



Transport and Road Safety Research Centre

Final Report

Survey of Pilot Fatigue for Australian Commercial Pilots

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Executive Summary

This report describes the findings of an independent survey of 1,132 Australian commercial pilots on their experiences of fatigue while working under CAO 48.0 and various exemptions currently allowed by CASA. The survey was conducted on-line by Transport and Road Safety (TARS) Research at the University of New South Wales (UNSW Sydney). Invitations to participate were sent by the Australian Federation of Air Pilots (AFAP) to all their members and advertisements inviting all commercial pilots to take part in the survey were placed in the fortnightly Aviation pages of The Australian newspaper over four weeks in June-July 2017.

The findings show that fatigue is a significant problem for Australian commercial pilots. Around half of pilots surveyed (52.4%) reported that fatigue is a substantial or major personal problem in their work. The majority had experienced fatigue both before or during duty at some stage in their flying career. Approaching half (46.1%) had experienced fatigue during half or more of their shifts.

Pilots reported significant consequences of experiencing fatigue. Almost all reported that fatigue had produced negative effects on performance. Over two-thirds had made an error due to fatigue at some stage and nearly half (45%) had experienced a microsleep while on duty and one in five had fallen asleep unplanned while on the flight deck.

Regression modelling of the major contributors to experiencing fatigue as a personal problem highlighted long duty periods including high flying hours, flying three sectors or more, night duties and inconsistent roster patterns as work-related factors and short recovery time and insufficient on-board rest as rest-related factors that significantly increased the odds of experiencing a fatigue problem.

Most pilots managed fatigue through use of caffeine-containing drinks and standing up and moving around, strategies that are easily accessible to all pilots. Controlled rest and napping, strategies that have longer term effectiveness for fatigue management but are more difficult to arrange, were used by a minority of pilots. Nearly 40 percent of pilots reported that they worked under a formal Fatigue Risk Management System (FRMS). Just over half (58%) had ever made a fatigue report but nearly half had reported sick instead of fatigued. Over half of pilots felt that their company always encouraged reporting of fatigue, but the most common reasons for not reporting were that they perceived no benefits in reporting or that there was likely to be an adverse response from the company if they reported. Nearly one-quarter didn't report as they felt too tired and couldn't be bothered.

Comparison of fatigue experiences for pilots doing different types of flying work

The survey showed large differences in the reported fatigue experiences of pilots doing different types of flying work. The greater majority of domestic (83%) and international (79%) pilots reported that fatigue was a substantial or major personal problem whereas smaller percentages of charter pilots (15%) and air ambulance pilots (25%) felt fatigue was a significant personal problem. Regional pilots and helicopter pilots were midway between the two groups but this represented about half of regional pilots and over one-third of helicopter pilots. On the other hand, almost all pilots doing all types of flying work had experienced negative effects on performance due to fatigue, although domestic and international pilots were more likely to have experienced microsleeps and fallen asleep unplanned on the flight deck.

Investigation of the potential causes of fatigue for these different pilot groups showed that domestic pilots did the longest duty and flying hours compared to all other work groups, followed by regional pilots who did the next longest duty periods and international pilots who did the next longest flying hours. Helicopter pilots did the lowest duty and flying hours. Most groups flew similar numbers of sectors in a duty period (median = 3-4). International pilots flew the least number (median=2) but the longest sectors (median 6 hours) compared to the one to two hour sectors for all other groups.

Pilot responses on their experiences of lists of potential contributors to fatigue also showed considerable differences between work types. Pilots were asked to indicate which potential contributors they had experienced and which they felt were the top three fatigue management problems from a list of seventeen potential issues (see Figure 1S for details). A range of the contributors were commonly experienced for each working type, with domestic and international pilots reporting the highest number of contributors, however the contributors experienced most often were not always in the top three cited fatigue management problems. The top three problems for domestic pilots were long duty periods, consecutive early then late duty and inconsistent roster patterns. For international pilots the most common top three problems were night flights, unfavourable times for rest and insufficient quality on-board rest. Regional pilots on the other hand felt starting early, short recovery time and minimum rest after extended duty were the top three problems. The remaining pilot groups all included starting early, night flights, finishing late, long duty periods or consecutive early then late duty in their top three.

Figure 1S: Comparison of fatigue contributors reported by at least 75% of pilots doing each type of work (shown by X) and the contributors rated in the top three fatigue management problems by the most pilots for each work type (shown by shaded cells)

Contributor	Air ambulance	Charter	Domestic	Helicopter	International	Other	Regional
Starting early <6am	X	X	X			X	X
Finishing late (after 10pm)	X						
Long duty periods ≥8 hrs			X		X	X	
Night flights 10pm to 6am			X		X		
Not sleeping at home several nights in a row							
Outward westward flight ≥ 2 time zones							
Outward eastward flight ≥ 2 time zones							
Return westward flight ≥ 2 time zones							
Return eastward flight ≥ 2 time zones							
Flying ≥ 3 sectors			X				
Unfavourable times for rest			X		X		
Short recovery time			X		X		
Minimum rest after extended duty			X		X		
Insufficient quality on-board rest							
Consecutive early then late duty	X	X	X				X
Inconsistent roster patterns			X				
Being on-call or standby							

Pilots were also asked to indicate which of a list of nine potential fatigue contributors they had experienced and, from these, which had a moderate to large effect on their capacity to manage fatigue (Figure 2S for details). There was considerable variation amongst the work types on which of these potential contributors they had experienced, but there was considerable similarity in their responses on which significantly affected their capacity to manage fatigue. The two contributors relating to coping with night work (long night shifts and consecutive back of the clock shifts) were cited as adversely affecting their capacity to manage fatigue by the majority of pilots doing each type of work, but they were a very common experience only for international or domestic pilots. All work types except air ambulance and charter pilots cited long duties with 2 hours or more commuting and disruptive or irregular shifts as causing problems for fatigue management although this was not experienced by more than 75 percent of any of the pilot groups. In contrast, longer hours of day shift were a common experience for all work groups, but only reported as affecting capacity to manage fatigue by domestic, regional and other pilots. Having duties after a single day off were also experienced by most pilots in all groups except helicopters, but only domestic, international and other pilots reported that this potential contributor reduced their capacity to manage fatigue.

Figure 2S: Comparison of fatigue contributors reported by at least 75% of pilots doing each type of flying (shown by X) and contributors reported by more than 50 percent of pilots doing each work type as having a moderate to large effect on their capacity to manage fatigue (shown by shaded cells)

Contributor	Air ambulance	Charter	Domestic	Helicopter	International	Other	Regional
> 10 hrs day shift	X	X	X	X	X	X	X
> 8 hrs night shift			X		X		
> 10 hrs duties and ≥2 hrs commuting home							
Flying > 3 sectors	X	X	X				X
On-call duties then flight duties		X	X		X		X
< 30 hrs to adapt to ≥ 2 hour time difference					X		
Duties after single day off	X	X	X		X	X	X
Irregular or disruptive schedules	X	X	X		X		X
Consecutive back-of-the-clock duties					X		

Strategies used to manage fatigue varied considerably between individual pilots doing different types of work. The most effective management strategies of controlled rest and napping were used most by domestic, international and helicopter pilots. The other groups used more temporary strategies like caffeine, standing up and walking around and talking to crew. Regional and charter pilots in particular did not use the most effective strategies.

Helicopter, domestic and international pilots were most likely to report that their company had a Fatigue Risk Management System (FRMS) in place. Only around one-quarter of regional and air ambulance and one-tenth of charter pilots reported having an FRMS. More domestic, international

and regional pilots responded that their company did not encourage reporting of fatigue compared to air ambulance and charter pilots, yet, domestic, helicopter and international pilots were most likely to have reported fatigue. The reasons for not reporting were also different between the groups. Domestic, international and regional pilots were most likely to not report as they saw no benefits in reporting or a likely adverse response from the company. Importantly, these three groups were also most likely to not report as they were too tired and couldn't be bothered, mirroring the higher reporting of fatigue as a personal problem for these three work groups.

Overall, this study provides insights into the experiences of fatigue for commercial pilots in Australia. As found from similar surveys in Europe in recent years, all types of commercial pilots working in Australia are experiencing concerning levels of fatigue, but especially for pilots doing domestic, international and, to a slightly lesser extent, regional work. The survey shows that many pilots doing all types of work are exposed to duty and work-related factors that potentially contribute to experience of fatigue or make it difficult to manage. It also indicates that current approaches to fatigue management are not sufficiently effective for many commercial pilots. Importantly, the survey brings to light the most important issues of fatigue management for pilots doing each type of work. These results, in particular, provide evidence-based directions for action to reduce the levels of fatigue experienced by commercial air pilots.

The survey was funded by the Australian Federation of Air Pilots to provide evidence to inform submissions to the Civil Aviation Safety Authority independent review of the fatigue risk management rules (CAO 48.1). The study was conducted independently by the Transport and Road Safety (TARS) Research Centre, School of Aviation, at UNSW Sydney.

Background

Fatigue has been identified as a significant risk factor for safe performance in air operations largely due to long and/or irregular flight duty times and circadian disruption required by the operational demands of air transport. Despite awareness that pilots in commercial aviation are likely to experience fatigue, there is little evidence of their experiences of fatigue, what factors contribute to their fatigue and how they manage fatigue.

The aim of this project is to conduct a survey of the fatigue experiences of commercial air pilots especially in response to the flight and duty times currently worked in Australian commercial aviation. The objective of this survey is to inform a submission to the Civil Aviation Safety Authority (CASA) independent review of the Australian fatigue risk management rules under Civil Aviation Order (CAO) 48.1 Instrument 2013 as amended.

Method

An on-line survey was developed to cover a range of aspects of the experience of fatigue for pilots, their experience of likely contributors to fatigue and details of how they manage it. Many of the questions were based upon air pilot surveys conducted in other countries or in other industries (European Cockpit Association, 2012; Williamson, Feyer, Coumarelos, and Jenkins, 1992; Williamson, Feyer, Friswell, and Sadural, 2001). A copy of the questions in the survey is included in Appendix 1. The survey was anonymous and no identifying information was included. Respondents could skip any questions that they wished.

The on-line survey was available for completion on the UNSW website for five weeks over the period from 28th May to 2 July 2017. Invitations were sent to from the Australian Federation of Air Pilots (AFAP) by email to all their members. Two reminder emails were also sent out. In addition, two advertisements were placed in the Friday Aviation page of the national newspaper, The Australian, which is well-read by the aviation community. This resulted in a total of 1,132 completed surveys. Respondents cover pilots from a range of different types of operations and types of work.

The survey was granted Ethics approval by the UNSW Human Ethics Committee (HC17259). This study was funded by the Australian Federation of Air Pilots.

Results

The following section summarises the main findings of the survey. The results are divided into three main sections. The first describes the fatigue experiences for all pilot respondents. The second section is a comparison of the fatigue experiences for pilots doing different types of work. The third section compares fatigue experiences for pilots working for companies with a Fatigue Risk Management System (FRMS) in place and pilots who do not.

Fatigue experiences for Australian commercial pilots: Overall results

Description of respondents

Amongst the 1,132 pilots who responded to the survey, the largest group were employed by Regional operators, followed by low-cost operators, mainline or legacy operators, charter and air ambulance. Small percentages of respondents worked for helicopter and cargo organisations (see Figure 1). Close to 40 percent of respondents fly smaller Turboprop (< 20 tonne) aircraft, one-third fly narrowbody jets and smaller percentages fly widebody jets and helicopters (Figure 2). Figure 3 shows the distribution of the type of work for all pilot respondents. Just over half were roughly equally distributed across regional and domestic intercapital work, around one in six did either charter work or air ambulance work, just under ten percent did international work and a small percentage did helicopter work. A small percentage were classified as other, mainly because they did combinations of types of flying (1.9%) or flying training ((1.1%).

Table 1 shows that the majority of respondents were permanent employees, with the remainder on fixed term contracts. While just over half were paid by salary with overtime, a significant minority were paid a salary with no overtime. A very small percentage was paid by the amount of work done. Respondents were fairly evenly distributed between 25 and 54 years of age and more than half had 15 years or more experience as a pilot. The greater majority of respondents were male, with females accounting for only ten percent of respondents.

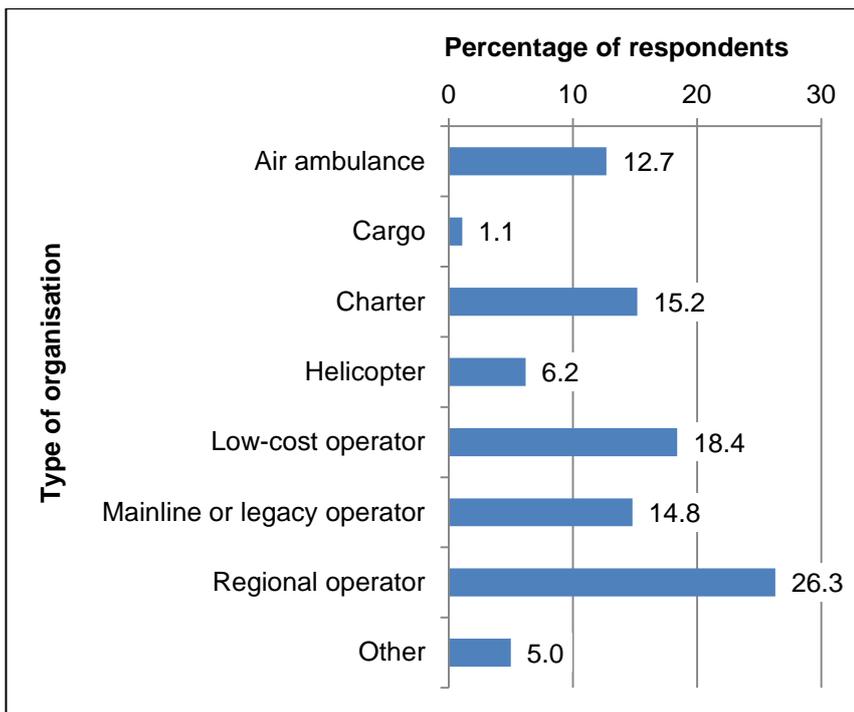


Figure 1: Type of organisation employing pilot respondents

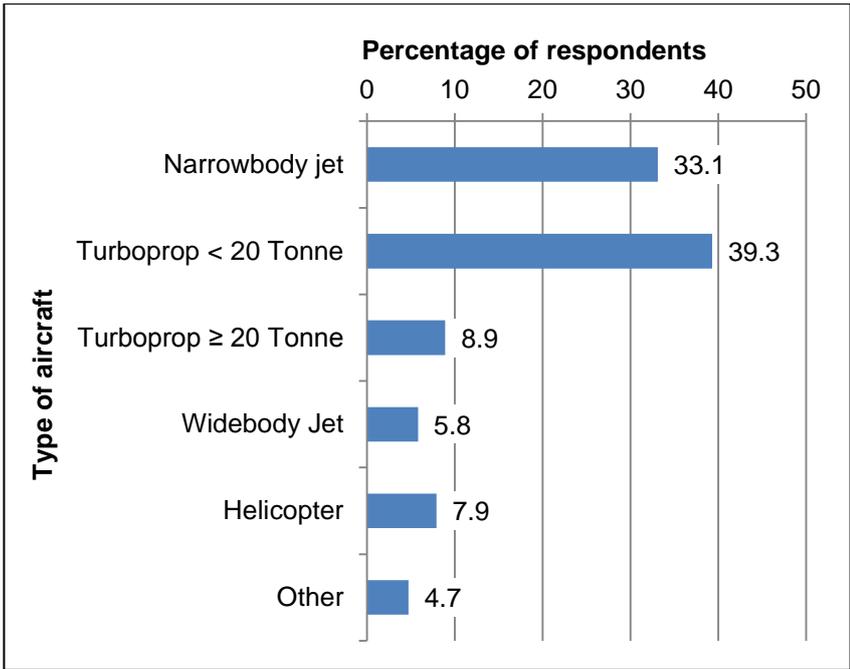


Figure 2: Type of aircraft flown by pilot respondents

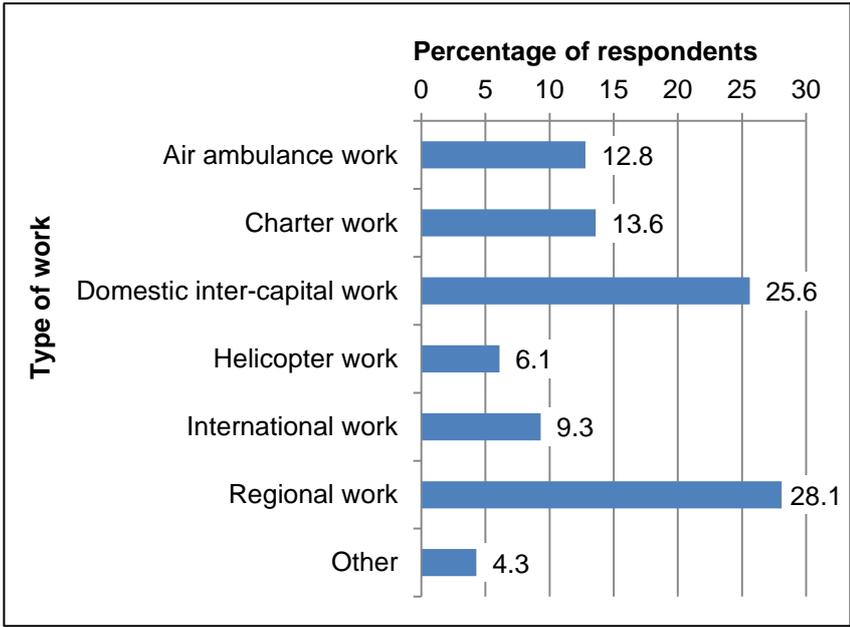


Figure 3: Type of work done by pilot respondents

Table 1: Employment and demographic characteristics of pilot respondents

Pilot characteristics	%
<i>Type of contract with the company</i>	
Permanent	81.3
Fixed term	17.1
Other	1.2
<i>How usually paid</i>	
By salary with payment for overtime	58.2
By salary with no payment for overtime	38.4
By amount of work done	1.6
<i>Age</i>	
< 25 yrs	3.4
> 65 yrs	1.1
25-34 yrs	26.0
35-44 yrs	26.9
45-54 yrs	30.7
55-64 yrs	11.6
<i>Experience as a pilot</i>	
< 5 yrs	8.1
5-9 yrs	17.8
10-14 yrs	21.5
15-19 yrs	17.0
20-24 yrs	14.8
25 yrs or more	20.7
<i>Gender</i>	
Male	90.3
Female	8.7

Pilots' experience of fatigue

As shown in Figure 4, most pilots viewed fatigue as a substantial or major problem for pilots in general (67.4%) and around half (52.4%) reported fatigue as a substantial or major personal problem during their flying work. As might be expected, there was a strong correlation between reporting of fatigue as an industry problem and as personal problem ($r_{(1129)}=0.76$, $p<0.0001$). Pilots who reported a personal problem with fatigue also reported it as an industry problem and vice versa.

The majority of pilots reported at least sometimes experiencing fatigue before (80.2%) and during (75.2%) duty (see Figure 5) with over one-third (36.2%) reporting that they experienced fatigue before at least half of their duty periods and nearly half (46.1%) reporting experiencing fatigue during duty on at least half of their shifts. When asked how many hours after starting flying they usually begin to feel fatigue, the mean duration during the day was 6.48 hours (sd = 2.53) and during the night was 4.54 hours (sd = 2.39).

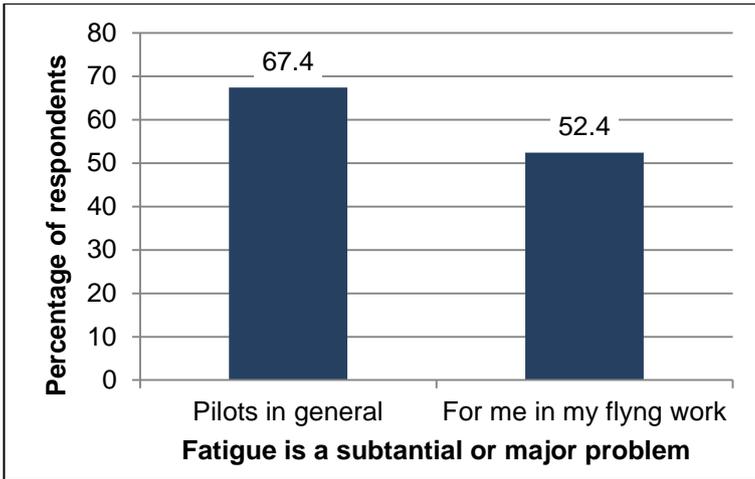


Figure 4: Percentage of pilots reporting fatigue as at least a substantial or major problem for pilots in general and for themselves in their flying work

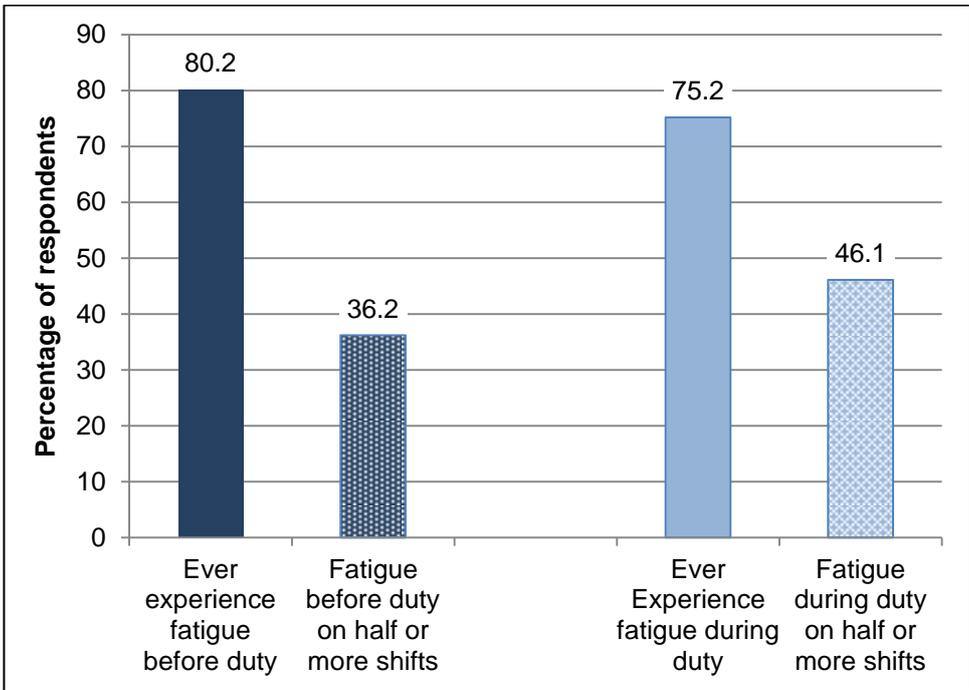


Figure 5: Pilots' reports of ever experiencing fatigue before and during duty and the percentage of pilots who experienced fatigue before or during at least half of their shifts

As shown in Figure 6, almost all respondents were aware of the potential for adverse effects on work performance as 93.7 percent reported that they have experienced fatigue on duty that has had a negative effect on their performance. Nearly half (45.0%) reported experience of microsleeps while on duty and one in five (19.3%) had unexpectedly fallen asleep on the flight deck. A small but notable minority (15.2%) reported having woken from sleep to find other crew also asleep.

