Association of Total Flight Hours and Health Conditions with Sick Leave Use Among Civilian Pilots

Bok-Soon Han; Eun-Hi Choi; Min-Seong Kim

INTRODUCTION: In-flight medical incapacitation jeopardizes flight safety. To reduce such breakdown episodes, airlines have implemented a sick leave system. This study aimed to examine the association of total flight hours and health status with sick leave use among civilian pilots in South Korea and to identify the demand for a health promotion program.

METHODS: For data collection, an online survey was conducted between August–November 2018, involving pilots of nine civil airlines in South Korea. A total of 456 pilots responded, of which data from 6 were excluded due to missing items; 450 pilots were included in the final analysis. The SPSS WIN 26.0 software was used for analysis, and a logistic regression analysis was performed.

RESULTS: The factors influencing sick leave were 7.39 times higher in the case of 1000–4999 h of total flight time than in the case of less than 1000 h, and 2.19 times higher for those with pre-existing conditions than for those without.

DISCUSSION: Future research is needed to focus on the relationship between sick leave use and chronic diseases and between sick leave use and health-promoting behaviors among pilots. In addition, health promotion programs may be more effective if they are tailored to the job characteristics of pilots. Furthermore, counseling and education programs regarding the numerous harms of high-risk drinking must be strengthened. This may include emphasizing the negative effects of drinking on flight safety and personal health.

KEYWORDS: pilot, sick leave, health promotion, flight safety, airline.

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In April 2016, an Easter Jet copilot lost consciousness in the cockpit while preparing to depart from Phuket, Thailand, to Incheon International Airport. At that time, the copilot's total flight time was 2980 h, and there had been no previous reports of any medical conditions. The International Civil Aviation Organization defines in-flight medical incapacitation as a state in which medical fitness is reduced to the extent that flight safety is at risk.[1] Furthermore, it implies incidents occurring in the critical phase in which the pilot is incapable of performing their flight duties.

Although incidences of in-flight medical incapacitation are extremely rare (0.19–0.45 times per 1 million flight hours),[2] it can greatly compromise aviation safety and lead to fatal accidents. Between 2010–2014, there were 4 cases of in-flight medical incapacitation where normal operations were completed and 11 cases where there were interruptions to aviation safety. These interruptions resulted in three cases of terrain collision, two cases of diversion, two cases of return, two cases of airspace infringement, and two case of preventive descent or landing.[3] The mental and physical health of pilots is one of the major human factors in aircraft accidents. Therefore, appropriate aviation-related health promotion activities for pilots should be performed to reduce medical risks threatening flight safety.

The main causes of in-flight medical incapacitation include cardiovascular, neurologic,[4] gastrointestinal, otorhinolaryngological, laser strikes,[5] and psychiatric.[6] Health risk factors include fatigue,[7] disturbance of the circadian rhythm due to

From the Kangbuk Samsung Hospital, Sungkyunkwan University School of Medicine, Jongno-gu, Seoul, Republic of Korea.

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Address correspondence to: Prof. Eun-Hi Choi, 712, Dongil-ro, Uijeongbu-si, Gyeonggi-do 11759, Republic of Korea; imague0@naver.com.

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shift work, long flight hours,[8] and work stress.[7] In addition, other health risk factors such as smoking, excessive alcohol consumption, lack of exercise, and limited healthy food options should also be considered. Based on the present findings,[9] aviation health researchers should further examine targeted, cost-effective interventions to promote healthy lifestyles, which can reduce the risk of in-flight medical incapacitation.

Aviation medical examination is an important system in terms of flight safety, as, beyond determining the pilot's suitability for flight, it enables the early detection and early treatment of any disease. However, this examination is insufficient for preventing medical problems or even promoting health.[10] Accordingly, the International Civil Aviation Organization enacted regulations to make aviation-related health promotion compulsory in November 2015. It recommended the implementation of appropriate aviation-related health promotion strategies for license holders subject to a medical assessment, in order to reduce future medical risks to flight safety. This initiative aims to improve flight safety levels by preventing or delaying the onset of diseases that threaten flight safety through health promotion activities. While most pilots maintain good health practices, this initiative can encourage those who do not consistently engage in health promotion activities to adopt healthier habits.

