Are you sitting comfortably? A survey into glider pilot comfort

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SUMMARY

While glider performance has improved over the last century, cockpit design has fundamentally not changed. This research aimed to establish if glider pilots are comfortable in flight, and if not, then why and what makes them uncomfortable. A questionnaire was conducted that received 244 valid responses and this found that most pilots had experience cockpit discomfort.

KEYWORDS

Pilot comfort, Aviation Human Factors, Glider Cockpit Safety

Introduction

Gliding is a form of general aviation, which as a term refers to all non-scheduled civil aviation and includes training, recreational flying and sports (Department for Transport, 2023) with over 6000 pilots being represented by the British Gliding Association (The British Gliding Association, 2023) and nine military clubs. Pilots are highly skilled and will stay airborne for extensive time periods (The British Gliding Association, 2023), spending multiple hours in sedentary positions in their small, and sometimes cramped cockpits. A survey of glider pilots at Europe's largest gliding club conducted in 2004 found that 70% of glider pilots had experienced discomfort in the cockpit over their flying career (Emck & Jackson, 2009). Since this time, glider design has been improved for aerodynamic performance, improving flight distance feasibility. This streamlining has impacted the cockpit, with more cramped seated conditions, likely increasing discomfort, with less space to move and reposition to avoid numbness and cramping. Increased discomfort in flight has been shown to lead to distraction, which can facilitate dangerous events, significant accident, and injury (Civil Aviation Authority, 2023). Therefore, this research captures an updated perspective of discomfort and its impacts during flight, to seek ergonomic and human factor recommendations to improve overall glider pilot safety and comfort, leading to performance.

Background Literature

Pilot comfort has been named as a key safety factor in all areas of aviation, with pilots often complaining of 'discomfort and low back pain' on mid to long range flights (Salem, et al., 2022). These complaints may lead to a loss of concentration, jeopardising the safety of the aircraft. Distraction due to discomfort could lead to errors in flight, which can cause accidents and loss of life. Therefore, it is important to prevent these errors from occurring by keeping pilots as comfortable as possible so that their sole focus is flying. These discomfort complaints are common in commercial pilots (Goossens, et al., 2000), general aviation pilots (Simpson & Porter, 2003) and specifically glider pilots (Segal, 1994), showing the significance of this issue across the aerospace sector. The most common complaint was 'lower back pain', because of 'insufficient lumbar support' (Goossens, et al., 2000). The lower limb, lumbar and buttock regions were the most

frequent source of discomfort in glider cockpits, which echoed the papers based on commercial and general aviation, further proving the significance of the issue (Emck & Jackson, 2009). These areas are said to suffer from muscle fatigue due to long periods of time under static loading conditions, which is more of an issue in gliding than in commercial aviation as glider pilots are constrained to their seat for the duration of their flight.

(Segal, 1994) observed that smaller pilots often expressed difficulties in reaching the controls. To counter this, they use a 'number of cushions' to help them sit higher and further forward. However, this is an unstable seating position and if the filler material used in the cushions is soft, then under high gravitational loads, the pilot could be pressed back into their cushion and slip out of reach of the controls. This compression and slippage caused a fatal accident in 1989 where a short and light pilot slipped out of reach of the controls and 'submarined' under their straps, leading their glider to dive towards the ground (Air Accident Investigations Branch, 1989). Although the official report did not directly blame the cause of the accident on the soft cushions in the cockpit, they are the only tangible factors in the accident (no evidence of previous mechanical failure was found (Air Accident Investigations Branch, 1989)).

A 2004 survey at Lasham Gliding Society indicated that 70% of pilots suffer from discomfort in some form when flying, and until now, there has been no follow-up to check whether this statistic has changed (Emck & Jackson, 2009). Additionally, Lasham is one of the world's largest gliding clubs (Lasham Gliding Society, 2023), but the views of pilots who only fly from there may have been skewed due to influences such as instructors, general club culture, and their social groups. Therefore, the aim of this research was to provide an updated perspective of discomfort in relation to glider pilot flight experience over the last 20 years. This brings to light the extent of discomfort experienced across general aviation to improve pilot-centred design for reduced risk in flight.

