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Ultralight Accidents in the US, UK, and Portugal

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Abstract: Ultralight accidents are reported to be more severe compared to those in other categories of sports aviation. In the absence of denominator data in the United States (US) but addressing a continuing concern in general aviation safety, this study gives a comparison between ultralight accidents in the US, the United Kingdom (UK) and Portugal. For the period 2000–2010, 35 accidents occurred in Portugal, 252 in the UK and 20 in the US. They were compared for their proportionate number of fatal accidents, their main causes, and the characteristics of the pilots. The UK showed a significantly smaller proportionate number of fatal accidents compared to that of the US and Portugal. The proportionate number of destroyed aircraft was significantly higher in Portugal than in the US, with the UK showing an even smaller percentage. The general profile of the pilots did not differ notably, but the types of causes were more often attributed to pilot error or piloting technique in Portugal compared to the other two countries. While the proportionate number of fatalities is a strong indicator of the differences between the three countries, the varying reporting traditions and regulations preclude a direct comparison. Nevertheless, based on these data, the concern for ultralight safety in the US has not diminished since previous studies. Although the concerns are similar to those raised for Portugal, US ultralight safety may benefit from practices in the UK.

Keywords: general aviation; sport aviation; cross-cultural; fatalities; denominator data

1. Introduction

Accidents in ultralights are commonly excluded from general aviation accident studies due to the specificity of the aircraft [1–3]. The Federal Aviation Administration (FAA) implemented new sport pilot and light sport aircraft regulations in 2004 [4], creating new certification classes for pilots and aircraft. This was in part to improve safety in sports aviation, including ultralights, but also impeded research on this class of aircraft. The new sports aviation class no longer distinguishes ultralights as a category separate from balloons and certain gyroplanes. The FAA defines an ultralight merely as a sports or recreational vehicle to be used for manned operation in the air by a single occupant and that, if powered, weighs less than 254 pounds empty weight in addition to fuel and speed limitations and if unpowered, weighs less than 155 pounds [5]. There are no denominator data collected for this class of aircraft in the United States (US).

In previous research [6,7], it was noted that in terms of numbers, both gliders and balloons are important areas of study. In terms of severity of accidents, both nominally and relatively, the main concern points to gyroplanes and ultralights as the crucial area for future studies in the US [4,8]. These motorized aircraft in sports aviation show a higher proportion of fatal accidents and aircraft loss [7]. Furthermore, ultralight aircraft accidents result in complex injury patterns [9,10], which are of concern when the crash site is away from designated trauma centers [10]. These accidents are not only specific to a type of aircraft but also to a particular operation outside the highly-regulated sphere of commercial aviation. This also suggests that accident statistics would differ from country to country depending on how this area of aviation is organized and regulated.

Accident analyses of ultralights have concentrated on data from the National Transportation Safety Board (NTSB) online database. While this remains an important source, this study explores the possibility of adding datasets from other regions, in this case the United Kingdom (UK) and Portugal, for comparative purposes. These two countries, in contrast with the US, also provide some denominator data that can be used in addition to the proportion of fatal accidents and accidents with a destroyed aircraft. Comparative studies of general aviation accidents across countries also increase insight into the dataset of individual countries. They may show to what extent the organizational element of ultralight operations is likely to affect safety.

In this study, we compare ultralight accident data from three countries using the proportionate number of fatal ultralight accidents as a proxy for accident safety. We compare these data to the available pilot and accident characteristics to determine any significant differences. In cases where significant differences between the proportionate number of fatalities cannot be related to available flight information in the respective countries, we postulate possible significant differences in the organization of ultralight aviation and make suggestions for future research.

2. Materials and Methods

A total of 35 ultralight accidents occurring within the 11-year period 2000–2010 in Portugal [11] were compared with 20 ultralight accidents extracted from the NTSB online database for the exact same period and 252 cases from the UK [12]. The time period was selected so that a reasonable sample for statistical analysis could be collected. In addition, only reports that had been completed, i.e., final accident reports, were used. Due to the large number of accidents still under investigation in the Portuguese dataset, the most recent year for analysis was 2010. To query the NTSB database, the terms “accident” and “ultralight” were selected. Automatic and manual search functions in this database provided different results for ultralights. However, upon closer examination of the search results, only 20 reports related directly to this type of aircraft.

The UK and Portuguese databases were searched by downloading all accidents for the selected time period and manually identifying those relating to “ultralight” or “microlight” aircraft.

Although there are some differences in definition between an ultralight in the US and those in the UK and Portugal, they mostly pertain to specific limitations on weight and speed in the latter two countries. Where possible, the NTSB coding [13] of each accident was mirrored for the Portuguese and British accidents to allow for a comparative analysis.

