability, 66% for room, and 21% for strap. The complete pass rate in every category assessed was 4%.

Assessment time was 4 minutes (standard deviation: ±1 minute) for questionnaire completion, 7 (standard deviation: ±3) minutes for assessment and feedback and 11 (standard deviation: ±3) minutes overall.

**TABLE 2.** Demographics

| Characteristic | Result |
|---|---|
| Family recruitment rate (percent) | 395/473 (84) |
| Number of participants | 479 |
| Age (years ± standard deviation) | 10 (±4) |
| Race distribution | |
| White | 389/434 (89) |
| Black | 9/434 (2) |
| Native American | 31/434 (7) |
| Other | 9/434 (2) |
| Participants accompanied by parent | 452/479 (94) |

## DISCUSSION

This is the first study to examine the issue of helmet condition and fit in detail. In short, even in our controlled setting, the overwhelming majority of children, adolescents and their parents cannot properly fit a bicycle helmet. This is true regardless of age, gender, level of education or frequency of bicycle use. By measuring the different components of condition and fit, it was possible to specifically identify the problem areas. There were 3 particular problems: 1) resting position too high on the forehead, 2) improper strap position and, as a result, 3) excessive helmet movement from front to back off the forehead. All of these factors expose the frontal region, the most common site of impact in bicycle head injuries.[13,14]

In 1989, Thompson et al[8] reported that helmet use reduced the incidence of bicycle related head injury by 85%. According to Consumer Product Safety Commission data,[15] helmet use increased from 18% in 1991 to 59% in 1999. Reported overall helmet use in this study was high (73% overall for bicycles). Although the validity of this data depends on reporting accuracy, this rate of helmet use would be one reason for cautious optimism.

However, Rivara et al[1] reported that improper helmet use is estimated to increase the risk of head injury by a factor of 3. In this light, our data suggests that most children and adolescents are receiving suboptimal head protection. Increased attention to teaching of helmet fit skills is required. We speculate that repeated reenforcement of proper helmet use techniques (ie, practice) will improve helmet fit rates. Possible locations for intervention include retail outlets, schools, bicycle rodeos, and (potentially) sites of pediatric care. A similar multidimensional approach has been shown effective for increasing the rate of helmet use.[16–19] Improvements in helmet design could also potentially simplify the process.

The practicality of helmet assessment in a medical setting has not been studied previously. However, the potential preventative health benefits make this idea worth considering. We speculate that assessment in a nonresearch setting will be substantially faster than it was in this study, and our anecdotal experience since the time of the initial data collection is consistent with this. Acceptance of routine helmet screening depends on convincing clinicians of its value as a preventative tool, which requires additional study. The value of many current routine components of the well examination has not been demonstrated,[20] and the authors caution against dismissal of an addition to the (already-demanding) well examination before an evidence-based evaluation of whether there is "fat to trim" from current recommendations.

This is also the first simultaneous assessment of helmet use patterns for bicycling, in-line skating, scooter-riding, and skateboarding. Although helmet use was a problem among adolescents in all groups,

**TABLE 3.** Self-Reported Helmet Use for Each Activity by Age Group

| Age Group (Years) | Helmet Use "Always" or "Almost Always" Percentages (95% Confidence Interval) | | | |
|---|---|---|---|---|
| | Bicycle | In-line Skates | Scooter | Skateboard |
| 4–8 | 89 (83–93) | 88 (79–94) | 80 (72–87) | 59 (44–72) |
| 9–12 | 82 (74–88) | 79 (71–86) | 64 (55–72) | 61 (49–72) |
| 13 or older | 49 (41–57) | 46 (36–55) | 21 (14–31) | 27 (16–41) |
| Overall | 73 (69–77) | 69 (63–75) | 58 (52–63) | 50 (42–58) |

scooters and skateboards show trends to decreased helmet use at an earlier age.

This study has potential weaknesses. The pass rate depends on the appropriateness of the criteria used for proper helmet fit, but our criteria were not overly stringent and were based on published guidelines.[11] In addition, a large majority of those who failed did so in >1 category. In fact, when the data were reanalyzed using only the most essential components (proper resting position, helmet movement not excessive, lack of significant visible damage), the pass rate was only raised to 19% (95% confidence interval: 15–23). The low overall pass rate limited the ability to analyze variables associated with passing. It is clear, however, that no group does sufficiently well. In addition, our population is predominantly white, not urban, and conceivably more health-conscious than families who did not receive well visits. The high reported rate of helmet use would suggest an acceptance of the importance of helmets. For this reason, we doubt that most other populations would show higher rates of proper fit.

## CONCLUSIONS

Although reported helmet use among our population was high, the vast majority of children and parents failed the helmet condition and/or fit assessment. Increased attention to helmet resting position low on the forehead, proper strap position, and reduction of front to back movement may help reduce head injury rates. This assessment could potentially become part of well child visits.

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