

# High-flying Risks

Variations in working conditions, health, and  
safety behaviors among commercial airline pilots  
in relation to safety climate

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# Contents

Abstract	1
Introduction	2
An industry in change	2
Study aim and questions	6
Method	7
Population and sample	7
Study design and implementation	7
Measurement instrument and variables	10
Data preparation and statistical analyses	16
Ethics	17
Results	18
Pilots' perceptions of safety climate	18
Working conditions and safety climate	21
Health and safety climate	31
Safety behaviors and incidents	36
Discussion and conclusions	39
References	43

# Abstract

Since the end of the 1990s the air transport market has undergone comprehensive deregulation and change, and is today greatly competition-driven. As a result, airlines have developed business models with new employment forms and new ways of organizing their operations. For commercial pilots this has meant changed, and often worsened, employment and working conditions. In this deregulation and the new business models, authorities both in Sweden and internationally see potential safety risks that can result in worsened flight safety. The aim of this study was to examine commercial pilots' perceptions of the safety climate, as well as shed light on how different types of perceived safety climate are connected to pilots' working conditions and health, as well as flight safety. Data were collected through self-reporting in a survey, with a total answer frequency of 46%. The results show clear differences between various types of safety climate. A cluster analysis resulted in three clear safety climate clusters, which were named *High-risk climate*, *Medium-risk climate*, and *Low-risk climate*. The High-risk climate cluster should be seen as a risk group for flight safety, as it was characterized by an inadequate reporting and learning climate, poor communication and safety commitment, insufficient resources for good safety work, and faults in the systematic safety work. The results also showed substantial variations between the different clusters regarding the pilots' working conditions, health and safety behaviors. Throughout the High-risk climate cluster, pilots reported worse working conditions, worse health and recovery, higher levels of anxiety and depression, more incidents and mistakes, and more dangerous safety behaviors than other pilots. From a practical safety and work-environment perspective, this study reveals a number of concrete conditions that are possible to change.

# Introduction

## An industry in change

Since the deregulation of the European air transport market in the mid-1990s, the airline industry has undergone fundamental changes. The European and Swedish aviation markets have gone from being state-run and protected to commercial and highly competition-driven. These changes have forced airlines to lower their costs and adapt their operations in order to realize a profit, which in turn has entailed the development of new business models with new and different types of employment forms and ways to organize operations (Transportstyrelsen, 2016).

For airline passengers, the deregulation has meant advantages in the form of, for instance, lower ticket prices and more airlines to choose from (Jorens et al., 2015; Luftfartsstyrelsen, 2008). For pilots, the market adjustment has meant changed – and often worsened – employment and working conditions (Jorens et al., 2015; Steer Davies Gleave, 2012, 2015). One of these changes has entailed that previously permanent positions at many airlines have been changed to contractual positions. Similarly, hires via staffing companies have become increasingly common, as have hires via companies with headquarters in other countries. This means, for example, that a pilot living in Sweden but employed by a company with its headquarters abroad is neither covered by the Swedish social insurance system nor has any guaranteed income. The practice of employers moving production from one area to another, or hiring employees from countries with lower salary levels, in order to lower costs and achieve a competitive advantage on a market has come to be called “social dumping”. It is already common in the shipping industry, and a similar development is underway in both the air sector and the haulage industry (Transportstyrelsen, 2016).

Besides the changed employment and working conditions, there have also been changes to the regulations regarding pilots’ flight time and rest. In February 2016 the regulations were modified, allowing pilots to work longer shifts, shortening their resting time between shifts, allowing more landings on the same shift, and increasing nighttime working hours. These changed working conditions have also been accompanied by increased work demands (Jorens et al., 2015; Steer Davies Gleave, 2012, 2015). Both Swedish and international research shows that many commercial pilots are working under great stress (ECA, 2012; SPF, 2011; Jorens et al., 2015). Among other things, pilots report considerable increases in fatigue and time press, as well as less possibility to speak out when they feel security is deprioritized. The changed working conditions, and the related experience of working under high stress, are also reflected in objective statistics from the Swedish National Insurance

Office (Försäkringskassan). The statistics show that pilots stand out as one of the professions with the greatest increase in absence due to illness for the years 2010-2013 (Försäkringskassan, 2014). Taken together, this picture implies worsened working conditions for Swedish pilots.

Authorities, both in Sweden and internationally, have called attention to the change in the airline industry, and see potential safety risks in the new market-adjusted business models and social dumping. Among other things, the Swedish Transport Agency has noted that the business models that today pervade the airline industry could lead to a distorted competition situation, worsened working conditions and, by extension, decreased safety (Transportstyrelsen, 2016). At the European Aviation Safety Agency (EASA) as well, work is underway to investigate whether the deregulation and the new business models might pose a risk to flight safety (Steer Davies Gleave, 2015).

### *Work organization and safety*

Extensive international work health research has shown that working conditions and work organization play an important role in the occurrence of both physical and psychological stress-related ill health (see, e.g., Levi et al., 2000; Holmes, 2001; Michie & Williams, 2003; Sverke et al., 2016). Of relevance for commercial pilots' working conditions are well studied stressors such as job insecurity, lack of control, high workload, complexity, and high level of responsibility. For example, unanimous research shows that job insecurity has a strong negative effect on individuals' psychological ill health (Ferrie et al., 2002; Hellgren & Sverke, 2003). There are also studies that more specifically indicate that flight safety is threatened by insecure employment conditions, as pilots – out of fear of losing their job – do not call in sick when they need to, and do not dare speak up or report incidents and errors (Jorens et al., 2015).

Traditionally, safety work in the airline industry has focused on investigating factors that cause incidents and accidents. In the current safety work, however, more focus has come to be placed on working conditions and factors on the management and organizational level (International Civil Aviation Organization, 2013), and how this in turn affects employees' possibilities to act in a safe way. In November 2013, an international standard for systematic safety work (Safety Management Systems) was adopted. In short, the standard entails that all companies operating within aviation (i.e. airports, airlines, air navigation and other organizations that can affect safety) are required to have a built-in system in their management for improving safety (ICAO's Annex 19). The implementation of a common systematic approach to working to improve flight safety entails great changes and increased demands for the airline industry. Instead of simply measuring *outcome* in the form of anomalies, incidents or accidents, industry now has to work more proactively and be

able to show the responsible authorities how they are working systematically to *avoid* incidents and accidents (Transportstyrelsen, 2014).

To describe how the interplay between individual-related, organizational, social and psychological factors in the work environment are linked to safety, the concepts *safety culture* and *safety climate* are often used. These concepts are related, but also differ in some ways (see, e.g., Törner, 2010; Guldemund, 2000). A clear difference is that the two concepts originate from different theoretical traditions. Safety culture has its foundations in an anthropological research tradition including organizational culture theory, while safety climate originates from a social-psychological ground in theories on organization climate. Their differences can be described as different starting points for studying and understanding safety and risk in an organization (Törner, 2010). Put briefly and simply, studies on safety culture focus on how the social surroundings *are created* by employees while those on safety climate focus on how the social surroundings *are perceived* by employees. In this study the concept *safety climate* will be used, as the intent is to examine pilots' perception of how various things function at the company where they work. Safety climate is defined as a work group's common experience, or perception, of the policy work, procedures and practices in force, in relation to safety within the organization (cf. Neal & Griffin, 2002).

To achieve and maintain a high level of safety, an interplay between multiple areas is necessary. The significance of organizational context for safety is currently well described, and research shows that safety climate is clearly associated with safety outcome. A number of studies within various industries clearly show associations between safety climate and safety behaviors (Parker et al., 2001), as well as between safety climate and involvement in accidents (Seo et al., 2004). A meta-analysis (Clarke, 2006) also notes positive associations between safety climate and not only safety behaviors but also fewer accidents. Together, these studies show that there are a number of factors that have been identified as decisive for a good safety climate – namely, leadership (managers' and team leaders' commitment, how managers' and team leaders' attitudes and behaviors regarding safety are perceived by a work group), open communication, participation, autonomy, trust (in coworkers as well as management, for instance regarding their competence), fairness, development of empowerment among employees, satisfaction with the functioning of the safety system within an organization, and the pressure to prioritize between production and safety (Flin et al., 2000; Törner, 2010).

### *Pilot health and safety*

Factors in the work environment and the work organization also play an important role in the occurrence of stress-related ill health. According to the OECD (2013), psychological ill health is the most common reason for people

of working age in Sweden not being on the job market. Depression comprises a significant proportion of the psychological ill health that is related to working conditions (Tennant, 2001; Paterniti et al., 2002). Internationally, depression is the third-most important cause of ill health, and affects an estimated 350 million people (Mathers et al., 2008; Center for Disease Control and Prevention, 2016). In Sweden today, stress-related psychological ill health is the leading reason for sickness absence and the cause of around half of all cases. Overall, depression is responsible for approximately 35% of these cases (Åsberg, 2014). In addition to depression, unease, worry and anxiety are commonly occurring conditions in Sweden. In total, approximately 6% of women and 3% of men report great difficulties due to unease, worry or anxiety, while 30% of the population report moderate difficulties (Folkhälsoinstitutets nationella folkhälsoenkät, 2015). The occurrence of depression, unease, worry and anxiety can be studied by means of individuals themselves describing their psychological health. For example, there are various self-report forms for detecting and measuring symptoms of anxiety and depression. One such instrument is the Hospital Anxiety and Depression Scale (HADS), which is often used in order to detect anxiety and depression symptoms in people not currently under psychiatric care. An evaluation of the HADS conducted in Sweden showed that the occurrence of depression was 6% while the corresponding figure for anxiety was 8% (Lisspers et al., 1997).

It can be difficult to detect depression and anxiety, however (Cepoiu et al., 2008). Pilots in particular can be unwilling to discuss various aspects of their psychological ill health with doctors, psychologists, or other healthcare personnel (Bor et al., 2002). Studies indicate that there is likely an underreporting of psychological issues and diagnoses among pilots (Parker et al., 2001; Lollis et al., 2009). The few studies that address depression in pilots, however, indicate – despite the medical checkups performed on them – that psychological ill health is on a level comparable to that of the general population (Bor et al., 2006). The results from a new study (Wu et al., 2016) examining depression and suicidal thoughts among pilots show that many commercial pilots go to work every day with symptoms of depression and in some cases even suicidal thoughts, but that few seek help. In total, 13.5% of the pilots participating in the study were deemed to be within the range of what is considered to correspond to clinical depression, while 4.1% reported having had suicidal thoughts within the previous two weeks.

Long weekly working hours, as well as working long hours while tired, are associated with increased risk for anxiety and depression among pilots (O'Hagan et al., 2016). The pilot profession is one with a high occurrence of fatigue-related problems (Caldwell et al., 2009; ECA, 2012; Åkerstedt, 2003), and statistics (British Airline Pilots Association) show that eight out of ten pilots report that their flight capacity in the past six months has been reduced



due to fatigue (BALPA, 2013). There are a number of studies that show a connection between a lack of sleep and reduced cognitive ability in pilots (see, e.g., Kecklund et al., 2010; ECA, 2012; Mobeus, 2008; Åkerstedt, 2003). There are also studies showing that depression and anxiety worsen pilots' cognitive ability (Tobias, 1985) and performance, and thereby negatively influence flight safety (Bor et al., 2002). The pilot profession differs from most others, however, as according to law (EC No. 216, 2008) pilots are not allowed to work if they are unsuited for it due to fatigue, illness, consumption of alcohol/medicine, or other conditions that could affect flight safety.

## Study aim and questions

The changes within the airline industry over the past decade have been pervasive. The deregulation of the air transport market, the revised regulations for pilots' flight times and rest, and increased competition and market adjustment have radically changed airlines' organization as well as pilots' working conditions. Despite this, however, the knowledge is still scant when it comes to how these changes are in practice related to pilots' health and flight safety.

The aim of this study was to examine pilots' perception of factors at various levels in the organizational context, especially factors of significance for the safety climate, as well as highlight how pilots' perception of the safety climate are related to their self-reported working conditions, health and experiences regarding flight safety. The following questions are in focus in the study:

1. How do the pilots perceive factors in their organizational context that are significant for the safety climate?
2. Is it possible to identify clusters of pilots who perceive factors in the organizational context that are significant for the safety climate in a similar way, and if so, what characterizes these safety climates?
3. Is there any connection between characteristics of the safety climate and the pilots' self-reported working conditions? Are there variations in how pilots who experience that they work in a secure and safe climate just their working conditions compared to pilots who experience that they work in a more insecure, risk-filled climate?
4. Are there any differences when it comes to stress, health and safety behaviors that can be related to how the pilots perceive the safety climate?

