Folksam Test of 13 Equestrian Helmets 2021

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Folksam

This is why we test equestrian helmets
Approximately half a million Swedes rides a horse regularly. Every week several riders sustain head injuries, which are some of the most serious injuries a rider can sustain. Studies from real-life accidents show that equestrian helmets are very effective in reducing serious and fatal injuries. We are committed to what is important to our customers and to you. When we test and recommend safe equestrian helmets, we believe this can help to make your life safer.

How does an equestrian helmet obtain our "Recommended" label?
Helmets that obtain the best overall results in the equestrian helmet test by Folksam are given our "Recommended" label. The "Recommended" symbol may only be used for products that have obtained a score at least 15% better than the median value for all tested helmets and the helmet also needs to get a better score than the median for the rotational and translational tests individually

Helena Stigson, PhD
Associate Professor
Research

Read more at folksam.se/ridhjalmar

Folksam

Why does Folksam test equestrian helmets?

Horse riding is a popular leisure activity and about half a million Swedes ride regularly to compete, to get exercise or as recreation. Equestrian sport, calculated in number of activities, is the third largest youth sport in Sweden (Riksidrottsförbundet, 2020). All 154,500 members of the Swedish Equestrian Federation, including beginner to competition riders, are insured by Folksam Insurance Group. Thereby, the members are covered during training, all Swedish Equestrian Federation activities as well as competitive riding. The insurance data shows that approximately 1,000 are injured annually (Meredith and Stigson, 2019). Folksam's injury data clearly show that the head is the most frequently injured body region. Every week approximately ten riders sustain a head injury. In 75% of accidents, the rider is injured while falling off the horse. The use of equestrian helmets can reduce the occurrence of head injuries. Therefore, the most important measure to prevent head injuries in equestrian sports is to wear a helmet.

All helmets models sold on the European market have been tested and 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 (VG1 01.040). This does not fully reflect the scenario in a fall from the horse, the most frequent incident type, or horse kick. The impact to the head will in these scenarios be oblique. 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 the safety level of helmets sold on the European market by conducting crash tests based on real-world impact scenarios, Table 1.

Table 1. Included helmets

Equestian Helmets 2021	Rotational Technologies	Price (SEK)
Back on Track EQ3 Lynx Eventing	MIPS	2000
Back on Track EQ3 Pardus+ Skruv Smooth	MIPS	2500
Charles Owen MS1 Pro	MIPS	2000
Charles Owen My Ps Wide Peak	MIPS	3500
CRW VG1 Classic		500
GPA Speed Air 2X		6000
Hansbo Ridhjälm HS Croc/Pearl med ratt		950
JH Collection Matrix MIPS VG1	MIPS	1600
Kask Star Lady Pure Shine		6000
OneK Avance Matt Chrome Pipe		3300
OneK VG1 Avance MIPS	MIPS	3800
Samshield Premium Leather Dressage		5200
Uvex Exxential II MIPS	MIPS	1500

Method

In total, 13 conventional helmets were selected from the Swedish market. To ensure that a commonly used representative sample was chosen, the range helmets available in shops and in online shops were all considered. Seven of the helmets were equipped with the technology, MIPS (Multi-directional Impact Protection System), aimed at reducing rotational acceleration. 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 1.8m onto a horizontal surface according to the European standard (the temporary VG1 01-040 2014-12 test protocol), which sets a maximum acceleration of 250 g. 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.

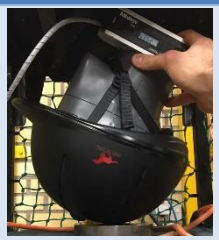
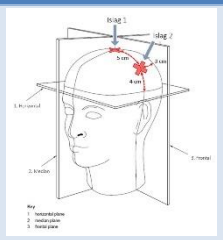
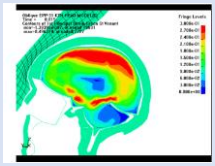
Oblique Tests

The helmeted head was dropped against a 45° inclined anvil with friction similar to asphalt (grinding paper Bosch quality 40). The impact speed was 6.25m/s. The Hybrid III dummy head was used without an attached neck. Two helmets were tested in each test configuration to minimize variations. The test set-up used in the present study corresponds to an additional test under consideration within 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 26 percent corresponds to a 50 percent risk for concussion (Kleiven and Hardy 2002). 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	
Shock Absorption Test (VG1 01.040) The helmet was dropped from a height of 1.8m to a horizontal surface correlated to the European Standard VG1 01-040 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 6.4 m/s.	 
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° Hybrid III 50th percentile Male Dummy head form was used. Velocity 6.3 m/s	
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° Hybrid III 50th percentile Male Dummy head form was used. Velocity 6.3 m/s.	
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. Hybrid III 50th percentile Male Dummy head form was used. Velocity 6.3 m/s	
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 26 percent corresponds to a 50 percent risk for concussion.	

