

Smart wearable airbags: Benefits for users and remaining challenges after 60 million kilometres and 3000 accidents

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1. Introduction :

Over the last five years, wearable airbag (“wairbag”) protectors have undergone a major technological and usage revolution and are becoming an increasingly popular protection solution for motorcyclists. These safety devices consist of inflatable bags embedded in the garments worn by motorcyclists which are activated in response to an abnormal event, i.e. an accident. The aim is to reduce trauma frequency and severity by inflating the airbag before the impact of the motorcyclist. Therefore, the effectiveness of the device does not only depend on impact attenuation but also on accident detection and inflation in a very short time, key elements to be protective before the first impact.

Epidemiological studies showed the severity of thoracic injuries sustained by motorcyclists and the need of ribcage and internal organs protection [1]. Since wairbags are the only equipment capable of absorbing impacts to the trunk and mitigating these injuries, the promotion of its use and the development of products more adapted to the needs and expectations of users have made it possible to significantly grow the equipped number of motorcyclists. In France, wairbag usage increased from 4% in 2016 to 8% in 2019, but it is still very low compared to helmet (100%), gloves (100%) and jackets (99%) wearing rates [2]. The use of helmets, gloves and jackets is similar in Europe, while the proportion of wairbag users is much lower (0.9%) [3].

The objective of this work is to make a state-of-art of wairbags in terms of product availability, diffusion, difficulties for being equipped with as well as users’ mentality evolution. The approach adopted combines an overall analysis of the wairbag ecosystem with a dedicated survey to obtain feedback from motorcyclists wearing In&motion products.

2. Materials and methods:

2.1 Wairbag ecosystem analysis:

The evolution of wairbag technology has been studied based on a market analysis and the knowledge acquired by In&motion through its strong involvement in the univers of protective equipment. Feedback from partner brands of motorcycle clothing and insurances as well as resellers completed the field information. The equipment of riders in the motorcycle road racing and cross-country world championships has provided data on the use of the product in the most demanding and extreme conditions.

2.2 Feedback from In&motion wairbag users:

In&motion wairbag users (120000 products on the market since 2018) are regularly contacted in order to understand their expectations, their uses and their perception of this technology. In July 2021, part of this population was asked by email to answer an online questionnaire. Data on the characteristics of the users, their riding experience and habits, the wearing of personal protective equipment (PPE) or the wairbag usage were collected.

3. Results:

3.1. Wairbag ecosystem analysis:

3.1.1. History of the wairbag:

The first wairbag for motorcyclist was developed at the end of the 90s and three generations followed one another after its appearance on the market:

1. Mechanical wairbags (1998): The triggering system is physically connected to the motorcycle with a lanyard. The piston that pierces the CO2 gas cartridge to inflate the bag is released when a great enough force is exerted on the cable.
2. Electronic radio wairbags (2012): The sensors allowing the detection of the accident are mounted on the bike. A communication box also installed on the motorcycle communicates by radio link with the wairbag.
3. Electronic autonomous wairbags (2016): All the sensors and electronic components are integrated into the garment worn by the motorcyclist making the wairbag bike-independent. Some of these products can share the recorded riding data and be updated remotely.

The wairbag has experienced a real acceleration over the last 5 years with a strong increase of the economic actors offering this safety equipment (Figure 1a). From 2000 to 2015 the number of manufacturers multiplied by 5, while between 2015 and 2021 the number of brands multiplied by 3.5. In 2022, 50% of companies offered mechanical devices, 30% electronic products and 20% both technologies. Motorcycle is the biggest market with 69% of wairbag brands commercializing these products (Figure 1b) and 1% of new users in France each year from 2019. However, the best seller is the Hovding airbag helmet for cyclists with 425000 units sold since 2013.