Safety climate is defined, with a starting point in Neal and Griffin (2002), as the shared perception regarding policy work, procedures and practices within a work group concerning safety in the organization. In this study of pilots, however, the focus is on the pilots' common perception of the organizational context and how it varies, rather than on work groups with reference to employees of a specific airline. The reason for this is that the conditions for

work that is flight-safe can differ substantially for different pilots working for the same airline. For example, pilots working within the same company can have different employment and working conditions, and may thereby perceive the organizational and social context in different ways. What this study aims to highlight is thus whether the pilots, regardless of airline, have a common perception of what a “good” and “bad” safety climate is, and if so, what characterizes these safety climates, as well as their connection to health and safety behaviors. The clusters that have been identified thus represent *a type of safety climate in which the pilots perceive their situation in a similar way*, regardless of which organization they belong to.

## Method

The survey presented in the report is the first of two in a longitudinal study of pilots’ working conditions, health and safety. The study is part of a larger research project, based at Karolinska Institutet, and is being conducted in collaboration with the Swedish Transport Agency with the aim of examining the consequences of the deregulation and market adjustment that has occurred within the airline sector, with a focus on how this is connected to pilots’ working conditions, health, and especially flight safety. The project has been reviewed and approved by the regional ethics board (dnr. 2016/250-31/2).

## Population and sample

The survey was conducted as a total survey, which entails that everyone belonging to a certain group is invited to participate in the study. This included the population of all pilots with a Swedish pilot’s license (ATPL, CPL or MPL) registered with the Swedish Transport Agency (2016-01-25). Based on these criteria, a total of 2,989 individuals were identified. Another criterion was to be currently working as a pilot within commercial civil aviation. As the Swedish Transport Agency does not have information on which airlines the registered pilots work for, the following question was posed in the introduction to the survey: *“You have received this survey because you have a CPL/ATPL. Are you currently working as a pilot within commercial civil aviation (employed or self-employed)?”* For those who answered no the survey was concluded, while those who answered yes were asked the remaining questions.

## Study design and implementation

Before the study was conducted, an inventory was done of relevant question areas and associated questions to include in the survey. The inventory took its

starting point in a systematic literature search, which identified research and reports from authorities and other organizations. Other existing surveys relevant to the target group were also reviewed. Additionally, general work-related questions were included as a complement to enable comparisons with other professions and other studies. Certain questions in the survey come from a previously conducted survey study by the Swedish Airline Pilots Association, to allow for reference results over time. For the same reason, questions from the international Ghent study (Jorens et al., 2015) were also included. For other question areas concerning, for example, stress or physical and psychological health, tested measurement instruments (in some cases somewhat modified to fit the target group) were used.

In the work designing the survey a number of reference groups were also established, consisting of representatives from the Swedish Transport Agency, the Swedish Airline Pilots Association, the School of Aviation at Lund University and the Swedish Aviation Industry Group, as well as two airlines with their headquarters in Sweden. The researchers met with the various reference groups during the design of the survey and discussed its principle aim, different question areas, a selection of questions, and marketing strategies. A selection of members of the reference groups who themselves were working or had worked as commercial pilots tested two versions of the survey, which was then modified before being sent out.

### *Implementation of the study*

The study was conducted as both a web and postal survey. Address lists for all pilots with a Swedish pilot's license (ATPL, CPL or MPL) were acquired from the Swedish Transport Agency. The original plan was to send out a link to a web survey via e-mail; however, the design had to be adjusted when we learned that the Transport Agency did not have the participants' e-mail addresses.

Instead, everyone in the sample (2,989 individuals) first received an invitation to participate via post. This communication consisted of a postcard inviting them to participate, as well as instructions for answering the web survey. After this a reminder was sent, in which everyone who had not answered the survey received a paper version of it. Finally, a second reminder was sent in the form of a postcard with a link to and login information for the web survey.

**Table 1.** Distribution of the web survey.

Date	Content	Number	Percentage
2016-05-30	Notification postcard with link to web survey	2,989	100%
2016-06-13	1 <sup>st</sup> reminder with postal survey	2,312	77%
2016-07-04	2 <sup>nd</sup> reminder with postcard containing link to web survey	2,049	69%
2016-08-30	Survey ends		

Both the web and postal surveys included a letter informing all participants of the study's background and aim. It also explained that the study was being conducted in collaboration between Karolinska Institutet and the Swedish Transport Agency. The information letter also made it clear that study participants' answers are protected according to Chapter 24, 8§ of the Public Access to Information and Secrecy Act (2009:400) as well as the Data Protection Act (1998:204), that collected information would be reported in a way that would not allow for specific individuals' answers to be identified, and that participation in the survey was voluntary and could be ceased at any point in time. Before the participants began answering the survey, they also signed (paper version) or checked a box on (web version) a consent form. The data collection and design of both versions of the survey were done by the company Enkätfabriken, on assignment by Karolinska Institutet.

### *Answer frequency and dropout*

The survey was sent to 2,989 people, of whom 1,299 answered. Some of the dropout consists of people whose addresses are unknown or whose letters were returned to us for other reasons, which resulted in a total of 43 returns. Additionally, some 30 people contacted us directly via e-mail or telephone and informed us that they could not participate due to other reasons (recently retired, or working in the cargo or private air industry or the Airforce). In other words, these individuals do not belong in the category of civil aviators. A dropout analysis showed that 67 people were aged 60 years or older (for pilots, 60 is the typical retirement age). If these individuals are excluded from the initial sample, the answer frequency is 46%.

A criterion for participation in the study was to currently be working as a pilot within commercial civil aviation. As the Swedish Transport Agency does not register information on workplace or position, a question was asked about this at the beginning of the survey. The initial plan was to only send web surveys via e-mail, and that those who answered no to this question would be instructed to stop filling out the survey at that point. This would inform us as to how many individuals in the original sample were not working in commercial civil aviation. However, as it became necessary to rework the web survey into a postal version, problems arose involving establishing dropout the exact number of individuals included in the total sample of pilots with a Swedish license who were working in commercial civil aviation. The problem lies in that many of those not working in commercial civil aviation – thus, those who would have answered no to the initial question on the survey – did not send in any answers at all. This is most clearly reflected in the fact that no postal surveys containing this no answer were received at all; that is, individuals working in some other capacity than pilots in commercial civil aviation. No answers were received from this group of pilots on the web survey either. This

has thus resulted in a complete lack of information on what proportion of the dropout is actually dropout, and what proportion simply does not belong to the target group; that is, how many people have a different job than being a pilot in specifically commercial civil aviation. It is thus highly likely that the dropout, now at 54%, is actually significantly smaller.

Another reason for the dropout that emerged in the contact via e-mail and telephone was that individuals had refrained from answering the survey due to worry and/or fear, despite the assurance of the confidential treatment of answers. Even in some of the open answers in the survey, a certain worry about having participated was expressed. While it is not possible to draw any conclusions as to how common this is simply based on these random contacts, it is naturally an extremely serious issue if pilots do not dare participate in this type of study due to fear of penalty. Previous studies also show that there is widespread fear of not only expressing views and criticism but also reporting oneself to be “unfit” if a pilot is tired, ill or otherwise unsuitable (Jorens et al., 2015; ECA, 2012). Disciplinary measures, negative influence on one’s career, stigmatization, and losing one’s job are some of the fears cited in this context. Overall, this indicates that the dropout has qualities that to a certain degree risk making an overevaluation of the general satisfaction.

The dropout analyses do not show any serious distortion. Regarding age, the average ages are quite similar: in the dropout group the average age is 41.4 years (S 11.57), while among those who answered it is 43.6 years (S 10.98). One difference can be noted, however, in a greater proportion in the dropout group among those living abroad (16%) while those who answered live in Sweden to a greater extent (only 4.6% live abroad).

## Measurement instrument and variables

The survey was relatively comprehensive, which is the result of a balance between scientific quality and a strive for as many participants as possible to have the energy to answer the questions and consider them personally relevant. The survey questions covered a number of areas, addressing topics such as employment conditions, working conditions, stress, physical and psychological health, as well as risk behaviors and flight safety. It consisted of seven parts, and was based on existing scales and questions that have been used in previous research. The first part of the survey contained questions on background factors, employment conditions and working hours. This part was followed by a section with questions on working situation, psychosocial load, and how the participant experienced the work. After this, questions were posed with reference to recovery, general health, illness, and health-related problems. The final section contained questions about the safety climate and safety

behaviors, and the survey concluded with an open question where it was possible to make personal comments.

### *Background conditions*

The following background variables were included: gender, age, education, number of years in this occupation, and number of flight hours. Age was divided into four categories:  $\leq 33$  years, 34-45 years, 46-54 years, and  $\geq 55$  years.

### *Safety climate*

The pilots' perception of factors in the organizational context that had significance for the safety climate were examined through questions from the Safety Culture Questionnaire Scale (Reader et al., 2015; 2016), translated into Swedish. The Scale includes six dimensions intended to measure: 1) management commitment to safety; 2) collaborating for safety; 3) incident reporting; communication; 5) colleague commitment to safety; and 6) safety support. The dimensions of the Scale greatly correspond to the themes identified as fundamental for a good safety climate (Flin et al., 2000). As the questions address how various factors significant for safety are perceived, they are used here to measure the safety climate even though the Scale was originally designed to measure safety culture. However, as the Scale does not include questions about fairness, which is one of the factors identified as decisive for an adequate safety

**Table 2.** Individual survey questions concerning the area of safety climate.

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<b>Statement</b>
Information about changes affecting flight safety within the company is communicated clearly to the employees within the company.
The communication regarding flight safety is good throughout the company.
Others in the organization understand how my job contributes to flight safety.
I trust the people I work with daily.
There is sufficient personnel to perform the work in a safe way.
We have the resources needed to do our work in a safe way.
The company learns from safety-related incidents and inspections.
Changes to the company's systems and routines are extensively evaluated from a safety and risk perspective.
Adequate education/training is offered when new systems and routines are put in place.
My manager is committed to safety.
My manager takes measures if we report safety inadequacies or risks.
My manager supports me if I am worried about safety.
People who report safety-related incidents are treated fairly.
I play a sufficient part in activities concerning flight safety.
I have good access to information about safety incidents and other occurrences within the company.
If I express views regarding the work environment and working conditions, I am listened to.
I avoid expressing critical viewpoints.

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climate, two questions about fair climate were added: “If I express views regarding the work environment and working conditions, I am listened to” and “I avoid expressing critical viewpoints”. A total of 18 questions on safety climate were included (Table 2). The pilots were to take a stand regarding each statement, marking an answer alternative based on a five-point scale (5=do not agree at all; 1=completely agree).

### *Working conditions and organization*

Regarding the pilots’ employment conditions and work models, questions were posed concerning the following: type of employment (permanent/other employment types); whether the pilots, according to their contract, work full or part time; whether they live in the country where they have their home base; whether they live in the city where they have their home base; and whether they, in the past six months, have flown long line/combined/short line.

Five questions were used to measure *work demands* (see Table 3), and an additional five question were used to construct an index of work demands (e.g., “I have much too great responsibility in my work”; “I’ve been given increasingly more to do at work in recent years”). Cronbach’s alpha for the index was 0.66. The pilots were to take a stand regarding each statement, marking an answer alternative based on a five-point scale (5=do not agree at all; 1=completely agree).

To measure *change and insecurity*, four questions were used (see Table 3) and an index. The “worry about changes” index included six questions from the Effort-Reward Imbalance Model (Siegrist, 2000; e.g., “I worry about changes in the organization or operations” and “I currently experience or expect a worsening of my working situation”). The reliability coefficient (Cronbach’s alpha) was 0.74. The participants were to take a stand regarding each statement, marking an answer alternative based on a five-point scale (1=do not agree at all; 5=completely agree).

To examine *management and resources*, an index and three questions were used (see Table 3). The “personnel orientation” index included three questions (Dallner et al., 1999; “Management is interested in the employees’ health and well-being”; “Management’s actions reflect that they wish to keep their personnel”), whereby the formulation of the questions was slightly modified to fit the research group. Cronbach’s alpha for personnel orientation was 0.85.

