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A comparison of special category light-sport and corresponding type-certificated aircraft safety

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A R T I C L E I N F O

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Introduction: The special category light sport airplane (light sport) sector of general aviation has grown 10-fold in as many years with solo operations requiring only a sports pilot's certificate. With little research on light sport airplane safety, the study objective was to compare light sport and type-certificated airplane accident rates. *Method:* Accidents were identified from the National Transportation Safety Board database. Statistics employed Poisson distribution/proportion analyses/Mann–Whitney U-tests. *Results:* For the 2009–2015 period, the light sport airplane accident rate (fatal/non-fatal combined) was >15-fold higher than comparable type-certificated aircraft, undiminished over time. The excessive light sport airplane accident rate was associated with inferior airman experience (time-in-type, certification). Mishaps were most frequent during landing (40%) and, of these, nearly half were due to a deficiency in the flare. There were a dis-proportionate number of trainees involved in landing accidents compared with mishaps for other phases of operations. *Conclusion:* Towards improving safety, additional light sport training with emphasis on landings and a focus on the flare and directional control is warranted. *Practical application:* In the confines of the present study considering that landing mishaps, the most common accident cause, are often related to deficiencies in the flare and loss-of-directional control, instructors should ensure that airmen have mastered these aspects of landing and, for trainees, acquired the appropriate visual monocular cues.

1. Introduction

General aviation, classified as all civil aviation excluding paid passenger/freight transport, unfortunately accounts for 94% of civil aviation fatalities in the United States (Boyd, 2017). One sector of general aviation that has dramatically (10-fold) (Federal Aviation Administration, 2017a) expanded over the last decade is the special category light sport aircraft, mainly comprised of airplanes (SLSA) but also inclusive of gliders, powered parachutes, weight-shift control aircraft, and lighter-than air aircraft. This category of general aviation aircraft, introduced in 2004 (Federal Aviation Administration, 2017a), must meet the following specifications: maximum takeoff weight of 1320 lbs., an airspeed in level flight not to exceed 120 kts., seat no more than two occupants (including the pilot), have a fixed landing gear and a propulsion system consisting of a single reciprocating engine with fixed pitch propeller (Adams, Curry, & Gaydos, 2014). Enthusiasm for these aircraft over the last 10 years probably reflects a combination of several factors. Training requirements are lower; 20 h to earn a sports pilot certificate compared with 40 h for a private pilot license (Electronic Code of Federal Regulation, 2017). Finally, low fuel consumption rates coupled with a modest purchase price have also likely contributed to the gain in popularity for this general aviation sector.

As to safety of the SLSA fleet there have been no peer-reviewed studies comparing the accident rate for SLSA airplanes (exclusive of experimental builds) with the rate for 14CFR Part 23-certificated general aviation aircraft corresponding in terms of maximum take-off weight (1321 lbs.) occupancy (2) and single power plant. For 2016, the SLSA fleet consisted of 2478 active airplanes flying 186,627 h for that year (Federal Aviation Administration, 2015). By comparison, the fleet of active 14CFR Part 23-certificated general aviation aircraft comparable in occupancy and power plant number comprised 32,044 airplanes that flew 2,105,790 h for the same year (Federal Aviation Administration, 2015).

2. Methods

2.1. Accident data source

The National Transportation Safety Board (NTSB) aviation accident Access database (March 1st, 2017 release) (National Transportation Safety Board, 2015) was queried for accidents occurring over the period

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spanning 2009–2015 involving either SLSA (airplane category and exclusive of experimental builds) or type-certificated airplanes of 1321 lbs. or less with a maximum of 2 seat occupancy and with one power plant all operating under 14CFR 91 regulations (Electronic Code of Federal Regulation, 2015). Experimental built airplanes were excluded from the current study since such aircraft have no FAA or industry consensus standards to meet other than those identified in the aircraft's operating limitations (Federal Aviation Administration, 2013). The database provides airman parameters such as certification, total time and time-in-type, and injury severity outcome as well as the final report as to the mishap cause.

2.2. Aircraft certification

Data were obtained from the FAA Regulation and Guidance Library (Federal Aviation Administration, 2017b).

2.3. Statistical analyses

A generalized linear model with Poisson distribution (log-linear) was employed to determine if a change in the rate of accidents was statistically significant (Dobson & Barnett, 2008). Fleet activities were from the general aviation annual fleet activity survey (Federal Aviation Administration, 2015) using data for either SLSA aircraft or single piston-powered airplanes with 1–3 seats each summed for the indicated period. The natural log of the summed fleet activities was used as an offset (Dobson & Barnett, 2008). Fleet activity for 2011 was derived by interpolation of data for the years 2010 and 2012.

Contingency tables employed a Pearson Chi-Square (2-sided) test to determine where there were statistical differences in proportions. If the expected minimum count was less than five the Fisher's Exact Test was used instead (Agresti, 2012; Field, 2009). p values for cells in multinomial tables were derived from adjusted standardized residuals (Z-scores) in post-hoc testing.

Normality testing of continuous data was performed using the Kolmogorov–Smirnov test. A $p < 0.05$ was indicative of non-normal distributed data (Field, 2009). Mann–Whitney tests were used to determine statistical differences in median values (Field, 2009) for non-Gaussian distributed data.

