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# Working and Health Conditions of Italian Air Traffic Controllers

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# Working and Health Conditions of Italian Air Traffic Controllers

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The paper summarises some studies carried out in recent years on Italian air traffic controllers. Work stress appeared related mainly to mental charge, aggravated by time pressure and high responsibility. Shiftwork was not considered highly stressful, thanks to the good shift schedules adopted. The disorders most frequently complained of had a prevalent psychosomatic component, concerning the digestive, neuropsychic, and cardiovascular systems. However, their prevalence was lower than, or similar to, that recorded in general population. The controllers engaged in regional centres showed slightly worse health conditions than those engaged in airport towers; the same was found in the radar controllers compared to those working in non-radar positions.

air traffic control  shiftwork  health  personal characteristics

## 1. INTRODUCTION

Air traffic control is generally considered a highly demanding job, as it entails a complex set of tasks requiring very high levels of knowledge, skill, and vigilance (Amerman et al., 1987); it also assumes high responsibility with respect to not only the risk to human life but also to the high economic costs of aeronautical activities.

The main sources of stress reported by Air Traffic Controllers (ATCs) are connected both to operative aspects (e.g., peaks of traffic load, time pressure, having to bend the rules, limitations, and reliability of equipment) and to organisational structures (e.g., shift schedules, night work, role

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conflicts, unfavourable working conditions, lack of control over work process; Crump, 1979; Farmer, Belyavin, Berry, Tattersall, & Hockey, 1990; Hurst & Rose, 1978; Melton, Smith, & McKenzie, 1978). Among these, shiftwork can be one of the most important in terms of physiological adjustment, performance efficiency, and health (Costa, 1996). The job in fact requires the best possible level of mental faculties at all hours of the day and the night, sometimes irrespective of the workload.

The circadian oscillation in psychophysiological functions appears to be influenced somewhat by the wake/sleep cycle and parallels the body temperature rhythm, with a peak during the day and a trough during the night. These fluctuations have been shown to vary according to task demands, suggesting different contributions from endogenous and exogenous components on mental activities (Akerstedt, 1996; Colquhoun, 1971; Folkard, 1990). Moreover, performance impairment and nocturnal declines increase with prolonging working hour and sleep deprivation, particularly in more complex tasks. The maximum decrement during the same extended duty period can be twice as severe when work starts at midnight rather than at midday (Klein & Wegmann, 1979).

Consequently, ATCs' work performance can be impaired at certain hours of the day by an excessive workload, but it can also be lowered during the night by a decline in mental and physical functions, even in spite of a reduced external load. In fact, a lack of stimulation from a low workload can further increase the normal drop in physical and mental efficiency during night hours, as also can a perturbation of sleeping habits and circadian rhythms due to shiftwork. This can be particularly harmful in emergency situations (Costa, 1991; Folkard, 1990).

Furthermore, the consequences on ATCs' performance and well-being may differ widely among the individuals in relation to many factors including age, life styles, life events, work experience, personality traits, behavioural characteristics, attitudes, motivation, physical and mental health, socioeconomic status, commuting, social support, and integration (Crump, 1979; Hurst & Rose, 1978; Kalsbeek, 1976; Karson, 1969).

In the long term, several studies indicate that this demanding occupational activity may be a risk factor for stress-related symptoms, such as headache, chronic fatigue, heartburn, indigestion, chest pain, as well as for serious illnesses, such as hypertension, coronary heart disease, diabetes, peptic ulcer, and psychoneurotic disorders. It is quite easy to foresee the high costs, both in the standard of life and economic, that these negative consequences of stress can entail, not only for the single person but also for the companies and society.

This report summarises some studies carried out in recent years among the Italian air traffic controllers, aimed at evaluating their health conditions with reference to their specific task and shiftwork.

## 2. PARTICIPANTS AND METHODS

Seven hundred and sixty-two male Air Traffic Controllers (ATCs), aged between 23 and 59 years (mean = 43.6 years) and having work experience ranging from 0.5 to 39 years (mean = 19.3 years) were investigated; 84.9% were married. They were a random sample of the 1,500 Italian ATCs, engaged in 26 out of the 46 Italian ATC centres, homogeneously distributed over the whole country.

Four hundred and ten were engaged in the four large regional centres (RATC), where they were in charge of the control of overall air traffic in national air sectors; 263 were engaged in 26 airport towers (TWR), where they had to control the approach, landing, and take-off of aircraft; 89 were formerly active controllers (F-ATC) and still working in the headquarters. The first two groups were engaged on shift and night work, the third consisted of dayworkers, who had previously been shiftworkers.

