ORIGINAL ARTICLE

FIELD TRIAL OF TIMED BRIGHT LIGHT EXPOSURE FOR JET LAG AMONG AIRLINE CABIN CREW

Tuuli Lahti1, Jukka Terttunen2, Sami Leppämäki1,3, Jouko Lönnqvist1,4, Timo Partonen1

1 National Public Health Institute, Department of Mental Health and Alcohol Research, FI-00300, Helsinki, Finland
2 Finnair Health Services, HEL-IH/67, FI-01053 Finnair, Finland
3 Helsinki University Central Hospital, Department of Psychiatry, P.O.Box 442, FI-00029 HUS, Finland
4 University of Helsinki, Department of Psychiatry, P.O. Box 22, FI-00014 University of Helsinki, Finland
tuuli.lahti@ktl.fi

Received 19 February 2007; Accepted 24 August 2007

ABSTRACT

Objectives. Commercial airlines’ flight crew members on transmeridian long-haul flights are constantly exposed to rapid changes in external time. Following rapid changes in circadian rhythm may lead to several symptoms known as jet lag. Our aim was to alleviate jet-lag symptoms by timed exposure to bright light (natural sunlight if present, otherwise artificial bright light).

Study design. Observational field trial with bright light against jet lag.

Methods. Information on the effects of bright lights on health was delivered through corporate level wellness programs. Volunteer study subjects were cabin crew members on long-haul flights. Subjects filled in a 16-Item Columbia Jet Lag Scale (maximum score 64) before the flight (expected symptoms based on previous flights), on the third day at the destination and again on the third day after returning home. Changes in scores were compared relative to the timed exposure to bright light, and to flights eastwards or westwards, and in summer or winter.

Results. Out of 75 subjects, 15 returned the questionnaires for a total of 28 flights. The mean estimated effect of bright light was a decrease of 5.3 points on the symptom scale. The difference was not significant (SE=3.4, df=11, t=−1.6, p=0.15). The flight had no influence on the estimate.

Conclusions. The results do not give support to the hypothesis that timed exposure to bright light would alleviate jet lag symptoms, although the small sample size was a problem. More field studies are needed to establish the feasibility of bright light for reducing jet lag.

(Int J Circumpolar Health 2007; 66(4):365-369)

Keywords: flight crew, cabin crew, jet lag, circadian clock, desynchronization, phototherapy, shift work
INTRODUCTION

Rapid crossings of time zones desynchronize the internal clock from external time cues. Most individuals react to this with a variety of symptoms, collectively known as jet lag. This kind of disturbance of the circadian system is known to impair both physical and psychological health (1). Common symptoms of jet lag include sleepiness, decreased daytime alertness and gastrointestinal problems (2–4). Since the sleep-wake cycle is very sensitive to changes, sleep problems are one of the most severe symptoms (5).

The duration of jet lag depends on the number of time zones crossed and the direction of the travel. Eastward travelling requires a phase advance while travelling west causes a phase delay. Westward travelling does not cause as bad jet lag symptoms as eastward travelling because the circadian clock has a natural tendency to a phase delay (6,7).

A recent research on experimental animals (8) showed that the advancing of the light cycle (as when travelling eastward) can cause even the death of aged experimental animals. No significant amount of deaths was observed with younger animals. In that study, delayers (as when travelling westward) fared much better than the advancers. These findings cannot be directly applied to humans. According to airlines’ occupational health units’ observations, the principle adaptations to shift work (and coping with jet lag) occur during the first year in the profession. There is no clear evidence that aging would automatically increase jet lag symptoms, especially among cabin crew members as a group, although individual situations differ significantly.

Light exposure is the most potent time-giver for the circadian system. It is also a safe non-pharmacologic antidepressant (9). Scheduled exposures of bright light may alleviate the symptoms of jet lag by accelerating the adjustment to a new time zone (2,10,11). Simulated jet lag studies in laboratory conditions have shown modest beneficial effects of light exposure, but field studies on the subject are sparse and their results inconsistent (12).

The aim of this study was to test the feasibility and effectiveness of a light exposure protocol to reduce jet lag in overseas cabin crew members on flights eastwards or westwards.

MATERIAL AND METHODS

Study participants were recruited through the Finnair personnel wellness program by Finnair Health Services (the airline’s integrated occupational health unit). Information on bright light’s (natural or artificial) affects on health, circadian rhythm, mood (including seasonal affective disorder SAD), alertness and shift work was delivered to all airline personnel and also, to some extent, to passengers through internal and external web and media networks.

Seventy-five cabin crew members out of approximately 500 flying continuously long-haul flights volunteered for the study and gave written informed consent. There were 62 women and 13 men, mean (SD) age 38.8 (8.3) years; range 25 to 56.