Other *psychosocial factors* were examined with the help of four indexes. The “silence” index contained six questions addressing, for instance, whether the pilots avoid voicing critical viewpoint and whether they are listened to if they express their views (“In my organization you can openly discuss problems with quality in the operations”; “If I express critical viewpoints, I risk having a worsened position at my workplace”). The reliability coefficient (Cronbach’s alpha) for the index was 0.87. The participants were to take a stand regarding

**Table 3.** Individual survey questions concerning the area of working conditions and organization

<b>Question</b>	<b>Answer alternatives</b>
<i>Work demands</i>	
How many days a month were you scheduled to fly, on average, in the past six months?	Fewer than 20 days More than 20 days
Are you required to be available even when you are off duty?	Yes/No
Do you feel you have enough time for the work that has to be done before and after a flight?	1=Very seldom to 5=Very often/Always
Does it sometimes happen that you start a new work period/week with only 36 hours' rest?	No, never Yes, sometimes Yes, often
In the past two years, have you experienced that your employer has broken the rules regulating the working time and rest periods of flying personnel?	1=Very seldom to 5=Very often/Always
<i>Change and insecurity</i>	
How many times in the past two years has SOP changed at the airline you work for?	Open answer – number of times
How often are other routines involving flying changed?	1=Very seldom to 5=Very often/Always
How many times in the past 12 months have you worked with a co-worker you hadn't previously worked with?	Open answer – number of times
Would you like to change your workplace?	Yes/No
<i>Management and resources</i>	
Would you be reprimanded in some way by the airline if you had to call in sick due to fatigue?	
If you report yourself Unfit for Flight, do you receive any compensation?	Yes/No
If you are sick-listed, do you receive any compensation?	

each statement, marking an answer alternative based on a five-point scale (1=do not agree at all; 5=completely agree).

*Participation* is an index based on six questions from the COPSOQ (Berthelsen et al., 2014) addressing, for example, whether the pilots have the possibility to influence essential decisions concerning their work and whether they are encouraged to speak up when they are dissatisfied with decisions concerning their work. Cronbach's alpha for participation was 0.80. The participants took a stand regarding each statement, marking an answer alternative based on a five-point scale (1=very seldom or never; 5=very often or always).

*Social support* was examined using five questions from the QPS (Dallner et al., 1999) and the COPSOQ (Berthelsen et al., 2014), which formed an index ("If I need it, I get support and help in my work from my co-workers"; "I get the support I need in difficult situations"). Cronbach's alpha for this index on



social support was 0.79. The participants took a stand regarding each statement, marking an answer alternative based on a five-point scale (1=do not agree at all; 5=completely agree).

*Work satisfaction* consisted of three questions (Kinsten et al., 2007), which formed an index (“How satisfied are you with your work?”; “How satisfied are you with your closest manager/team leader?”). Cronbach’s alpha for work satisfaction was 0.70. The pilots took a stand regarding each statement, marking an answer alternative based on a five-point scale (1=very poorly; 5=very well).

### *Health-related outcome*

Health behaviors were examined with the help of four questions that addressed smoking (yes/no), snuff use (yes/no), physical activity (answer alternatives: 1=none at all; 4=more than an hour a day), and medicine consumption (answer alternatives: no, not at all/yes, at the moment/yes, regularly). Health and working ability were measured using three questions (see Table 4).

Fatigue and recovery were measured using eight questions, which formed an index for recovery (Gustavsson et al., 2008; von Thiele et al., 2006; “Do you feel rested and recovered when you start work?”; “Do you feel tired during the workday?”). Cronbach’s alpha for fatigue and recovery was 0.79. The pilots answered the questions by marking an answer alternative based on a five-point scale (1=very seldom or never; 5=very often or always).

Stress-related problems were examined using an index for stress-related problems (see, e.g., Eriksen et al., 1999), consisting of 17 questions (Cronbach’s alpha 0.90) with three subscales for pain (“How often in the past month have you had problems with pain in your neck/shoulders/back?”), fatigue (“How often in the past month have you had problems with fatigue/difficulty relaxing?”) and cognitive problems (“How often in the past month have you had problems with your concentration/difficulty making decisions?”). Cronbach’s alpha for the pain subscale was 0.80, for fatigue 0.84, and for cognitive problems 0.82. The pilots answered the questions by marking an answer alternative based on a five-point scale (1=very seldom or never; 5=very often or always).

Psychological ill health was measured using five questions (see Table 4), along with help from the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983). The HADS is a self-evaluation form comprising a total of 14 statements, of which seven aim to measure symptoms of anxiety and seven aim to measure symptoms of depression. In completing the form the informant answers, for example, how often in the past week they have felt “as if something terrible is going to happen” or whether they “enjoy the same things as before”. Answers are given along a four-point Likert scale from 0 to

3. The points are totaled, and can result in a maximum of 21 points per subscale. Someone scoring 7 or lower on any of the subscales likely does not suffer from anxiety or depression in the clinical sense. A score of 8 to 10 is regarded as borderline, while 11 points or higher on a subscale likely indicates clinical depression or anxiety. The HADS is often used in research contexts (Bjelland et al., 2002; McCue et al., 2006), and shows good reliability as a screening instrument for clinically significant anxiety and depression (van Ballegooijen et al., 2016).

**Table 4.** Individual survey questions concerning the area of health-related outcomes.

<b>Question</b>	<b>Answer alternatives</b>
<i>Health and working ability</i>	
How do you perceive your own health to be?	1=Very poor 5=Very good
Assume that your working ability, at its best, was rated ten points. How many points would you give your current working ability?	1=Completely unable to work to 10=Working ability at its best
Do you have any chronic diseases?	No/Yes: What disease?
<i>Psychological ill health</i>	
Have you ever noticed signs of psychological ill health in any of your pilot colleagues that could affect flight security?	No, never Yes, a few times Yes, many times
Are regular checks done on pilots' psychological health at the airline you work for?	Yes/No
What are your usual feelings about your work when you're on the way to work?	5=Great reluctance to 1=Happy and satisfied
Do you usually drink alcohol in order to fall asleep when you have duty overnight)?	
Do you take some type of sleeping medication in order to fall asleep when you have duty over night?	No/Yes

### *Safety-related outcomes*

Incidents and reporting were examined using three questions, fatigue and mistakes with five questions, and (mis)judgements with two questions (see Table 5).

**Table 5.** Individual survey questions concerning the area of security-related outcomes

Question	Answer alternatives
<i>Incidents and reporting</i>	
How many aviation events that influenced, or could have influenced, flight safety have you been involved in?	Open answer – number of times
How many actual incidents that influenced flight safety have you been involved in?	
Did you report these aviation events and/or incidents?	Yes, all of them/ Only the more serious ones/ No
<i>Fatigue and mistakes</i>	
In the past 12 months, has it ever happened that during a flight you've felt so tired/worn out/unfit for other reasons that it occurred to you that you shouldn't be on duty at that point/those points?	No Yes: How many times?
In the past 12 months, has it happened that, because you felt tired/worn out/unfit for other reasons, you've made a mistake in the cockpit while on duty?	
In the past 12 months, have you reported yourself Unfit for Flight due to accumulated tiredness/fatigue/other reasons?	
In the past 12 months, have you called in sick because you were too tired/worn out/unfit for other reasons?	
In the past 12 months, has it happened that you "dozed off"/fell asleep in the cockpit when this had not been agreed on with your FC/FO?	
<i>(Mis)judgements</i>	
How many times in the past 12 months has it happened that you began a flight even though, taking into account your health status, actually should have sick-listed yourself?	Open answer – number of times
How many times in the past 12 months has it happened that you began a flight, even though you were too tired/worn out/unfit for other reasons?	

## Data preparation and statistical analyses

First, so-called cluster analyses were done in order to identify various types of safety climate. These analyses were conducted using the answers to the questions about how the pilots perceived factors in their organizational context that had significance for the safety climate. In a cluster analysis we compared how different individuals answered the various questions, and then made a grouping of the individuals (see, e.g., Aldenderfer & Blashfield, 1991). Those who gave similar answers, and thus show similar answer patterns, were categorized into the same group. The cluster analysis done here requires that the number of groups be specified in advance, based on previous studies, but also that different numbers of clusters be compared before a theoretically and empirically logical number of clusters can be determined. Based on theoretical

starting points and statistical requirements that ensure the reliability of the analysis, the cluster analysis resulted in three clusters. Each cluster includes individuals with similar answer patterns to the questions addressing how they perceive the safety climate. The clusters' names reflect the answer pattern among those in the group. As the answer patterns here entailed the perception of the safety climate the clusters, or groups, were named *High-risk climate*, *Medium-risk climate*, and *Low-risk climate*.

In order to compare demographical background factors, psychosocial work environment and health-related factors between the different groups, chi2 tests and variance analyses were performed. In these analyses, a statistical test was done to examine whether there were statistically significant differences in various factors between the different groups. This entails determining the certainty with which one can say that the differences between the groups reflect an actual difference beyond the margin of error. Normally, the limit for a statistically significant difference is set at a risk level of 5%; this is the risk level that has been set for the analyses reported here. Thus, there is less than a 5% risk that the conclusion regarding an actual difference is wrong and is due to chance rather than true differences. Besides reporting a risk level of 5%, we also make it clear when the risk level is 1% or lower. In the reporting of the results, this is expressed as  $p < .05$ ,  $p < .01$ , or  $p < .001$ . Finally, we also report the percentages of study participants who gave different answers to the various questions that were analyzed. All analyses were done using SPSS 22.0 for Mac.

## Ethics

As part of the research project "Sambandet mellan och effekterna av avreglering och förändrade anställningsförhållanden för trafikpiloters arbetsvillkor, stressrelaterade hälsa och flygsäkerhet" (*The relation between and effects of deregulation and changed employment conditions for commercial pilots' working conditions, stress-related health and flight safety*) this study has been reviewed and approved by a regional ethics board (dnr. 2016/250-31/2). Research ethics principles entail that each study participant has the right to choose whether to participate and can, at any time and without explanation, stop participating. All information the participants provide within the frame of the research project is treated confidentially. This entails that all material on the participants is coded, and that no information from any individual participant is given to employers, unions, or other parties. Reporting to various interested parties and scientific reporting is done on a group level, so no individual person can be identified.

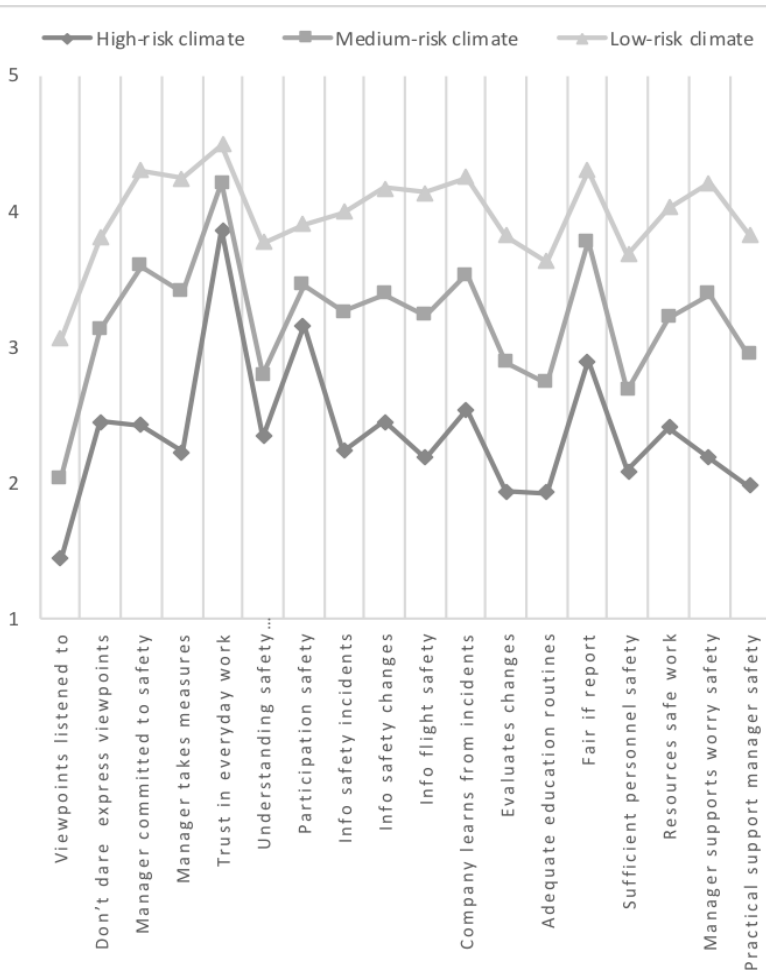
# Results

## Pilots' perceptions of safety climate

The aim of this study was to examine these pilots' perceptions of factors in the organizational context with significance for the safety climate, as well as to shed light on the connection between the pilots' safety climate and their working conditions, health and flight safety. The first question that was posed was how the pilots perceive factors in the organizational context with significance for their safety climate, and whether it is possible to identify clusters of pilots who perceive their safety climates in a similar way and, if so, what characterizes these safety climates. To answer this question, we performed a cluster analysis that included the answers to the survey questions addressing safety climate. Three different groups (clusters) were identified, each representing a type of safety climate for which the pilots perceived their situation in a similar way. The analysis showed great differences in how the pilots perceived the safety climate, and there were statistically significant differences in the mean value for all questions included in the measure of safety climate. The three identified safety climate clusters were named *High-risk climate*, *Medium-risk climate*, and *Low-risk climate*. With a starting point in the mean values of the different questions regarding safety climate, Figure 1 shows what characterizes the various cluster profiles. As regards company affiliation, it can be seen that the pilots' perceptions of the safety climate can vary even within one and the same company. Thus, pilots working for the same company can perceive its safety climate in different ways. This means that the identified types of safety climate are not mutually exclusive at the company level. However, it can be clearly seen that the different airlines are greatly characterized by one of the different types of safety climate; for instance, at the airlines where a majority of the pilots can be found in the *High-risk climate* cluster, the proportion who perceive that they have a low-risk safety climate is low, and vice versa.