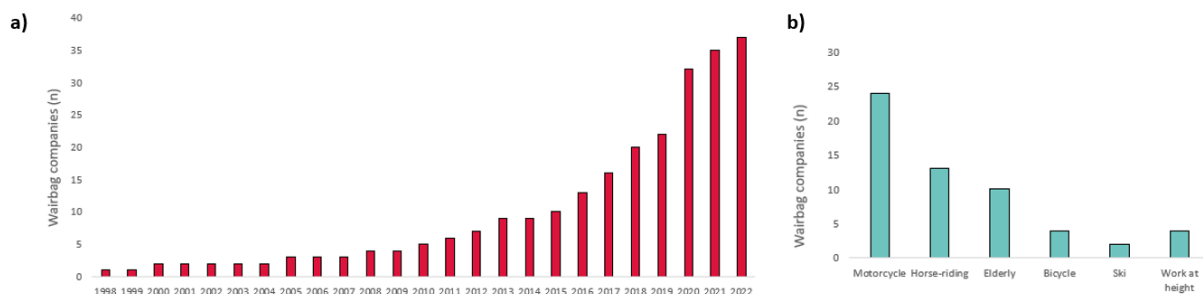


Figure 1. (a) Evolution of the number of companies commercialising wairbags. (b) Usage of the available wairbags in 2021.

3.1.2. The 3 factors explaining the acceleration of wairbag diffusion:

1-Increment and availability of the products

During the last 6 years, the three main manufacturers of electronic wairbags, i.e. In&motion, Dainese and Alpinestars, offer 25 different products which are available in 2000 sales points in Europe (700 in France versus 160 in 2014). Most wairbags are sold in motorcycle clothing and accessory stores, dealers and specialised e-commerce websites.

2-Fall of prices

Figure 2 shows the sale prices evolution of electronic systems for road use. The first products with sensors installed on the motorcycle costing 1300 € were definitively replaced in 2018 by the new generation of autonomous wairbags. Sold from 1200 to 1500 € at launch, their prices have dropped significantly to stabilize around 600-800 €. In&motion purchase and rental options decrease the initial purchase price to 350-400 €. The mechanical devices are sold between 300 and 600 €.

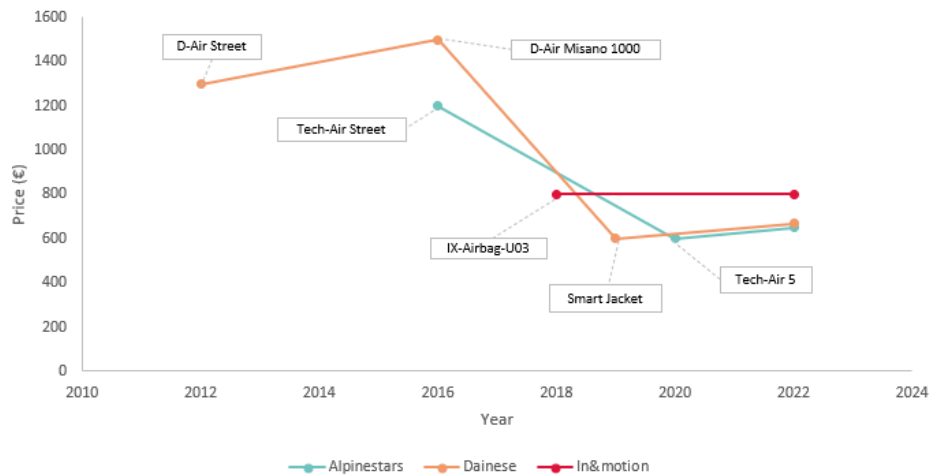


Figure 2. Electronic wairbags price evolution.

3-The involvement of third parties: insurers, governments, federations

At the same time, some stakeholders have promoted the use of motorcycle wairbags. Based on the SRA rating [4], insurers offer purchase aids and formulas to cover the recharge cost or even replace the wairbag after an accident. Today, one in two French motorcyclists can benefit from a wairbag purchase reduction thanks to their insurance company. Governments also helped to the spread of the wairbag with millionaire communication campaigns such as “Plan Airbag” in France (2019 and 2021) or “Ponte Un Airbag” in Spain (2021).

More and more motorcycle championships are recommending or even imposing the use of wairbags. The MotoGP world championship was the first to make the wairbag compulsory in 2018, followed by the Dakar (2021), the JuniorGP (2022) and the IDM (2022). The use of these devices has already paid off with a drop of chest injuries by 50% in the Dakar 2021 compared to the previous edition. In MotoGP, the only compulsory coverage area are the shoulders and wairbags have reduced the number of collarbone fractures. Between 2013 and 2017, collarbone fractures accounted for 24% of the total number of fractures [5], while for the 2020 and 2021 seasons this type of injury decreased to 16% [6,7].