Such activities promote health by improving health awareness or lifestyle. It is well-established that maintaining a healthy lifestyle through practices such as smoking cessation, engagement in regular physical activities, reduction of alcohol consumption, and adequate rest can prevent or delay the onset of physical or mental disease.[11] However, considering pilots' working conditions, such as irregular flight schedules, jet lag, overnight flights, and long flights, it is not easy for them to regularly engage in health promotion activities on their own.

Furthermore, although pilots' health promotion is an important aspect of flight safety, there is a paucity of research on related matters in South Korea. Hence, this study aims to determine the association of factors related to pilots' working conditions and personal health with sick leave use. The study also seeks to identify the need for programs that can promote pilot health and support safe flight operations. The hypotheses of the study are as follows: 1) pilots' working conditions are associated with sick leave use and 2) pilots' health status is associated with sick leave use.

METHODS

Subjects

The study was approved by the Institutional Review Board of E University (EUN21-021). Each subject provided written informed consent before participating. Subjects were informed about their right to withdraw from the study at any time without any consequences. Data were anonymized, and only aggregated results were used for analysis. The target population for this study comprised 6065 active pilots working for 9 civil airlines in South Korea. All the pilots from these nine civil airlines were invited to participate and were convenience-sampled from the overall population. The exclusion criteria were: 1) pilots currently on leave or retired in South Korea and 2) those employed by a foreign airline not based in South Korea and making only transit stops in South Korea.

Procedure

The research team visited all the nine airline companies and held a briefing session with the managers responsible for operation and health management, in which they outlined the purpose of the study and the survey. Consent was obtained from each airline. Subsequently, instructions for the online survey and the survey platform were distributed to the pilots through the airlines. In addition, the study's purpose and confidentiality procedures were explained to the subjects. The self-administered survey took approximately 20 min to complete. Data were collected from August–November 2018. The study design is presented in **Fig. 1**.

Although 456 pilots initially responded to the survey, 6 were excluded owing to missing responses. Finally, the responses of 450 pilots were considered for analysis. There was a sufficient number of samples, as the minimum sample size required for regression analysis was 194 subjects. This value was calculated using the G*Power 3.1.9.4 program set to median effect size 0.15, significance level 0.05, statistical power 0.95, and predictor variable 14.

The subjects' general characteristics included sex, age, and marital status. Their job-related characteristics included rank (i.e., pilot or copilot), total flight time, and whether they were carrying out normal duties. The total flight time was calculated from the time when the pilot joined the airline until the time of the survey and was categorized as follows: under 1000 h; 1000 h to under 5000 h; 5000 h to under 10,000 h; and 10,000 h or more. Normal duty was defined as normal working in the past 3 mo, and the subjects responded either "yes" or "no" to the questions.

Health-related factors were classified into health behaviors and health problems. Health behaviors included smoking, alcohol consumption, and physical activity. The subjects were asked about their cigarette and e-cigarette smoking experiences. According to the standards outlined in the Korean National

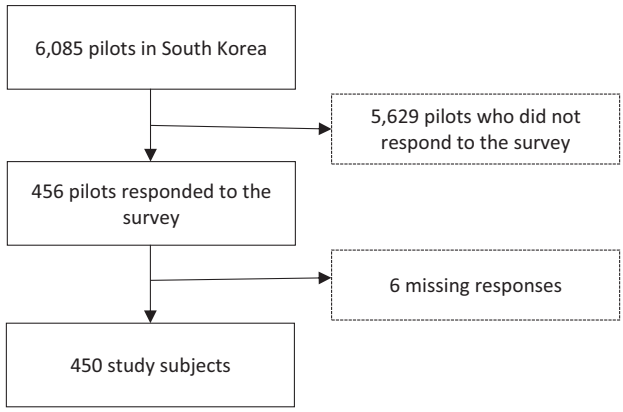

Fig. 1. Research model.

Health Examination, alcohol consumption is "high-risk" if an individual engages in either excessive or binge drinking behavior. Excessive drinking refers to consuming more than 14 standard drinks in a week, while binge drinking refers to consuming more than 4 standard drinks in one sitting. The subjects were also asked about their time spent performing high-intensity or moderate-intensity physical activities in a week: 150 min or more was considered as meeting the standard recommendation for physical activity, while less than 150 min was considered insufficient but not indicative of complete inactivity.