All statistical analyses were performed using SPSS (v24) software. A p value of <0.05 was generally used as cut-off for statistical significance. However considering the potential for inflated alpha error rates associated with five variables in the risk factor analysis, a Bonferroni correction (Field, 2009) was made. This yielded a more stringent statistical cut-off ($p < 0.01$).

3. Results

3.1. Accident rates for SLSA and comparable type-certificated aircraft

First, the accident rates of SLSA airplane (hereafter, the term SLSA is restricted to those in the airplane category) and a comparator group, comprised of type-certificated airplanes corresponding in weight (≤1321 lbs.), maximum occupancy (2) and single power plant, were determined for the period spanning 2009–2015. For the initial period (2009–2010), the accident rate of SLSA was 15 fold higher (Fig. 1) than that for comparable type-certificated aircraft (20.2 and 1.3 accidents/100,000 h, respectively). Although a modest decline (incident rate ratio = 0.75, 95% Wald confidence intervals 0.51, 1.10) in this rate was apparent for SLSA for the most recent period (2013–2014), this reduction was not statistically significant ($p = 0.140$) using a Poisson probability distribution. Moreover, the SLSA accident rate was still 15 fold higher than that of type-certificated aircraft for the 2013–2014 period.

The accident fatality rate was then compared for both groups of airplanes. A fatal accident was defined as any in which one, or more, occupants perished within 30 days of the mishap from injuries incurred in the crash (Electronic Code of Federal Regulation, 2010). Over the seven year period, 12.1 and 14.1% of SLSA and comparable type-certificated airplane accidents were fatal (Fig. 2). Accidents with fatal outcomes were not dis-proportionate in either group ($p = 0.653$). Note that the total number of accidents was larger than that showed in Fig. 1 as injury severity assessment included an additional year (2015).

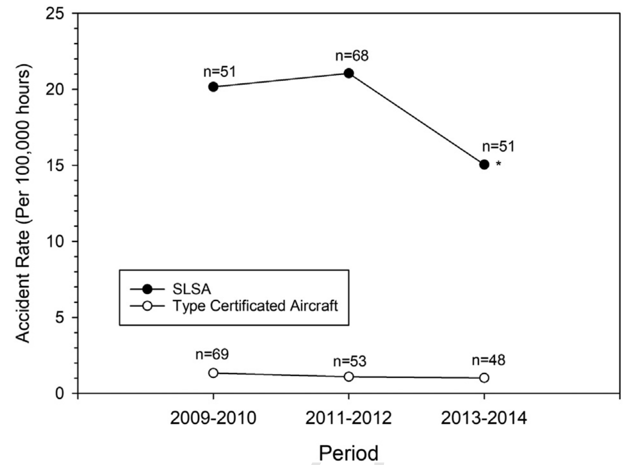

Fig. 1. Accident Rate for SLSA and Comparable Type-Certificated Airplanes. Accident rates are shown for SLSA and comparable (occupancy, maximum weight, single powerplant) type-certificated airplanes for the period spanning 2009–2014. Fleet activity data used as denominator were for SLSA and single piston-powered aircraft with 1–3 seats respectively. For each airplane category, fleet activity was summed for the indicated period. n, accident count. A Poisson distribution was used to determine if SLSA accident rate changed over time using the initial period as referent.

3.2. Pilot flight history and certification

The markedly elevated accident rate for SLSA operations compared with type-certificated airplanes begged the question as to why. Accordingly, a variety of parameters previously identified as accident risk factors were examined (Table 1).

Lower flight time in aircraft of the same make and model (time-in-type) (Boyd, 2015) is a known risk factor and indeed, airmen in SLSA accidents had logged half the time-in-type compared with airmen in type-certificated aircraft. Similarly, the total flight time of pilots (Li, Baker, Grabowski, & Rebok, 2001) involved in

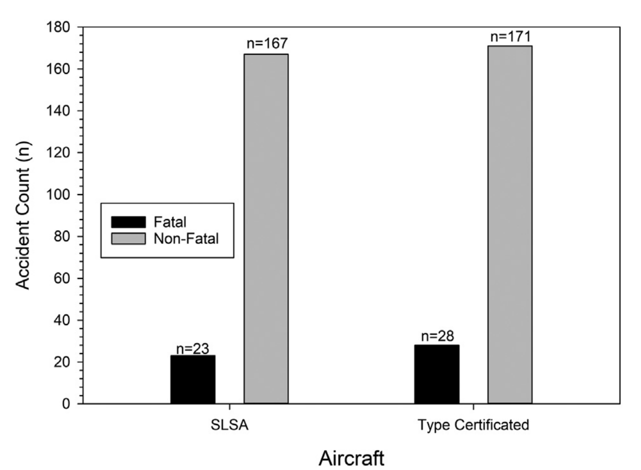

Fig. 2. Proportion of Fatal Accidents for SLSA and Comparable Type-Certificated Aircraft. A fatal accident was any in which one more occupants perished from his/her mishap-related injuries within 30 days of the event. A Pearson 2-sided Chi-Square test (n, 389, df, 1) was used to determine differences in proportions. n, accident count.

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