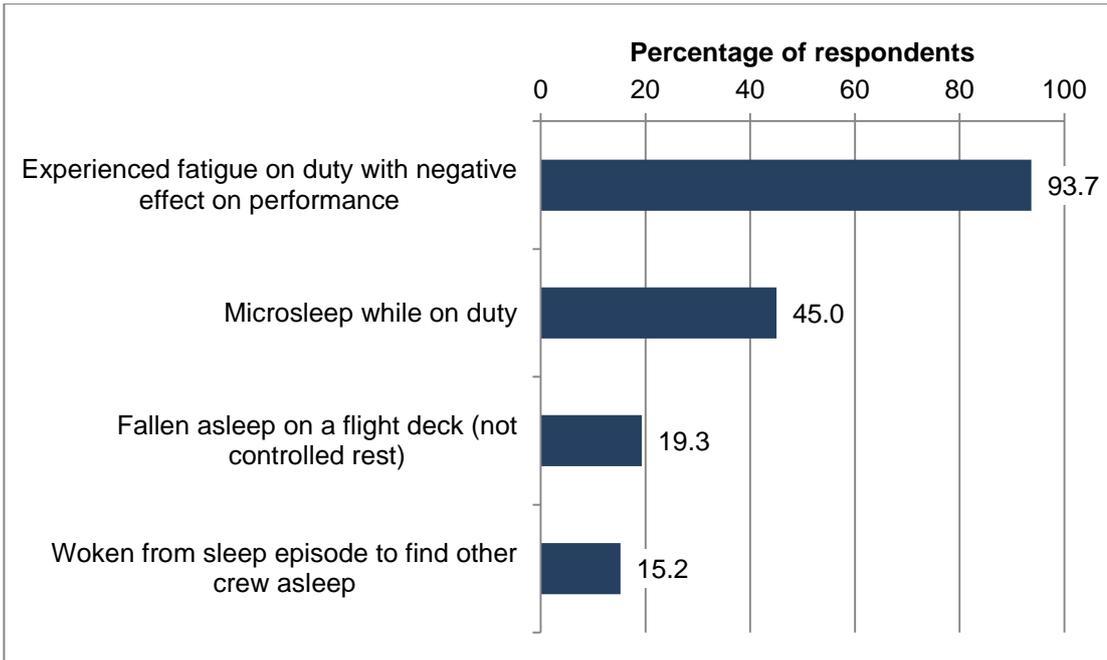


Figure 6: Percentage of pilots experiencing fatigue-related incidents during duty

More than two thirds of pilot respondents (71.2%) reported that fatigue affected their capacity to perform their work (Figure 7). For most pilots this occurred on a relatively small percentage of duty periods, but for 8.8% it occurred on more than half. A similar percentage of pilots reported having made an error due to fatigue while on duty (71.5%), and although fewer reported errors as very frequent occurrences, around one-third of pilots estimated that they made errors on more than 10 percent of duty periods.

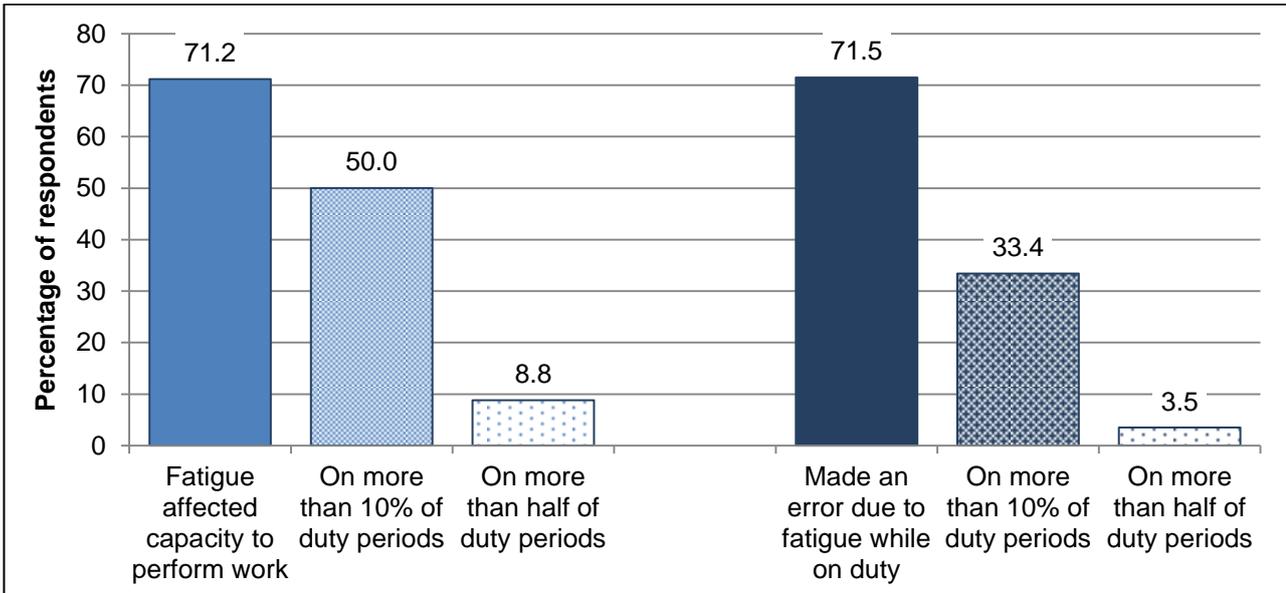


Figure 7: Percentage of respondents reporting that fatigue had affected their capacity to perform their work and Percentage reporting making an error while on duty and in each case the frequency with which this had occurred (more than 10% and more than 50% of duty periods)

Contributors to fatigue

Pilots were asked a range of questions about characteristics of their work and rest that could contribute to fatigue. As shown in Figure 8, most pilots reported their normal travel time to or from work was less than one hour, however, one-quarter travelled for 1 to 2 hours between home and work and a small percentage travelled for up to five hours. Many pilots also reported disruptions to their rosters, being on standby and long working hours that are also potential causes of fatigue. As shown in Figure 9, just over one-third of pilots reported that their published roster often or always changed during the roster period. A similar percentage was often or always on standby during a roster period and almost half reported that they were often or always called into work when on standby. Around one-third of pilots also reported often to always being asked to work on days off. Approaching one-fifth of pilots reported that their duty time often or always exceeded 12 hours.

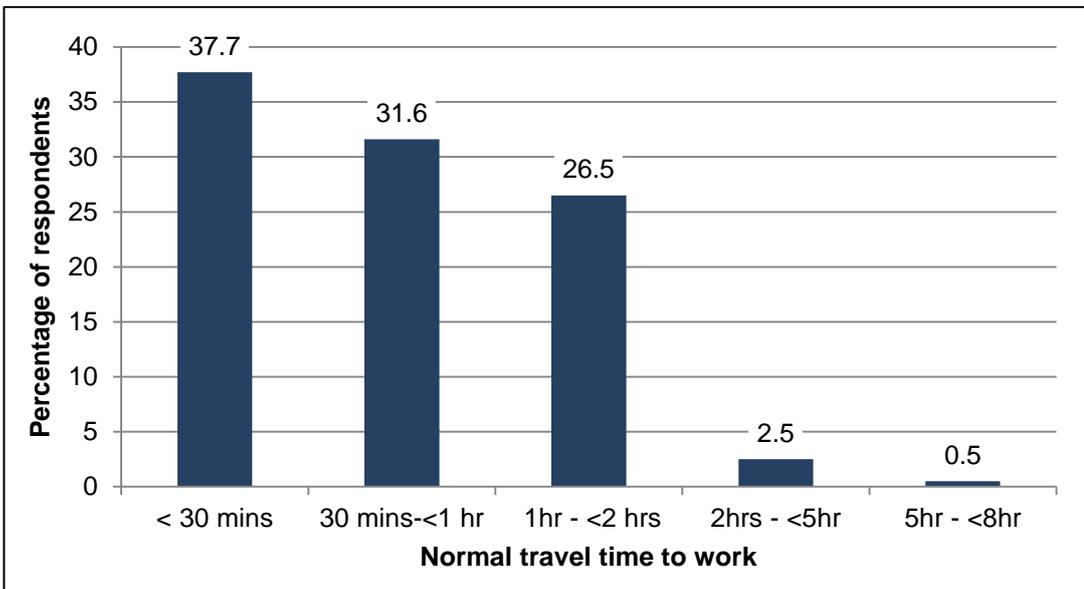


Figure 8: Normal travel time between home and work

Pilots were asked about characteristics of their duty periods (see Table 2). Overall, the median usual duty period was 120 hours in a 28 day roster period with slightly less than half of that time involving flying. Most pilots reported doing four duty periods per week with a median of 16 hours off at home base between duty periods. Within a duty period, pilots flew three to four sectors with each sector being one to two hours for most pilots. The time between sectors was around one hour for most pilots.

Table 2: Duty characteristics of pilot respondents showing median and 25, 50 and 75 percentiles

Duty characteristic	Mean	Median	SD	25%	50%	75%
Usual duty hours in a 28 day roster period	118.7	120.0	40.6	110.0	120.0	140.0
Duty hours in the last 28 day roster period	116.7	120.0	42.3	101.0	120.0	140.0
Usual duty flying hours in a 28 day roster period	57.2	55.0	28.4	44.0	55.0	75.0
Hours flown in last 28 day roster period	54.7	54.0	24.7	38.0	54.0	75.0
Usual duty periods each week	5.8	4.0	7.9	4.0	4.0	5.0
Usual time off between duty periods at home base (hours)	50.4	16.0	259.9	12.0	16.0	18.0
Sectors usually flown in duty period	4.9	4.0	7.3	3.0	4.0	4.0
Length of average sector (hours)	2.3	1.0	6.3	1.0	1.0	2.0
Time between sectors (hours)	3.0	1.0	9.5	0	1.0	1.0

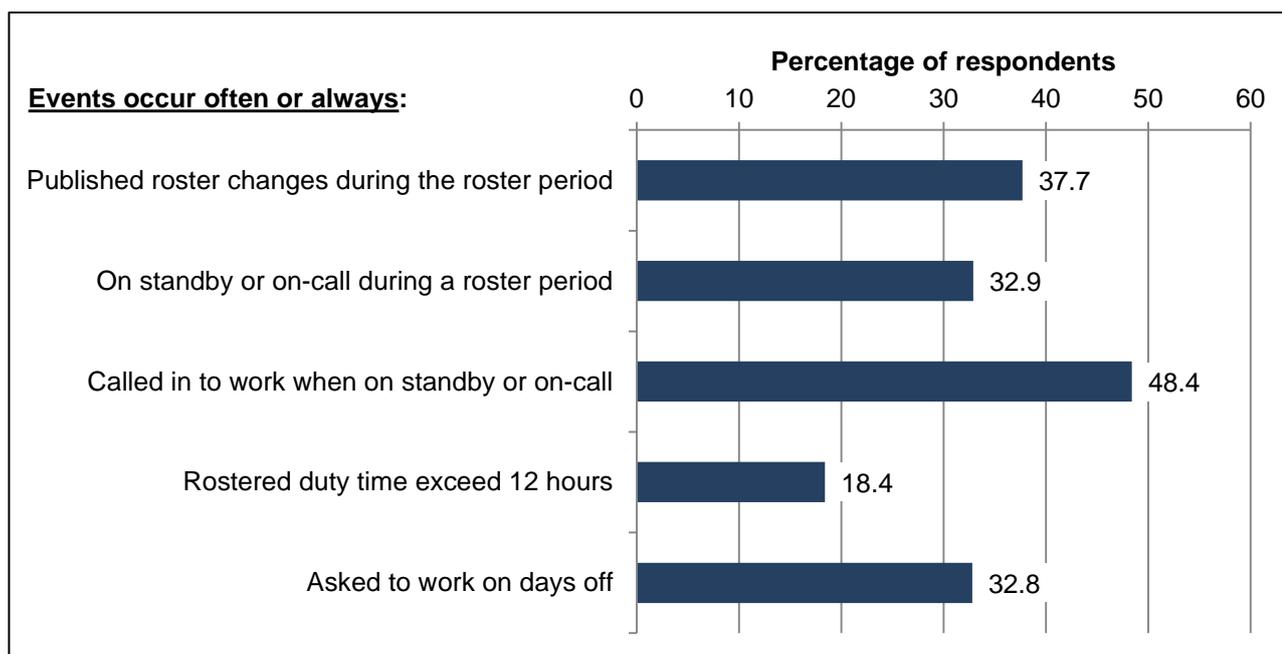


Figure 9: Percentage of pilots reporting different types of roster characteristics occurring often or always during a roster period

The survey included a range of questions about pilot experiences of a range of acknowledged potential contributors to fatigue as shown in Figure 10. The most common potential contributors, reported by more than half of pilot respondents were early starts (pre 06:00hrs), consecutive early then late duty periods, finishing late (after 22:00hrs), long duty hours of 8 hours or longer, minimum rest following extended duty, short recovery time between duties and inconsistent roster patterns. Pilots were asked to nominate their top three problems amongst the range of potential contributors to fatigue. The contributors nominated most often were mainly the same as those experienced by most pilots. More than half of the pilots who had early starts or consecutive early

then late duty periods nominated these factors as in their top three problems. Similarly, more than 40 percent of the pilots who did night flights during 10pm and 6am, long duty period of 8 hours or longer, had inconsistent roster patterns or short recovery time between duties nominated these factors as one of their top three problems.

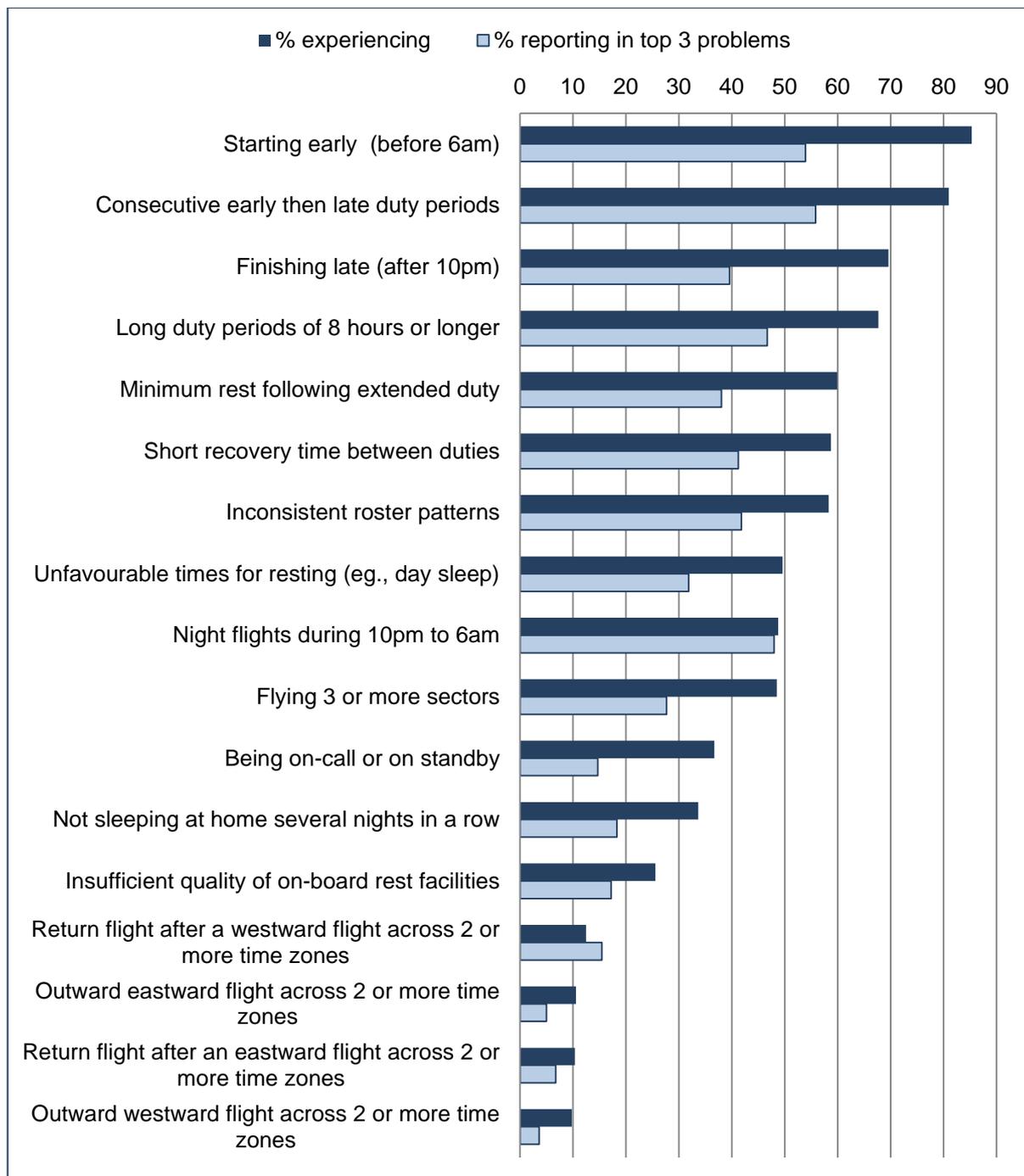


Figure 10: Potential contributors to fatigue: Percentage experiencing and percentage of pilots experiencing each contributor who rank it as a top 3 problem

Pilots were asked about their experience of some specific types of flight duties that might be expected to make a higher contribution to fatigue. As shown in Figure 11, the majority of pilot respondents (over 75 percent) reported that they had experienced duties of more than 10 hours

during the day time, duties involving more than three sectors, been on-call then had flight duties, had a duty period after only one day off and had experienced irregular or disruptive schedules. When asked the extent to which each of these types of duties contributed to their capacity to manage fatigue, there was a different pattern of responses. For pilots who reported doing duties of more than 8 hours during night time or consecutive back-of-the-clock duties, well over 80 percent reported that these duties had a moderate to large effect on their capacity to manage fatigue. Similarly, even though fewer pilots reported doing duties of more than 10 hours when their flights involved commuting of two or more hours from home base or doing duties with less than 30 hours to adapt to a two or more hour time difference, more than 60 percent of these pilots reported moderate to large effects on their capacity to manage fatigue.

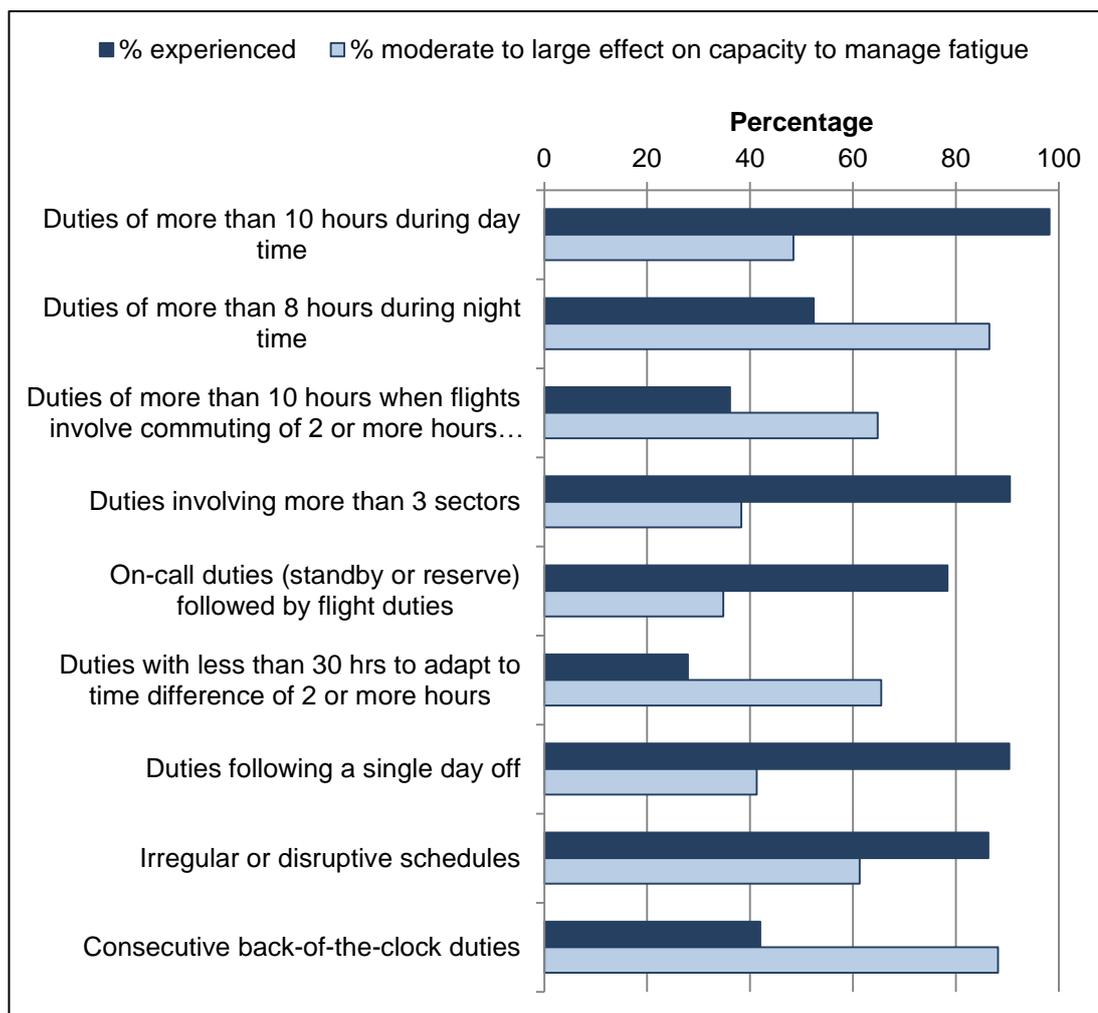


Figure 11: Experience of different types of flight duties: Percentage experiencing each type of duty and of those, percentage reporting a moderate to large effect on capacity to manage fatigue

The results of analysis of the relationships between the potential range of fatigue contributors and pilots' experience of fatigue as a personal problem are shown as correlations in Table 3. Larger correlation values indicate that experience of the contributor was associated with higher ratings of fatigue as a personal problem. Statistically significant relationships are shaded.

Table 3: Correlations between pilots reporting that they experienced each potential Contributor and their ratings of fatigue as a personal problem. Correlations with an * indicate a stronger or statistically significant relationship (p<0.01)

Contributor	Fatigue as a personal problem
Duty characteristics (Pearsons correlations)	
Usual duty hours in a 28 day roster period	0.11
Duty hours in the last 28 day roster period	0.12
Usual flying hours in a 28 day roster	0.33*
Hours flown in last 28 day roster period	0.35*
Usual duty periods each week	0.08
Usual time off between duty periods at home base (hours)	0.05
Sectors usually flown in duty period	0.04
Length of average sector (hours)	0.09
Time between sectors (hours)	0.09
Potential contributors to fatigue (Spearman's correlations)	
Starting early <6am	-0.04
Finishing late (after 10pm)	-0.04
Long duty periods ≥8 hrs	0.56*
Night flights 10pm to 6am	0.42*
Not sleeping at home several nights in a row	0.31*
Outward westward flight ≥ 2 time zones	0.22*
Outward eastward flight ≥ 2 time zones	0.25*
Return westward flight ≥ 2 time zones	0.24*
Return eastward flight ≥ 2 time zones	0.25*
Flying ≥ 3 sectors	0.45*
Unfavourable times for rest	0.48*
Short recovery time	0.52*
Minimum rest after extended duty	0.51*
Insufficient quality on-board rest	0.42*
Consecutive early then late duty	0.08
Inconsistent roster patterns	0.50*
Being on-call or standby	0.37*
Flight duties likely to contribute to fatigue (Spearman's correlations)	
> 10 hrs day shift	0.04
> 8 hrs night shift	0.47*
> 10 hrs duties and ≥2 hrs commuting home	0.17
Flying > 3 sectors	-0.04
On-call duties then flight duties	0.12
< 30 hrs to adapt to ≥ 2 hour time difference	0.34*
Duties after single day off	0.02
Irregular or disruptive schedules	0.05
Consecutive back-of-the-clock duties	0.42*

Contributors found to be statistically significantly correlated with pilot fatigue experiences were then used as predictors in a logistic regression analysis. The results of the regression analysis are shown in Table 4. For this analysis, pilot’s ratings of personal fatigue were combined into responses of no and minor problem as the reference category and responses of substantial and major problem as the comparison category. This analysis tests each contributor for statistical significance after the impact of the other contributors had been accounted for. Those that are statistically significant ($p < 0.05$) have an effect that is in addition to the effect of the other contributors. This can also be seen by looking at Odds Ratios for each predictor, which when larger than one indicate that the odds of experiencing fatigue as a personal problem are significantly increased.

