

Folksam

2025

**Folksam's report
on bicycle helmets
for children**

Why does Folksam test child bicycle helmets?

Every week approximately six children sustain a head injury and seek medical care at hospital after a bicycle accident in Sweden (Axelsson and Stigson 2019). In total 74 percent of the head injuries occur in a single bicycle crash. Even though only 14% of the head injuries occur when a motor vehicle was involved, these often result in the most severe injuries. The risk of sustaining a head injury is mitigated if the cyclist is wearing a helmet. This has been demonstrated by epidemiological studies showing that bicycle helmets can reduce head injury risk by up to 69% (Olivier and Creighton 2016). All helmets included in the test are approved according to the CE standard, which means that the energy absorption of the helmets has been tested with a perpendicular impact to the helmet (EN1078 2012). This does not fully reflect the scenario in a bike accident. In a fall or a collision, the impact to the head will be oblique (Willinger et al. 2014; Fahlstedt 2015; Bland et al. 2018). The intention was to simulate this in the test since it is known that angular acceleration is the dominating cause of brain injuries.

The objective of this test was to evaluate helmets sold on the European market for children. In total, nine conventional child bicycle helmets were selected from the Swedish market, Table 1. To ensure that a commonly used representative sample was chosen, the range of helmets available in bicycle/sports shops and in online shops were all considered. Four out of nine helmets were equipped with technologies aimed at reducing rotational acceleration (eight with MIPS (Multi-directional Impact Protection System) and one with KinetiCore). The recommendation in Sweden is that children up to seven years of age should be using a helmet with a green buckle. Therefore, child helmets with green buckles, a self-release system tested and approved according to CE standard EN 1080 (EN1080), were also selected. In this test, two out of nine child helmets were fitted with it.

Table 1. Included helmets

Bike helmets	Green buckle	Rotational technologies	Price (SEK)
Abus Smiley 3.0	Yes	-	600
Abus Kids Youdrop FF	No	-	1 500
Lazer Maze JR KinetiCore	No	KinetiCore	500
Limar 360° Teen	No	-	400
Limar Kid Pro M	No	-	350
Occano Junior Mips HLM	Yes	MIPS	600
Specialized Shuffle 2 led	No	MIPS	700
Sweet Protection Stringer Mips Helmet Junior	No	MIPS	900
Woom Kids´Helmet	No	-	900

Method

Five physical tests were conducted, two shock absorption tests with straight perpendicular impact and three oblique impact tests (Table 2). The tests were performed by Research Institutes of Sweden (RISE), which is accredited for testing and certification in accordance with the European standard. Computer simulations were subsequently carried out to evaluate the risk of concussion.

Shock absorption test

The helmet was dropped from a height of 1.5m onto a horizontal surface according to the European standard (EN1078 2012), which sets a maximum acceleration of 250g. The shock absorption test is included in the test standard for helmets, in contrast to the oblique tests. The helmet was impacted at two different locations: one at the top of the head and one at the side of the head, see Table 2.

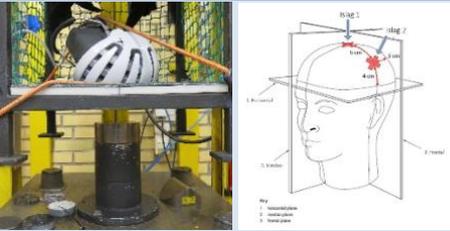
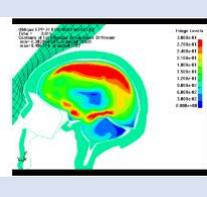
Oblique Tests

The helmeted head was dropped against a 45° inclined anvil with friction similar to asphalt (grinding paper Bosch quality 40). The impact speed was 6.25 m/s. The new test dummy head was used without an attached neck (SS-EN17950 2024). Two helmets were tested in each test configuration to minimize variations. The test set-up used in the present study corresponds to the CEN Working Group’s 11 “Rotational test methods” (Willinger et al. 2014).

Computer simulations with FE Model of the brain

Computer simulations were carried out for all oblique impact tests. The simulations were conducted by KTH (Royal Institute of Technology) in Stockholm, Sweden, using an FE model that has been validated against cadaver experiments (Kleiven and Hardy 2002; Kleiven 2006) and against real-world accidents (Kleiven 2007; Patton et al. 2013). It has been shown that a strain above 30% corresponds to a 50% risk for concussion (Fahlstedt et al 2022). As input into the FE model, X, Y and Z rotation and translational acceleration data from the experimental testing were used. The FE model of the brain used in the tests is described by Kleiven (Kleiven 2006; Kleiven 2007).