The cluster called *High-risk climate* consists of 251 individuals, and is characterized by low (poor) values. Here, low values entail unsatisfactory levels or dangerous situations. This applies to all area identified as fundamental for a good safety climate: management's and managers' attitudes and behaviors concerning safety, communication, participation, trust, fairness, and safety systems. The High-risk climate is also characterized by silence. This means that the pilots in this cluster avoid voicing critical viewpoints, and when they do voice them they do not feel they are listened to. Resources and support in their work are also perceived as inadequate; for example, a lack of adequate education and training when new systems and routines are established. The pilots in this cluster also do not feel they receive enough practical support from

the safety manager/department in their safety work, and that there is a lack of sufficient personnel for the work to be done in a safe way. The High-risk climate is also characterized by organizational problems when it comes to education and training. This means that changes to the company's system and routines are not sufficiently evaluated from safety and risk perspectives. The pilots in the High-risk climate also feel they lack support from their manager if they are worried about safety. The only aspect that is at an acceptable level in this cluster is the collaboration between the pilots: they report that they have trust in the people they work with daily ( $M=3.86$ ).



**Figure 1.** Mean values for the questions on safety climate for the three clusters.

In contrast to the High-risk climate cluster, the *Low-risk climate* cluster shows relatively high values throughout. This means that the values in all areas are quite good. The cluster consists of 428 individuals. Management and communication are perceived as well functioning, and managers are reported to be committed to safety issues and to take measures if safety deficiencies are reported. In contrast to the pilots in the High-risk climate cluster, those in the Low-risk climate cluster feel they receive support from their manager if they have worries about safety (High-risk climate:  $M=2.19$ ; Low-risk climate:  $M=4.21$ ). The pilots in this cluster perceive that the communication concerning flight safety at the airline where they work is good, which also applies to information about changes to flight safety. The pilots also perceive that their company to a high degree learns from safety-related incidents and investigations. In the Low-risk climate cluster, the pilots also feel they have access to the resources needed to do their work in a safe way. Compared to the other areas, however, even this cluster has somewhat low levels in the areas of silence and participation. For the question of whether the pilots are listened to when they express viewpoints regarding the work environment and working conditions, for example, the mean value for this cluster is 3.06, which corresponds to the answer alternative “agree somewhat” (whereas the respective mean values in the High-risk and Medium-risk climate clusters are 1.45 and 2.04; i.e. “do not agree at all” and “disagree somewhat”).

The *Medium-risk climate* consists of 357 individuals. In this cluster, the situation is perceived as varying: within certain areas it is quite good, while in others it is slightly too low to be considered safe. Regarding resources, for instance, the cluster’s mean value is 2.74 for the question of whether adequate education/training is offered when new systems and routines are established. The pilots in the Medium-risk climate also feel there is a lack of sufficient personnel to allow their work to be carried out in a safe way ( $M=2.69$ ), and say that changes to the company’s systems and routines are not sufficiently evaluated from safety and risk perspectives ( $M=2.89$ ). In contrast to the Low-risk climate cluster, collaboration within the company is also not regarded as optimal. For the question of whether others in the organization understand how the pilots’ job contributes to flight safety, the mean value is 2.80 (in the Low-risk climate cluster the mean value is 3.77). On the other hand, the pilots in the Medium-risk climate cluster are at a high level for the question of whether they trust the people they work with daily ( $M=4.21$ ). In this cluster, management seems to also do well: the pilots perceive that their managers are committed to safety issues ( $M=3.60$ ).

When demographic factors are compared, significant differences emerge between the High-, Medium- and Low-risk climate clusters concerning the pilots’ age, years in the occupation, and number of flight hours. However, there are no statistically significant differences in gender [ $\chi^2(2)=2.909$ ,  $p=.234$ ] or

education [ $\chi^2 (2)=3.961, p=.682$ ] between the pilots in the different safety climate clusters.

**Table 6.** Demographic background factors.

	n	%
<i>Age</i>		
≤33	292	22.5
34–45	387	29.8
46–54	414	31.9
≥55	205	15.8
<i>Gender</i>		
Female	89	6.8
Male	1211	93.2
<i>Highest completed level of education</i>		
Elementary school	5	0.4
High school	535	41.9
University	722	56.5
Higher academic education	16	1.3
<i>Years in occupation</i>		
≤10	303	27.1
10–20	378	33.8
20–30	321	28.7
30–40	104	9.3
≥40	12	1.1
<i>Number of flight hours</i>		
<1000	57	5
1000–3000	123	10.9
3001–5000	181	16
5001–10000	305	26.9
>10 000	466	41.2

## Working conditions and safety climate

The question is how the perceived safety climate is connected to the pilots' self-reports on their own working conditions: are there differences in judgement of one's own working conditions between pilots who feel they work in a safe and secure environment (Low-risk climate) and those who feel they work in a more unsafe and risk-filled environment (High-risk climate)? A majority of the pilots (85%) are permanently *employed*. The remaining 15% are employed under other forms, such as temporary employment or employment through a staffing company or their own company. The differences between the safety climate clusters are statistically significant [ $\chi^2 (2)=10.993, p=.004$ ]. In the High-risk climate cluster nearly a fifth (19.4%) have other employment forms than permanent employment, while the corresponding figures for the Medium- and Low-risk climate clusters are 12.1% and 10.1%, respectively.



There are also statistically significant differences between the clusters when it comes to the degree to which the pilots work *full or part time* [ $\chi^2(2)=10.435$ ,  $p=.0001$ ]. In the High-risk climate cluster 72.3% of the pilots work full time, while the corresponding figures for the Medium- and Low-risk climate clusters are 76.5% and 83.1%, respectively. In the entire population, 77.7% of the pilots work full time and 22.3% part time.

As to whether the pilots *live in the same country or the same city* where they have their home base, there are no statistically significant differences between the various clusters (country: [ $\chi^2(2)=.605$ ,  $p=.739$ ]; city: [ $\chi^2(2)=3.492$ ,  $p=.174$ ]). In the entire population, just over half (52.2%) live in the city as their home base and 75.5% live in the same country as their home base. Concerning whether the pilots *fly long line, short line, or mixed* [ $F(2, 1035)=2.898$ ,  $p=.056$ ] and how many other airlines they have worked for in the past [ $F(2, 1027)=.222$ ,  $p=.801$ ], there are no statistically significant differences between the clusters.

### *Work demands*

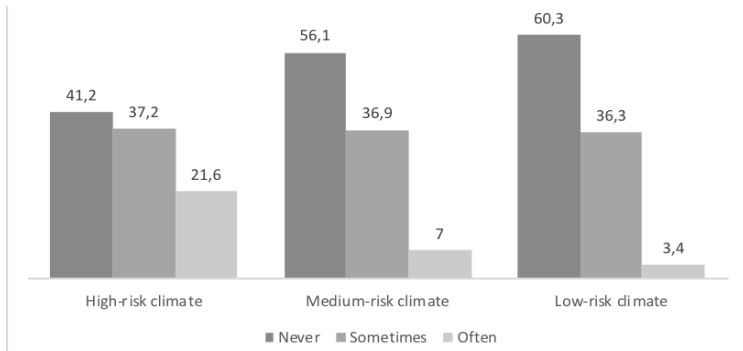
As regards the demands of the work, just over a quarter (26.9%) of the pilots in the study report that they seldom, very seldom, or never have *enough time for the work that has to be done before and after a flight*, while just under a quarter (24.8%) say they sometimes do and nearly half (48.3%) say they often, very often, or always do. There are statistically significant differences between all the clusters [ $F(2, 1031)=80.921$ ,  $p=.001$ ], with the pilots who report working in a High-risk climate showing the worst possibilities to have time for the work to be done before and after a flight, and those in the Low-risk climate showing the best possibilities. Again, in response to the question of whether *it happens that they start a new work period/week with only 36 hours' rest*, it is the pilots in the High-risk climate cluster who report having the worst working conditions. Here, 58.8% respond that it sometimes or often happens that they start work with only 36 hours' rest, while the corresponding figure for the Low-risk climate cluster is 39.7%. The differences between all the clusters are statistically significant [ $\chi^2(2)=22.880$ ,  $p=.0001$ ]. In the entire study group, just under half (46.7%) say that it sometimes or often happens that they start work after just 36 hours' rest.

The differences between the clusters are also statistically significant when it comes to *how many days a month on average the pilots are scheduled to fly* [ $\chi^2(2)=11.201$ ,  $p=.0004$ ] and whether they are *required be available even when off duty (not on standby/scheduled)* [ $\chi^2(2)=31.602$ ,  $p=.0001$ ]. Among the pilots in the High-risk climate cluster 30% report being scheduled for more than 20 days, while the corresponding figures for the Low-risk and Medium-risk climate clusters are 18.4% and 22.9%, respectively. Regarding their work schedule, 10.4% of the pilots in the High-risk climate cluster and 16.4% of

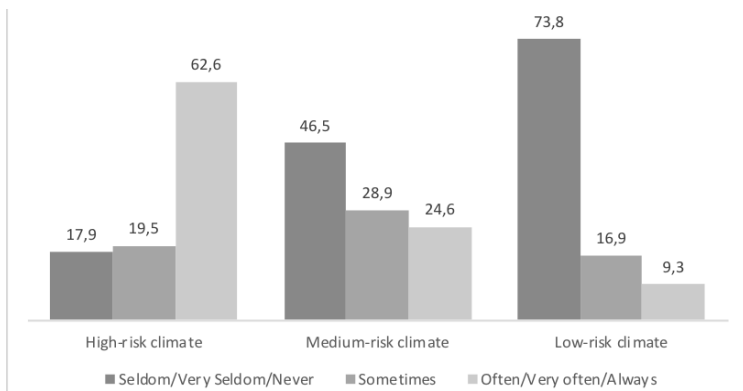
those in the Low-risk climate cluster say they get their work schedules three weeks ahead of time. In total, 7.2% of the pilots in the High-risk climate cluster report that they do not get any work schedule at all, while the corresponding figure for the Low-risk climate cluster is 2%. As for the requirement to be available when off duty, a fifth (20.5%) of the pilots in the High-risk climate cluster say there are such requirements while the corresponding figures for the Medium- and Low-risk climate clusters are 8.5% and 7%, respectively.

In the survey, a question is also posed concerning whether the pilots in the past two years have experienced that their employer broke the rules (Subpart Q/FTL) regulating flight personnel's working time and rest periods. In the entire study group 71.3% answered that this happens seldom, very seldom, or never, while nearly a third (28.6%) reported that it actually happens (sometimes, often, very often or always). Here, there are great differences between the different climate clusters [ $F(2, 1032)=141.555, p=.0001$ ]. Among the pilots in the High-risk climate cluster 62.6% say it happens sometimes, often, very often or always, while the corresponding figure for the Low-risk climate cluster is 9.3%. Similarly, it is also the pilots in the High-risk climate cluster who are the very least satisfied with their working times. In this cluster 63.6% report that they are rather dissatisfied or very dissatisfied with their working times, while the corresponding figures for the Medium- and Low-risk climate clusters are 35.4% and 19.3%, respectively. These differences are statistically significant between all three clusters [ $F(2, 1029)=130.617, P=.000$ ]. In the entire study group 42.4% of the pilots report being rather or very satisfied with their working times, 21.6% report being neither satisfied nor dissatisfied, and 36% report being rather or very dissatisfied.