Table 4: Logistic regression of potential contributors to fatigue associated with pilots’ ratings of fatigue as a personal problem showing

Predictors	B	S.E.	df	Sig.	Odds Ratio	95% C.I. for OR	
						Lower	Upper
Usual flying hours in a 28 day roster	.02	.003	1	.000	1.02	1.009	1.022
Long duty periods ≥ 8 hrs	1.07	.247	1	.000	2.91	1.791	4.724
Night flights 10pm to 6am	-.26	.233	1	.263	.77	.488	1.216
Not sleeping at home several nights in a row	.07	.184	1	.712	1.07	.746	1.535
Outward westward flight ≥ 2 time zones	-.30	.464	1	.517	.74	.298	1.840
Outward eastward flight ≥ 2 time zones	.67	.474	1	.155	1.96	.775	4.961
Return westward flight ≥ 2 time zones	-.18	.378	1	.627	.83	.397	1.746
Return eastward flight ≥ 2 time zones	-.28	.453	1	.535	.76	.311	1.835
Flying ≥ 3 sectors	.64	.180	1	.000	1.89	1.329	2.688
Unfavourable times for rest	.39	.215	1	.070	1.48	.969	2.252
Short recovery time	.56	.210	1	.007	1.76	1.162	2.651
Minimum rest after extended duty	.38	.220	1	.084	1.46	.950	2.253
Insufficient quality on-board rest	.69	.231	1	.003	1.99	1.266	3.125
Inconsistent roster patterns	.56	.198	1	.005	1.75	1.190	2.580
Being on-call or standby	.06	.187	1	.743	1.06	.737	1.532
> 8 hrs night shift	.52	.234	1	.026	1.68	1.065	2.663
< 30 hrs to adapt to ≥ 2 hour time difference	.17	.219	1	.444	1.18	.770	1.816
Consecutive back-of-the-clock duties	.56	.220	1	.011	1.75	1.136	2.685
Constant	-3.6	.274	1	.000	.03		

Hosmer-Lemeshow test $\chi^2=22.89$, $p < 0.004$

Contributors found to increase the odds of pilots experiencing a substantial or major fatigue problem included factors to do with the length of duty periods: 8 hour duty periods increased the odds of a fatigue problem by nearly three times, longer than 8 hour night shifts increased odds by 68 percent, flying three or more sectors in a duty (increased odds by 89%), consecutive night duties (increase odds by 75%) and usual flying hours in a 28 day roster. Factors relating to the timing and nature of rest also increased the odds of fatigue being a personal problem: short recovery times (increase of 76%) and insufficient on-board rest (nearly double the odds). In addition, inconsistent roster patterns increased the odds by 75 percent.

Strategies for fatigue management

The most common strategies used by pilots for managing fatigue while working are shown in Figure 12. The most common method reported was using coffee or other caffeine-containing drink, followed by standing up and moving around, and using controlled rest. Very few pilots reported having no specific strategy for managing fatigue. Just over one-third of pilots reported that their company has a Fatigue Risk Management System in place (Figure 13), and only a small percentage of pilots was not aware of whether or not their company had an FRMS.

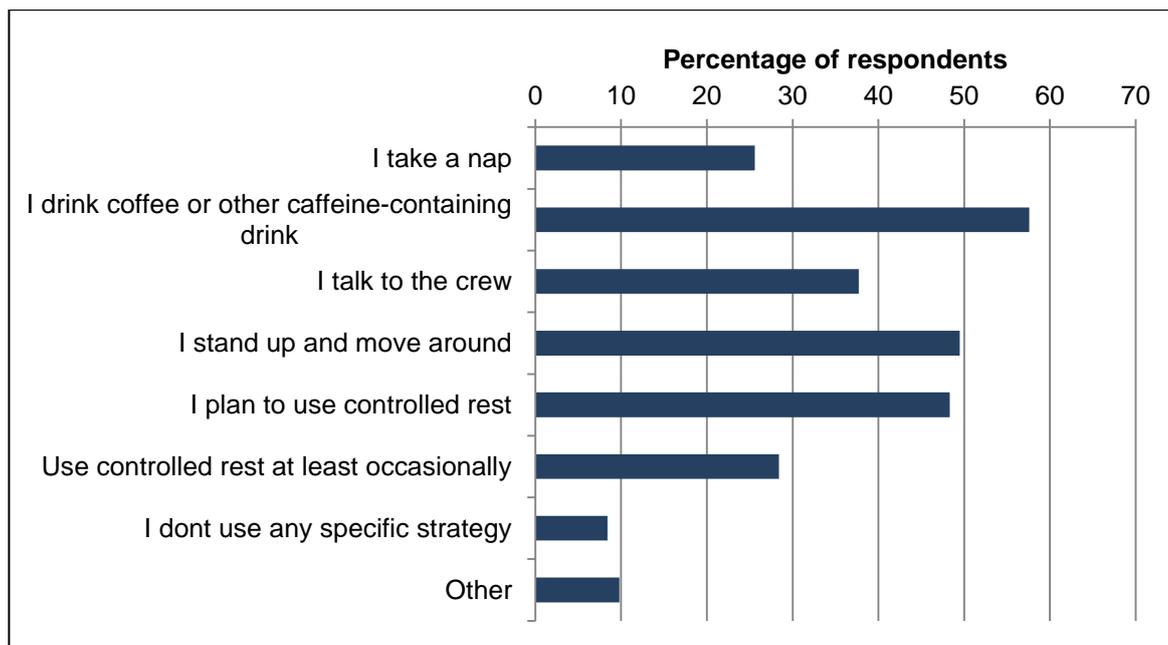


Figure 12: Methods for managing fatigue while working

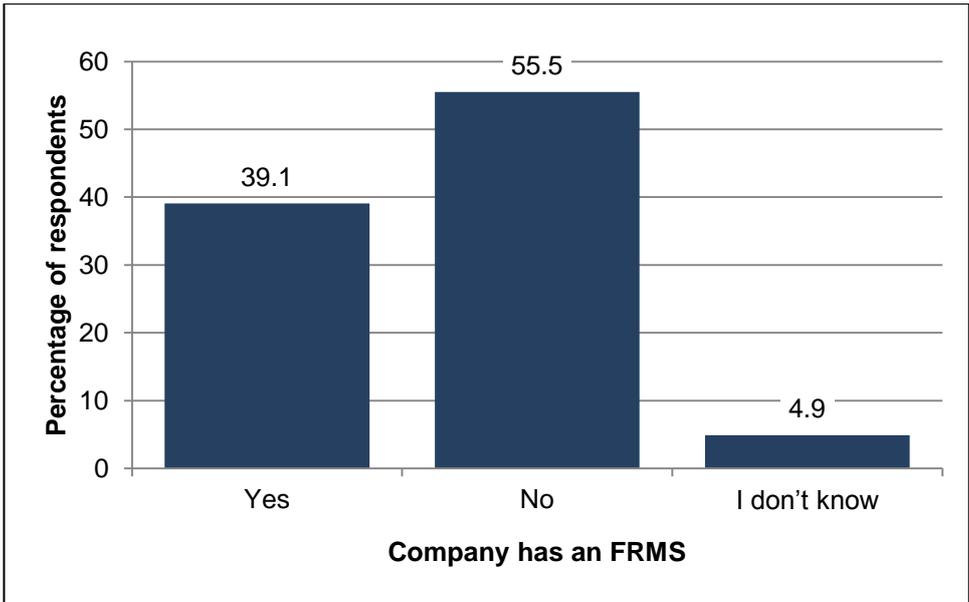


Figure 13: Pilots reporting whether their company has a Fatigue Risk Management System

Just over half of pilots responded that they have ever reported their experience of fatigue before or during work (see Figure 14) but of these, most reported that they have done so rarely. Not surprisingly, there was a significant relationship between experiencing fatigue as a personal problem and reporting of fatigue (Spearman's $r_{(1129)}=0.37$, $p<0.0001$). When asked why they do not report their work-related fatigue experiences, the most common reason was that there were no benefits in reporting fatigue (Figure 15). Over one in four felt that there was likely to be an adverse response from their company if they reported fatigue whereas a similar proportion said that they did not report fatigue as they were too tired and couldn't be bothered.

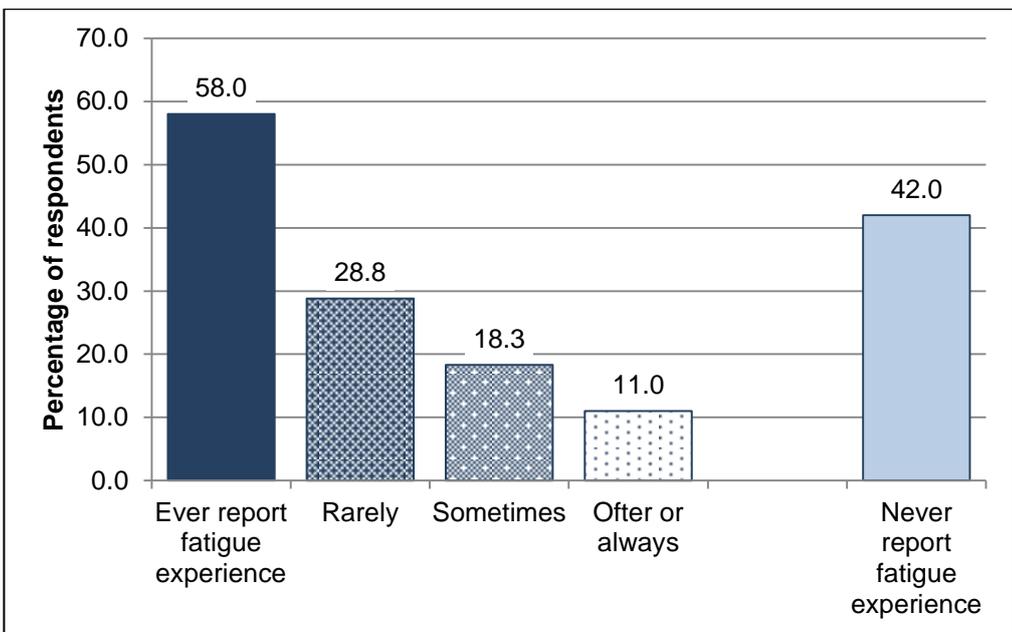


Figure 14: Pilot reporting of fatigue experiences before or during work

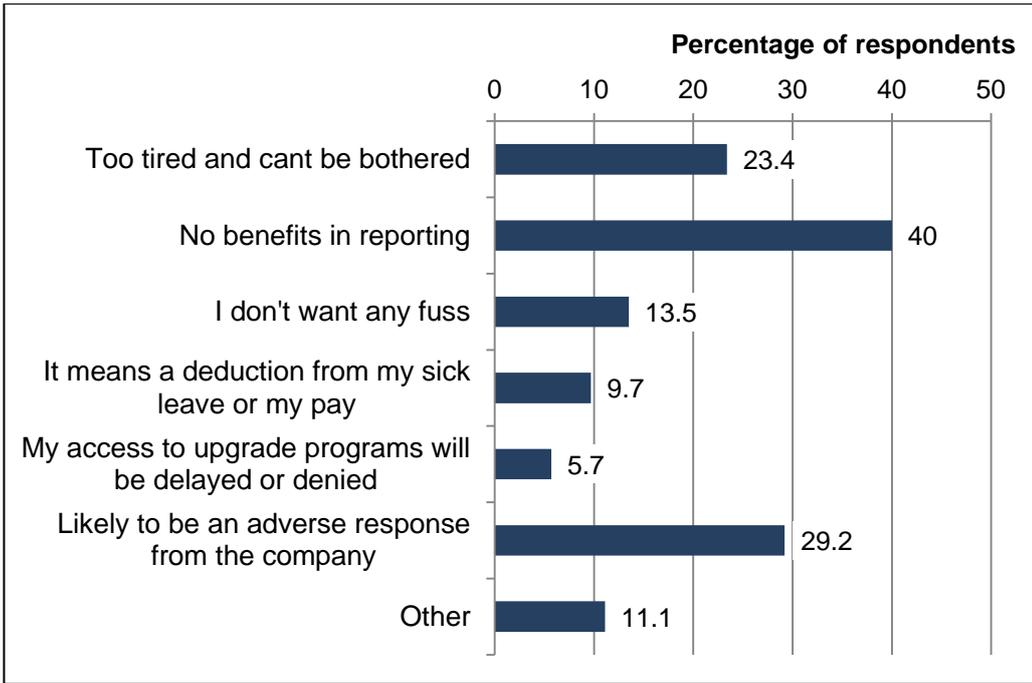


Figure 15: Reasons for pilots not reporting fatigue before or during work

Questions were asked about alternatives to reporting fatigue to the company. As shown in Figure 16, approaching half of the respondents had reported sick instead of reporting fatigued and a slightly lower percentage had removed themselves from duty due to fatigue. Again, this was done rarely by most pilots who reported taking this action in response to experiencing fatigue at work. Despite these findings of relatively rare reporting of fatigue and of pilots taking alternative action to reporting fatigue, most pilots felt that their company encourages reporting (see Figure 17). Fewer than one in five pilots felt that their company discouraged reporting of fatigue.

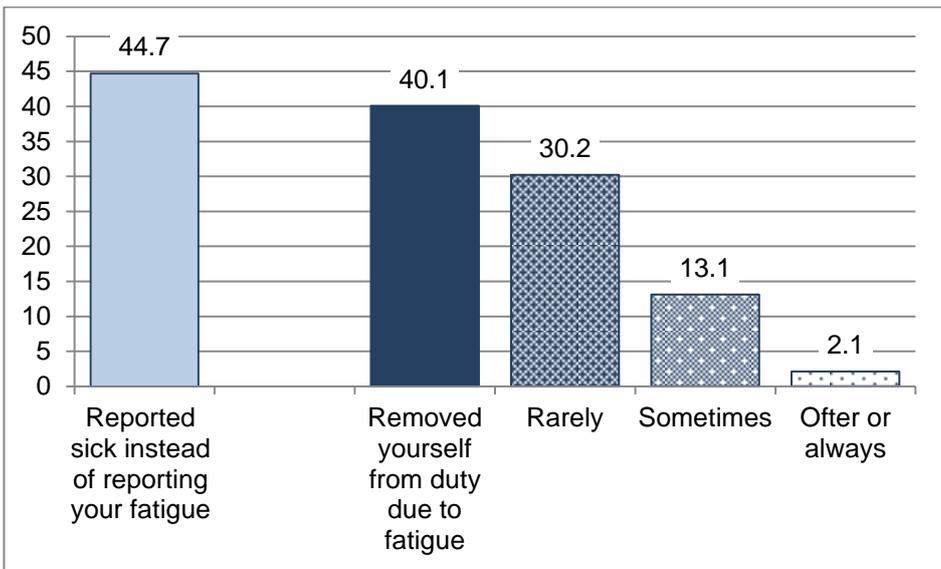


Figure 16: Percentage of pilots reporting sick instead of reporting fatigued and percentage who have ever removed themselves from duty due to fatigue and how often they have done so

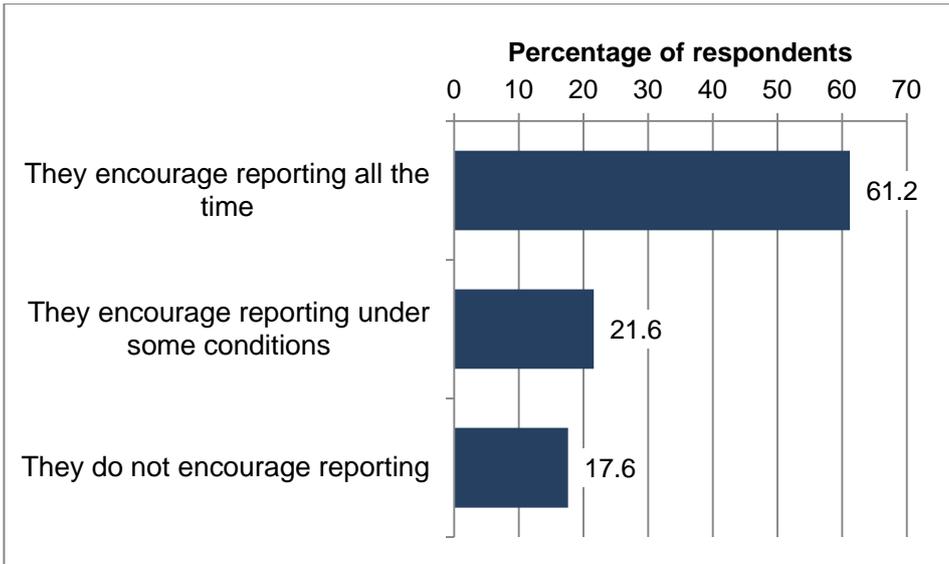


Figure 17: Pilots perceptions of how their company views reporting of fatigue

Comparison of pilots doing different types of work

In this section, the analysis of survey responses examines and compares the responses of pilots doing different types of flying work. The analysis first looks at the nature of the employment status between work types, the characteristics of pilots doing each type, then looks at the fatigue experience and the contributors to fatigue for pilots doing each type of work. The analysis then looks at the way pilots doing each type of work report that they manage fatigue.

Characteristics of pilot respondents for each work type

The majority of pilots doing all types of work are permanent employees (see Figure 18). Fixed contracts were most common among charter pilots (33%), air ambulance pilots (23%) and International pilots (20%). The greater majority of domestic and international pilots and most helicopter pilots were paid a salary with overtime. In contrast, most charter, air ambulance and regional pilots were paid a salary without overtime. Very small percentages of pilots doing international, other and helicopter work were paid by the amount of work done.

The vast majority of pilots in all work groups were male (Figure 18). The work type with the greatest proportion of female pilots was regional work (17%), which accounted for just over half of the female pilot respondents (53%). Small percentages of charter and air ambulance pilots were female (12% and 9% respectively). Fewer than five percent of domestic and international pilots were female. There were no female helicopter pilot respondents.

Most respondents across all work types were in the 25 to 54 age group (Figure 19). Domestic and international pilot respondents were fairly evenly distributed across this age range, but air ambulance, charter and helicopter work groups were typically at the older end of this range (45 to 54 years). Small percentages of pilots from charter, domestic and regional work types were younger than 25 years, and this age group was absent from the other work types. Even smaller percentages of respondents were 55 years or older and very small percentage of pilot respondents were over 65 from the air ambulance, charter and helicopter work groups.

Domestic, international and helicopter pilots were most experienced, with the greatest percentage of pilot respondents having 25 years or more (see Figure 19). Charter and regional pilot respondents tended to be younger, with the largest percentages of these respondents having less than 15 years of experience of being a pilot.

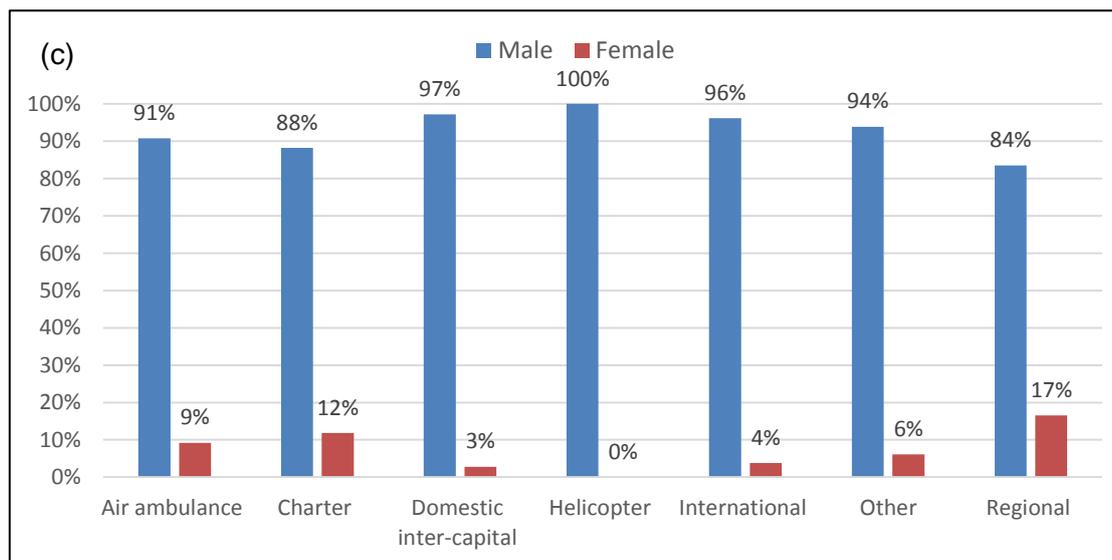
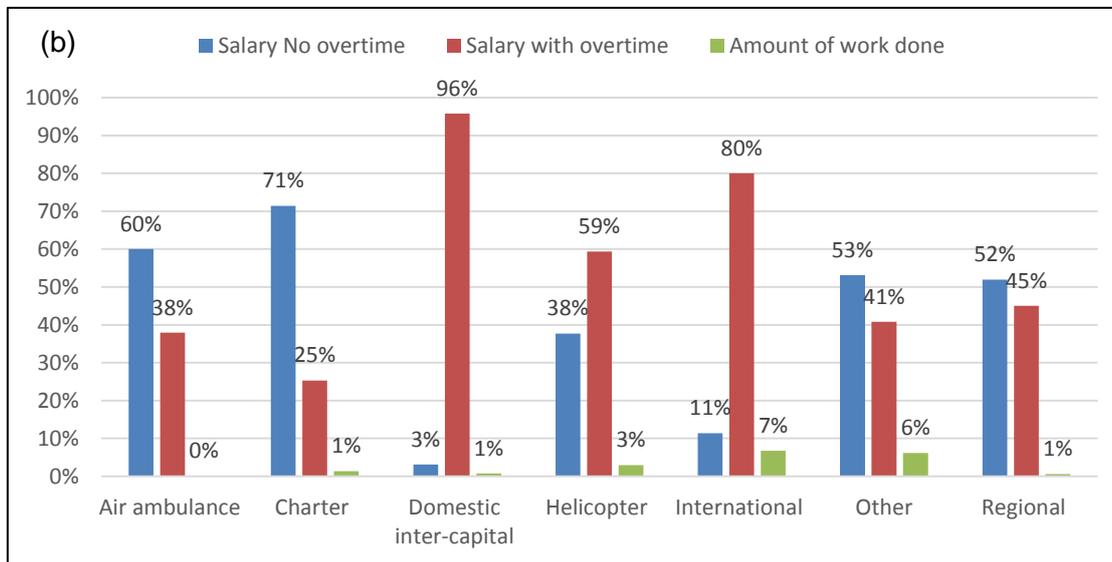
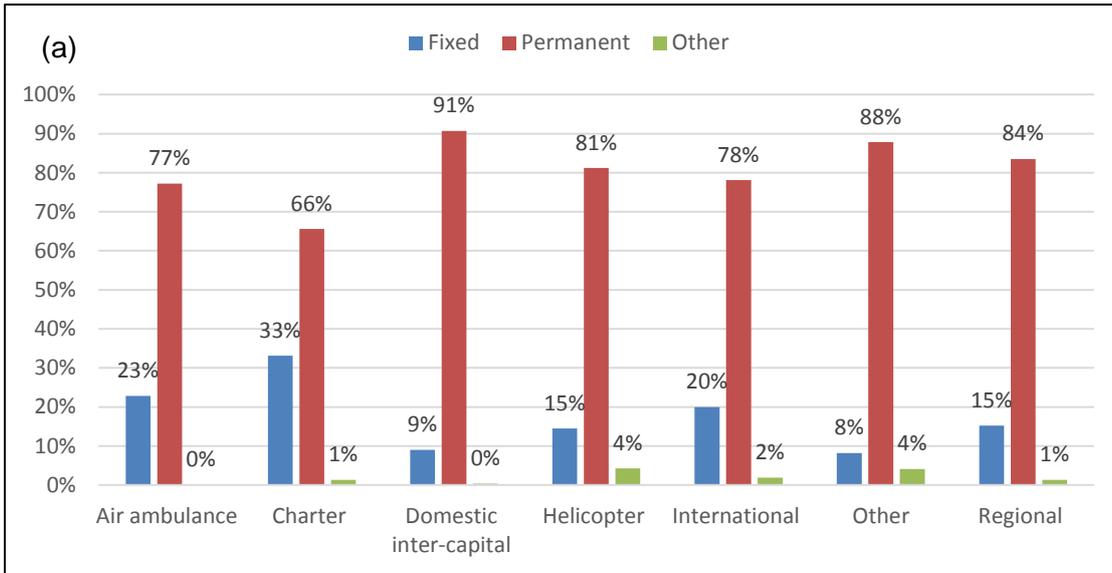


Figure 18: Time of work for pilots by (a) their type of contract, (b) type of remuneration and (c) gender