2.2. Feedback from In&motion wairbag users:

The questionnaire was completed by 4653 people, 92.5% were male and 7.5% female. The average age is 46 (similar to that of motorcyclists in France), while 79% of the population is over 35 (Figure 3). The most represented age range for both sexes is 50-64 with 46% of men and 39% of women.

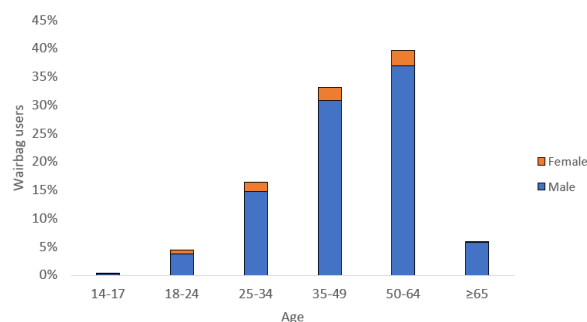


Figure 3. Respondents age distribution.

Regarding riding experience and habits, 74% of respondents have been using a motorcycle for more than 5 years and almost half of the population (48%) is over 15 years of experience. Most bikers (63%) ride during all the year, 23% 8 months/year and 14% only when the weather is nice. Almost 60% of respondents travel more than 5000 km per year (Figure 4).

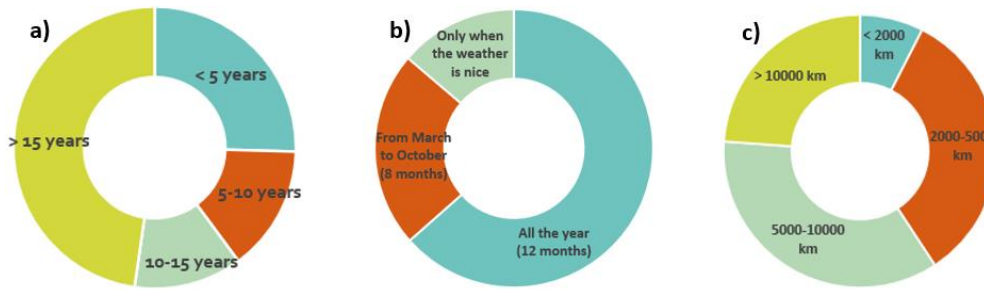


Figure 4. (a) Riding experience. (b) Riding time during the year. (c) Number of kilometres per year.

The protective equipment worn by the participants is listed in Figure 5. In addition to the wairbag and the back protector embedded in, the most used PPEs are the helmet (100%), gloves (93%), jackets (93%) and footwear (90%).

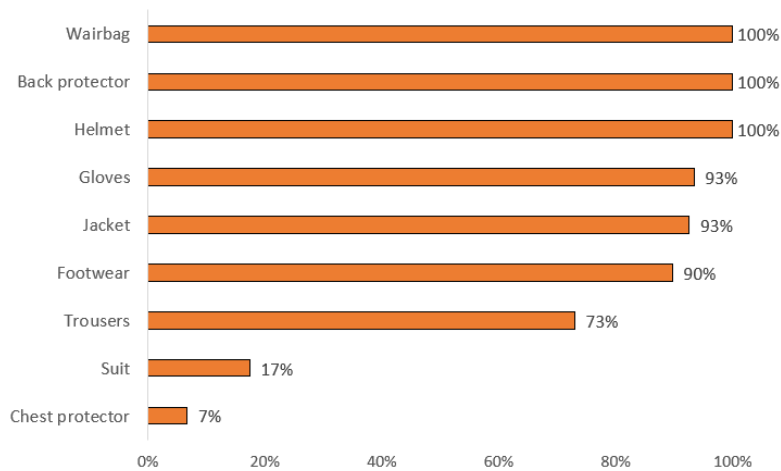


Figure 5. PPE wearing rates.

Only 10% of the sample wore a wairbag before purchasing the In&motion system (75% mechanical and 25% electronic). At the time of purchase of the In&motion device, having an autonomous wairbag was the first buying criterion (55%), followed by wearable under the jacket (13%), the protection zones (7%), the ease of use (5%) and the intervention time (5%).