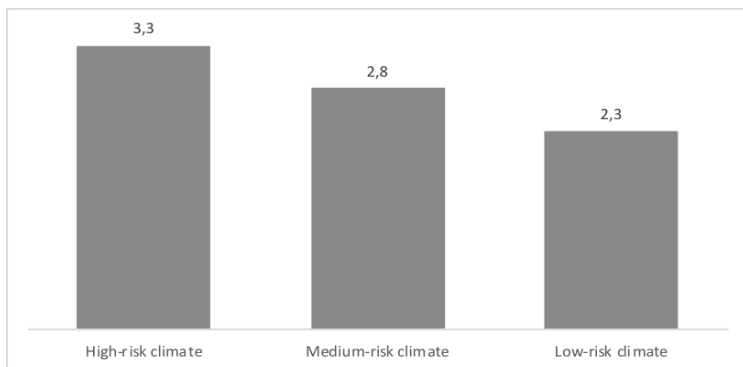
Regarding *work demands* in general – for example if the pilots feel they have too great a responsibility in their work or if the work contains aspects that place too great a demand on their capacity – these are also experienced as the highest among the pilots in the High-risk climate cluster [ $F(2, 1032)= 155.528, P=.000$ ], and the differences between all clusters are statistically significant. A question within this framework that ranks high in the entire study group is whether the pilots report having been given more to do at work in the past year. Here a majority, 65.2%, mostly or completely agree that they have been given more to do in the past year. Among the pilots in the High-risk climate cluster, 59% say they completely agree and 21.9% say they mostly agree. In the Low-risk climate cluster, on the other hand, it is only 27% of the pilots who completely agree while 19.7% mostly agree.



**Figure 2.** Sometimes start a new work period/week with only 36 hours' rest; answer frequencies in percent.



**Figure 3.** Employer has broken the rules (Subpart Q/FTL) regulating working time and rest periods; answer frequencies in percent.



**Figure 4.** Demands index; mean values for questions about demands on a five-point scale (1=do not agree at all, 3=agree somewhat, 5=completely agree).

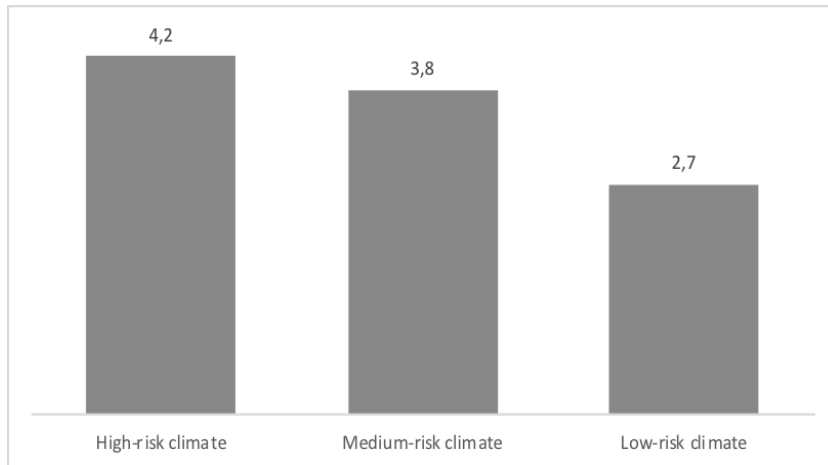
### *Changes and insecurity*

Concerning the question of *how many times in the past two years SOP has been changed at the company where they work*, the mean value is 3.5 times for the entire study group. The conditions differ among the pilots in the three different safety climate clusters, and these differences are statistically significant [F(2, 1001)=4.572, P=.011]. For the pilots in the High-risk climate cluster the mean value is 4.2 times, while the corresponding figures for the Medium- and Low-risk climate clusters are 3.8 and 2.7 times, respectively. When it comes to *how often other routines concerning flights are changed*, there are also statistically significant differences between the clusters; for this question, there are great differences between all clusters [F(2, 1035)=33.146, p=.0001]. A total of 43.8% of the pilots in the High-risk climate cluster say that other routines concerning flights are changed often, very often or always, while in the Low-risk climate cluster only 19.1% report this. In the Medium-risk climate cluster 29.4% say that other routines concerning flights are changed often, while in the entire study group the corresponding figure is 29.1%.

There are also differences between the clusters when it comes to *how many times the pilots have worked with someone they had not previously worked with*. These differences were not statistically significant, however [F(2, 1023)=1.006, p=.366]. The mean value for the entire study group for this question is 19.6 times. The pilots in the High-risk climate cluster had worked with someone they had not previously worked with an average of 21.1 times in the past year, while the corresponding figures for the Medium- and Low-risk climate clusters were 20 and 17.9 times, respectively.

Generally, there appears to be a *worry about changes* among the pilots in the study. The questions concerning “worry about change” addressed aspects such as changes in the organization or operations, or whether the pilots are currently experiencing or expecting a worsening of their working situation. Over half the pilots in the entire study group (51.7%) reported currently experiencing or expecting a worsening of their working situation (mostly agree /completely agree). The differences between the various clusters regarding worry are statistically significant, with the most worried pilots found in High-risk climate cluster and the least worried in the Low-risk climate cluster [F(2, 1027)=118.372, P=.000]. For example, just over half (51.8%) the pilots in the High-risk climate cluster mostly agree or completely with the statement that they worry about changes in the organization or operations, while the corresponding figure for the Low-risk climate cluster is 27.2%. Furthermore, a third (33.4%) of the pilots in the High-risk climate cluster say they worry about losing their job (mostly agree/completely agree), while the corresponding figure for the Low-risk climate cluster is 15.9%. There are also great differences between the pilots in the different clusters when it comes to *desire to change workplace* [ $\chi^2$  (2)=177.667, p=.0001]. Among the pilots in the High-

risk climate cluster 66.5% answered yes to this question, while the corresponding figures for the Medium- and Low-risk climate clusters were 32.3% and 14.6%, respectively. In the entire study group, just over a third (34.5%) said they would like to change their workplace.



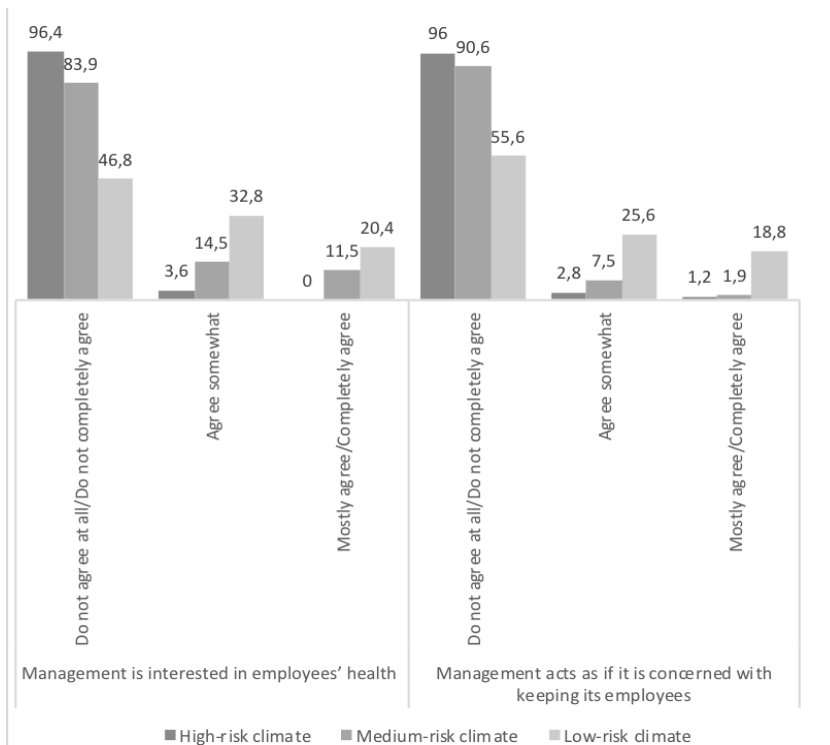
**Figure 5.** How many times in the past two years SOP in the company has been changed; mean values.

### *Management and resources*

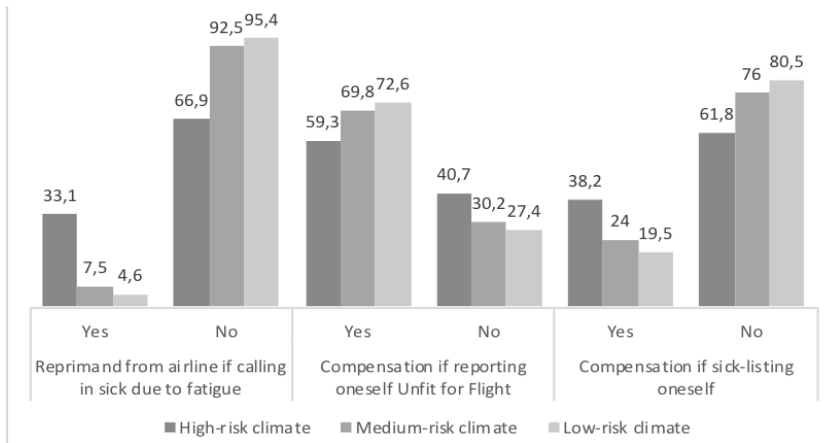
There are also factors that seem to be indirectly related to safety but that have great significance for health and well-being among pilots, and thus by extension for safety as well. One such central factor is what is usually called *personnel orientation*; that is, the degree to which employees feel they are “seen” and experience that management is interested in their performance and health. The results of this study are discouraging in this regard, as two-thirds (74.4%) of the pilots in the study experience that management lacks interest in employees’ health, and as much as 79.6% report that management does not act as if it is concerned with keeping its employees. Here, again, there are great and statistically significant differences between the clusters: as before, it is the pilots in the High-risk climate cluster who say they have it the worst and perceive that they are the least appreciated and acknowledged [F(2, 1033)=231.300, P=.000]. For example, as much as 96.4% of the pilots in the High-risk climate cluster did not agree at all or did not completely agree with the statement that management is interested in employees’ health and well-being, and 96% did not agree with the statement that management acts as if it is concerned with keeping its employees. Among the pilots in the Low-risk climate cluster 46.8% say they do not agree at all or do not completely agree with the statement that management is interested in employees’ health and

well-being, while 55.6% say management does not at all act as if it is concerned with keeping its employees.

A more tangible factor concerning safety and health is related to how an organization treats its pilots if they report themselves Unfit for Flight (UF) or sick-list themselves. The survey contained a question about whether the pilots would receive *some kind of reprimand from the airline if they needed to call in sick due to fatigue*. Just over a tenth of the pilots (12.6%) in the entire study group answered yes to this question, while the rest (87.4%) answered no. In a comparison between the clusters, once again great and statistically significant difference emerged [ $\chi^2 (2)=120.477, p=.0001$ ], with the High-risk climate cluster standing out in a negative way. Among the pilots in this cluster a third (33.1%) say they would receive a reprimand, while the corresponding figures for the Medium- and Low-risk climate clusters are 7.5% and 4.6%, respectively. Similar patterns, albeit with less variation between the High-risk climate cluster and the other two, also emerge when it comes to *whether the pilots receive compensation if they report themselves UF* [ $\chi^2 (2)=12.164, p=.002$ ].