Methodology

A comprehensive survey was created using Microsoft Forms, asking a range of demographic, open ended, closed-ended, multiple choice and Likert scale questions. The survey was circulated to pilot groups and flying organisations and received a total of 245 responses, over 5 days of open collection. 244 of these responses were retained in the survey analysis, following filtering to relevant and appropriate content. Ethical approval was gained through the Loughborough University ethics human participants sub-committee prior to distributing the questionnaire (Approval code: 2022-11231-12351). Ethical approval was granted on the provision that no 'personal and/or sensitive' was collected. This included factors such as age, height, weight, and sex. The authors are aware that these factors may play a role in pilot comfort and recommend that these be included in any further or follow up work.

Alongside the closed question responses, qualitative data was inductively coded using NVIVO 14 to extract relevant and repeated themes in free-text answers. A sample of twenty-five random participants (circa 10 % sample) was taken to create the inductive codes. Each respondent's answers were then analysed for common themes, which became the codes for the rest of the data, with remaining data analysed and tabulated to identify relevance and occurrence of response. The quantitative data was then reviewed using statistical analysis formulae in Microsoft Excel and SPSS 29, with mean, median, standard deviation, minimum and maximum found for each category.

Results

The results are presented according to the survey structure. They outline pilot demographics, hours and experience, and the comfort levels in the cockpit, with further investigation on potential relevance between these factors.

Demographics

The survey was distributed online with basic demographic data collected to account for any variability in the answers between regions. This survey is the first known attempt to gather demographic information pertaining to glider pilots, with 99.2 % of filtered results returning demographic information. The United Kingdom census categories were used to classify ethnicity due to the United Kingdom being the base for the survey (UK Government, 2024). The overwhelming majority of responses (95.1% of the respondents) were White, with 4.1% of responses from Asian, Mixed, or other ethnicities (see Figure 1). Whilst demographic information shows a significant majority in one grouping, this provides greater resolution on how to best represent the gliding population using anthropometric data, and to provide opportunity for future widening participation into the sport by targeting underrepresented groups.

Of the respondents, 69% of the overall surveyed population classified themselves as 'English, Welsh, Scottish, Northern Irish or British', indicating that the survey reached mostly pilots from the United Kingdom. While the United Kingdom represents a large portion of the worldwide gliding population, there are 38 other countries represented by the Fédération Aéronautique Internationale (FAI) (Roake, 2006). 17 regions represented by the FAI are also present in the responses to the survey, ensuring the relevance of the analysis to the worldwide gliding population. While these regions are represented, the responses are not necessarily proportional to the worldwide gliding population and therefore this survey is primarily indicative of the comfort of English, Welsh, Scottish, Northern Irish and British pilots. The remaining White ethnicities are represented in Figure 2. Different ethnicities have different anthropometric scales, and with the primary response to this survey being Western, it can be assumed that western databases are suitable to be used when looking at this sporting population. Data sources such as CAESAR are therefore appropriate representations to use for further user-centred design features relating to general aviation pilots, as well as specific population information (SAE International, 2024).

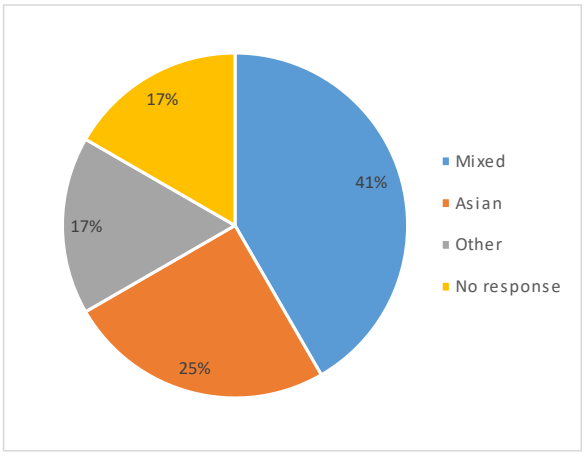

Figure 1: Breakdown of non-white responses.