Regarding health problems, the subjects responded either "yes" or "no" to the question, "Have you ever received a diagnosis by a physician for a health condition?" If "yes," the subject was asked to provide the name of the condition under the "type of health condition." Responses to the question on participation in a health promotion program, "Have you ever taken part in a health promotion program?" included "yes" or "no."

Sick leave was defined as a situation in which an individual was not able to fulfill flight duties owing to health reasons. The subjects were asked the question, "How many days of sick leave did you take in the past year due to a health issue?" The response was "yes" if the subject had taken one or more days of sick leave and "no" if the subject had taken no sick leave.

Information on the types of health promotion programs the subjects had participated in was collected through the question, "What types of health promotion programs have you taken part in?" For this question, the subjects were asked to identify all types of programs they had attended. Reasons for nonparticipation in health promotion activities were framed through the question, "What has prevented you from practicing healthy lifestyle habits (i.e., smoking cessation, reduced alcohol consumption, and regular physical activity)?" The subjects could select up to three answers. To identify the types of health promotion programs the subjects felt they needed, we asked the question, "What type(s) of health promotion program(s) do you think is (are) necessary?" The subjects were asked to select up to three answers. To understand the support needs for applying to a health promotion program, the subjects were asked to select one answer to the question, "What do you think is the most important factor in implementing a pilot health promotion program?"

Statistical Analysis

This study used the SPSS WIN 26.0 software for data analysis. The subjects' characteristics were analyzed using descriptive statistics, and a Chi-squared test was performed on the occurrence of sick leave based on the subjects' characteristics. A logistic regression analysis was performed on the factors influencing subjects' sick leave. The logistic regression model was then verified using the Hosmer-Lemeshow test. This test verified the presence or absence of a significant difference between the prediction model and the data. Ideally, there should not be any difference.

The demand for health promotion programs was not included in the logistic regression analysis. Rather, only a frequency analysis was performed. Responses pertaining to demand were analyzed using a multiple response analysis, as the answers contained multiple responses. The response rate was set as 100%.

RESULTS

The general and job-related characteristics of the subjects are presented in **Table I**. The mean age was 43.4 yr; 19.6% of the subjects were single, while 80.4% were married. Regarding rank, 49.8% of the subjects were pilots. The subjects' mean total flight time was 5919.2 h. Of the participants, 427 (94.9%) worked normal workdays over the past 3 mo, while 23 (5.1%) did not. Of these 23 participants, 6 took sick leave, 11 were in training, and 6 had other reasons for not working normal working days.

Based on the responses, 22.0% of the subjects were current smokers, 69.1% engaged in high-risk alcohol consumption, and 78.7% engaged in standard physical activity. Moreover, 11.8% had a health condition, of which 27.9% had dyslipidemia, 20.6% had hypertension, 16.2% had a sleep disorder, 10.3% had cancer, 7.4% had diabetes, and 17.7% responded as "other."

Regarding participation in the health promotion program provided by the airline, 12.9% of the respondents reported having participated. This program is available to pilots employed by the airline. Further, 28.4% took sick leave in the past year, for an average duration of 3.6 d; of the reasons for taking sick leave, 33.5% were for the common cold, followed by 17.1% for digestive disease, and 14.6% for ENT disease, such as otitis media.

The differences in sick leave based on subject characteristics are displayed in **Table II**. Factors demonstrating statistical significance for sick leave were age ($\chi^2 = 8.466$, $P = 0.037$), rank ($\chi^2 = 5.994$, $P = 0.014$), and total flight time ($\chi^2 = 28.848$, $P < 0.001$).

The results of the logistic regression analysis for identifying the factors influencing sick leave are provided in **Table III**. The −2 log-wood of the logistic regression model was 483.744, while the Cox and Snell R^2 was 0.103, and the Nagelkerke R^2 was 0.148. The Hosmer-Lemeshow value was $\chi^2 = 8.243$ ($P = 0.410$), indicating that there was no difference between the data and the prediction model. Normal work was treated as a control variable.