**Figure 6.** Management's actions to keep employees, and its interest in their health; answer frequencies in percent.



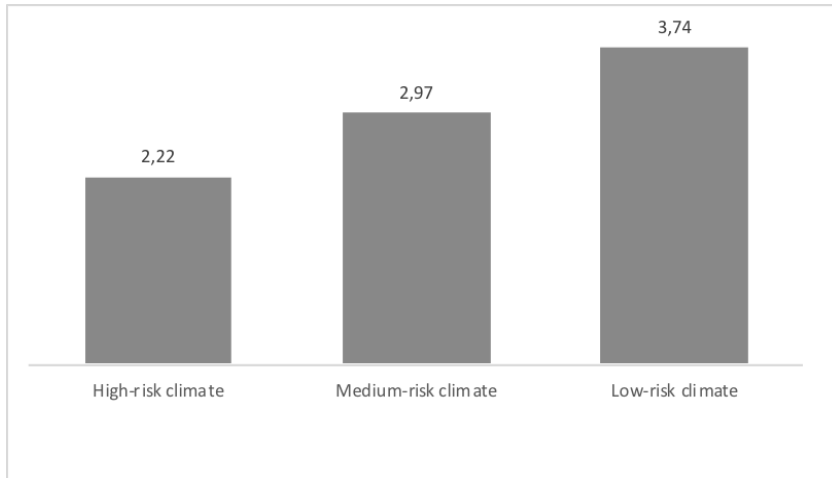
**Figure 7.** Reprimands and compensation for fatigue, Unfit for Flight (UF), and sick-listing; answer frequencies in percent.

Among the pilots in the High-risk climate cluster, 40.7% receive no compensation; the corresponding figures for the Low- and Medium-risk climate clusters are 27.4% and 30.2%, respectively. The pilots were also asked whether they receive compensation if they sick-list themselves, and the answers here resemble those to the question concerning compensation for UF. The differences between the clusters are statistically significant [ $\chi^2 (2)=27.487$ ,  $p=.0001$ ], with 38.2% of the pilots in the High-risk climate cluster not receiving any compensation while the corresponding figures for the Medium- and Low-risk climate clusters are 24% and 19.5%, respectively.

### *Psychosocial factors*

There are additional factors that play an important role in not only the occurrence of stress-related ill health but also the influence on safety. Whether employees feel they can voice their opinions and criticism, and experience that there is an openness in the organization, is one such central factor. In this respect, there are considerably great differences between the safety climate clusters. The *Silence* index contains questions addressing, for instance, whether the pilots avoid expressing critical viewpoints and whether they are listened to if they voice their opinions about the work environment and working conditions. In the entire study group, 61.7% say they are not listened to if they voice opinions about the work environment (do not completely agree/do not agree at all). Nearly a third (27.8%) say they avoid expressing critical viewpoints (mostly agree/completely agree), while an additional 28% agree somewhat with this statement. The differences between the clusters are

statistically significant [ $F(2, 1030)=381.771, P=.000$ ], with over half (54.6%) the pilots in the High-risk climate cluster mostly or completely agreeing that they avoid expressing critical viewpoints (an additional 27.1% agreed somewhat with this statement). In the Low-risk climate cluster 9.2% say they avoid expressing critical viewpoints (mostly/completely agree), while the corresponding figure for the Medium-risk climate cluster is 27.6%.



**Figure 8.** Silence index; mean values for questions about silence (five-point scale: 1=do not agree at all, 3=agree somewhat, 5=completely agree).

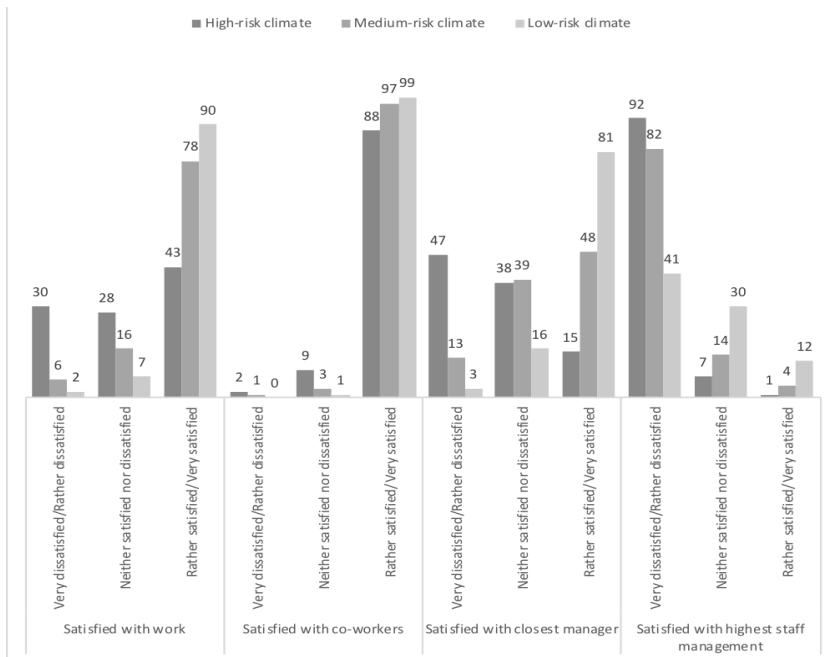
Similar questions were included in *Participation*, which addressed, among other things, whether the pilots have the possibility to influence important decisions concerning their work and whether they are encouraged to speak up when they are dissatisfied with decisions affecting their work. Here as well, the differences between the clusters are statistically significant [ $F(2, 1023)=172.716, P=.000$ ]. Yet again, it is the pilots in the High-risk climate cluster who have the worst conditions for participating. For example, 66.5% of the pilots in this cluster say they do not agree at all with the statement that they and their co-workers are encouraged to speak up if they are dissatisfied with decisions affecting their work, and an additional 23.1% say they mostly do not agree. In the Low-risk climate cluster 13.4% say they are not at all encouraged to speak up, while in the Medium-risk climate cluster this figure is 34.1%.

Things look much better when it comes to *social support* and *work satisfaction*. It should be noted, however, that there are great differences between the clusters even in these areas (Social support [ $F(2, 1032)=329.644, P=.000$ ], Work satisfaction [ $F(2, 1035)=424.531, P=.000$ ]). The mean values in the High-risk climate cluster are 2.31 (work satisfaction) and 2.62 (social support), which respectively correspond to the answer alternatives very poor



and rather poor. The mean values in the Low-risk climate cluster, on the other hand, are 3.78 (work satisfaction) and 3.80 (social support), which means that the pilots in this cluster feel these aspects are rather good.

When it comes to work satisfaction, however, it should be noted that there are great differences among the various sub-questions. In the entire study group, nearly three-fourths (73.9%) say they are rather or very satisfied with their work, and practically everyone (95.5%) say they are very satisfied with their co-workers. Just over half (51.1%) are rather or very satisfied with their closest manager/staff management, while only 12% are rather or very satisfied with the highest staff management. There are also considerable and statistically significant differences between the clusters for these questions. In the High-risk climate cluster only 42.7% of the pilots say they are satisfied or very satisfied with their work, compared to 90.1% of the pilots in the Low-risk climate cluster. It seems to be the worst when it comes to managers and the highest management: In the High-risk climate cluster only 1.6% say they are very satisfied with their closest manager/staff management (with another 13.5% saying they are rather satisfied), while among the pilots in the Low-risk climate cluster 37.5% are very satisfied with their closest manager/staff



**Figure 9.** Satisfaction with work, co-workers, managers and the highest staff management; answer frequencies in percent (rounded to whole percentages).

management (with another 43.7% saying they are rather satisfied). In the High-risk climate cluster, none (0%) of the pilots say they are very satisfied with the highest staff management (in the Low-risk climate cluster the corresponding figure is 6.7%). Instead, in the High-risk climate cluster 92.1% say they are rather or very dissatisfied with the highest staff management, while the corresponding figure for the Low-risk climate cluster is 40.9%.

## Health and safety climate

There are several factors in the pilots' working conditions that are worrying from a health and safety perspective. The results of this study show that there are great differences between the various safety climate clusters in how working conditions are perceived. The pilots in the cluster called High-risk climate experience their working conditions the overall worst, and pilots with such working conditions should thereby run the greatest risk of developing ill health. Based on the various aspects of health examined in this study, the results also consistently show that the pilots in the High-risk climate cluster feel the worst: they perceive themselves as having the worst health, are the least recovered, have the most stress-related problems (albeit to a rather low degree), and have the most work-related sleep problems. They also top the list when it comes to anxiety and depression. Although the levels here are also quite low, it must be regarded seriously that anxiety and depression occur at all even to this degree, and that there are such great differences between the different safety climate clusters.

As with the background factors reported earlier, such as gender, education and age, there are no statistically significant differences in health-related individual factors between the clusters. This supports the notion that it is mainly working conditions and factors on the organizational level, rather than individual factors, that determine the characteristics of the different clusters. For example, there are no statistically significant differences when it comes to whether the pilots *take medicine* [ $\chi^2(2)=2.840, P=.585$ ], *smoke* [ $\chi^2(2)=2.096, P=.351$ ] or *use snuff* [ $\chi^2(2)=3.263, P=.196$ ], or the degree to which they are *physically active* [ $F(2, 1011)=1.920, P=.147$ ].

### *Health and working ability*

Overall, the health of the pilots in this study can be regarded as relatively good. This is reasonable, seeing as this is a study group consisting of professionals. Regarding the question of how they *perceive their own health*, 83.3% say it is good or very good. Despite this, however, there are statistically significant differences between the various safety climate clusters [ $F(2, 1018)=18.451, P=.000$ ]. These differences reflect that the pilots in the High-risk climate cluster judge their health to be worse in comparison to those in the other two

clusters. In the High-risk climate cluster 73.3% report their health as good or very good, while the corresponding figure in the Low-risk climate cluster is 88.8%. When the pilots *rated their working ability* on a ten-point scale, the mean value for the entire study group was 8. Here, as well, there are statistically significant differences between all the clusters [F(2, 1015)=57.145, P=.000]. The pilots in the High-risk climate cluster rate their working ability the lowest, with a mean value of 7.49, while the mean values for the Medium- and Low-risk climate clusters are 7.90 and 8.59, respectively. For the question of whether the pilots have any *chronic illnesses* (e.g., migraines, high blood pressure, allergies), once again there are statistically significant differences between the clusters [ $\chi^2$  (2)=7.454, P=.024], but here it is the pilots in the Medium-risk climate cluster who report this to the greatest degree: just over a quarter (25.9%) of the pilots in this cluster have a chronic disease, while the corresponding figures for the High- and Low-risk climate clusters are 21.2% and 17.8%, respectively. In the entire study group, 22.3% of the pilots had some type of chronic disease.

**Table 7.** Self-rated health, working ability and chronic disease.

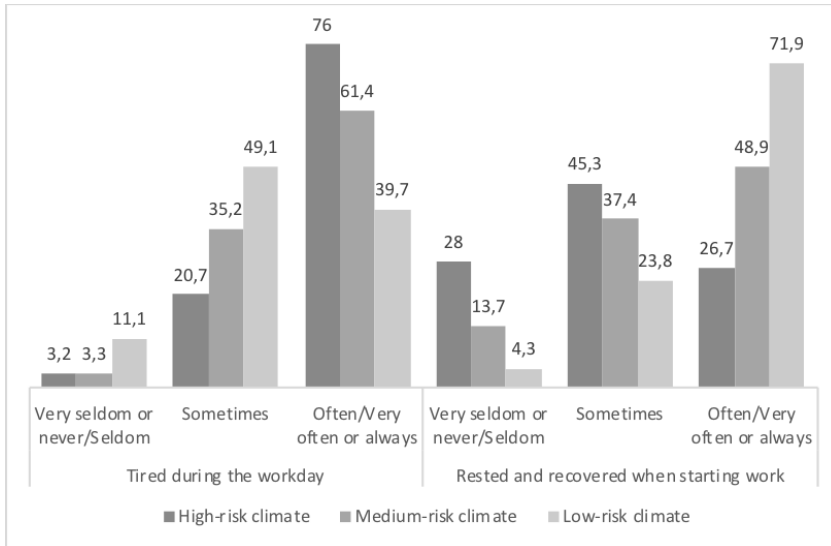
	High-risk climate	Medium-risk climate	Low-risk climate	Total	F
Percent with good general health	73.3	84.8	88.8	83.4	18.45 <sup>a</sup>
Working ability 1-10	7.49	7.9	8.59	8.04	57.15 <sup>a</sup>
Percent with chronic disease	21.1	25.9	17.8	22	3.74 <sup>b</sup>

a. =  $p \leq .001$

b. =  $p \leq .05$

### *Fatigue and recovery*

Regarding *fatigue and recovery*, the results of this study are greatly in line with what has been found in previous studies. A majority of the pilots are tired while working: more than half (57.4%) say they often, very often or always feel tired during the workday, and another 36.7% say they are sometimes tired during the workday. Half (50.3%) of the entire study group feel *rested and recovered when they start working*, reporting that this is the case often, very often or always. Regarding recovery and fatigue, there are also statistically significant differences between the clusters. When it comes to recovery, it emerges that the pilots in the High-risk climate cluster are the ones who perceive themselves to be the least recovered, while those in the Low-risk climate cluster are the most recovered [F(2, 994)=97.980, P=.000]. For example, only just over a quarter (26.7%) of the pilots in the High-risk climate cluster say they often, very often or always feel rested and recovered when starting work, while nearly three quarters (71.9%) of those in the Low-risk climate cluster report this. Also noteworthy is that 76% of the pilots in the High-risk climate cluster often, very



**Figure 10.** Recovery in the form of fatigue during the workday and recovery upon starting work; answer frequencies in percent.

often or always feel tired during the workday, while the corresponding figures for the Low- and Medium-risk climate clusters are 39.7% and 61.4%, respectively.