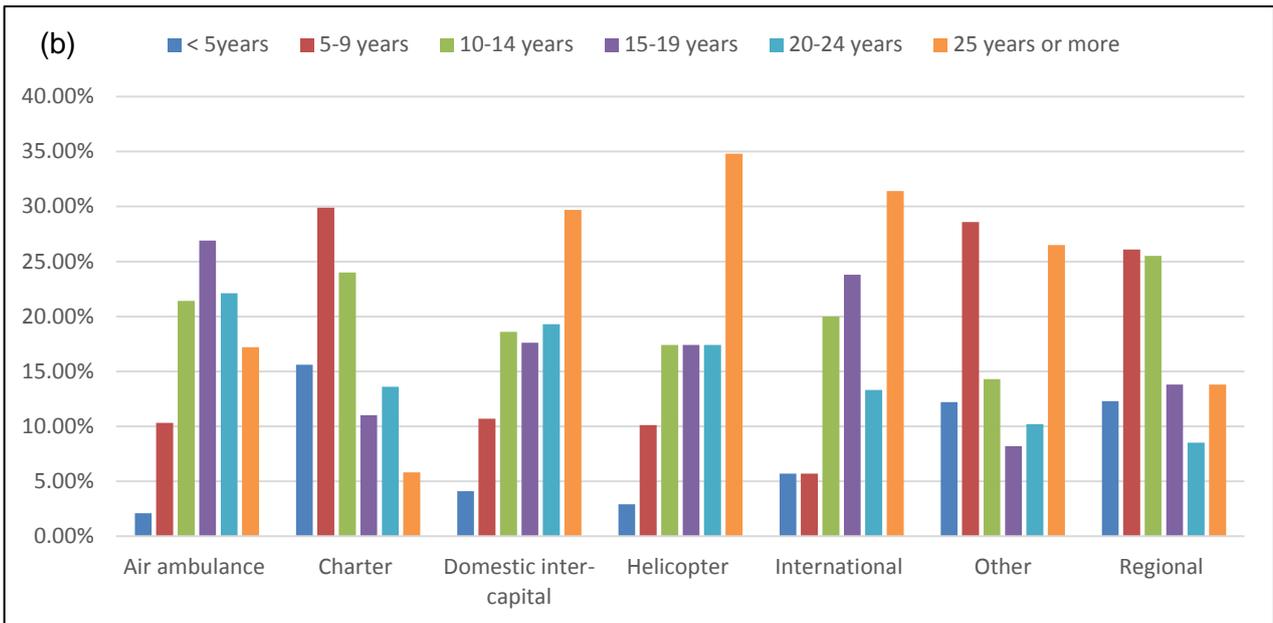
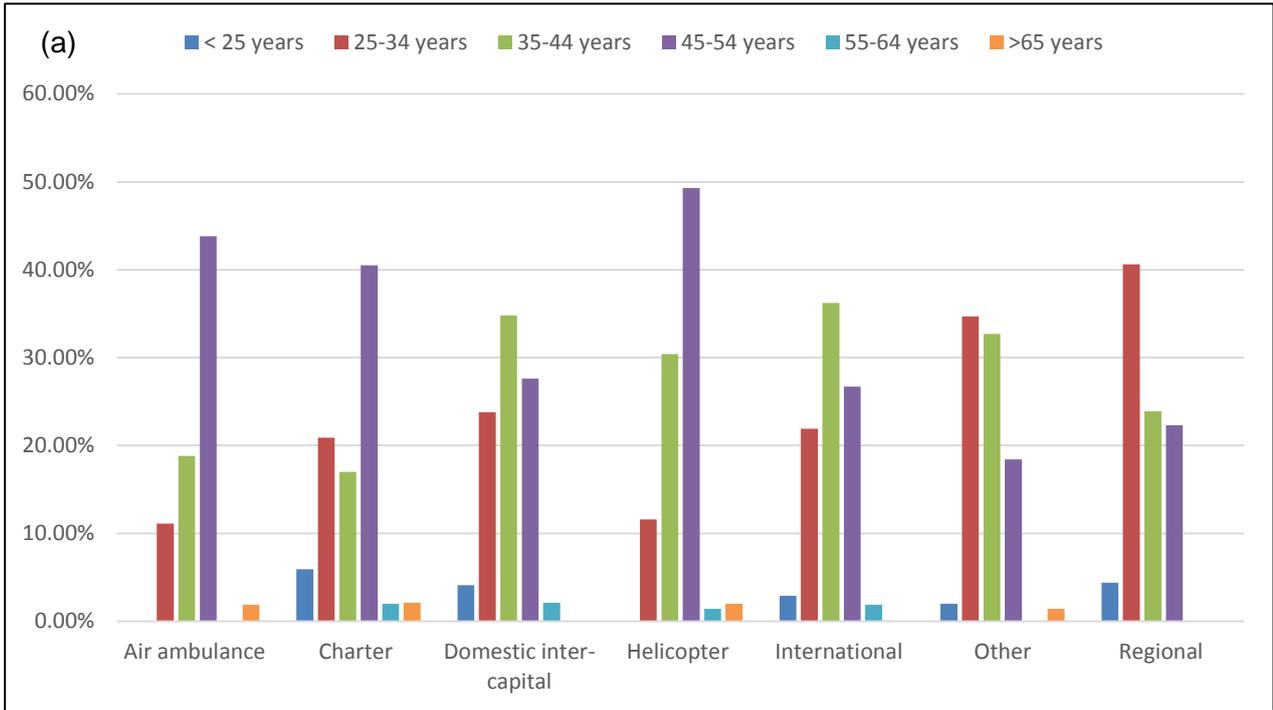


Figure 19: Type of work for pilots by (a) age group and (b) years of pilot experience

Experience of fatigue for each work type

There were large differences between pilots doing different work types in their views and experiences of fatigue (see Figure 20). Almost all of the domestic inter-capital and international pilots felt that fatigue is a substantial or major problem for the industry. Between one half and three quarters of pilots doing regional, helicopter or other work reported fatigue as a substantial or major industry problem. In contrast, only around one-third of air ambulance and one quarter of charter pilots felt that fatigue is a substantial or major problem for the industry. These differences in reports of the extent of the fatigue problem for pilots generally mirrored the differences between work types in pilots' own experiences of fatigue problems. In all the work types, however, pilots reported that serious fatigue problems were somewhat more common for pilots generally than for themselves.

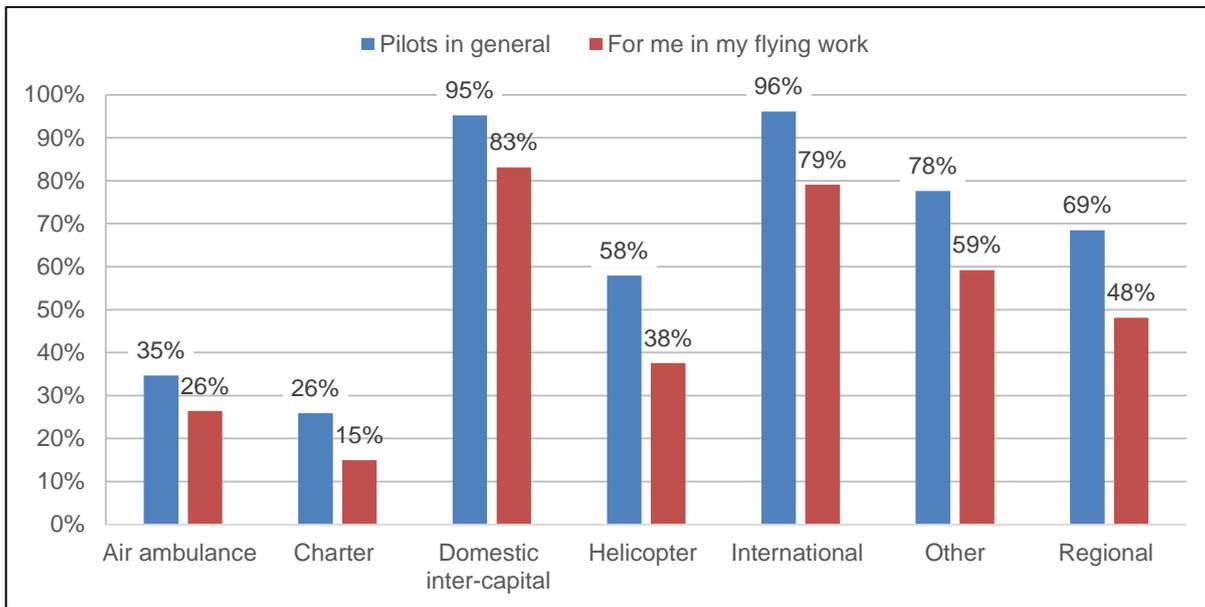


Figure 20: Percentage of pilots doing each type or work who reported fatigue as a substantial or major problem for pilots in general and for themselves

There were clear differences between the mean hours into the flight that pilots reported experiencing fatigue for pilots doing different types of work. As shown in Table 5, pilots doing regional and other types of work reported fatigue earliest during day duty occurring at around six hours after starting flying. Air ambulance and charter pilots reported fatigue occurring the latest. Fatigue was experienced considerably earlier during night duties for all types of work. Pilots doing international, helicopter and other work types all reported fatigue occurring after around four hours of flying, and, again, air ambulance reported fatigue occurring after the longest period at night.

Table 5: Pilot reports of the number of hours into the flight that they begin to experience fatigue on day and night duty flights for each work type showing means (M) and standard deviations (SD)

		Air ambulance	Charter	Domestic intercapital	Helicopter	International	Other	Regional
Hours to fatigue on day duty	M	7.6	7.4	6.6	6.5	6.3	5.7	6.0
	SD	2.5	2.9	2.4	2.8	2.9	2.6	2.2
Hrs to fatigue on night duty	M	5.7	5.2	4.7	4.0	4.0	4.1	4.4
	SD	2.4	3.9	2.0	2.5	2.1	2.4	2.3

As shown in Figure 21, most pilots from most work groups reported that they have experienced fatigue before duty and during duty. The exceptions are air ambulance and charter work where only around half of pilots report experiencing fatigue before or during duty. Around half of domestic and international pilots reported experiencing fatigue during at least half of their duty periods and this is considerably higher than any of the other work groups. The experience of fatigue before duty was less common with around one-third of domestic and international pilots reporting fatigue before half or more of their duty periods. Fatigue before duty was a less common experience for pilots doing all other work types.

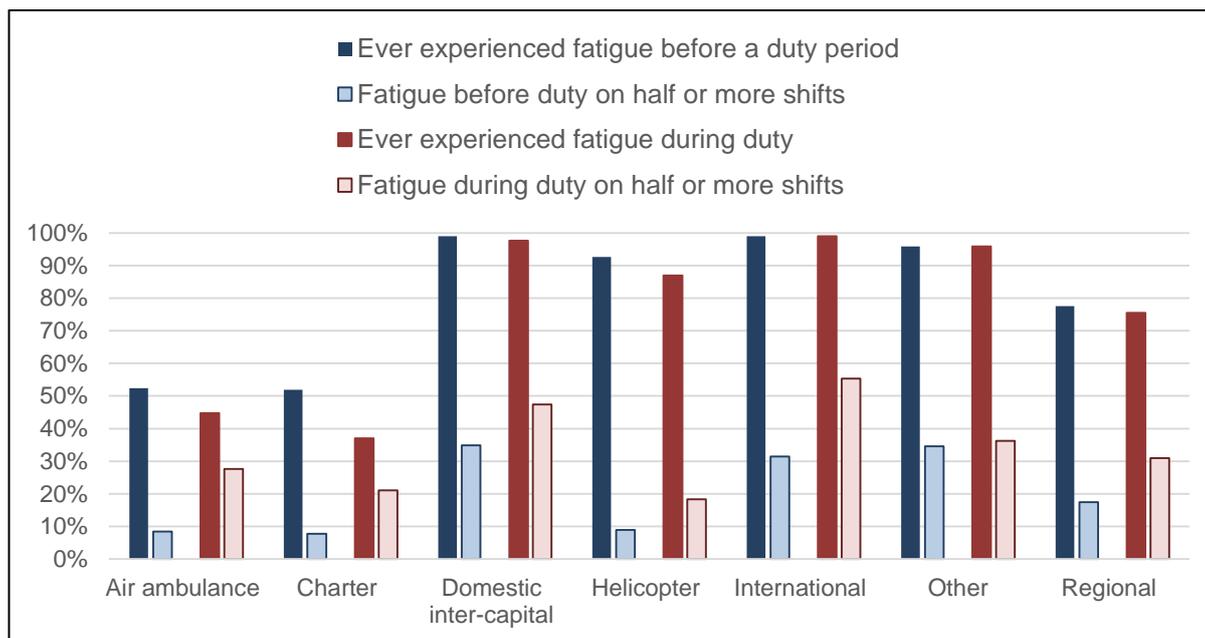


Figure 21: Percentage of pilots from each work type reporting experiencing fatigue before and during duty and the percentage experiencing fatigue before or during at least half of their duty periods

Pilots were asked about their experience of fatigue-related incidents during their duty. As shown in Figure 22, for all types of work, almost all pilots reported that when they have experienced fatigue during duty, it had a negative effect on their performance. Around three-quarters of domestic and international pilots reported having a microsleep while on duty, whereas this was considerably lower for pilots doing other types of work. Significant percentages of domestic and international pilots also reported falling asleep while on duty on the flight deck (34.5% and 41.0% respectively) and waking from sleep to find other crew asleep (33.1% and 42.9% respectively). For the other work types, falling asleep and finding other crew members also asleep were relatively uncommon experiences.

Domestic and international pilots were also most likely to report that fatigue affected their capacity to perform their work (see Figure 23), followed by regional pilots and helicopter pilots with air ambulance and charter pilots were least likely to report performance effects. Looking at how frequently pilots in each work group experience performance effects due to fatigue, again, larger percentages of domestic and international pilots who reported experiencing the performance effects did so on more than 10 percent of duties and on more than half of duties, although the latter only represented less than one-fifth of pilots. Interestingly, although comparatively fewer air ambulance and charter pilots report that fatigue affects their performance, more than half of them reported that it occurred on more than 10 percent of duty periods.

Very similar patterns were shown for pilots reporting ever making a fatigue-related error while on duty. Again, greater percentages of domestic and international pilots reported that they had ever made errors due to fatigue compared to the other work groups, but these errors occurred much less often than fatigue effects on performance more generally. In fact, fatigue-related errors were reported to be much less common than effects on performance for all groups of pilots.

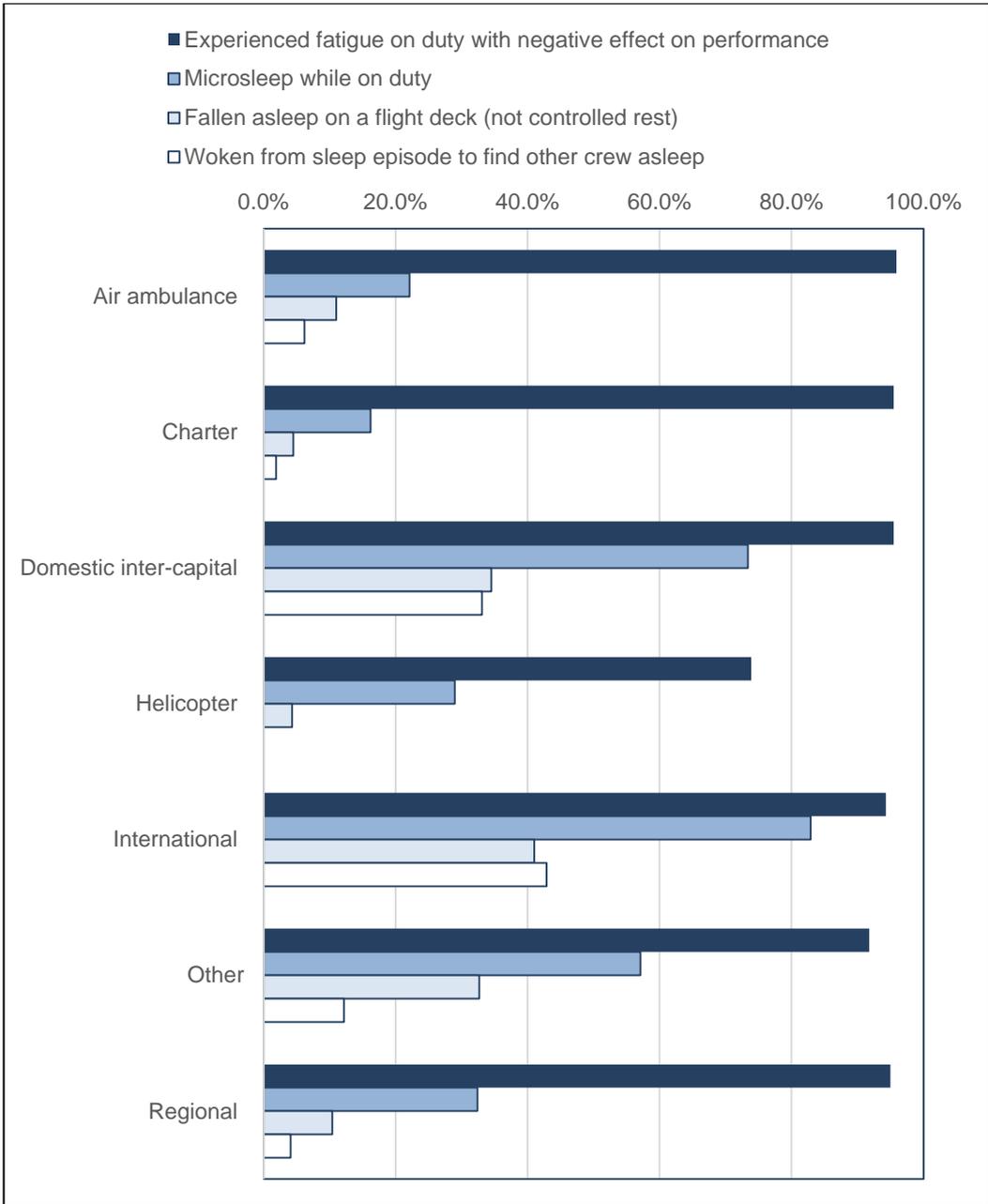


Figure 22: Type of flying work by experience of fatigue-related incidents during duty

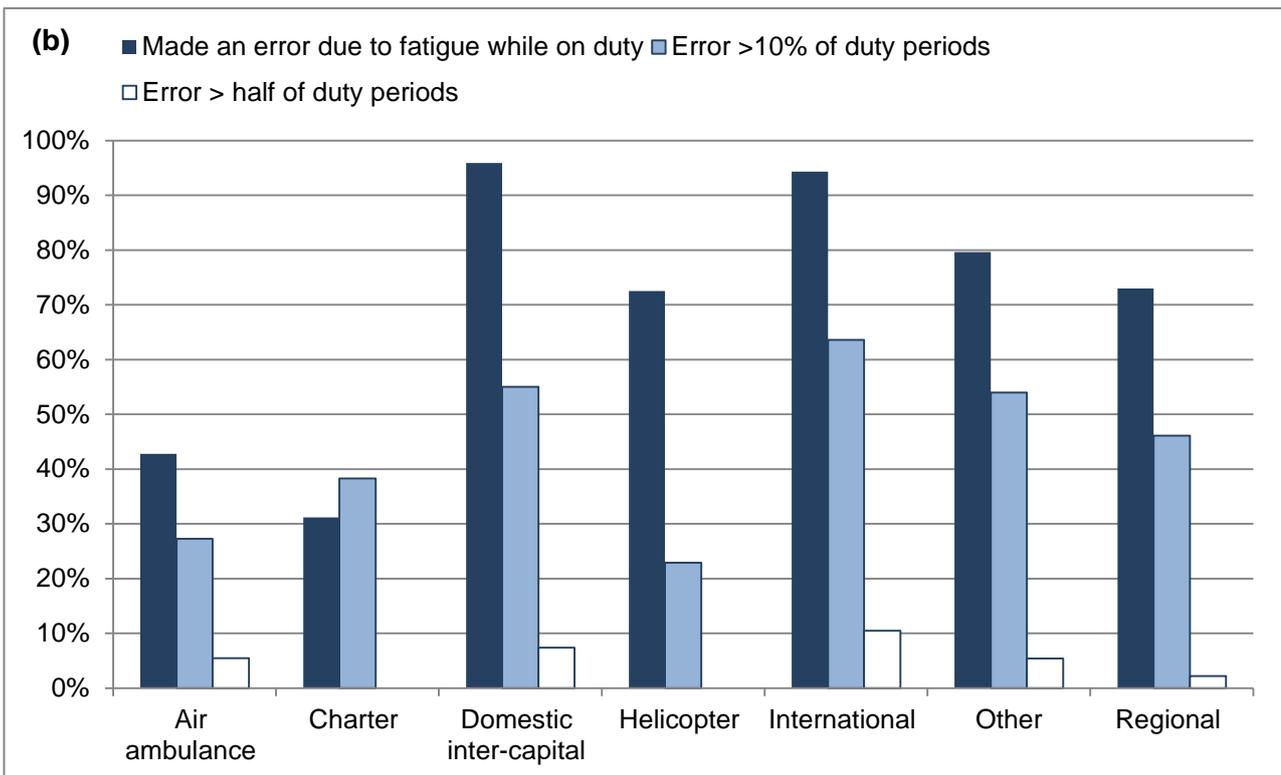
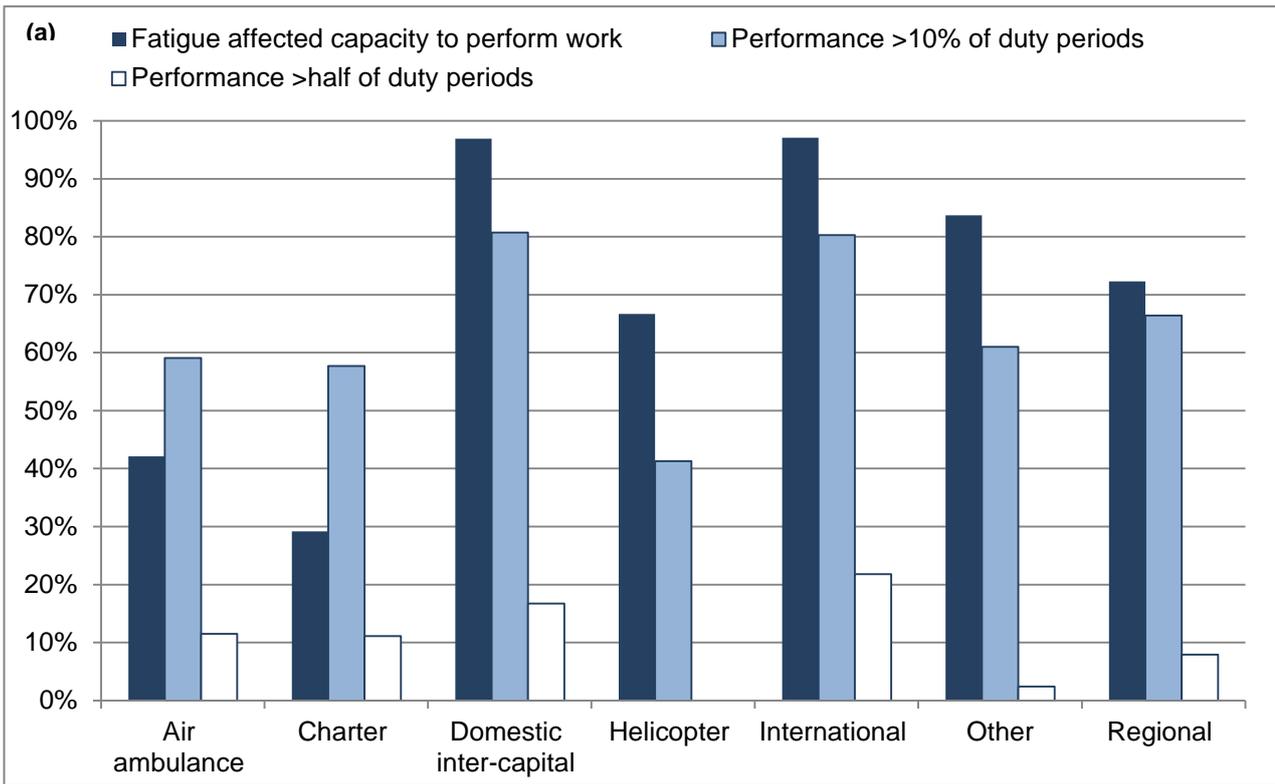


Figure 23: Percentage of pilots doing each type of work reporting that fatigue has affected their capacity to work and reporting having made an error due to fatigue while on duty and in each case the percentage reporting this occurring on more than 10% of duty periods or more than half of duty periods

Contributors to fatigue for different types of flying work

There were a number of significant differences between work groups in the factors that may influence pilot's experience of fatigue. Figure 24 shows the average normal travelling time between home and work for each work group of pilots. International pilots reported the longest travel time, with significantly longer travel times than any other work group. Domestic, helicopter and regional pilots had the next longest commuting times and air ambulance and charter pilots the shortest commuting times.