The NTSB defines an occurrence as an accident if one of the occupants or ground crew was severely or fatally injured or if the aircraft was seriously damaged or destroyed. Definitions used in Portugal and the UK did not differ in any way that was relevant for our comparison. In this study, only accidents were used for analysis for the Portuguese, UK, and US data.

Since the content and detail of the narrative texts accompanying the accident reports varied widely between the three countries, an analysis of causes could not be informed consistently by further details from the texts. Much of the comparison needs to be limited to data being consistently reported. This limitation concerns most comparisons across countries but was exacerbated by the small sample size of accidents with this type of aircraft.

Portuguese ultralight flights are regulated and monitored, while the US and UK rely on self-reports for accident analysis to take place. Regulations in each country mandate the reporting of accidents as defined above. The parameters used in the accident reports differed for each country and, therefore, only comparable data were used for our analysis. Significant relations between datasets were determined using Pearson’s χ^2 analysis. Relations were defined significant if p-values were below 0.05 [14].

In a previous study [8], it was explained that denominator data provided by the FAA have ultralights and gyroplanes categorized under fixed-wing, experimental, or amateur aircraft depending on their size and use. In 2004, the FAA introduced the light-sport aviation category that includes all gyroplanes, most ultralights, and a range of other light aircraft. The NTSB category of ultralights does not have appropriate denominator data provided by the FAA.

The scale of US, UK, and Portuguese operations can be determined by looking at the total number of active aircraft in each year. An estimate for this number in the US was given in 1987 with ca. 15,000 active ultralight aircraft [9]. However, this number seems highly speculative and for the purposes of this study, was deemed outdated. The Federal Aviation Regulation Part 103, which became effective in 1982, specifically states in paragraph 103.5 that ultralight vehicles are not required to meet the airworthiness certification standards specified for aircraft and are not required to be registered. The UK reported an increasing number of "microlights" from 3548 in the year 2000 to 4375 in 2010 [15]. In Portugal, the 2013 count for ultralights was 410 aircraft. These numbers suggest that operations in the UK are ten times as large as in Portugal and, possibly, more than three times smaller than in the US. While these numbers are far from satisfactory as they were collected in different years and by different means, they at least suggest that the operations in these three countries are significantly different in size and that this is likely to be reflected in the accident data, such as the number of accidents per movement or flight.

Since common denominator data are absent in this aviation segment, alternative indicators needed to be used in order to determine accident risk; an excessive focus on denominator data for areas of aviation where this cannot be obtained without prohibitive costs might have the undesired consequence of eliminating studies in these areas altogether [16,17].

Following previous studies, the proportionate number of fatalities, i.e., the percentage of fatal accidents as part of the total number of accidents, was used as an indicator of risk for all three countries, a measure that is independent of the size of a country's operation [16,17]. This proportion is particularly useful as it is independent from the size of the fleet or the number of flight movements—indicators that are otherwise used as denominator data. It is noted that underreporting of non-fatal accidents, as opposed to fatal accidents where this is least likely to be the case, may affect self-reporting systems and possibly inflate safety concerns.

3. Results

In the period 2000 to 2010, the number of accidents in Portugal (N = 35) was higher than that of the US (N = 20) and smaller than that of the UK (N = 252).

All pilots in the Portuguese group were male, all but one was male in the US group with one unreported case, and all but three were male in the UK with 51 unreported. See Table 1.

Table 1. Pilot gender.

Country	Male	Female	Unknown
Portugal	35	0	0
USA	18	1	1
UK	198	3	51

Average age for Portuguese pilots was 46.7 years, for Americans 55 years, and for the British 54.5 years. Total flying hours was reported for 28 Portuguese with 767 h on average with 50% (N = 14) of the pilots having 100 h or less, while 17 Americans made for an average of 600 total flight hours with 47% (N = 8) of the pilots having 100 h or less, and 250 British pilots averaging 675 h with 23% (N = 58) having 100 h or less. See Table 2.

Table 2. Pilot average age and flying hours.

Country	Average Age	Pilots < 100 Flying Hours	Average Flight Experience (h)
Portugal	46.7	14 (50%)	767
USA	55	8 (47%)	600
UK	54.5	58 (23%)	675

In a previous study on US accidents dating from 1982 to 2007 [7], it was reported that most accidents in sports aviation occur during the months from May until the end of August (51.7%). This was 51.4% for our Portuguese dataset and only 40% in our new set for the American cases, a difference that was not significant ($\chi^2 = 0.667$, $p > 0.05$). The UK had 131 or 52% of its accidents reported in those months. These results are not unexpected since recreational flying is seasonal and dependent on favorable weather conditions, and this observation holds for all three countries. Weather and time of day were not significantly different between datasets, as fair weather and daytime flying were present with few, if any, exceptions.