Factors influencing sick leave were 7.39 times higher in the case of 1000–4999 h than in the case of less than 1000 h of total flight time ($P < 0.001$), and they were 2.19 times higher in the case of disease than in the presence of a health condition ($P = 0.023$).

The types of health promotion programs that the subjects had participated in, types of programs needed, and reasons for nonparticipation in health promotion behavior were analyzed as multiple responses (see **Table IV**). The types of health promotion programs the subjects had taken part in were as follows: improvements in diet (21.1%), exercise management (16.8%), and overweight management (13.7%). The types of health promotion programs needed, ranked in the order of importance, were exercise management (17.0%), sleep management (16.8%), and improvements in diet (12.3%). The reasons subjects could

Table I. Characteristics of the Subjects ($N = 450$).

CHARACTERISTICS	*N* (%)
Gender	
Male	441(98.0)
Female	9(2.0)
Age (yr)	
≤39	180(40.0)
40–49	164(36.4)
50–59	75(16.7)
≥60	31(6.9)
Mean ± SD†	43.4 ± 8.8
Marital status	
Single	88(19.6)
Married	362(80.4)
Rank	
Pilot	224(49.8)
Copilot	226(50.2)
Total flight time (h)	
<1000	46(10.2)
1000–4999	188(41.8)
5000–9999	129(28.7)
≥10,000	87(19.3)
Mean ± SD†	5919.2 ± 5035.4
Ability to perform normal duties	
Yes	427(94.9)
No	23(5.1)
Current smoking status	
Smoker	99(22.0)
Nonsmoker	351(78.0)
History of smoking e-cigarette(s)	
Yes	120(26.3)
No	330(73.7)
High-risk alcohol consumption	
Yes	311(69.1)
No	139(30.9)
Physical activity	
Adequate	354(78.7)
Inadequate	96(21.3)
Pre-existing health condition(s)	
No	395(87.8)
Yes	53(11.8)
Type of pre-existing health condition(s)*	
Dyslipidemia	19(27.9)
Hypertension	14(20.6)
Sleep disorder	11(16.2)
Cancer	7(10.3)
Diabetes	5(7.4)
Other	12(17.7)
Participation in a health promotion program	
Yes	58(12.9)
No	392(87.1)
Sick leave	
No	322(71.6)
Yes	128(28.4)
Mean ± SD†	3.6 ± 16.4
Reason for sick leave*	
Common cold	53(33.5)
Digestive symptom(s)	27(17.1)
ENT-related symptom(s)	23(14.6)
Musculoskeletal disorder	16(10.1)
Accidental fracture	11(7.0)
Infections except the common cold	7(4.4)
Cancer	5(3.2)
Hypertension, stroke	2(1.3)
Sleep disorder	2(1.3)
Other	12(7.6)

*Responses of "yes" were set to 100% and processed as multiple responses; †Mean ± SD

not participate in health promotion activities included heavy workload (19.9%), lack of motivation (17.9%), stress (14.9%), and shift work (13.2%). The needs identified for the successful implementation of health promotion projects were financial support from the airline (28.2%), improved awareness (20.4%), and strengthened legal basis (18.7%).

DISCUSSION

This study aimed to determine the association of pilots' working conditions and health status with sick leave use, thereby contributing to improved pilot health and safe flight operations. It was found that 28.4% of subjects had taken one or more sick leaves in the past year. A previous study reported that 12.9% of pilots of one airline took sick leaves,[12] which was lower than that observed in this study. This discrepancy may have arisen from the use of different sample sizes; while the previous study considered only one airline in Korea, the current study involved pilots from nine civil airlines across South Korea. The causes of sick leave included the common cold, gastrointestinal diseases such as enteritis, and infectious diseases such as herpes zoster. Existing literature has reported that the cabin environment and long flights can influence the incidence of infections.[13] Additionally, many aircrew members continue to fly when sick, which may further contribute to the spread of infections. This highlights the importance of addressing sick leave utilization among aircrew members. The next most frequently observed health conditions among pilots were ENT diseases such as otitis media, which is supported by previous research that found common medical problems in flight attendants and pilots.[14] The treatment period for otitis media usually lasts for 8.23 d; therefore, it is essential for pilots to undergo sufficient treatment before returning to resume their flight duties.[13] Existing literature identified syncope, chronic gastritis, and herniated discs as health conditions associated with longer sick leaves.[15] In this study, conditions such as musculoskeletal disorder, cancer, and stroke were also observed, as well as chronic fatigue under the option "other."