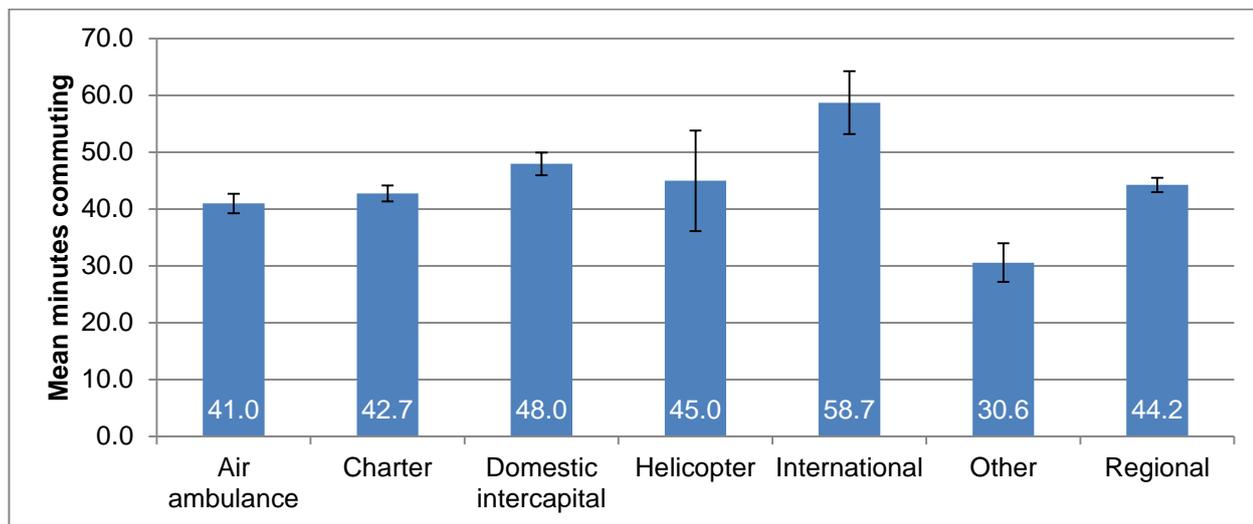


Figure 24: Type of flying work by normal travel time between home and work showing means and standard errors for each work group

Pilots doing each type of work reported on the characteristics of their usual and most recent duty period. As shown in Table 5, pilots doing domestic intercapital flying did the longest duty hours both usually and on their last 28 day roster period, and the longest flying hours over the same period. International pilots did considerably fewer duty hours but, together with domestic pilots also did longer flying hours compared to the other types of work. Regional pilots did reasonably long overall duty hours but fewer flying hours in the roster period than domestic or international pilots. Air ambulance and charter pilots did somewhat fewer overall duty hours but only around half the flying hours over the roster period compared to domestic pilots. Helicopter pilots did the least duty and flying hours of all work types.

Domestic pilots did the largest number of duty periods per week with a mean of 7 duty periods, followed by regional pilots (around 6 periods) then helicopter, international and other pilots (around five periods), whereas air ambulance did the least. Usual time off between duty periods was quite variable and skewed for all work types, especially domestic pilots, so medians provide the best estimate of the average. For all work types, the median time off at home base was between 12 and 16 hours, except for international pilots where it was 48 hours.

The patterns of sectors flown were also very variable. Looking at median number of sectors usually flown, time between and length of sector, domestic pilots did a median of 4 sectors, median length of sector of 2 hours and a median of 0 hours off between sectors. International pilots did a median of 2 sectors per duty, 6 hours length and 1 hour between sectors. Median sectors flown for the other work types were between 3 and 4, sector length was one hour and time off was 1 hour except for regional pilots whose median was 0 hours off between sectors.

Table 5: Duty characteristics for pilots doing different types of work showing means, median, standard deviations and range

		Air ambulance	Charter	Domestic intercapital	Helicopter	International	Other	Regional
Usual duty hours in a 28 day roster period	Mean	118.0	117.1	127.7	91.2	101.2	121.2	118.7
	Median	120	119	130	80	100	120	120
	SD	49.7	34.4	29.0	76.0	41.2	56.9	40.6
	Range	328	220	200	336	214	241	243
Duty hours in the last 28 day roster period	Mean	114.0	115.4	125.3	87.9	101.5	123.7	120.8
	Median	111	115	130	78	104.5	122.5	120
	SD	49.8	33.2	31.6	75.1	46.7	55.3	33.1
	Range	331	203	196	345	255	255	260
Usual duty flying hours in a 28 day roster period	Mean	40.0	47.2	75.6	22.9	69.2	46.3	58.4
	Median	40	48	80	20	75	45	60
	SD	16.0	35.0	14.9	26.4	29.5	26.2	24.7
	Range	87	444	95	100	250	98	398
Hours flown in last 28 day roster period	Mean	38.6	45.4	72.4	20.3	65.7	46.1	55.4
	Median	38	48	77	20	70	45	55
	SD	18.0	15.6	19.4	18.6	26.8	30.9	19.0
	Range	90	100	103	94	150	115	96
Usual duty periods each week	Mean	3.9	4.4	7.3	5.3	5.3	5.3	6.3
	Median	4	4	5	5	4	5	5
	SD	1.9	5.6	10.6	2.9	7.6	2.5	8.8
	Range	19	55	75	22	55	18	54
Usual time off between duty periods at home base (hours)	Mean	26.5	21.1	82.0	36.8	77.3	20.3	45.7
	Median	16	16	15	12	48	12	16
	SD	84.8	40.3	431.9	84.7	263.0	20.1	201.0
	Range	1012	470	4869	504	2448	96	2024

Table 5 (continued): Duty characteristics for pilots doing different types of work showing means, median, standard deviations and range

		Air ambulance	Charter	Domestic intercapital	Helicopter	International	Other	Regional
Sectors usually flown in duty period	Mean	4.2	4.2	5.2	5.8	3.5	5.8	5.3
	Median	4	3	4	3	2	3	4
	SD	3.6	4.7	7.3	8.2	7.1	10.4	8.6
	Range	34	47	59	50	60	50	79
Time between sectors (hours)	Mean	1.5	1.9	3.3	2.0	11.9	0.6	1.8
	Median	1.0	1	0	1	1	0	0
	SD	3.9	6.9	9.4	6.6	19.9	0.7	6.6
	Range	30	80	45	48	152	30	45
Length of average sector (hours)	Mean	1.0	2.2	2.5	1.1	6.2	2.5	1.6
	Median	1.0	1	2	1	6	2	1
	SD	0.4	8.3	7.9	0.9	3.5	2.0	6.4
	Range	3	80	90	4	15	7	90

Figure 25 summarises the differences between work types for the amount of standby or on-call work, longer work shifts of more than 12 hours and being asked to work on days off. These results show that 50 percent of helicopter pilots reported being often or always on standby or on-call, but then only around one-quarter are often or asked to work when on-call or standby. In contrast, while 40 percent of domestic pilots reported that they were often or always on standby or on-call, over three-quarters of them were often or always asked to work. A smaller percentage of regional pilots (29%) reported often/always being on-call, but more than half (55%) reported often/always being called in to work. International pilots showed similar patterns to regional pilots with around one-third often or always on call, but just less than half were often or always called in to work. Work shifts of more than 12 hours were most common for international pilots with around half reporting their work often or always involved shifts of at least this length. This was less frequent for domestic pilots, with around one in four reporting often or always doing duties of more than 12 hours. For the other pilot groups, rosters were much less frequently over 12 hours. Approaching two-thirds of domestic pilots reported often or always being asked to work on days off. This was much less frequent for the other groups: around one-third of regional and international pilots, only 16% of helicopter pilots and less than 10% of air ambulance and charter pilots are often or always asked to work on days off.

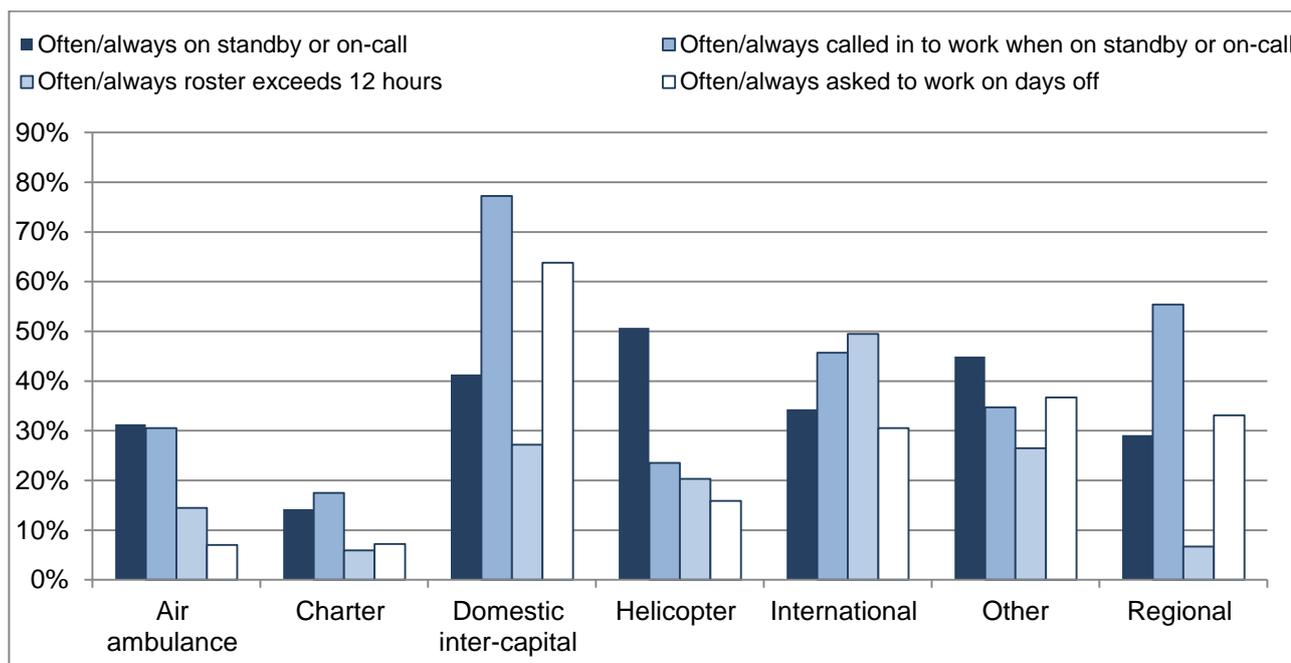


Figure 25: Type of flying work by frequency duty involves standby, on-call, rosters longer than 12 hours and work on days off

Pilot respondents were provided with a list of 17 characteristics of flying work that are likely to increase fatigue and asked to indicate which characteristics they have experience and which represents their top three greatest problems for managing fatigue. These results are shown for each work group separately in the next seven figures (Figure 26 to 32).

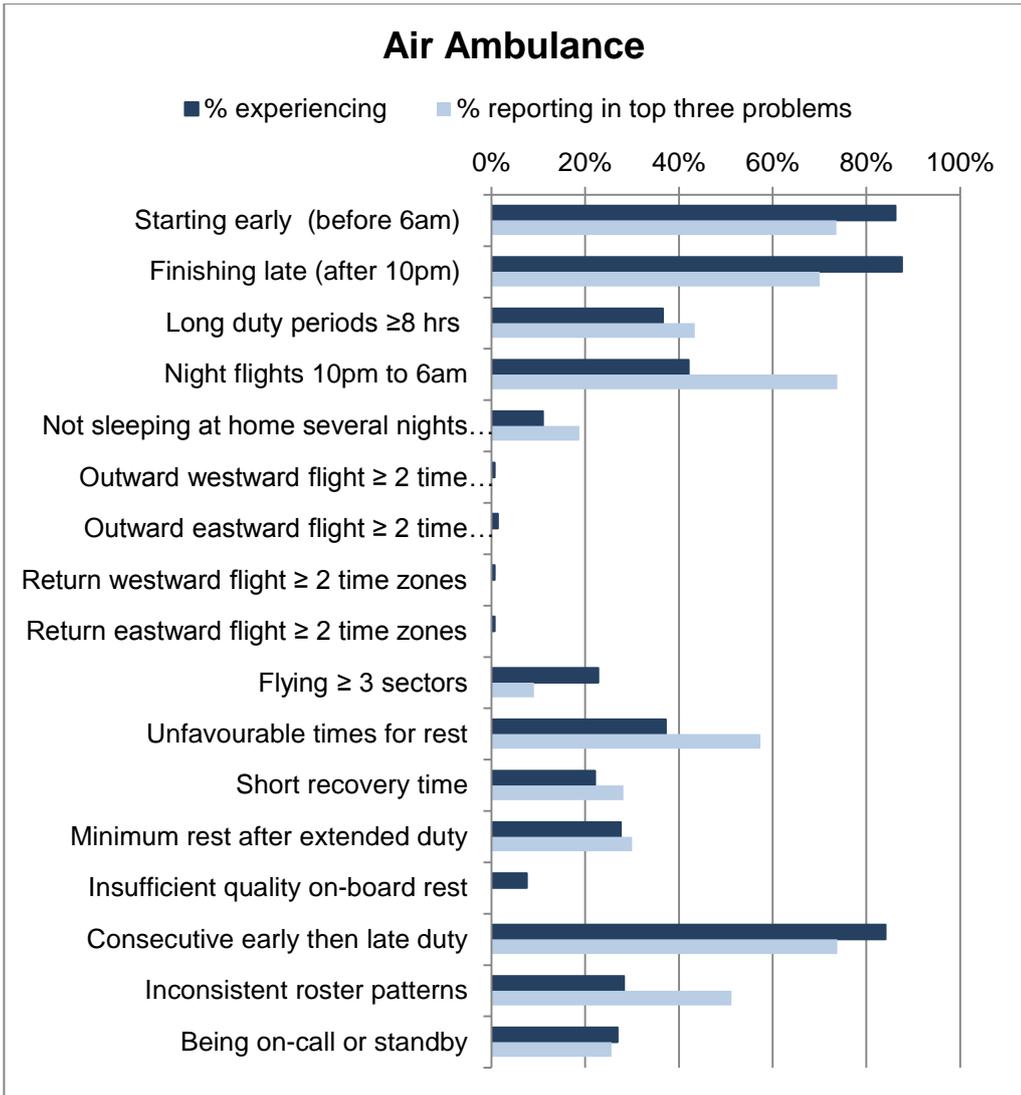


Figure 26: Percentage of air ambulance pilots who have experienced each potential contributor to fatigue and the percentage of those who then rate each characteristic as one of the top three problems for managing fatigue

For air ambulance pilots, the most commonly experienced contributors to fatigue were starting early, finishing late, and consecutive early then late duties. These contributors were also most often in the top three problems. However night flights, which were not experienced by as many air ambulance pilots, were nonetheless rated in the top three problems by around three-quarters of pilots who experienced them. In addition, unfavourable rest times and inconsistent roster patterns were also not such common experiences for air ambulance pilots but these were rated as among the top three problems for at least half of those who experienced them.

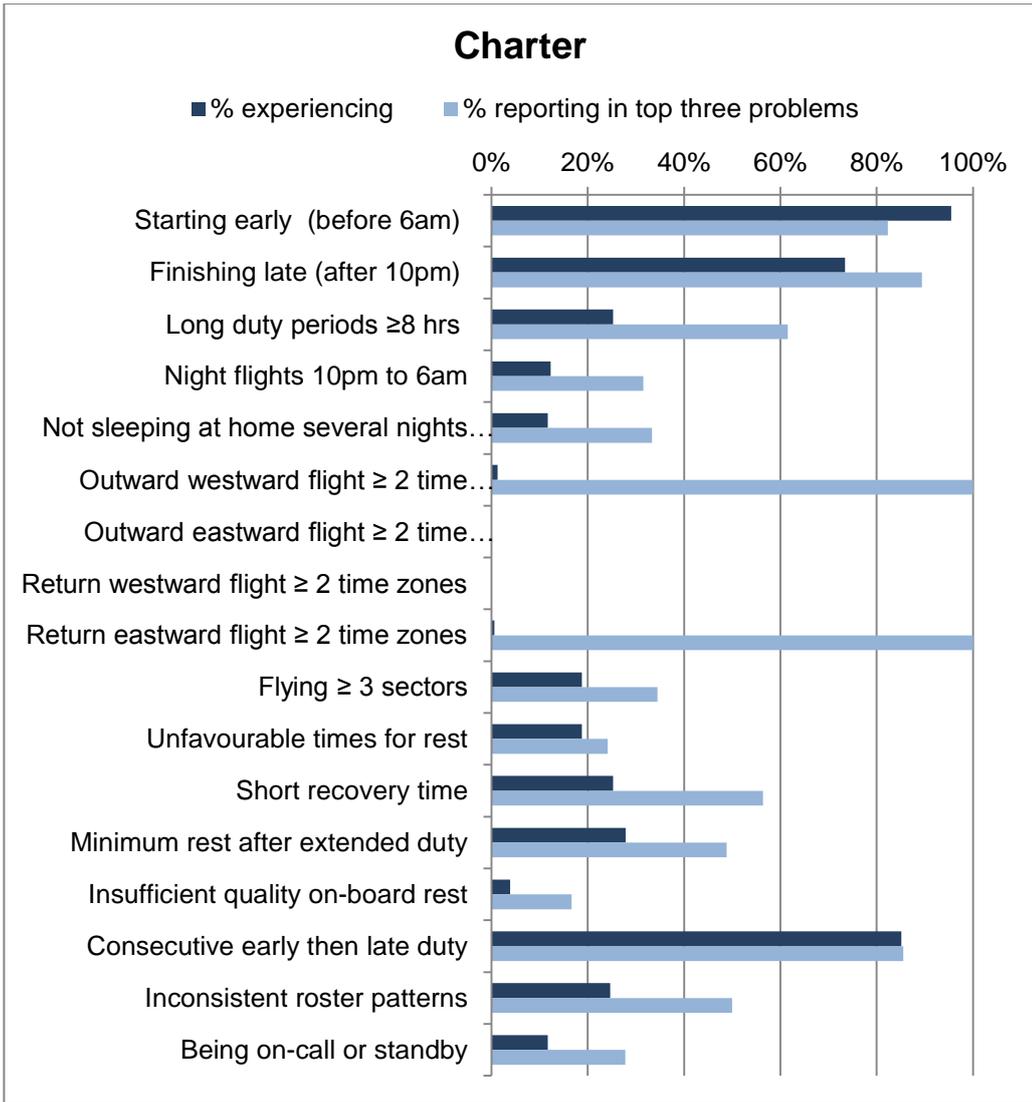


Figure 27: Percentage of charter pilots who have experienced each potential contributor to fatigue and the percentage of those who then rate each characteristic as one of the top three problems for managing fatigue

For charter pilots, the most common potential fatigue contributors were starting early which was reported by almost all charter respondents, consecutive early then late duties and finishing late. These were also most common contributors ranked in the top three problems. Only around one-quarter of charter pilots experienced long duty periods of eight hours or more, had short recovery time, or inconsistent roster patterns, but in each case the contributor was ranked in the top three for at least half of these pilots. Two contributors, outward westward flights crossing two or more time zones and return eastward flights over two or more time zones were reported by only one pilot but who rated them as a top three problems.

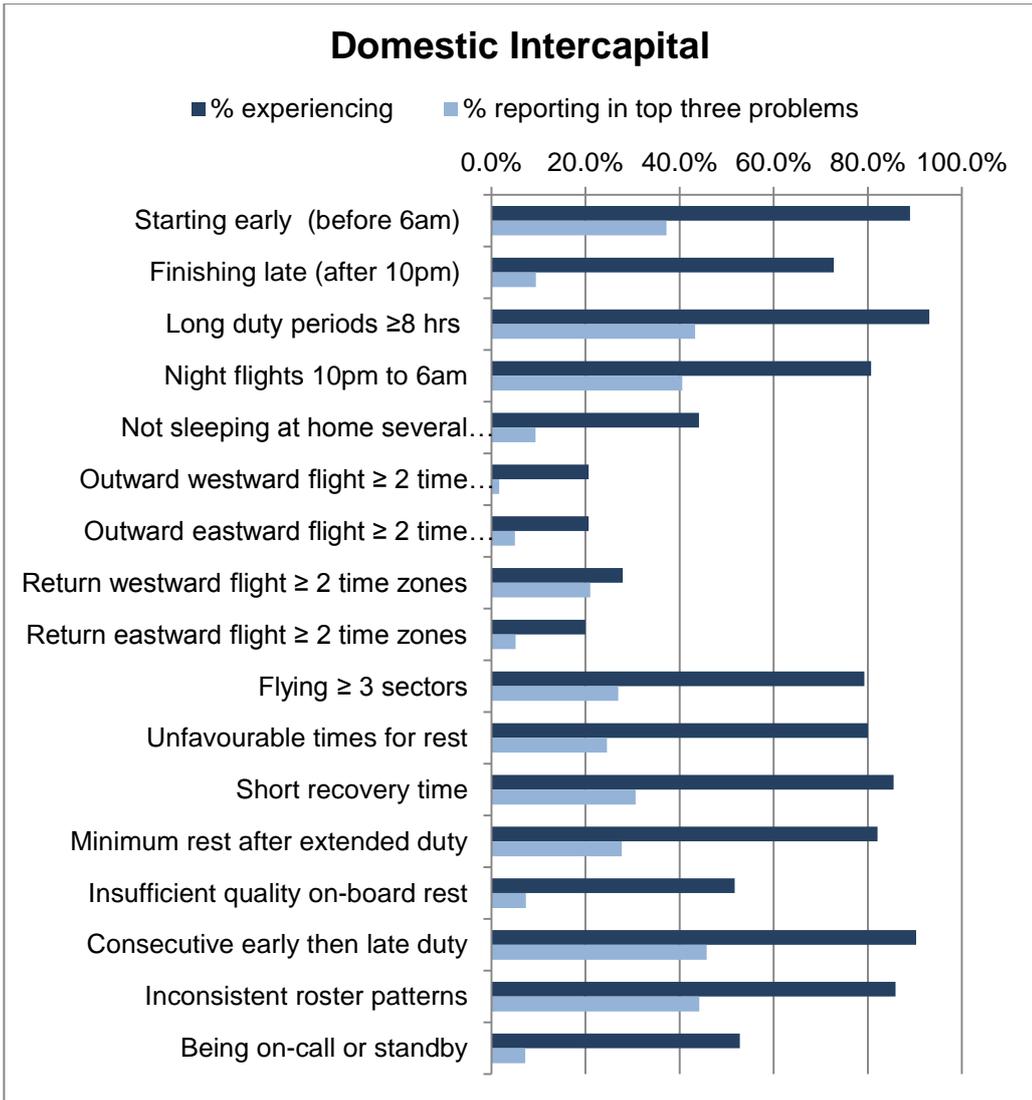


Figure 28: Percentage of domestic intercapital pilots who have experienced each potential contributor to fatigue and the percentage of those who then rate each characteristic as one of the top three problems for managing fatigue

Many of the potential fatigue contributors were experienced by 80 percent or more of domestic pilots. Including starting early, long duty periods, night flights, flying three sectors or more, unfavourable times to rest, short recovery time, minimum rest after extended duty, consecutive early then late duties and inconsistent roster patterns. The factors rated in the top three by the most domestic pilots (more than 40%) were duty hours of 8 hours or more, consecutive early then late duties, inconsistent roster patterns and night flights.