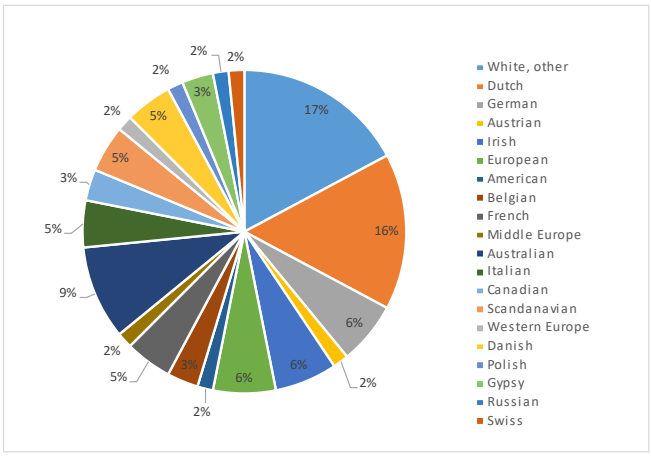

Figure 2: Breakdown of white responses.

Pilot Experience

Pilot experience was collected to further investigate time flown against discomfort experienced. Of the 244 respondents, 83% are qualified glider pilots, meaning they meet the minimum experience requirements to be licensed. In the United Kingdom, this is a minimum of 50 launches while being the Pilot in Command (P1) or 10 hours flying time as P1 in a glider (The British Gliding Association, 2024). This indicates a broad and diverse range of experiences from respondents. The distribution of both Pilot in Command (P1) and Pilot under Instruction (P2) hours flown appears to

be non-normal as shown in Figure 3. When tested for normality using the Kolmogorov-Smirnov and Shapiro-Wilk tests, both P1 and P2 hours flown were found to have p values of less than 0.001, which further iterates the non-normality of the data. The mean number of P1 hours flown is 846, with the median value being 300, showing high experience within the responses, but with skew in the data. The mean number of P2 hours flown is 128.7 hours and the median number of hours flown is 80, which echoes the high experience and skew found within the P1 hours. When collecting and analysing experience data, it is common to see a skew in experience collected, rather than normality, as this also includes those who are keen adopters but lack the time and motivation to continue sport and training pursuit. This has been seen in other areas when capturing human experience in a sector, leading to views of 'subject experts' who have high hours attributed, but there are few that develop this over time (Grant, et al., 2021).

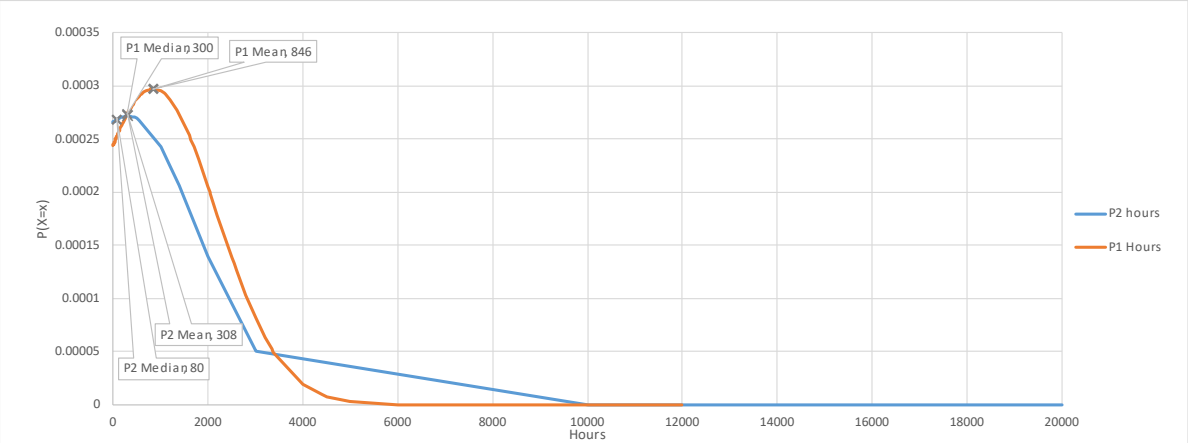

Figure 3: Distribution of P1 and P2 hours flown.