All subjects first filled in the Seasonal Pattern Assessment Questionnaire (SPAQ) (13), the RAND 36-Item Health Survey (14) and a 26-item questionnaire on general health habits (exercise, smoking, consumption of alcohol).
The study protocol required a one-way flight over at least 3 time zones, and a minimum stopover of 3 days at the destination. The timing of the light exposure was intended to achieve rapid resynchronization of the internal clock. Instructions were printed on separate leaflets for each of the 8 destination cities (west of Helsinki: San Francisco, Bangor, New York; east of Helsinki: Bangkok, Singapore, Beijing, Osaka, Tokyo) and delivered to the subjects. Portable bright light devices with two 55-W cool white fluorescent lamps (Philips Ltd., Eindhoven, The Netherlands) were used to produce bright light of 5000 lx at eye level while indoors. The light units were situated in the cabin crew briefing area (Finnair Flight Crew Centre, Helsinki-Vantaa Airport, Finland), in the flight crew hotels (overseas destination airports) and in the participants’ homes. When the sun was shining, subjects could alternatively spend time outdoors according to the instructions.

Before the flight, the subjects were asked if they had experienced disturbing symptoms on previous long-haul flights and to assess how disturbing they were. Their jet lag symptoms were assessed with a modified 16-Item Columbia Jet Lag Scale (15), scoring from 0 (none) to 4 (extremely disturbing). The Jet Lag Scale was filled in for the second time on the third day after the return flight back home. The main outcome was the change in the total scores on the Jet Lag Scale.

Statistical analyses
Means were compared with one-way analysis of variance (ANOVA), with light as the between-groups factor. A linear mixed-effects model for repeated measures data (LME) was used for the intervention effect analysis (16). The LME takes into account the intra-individual correlation between measurements by treating each subject as a separate cluster in modeling. The use of light was introduced into the model as a fixed effect. The treatment effect was controlled for the pre-intervention score, direction of flight (east/west), season (summer/winter), and subject characteristics (sex, age, seasonality, BMI, health habits).

Data were screened and analysed with S-Plus 2000 for Windows (Professional Release 1, Mathsoft, Inc.). The ethics committee of the National Public Health Institution approved the study protocol.

RESULTS
Two letters to all 75 study volunteers were sent from Finnair Health Services encouraging them to complete the study. Unfortunately, only 15 subjects returned all the questionnaires, for a total of 28 flights; the mean (SD) age of the 14 women and 1 man was 42.3(9.6) years, range 25 to 56.

Their BMI, scores on the SPAQ and RAND and self-reported smoking habits, consumption of alcoholic beverages and frequency of physical exercise were all comparable to those who volunteered for the study but failed to complete it.

Of the 28 flights, 12 were eastward, 16 westward. Subjects had used light after 20 flights; 23 flights were in the summer and 5 were in the winter.

The ANOVAs are presented in Table I. All comparisons were compromised by the size of the intervention groups. The Jet Lag Scores were significantly lower after the use of light
Bright light and jet lag

(\(p=0.04\)). However, after controlling (LME) for the pre-flight score, the estimated effect of light on the Jet Lag Score was a decrease of 5.3 points, and the difference from the no light condition was not significant (SE=3.4, df=11, \(t=-1.6, p=0.15\)). Controlling for direction of flight, time of year and the background variables did not change the estimate.

**Table I. Mean (95% CI) Jet Lag Scores according to the Columbia Jet Lag Score (15).**

| Use of light | Expected symptoms | Symptoms after flight | Difference in scores |
|-------------|-------------------|----------------------|---------------------|
| yes         | 22.4 (16.7 to 28.0) | 12.7 (8.6 to 16.8) * | -9.7 (-15.0 to –4.3) |
| no          | 24.0 (19.6 to 28.4) | 20.1 (14.5 to 25.8) | -3.9 (-10.5 to 2.8) |
| Season      |                   |                      |                     |
| summer      | 25.0 (20.8 to 29.1) * | 15.7 (12.1 to 19.3) | -9.3 (-14.1 to –4.4) |
| winter      | 13.0 (11.12 to 24.9) | 10.8 (0 to 24.2) | -2.2 (-11.5 to 7.1) |
| Direction of flight |       |                      |                     |
| eastwards   | 20.8 (15.9 to 25.7) | 15.4 (9.2 to 21.7) | -5.4 (-10.0 to –0.9) |
| westwards   | 24.3 (17.8 to 30.8) | 14.4 (9.9 to 18.8) | -9.9 (-16.8 to –3.1) |

* \(p<0.05\)

**DISCUSSION**

In the present study, timed light exposure was not effective in alleviating symptoms of jet lag in real-life situations. This negative finding could be a consequence of the fact that air crew members have most probably became accustomed to transmeridian flights. The disappointingly low response rate limited the power of the statistical analysis, which might have caused a significant effect to be missed. However, the bright light devices were used by most of the study volunteers. It is possible that those who failed to return the questionnaires were less motivated, or felt there was insufficient benefit from the light exposure for the effort of following the study protocol. This could have caused positive bias in the results.

The generalization of the results is limited first by the small sample size, second by the preponderance of women (93%) and third by many years of adaptation to flight work. The interests of both genders in participating in the study seemed equal (approximately 90% of cabin crew members are female). Women are usually considered to be more aware of health issues and pay more attention to their well-being. Our study hints that women may experience the symptoms of jet lag as being more stressful than do men.