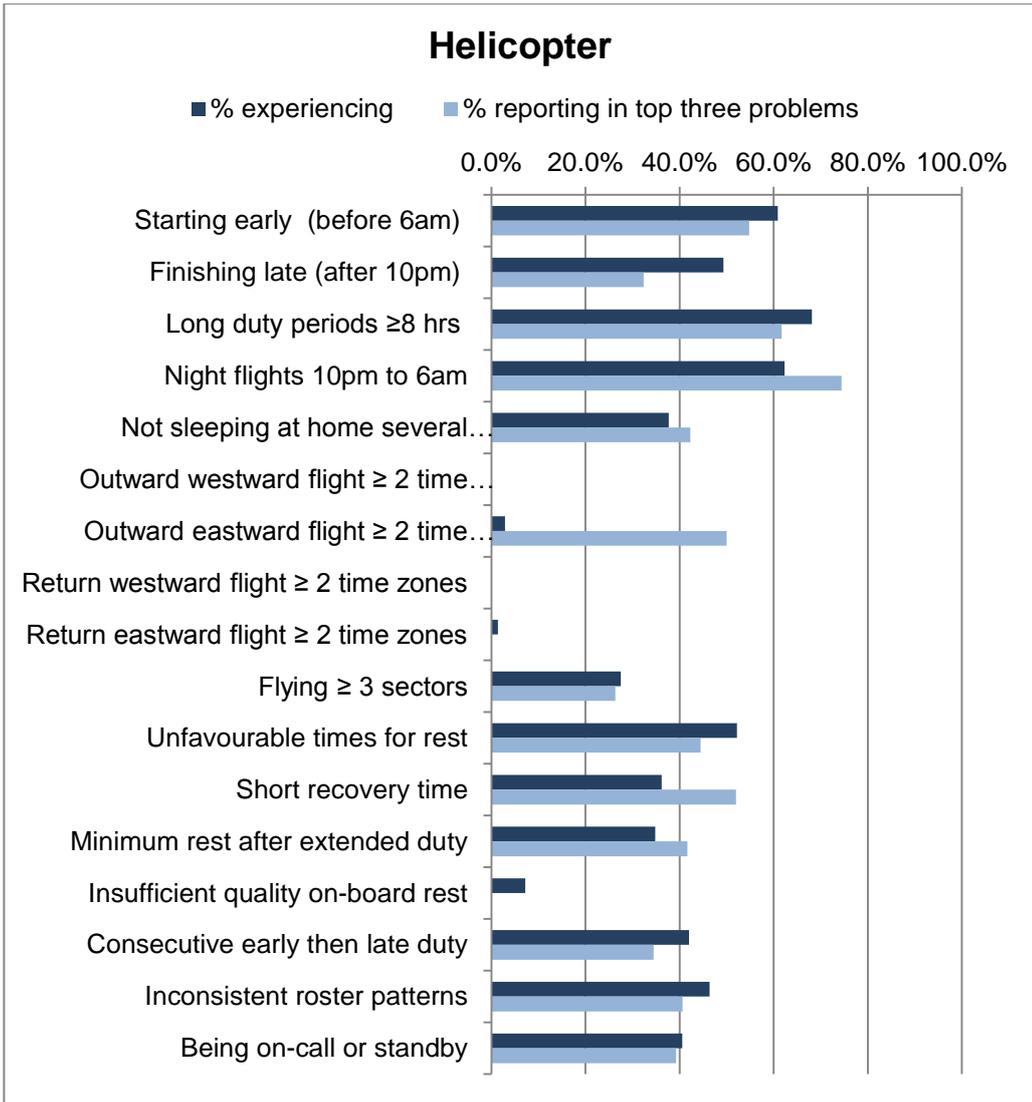


Figure 29: Percentage of helicopter pilots who have experienced each potential contributor to fatigue and the percentage of those who then rate each characteristic as one of the top three problems for managing fatigue.

The most commonly experienced fatigue contributors for helicopter pilots were long duty periods of 8 hours or more, night flights and starting early all of which were reported by at least 60 percent of helicopter pilots. These factors were also most likely to be in the top three problems. Only two helicopter pilots experienced outward eastward flights crossing two or more time zones, but one of them included this factor in the top three problems.

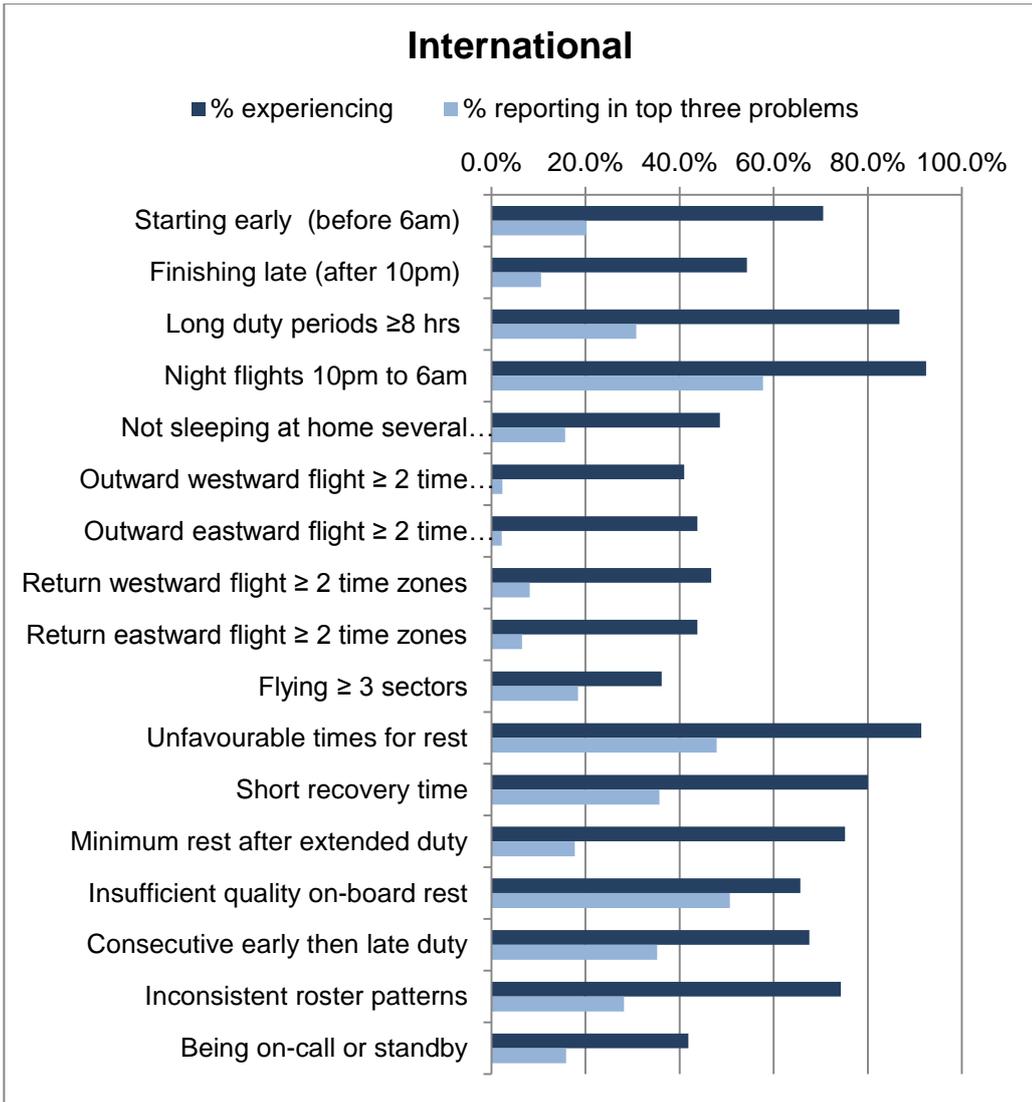


Figure 30: Percentage of international pilots who have experienced each potential contributor to fatigue and the percentage of those who then rate each characteristic as one of the top three problems for managing fatigue

International pilots reported night flights, long duty periods of eight hours or more, unfavourable times to rest and short recovery time most often. Smaller percentages of international pilots reported most of the contributors as in the top three problems. Night flights were in the top three for over half of the pilots who reported it. Insufficient quality of on-board rest and unfavourable times for rest were both top three factors for around half of the pilots who experienced them.

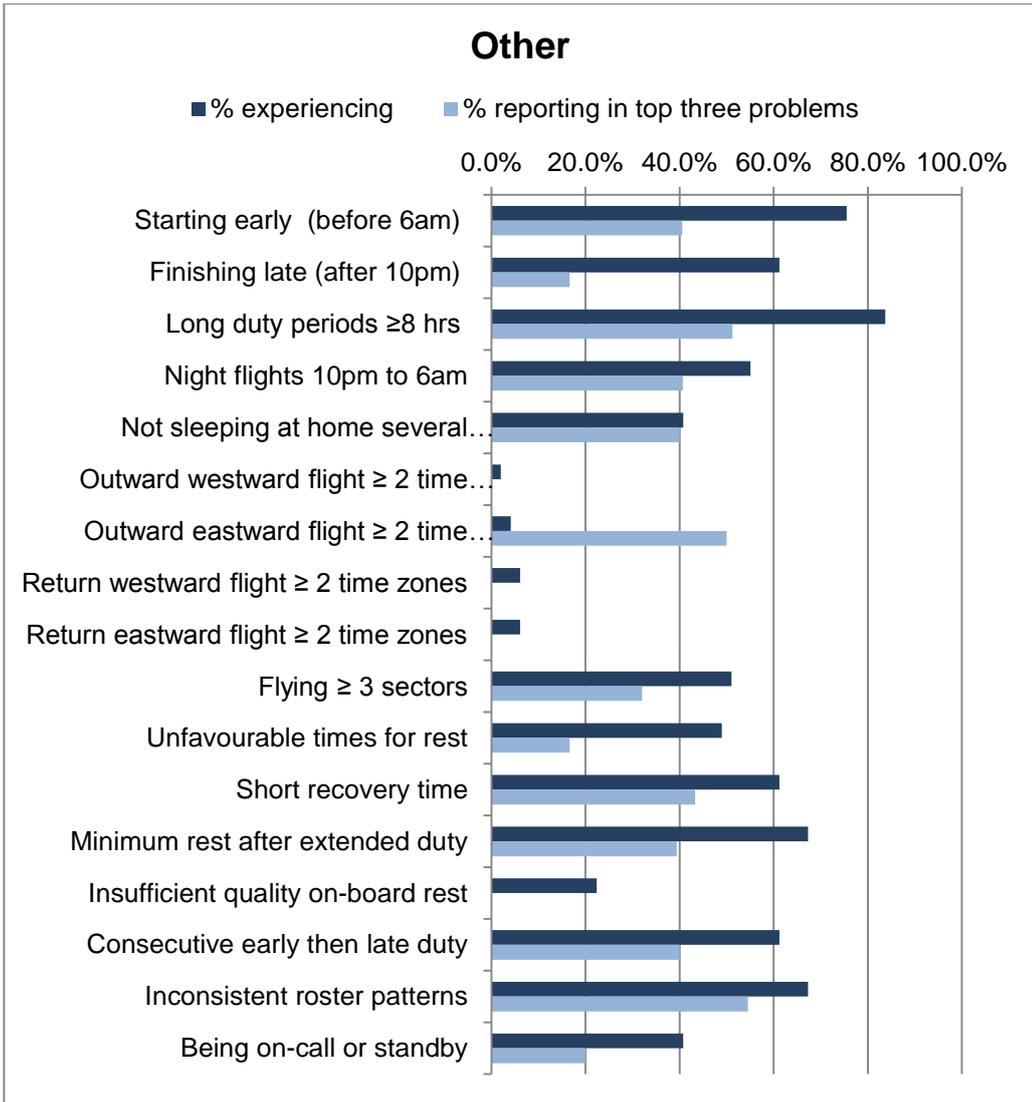


Figure 31: Percentage of Other classified pilots who have experienced each potential contributor to fatigue and the percentage of those who then rate each characteristic as one of the top three problems for managing fatigue

Of the pilots classified as Other, long duty periods, starting early, minimum rest after extended duty and inconsistent roster patterns were reported by the most pilots. Most of these contributors were also ranked in the top three problems for these pilots. Again, only two of these pilots had experienced outward eastward flights over two or more time zones. One of them ranked this factor as a top three problem.

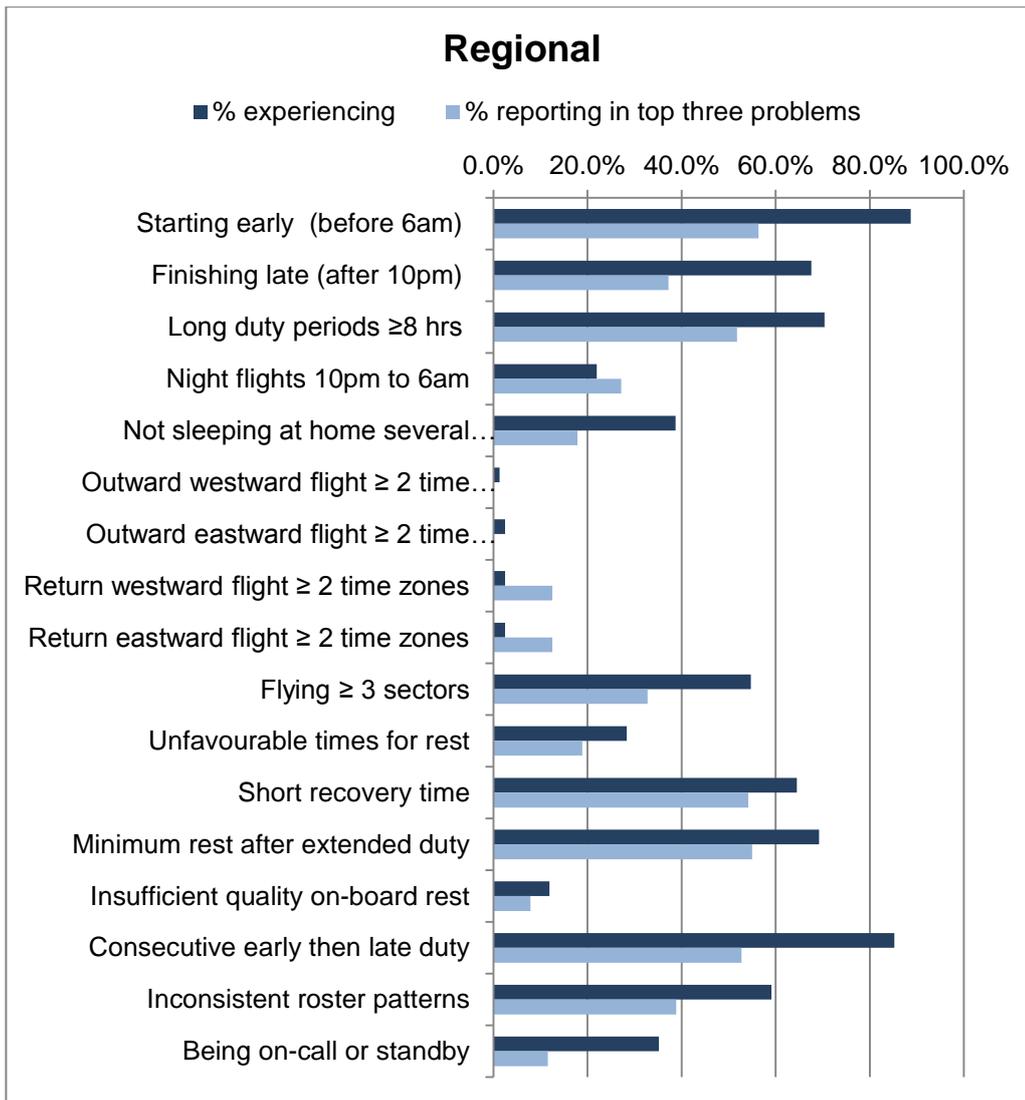


Figure 32: Percentage of regional pilots who have experienced each potential contributor to fatigue and the percentage of those who then rate each characteristic as one of the top three problems for managing fatigue

Over 60 percent of regional pilots reported experiencing starting early, consecutive early then late duties, long duties of eight hours or more, minimum rest after extended duty, finishing late and short recovery times. For each of these contributors, around half of the regional pilots who reported them ranked them in the top three problems.

Figures 33 to 35 show responses for pilots doing different work types to questions on whether they experienced a number of different types of flight duties that potentially contribute to fatigue and if so, the extent that each duty affects the pilot's capacity to manage fatigue.

Almost all air ambulance pilots reported doing duties involving more than 10 hours during the day time, more than three sectors, on call followed by flight duty, resuming duty after a single day off and irregular and disruptive schedules. While these were common experiences, none were reported as having a moderate to large effect on the air ambulance pilot's capacity to manage fatigue. On the other hand, although duties involving more than 8 hours at night and consecutive back-of-the-clock duties were reported by only around 40 percent of pilots, the greater majority of

them felt that these duties had a moderate to large effect on their capacity to manage fatigue. A small percentage of air ambulance pilots reported duties where they had less than 30 hours to adapt to time differences of two or more hours, but most of them felt that this had an adverse effect on their capacity to manage fatigue.

Duties experienced by charter pilots were similar to air ambulance pilots. Duties involving more than 10 hours during the day, more than three sectors, following being on-call, following a single day off and irregular and disruptive shifts were again, common experiences, but did not have a major effect on their capacity to manage fatigue. For this group of pilots too, duties of more than 8 hours at night and consecutive back-of-the-clock duties were experienced by only a small percentage of charter pilots, but most of them felt that these duties had a moderate to large effect on their capacity to manage fatigue.

For domestic pilots the majority reported duties involving more than 10 hours during the day, more than 8 hours during the night, more than three sectors, on-call followed by flight duties, after a single day off and irregular or disruptive shifts. Of these, duties involving 8 hours during night and irregular or disruptive shifts were cited by more than 80 percent of the domestic pilots who did them as having a moderate or major effect on their fatigue management and duties involving more than 10 day hours and more than three sectors were cited by more than 60 percent of domestic pilots. Consecutive back-of-the-clock duties were reported as having a moderate to large effect on their capacity to manage fatigue for almost all of the nearly 69 percent of the domestic pilots who did them. Similarly, whereas fewer domestic pilots reported duties of more than 10 hours involving two hours or more commuting from home, over three-quarters reported that this adversely affected their capacity to manage fatigue.

Smaller percentages of helicopter pilots reported all of the duties with potential contribution to fatigue. Duties involving more than 10 day hours were reported by over 90 percent, whereas 8 hours of night duty, more than three sectors, a single day off and irregular shifts were reported by around 60 percent. The duties that had a moderate to major effect on fatigue management for more than three-quarters of helicopter pilots who experienced them were doing more than 8 hours at night, consecutive back-of-the-clock duties, having less than 30 hours to adapt to a two hour or longer time difference and irregular and disruptive schedules.

Almost all international pilots reported doing duties of more than 10 hour days and more than 8 hour nights. Three-quarters reported duties involving consecutive back-of-the-clock, disruptive schedules, a single day off, having less than 30 hours to adapt to two or more hour time differences and being on-call followed by flight duties. In each case, at least half of the international pilots doing these duties reported that they had a moderate to large effect on their capacity to manage fatigue. The exception was doing more than 10 hour day shifts which only around 40 percent of international pilots felt had an adverse effect on their capacity to manage fatigue.

For regional pilots, almost all reported doing duties involving more than 10 day hours, more than three sectors and more than three-quarters reported having only a single day off, irregular shifts and doing on-call followed by flight duties. In the case of 10 hour day shifts and irregular shifts, around 60 percent of these pilots felt that these duties had a moderate to large effect on their fatigue management, but for the other common types of duties, far fewer regional pilots reported adverse effects on capacity to manage fatigue. While comparatively few regional pilots reported doing night duty of longer than 8 hours, less than 30 hours to adapt to a two hour or longer time difference, duties over 10 hours with at least 2 hours commuting and consecutive back-of-the-clock duties, the majority of pilots who do these duties felt that they adversely affected their capacity to manage fatigue.

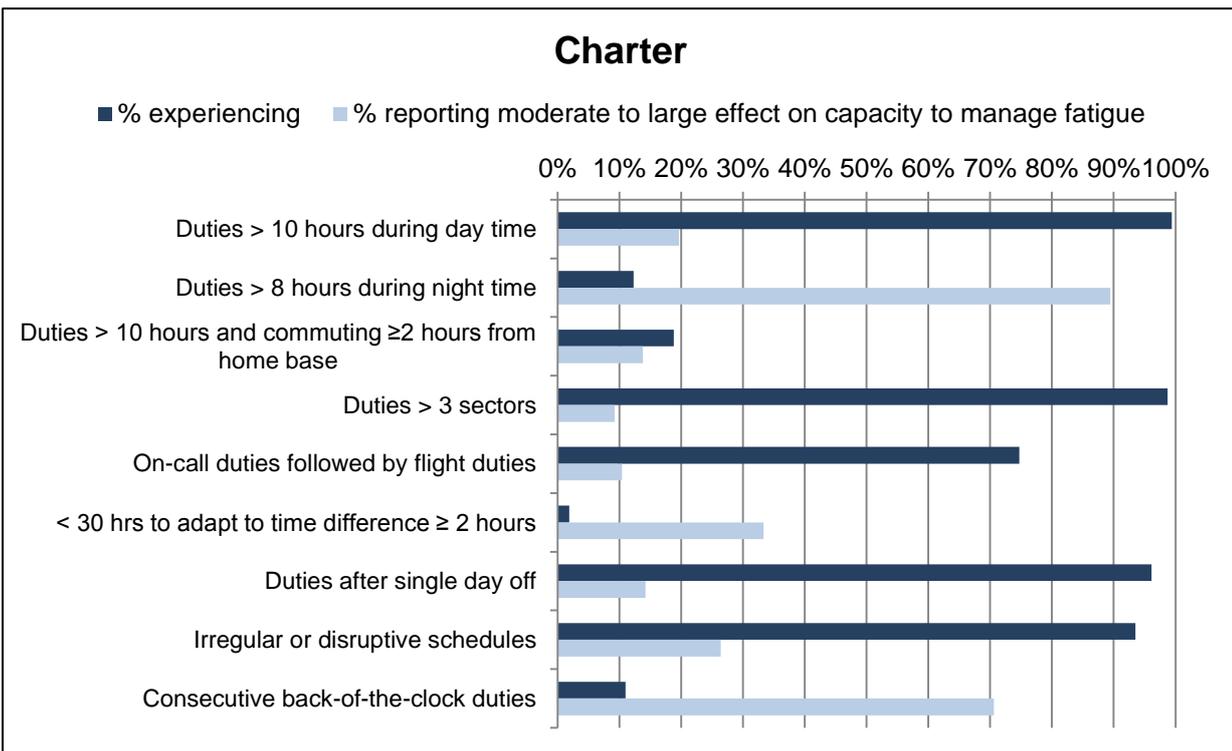
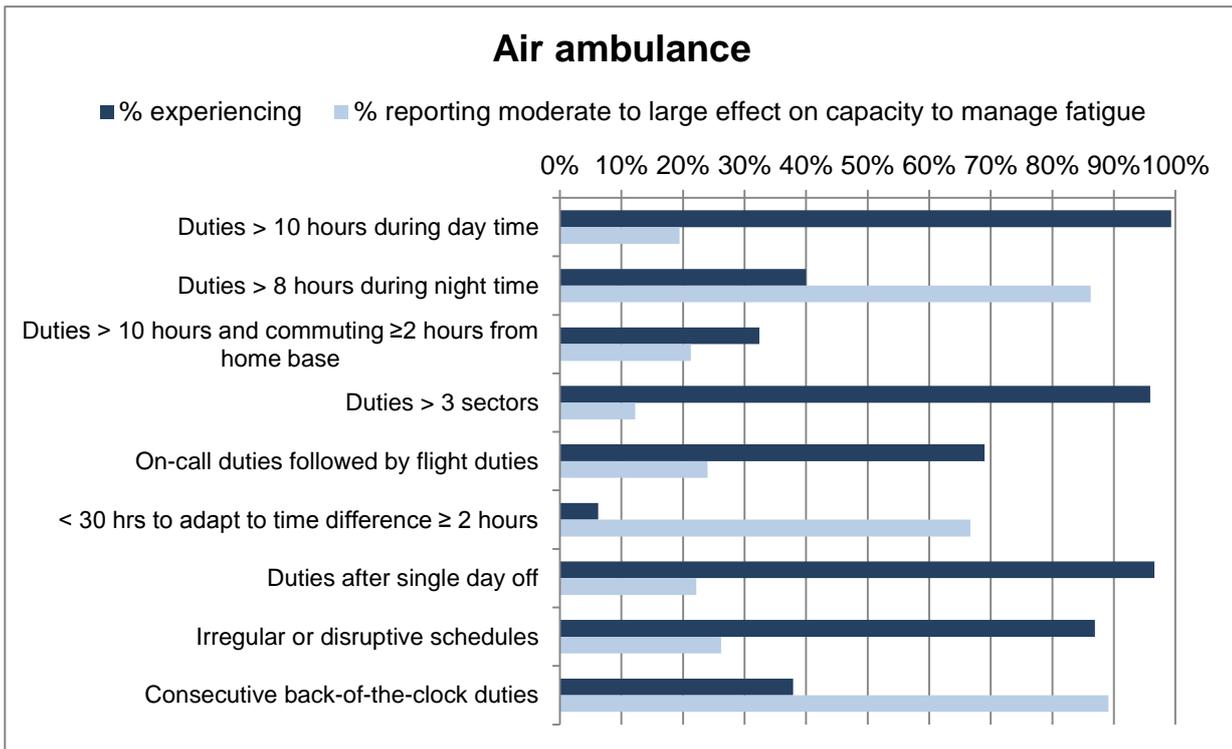


Figure 33: Air ambulance and charter pilots reports of their experiences of duties likely to contribute to fatigue and percentage reporting that the experience had a moderate to large effect on their capacity to manage fatigue