Regarding the subjects' health behavior, 22.0% were current smokers and 21.3% had inadequate physical activity. Considering that most subjects were men, the rate of smoking was low while that of physical activity was high compared to the national smoking (36.7%) and physical activity rates (51.0%) in Korea.[16] The same study also reported high rates of e-cigarette use; however, it is difficult to compare the findings with the results of this study as data on pilots' current use of e-cigarettes were not collected. In addition, the smoking rate of Korean pilots in this study was higher than that of U.S. adults (reported to be 19.0% in a previous study),[17] which is perceived as a cultural difference. The rate of high-risk alcohol consumption among the subjects (69.1%) was also relatively high compared to the 2018 national rate of high-risk alcohol consumption among Korean men (20.8%).[16] Previous research also found that the health status of flight attendants was better than that of other groups; however, their rate of excessive drinking was higher.[18]

Table II. Differences in Sick Leave Based on Subject Characteristics (*N* = 450).

CHARACTERISTICS	CATEGORIES	SICK LEAVE		χ^2	*P*
		NO	YES		
Gender	Male	318(72.1)	123(27.9)	3.316	0.069
	Female	4(44.4)	5(55.6)		
Age (yr)	≤39	116(64.4)	64(35.6)	8.466	0.037
	40–49	123(75.0)	41(25.0)		
	50–59	57(76.0)	18(24.0)		
	≥60	26(83.9)	5(16.1)		
Marital status	Single	59(67.0)	29(33.0)	1.093	0.293
	Married	263(72.7)	99(27.3)		
Rank	Pilot	172(76.8)	52(23.2)	5.994	0.014
	Copilot	150(66.4)	76(33.6)		
Total flight time (h)	<1000	41(89.1)	5(10.9)	28.848	<0.001
	1000–4999	110(58.5)	78(41.5)		
	5000–9999	102(79.1)	27(20.9)		
	≥10,000	69(79.3)	18(20.7)		
Current smoking status	Smoker	75(75.8)	24(24.2)	1.101	0.294
	Nonsmoker	247(70.4)	104(29.6)		
High-risk alcohol consumption	Yes	227(73.0)	84(27.0)	1.018	0.313
	No	95(68.3)	44(31.7)		
Physical activity	Adequate	252(71.2)	102(28.8)	0.111	0.739
	Inadequate	70(72.9)	26(27.1)		
Pre-existing health condition	Yes	33(62.3)	20(37.7)	2.747	0.097
	No	289(73.2)	106(26.8)		
Participation in health promotion program	Yes	39(67.2)	19(32.8)	0.609	0.435
	No	283(72.2)	109(27.8)		

In particular, despite the high prevalence of smoking and high-risk drinking, there was little demand for smoking cessation and alcohol reduction programs. This is interesting because even though smoking cessation and moderation are commonly targeted in health promotion programs, the pilots did not perceive these program outcomes as important. This perception may impact the effectiveness and focus of health promotion strategies. Although pilots tend to engage in healthy lifestyle habits equally or more than other groups, there is a need to identify their hidden high-risk behaviors. High-risk alcohol consumption is highly associated with stress and depression,[19] although leisure time is often spent drinking with colleagues or friends.[20] In other words, high-risk alcohol consumption is considered socially acceptable as a means to relieve stress; however, such behaviors are also highly associated with diminished health-related quality of life in pilots.[21] Future research should investigate the cultural factors that shape these behaviors and how they can be incorporated into more effective health promotion interventions for pilots.

In this study, a factor affecting sick leave was a total flight time of between 1000–4999 h, whose impact was 7.39 times greater than that of a total flight time of under 1000 h. There is a paucity of research on the relationship between flight time and sick leave. New pilots with less than 1000 flight hours may have less opportunity to use sick leave because they have not accumulated much sick leave, or they may be more cautious about using sick leave because they are more likely to be on probation. On the other hand, pilots with between 1000–5000 flight hours may have had the time to accumulate sick leave after 1–2 yr of employment, have the leeway to use sick leave to

Table III. Factors Influencing Sick Leave (*N* = 450).

