

SHIFT-WORK DYNAMICS OF SOME PARAMETERS OF FATIGUE AND WORKING CAPACITY IN AIR-TRAFFIC CONTROLLERS

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The purpose of the present work was to study the changes of some psychophysiological parameters in air-traffic controllers under the influence of the working process and occupational environment. Some 28 air-traffic controllers at a mean age of 34,9 years and mean length of service of 11,8 years were examined. A dynamic following-up the changes of psychic working capacity according to the shift-work regimen - at the beginning and at the end of the morning, afternoon and night shifts was performed. Fatigue and neuro-emotional stress underwent a subjective evaluation. Objectively, the following parameters were examined: attention properties, speed and preciseness of the visual-motor reaction, movement coordination, static tremor, and rate of hand movements. The labour of the air-traffic controllers was characterized by a high intensity and was related with heavy responsibility and permanent stress situations as well. A significant subjective reduction of the working capacity along with an enhanced voluntary effort at the end of the working shifts was established. The subjective scores were lower during the night shift than those during the day shift. The changes of the attention parameters such as productivity, volume and rate of processed information during the night shift appeared to be particularly indicative when the objective examinations were concerned.

Key-words: Working capacity, air-traffic controller, shift work, attention, coordination, stress

Air-traffic intensity is directly related with improving the management system. The profession of air-traffic controller occupies an important place within the complex automatized

biotechnical set of transport management. The occupational activity of the air-traffic controllers is extraordinarily work-loading. Chronic neuro-psychical and emotional stress combined with the unfavourable shift-work effect disturbing the alternating sleep and rest rhythm belongs to the factors influencing upon the health and working capacity of this professional group (3,8,11). These fac-

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tors substantially affect the work reliability of the air-traffic controllers and this can lead to irretrievable consequences (2) taking particularly into consideration the circumstance that the risk is more commonly related with the altered psychic working capacity than with technical troubles (10). Recently, numerous data accumulate that psychogenic factors along with chronic neuro-emotional stress are undoubtedly involved in the etiology and course of several psychosomatic diseases (4,11).

The aim of the present study is to follow-up some subjective indicators of fatigue and stress as well as attention properties of air-traffic controllers during shift work.

MATERIAL AND METHODS

The study covered 28 air-traffic controllers at a mean age of 34,9 years and mean length of service of 11,8 years. The changes of psychic working capacity during the shift-work dynamic regimen - at the onset and at the end of the shifts: morning, I daily shift, 8⁰⁰ a. m. - 2⁰⁰ p. m., afternoon, II daily shift, 2⁰⁰ p. m. - 8⁰⁰ p. m., and III night shift, 8⁰⁰ p. m. - 8⁰⁰ a. m. were followed-up. Fatigue and neuro-emotional stress underwent an evaluation by using a questionnaire. The objective assessment of the functional state of the central nervous system was done using the following parameters: qualities and properties of the attention - through

Anfimov's correction test and Schulze-Platonov's test, latent time and preciseness of the complex visual-motor reaction - by means of a computerized test, visual-motor movement coordination - through tremometry (5), etc. The results were processed after the method of variation analysis.

RESULTS AND DISCUSSION

The air-traffic controllers manage the flights of all the airplanes flying over the region. Their immediate occupation includes a permanent visual control on the radar monitor and the other radiolocation devices, a rapid analysis of the information obtained from the "Flight Information Service" about landing, from the "Meteorology Service" and on board the plane resulting in decision making in the concrete situations under conditions of superstress. The formation of the functional system during the labour process inevitably reflects upon the stable interactions of the sensory, motor, and vegetative functions and the corresponding subjective sensations (7). The study of the dynamics of the systemic organization of these relationships is of great interest for the diagnosis of fatigue.