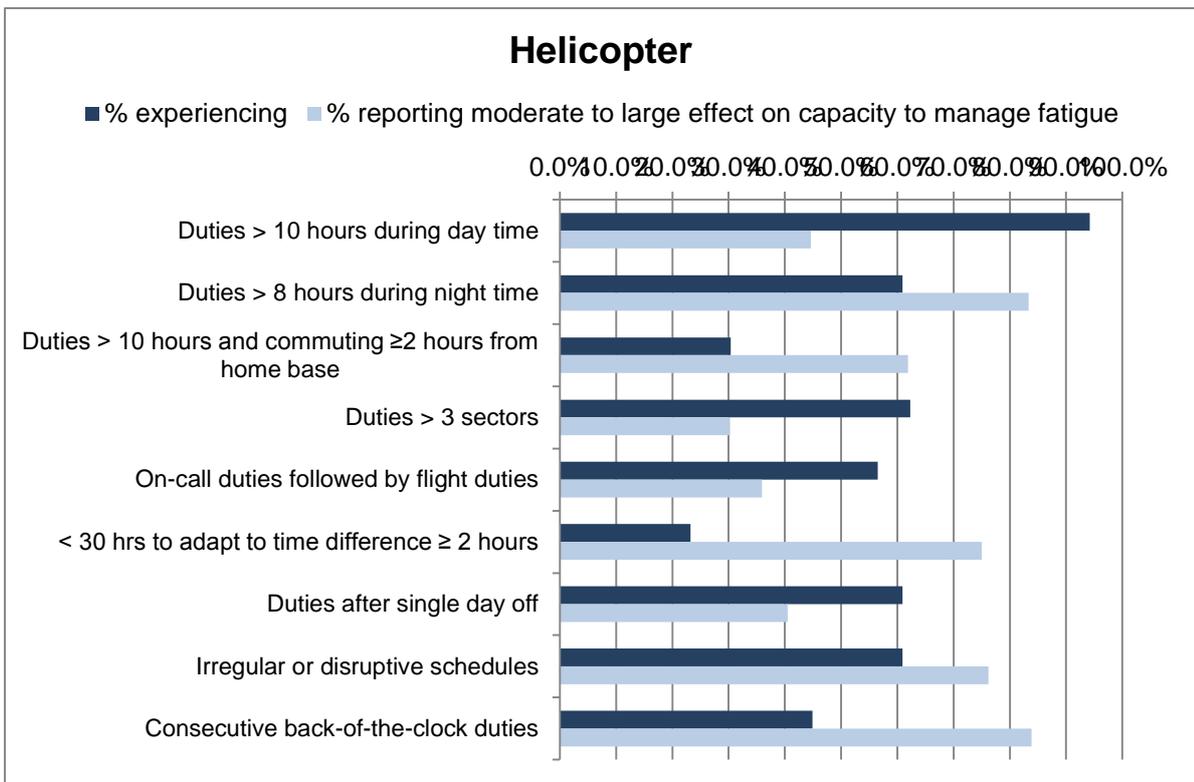
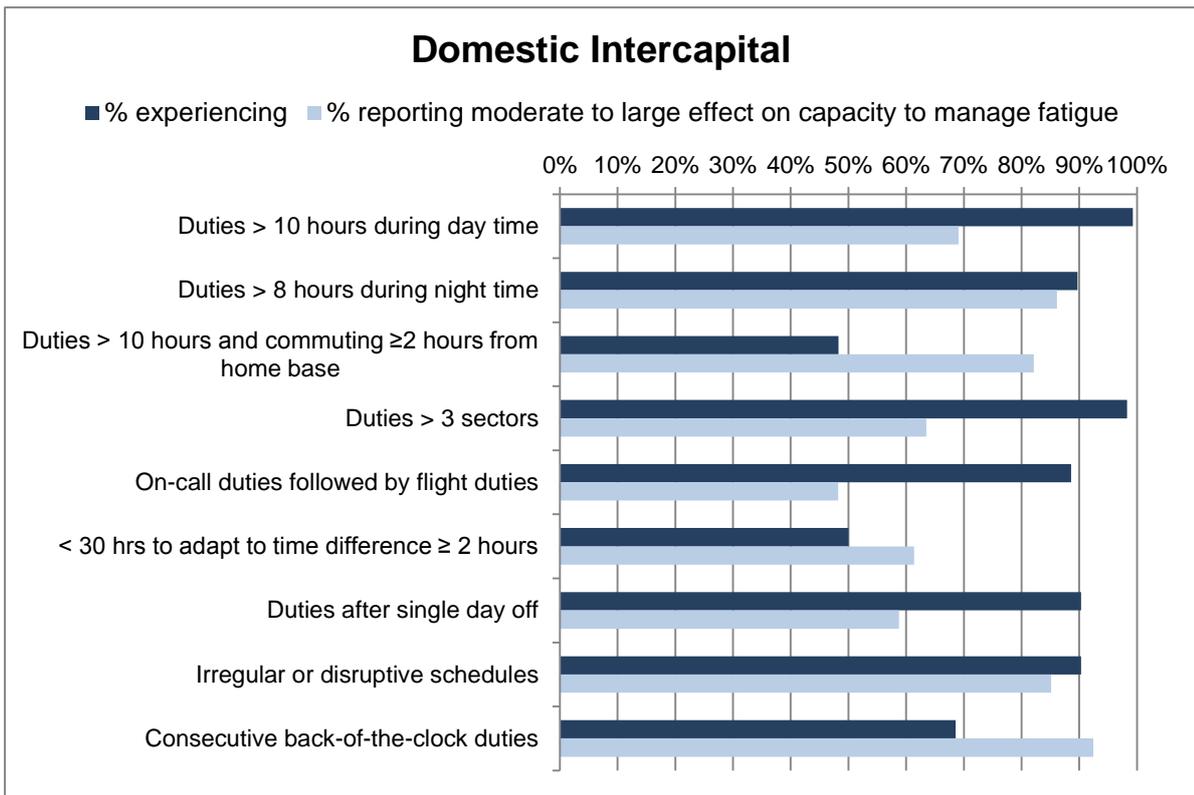


Figure 34: Domestic intercapital and helicopter pilots reports of their experiences of duties likely to contribute to fatigue and percentage reporting that the experience had a moderate to large effect on their capacity to manage fatigue

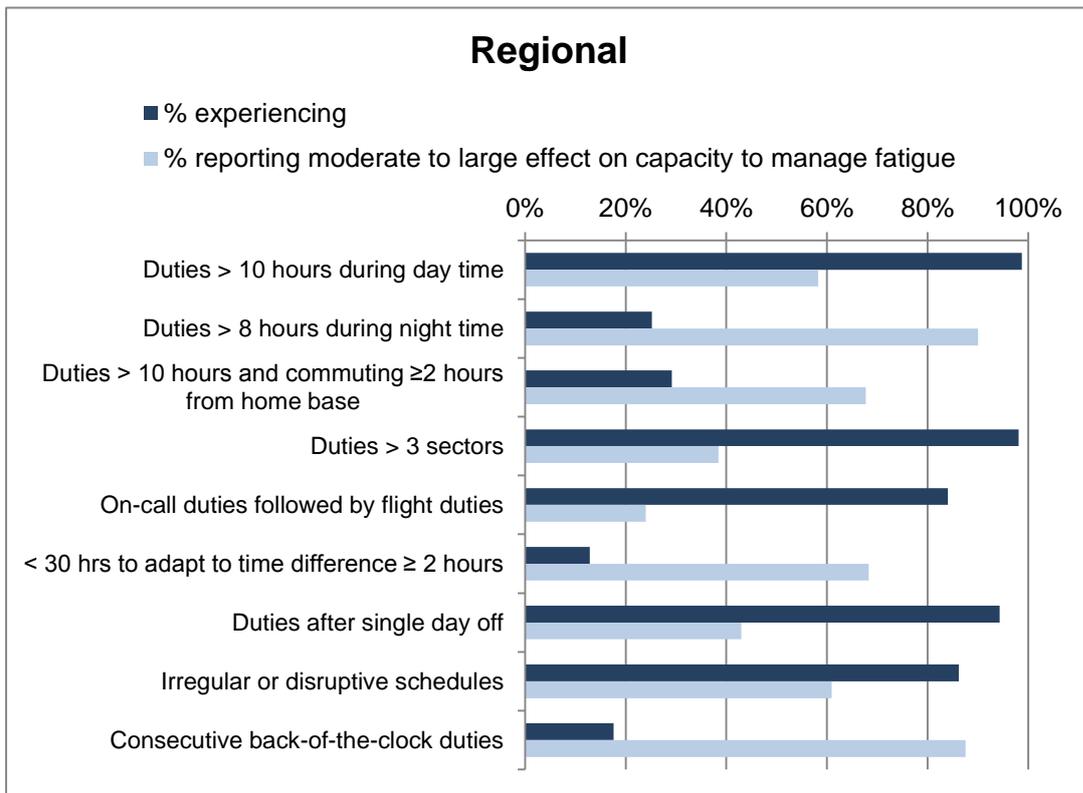
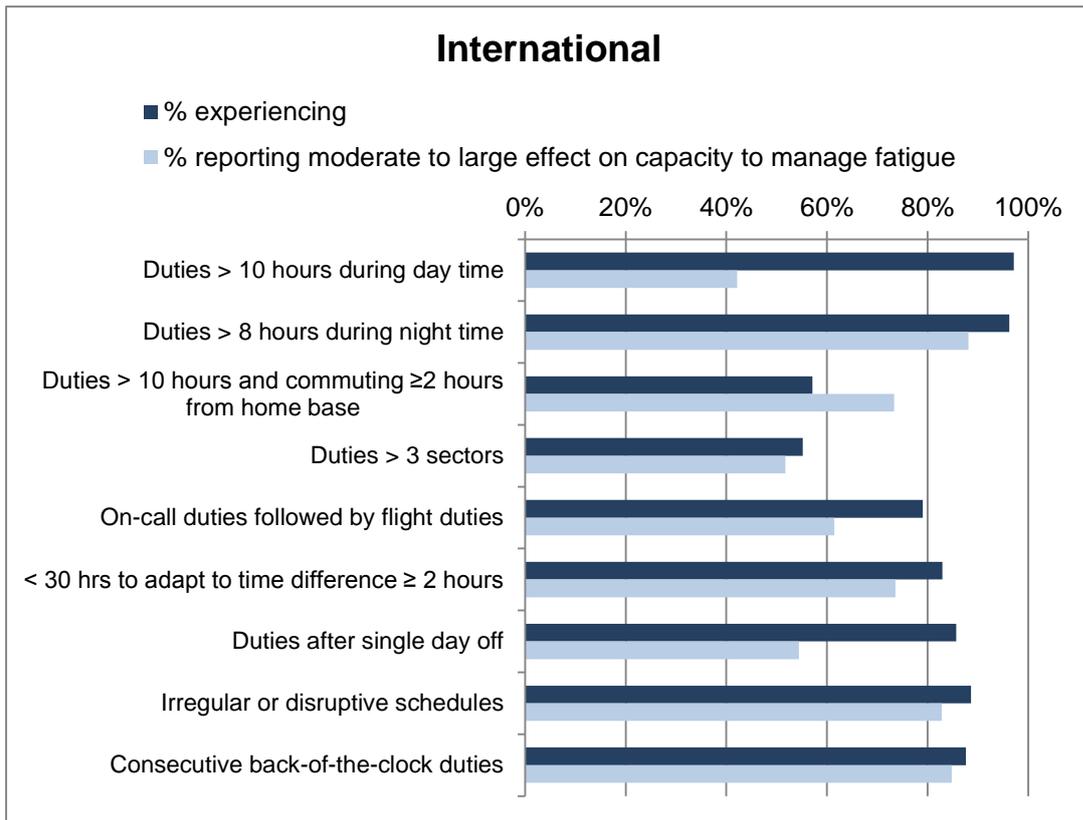


Figure 35: International and regional pilots reports of their experiences of duties likely to contribute to fatigue and percentage reporting that the experience had a moderate to large effect on their capacity to manage fatigue

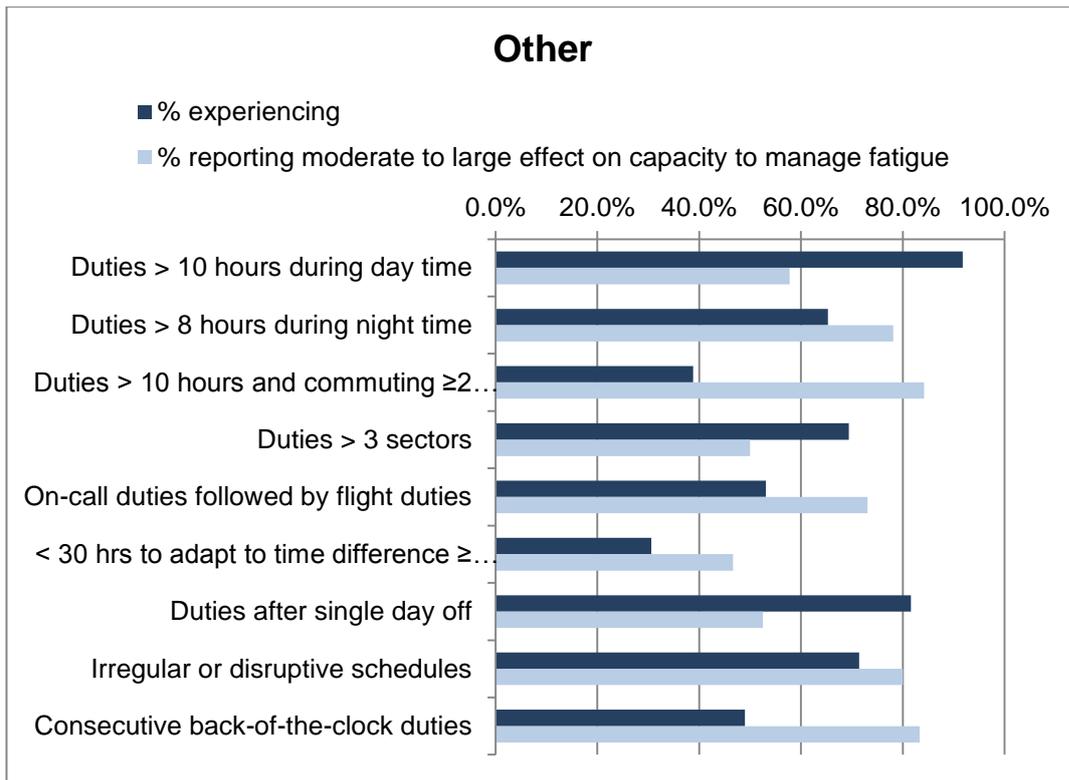


Figure 36: Other pilots reports of their experiences of duties likely to contribute to fatigue and percentage reporting that the experience had a moderate to large effect on their capacity to manage fatigue

Strategies for management of fatigue used by pilots working different types of flying work

The survey included a number of questions about how pilots attempt to manage fatigue when it occurs. Figure 37 shows the responses of pilots doing different types of work to questions on a range of fatigue management strategies. The results show that air ambulance and charter pilots use similar strategies with standing up and moving around being used by most pilots, followed by talking to crew, caffeine-containing drinks and planning to use controlled rest. In each case fewer charter pilots reported using each strategy than did air ambulance pilots. Taking a nap and occasional use of controlled rest were reported by the smallest percentages of pilots doing both types of work.

Most domestic pilots reported planning to use controlled rest and caffeinated drinks. Approaching 60 percent reported using controlled rest occasionally and just over one-third reported using naps.

Among helicopter pilots, the most common strategies reported were planning to use controlled rest, with around 50 percent reporting using controlled rest occasionally and reporting taking a nap. Using caffeine-containing drinks was also reported by just over half of helicopter pilots.

International pilots mostly reported planning to use controlled rest and using it occasionally, taking a nap, as well as using caffeine-containing drinks and standing up and moving around.

In contrast, very few regional pilots reported taking a nap, or planning or using controlled rest occasionally. The most common strategies for regional pilots were caffeine-containing drinks, standing up and moving around and talking to the crew.

It is notable that pilots from all work groups reported some strategies for fatigue management. Few pilots from any work group reported having no specific strategy.

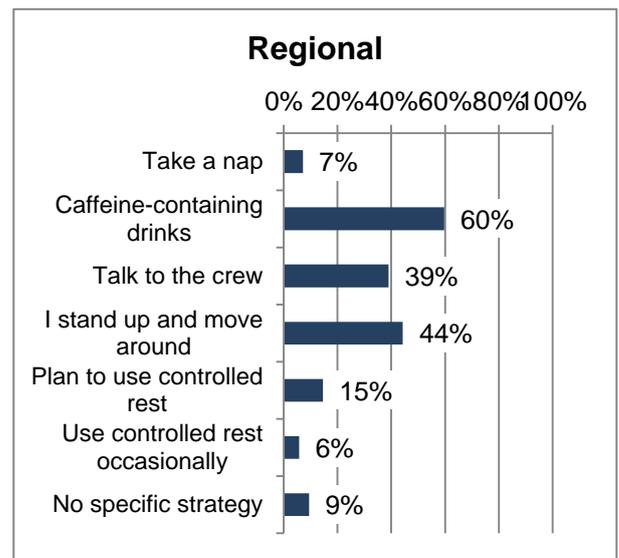
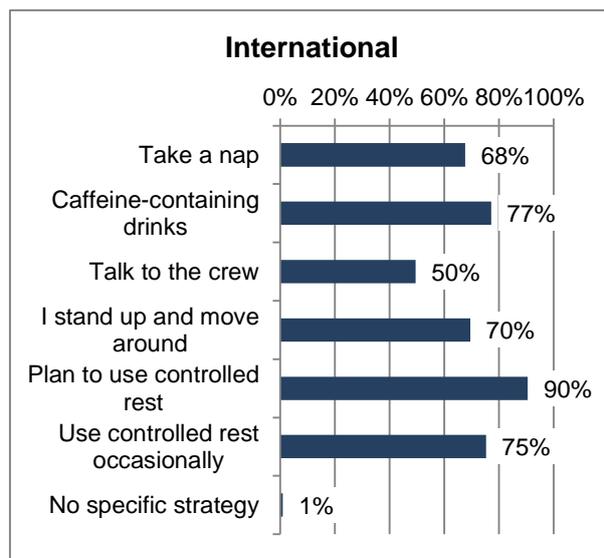
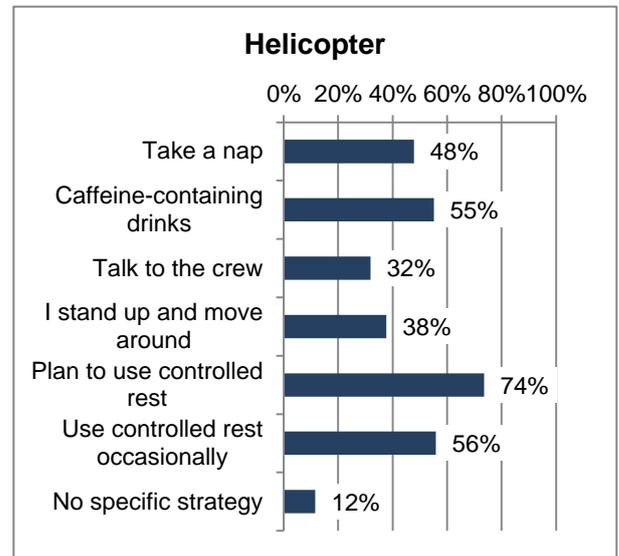
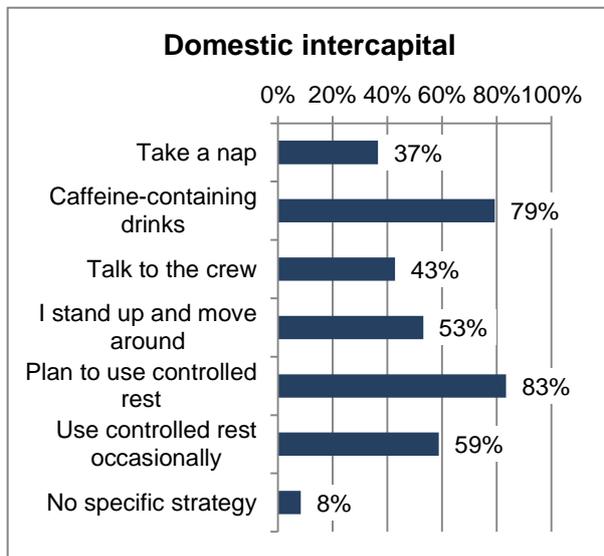
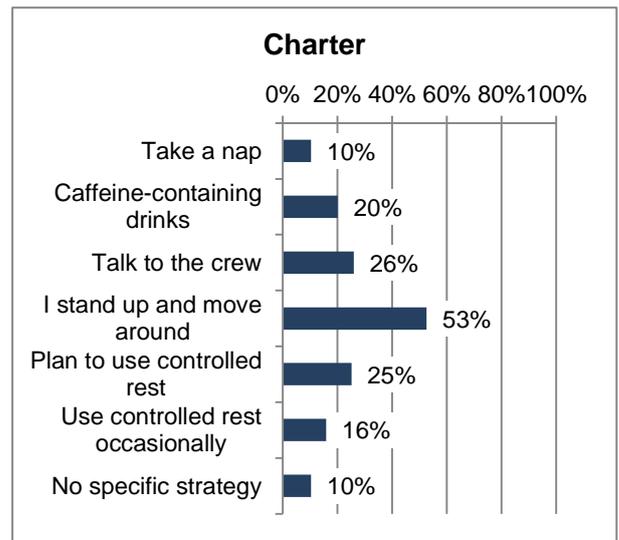
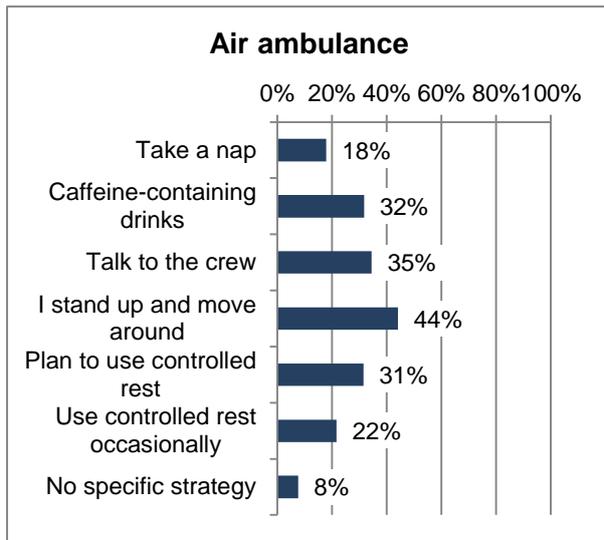


Figure 37: Methods for managing fatigue while working for pilots doing different types of flying work

As shown in Figure 38, pilot respondents were asked whether their company had a Fatigue Risk Management System (FRMS) for pilots. The majority of helicopter pilots worked for a company with FRMS. Around half of domestic and international pilots, around one-quarter of air ambulance and regional pilots reported having an FRMS, but only 10 percent of charter pilots reported that their company had an FRMS.

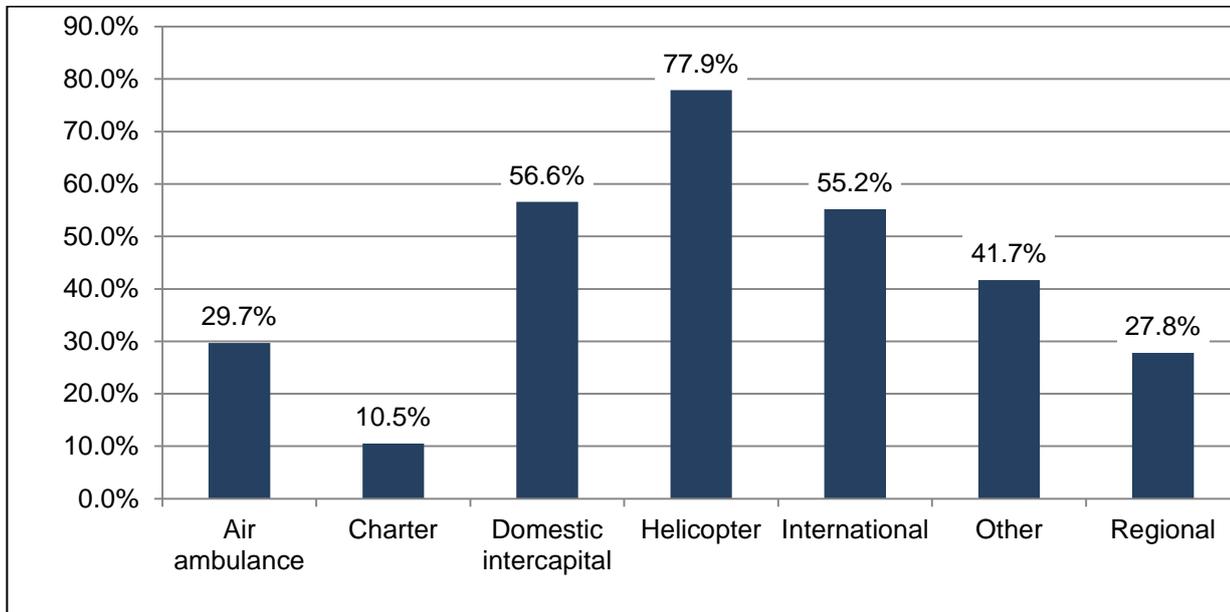


Figure 38: Companies who have FRMS for Pilots working different types of flying work

The survey also asked for pilot’s views about their company’s attitude towards reporting fatigue (see Figure 39). Most pilots doing all types of work reported that they felt that their company encouraged reporting either all or at least under some conditions. The greater majority of air ambulance pilots reported that they felt their company encouraged reporting fatigue all of the time. This was similar for charter pilots. For the other types of work, especially domestic, international and regional pilots, around one in five pilots felt that their company did not encourage reporting of fatigue.