### *Stress-related problems*

Stress-related problems do not appear to be any greater issue for the pilots in this study. The mean value for *stress-related problems* for the entire study group is 1.96, which means they reported that they seldom or never have such problems. Yet, even here there are statistically significant differences between all clusters, with the most problems reported by the pilots in the High-risk climate cluster [ $F(2, 979)=68.871, P=.000$ ]. When the stress-related problems are divided into specific groups, such as pain, fatigue, and cognitive problems in the form of concentration and memory difficulties, the pattern remains the same as regards the differences between the clusters: here again it is the pilots in the High-risk climate cluster who report having the most pain, being the most tired, and experiencing the most cognitive problems (such as concentration and memory difficulties). Even though the mean values are generally low, the differences between all clusters are statistically significant. For instance, 37.6% of the pilots in the High-risk climate cluster say they have often, very often or always had problems with back pain in the past month, while the corresponding figures for the Low- and Medium-risk climate clusters

are 12.4% and 25.6%, respectively. A third (32.1%) of the pilots in the High-risk climate cluster also say they have often, very often or always had problems sleeping in the past month, while the corresponding figures for the Low- and Medium-risk climate clusters are 6.1% and 15.6%, respectively.

### *Psychological health*

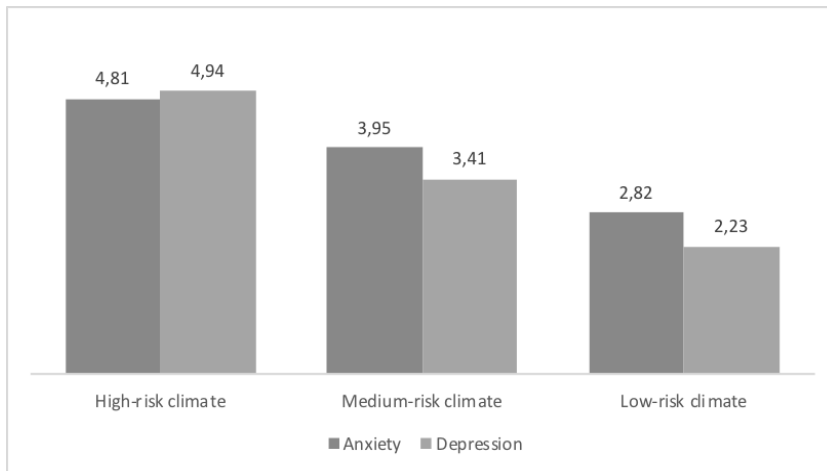
The survey also contained a number of questions addressing the pilots' psychological health. For the question of whether they *had ever seen signs of psychological ill health in any of their pilot colleagues that might affect flight security*, (e.g., mood changes or behaviors they were not accustomed to) there are statistically significant differences between all clusters [F(2, 1027)=46.297, P=.000]. In the High-risk climate cluster 18.1% of the pilots report having seen this in multiple colleagues and 59.3% have seen it in the occasional colleague, while the respective corresponding figures for the Low-risk climate cluster are 2% and 44.9%. It does not appear that *regular checkups of the pilots' psychological health* are conducted to any greater degree: in the entire study group, 95.6% say this is not done at the company where they work. The differences between the clusters are statistically significant here as well [ $\chi^2$  (2)=16.911, P=.000]. In the High-risk climate cluster 97.2% of the pilots report that it is not done at the company where they work, while the corresponding figures for the Medium- and Low-risk climate clusters are 97.7% and 91.9%, respectively.

In the High-risk climate cluster, nearly a quarter (22.9%) say they feel a slight or strong *reluctance concerning their work when they are on their way to their job*. Here, the differences between the clusters are considerable [F(2, 1016)=109.401, P=.000]. In the Low-risk climate cluster only 2.9% of the pilots report this, while the corresponding figure for the Medium-risk climate cluster is 8.1%. Additionally, in the Low-risk climate cluster 86.9% of the pilots report feeling happy and positive at the thought of the work ahead of them, while the corresponding figures for the High- and Medium-risk climate clusters are 40.8% and 66.1%, respectively. Health behaviors also differ between the clusters: to the question of whether they *drink alcohol in order to fall asleep when they have duty overnight*, 7.5% of the pilots in the High-risk climate cluster answer yes, while the corresponding figures for the Low- and Medium-risk climate clusters are 0.9% and 2.7%, respectively. The differences between all clusters are statistically significant [ $\chi^2$  (2)=20.140, P=.000]. In the entire study group, 3.2% say they usually drink alcohol in order to fall asleep when they have duty over night. The differences are also statistically significant when it comes to whether the pilots *take sleeping medication in order to fall asleep when they have duty over night* [ $\chi^2$  (2)=16.142, P=.000]. Among the pilots in the High-risk climate cluster 6.7% take sleeping medication, while

the corresponding figures for the Medium- and Low-risk climate clusters are 3.6% and 0.6%, respectively.

The survey also contained a self-rating instrument (HADS), which provides information on symptoms of anxiety and depression. Someone scoring 7 or lower on its subscales is considered not to have any anxiety or depression, while a score of 8-10 is regarded as borderline and can indicate a condition of anxiety or depression. Those scoring 11 or higher likely have clinical anxiety or depression. In this study 2.9% of the pilots scored 11 or higher on the depression scale and 3% scored 11 or higher on the anxiety scale, and thus likely suffer from clinical depression. Another 7.1% (depression) and 8.6% (anxiety) of the pilots are considered to be borderline cases, meaning an indication of a condition involving anxiety or depression.

The mean value for depression in the pilots is at almost the same level as for the general population in Sweden. This is somewhat unexpected, considering the selection process used in the hiring of pilots and the regular medical checkups that are to be conducted. In the entire study group, the mean value for anxiety was 3.77 and for depression 3.38. However, there were great and statistically significant differences between the clusters for both anxiety [ $F(2, 1008)=34.989, P=.000$ ] and depression [ $F(2, 1004)= 66.502, P=.000$ ]. For example, the pilots in the High-risk climate cluster show a mean value of 4.81 for anxiety while the corresponding figure for the Low-risk climate cluster is 2.82. The differences for depression are even greater: here, the mean value is 4.94 in the High-risk climate cluster and 2.23 in the Low-risk climate cluster.



**Figure 11.** Mean values for symptoms of anxiety and depression (Hospital Anxiety and Depression Scale).

Based on the existing threshold values, this means that 6.6% of the pilots in the High-risk climate cluster likely have clinical anxiety, while the corresponding figures are only 1.2% and 2.4% for the Low- and Medium-risk climate clusters. Another 15.6% of the pilots in the High-risk climate cluster are borderline cases; that is, their scores indicate the possible existence of anxiety. In the Low-risk climate cluster, 3.7% of the pilots are in this borderline area. When it comes to depression the values are similar: In the High-risk climate cluster 6.9% likely have clinical depression, while the corresponding figures for the Low- and Medium-risk climate clusters are 0.9% and 1.7%. Another 13.5% of the pilots in the High-risk climate cluster are borderline cases, while the corresponding figures for the Low- and Medium-risk climate clusters are 2.9% and 6.7%.

## Safety behaviors and incidents

Up to this point, in a number of important aspects the results have shown clear and statistically significant differences between the pilots in the different safety climate clusters as regards working conditions and health outcomes. The question is, what does it look like when it comes to outcomes in association with safety, and more specifically incidents, reporting and behaviors that affect flight safety? It turns out that the patterns from previous results are repeated here as well: the results for the High-risk climate cluster consistently indicate a significantly higher degree of risk behaviors and incidents compared to the other two clusters.

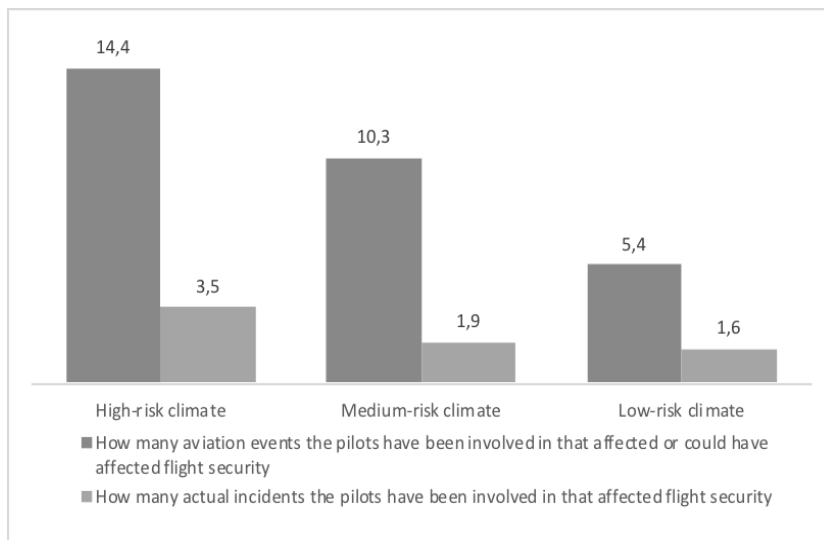
### *Incidents and reporting*

The reporting of aviation events and incidents is a customary way of measuring safety, and reports are often made both within the airline and to the Swedish Transport Agency. In previous studies, as well as from the authorities' side, it has been noted that there is likely a large number of unknown cases in the formal registers of reported events. Therefore, the survey contained an open question asking *how many aviation incidents the pilots had been involved in that had affected, or could have affected, flight safety*. In the entire study group, 14.2% had not been involved in any events at all; for the rest of the group, the mean value was 9.6 events. The differences between the clusters were great, however [ $F(2, 988)=8.070, P=.000$ ]. Among the pilots in the High-risk climate cluster the mean was 14.4 events, while the corresponding figures for the Low- and Medium-risk climate clusters were 5.4 and 10.3. When it comes to *actual incidents that affected flight security*, 40.4% in the entire study group had not been involved in any at all; the average for the rest of the group was 2.2 incidents. Even here, the differences are great between the High-risk and the other two climate clusters [ $F(2, 1004)=10.785, P=.000$ ]. The pilots in the High-

risk climate cluster had been involved in an average of 3.5 incidents, while the corresponding figures for the Medium- and Low-risk climate clusters are 1.9 and 1.6, respectively. Nearly two-thirds (72%) of the pilots in the entire study group reported these incidents, 17% only reported those that were somewhat more serious, and 11% did not report any of them. The differences between the Low- and High-risk climate clusters are statistically significant [ $F(2, 982)=3.335, P=.036$ ], with 78.5% of the pilots in the Low-risk climate cluster reporting all incidents but only 63.5% of those in the High-risk climate cluster doing so.

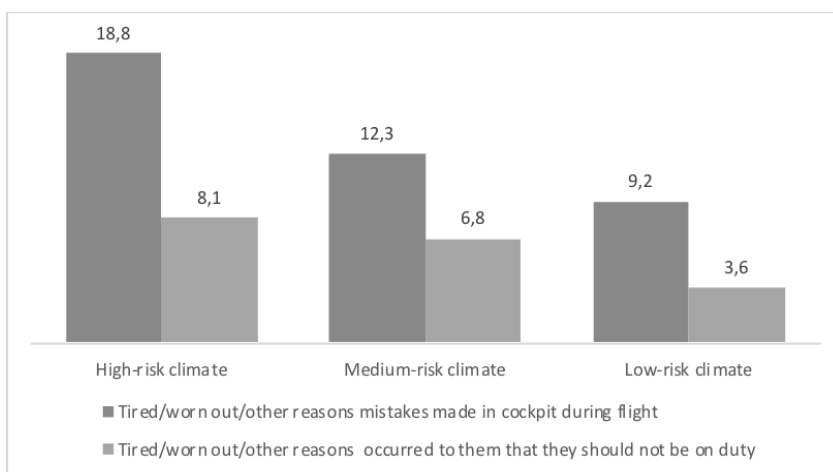
Three-fourths (75%) of all the pilots in the study said that in the past 12 months it had happened that they made a mistake in the cockpit while on duty because they had felt tired/worn out/unfit for other reasons. In line with this, 68% also reported that in the past 12 months it had happened that they felt tired/worn out/unfit for other reasons during a flight and it had occurred to them that they should not be on duty. On the other hand, only a quarter (25%) had reported themselves Unfit for Flight (UF) due to accumulated fatigue or for other reasons in the past 12 months, and 30% had called in sick because they were too tired/worn out/unfit for other reasons.

