PSYCHOLOGICAL ASPECTS OF PROLONGED HEAD-DOWN BED REST IN HEALTHY MALE SUBJECTS

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Abstract

The aim of the study was to examine the effects of head-down bed rest on psychological well-being in young healthy subjects.

Head-down tilting bed rest (BR) is a well-accepted method by which to simulate an acute stage of human adaptation to the microgravity in space flights and also an important model to study consequences of physical inactivity and sedentarism on human body. The subject participating in the study were ten healthy males aged between 20 and 30 who were exposed to a 35-day strict rest in hospital environment. The participants were asked to complete psychometrical inventories – General Health Questionnaire, Satisfaction with Life Scale, State Anxiety Inventory, Center for Epidemiological Studies Depression Scale and Emotional States Questionnaire – on before and after the BR experiment.

There were no significant differences in examined psychological variables between pre and post BR period. Research results do not show any adverse effects of a prolonged physical inactivity on perception of health and psychological well-being of selected group of subjects.

The importance of this research was to provide evidence that the provision of favourable habitability countermeasures can prevent deterioration in the psychological state under conditions of physical immobilisation. Our findings applied value in the field of health prevention and rehabilitaion.

Research of psychological and cognitive aspects within bed rest studies deserves special attention and consideration in the future. Psychic balance and emotional strength have undoubtedly an important role in reducing the consequences of physical impairment and physiological changes due to prolonged bed rest.

Keywords: physical inactivity, bed rest, psychological well-being, young healthy individuals

Introduction

Different contemporary studies are confirming that regular physical activity have an important role in the maintenance and enhancement of mental health (Fox, 2000; Landers & Arent, 2007; Salmon, 2001). Although the causality is not clear, the pattern of evidence suggests the theory that exercise training recruits a process which confers enduring resilience to stress.

Research establishing the effects of total physical inactivity on the mental state and feelings of individuals is practically non-existent. It is difficult to induce and monitor total physical inactivity in everyday life. An example of an experimental situation where such a state can be established is simulated weightlessness or *bed rest* (BR) study, which presupposes strict rest in a lying-down position and is today one of the methods most commonly used to monitor the consequences of long-term physical inactivity.

World literature that addresses the psychological aspects of adaptation to a prolonged period of rest in the lying-down position discusses horizontal bed rest (HBR) experiments and 6-degree head-down tilt bed rest (HDT) experiments. In comparison to the HBR, the HDT appears more appropriate, considering that simulation of this type speeds up all processes in human organism and comes closest to

matching the conditions of weightlessness occuring during space missions (Hyeteok et al., 2003; Iwase et al., 2004).

DeRoshia and Greenleaf (1993) have studied cognitive functions and mood state during a 30-day HDT in eighteen healthy male subjects. The participants completed psychological tests and questionnaires (ten cognitive tests and eight scales – six relating to mood and two to sleep) before, during and after the BR period. Although a trend of mild decrease in the values of the measured parameters was established during the experiment, the authors conclude that mood and performance did not deteriorate in response to prolonged BR. Shehab, Schlegel, Schiflett & Eddy (1998) studied the effects of a 17-day HDT on cognitive performance in eight male volunteers with the application of the NASA Performance Assessment Workstation test battery which was initially developed for the purpose of studying mental functions during space flights. The test battery uses six performance tasks to assess directed and divided attention, spatial, mathematical, and memory skills, and tracking ability. No statistically significant differences in performance were observed when comparing BR with control period.

Ishizaki, Fukuoka, Katsura et al. (1994) evaluated the effect of immobilization during BR on the mental health of nine young subjects (six male and three female) before, during and after 20 days HBR. The psychological state was repeatedly assessed by measuring their depression status (Self-Rating Depression Scale) and neurotic symptoms (Cornell Medical Index and General Health Questionnaire). Although no influence of BR on Cornell Medical Index was seen, Self-Rating Depression Scale and General Health Questionnaire displayed a tendency to development of depression and neurotic symptoms, respectively. This tendency had disappeared two months after the BR study.

In a more recent study, Ishizaki, Ishizaki, Fukuoka et al.(2002) evaluated changes of mood status and depressive and neurotic levels in nine healthy male subjects aged 18–28 during a 20-day HDT. Depressive and neurotic levels were enhanced, mood state "vigor" was impaired and "confusion" was increased during BR compared to pre-BR and ambulatory control periods, whereas the mood "tension-anxiety", depression-dejection", "anger-hostility" and "fatigue" were relatively stable during experiment.