Pilot Comfort

Pilots also provided their general in-flight comfort on a Likert scale, with 1 being extremely uncomfortable and 7 being extremely comfortable. No linear correlation was found between hours flown and the level of comfort ($R^2 = 0.0151$), even when values greater than 3 standard deviations away from the mean were removed, ($R^2 = 0.0231$). However, Table 1 and Figure 4 indicate that the most comfortable pilots had a higher median number of P1 hours than their extremely uncomfortable counterparts. The median value of P1 hours flown for an extremely comfortable pilot is 750 hours, whereas the median value of P1 hours flown for an extremely uncomfortable pilot is only 250 and the data is skewed to a lower level, which may indicate that the least comfortable pilots with lower training hours are more likely to give up the sport. Table 1 and the boxplots shown in Figure 4 show a U-shaped distribution, indicating that in this data set that higher hour pilots could be more likely to feel strongly about their comfort levels, whether they are more or less comfortable than a lower-hour or less experienced pilot.

Table 1: Breakdown of pilot comfort rating

	Uncomfortable			Neutral	Comfortable		
Comfort Rating	**1s**	**2**	**3**	**4**	**5**	**6**	**7**
Frequency	4	18	38	23	36	91	34
% makeup	25%	9%	66%	9%	15%	37%	14%
Median P1 hours	250	350	175	70	216	500	750

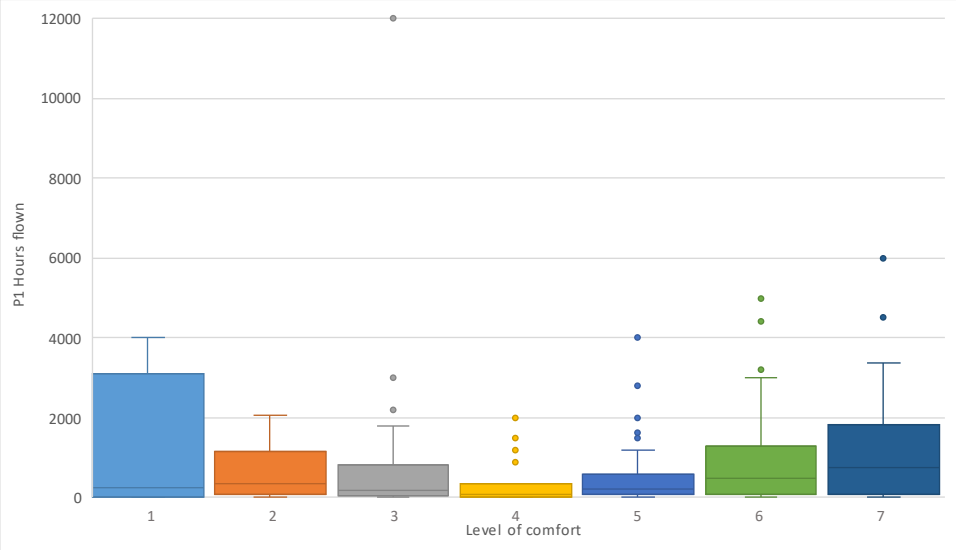

Figure 5: Boxplots of Pilot Comfort vs Hours Flown.

66% of pilots stated that they were comfortable in flight, but when asked whether they had suffered from discomfort in the cockpit, 82% of total respondents stated that they had been affected by in-flight discomfort of some form over the course of their flying careers with 274 mentions of pain. When asked to elaborate on this, it was found that 52% of all pain-based complaints involved back pain or back ache. Other complaints included a numb backside (14%), numb feet (12%), joint pain (11%), cramps (10%) and pressure (1%), illustrated in Figure 5. Pain in sports can be seen as a part of a 'culture of risk' (Miller, et al., 2022) and in safety critical sports such as gliding, risk must be reduced as much as possible.