Among the 4653 respondents, 10% have already had an accident wearing the In&motion wairbag. In 61% of the cases the victim thinks that the inflation of the device has undoubtedly avoided injuries, while 16% of the riders believe that there are still elements to improve even if the device has inflated. The wairbag did not trigger in 23% of the falls, of which 66% were not necessary according to the motorcyclist. Only 8% of the falls were not covered by the wairbag and the victim felt that inflation was necessary. Among the falls where triggering seems necessary (user perception), the system inflated in 91% of the cases (Figure 6a).

Figure 6b shows the opinion of the participants when they are asked about the possibility of riding again without a wairbag. The responses are similar for both samples having had and don't having had an accident with the system. For about 66% of respondents riding without a wairbag is unthinkable and around 30% of people would have moderate discomfort.

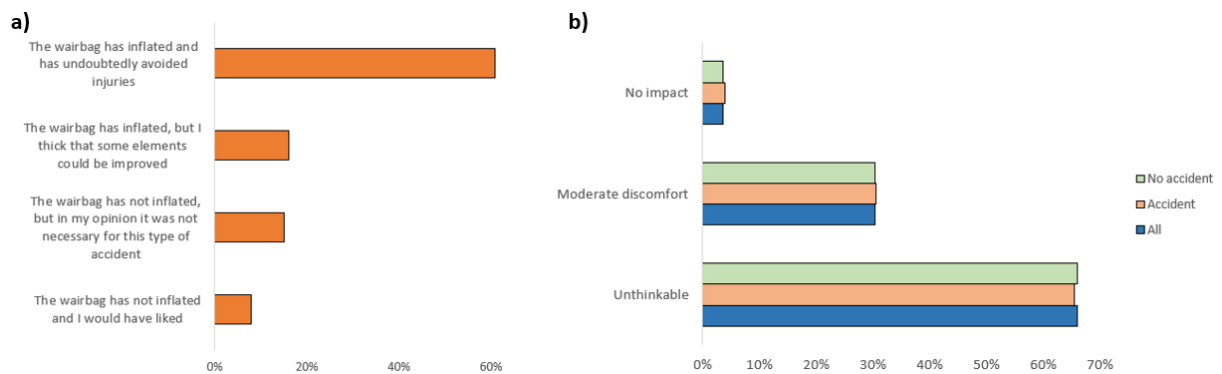


Figure 6. (a) Effectiveness of the wairbag in case of accident. (b) Feeling of riding without wairbag.

In&motion wairbags are connected and their operation requires the creation of an account which allows monitoring the use of the system over time. After more than 3 years and a half, less than 5% of the customers have stopped using the protector with more than a half also stopping the bike. These 2 elements confirm that most of the users don't go back once they decide to wear a wairbag.

Conclusion

Arrived on the French market during the 2000s, the wairbag has evolved from an innovation reserved for the elite to a product available and accessible to most people. It is one of the must-have in accessory stores and its diffusion is following strong growth. Since 2018, the wairbag has experienced a real acceleration: the price of electronic systems reduced by two, massive dissemination in specialized distribution networks, promotional campaigns, obligation in many disciplines and above all, wearing rates constantly growing.

The users of these devices are experienced motorcyclists, most of them between 35 and 65 and well-equipped. They ride during almost all the year and the majority of them travel more than 5000 km per year. Those who have had an accident with the In&motion wairbag highlight the correct functioning of the system and its effectiveness in avoiding injuries. Less than 4% would take the road without being equipped which is confirmed by the very low end-of-use rate (around 2% per year). For any technological innovation, its diffusion to this first group of users called "early adopter" allows its exposure to other groups and thus, when the opinions are positive, the acceleration of its spread among the rest of the users.

Previous studies have estimated the wairbag effectiveness from 1 to 2 levels of AIS reduction for the thorax [8]. In 2022, In&motion has recorded more than 3000 accidents during more than 60 million kilometres travelled. Scientific studies are in progress on this constantly increasing database in order to confirm or refute, via real cases, the levels of injury reduction due to the use of the wairbag.

The wairbag is the biggest safety revolution for motorcyclists since the helmet and its innovation potential is major. Constant improvements of detection algorithms enable to envisage accident coverage rates close to 100% in 2023. The optimization of protective areas and the addition of e-call could further reduce injury severity as well as improve medical intervention in case of accident. In conclusion, the wairbag is positioned as a solution with a unique "ease of diffusion/protection performance" ratio comparable to the helmet 50 years ago.

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