Styf, Hutchinson, Carlsson & Hargens (2001) investigated back pain, mood state, and depression in six subjects, all of whom were exposed to microgravity, simulated by two form of BR, for 3 days. One form consisted of bed rest with 6 degrees of head-down (HDT) and balanced traction, and the other consisted of horizontal bed rest (HBR). Subjects had a 2-week period of recovery between the experiments. They experienced significantly more intense lower back pain, lower abdominal pain, headache, and leg pain during HDT. They had also more depressive symptoms and poorer mood status during HDT compared to HBR.

A recent study examined the effect of acute simulated microgravity on nocturnal sleep, daytime vigilance, and psychomotor performance. Seven subjects were maintained for 3 days of head-down and horizontal bed rest in a counter-balanced design. Results suggest that nocturnal sleep, daytime vigilance, and psychophysiological functions were not disturbed in head-down conditions, although there was a mild deterioration of higher attentional function in the morning (Komada, Inoue & Mizuno, 2006).

Event though it would be difficult to determine the exact cause of psychological change of subjects, we can offer some possible explanations. Extreme and prolonged confinement to bed and immobility resulting from simulated weightlessness might contribute to psychological changes reflected in tension, greater stress, and also alteration of mood status and behaviour. Another factor that plays an important role is isolation from familiar environment and adaptation to experimental conditions.

Also cardiovascular and skeletal-muscle changes due to the microgravity simulated by BR might induce headache, back pain, sleep disturbances, and other problems (Kume, 1997) which could affect the psychological well-being of an individual (e.g. greater depression levels and poorer mood status).

The objective of the study was to evaluate the effects of a 35-day head down bed rest on psychological well-being in young healthy subjects.

Applied method

Participants

Ten male subjects aged 20–30 (23.4 ± 2.2 years; mean ± standard deviation) volunteered to participate in the "Bed Rest – Valdoltra 2008". The study was conducted in July and August 2008 at the Orthopaedic Hospital Valdoltra, Slovenia. Screening medical examinations documented that the subjects were healthy. The purpose and procedure of the study were explained before the experiment. Written informed consent was obtained from all participants. The National Committee for Medical Ethics at the Ministry of Health, Slovenia approved the experimental procedure.

Experimental protocol

A 35-day bed rest was carried out in a strictly 6-degree head down position reflecting total physical inactivity. Subjects performed all daily activities lying down. Physical activity was strictly forbidden throughout the experiment. Subjects were under constant video surveillance and provided with 24-hour medical care. Three times a week they received physiotherapy, which included passive exercise of the joints and gentle neck and back massage. During this time, subjects were allowed to read, watch TV, listen to music, and use computers and the Internet.

The participants were asked to complete psychological inventories during the pre-BR period (5 days before the experiment) and on day 35 of BR (after the experiment).

Psychological instruments

- *The General Health Questionnaire* (GHQ-12; Goldberg & Hiller, 1979) is a measure of current mental health. The Slovenian version of the questionnaire consists of 13 questions relating to the recent feelings and experiences of the individual. The participant responds on a scale from 1 (not at all) to 5 (much more than usual). The overall result is the sum of all the answers. A high score indicates the presence of neurotic symptoms (e.g. the individual has problems sleeping, finds it hard to concentrate on his work, feels under pressure, cannot overcome difficulties, is unhappy, irritable and depressed, has lost self-confidence in himself and his abilities, etc.)
- *Center for Epidemiological Studies-Depression Scale* (CES-D; Radloff, 1977) is designed to measure depressive symptoms in the general population (i.e., nonpsychiatric persons older than 18). The 20-item self-administered scale measures the major components of depressive symptomatology, including depressive mood, feelings of guilt and worthlessness, psychomotor retardation, loss of appetite, and sleep disturbance. The CESD is scored by summing the ratings for the 20 items. Each item is rated on a 4-point scale ranging from 0 to 3. The maximum total score is 60. A score of 16 or higher indicates and elevated level of depression symptoms. It was found to have very high internal consistency and adequate test-retest repeatability. Validity was established by patterns of correlations with other self-report measures, by correlations with clinical ratings of depression, and by relationships with other variables that support its construct validity.
- *Satisfaction with Life Scale* (SWLS; Diener et al., 1985) is among the various components of subjective well-being focused on measuring the cognitive aspect of satisfaction with life. The result on the scale can be labelled as the individual's global assessment of quality of life with regard to personal criteria (the feeling that life has been and is good, that the current stage of life or life in general is full, meaningful and pleasant). The scale contains five statements to which the participant responds using a 7-point scale (1 – strongly disagree, 7 – strongly agree). The internal reliability of the original scale is 0.86 and of the Slovenian version 0.85.
- *Emotional States Questionnaire* (ESQ; Lamovec, 1988) was used to assess the mood status. The individual responds on a 4-point scale from "none at all" to "extreme" in accordance with his current mood. The items comprise six emotional states: depression, contentment, agression, indifference, positive and negative self-concept.
- *State-Trait Anxiety Inventory* (Spielberger, 1983) provides a reliable measure of both temporary and dispositional anxiety in adults. For the purpose of the study, we have included

