EFFECTS OF LONG-TERM PHYSICAL INACTIVITY ON DEPRESSIVE SYMPTOMS, ANXIETY, AND COPING BEHAVIOUR OF YOUNG PARTICIPANTS

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Abstract:

The aim of the study was to examine the effects of a prolonged period of physical inactivity, induced by bed rest, on depressive symptoms, state anxiety levels and coping with stress strategies. Ten healthy males, aged between 20 and 30 years, were exposed to a 35-day head-down bed rest in a strict hospital environment. Participants completed the *Center for Epidemiological Studies Depression Scale*, the *State-Trait Anxiety Inventory*, and the *Coping Responses Inventory* before and after the bed rest (BR) experiment. Results showed that following the period of prolonged physical inactivity there were no significant differences in perceived depressive symptoms and state anxiety levels. Among the evaluated coping strategies, the use of "seeking guidance and support" significantly decreased after the prolonged bed rest. Research findings have an applicative value in the areas of health, sport, and rehabilitation, suggesting that the provision of favourable habitability countermeasures could prevent deterioration of psychological state under the conditions of prolonged physical inactivity.

Key words: *physical inactivity, mental health, bed rest*

Introduction

The health-promotion benefits of regular physical activity and sports to the human body are well documented (Donaldson, 2000; Morris, 1994). Physical activity (PA) is associated with a lower risk of heart disease, type 2 diabetes, high blood pressure, and osteoporosis (Vuori, 2004, 2010). Being physically active provides a human being with an adequate psychophysical condition and functional abilities of the body. PA can help him/her to maintain a healthy weight, thus reducing the risk of obesity (Pate, Pratt, & Blair, 1995; Turner & Robling, 2004). Alternatively, numerous research findings have determined insufficient physical activity and a sedentary lifestyle represent an important risk factor related to different health problems and diseases (Keim, Blanton, & Kretsch, 2004).

Different contemporary studies confirmed that overall bodily fitness and physical/sporting activity have an important role in mental health preservation and promotion (Landers & Arent, 2007; Salmon, 2001): they contribute to the reduction of depressive and anxiety symptoms (Arent, Landers, Matt, & Etnier, 2005; Dunn, Trivedi, & O'Neal, 2001), enhance resistance to stress (Alderman, Rogers, Johnson, & Landers, 2003) and provide the formation of positive physical self-concept and self-esteem (Ekeland, Heian, Hagen, Abbott, & Nordheim, 2004; Fox, 2000). Some current epidemiological studies have also established the beneficial effects of regular physical activity on cognitive functions, such as attention, concentration, working memory, information processing speed and problem-solving ability (Etnier, Nowell, Landers, & Sibley, 2006).

Research establishing the effects of total physical inactivity on the mental state of individuals is practically non-existent. It is difficult to induce and monitor an extended period of forced inactivity in everyday life. Researchers have addressed this problem in different ways (Adams, Caiozzo, & Baldwin, 2003; LeBlanc, et al., 2000; Pavy-Le Traon, et al., 1998). Simulated weightlessness, better known as *bed rest* (BR), which presupposes strict rest in a lying, head-down position for a specific period of time, represents an important ground-based model for studying the effects of zero gravity on humans. Numerous research studies have shown that the physiological and psychological changes which occur following a prolonged period of BR are similar to the changes observed in astronauts on their return from space travel (Krasnoff & Painter, 1999; Sato & Maeda, 2002). Bed rest experiments

represent a useful method to study the consequences of prolonged forced physical inactivity (Lipnicki & Gunga, 2009).

Several studies evaluated the effects of prolonged inactivity induced by BR on mental health. Research findings report increased depressive and neurotic levels during the bed rest period (Ishizaki, et al., 1994; Ishizaki, et al., 2000; Ishizaki, et al., 2002; Styf, Hutchinson, Carlsson, & Hargens, 2001). Some authors have tried to determine cognitive functions (directed and divided attention; spatial, mathematical and memory skills; tracking ability) in response to prolonged BR (Shehab, Schlegel, Schiflett, & Eddy, 1998). Although a trend of mild value decrements of the measured parameters was established during the experiment, no statistically significant differences in cognitive performance were observed when comparing the BR period with the pre-BR period.

Even though it would be generally difficult to determine the exact cause of any psychological change, some probable explanations are viable. Extreme and prolonged confinement to bed and immobility resulting from the simulated weightlessness might contribute to psychological changes like, for example, tension, elevated stress, alteration of mood status and behaviour outbursts. Another potential influential factor is the isolation from familiar environments and indispensable adaptation to the experimental conditions. The lack of social contacts and isolation from familiar environments and people is expected to contribute to the psychological changes occurring during BR. Further, cardiovascular and skeletal-muscular changes due to the prolonged BR might induce headache, back pain, sleep disturbances, and other unpleasant problems (Kume, 1997), which could impair psychological well-being of in-bed-resting individuals.