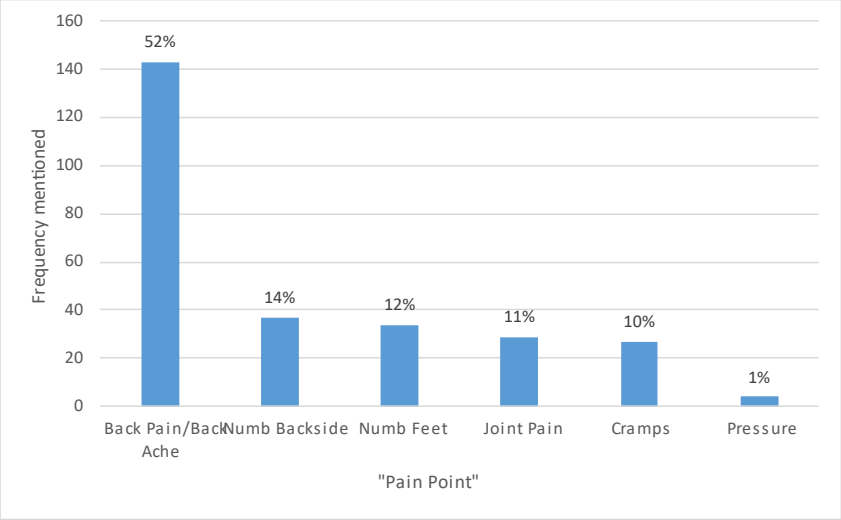

Figure 4: How pilots have been affected by discomfort in flight

All pilots were asked whether they modify the cockpit of gliders prior to flight, to explore modifications for comfort. Gliders are either owned by a club, where members hire them for the duration of their flights or are owned privately by individuals or syndicates. Privately owned gliders can therefore have more permanent modifications made, whereas club gliders need temporary, removable modifications. Of the 244 pilots surveyed, 55% required modifications to be made to club-owned gliders before flying them (see Figure 6). Some pilots required multiple modifications to be made, with 193 modifications defined for club-owned aircraft from 133 responses, with 82% involving adding some form of back support. This typically involves adding viscoelastic foam

cushions to sit on and to place behind the back, adding some form of lumbar support or the use of a removable seat back (which is generally created by the glider manufacturer). Cushions of some form (whether on the seat pan or behind the pilots back) made up 45% of modifications, which implies that gliders can lack the features to help keep a wide range of pilots comfortable in flight, and they must resort to their own makeshift solutions. While these solutions may reduce discomfort and enhance reach, they can cause other issues if not secured properly in the glider – for example, some pilots noted that the cushions used behind their backs often slip and due to the hard nature of the viscoelastic foam used, cause discomfort when shifted from the original position. Other, non-back related modifications to the cockpit include the use of control extensions so that pilots are not stretching to reach critical control surfaces and pedal adjustments for shorter-legged pilots, as shown in Figure 7. Alternatively, some pilots (8%) require all non-essential items to be removed so that they can fit into the cockpit, which highlights that neither tall nor small pilots are catered for in current glider designs.

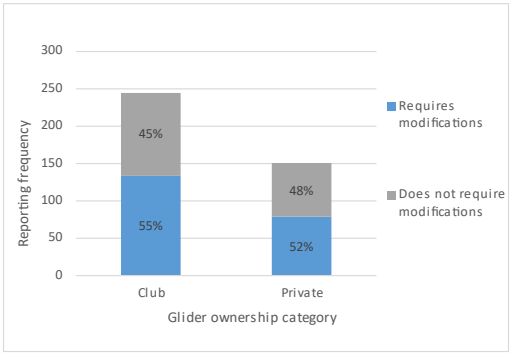

Figure 6: Requirement of modifications.

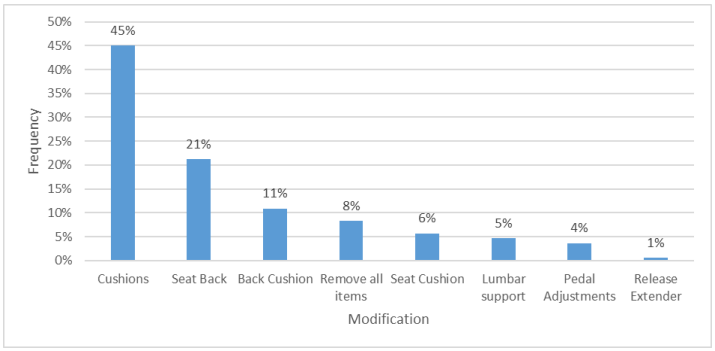

Figure 7: Pilot modifications to club gliders.