The differences between the safety climate clusters are great in these aspects as well. For instance, the pilots in the High-risk climate cluster had made mistakes in the cockpit while on duty an average of 19 times in the past 12 months because they had felt tired/worn out/unfit for other reasons, while this figure for the pilots in the Low-risk climate cluster was nine [ $F(2, 575)=11.206, P=.000$ ]. The results are similar when it comes to whether they in the



**Figure 12.** Number of aviation events and incidents; mean values; fatigue and mistakes.





**Figure 13.** Fatigue and safety; mean values in the various safety climate clusters.

past 12 months had felt tired/worn out/unfit for other reasons during a flight and it had occurred them that they should not be on duty [ $F(2, 574)=4.090$ ,  $P=.017$ ]. Among the pilots in the High-risk climate cluster this had happened an average of eight times, while the corresponding figure for the pilots in the Low-risk climate cluster was just under four (3.6).

There are also statistically significant differences in whether the pilots reported themselves as UF due to accumulated tiredness/fatigue/being unfit for other reasons [ $F(2, 261)=4.518$ ,  $P=.012$ ]. Those in the High-risk climate cluster had reported themselves as UF an average of just over twice (2.12) in the past 12 months, while those in the Low-risk climate cluster had done so an average of 1.4 times. Here it is worth noting that only 25% of all pilots had reported themselves as UF. Those in the High-risk climate cluster had *called in sick* due to being too tired/worn out/unfit for other reasons an average of 2.4 times in the past 12 months, while the corresponding figure for the Low-risk climate cluster was 1.6 times [ $F(2, 291)=6.585$ ,  $P=.002$ ]. There are also statistically significant differences between the clusters when it comes to whether the pilots had in the past 12 months *dozed off/fell asleep in the cockpit when this had not been agreed on with their FC/CO* [ $F(2, 328)=6.470$ ,  $P=.002$ ]. In the High-risk climate cluster this had happened an average of 8.5 times, and in the Low-risk climate cluster an average of 4.8 times. In the entire study group, 63% said this had never happened.

### *(Mis)judgements*

Another way to examine flight safety is to ask questions about pilots' behaviors, especially the relationship between their actual behavior and the

knowledge/desire regarding how a pilot should, and wants to, behave. In turn, this is dependent on what the working conditions, resources and incitements look like at an organization; that is, the existing conditions that allow one to behave in a certain way. In this respect, the conditions are fundamentally different for the pilots in the different safety climate clusters. The survey contained a question asking *how many times in the past 12 months it had happened that the pilots had begun a flight despite being too tired/worn out/unfit for other reasons*. In the entire study group this had happened an average of 3.7 times and, as before, there are statistically significant differences between the safety climate clusters [ $F(2, 1005)=17,197, P=.000$ ]. The pilots in the High-risk climate cluster had started a flight despite being too tired or unfit for other reasons an average of 5.8 times in the past 12 months, while those in the Low-risk climate cluster had done so an average of 1.9 times. The pilots were also asked *how many times in the past 12 months it had happened that they started a flight even though, considering their health status, they actually should have sick-listed themselves*. The average for all pilots for this question was 1.4 times, and here again there were statistically significant differences between the clusters [ $F(2, 1000)=39,441, P=.000$ ]. The average for the High-risk climate cluster was 2.4 times, while the corresponding figure for the Low-risk climate cluster was not even once (0.7).

## Discussion and conclusions

As regards the aim of examining pilots' perceptions of safety climate and describing how the safety climate relates to pilots' working conditions, health and safety behaviors, this study shows distinct and statistically significant differences between different safety climate clusters. Compared to pilots in the so-called Low- and Medium-risk climate clusters, those in the High-risk climate cluster consistently had worse working conditions, health and recovery; higher levels of anxiety and depression; more incidents and mistakes; and more dangerous safety behaviors. The differences were not only statistically significant but also surprisingly large. For example, just over a third of the pilots in the High-risk climate cluster said they risked being reprimanded if they sick-listed themselves due to fatigue, while the corresponding figure for pilots in the Low-risk climate cluster was only 4.6%. Another example concerns health; more specifically, the fact that 6.9% of the pilots in the High-risk climate cluster were within the threshold values for what can be regarded as clinical depression while the corresponding figure for pilots in the Low-risk climate cluster was only 0.9%.

The results also clearly show that the statistically significant differences that were noted between the clusters consistently and broadly exist beyond

individual-related factors. This means that the differences that emerged between various aspects of working conditions, health and safety behaviors among the various safety climate clusters lacked any consistent counterpart as regards factors at the individual level. There were thus no consistent, statistically significant differences when it came to gender, education, or health behaviors (smoking, using snuff, physical activity). The differences that did emerge concerned age, number of years in the occupation and number of flight hours, and were rather in the opposite direction than what might have been expected. This meant that more experienced and older pilots could be found in the High-risk climate cluster. This could naturally be interpreted as reflecting a greater awareness of safety issues among older pilots with more flight hours than among their younger colleagues with fewer flight hours and years in the occupation. Similarly, older pilots could also have different points of comparison and, by having held more jobs, also remember and be able to relate to how things used to be in the airline industry. Nonetheless, the results make a contribution by offering a depiction of commercial pilots' working conditions that is both nuanced and clear. The great differences between the different safety climate clusters when it comes to perceived working conditions and self-rated health give an indication that the conditions for safe flight work can look very different for pilots.

Taken together the results are worrying in many respects, for instance when it comes to pilots' working conditions, health and flight safety. In some cases, the results are striking; for example, employers breaking the rules regulating flight personnel's working time and rest periods, as reported by the pilots, should not occur at all, and the fact that a large proportion (nearly two-thirds) of the pilots are in the High-risk climate cluster is disquieting.

It is also troubling that a third of the pilots in the High-risk climate cluster say they would be reprimanded if they sick-listed themselves or reported themselves as "Unfit" due to fatigue. A highly central risk factor for flight safety that clearly emerges in the results concerns precisely silence, fear of reprimand, and a lack of communication. In a number of studies on operations in the public sector in Sweden, it is shown that the possibility to express views and criticism has decreased (Astvik et al., 2013; Aronsson & Bejerot 2014). Research shows that there are types of control in the form of norms, values and incitements that result in "silent" workplaces, where neither the employees nor managers are allowed to, have the possibility to, or dare voice criticism or report shortcomings that have significance for operations. Similar results were found here concerning the pilots: in the entire study group, 61.7% said they are not listened to if they express viewpoints about the working environment, and nearly a third said they avoid expressing critical viewpoints. In the High-risk climate cluster, these figures were even higher.

For a good flight safety climate, it is crucial that there is good communication, as well as conditions for the sensible reporting of incidents so that employees have the possibility to act and make decisions without the fear of guilt or being regarded as difficult or disloyal. A good safety climate is characterized by, among other things, higher management and immediate managers prioritizing – and acting to address – risk factors concerning health-related problems, taking seriously the signals they receive from employees regarding problems, and having routines for detecting such problem signals. It is clear that the pilots in this study do not perceive that this happens in their organizations. Regarding the statement “Management is interested in the employees’ health and well-being”, only 9% in the entire study group say they agree completely or mostly. The pilots also do not perceive that management’s actions reflect that they wish to keep their employees; here, only 7.6% agree mostly or completely. In the High-risk climate cluster, no one (0%) agrees that management is interested in the employees’ health and well-being. The results also show significant problems when it comes to questions about how satisfied the pilots are with the highest management: nearly two-thirds of the pilots in the entire study group are very or rather dissatisfied in this regard.

The great differences between the safety climate clusters as regards the pilots’ safety behaviors give an indication that the safety climate and working conditions are related to the pilots’ possibilities to act in a safe way. When it comes to the various aspects of safety outcomes that were analyzed, the pilots in the High-risk climate cluster had an average of twice as many – or even more – aviation events, incidents, mistakes in the cockpit, thoughts that they should not be on duty, occasions when they had dozed off without this having been agreed on, and times they had begun a flight despite being too tired, ill or unfit for other reasons. It is important to point out that, although it is the pilots’ individual safety behaviors that are measured here, it is the conditions of the work and the climate in which the individuals form their understanding of the work that must receive attention and be changed in order to improve flight safety. Safety climate concerns how the norms, values, policy work and behaviors that characterize an organization are perceived (Dollard & Bakker, 2010). This means that it is these aspects that need to be made visible in order to then be subjected to critical evaluation. This is also a way to depart from the individualization of risk in the form of, for instance, a certain individual’s psychological ill health being highlighted as the greatest risk factor in an organization’s safety work. While the plane crash in the French Alps, for example, had immediate consequences in the form of new rules and routines for pilots’ work in the cockpit, recurring and relatively alarming reports about pilots’ worsened working conditions and increased fatigue/ill health have gone unnoticed, and measures for addressing this situation are still lacking.

Pilots' psychological health should naturally be taken very seriously. There is comprehensive and well established knowledge about which factors in the psychosocial work environment and organization carry an increased risk of psychological ill health. The results of this study show that commercial pilots' work environment includes many of the factors associated with an increased risk of anxiety, depression, and stress-related ill health. These results are in line with previous research on pilots and depression, which shows that pilots as a group are susceptible to psychological ill health to the same degree as the general public, despite the medical checkups pilots undergo. This study, however, contributes to further highlighting the great differences in pilots' psychological health depending on what type of working conditions and safety climate they perceive they work in. It is noteworthy that, among the pilots in the High-risk climate cluster, there were more individuals within the threshold values for clinical depression (6.6%) than in the general population in Sweden (6%); another 13.5% are borderline. Among the pilots in the Low-risk climate cluster, however, the occurrence of depression is very low; here, only 1.2% are within the threshold values for clinical depression. This can be viewed in relation to a recently published study on pilots' psychological health (Wu et al., 2016), in which as much as 13.5% of the pilots in the study group were found to be within the threshold values for what is judged to correspond to clinical depression.

When it comes to the reliability of the results of this study, they generally tend to be somewhat distorted in a positive direction, as regards not only health outcomes but also working conditions and safety behaviors. The reasons for this "satisfaction bias" are connected to, among other things, the fact that a large proportion of the respondents were permanently employed, and that it was only possible to contact pilots with a Swedish license. This meant that pilots in Sweden who for various reasons had a license from other countries were not included. In a previous study, the so-called Ghent study (Jorens et al., 2015), it was found that pilots without permanent employment were those who had the worst working conditions and possibilities to make safety-related decisions.

While a cross-sectional study like this does not have the possibility to draw conclusions regarding the direction of associations, and a certain caution is thus necessary when it comes to the conclusions that can be drawn concerning causal links, the results nonetheless give a relevant and clear picture of the associations between how safety climate is perceived and self-reported working conditions, health, and flight safety among commercial pilots. The results show distinct variations between the different safety climate clusters when it comes to the pilots' working conditions, health, and safety behaviors. As concerns research, the study offers a good starting point and clear direction for continued analyses and research. As further steps there are good

possibilities to expand and deepen the knowledge regarding what factors carry the greatest risk for pilots' ill health and for flight safety. One important question, for example, concerns the relationship between pilots' working conditions, the occurrence of depression, and flight safety, whereby it is urgent that it be made clear what factors increase the risk of depression but also the degree to which there is an association between depression and safety behaviors. The distribution of pilots in the different clusters, as well as the great differences between the clusters as regards working conditions, health, and safety behaviors, also provides new knowledge that is of practical relevance. With a starting point in this study it will be possible, for example, for airlines to examine which type of safety climate characterizes their organization and relate this to the risks and possibilities for continued organizational development work. From a practical safety and work-environment perspective, the study thereby reveals a number of concrete conditions that are possible to change.

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