CHARACTERISTICS		OR*	95% CI†	*P*
Gender (ref = male)		3.24	0.68–15.31	0.139
Age (ref = ≥60)	≤39	3.01	0.74–12.31	0.126
	40–49	1.84	0.50–6.73	0.360
	50–59	1.72	0.52–5.65	0.374
Marital status (ref = married)		1.31	0.71–2.42	0.394
Rank (ref = copilot)		1.30	0.62–2.71	0.486
Total flight time (ref = <1000)	1000–4999	7.39	2.56–21.31	<0.001
	5000–9999	2.93	0.78–11.07	0.112
	≥10,000	3.03	0.66–13.99	0.155
Current smoking status (ref = nonsmoker)	Yes	0.77	0.44–1.34	0.354
High-risk alcohol consumption (ref = no)	Yes	0.84	0.52–1.36	0.479
Physical activity (ref = adequate)	Inadequate	0.87	0.50–1.52	0.615
Pre-existing health condition (ref = no)	Yes	2.19	1.11–4.30	0.023
Participation in health promotion program (ref = yes)	Yes	1.26	0.65–2.44	0.500

Normal work treated as a control variable; *odds ratio; †confidence interval.

Table IV. Subjects' Participation in and Demand for Health Promotion Programs ($N = 450$).

CHARACTERISTICS	CATEGORIES	*N* (%)
Participation in health promotion program(s) (Multiple responses [a])	Improved diet	20(21.1)
	Exercise management	16(16.8)
	Obesity management	13(13.7)
	Management of metabolic syndrome	12(12.6)
	Management of job stress	12(12.6)
	Sleep management	6(6.3)
	Management of cerebrovascular disease	5(5.3)
	Reduced alcohol consumption	4(4.2)
	Other	7(7.4)
	Have already been participating	105(9.3)
Necessary health promotion program (Multiple responses [a])	Physical activity	230(17.0)
	Sleep management	227(16.8)
	Improved diet	166(12.3)
	Management of job stress	141(10.4)
	Obesity	93(6.9)
	Smoking cessation	73(5.4)
	Metabolic syndrome	66(4.9)
	Management of digestive health	63(4.7)
	Management of mental health	61(4.7)
	Reduced alcohol consumption	32(2.4)
	No need, not sure	118(8.7)
Reasons for nonparticipation in health promotion activities (Multiple responses [a])	High workload	224(19.9)
	Lack of motivation	202(17.9)
	Stress	168(14.9)
	Shift work	149(13.2)
	Parenting and domestic tasks	112(9.9)
	Time spent commuting to and from work	90(8.0)
	No need	67(5.9)
	Other	11(1.0)
Items necessary for a successful implementation of health promotion projects	Financial support from airline	127(28.2)
	Improved awareness	92(20.4)
	Strengthened legal basis	84(18.7)
	Pilot participation	77(17.1)
	Strengthened connection with the local community	25(5.6)
	Other	45(10.0)

[a]Response rate set to 100% for multiple response analysis.

treat previously untreated health problems, and feel more comfortable using sick leave as they become more accustomed to working for an airline. Nevertheless, owing to reports linking longer flight times to increased fatigue, sleep disorders, mental health problems,[22] and susceptibility to obstructive sleep apnea during daytime sleep after night flights,[23] it is often assumed that pilots with long total flight times mainly operate large aircrafts at night and engage in long-haul operations. However, the study by Venus and Holforth reported that short-haul pilots experienced more issues in these areas than long-haul pilots.[22] This underscores the importance of understanding the different health challenges associated with short- and long-haul flights and implementing tailored health management interventions to effectively address these specific needs. However, a total flight time of 5000 h or more did not seem to influence sick leave, which may be a limitation attributed to the cross-sectional design of this study. This is because pilots on sick leave or those permanently grounded for medical reasons were not included in this study, which may present as a limitation of the healthy worker effect. Indeed, a follow-up study on pilots who have lost their licenses for medical reasons may be needed in the future.