An important aspect of studying the psychological effects of the prolonged physical inactivity is proposed to be stress-coping behaviour (Gunji, 1997). Coping strategies refer to the specific efforts, both behavioural and psychological, that people employ to master, tolerate, reduce, or minimize stressful events (Lazarus, 1993). Two general coping strategies have been distinguished: problem--solving strategies are efforts to do something active to alleviate stressful circumstances, whereas emotion-focused coping strategies involve efforts to regulate the emotional consequences of stressful or potentially stressful events. Research indicates that people use both types of strategies to cope with the most stressful events (Lazarus & Folkman, 1984). The prevalence of one type of strategy over the other is determined, in part, by a personal style (e.g. some people cope more actively than the others) and also by the type of the very stress-causing event; for example, people typically employ problem--focused coping to deal with potentially controllable problems such as work-related problems and family--related problems, whereas stressors perceived as less controllable, such as certain kinds of physical health problems, prompt more emotion-focused coping (Lazarus, 1993).

The objective of the study was to examine the state anxiety level and depressive symptoms, as well as different coping strategies of the participants during a prolonged period of physical inactivity, induced by a 35-day head-down bed rest.

Methods

Participants

Ten males, aged between 20 and 30 years (M=23.4 years, SD=2.2), volunteered to participate in the "Valdoltra Bed Rest Study 2008", which was performed to investigate the effects of simulated weightlessness on the human organism. The selection process included an interview about the past and present condition of the subjects' physical and socio-psychological status, as well as a physical examination, in which routine medical and laboratory analyses were used to exclude chronic diseases. Also, the standard personality test was administered and an interview was conducted to be sure that the men were free from any clinical symptoms of mood disorders or other psychiatric illnesses. The selected participants were university students, nonsmokers, and they took no medications or drugs. The written informed consent was obtained from all the participants, following a detailed explanation of the study protocol. The study was conducted in July and August 2008 at the Orthopaedic Hospital Valdoltra, Slovenia. The Slovenian National Committee for Medical Ethics at the Ministry of Health approved the experimental procedure. The participants were symbolicaly remunerated for their participation in the study.

Experimental protocol

The 35-day bed rest was carried out in a strictly head-down position reflecting total physical inactivity. The subjects performed all their daily activities lying down. Physical activity was strictly forbidden throughout the experiment. The participants were housed in three hospital rooms (three/four persons per room). The 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 the entire experiment, the subjects were allowed to read books and magazines, watch televison, listen to music, and use computers and the Internet. The daily time schedule was as follows: awakening at 7:00, breakfast at 7:30, lunch at 12:00, dinner at 18:30, and sleeping at 23:00. During the experiment, physicians checked the physical condition of the participants.

The participants were asked to complete psychological inventories during the pre-BR period (5 days before the experiment) and on the 35th day of BR (post experiment). On both occasions they filled out the questionnaires after breakfast, between 9:00 and 10:00 a.m.

Instruments

The *Center for Epidemiological Studies--Depression Scale* (CES-D; Radloff, 1977) was used to measure the depressive symptoms in the participants. The scale is designed to assess depressive symptoms in the general population, that is, in the non-psychiatric persons older than 18 years. 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 CES-D is scored by adding up the ratings for the 20 items. Each item is rated on a four-point scale ranging from 0 to 3. The maximum total score is 60. Usually, 16 is taken as a cut-off point for clinically important depressive symptoms (Radloff, 1977). Acceptable reliability and validity of the original scale have been found among adolescents and young adults (Radloff, 1991). The internal consistency (α) in the Slovene sample was .88 (Musek & Avsec, 2006).

The *State-Trait Anxiety Inventory* (STAI; Spielberger, 1983) was used to determine the anxiety level of the participants. The 20-item inventory provides a reliable measure of both temporary and dispositional anxiety in adults. For the purpose of the study, only the part of the instrument that relates to state anxiety and allows the identification of the temporary emotional state of individuals was utilized. Participants 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 the higher scores indicating the greater level of anxiety. The instrument is frequently used for studying anxiety in research settings. Lamovec (1988) reported the correlation .80 with the *Manifest Anxiety Scale*, which is an indicator of STAI-X2 validity. The Slovene version of the scale showed an adequate internal consistency (α=.88).