The dynamics of the subjective sensations of fatigue and neuro-emotional stress demonstrates a reliable working capacity reduction at the end of the shifts (Fig. 1). Motivation dimin-

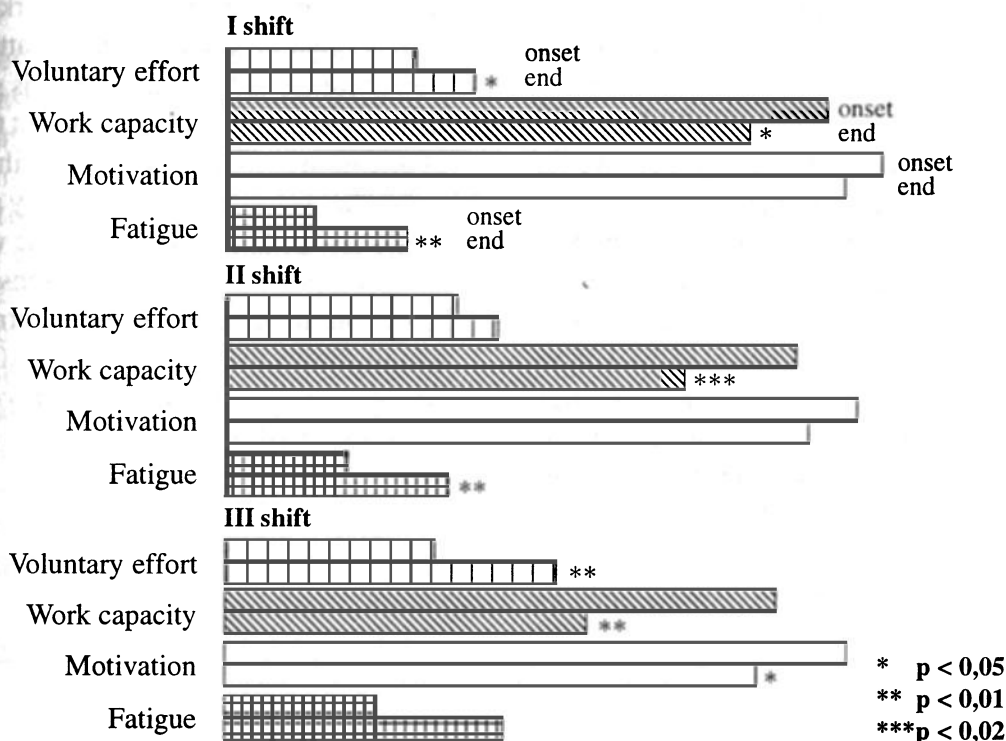


Fig. 1. Shift dynamics of some parameters for subjective assessment of fatigue and neuro-emotional stress in air-traffic controllers

ishes that is statistically significant during the night shift only. The fatigue is considerably increased at the end of the three shifts as compared with that at their onset. The enhanced voluntary effort particularly manifested in shifts one and three both is, most probably, related with the surmounting the fatigue. A tendency towards a progressive diminution of the working capacity and motivation along with enhancement of the voluntary effort and fatigue from the I up to the III shift becomes outlined. The air-traffic controllers start and finish the night shift at a statistically reliably

higher fatigue level than they do the daily shift ($p < 0,05$). Correspondingly, the working capacity and motivation are lower but the voluntary effort is stronger after the night shift than after the daily one. There are special night-labour requirements for these persons as mentioned by other authors (9) determined by the natural physiological working capacity reduction, on the one hand, and by the absent opportunity for sufficient rest during the daytime, on the other. That is why the air-traffic controllers show a higher fatigue level during the night shift as compared with that dur-

ing the other shifts. Besides the capacity for adaptation to the working conditions during the day (from a daily to a night shift) decreases, too, which is related with the state of vegetative homeostasis reserves (6).

The role of the attention in the occupation of flight managers is extraordinary. The attention underlies the permanent visual control of the devices. Data from the examination of the attention using Anfimov's test demonstrate a certain diminution of the accuracy and

productivity at the end of the working shifts (Table 1). The reduction of attention accuracy at the end of work is statistically significant in shift one but that of attention productivity - in shift three only. These changes in the accuracy and productivity of attention reduce the volume and speed of the processed sensory information and cause eventual errors mainly during the night shift ($p < 0,05$). Other investigators draw similar conclusions based on indirect proofs, too (9).