In this study, health behavior was not associated with sick leave. However, previous studies have demonstrated the impact of health behaviors on absenteeism. For instance, smoking led to a 2.89 times higher rate of absence,[24] while high-risk alcohol consumption was also found to have a significant impact on absence.[25] At a workplace, the absences are generally classified as sick leaves—it must be noted that health problems and sick leaves are regarded as the same in pilots' medical assessments. Such a phenomenon can be explained by the findings of this study, which revealed a 2.19 times greater likelihood of taking sick leave among pilots with a health condition compared to those without. This means that, although there was no direct correlation in previous research between health problems and sick leave, smoking and high-risk alcohol consumption influenced absence in individuals without pre-existing health conditions. Although these studies highlight the relationship between health behaviors and absenteeism, there is currently no research specifically addressing the impact of health behaviors on sick leave or absenteeism within the aviation industry. Therefore, follow-up research is needed to explore the relationship between pilots' health behavior and absenteeism rates. The type of pre-existing diseases also had an impact on the number of days of sick leave. Dyslipidemia

and hypertension were identified as causes of an increased rate of absence in previous studies,[26] while sleep disorders were reported to affect workplace safety due to drowsiness during work hours.[27] Therefore, there is a need to develop and implement health interventions to manage sick leave.

In this study, 12.9% of pilots responded that they had taken part in a health promotion program. Furthermore, there were discrepancies in the health promotion programs the subjects had attended and those they believed were needed. According to previous research, the reasons for nonparticipation in health promotion included irregular flight schedule, lack of motivation, and lack of time to participate.[28] Similar results were revealed in this study, in which workload, lack of motivation, stress, and shift work were identified as reasons for neglecting health promotion activities. Pilots face a variety of health risks such as disturbance of the circadian rhythm, flight fatigue, and stress. Moreover, working overnight shifts can lead to increase saturated fat intake,[26] smoking,[29] and overdrinking.[18] Furthermore, although more active engagement in health promotion activities is needed with an increase in age, there is a shortage of health promotion programs dedicated to older staff, and those available are said to be of low quality. Therefore, it is essential to develop and enhance health promotion programs specifically tailored for older pilots and improve their overall quality to better meet their needs.

Limitations of this study include a lower-than-expected response rate, despite efforts to encourage participation, and the excluded pilots who dropped out owing to health-related factors, which may limit the generalizability of the results. Furthermore, as the survey was conducted online, it is likely that individuals who were already interested in health were keener on participating. In addition, this study is cross-sectional, which does not allow clear causal statements to be made, and inferences from the results should be drawn with caution. Although this study identified associations between chronic medical conditions and sick leave, it does not directly support the conclusion that health promotion programs will necessarily improve these outcomes or enhance aviation safety. Further, the survey revealed that some pilots were engaging in risky drinking and had high smoking rates. Additionally, the participants reported the need for sleep management, nutrition, and exercise programs. Therefore, while this study explores the relationship between health-related factors and pilots' use of sick leave, it contributes to the broader understanding of aviation health. The findings may also serve as preliminary data for developing strategies to improve pilots' health. Future research should focus on modeling the relationships between health behaviors, work conditions, health issues, and absenteeism.

Based on the above research results, first, it is necessary to intensively study the relationship between chronic diseases of pilots and sick leave use, as well as the relationship between sick leave use and health promotion behaviors, in the future. Second, the development of health promotion programs tailored to the characteristics of pilots' work is recommended. Despite the implementation of an existing health promotion program, no significant effect was observed on the pilots' use of sick leave. This may be because the content of the health promotion program and its method of delivery may not be sufficiently sound or attractive, resulting in low participation rates among the pilots. Third, despite the high prevalence of high-risk drinking in this study, the demand for health promotion programs to reduce drinking was low. This highlights the need for increased counseling and education programs regarding the harms of high-risk drinking. This could include emphasizing the negative effects of drinking on flight safety and personal health.

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Authors and Affiliations: Bok-Soon Han, M.D., Ph.D., Department of Occupational and Environmental Medicine, Kangbuk Samsung Hospital, Sungkyunkwan University School of Medicine, Jongno-gu Seoul; Eun-Hi Choi, College of Nursing, Eulji University, Uijeongbu-si, Gyeonggi-do; and Min-Seong Kim, Asan Medical Center, Songpa District, Seoul, Republic of Korea.

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