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 runs conducted in 2018 and 2021. In previous tests, the safety assessment has only been made by relating the helmets' measured values to the median value from that test series. This year, however, the median calculation has been made by using measurement data from two latest test runs to provide a more stable calculation basis and to reduce the influence of an individual helmet on the median calculation. 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

In total, five helmets obtained the Folksam “Recommended” label, Table 2. These five helmets are more than 15 percent better than the average result and scored better than the median for the rotational and translation tests individually. The Charles Owen My Ps Wide Peak preformed best and was more than 40 percent better than the average helmet.

Table 3. Overall results

Equestian Helmets 2021	Overall result	Folksam Recommended
Back on Track EQ3 Lynx Eventing	36%	Recommended
Back on Track EQ3 Pardus+ Skruv Smooth	29%	Recommended
Charles Owen MS1 Pro	37%*	
Charles Owen My Ps Wide Peak	40%	Recommended
CRW VG1 Classic	-6%	
GPA Speed Air 2X	-24%	
Hansbo Ridhjälm HS Croc/Pearl med ratt	-11%	
JH Collection Matrix MIPS VG1	27%*	
Kask Star Lady Pure Shine	-9%	
OneK Avance Matt Chrome Pipe	-4%	
OneK VG1 Avance MIPS	33%	Recommended
Samshield Premium Leather Dressage	-6%	
Uvex Exxential II MIPS	25%	Recommended

* The helmet’s results were worse than the median in at least one of the tests.

All helmets had lower than 250 g in resultant acceleration in the shock absorption test, Figure 1. The Uvex Exxential II MIPS (197 g impact to the crown) and Charles Owen My Ps Wide Peak (152g impact to the side) performed best of the helmets, and Hansbo Ridhjälm HS Croc/Pearl med ratt (237g impact to the crown) and Kask Star Lady Pure Shine (209g impact to the side) preformed worst of the helmets.

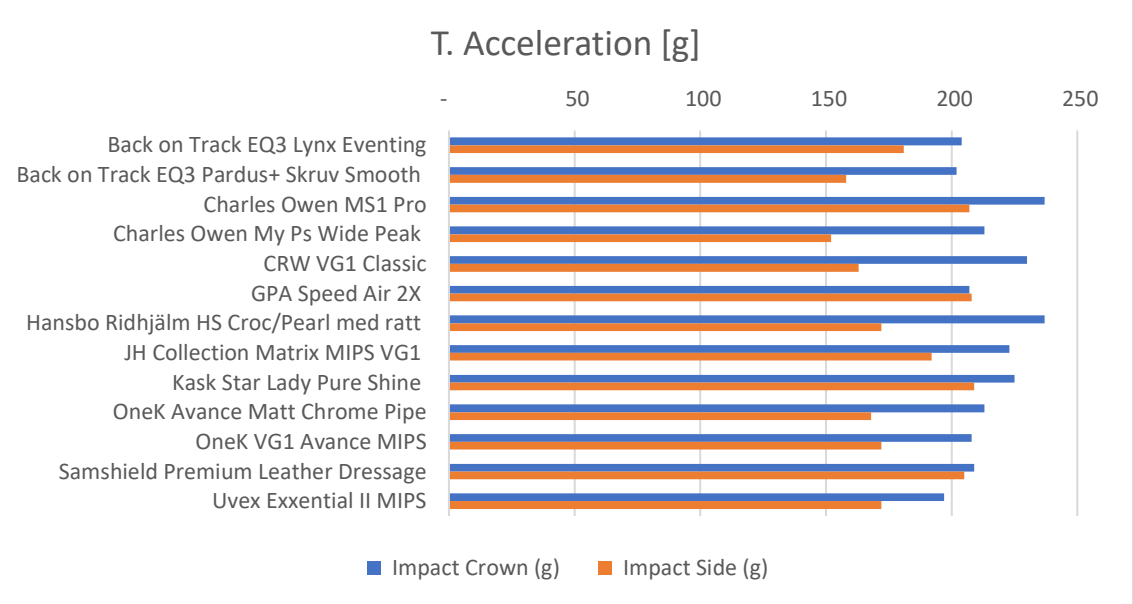


Figure 1. Shock absorption measuring linear acceleration

Table 4 shows the tests that reflect the helmet's protective performance in an equestrian 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 13 percent and 43 percent between the helmets. Only four helmets, Back on Track EQ3 Pardus + Skruv Smooth, Charles Owen MS1 Pro, Charles Owen My Ps Wide Peak and JH Collection Matrix MIPS VG1, got a result that was below the threshold for a 50 percent risk of concussion in all the tests.

In general, the lowest values were measured when the helmet was tested in impacts to the side of the helmet (rotation around the X-axis) and in all helmets except one (GPA Speed Air 2X), values corresponding to less than 50 percent risk of concussion were found. The median value corresponded to a 33 percent risk of concussion. In the test with impact to the upper part of the helmet (rotation around the Y-axis), values corresponding to less than 50 percent risk of concussion were found in seven of the 13 helmets tested, while only four of the helmets passed this threshold when impacting to the front of the helmet (rotation around the Z axis). Median value corresponded to 33 percent and 65 percent risk of concussion, respectively. The seven helmets equipped with Multi-directional Impact Protection System (MIPS) in general performed better than the others. However, all helmets need to reduce rotational acceleration more effectively. A helmet that meets the current standards does not necessarily prevent concussion.