Table 1

Shift-work dynamics of some attention parameters

Parameters of attention	Shift	Onset	End	p
	No.	$\bar{x} \pm S\bar{x}$	$\bar{x} \pm S\bar{x}$	
Accuracy (conditional units)	I	0,90 ± 0,02	0,83 ± 0,027	< 0,05
	II	0,87 ± 0,04	0,83 ± 0,021	> 0,05
	III	0,90 ± 0,02	0,85 ± 0,03	> 0,05
Productivity (conditional units)	I	209,1 ± 8,24	206,1 ± 14,87	> 0,05
	II	214,01 ± 9,73	207,9 ± 12,04	> 0,05
	III	235,11 ± 15,7	192,1 ± 10,69	< 0,05
Switching over - time (sec)	I	205,4 ± 11,62	233,6 ± 15,65	> 0,05
	II	218,5 ± 11,76	215,75 ± 11,45	> 0,05
	III	229,4 ± 17,95	228,35 ± 9,46	> 0,05
Volume of processed information (signs)	I	250,8 ± 8,49	267,8 ± 15,4	> 0,05
	II	263,22 ± 9,59	263,5 ± 11,42	> 0,05
	III	281,9 ± 21,53	232,19 ± 5,28	< 0,05
Speed of information processing (bit/sec)	I	2,09 ± 0,07	2,22 ± 0,13	> 0,05
	II	2,13 ± 0,09	2,22 ± 0,09	> 0,05
	III	2,36 ± 0,16	1,94 ± 0,11	< 0,05

Following-up the short-lasting attention switching-over during the transition from one operation to another being a precondition for the rapid reconstruction of operative activity does not establish any significant changes of the attention at the end of the shifts. Maintaining the attention switching-over is, probably, on the account of enhanced voluntary effort related to the heavy responsibility of flight managers. The professional selection and training of these qualities is of importance, too. We establish the highest values of reaction rate during the night shift in contrast to other authors who report the lowest reaction rate in the night because of reduced general tone of the organism (1).

Promptness, adequacy, and preciseness of reactions and decision making as a whole play a crucial role during the working process of the air-traffic controllers. Data about the latent period of the complex visual-motor reaction of flight managers indicate a certain prolongation of the reaction time at the end of the three shifts in comparison with the initial values. The errors at the end of shifts one and two decrease insignificantly while during the night shift a tendency towards their augmentation can be seen ($p > 0,05$). The parameter of "exactness of selected re-

action" demonstrates statistically insignificant differences between the onset and the end of the observation period, too.

The functional changes of the motor apparatus followed-up through examination of the movement coordination, static tremor, and rate of hand movements demonstrate that the coordinated movements are characterized by a certain tendency towards enhanced inaccuracy and delay.

CONCLUSION

Air-traffic controllers' labour is characterized by high intensity, heavy responsibility, and continuous stress situations.

The dynamic following-up the subjective sensations about fatigue and neuro-emotional stress of the air-traffic controllers demonstrates a working capacity reduction and voluntary effort enhancement at the end of the working shifts. During the night shift the subjective working capacity is lower than that during the daily one. The changes of the attention such as decreased productivity, volume and rate of processed information during the night shift are indicative of a reduced working capacity when the objective examinations are concerned.

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Сменна динамика на някои показатели за умора и работоспособност при авиодиспечери

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Резюме: Цел на настоящата работа е да се изследват промените в някои психофизиологични показатели при авиодиспечери. Изследвани са 28 авиодиспечери на средна възраст 34,9 г. и среден трудов стаж 11,8 г. Проследени са промените на психическата дееспособност в сменна динамика - в началото и края на сутрешна, следобедна и нощна смени. Субективно е определена умората и нервно-емоционалното напрежение. Обективно са изследвани: качествата на вниманието, бързината и точността на зрително-моторната реакция, координацията на движенията, статичният тремор и темпът на движения на ръката. Трудът на авиодиспечерите е свързан с високо напрежение, голяма отговорност и непрекъснати стрес-ситуации. Установява се значимо понижаване на работоспособността и увеличаване на волевото усилие в края на работните смени. През нощната смяна субективните оценки са пониски в сравнение с тези през дневната. От обективните изследвания показателни са промените на вниманието - продуктивност, обем и скорост на преработената информация през нощната смяна.