Another limitation of the study is that physical activity was not considered as a variable. Outdoor exercise has been found to have some effects in hastening the resynchronization of the internal clock (17). However, in humans, light has a stronger influence than exercise, although a combination of the two may have enhanced efficacy (18). The third limitation of our study was that the main outcome measure was calculated as the difference in the ratings of the usual (in retrospect) and current (as actual) symptoms. This may have resulted in some degree of recall bias, as people may have exaggerated the magnitude of symptoms they were experiencing.
Conclusions

The present study does not provide conclusive support for the hypothesis that light reduces symptoms of jet lag. Further field studies are needed to establish more practicable ways of administering light, possibly in conjunction with physical exercise.

Acknowledgements

The authors would like to thank the personnel at the Finnair Health Services, Finnair Cabin Operations, Finnair Cargo and Finnair Ground Operations for technical help, and Jari Haukka, Ph.D., for statistical advice. Philips DAP provided the light devices used in the study.

REFERENCES

1. Winget CM, DeRoshia CW, Markley CL, Holley DC. A review of human physiological and performance changes associated with desynchronosis of biological rhythms. Aviat Space Environ Med 1984;55:1085–1096.
2. Boulos Z, Campbell SS, Lewy AJ, Terman M, Dijk DJ, Eastman CI. Light treatment for sleep disorders: consensus report. VI. Jet lag. J Biol Rhythms 1995;10:167–176.
3. Cho K, Ennaceur A, Cole JC, Suh CK. Chronic jet lag produces cognitive deficits. J Neurosci 2000;20:RC66(1–5).
4. Waterhouse J, Edwards B, Nevill A, Atkinson G, Reilly T, Davies P, Godfrey R. Do subjective symptoms predict our perception of jet-lag? Ergonomics 2000;43:1514–1527.
5. Haimov I, Arendt J. The prevention and treatment of jet lag. Sleep Med Rev 1999;3:229–240.
6. Aschoff J, Hoffmann K, Pohl H, Weber R. Re-entrainment of circadian rhythms after phase-shifts of the Zeitgeber. Chronobiologia 1975;2:23–78.
7. Czeisler CA, Duffy JF, Shanahan TL, Brown EN, Mitchell JF, Rimmer DW, Ronda JM, Silva EJ, Allan JS, Emens JS, Dijk DJ, Kronauer RE. Stability, precision, and near-24-hour period of the human circadian pacemaker. Science 1999;284:2177–2181.
8. Davidson AJ, Sellix MT, Daniel J, Yamazaki S, Manker M, Block GD. Chronic jet-lag increases mortality in aged mice. Curr Biol 2006;16:R914–916.
9. Postolache TT, Oren DA. Circadian phase shifting, alerting, and antidepressant effects of bright light treatment. Clin Sports Med 2005;24:381–413.
10. Parry BL. Jet lag: minimizing its effects with critically timed bright light and melatonin administration. J Mol Microbiol Biotechnol 2002;4:463–466.
11. Kelly TL, Kripke DF, Hayduk R, Ryman D, Pasche B, Barbault A. Bright light and LEET effects on circadian rhythms, sleep and cognitive performance. Stress Med 1997;13:251–258.
12. Samel A, Wegmann HM. Bright light: a countermeasure for jet lag? Chronobiol Int 1997;14:173–183.
13. Rosenthal NE, Genhart MJ, Sack DA, Skwerer RG, Wehr TA. Seasonal affective disorder and its relevance for the understanding and treatment of bulimia. In: Hudson JL, Pope HG, editors. The Psychobiology of Bulimia. Washington, DC: American Psychiatric Press; 1987. p. 205–228.
14. Hays RD, Sherbourne CD, Mazel RM. The RAND 36-Item Health Survey 1.0. Health Econ 1993;2:217–227.
15. Spitzer RL, Terman M, Williams JB, Terman JS, Malt UF, Singer F, Lewy AJ. Jet lag: clinical features, validation of a new syndrome-specific scale, and lack of response to melatonin in a randomized, double-blind trial. Am J Psychiatry 1999;156:1392–1396.
16. Lindstrom MJ, Bates DM, Newton-Raphson and EM algorithms for linear mixed-effects models for repeated-measures data. J Am Stat Assoc 1988;83:1014–1022.
17. Atkinson G, Edwards B, Reilly T, Waterhouse J. Exercise as a synchroniser of human circadian rhythms: an update and discussion of the methodological problems. Eur J Appl Physiol 2007;99:331–341.
18. Leppämäki S, Partonen T, Lönnqvist J. Bright-light exposure combined with physical exercise elevates mood. J Affect Disord 2002;72:139–144.

Tuuli Lahti, B.Sc.
National Public Health Institute, Department of Mental Health and Alcohol Research
Mannerheimintie 166,
FI-00300 Helsinki, FINLAND
Email: tuuli.lahti@ktl.fi