Table 2. Included tests

Included Test		
<p>Shock Absorption Test (EN 1078) The helmet was dropped from a height of 1.5 m to a horizontal surface correlated to the European Standard EN1077 test protocol. The ISO head form was used, and the helmets were tested in a temperature of 18°C. The head was impacted at two different locations. One at the top of the head and one at the side of the head, see figure. Velocity 4.7 m/s</p>		
<p>Oblique Impact – Rotation around X-axis Contact point on the side of the helmet resulting in a rotation around X-axis. Initial position of the headform X-, Y- and Z-axis 0° 5th percentile female dummy head form was used. Velocity 6.3 m/s</p>		
<p>Oblique Impact – Rotation around Y-axis Contact point on the upper part of the helmet resulting in a rotation around Y-axis. Initial position of the headform X-, Y- and Z-axis 0° 5th percentile female dummy head form was used. Velocity 6.3 m/s</p>		
<p>Oblique Impact – Rotation around Z-axis Contact point on the upper part of the helmet resulting in a rotation around Y-axis. Initial position of the headform X- and Z-axis 0° and 65° around Y-axis. 5th percentile female dummy head form was used. Velocity 6.3 m/s</p>		
<p>Computer Simulations Computer simulations were carried out for all oblique impact tests. As input into the FE model, the measured rotational and translational accelerations from the HIII head in the three tests above were used. A strain above 30% corresponds to a 50% risk for concussion.</p>		

Rating of helmets

The safety level of a helmet was rated relative to the median value for the test results of all the helmets included in test run. Since the most common brain injuries often occur in oblique impacts, the three oblique tests influenced the rating to a greater extent. The overall result was calculated according to the equation below, where T1 and T2 are the relative results in shock absorption and T3-5 are the relative results in the oblique impact tests. To obtain the best overall result and thereby be awarded our “Recommended” label, the helmet needs to perform better than the median in both the shock absorption test and the oblique impact test.

$$\frac{\frac{T_1 + T_2}{2} + \frac{2 * (T_3 + T_4 + T_5)}{3}}{3}$$

Results

One child helmet obtained the Folksam “Recommended” label: Occano Junior Mips HLM, Table 3. The helmets performed up to 19% better than the average helmet and is fitted with MIPS designed to reduce rotational energy. The helmet is also fitted with a green buckle.

Table 3. Overall results

Child Helmets 2021	Overall result	Folksam Recommended
Abus Smiley 3.0	-12%	2
Abus Youdrop FF	-1%	2
Lazer Maze JR Kineticore	-31%	1
Limar 360° Teen	-21%	1
Limar Kid Pro M	10%	2
Occano Junior Mips HLM	19%	Recommended
Specialized Shuffle 2 led	16%*	3
Sweet Protection Stringer Mips Helmet Junior	32%*	3
Woom Kids' Helmet	-7%	2

All helmets scored lower than 250 g in resultant acceleration in the shock absorption test (Figure 1). The lowest values were measured for the two helmets Woom Kids' Helmet (158 g impact crown) and Specialized Shuffle 2 led (156 g Impact side).

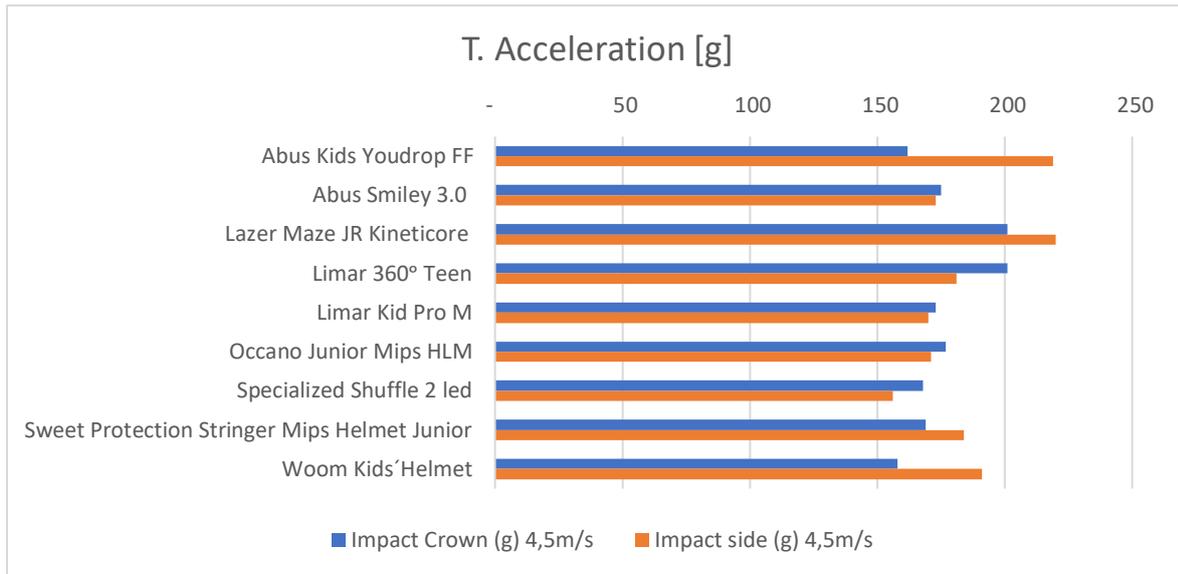


Figure 1. Shock Absorption measuring linear acceleration.