Table 3. OBLIQUE TESTS (ROTATION AROUND THE X, Y AND Z-AXIS)

	OBLIQUE IMPACT A (X-AXIS)						OBLIQUE IMPACT B (Y-AXIS)						OBLIQUE IMPACT C (Z-AXIS)					
HELMET	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 [%]
Back on Track EQ3 Lynx Eventing	125.5	4511.8	21.8	0.35	15	18	123.3	4918.3	22.5	0.41	19	25	123.3	5057.6	21.4	0.51	27	51
Back on Track EQ3 Pardus+ Skruv Smooth	146.9	2840.4	14.9	0.25	20	30	165.3	5219.9	22.1	0.40	22	33	111.0	7934.5	21.3	0.53	26	47
Charles Owen MS1 Pro	144.2	6545.5	16.9	0.28	13	14	135.2	3264.9	21.5	0.38	17	22	114.3	6043.0	20.2	0.50	25	43
Charles Owen My Ps Wide Peak	136.4	4688.6	17.3	0.28	16	18	133.3	3187.0	18.8	0.34	15	17	119.7	6846.4	22.4	0.54	26	48
CRW VG1 Classic	154.4	11307.3	30.1	0.47	25	43	146.6	9975.2	35.7	0.63	38	82	129.3	7887.2	31.1	0.70	40	85
GPA Speed Air 2X	141.6	14868.9	33.7	0.56	32	68	146.3	10734.1	37.4	0.66	41	87	144.4	7442.9	28.8	0.67	37	79
Hansbo Ridhjälm HS Croc/Pearl med Ratt	139.8	11751.1	31.4	0.50	26	47	156.7	11320.5	34.5	0.62	39	83	138.0	9661.4	33.0	0.74	43	89
JH Collection Matrix Mips VG1	140.4	4258.2	16.6	0.28	21	33	149.6	5114.2	21.9	0.40	20	29	117.7	6127.7	15.3	0.39	21	33
Kask Star Lady Pure Shine	151.1	11066.9	27.7	0.45	24	41	128.0	8686.9	38.3	0.68	41	88	146.5	7780.1	27.0	0.60	37	81
OneK Avance Matt Chrome Pipe	140.8	8540.8	26.8	0.43	26	47	153.5	11324.2	34.3	0.61	38	81	134.8	8165.2	29.5	0.66	34	73
OneK VG1 Avance Mips	126.7	4557.6	16.1	0.28	16	20	140.7	5433.0	22.6	0.40	22	33	115.2	5150.0	18.3	0.46	27	51
Samshield Premium Leather Dressage	155.1	9459.2	28.7	0.47	26	46	156.0	10216.1	34.7	0.62	39	83	124.6	6667.7	25.7	0.59	32	68
Uvex Exxential II Mips	141.6	10439.2	25.6	0.42	22	33	119.5	4013.6	16.8	0.31	17	21	98.3	7062.2	23.4	0.50	31	65

Discussion

Folksam's test of 13 riding helmets for children and adults shows that there is a large spread between the tested helmets' ability to protect in case of an impact. The tests also show that it is possible to meet the current European certification threshold with a good margin (at best 152g compared to the legal requirement's 250 g). However, the results from Folksam's test clearly show that a helmet that meets today's requirements of 250 g can still cause concussion. Only four helmets got a result that was below the threshold corresponding to a 50 percent risk of concussion in all three oblique impact tests. Based on analysis of Folksam's claims reports of equestrian riders we know that one out of seven riders who sustain a head injury will result in long-term medical impairment. The translational acceleration, which is measured in the certification test, is mainly linked to the risk of skull fracture. In an accident, the brain will be exposed to rotational force, which the brain is very sensitive to and therefore injuries such as concussions or more serious injuries may occur. Therefore, Folksam has chosen to include three tests where the helmets are exposed to oblique impacts and where the rotational force is measured to evaluate the helmets' ability to reduce rotational acceleration. The present study provides evidence of the relevance of including rotational acceleration in consumer tests and legal requirements. They also indicate that there is a link between rotational energy and strain in the grey matter of the brain. In the future, legal helmet requirements should therefore ensure a good performance for rotational forces as well. Before this happens, consumer tests like this test play an important role in informing and guiding consumers in their choice of helmets. The initial objective of the helmet standards was to prevent life threatening injuries but with the knowledge of today a helmet should preferably also prevent brain injuries resulting in long-term consequences. Helmets should be designed to reduce the translational acceleration as well as rotational energy. A conventional helmet that meets current standards does not prevent an equestrian from getting a concussion in case of a head impact. To be able do that, helmets need to absorb energy more effectively.

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