The *Coping Responses Inventory* (CRI; Moos, 1993) was used to measure the coping strategies of the participants. The instrument includes 48-items which assess the coping responses to stressful life experiences in adults aged 18 and over. These responses are measured by using a four-point scale (from *not at all* to *fairly often*). The inventory measures eight types of coping responses, each assessed by six items. The eight subscales are: *logical analysis, positive reappraisal, seeking guidance and support, problem solving, cognitive avoidance, acceptance or resignation, seeking alternative rewards,* and *emotional discharge*. Approach coping is measured by the first four subscales; avoidance coping is measured by the second four subscales. The authors of the Slovene version of the CRI (Masten, Tušak, Zalar, & Ziherl, 2009) determined that the instrument has an appropriate reliability (.80<α<.92) and an adequate construct validity.

Data processing methods

The paired samples *t*-test was used to determine the differences in the studied psychological variables before and after the BR experiment. To assess the practical significance as a supplement to statistical significance testing, Cohen's *d* effect size was computed (Kirk, 1996). Cohen defined *d* as the difference between the means, divided by the standard deviation of either group. Effect sizes are generally defined as small (*d*=.20), medium (*d*=.50), and large (*d*=.80).

Results

To evaluate the changes among the Slovenian young male participants in their psychological status during long-term physical inactivity, a questionnaire study using three types of psychometric inventories was conducted.

The mean (M), standard deviation (SD), *t* values, and Cohen's *d* indices of STAI, CES-D scores, and eight coping strategies of CRI are shown in Table 1.

CES-D scores among the participants ranged from 1 to 10 in the pre-BR period and from 1 to 15 in the post-BR period, whereas STAI scores ranged from 22 to 41 in the pre-BR period and from 20 to 59 in the post-BR period. The variability of the results was greater in both variables at the end of the experiment. No significant differences (p<.05) in the participants' perceived depressive symptoms and state anxiety level, assessed by CES-D and STAI respectively, were found after the period of total phyical inactivity. Among the evaluated coping strategies (CRI), the use of *seeking guidance and support* significantly decreased after the prolonged bed rest (p<.05).

The Cohen's *d* indices for depressive symptoms, and the coping strategies *positive reappraisal* and *problem solving* were close to .50, indicating a medium effect size. In the cases of participants' reports of depressive symptoms, the statistical significance was not established, whereas the index of the Cohen's *d* indicated a medium effect size.

Discussion and conclusions

On the basis of the results, the psychological status of the participants, in terms of depressive symptoms and state anxiety level, remained relatively unchanged during the experiment. The participants manifested, on average, a low anxiety

Table 1. Differences between the studied psychological variables before and after bed rest (BR) period

	Before BR		After BR		*t*	p	*Cohen's d*
	M	SD	M	SD			
STAI – state anxiety	27.89	6.77	31.33	11.33	-0.90	.393	-0.37
CES-D – depression	4.51	3.24	6.20	4.83	-1.93	.086	-0.41
CRI – logical analysis	11.80	2.86	11.20	3.46	0.56	.588	0.19
CRI – positive reappraisal	11.90	4.20	10.00	3.50	2.03	.073	0.49
CRI – seeking support	8.80	1.55	6.10	1.97	4.26	.002	1.54
CRI – problem solving	13.10	2.38	11.80	3.16	2.05	.070	0.47
CRI – cognitive avoidance	7.10	3.96	7.30	4.92	-0.23	.823	-0.05
CRI – acceptance	4.70	3.53	4.90	4.04	-0.23	.820	-0.05
CRI – alternative rewards	9.70	3.33	9.10	3.60	0.73	.383	0.17
CRI – emotional discharge	4.00	3.13	4.40	4.12	-0.77	.462	-0.11

level throughout the experiment. There was a slight tendency towards an enhancement of reported depressive levels after long-term physical inactivity. Despite this, the values remained lower than the CES-D mid-point.

These findings are mostly inconsistent with the majority of research findings reporting significant mood impairments and increased values of depressive and neurotic experience after a BR period (Ishizaki, et al., 2002; Styf, et al., 2001). A considerable degree of the participants' adaptability to the conditions in the current study was attributed to the selection of subjects with the characteristics optimal for the adaptation to confinement and restricted mobility and to the highly favourable environmental habitability factors in this study relative to previous studies. It should be emphasized that previous BR studies were carried out under strict experimental conditions where, in addition to the conditions of physical immobility, also the conditions of extreme social isolation and seclusion were created (similar to those during space travel). Those studies involved significantly limited social contacts between the participants and the social environment, meaning that the participants spent the majority of the BR days without seeing family members and friends (Gunji, 1997; Ishizaki, et al., 2000; Ishizaki, et al., 2002; Weiss & Moser, 1998). In contrast, favourable habitability factors were created in the current study, including a stimulating environment, access to various media usage (television, radio, computer and the Internet), communication with medical personnel, researchers, friends and relatives.