In 45.7% (N = 16) of the cases, Portuguese pilots suffered a fatal injury as opposed to 30% (N = 6) of Americans, but this difference was not significant ($\chi^2 = 1.309$, $p > 0.05$). The British suffered only 2.78% (N = 7) fatalities, which is significantly different from the American data ($\chi^2 = 30.172$, $p < 0.01$), see Table 3. The proportion of fatal accidents in the Portuguese and US datasets was similar to what has been reported in previous studies [7,8] but higher when compared with other general aviation aircraft [18].

Table 3. Accident cause and injury analysis.

Country	Number of Accidents	Fatal Injuries	Cause Engine Failures	Cause Pilot in Command
Portugal	35	16 (45.71%)	7 (20%)	22 (62.90%)
USA	20	6 (30%)	6 (30%)	11 (55%)
UK	252	7 (2.78%)	57 (22.62%)	86 (34.13%)

Aircraft were destroyed in 74.29% (N = 26) of the cases in Portugal, 40% (N = 8) in the US, and 10.32% (N = 26) in the UK. The difference between Portugal and the US was significant ($\chi^2 = 6.339$, $p < 0.05$), as was the difference between the UK and the US ($\chi^2 = 14.926$, $p < 0.01$). The Portuguese dataset reported 20% (N = 7) engine failures with 30% (N = 6) for the American set and 22.6% (N = 57) for the UK, but these differences were not significant. See Table 3.

In 62.9% (N = 22) of the cases, the Portuguese reports suggested that the pilot-in-command was associated with the primary cause of the accident due to errors during flight or deficient techniques. In the American dataset, the pilot-in-command was involved eight times with the primary cause of the accident and three times with the secondary cause. This meant a total of 55% (N = 11) of causes were attributed to the pilot. The UK set had "deficient piloting technique" (N = 8) and "pilot/pilot error" (N = 78) together accounting for 34.1% (N = 86) of the accidents. The difference between the US and UK data was not significant ($\chi^2 = 3.5189$, $p = 0.06$), but the UK and Portuguese data were significantly different ($\chi^2 = 10.81$, $p = 0.001$). See Table 3.

Previous research [8] has found that pilots with less than 40 make/model hours were significantly more likely to be involved in fatal accidents than pilots with 40 or more make/model hours. The present dataset did not have enough pilots in the group of less than 40 make/model flying hours that were involved in fatal accidents: 11.1% (N = 1) for Portuguese accidents against 22.2% (N = 2) for the American dataset and 1.2% (N = 1) for the British set.

4. Discussion

Any international comparison of general aviation accident statistics is confronted with different safety cultures, reporting practices, and regulations in the respective countries. While this situation limits possible conclusions, both similarities and contrasts between countries may point to specific areas of concern that cannot be identified otherwise. In our three-way comparison of ultralight accidents, it is shown that types of causes and pilot experience did not differ significantly across our three samples. Instead, the proportionate number of fatal accidents varied significantly and to an extent that cannot immediately be explained by differences in reporting practices. Previous research has shown that national culture can play a role in aircraft accidents related to human factors [19]; future work may investigate whether safety cultures and regulation differences provide a better explanation of the results of this study and whether they should be the focus of improvement in ultralight aviation practices.

The accident statistics of the three countries cannot be compared without consistent denominator data. However, the proportionate number of fatalities and general characteristics of the data are largely independent from such information. Without abandoning research on US ultralights accidents or comparative research in general, these proportions provide valuable indicators that inform future research and stress the unfortunate lack of denominator data for US sports aviation [16].

The number of accidents reported in the US is relatively low and has also been nominally decreasing since the last study on this group of accidents [8]. When compared to the Portuguese group, few other characteristics of the dataset stand out. The proportion of fatalities, the experience of the pilots, and the types of accidents were not significantly different between the US and Portugal even though Portugal is less reliant on self-reporting and keeps more statistics on ultralights [11].

The UK reported a much larger number of accidents, but this seems to be proportionate to the size of their fleet when compared to the ones in Portugal. For both these countries, the count of registered ultralight aircraft was collected by the aviation authorities, allowing an appropriate comparison [12,15]. A comparison between the UK and US could perhaps be explained by less self-reporting on the part of US pilots even though US regulations mandate the reporting of all accidents.