Table 4 shows the tests that reflect the helmet’s protective performance in a bike accident with oblique impact to the head (rotation around the X-axis, Y-axis and Z-axis). The simulations indicated that the strain in the grey matter of the brain during oblique impacts could vary between helmets, from 30% to 43%. In all three tests, all helmets except the Lazer Maze JR Kineticore and Limar 360° Teen performed below the threshold associated with a 50% risk of concussion.

Table 4. OBLIQUE TESTS (ROTATION AROUND THE X, Y AND Z-AXIS)

BICYCLE HELMET	OBLIQUE IMPACT A (X-AXIS)						OBLIQUE IMPACT B (Y-AXIS)						OBLIQUE IMPACT C (Z-AXIS)					
	T. ACC. [g]	R. ACC. [rad/s ²]	R. V [rad/s]	BrIC	Strain [%]	Risk of Concussion [%]	T. ACC. [g]	R. ACC. [rad/s ²]	R. V [rad/s]	BrIC	Strain [%]	Risk of Concussion [%]	T. ACC. [g]	R. ACC. [rad/s ²]	R. V [rad/s]	BrIC	Strain [%]	Risk of Concussion [%]
ABUS SMILEY 3.0 SE	135	5074	22,1	0,41	28	46	134	5686	24	0,40	25	33	133	6737	27	0,60	28	44
ABUS YOUDROP FF	132	4457	22,6	0,41	24	30	108	5267	28	0,48	25	35	120	5017	28	0,61	26	38
LAZER MAZE JR KINETICORE	144	4201	23,0	0,40	25	35	143	6632	27	0,46	28	44	172	9703	28	0,59	35	69
LIMAR 360 TEEN	160	4104	20,2	0,37	26	37	161	5839	25	0,43	25	33	167	8604	28	0,58	35	70
LIMAR KID PRO M	130	4445	20,7	0,38	24	29	121	4299	21	0,36	21	21	118	6232	29	0,65	28	43
OCCANO JUNIOR MIPS HLM	123	3881	15,1	0,30	23	28	154	3327	17	0,30	19	16	117	4969	23	0,49	25	33
SPECIALIZED SHUFFLE 2 LED	130	3329	20,8	0,39	24	29	125	3767	20	0,35	18	14	125	5256	27	0,60	28	44
SWEET PROTECTION STRINGER MIPS HELMET JUNIOR	112	3458	16,8	0,35	21	22	114	3152	22	0,38	18	13	114	3835	18	0,41	20	19
WOOM KIDS'HELMET	122	4376	23,0	0,41	26	37	133	6224	26	0,44	27	39	127	6235	26	0,56	27	39

Discussion

The current European certification test standard does not cover the helmets' capacity to reduce rotational acceleration, i.e., when the head is exposed to rotation due to impact. The present study provides evidence of the relevance of including the helmets' ability to reduce rotational acceleration in consumer tests as well in legal requirements. The results have shown that rotational acceleration after impact varies widely among helmets on the European market. They also indicate that there is a link between rotational energy and strain in the grey matter of the brain. In future, legal helmet requirements should therefore ensure a good performance for rotational loading as well. Before this happens, consumer tests play an important role in informing and guiding consumers in their choice of helmets. Since 2012 Folksam have conducted 18 consumer helmet tests (13 bicycle helmet tests, three equestrian helmet tests and two ski helmet tests). During this time, the proportion of helmets fitted with additional new technologies designed to reduce rotational acceleration have become increasingly common. In this round of testing, four out of nine helmets had some of these technologies. Previous tests have shown that helmets equipped with technologies aimed at reducing rotational acceleration performed in general better than the others. However, all helmets need to reduce rotational acceleration more effectively. The initial objective of the helmet standard EN 1078 was to prevent life threatening injuries, but with the knowledge we have today, helmets should preferably also prevent brain injuries that have long-term consequences. Therefore, helmets should be designed to reduce translational acceleration as well as rotational acceleration. A conventional helmet that meets current EN 1078 standard does not prevent a cyclist from sustaining a concussion in the event of a head impact. In addition to an improved performance regarding protection of rotational loading, helmets need to absorb energy more effectively. The safety standard EN 1078 that needs to be met for any bicycle helmet sold in the EU to obtain the CE mark should be seen as a minimum requirement. The potential outcome is that bicycle helmets meeting the EN 1078 standard requirements may not sufficiently protect in real-life collisions or falls.

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