only the part of the instrument that relates to state anxiety and allows the identification of temporary emotional state of individuals. The scale contains 20 items. Subjects are asked to evaluate how they feel "right now, at this moment", on a four-point scale (1 – not at all, 2 – sometimes, 3 – moderately so, 4 – very much so). Scores range from 20 to 80, with higher scores indicating greater level of anxiety. The instrument is frequently used for studying anxiety in research settings.

Statistic analysis

The data was analysed with the software package SPSS 14.0 for Windows. The paired semples t-test was used to determine differences in studied psychological variables before and after the BR experiment.

Results

The mean (M), standard deviation (SD) and paired t-tests of the studied variables scores are shown in Table 1. No significant difference was seen in SWLS, CES-D, STAI and ESQ scales (depression, contentment, agression, indifference, positive and negative self-concept) comparing the pre-BR with post-BR period. There is a tendency to increasing of neurotic levels according to the GHQ, although the difference is not statistically significant (P=0.073).

Table 1: Differences in studied psychological variables before and after BR period

	Before BR ***M ± SD***	***After BR*** ***M ± SD***	***t (df=9)***	***P***
GHQ – neurotic level	15.50 ± 3.31	19.30 ± 4.48	-2.03	0.073
SWLS – satisfaction with life	23.50 ± 7.26	22.00 ± 8.89	1.31	0.224
CES-D – depression	24.56 ± 5.36	28.56 ± 8.84	-1.65	0.138
STAI – anxiety	27.89 ± 6.77	31.33 ± 11.33	-0.90	0.393
ESQ – depression	13.30 ± 2.97	17.20 ± 2.99	0.48	0.642
ESQ – contentment	28.30 ± 6.36	26.20 ± 6.88	1.39	0.197
ESQ – agression	11.90 ± 1.29	11.70 ± 1.06	0.38	0.716
ESQ – indifference	9.00 ± 3.71	8.60 ± 3.83	0.65	0.534
ESQ – positive self-concept	17.70 ± 2.63	15.30 ± 3.68	1.80	0.106
ESQ – negative self-concept	6.50 ± 0.97	6.60 ± 0.84	-0.56	0.591

Discussion

To evaluate the effects of complete physical inactivity during a 35-day bed rest on psychological state and well-being in young male subjects, we conducted a survey including different psychometrical inventories.

On the basis of the results, we found that the mood status, state anxiety level, reported satisfaction with life and perceived depressive sympotoms did not change after a prolonged period of total physical inactivity. During the experiment there was an increase in average neurotic symptoms values, although the difference between pre and post BR period was not significant. Even after the period of physical immobilisation, however, the expression of these symptoms remains relatively low and does not represent a risk to the mental health of the subjects.

Our results are inconsistent with the majority of findings that report mood impairments and increased values of depressive and neurotic experience after BR period (Ishizaki et al., 2002; Styf et al., 2001).

The discussed previous BR studies were carried out under extremely strict experimental conditions where, in addition to the conditions of simulated weightlessness (i.e. physical immobility and confinement), researchers tried to recreate the conditions of extreme social isolation and seclusion similar to those experienced by astronauts on space missions. Participants were exposed to limited social contacts between subjects and the exterior environment, meaning that the subjects spent the majority of the BR days without seeing visitors. Lack of social contacts and isolation from familiar environment are expected to contribute greatly to the psychological changes occuring during the period of prolonged BR.