Discussion and recommendations for further work

This survey provides an updated perspective of glider pilot comfort, almost 20 years after the initial survey conducted at Lasham Gliding Society. The answers explored here echo the themes found in the Lasham Survey showing a lack of progression over the last two decades, and more reason to address discomfort during flight. It also provides answers from an increased number of, and a more diverse range of pilots, who fly from various clubs rather than just focussing on one club which may lead to skewed localised answers. However, it must be noted that 95.1% of the respondents described themselves as White and 69% of the overall surveyed population classified themselves as ‘English, Welsh, Scottish, Northern Irish or British’. While there is some representation from the other countries represented by the FAI, they are not represented proportionally and therefore this work predominantly represents the British population. Due to the variances in human anthropometry with demographic and geographical location, future work should aspire to represent the remaining 37 locations that participate in international gliding competitions. Only then, will a more accurate, and representative account of global glider pilot’s comfort be recorded.

P1 and P2 hours are non-normally distributed, which indicates a broad range of experience between pilots. The data was severely skewed, which prompts further question into the tangibility of the relationship between experience and comfort, but with the high incidence of discomfort sources listed, there is significant reason to further explore demographic and anthropometric causation for improved pilot-centred design.

While 66% of pilots answered that they are comfortable in the cockpit, 82% of them later stated that they have suffered from discomfort in the cockpit at some point over their flying career. These two statistics almost contradict each other, and therefore further development of this work should investigate why this difference occurred, which will provide a clearer insight into perceived cockpit comfort. There may be some psychological factors that caused the difference in these two answers, and this must be investigated in further work.

Most pilots surveyed indicated that modifications are required before flight, which implies that they would be unable to sit comfortably and control the aircraft safely without them. Even with these modifications, 52% of all pain-based complaints involved back pain or back ache, which is alternate to the major finding of the Lasham survey (most pilots in the Lasham survey indicated that they suffered from 'lower limb disorders'), requiring further investigation into the differences in definition. This statistic also links to the high percentage of pilots that use viscoelastic foam cushions to sit or lean on. The use of these cushions is the most common modification made to club owned gliders, which may imply that they help to relieve some amount of discomfort. Future work could investigate the best types and shapes of cushions to effectively reduce pressure and pinch points to alleviate discomfort in pilots, and whether this is localised to particular anthropometric and demographic populations.

Conclusions drawn

This survey has highlighted pilot discomfort as a significant, widespread, and serious issue, with the discovery that 82% of pilots have suffered from discomfort in the cockpit over their flying career. This value is far from being insignificant and serious design work must be conducted by glider designers and manufacturers to reduce this statistic in the future. While the survey was primarily aimed at glider pilots, the findings may also apply to other aspects of general aviation and other seated endurance-based environments.

The use of viscoelastic foam cushions is the most popular method of alleviating reported discomfort, but as there are no standards or formalised guidelines on the size and shape of these, it is often up to the pilot to decide how to tackle their issues, which may lead to further complications when trying to solve an initial problem. A Root Cause Analysis investigation could be employed to identify the source and location of the issue, to further improve product design.

Further work is required to ensure that the survey represents the worldwide gliding population and that the number of responses from each of the 38 regions represented by the FAI are proportionate to their share of the gliding population. Additional investigation could explore why the focus of discomfort has shifted from 'lower limb disorders' to 'back pain' over the 20 years since the Lasham survey. A comprehensive understanding of the root cause of back pain will also be required before consultation with glider designers and manufacturers to change the way they design their cockpits for human interaction. The findings of this work have the potential to shape the future of gliding and general aviation in the coming years, hopefully making both areas safer, more comfortable and more size-inclusive to all.

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