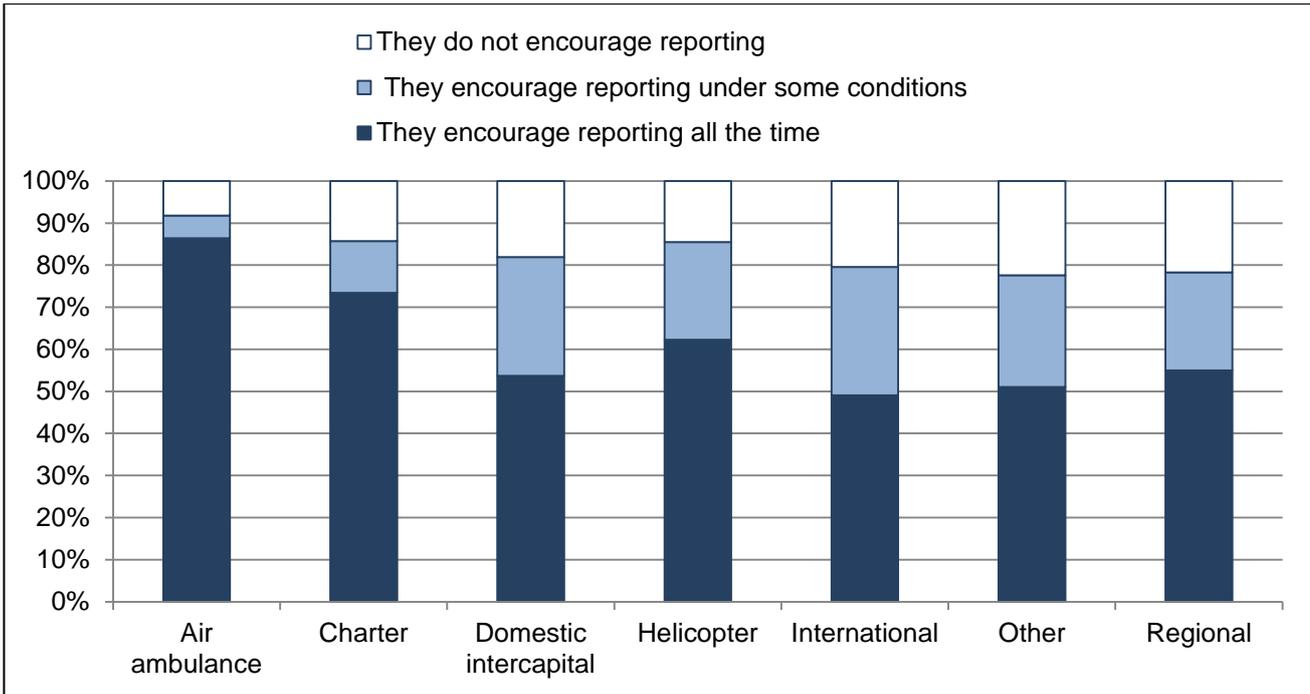


Figure 39: Company’s attitude to reporting fatigue for pilots doing different types of flying work

When asked how often they report their experience of fatigue, there were large differences between the pilots doing different types of work (see Figure 40). Air ambulance and charter pilots are most likely to never report fatigue, although both groups were also least likely to experience fatigue. Around half of the regional pilots also reported that they never reported fatigue. All of the other groups were much more likely to report fatigue, with around 20 percent of domestic, helicopter and international pilots reporting fatigue often or always. The results for pilots removing themselves from work due to experiencing fatigue showed similar patterns although very few in any of the groups reported that they always or often removed themselves from work (see Figure 41).

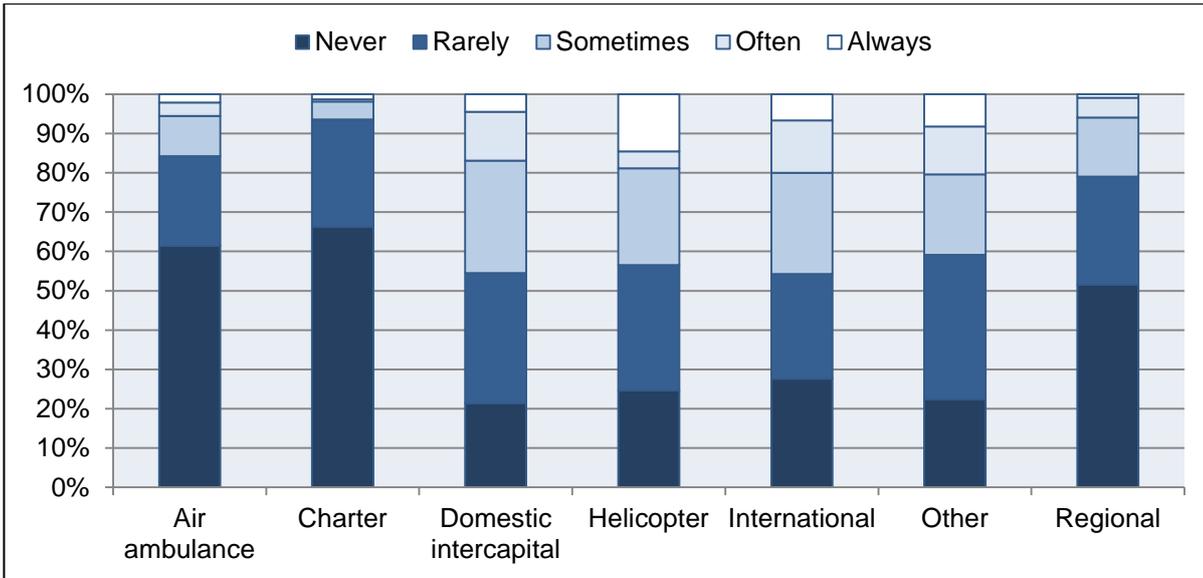


Figure 40: Frequency of pilots reporting their experience of fatigue to the company for pilots doing different types of flying work

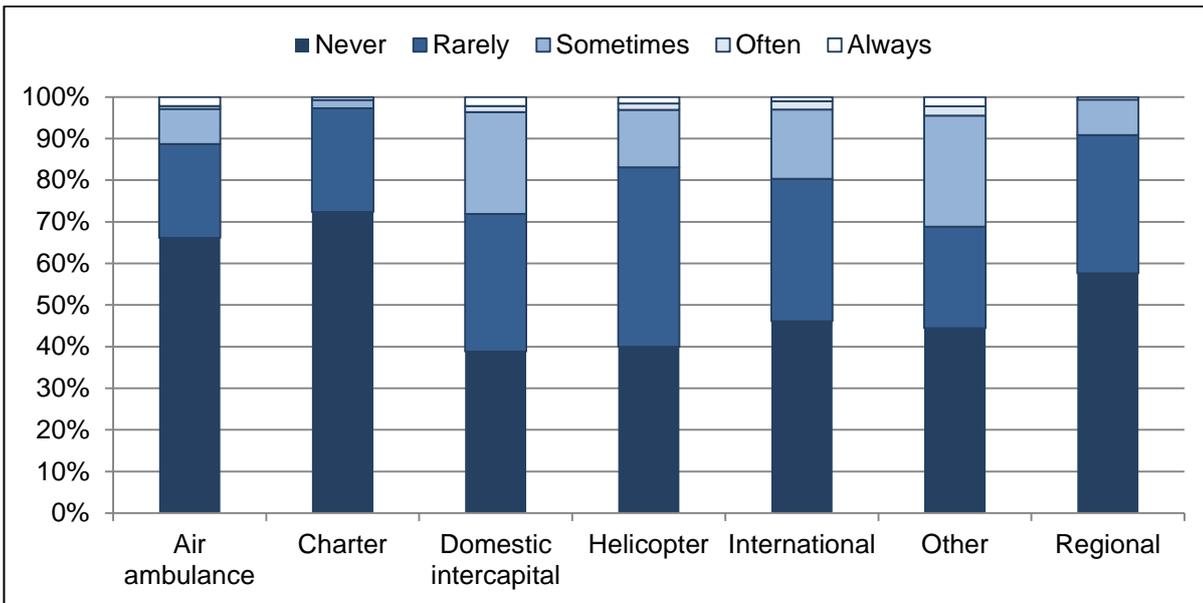
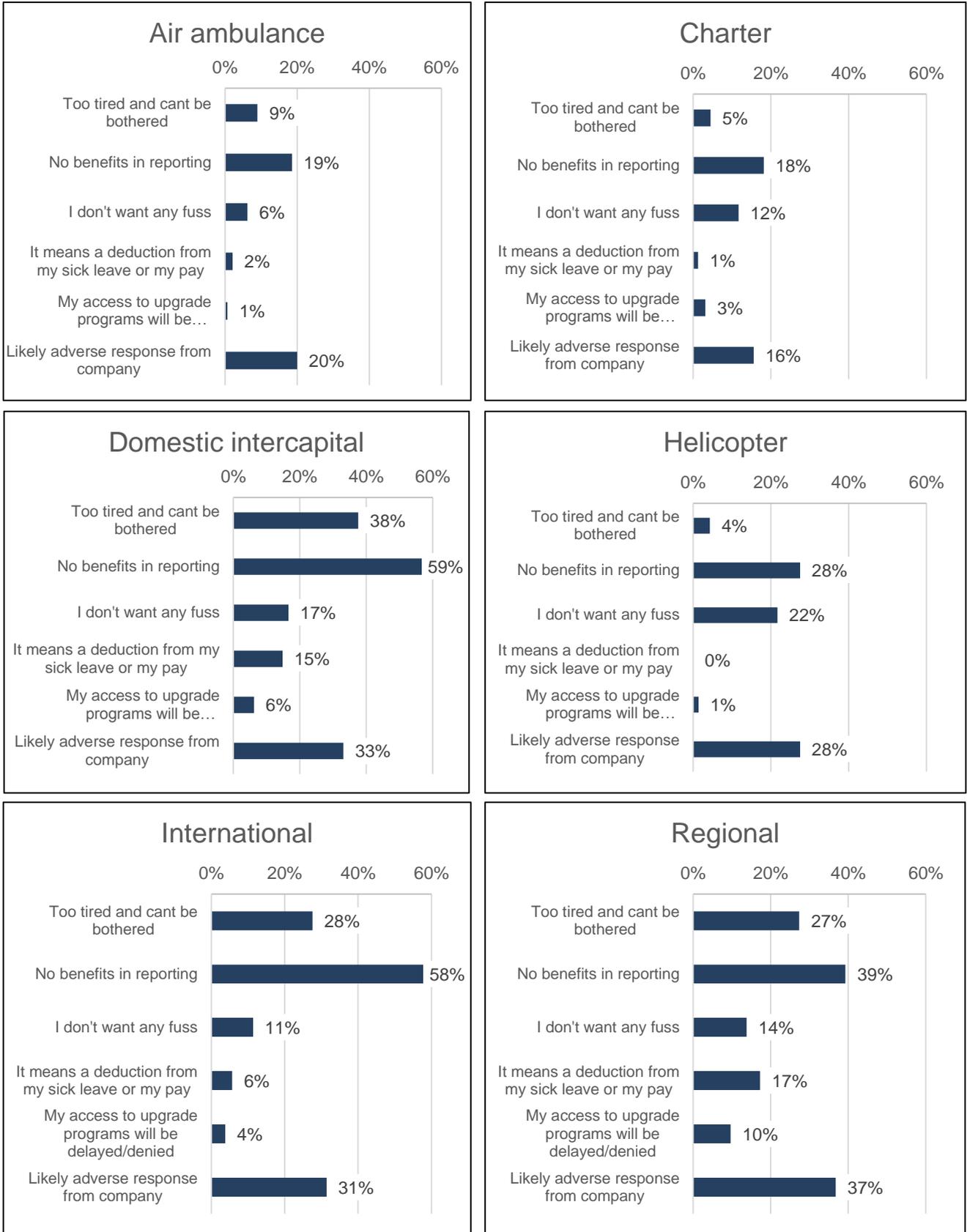


Figure 41: Pilots reporting frequency of ever removing themselves from duty due to experiencing fatigue for pilots doing different types of flying work

Analysis of the reasons for not reporting fatigue (see Figure 42) shows considerable similarity between pilots doing different types of work. For almost all groups, the most common two reasons for not reporting fatigue were that there were no benefits in reporting or that there was likely to be an adverse response from the company if they reported. More than half of the domestic and international pilots, in particular, reported that there were no benefits of reporting and around one-third felt that there was likely to be an adverse response from the company. A similar percentage of regional and helicopter pilots reported that the company would have an adverse response, whereas a smaller percentage of air ambulance and charter pilots held this view. Notably, more than one-third of domestic pilots and just over 25 percent of international pilots and regional pilots said that they didn't report because they were too tired and couldn't be bothered.

Figure 42: Reasons for not reporting experiences of fatigue for pilots doing each type of work



Discussion

The major finding from this large survey of Australian commercial pilots is that there is a high awareness of fatigue as an industry problem and a significant problem for the pilots who responded in the survey. Over 50 percent of respondents reported that fatigue is at least a substantial problem for them in their flying work and approaching half reported that they experience fatigue on at least half of their duty periods. Furthermore, almost all pilots reported adverse consequences of their experience of fatigue while working. Microsleeps while on duty were reported by 45 percent of pilots, and unplanned sleeping on the flight deck was reported by around one in five pilots. Over two-thirds reported having made an error due to fatigue while on duty, with around one-third reporting that this occurred as often as on ten percent of duty periods. Overall, this level of reported fatigue is concerning as it represents considerable threat to the safety, efficiency and well-being of the Australian pilots who experience it.

The findings are consistent with those found for pilots in Europe. A recent survey of European pilot's perceptions of safety included questions about their experience of fatigue (Reader, Parand and Kirwan, 2016). Completed by over 7,000 commercial pilots, the survey showed that over half (57.8%) reported that the pilots in their company were often tired at work. Australian pilots' views of fatigue suggest an even larger problem, with two thirds reporting that fatigue is a substantial or major problem for pilots in general. Other European surveys of pilot fatigue also show similar reporting of error due to fatigue as reported by Australian pilots (ECA, 2012). Comparable reporting of microsleeps and falling asleep on the flight deck were reported by pilots in the UK, France, Denmark, Norway and Sweden (ECA, 2012).

The current survey included a wide range of questions about pilots' experiences of potential causes of fatigue. Around half of respondents did duty periods of over 120 hours and 25 percent did more than 140 hours in a 28 day roster period. Flying represented about half of the duty time. Each week, most pilots did around four duty periods comprising four sectors of at least one hour. The time between sectors was one hour for most pilots and the time off between duty periods was around 16 hours.

Large percentages of pilots experienced a range of factors known to increase the likelihood of fatigue. These include early starts and late finishes either separately or consecutively, long duty hours with a notable minority reporting often or always being rostered for shifts of more than 12 hours, short recovery time between duties, including after a single day off and irregular or inconsistent rostering. In fact, around one-third of pilots reported that their published roster commonly changed during the duty period. Standby or on-call was a common experience for around one-third of pilots and around half reported that they are often or always asked to work when on-call. A significant number of pilots reported that they are commonly asked to work on days off. These factors have also been identified in surveys of pilots in many European countries (ECA, 2012).

Regression modelling analysis was conducted to determine whether any of these potential fatigue contributors predict actual higher pilot fatigue. This showed that factors relating to the length of duty significantly increased the odds of pilots experiencing fatigue as a problem. Specifically,

these included working for 8 hours or more, flying three or more sectors in a duty period and doing longer flying hours over a 28 day roster. Factors relating to the timing of the duty period also significantly increased the odds that pilots would find fatigue a problem, including longer and consecutive night shifts. Patterns of rest were also predictive of pilots finding fatigue a personal problem. Short recovery times and insufficient quality of on-board rest increased the odds that pilots had a personal problem with fatigue. Lastly, inconsistent roster patterns also showed increased odds of a personal problem with fatigue. Interestingly, a British survey of pilots also showed that fatigue prevalence was associated with flying more sectors and longer duty hours (ECA, 2012).

The strategies used by most pilots to manage fatigue tended to be temporary approaches such as using caffeine-containing beverages, standing up and moving around and talking to the crew. Strategies likely to have more sustained benefits were used by fewer pilots including planning to use controlled rest and napping, although only around one-quarter of pilots reported taking a nap or occasionally using controlled rest.

Systemic approaches to fatigue management like a formal company Fatigue Risk Management System (FRMS) were reported by just over one-third of pilots. More than half of pilots felt that their company always encouraged reporting of fatigue, and a similar percentage had reported fatigue to their company at some time. The most common reasons for not reporting fatigue were a perception that there were no benefits in reporting or that the company was likely to have an adverse response to reporting. Approaching half of pilots had reported sick rather than reporting fatigue and a similar proportion had removed themselves from duty when fatigued, although this was not a common experience.

Influence of type of flying work on fatigue experiences for pilots

There were marked differences in experiences of fatigue between pilots doing different types of work. Domestic intercapital and international pilots were the largest reporters of fatigue both as an industry and a personal problem. More than three-quarters of pilots doing domestic or international work find that fatigue is a substantial or major personal problem. Not surprisingly, then, almost all domestic and international pilots reported ever experiencing fatigue either before or during duty and around 50 percent reported that this occurred on half or more of their shifts. In comparison, air ambulance and charter pilots were least likely to report fatigue as a problem with around one-quarter or fewer pilots seeing fatigue as a personal problem and a minority reporting fatigue was a common experience for them.

Pilots doing all types of work agreed that fatigue has adverse effects on their performance, but they differed greatly in reporting of their experiences of the consequences. Three-quarters of domestic and international pilots reported having a microsleep on duty whereas this was reported by much smaller percentages of pilots from the other work types. There was less difference between the work types for falling asleep on the flight deck and waking from sleep to find the other crew asleep, but these experiences were still reported by more domestic and international pilots than the other groups. The same patterns were shown for reporting of instances where fatigue affected the pilot's capacity to perform or made an error due to fatigue although for these

outcomes, regional pilots and pilots classified as other also showed high reporting of fatigue consequences.

There were common views among pilots doing different types of work on the difficulties of managing some potential contributors to fatigue. Most pilots doing all work types reported that irregular and disruptive schedules had a moderate to large effect on their capacity to manage fatigue. Similarly, for pilots who experienced them, most pilots from all work types had problems managing longer night shifts which was a common experience for all groups. The problem of coping with consecutive back-of-the-clock shifts was cited as a problem for managing fatigue by the majority of all groups, although this was a very common experience only for international pilots and to a lesser extent domestic pilots. All groups except air ambulance and charter pilots had difficulty managing their fatigue when they experienced irregular and disruptive schedules or longer duties combined with two hours or more commuting. Most groups except charter and other pilots also reported that having less than 30 hours to adapt to a time difference of two or more hours presented a significant effect on their capacity to manage fatigue. Some contributors were reported as a moderate to large problem for managing fatigue by only some work types. Longer day shifts were not reported as a common problem by the majority of air ambulance, charter, helicopter or international pilots even though more than three-quarters of these pilots experienced them. Similarly, in spite of the finding that most pilots experienced them, the need to fly three or more sectors and needing to return to duties after only one day off were not reported by a majority of air ambulance, charter, helicopter or regional pilots. On the other hand, flight duties following being on call was only reported as a moderate to large problem by international and other pilots.

Investigation of the duty characteristics for each of the working groups, provided some support for the higher reporting of fatigue by domestic pilots. Domestic pilots reported the longest duty times and flying time and highest number of duties per week on average compared to all other work groups. Regional pilots reported the second highest duty hours and higher than international pilots, but international pilots did the second highest flying hours and considerably higher than regional pilots as well as longest sectors of all groups. Usual flying hours and long duty periods were significant predictors of pilot experience of fatigue, so it is likely that the high fatigue reported by domestic and international pilots is due at least partly to their greater duty and flying time. Conversely, the lower fatigue reported by air ambulance, charter and to a lesser extent, helicopter pilots may be due to less duty and flying work.

Pilots' views of their worst fatigue problems also reveal differences between working groups and characteristics of their work. The top three fatigue management problems for domestic intercapital pilots were long duty periods, consecutive early then late shifts and inconsistent roster patterns. For international pilots, the top three were night flights, unfavourable times to rest and insufficient quality of on-board rest which reflected their generally longer sectors, need to rest during duty and greater time zone changes. Regional pilots rated early starts, short recovery times and minimum rests after extended duties as their top three problems for fatigue management.

Pilots doing different work types used different strategies to manage fatigue. Controlled rest and napping should be the most effective strategies for fatigue management. The largest percentages of international, domestic and helicopter pilots reported using these strategies. In contrast, hardly any regional and few charter pilots reported using these strategies and air ambulance were

somewhat more likely to report using controlled rest and napping. For all groups, the more accessible but temporary strategies of standing up and moving around, caffeine use and talking to crew were used by a large percentage of pilots. Very few pilots in any group said that they used no specific strategy indicating that pilots across the board are aware of the need to manage fatigue.

Fatigue Risk Management Systems were implemented in the companies for three-quarters of helicopter pilots, only around half of domestic and international pilots and around a quarter of air ambulance and regional pilots. Hardly any charter pilots reported that their company had an FRMS. Despite this, the majority of charter and air ambulance pilots reported that their company always encouraged reporting of fatigue. Far fewer pilots from the other groups felt that their company always encouraged reporting, in fact, around one in five of international, regional and other pilots reported that their company did not encourage reporting of fatigue at all. Consistent with the overall finding of a moderate, but statistically significant relationship between fatigue as a personal problem and reporting fatigue, pilots from work types with higher percentages of personal fatigue were also more likely to at least sometimes report it and to have ever removed themselves from duty due to fatigue. The exception was helicopter pilots who were most likely to respond that they always report fatigue but had a lower percentage of pilots rating fatigue as a substantial personal problem.

The reasons pilots gave for not reporting experiences of fatigue were very different between work types. The most common reasons for not reporting for domestic, international and regional pilots was that they perceived no benefits in reporting, that there was likely to be an adverse response from their company or they were too tired to report and couldn't be bothered. Pilots from the other groups also reported these reasons, but by a marked percentage of pilots.

This survey has provided some important insights into the experiences of fatigue for Australian commercial pilots in general and for pilots doing different types of work. The invitation to participate generated a good response, although as it was a general invitation to all commercial pilots, it is not possible to determine the actual response rate. Nevertheless, the sample of over 1,000 pilots covering the wide range of different types of work provides some confidence that the results reflect general views and experiences of Australia pilots. In addition to the results presented in this report, there is opportunity for further potentially useful analysis. This includes a comparison of pilot fatigue experiences and fatigue contributors in companies that employ FRMS or not. As FRMS are implemented with the intention of formalising and potentially improving fatigue risk management, this survey provides an opportunity to evaluate their effectiveness under Australian aviation conditions. Furthermore, more than half of the pilots responding to the survey included considerable additional comment about their views of fatigue risk management in aviation and additional comments on some questions such as the nature of the errors made due to fatigue and more details of when fatigue occurs. Analyses of this more in-depth data can form the basis of further reports.

Overall, this survey shows that, similar to findings for European aviation, Australian commercial pilots are experiencing fatigue at levels that should cause concern. All pilots were aware that fatigue impairs their performance capacity and the majority reported having made an error due to fatigue while on duty. The results indicate that, in particular, the majority of domestic intercapital and international pilots are experiencing substantial to major problems due to fatigue and that

fatigue is a problem for a significant percentage of regional pilots. Fatigue is a problem for much smaller percentages of air ambulance, charter and helicopter pilots. This study highlights a range of work and rest characteristics that pilots report either increase their fatigue or make fatigue risk management more difficult. These causes vary between pilots doing different types of work, which is not surprising given the differing nature of each work type. This information on the primary causes of fatigue for different pilot work groups provides important targets for action to reduce the problem of fatigue for commercial pilots.

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