The higher degree of subject adaptability to the conditions in our study was attributed to the selection of subjects with optimal characteristics for adaptation to confinement and restricted mobility and to the highly favourable environmental habitability factors in our study relative to previous studies. These habitability factors included maintenance of a stimulating environment, the possibility to use various media (TV, radio, computer and Internet), acess to communications with friends and relatives, and absence of stuff/subject conflicts.

Our results suggest that favourable living conditions and the possibility of social interaction during a period of total physical inactivity represent a kind of safeguard against an impairment of mental state, or, in other words, that they mitigate the negative effects caused by prolonged physical inactivity.

Conclusions

The study of psychological and cognitive aspects under conditions of simulated weightlessness undoubtedly deserves special attention and in-depth consideration in the future. Our research represents a small, yet an important and valuable contribution in this direction.

Research on the psychological aspects within bed rest studies potentially has a great applied value in the field of health prevention and rehabilitation. Namely, we could apply the findings in the study of the effects of physical inactivity on human mental health (post-operative conditions requiring long-term recovery; in cases of health indications requiring physical inactivity or bed rest; in lifestyles dominated by extreme physical inactivity) and anticipate the use of appropriate psychological interventions to prevent psychological stress and increase the quality of life under conditions of prolonged physical inactivity.

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Reference

1. DeRoshia, C. W., & Greenleaf, J. E. (1993). Performance and Mood State Parameters during 30-Day 6-Degree Head-Down Bed Rest with Exercise Training. Aviat Space Environ Med, 64, 522-527.
2. Diener, E., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The Satisfaction with Life Scale. Journal of Personality Assessment, 49, 71-75.
3. Fox, K. R. (2000). Physical activity and mental health promotion: the natural partnership. International Journal of Mental Health Promotion, 2, 4-12.
4. Goldberg, D. P., & Hiller V. F. (1979). A scaled version of the General Health Questionnaire. Psychological Medicine, 9 (1), 139-145.

5. Hyeteok, K., Iwasaki, K., Miyake, T., Shiozawa, T., Nozaki, S., & Yajima, K. (2003). Changes in Bone Turnover Markers during 14-Day 6° Head-Down Bed Rest. J Bone Miner Metabol, 21, 311-315.
6. Ishizaki, Y., Fukuoka, H., Katsura, T., Nishimura, Y., Kiriyama, M., Higurashi, M. et al. (1994). Psychological Effects of Bed Rest in Young Healthy Subjects. Acta Physiol Scand, Suppl, 616, 83-87.
7. Ishizaki, Y., Ishizaki, T., Fukuoka, H., Kim, C. S., Fujita, M., Maegawa, Y. et al. (2002). Changes in Mood Status and Neurotic Levels during a 20-Day Bed Rest. Acta Astronaut, 50, 453-459.
8. Iwase, S., Takada, H., Watanabe, Y., Ishida, K., Akima, H., Katayama, K. et al. (2004). Effect of Centrifuge-Induced Artificial Gravity and Ergo-Metric Exercise on Cardiovascular Deconditioning, Myatrophy & Osteoporosis Induced by a 6-Degree Head-Down Bedrest. J Grav Physiol, 11, 243-244.
9. Komada, Y., Inoue, Y., Mizuno, K., Tanaka, H., Mishima, K., Sato, H. et al. (2006). Effects of Acute Simulated Microgravity on Nocturnal Sleep, Daytime Vigilance, and Psychomotor Performance: Comparison of Horizontal and 6-Degree Head-Down Bed Rest. Percept Mot Skills, 103, 307-317.
10. Kume, M. (1997). Mental and Psychological Problems. Bone, 11, 113-119.
11. Lamovec, T. (1988). Priročnik za psihologijo motivacije in emocij. Univerza v Ljubljani, Filozofska Fakulteta, Oddelek za Psihologijo, 241-256.
12. Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. Applied Psychological Measurement, 1, 385-401.
13. Shehab, R. L., Schlegel, R. E., Schiflett, S. G., & Eddy, D. R. (1998). The NASA Performance Assessment Workstation: Cognitive Performance during Head-Down Bed Rest. Acta Astronaut, 43, 223-233.
14. Styf, J. R., Hutchinson, K., Carlsson, S. G., & Hargens, A. R. (2001). Depression, Mood State, and Back Pain during Microgravity Simulated by Bed Rest. Psychosomat Med, 63, 862-864.
15. Spileberger C. D. (1983). Manual for the State-Trait Anxiety Inventory (STAI), Consulting Psychologists Press, CA: PaloAlto.