Some changes in the coping behaviour were found after prolonged physical inactivity. The use of the coping *strategy seeking* support decreased during BR. A tendency toward a decrease of strategies *problem solving* and *positive reappraisal* were also noted. Other evaluated coping strategies (*logical analysis, cognitive avoidance, acceptance, alternative rewards, emotional discharge*) remained relatively unchanged after the BR experiment.

Physical immobility required a high degree of adaptation capability in new and never before experienced circumstances (performing all activities in a lying-down position, frequent measurements and physiological tests, other demands from the experimental protocol). For that reason the participants depended upon information and the help of others. The need for support was especially noticeable before and at the beginning of BR and then it decreased, probably because the experimental situation became more familiar and predictable to the subjects. Another important thing was the constant contact with medical staff and researchers during the experiment, so help and support to participants were provided.

Prolonged physical immobility undoubtedly represents an important source of physical and psychological stress (Gunji, 1997; Weis, Nicholas, & Charras, 2005). The concept of the coping behaviour is an important dimension of an individual's adaptation to stress. The participants in this study were expected to reduce tension through relaxation of negative emotions. These findings have shown that passive and dependent conditions, induced by BR, did not promote the use of coping strategies focused on emotions, but rather reduced the use of problem-focused coping strategies.

Interpersonal relationships are among the most important factors of the psychological conditions during periods of restriction to a limited space (Weiss & Moser, 1998). In this study, all the participants answered that they experienced no interpersonal conflict with any other participant or the staff during prolonged physical inactivity, and that the social climate was agreeable.

Based on the findings, it was assumed that some changes in the studied psychological characteristics during the experiment were more the consequence of the prolonged lying in a head-down position and the accompanying physiological changes than the result of the living and/or socio-psychological conditions during the BR period. The results obtained

suggest that favourable living conditions and the possibility to interact socially during a period of total physical inactivity represent a kind of "protective factor" against any impairment of mental state, or, in other words, that they mitigate the negative effects caused by the prolonged physical inactivity.

Physical inactivity has become a major public health problem. In the last decade the authors have noticed an increased research interest in clarifying the relationship between physical activity and some indicators of mental health and psychological adaptation (Biddle & Mutrie, 2008). Although the causality of this relationship is not clear, the pattern of evidence suggests that exercise programmes recruit a process which confers enduring resilience to stress. Until now, research has focused mostly on habitual physical inactivity, otherwise known as sedentarism. However, it is also important to study the psychological and socio-psychological aspects of acute physical inactivity, using the bed rest model. Research findings have applicative value in the areas of health, sport, and rehabilitation. Namely, the results explain the effects of physical inactivity on human mental health under diverse living conditions like: post-operative period requiring a long-term recovery; health indications requiring physical inactivity or bed rest, or lifestyles in which extreme physical inactivity prevails. Also, the results anticipate the use of appropriate psychological interventions to prevent psychological stress thus increasing quality of life under conditions of prolonged physical inactivity.

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UTJECAJ DUGOTRAJNE FIZIČKE NEAKTIVNOSTI NA SIMPTOME DEPRESIJE I ANKSIOZNOSTI TE NA SUOČAVANJE SA STRESOM U MLADIH MUŠKARACA

Cilj ovoga istraživanja bio je ispitati učinke dužega razdoblja fizičke neaktivnosti, izazvane simulacijom bestežinskoga stanja (*bed rest experiment* – striktno mirovanje u postelji) na simptome depresije i anksioznosti te na strategije suočavanja sa stresom. U istraživanje su bili uključeni zdravi muškarci (N=10) u dobi između 20 i 30 godina, koji su 35 dana mirovali u vodoravnom položaju u strogim eksperimentalnim (bolničkim) uvjetima. Sudionici su prije i poslije eksperimenta ispunili sljedeće upitnike: Upitnik/skalu depresije (*Center for Epidemiological Studies Depression Scale*), Upitnik o anksioznosti kao stanju i osobini ličnosti (*State-Trait Anxiety Inventory*) i Upitnik o suočavanju sa stresom (*Coping Responses Inventory*). Nakon razdoblja dugotrajne fizičke neaktivnosti nije bilo značajnih razlika u simptoma depresije i razini anksioznosti, dok se na području suočavanja sa stresom značajno smanjilo korištenje strategije *traženje i primanje socijalne potpore*. Rezultati istraživanja su primjenjivi na području zdravlja, sporta i rehabilitacije; naime, pokazuju da su pogodni životni uvjeti i povoljne socijalne okolnosti važne protumjere koje mogu spriječiti pogoršanje psihološkoga stanja u uvjetima dugotrajne fizičke neaktivnosti.

Ključne riječi: *fizička neaktivnost, mentalno zdravlje, bed rest eksperiment*