Previous work has looked into the link between safety culture and reporting behavior [20]; future research may investigate the self-reporting culture in the US by interviewing and surveying ultralight pilots. Cooperation with local ultralight aviation clubs and associations can facilitate this process. Such research may also glean information on topics such as cockpit quality, flight planning and preparation practices, conditions of equipment etc. that may further inform the safety culture in individual countries.

The characteristics of the UK dataset remain in marked contrast to that of Portugal and the US regardless of the presence of denominator data. While gender, average age and total flying hours of the pilots did not differ substantially, the proportion of fatal accidents and accidents with destroyed aircraft is dramatically smaller in the UK. The Portuguese dataset shows the highest proportions on both these issues. The UK proportion of destroyed aircraft is smaller by a factor of four compared to the US and in the case of fatal accidents, by a factor of 10. Although differing levels of self-reporting may be present in the UK, the more regulated ultralights in Portugal and the similar characteristics of the US dataset suggests that assuming differing regulations and levels of reporting insistence do not necessarily explain the results. We may infer from this difference that self-reporting itself is not necessarily problematic but that a good reporting culture, such as reporting of less serious accidents, should improve safety.

From the perspective of training requirements, both British [21] and Portuguese [22,23] pilots are required to undergo training to obtain and hold a specific license that allows them to legally fly ultralights. These training requirements for the UK and Portugal are particularly similar (see Appendices A and B), but there are no such requirements for US pilots where the Federal Aviation Regulation Part 103.7b states that "operators of ultralight vehicles are not required to meet any aeronautical knowledge, age, or experience requirements to operate those vehicles or to have airman or medical certificates" [5]. While the requirement for training and license holding seems to have a clear protective effect for pilots in the UK, this does not explain the accident statistics for Portuguese pilots.

The implications of this international or cross-cultural comparison need to be understood within the limitations of comparing different aviation traditions. These may pertain to flying practices and regulations as well as the absence or presence of relevant data. Considering these limitations, it is still shown that ultralight operations need significant improvements. Both Portuguese and American operations show safety concerns absent in the UK. In other words, the many possible differences per country do not put the US data in a particularly positive light even if the total number of fatalities reported in the US is relatively low. Second, a two-way comparison of the US and Portugal would not have revealed significant problems in either region, in part because reliable denominator data are not available for the US. This means that the absence of denominator data obfuscates safety issues even when international comparisons are made. Third, the significance of the proportion of fatal accidents and the type of accident are shown to be more telling than any characteristics of the pilots. This latter observation suggests that the community of pilots is much alike and that the operations and regulations of each country are more likely to have made the difference. The deregulation of sports aviation in the US does not help to address this aspect of aviation safety as government control—and thereby any countrywide improvement of ultralight operations—is now more difficult to implement from the side of regulators.

Further research is required to determine the specific regulations and traditions that may explain the differences attested in this study. These may include similar comparisons of other aircraft operations or other countries for which relevant denominator data are available as well as studies of ultralight flying practices within the different communities of each country.

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Appendix A

This appendix provides an overview of the theoretical training requirements for Portuguese ultralight pilots (Table A1) and practical training requirements (Table A2). These requirements can differ slightly depending on the ultralight aircraft for which the pilot is attempting qualification [22,23].

Table A1. Theoretical training requirements for Portuguese ultralight pilots.

Theoretical Knowledge Subjects
Legislation and ATC procedures
General Knowledge of Ultralight Aircraft
Performance and Weight & Balance
Behavior and Human Limitations
Meteorology
Navigation and Flight Planning
Operational Procedures
Principles of Flight
Communications

Table A2. Practical training requirements for Portuguese ultralight pilots.

Training Item	Requirement
Solo Flight Time	8 h
Dual Command Flight Time	22 h
Total Flight Time	30 h
Trip Requirements	120-mile trip; full stop landing on two runways other than the departure runway.

Appendix B

This appendix provides an overview of the theoretical training requirements for British ultralight pilots (Table A3) and practical training requirements (Table A4). These requirements can differ slightly depending on the ultralight aircraft for which the pilot is attempting qualification. Note, however, that these requirements were in place during the time of this study [21] but have changed as of 2016.

Table A3. Theoretical training requirements for British ultralight pilots.

Theoretical Knowledge Subjects
Aviation Law, Flight Rules and Procedures
Human Performance and Limitations
Navigation
Meteorology
Aircraft (General)
Aircraft (Type)

Table A4. Practical training requirements for British ultralight pilots.

Training Item	Requirement
Solo Flight Time	10 h
Dual Command Flight Time	15 h
Total Flight Time	25 h
Trip Requirements	40-mile trip; two solo qualifying cross-country flights must be flown over different routes and to different sites.

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