The working times schedules were generally organised as rapidly rotating shift systems of 6- or 9-day cycles with a backward rotation (e.g., A-M-N-R-R-R or A-M-N-R-A-M-R-R-R), in some cases having the morning shift and the night shift on the same day. Morning shift (M) started at 07:00 in the regional centres, but at 08:00 in many airport towers; afternoon shift (A) started at 13:00 or 14:00, and night shift (N) at 20:00. A 2-hr pause was allowed during the night shift, during which the ATCs could take turns to sleep in rest rooms.

Four occupational health physicians, who were not members of the company and were not involved in the periodic health checks, submitted all the controllers to a clinical examination.

An Italian version of the Standard Shiftwork Index (SSI; Barton, Folkard, Smith, Spelten, & Totterdell, 1990) was used and given personally to each controller by the examining doctors. It includes several independent questionnaires concerning issues related to shiftwork and personal characteristics. In particular General job satisfaction; Sleep hours and disturbances; Chronic fatigue; Physical health (digestive and cardiovascular troubles); Minor psychological disorders (General Health Questionnaire); Cognitive and somatic anxiety; Coping strategies; Morningness; Languidity in overcoming drowsiness and Flexibility of sleeping habits (Circadian Type

Inventory); Neuroticism and Extraversion (Eysenck Personality Inventory).

A modified version of the Royal Air Force/Institute of Aviation Medicine (RAF IAM) Survey (Farmer et al., 1990) was used for the evaluation of the stress factors connected with the work.

During the clinical examination the physicians also recorded height, weight, and blood pressure; eating and smoking habits; illnesses suffered; prolonged (more than 3 months) use of medications; and sick leaves and medical consultations in the previous 12 months.

## 3. RESULTS

ATCs were in general satisfied with their job (86.5%), considering it very (61.3%) or fairly (34.0%) interesting, but 71.8% expressed some concerns about work organisation. Among the different components of the workload (Figure 1), ATCs reported a marked mental load, aggravated by the necessity to operate under time pressure and with high emotional load due to the responsibility of the task. The mental load was perceived to be higher during the day shifts, connected to the high traffic peaks, whereas at night there was a greater physical demand due to the necessity to keep alert and vigilant (Costa, 1993).

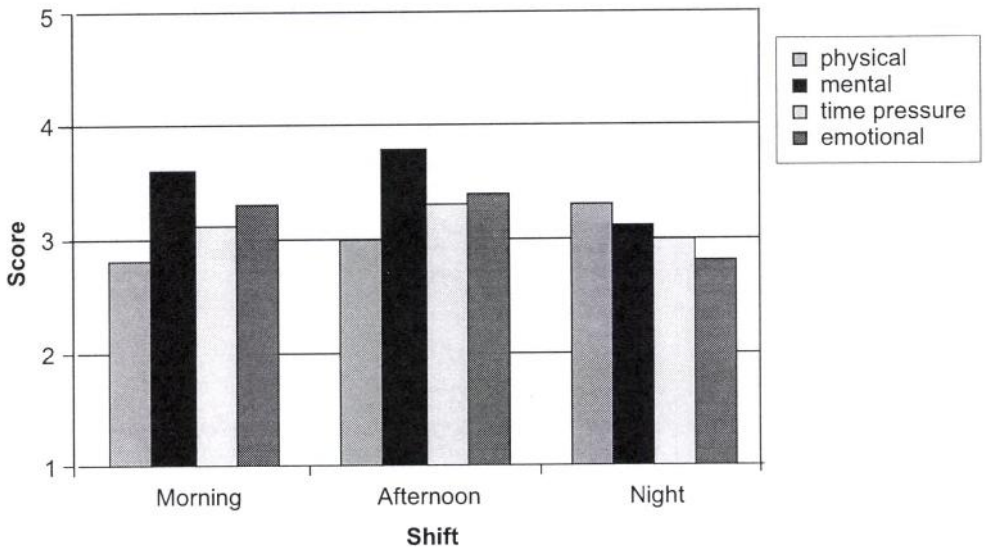


**Figure 1. Evaluation of workload components in three shifts (mean values; 1—minimum, 5—maximum).**

Among the 28 possible stressful factors taken into consideration according to the RAF IAM Survey (Table 1), those perceived as most stressful were connected with a specific task (e.g., peaks of traffic, periods of continuous activity), followed by those related to equipment and duty hours. Moreover, 147 participants signalled high level of stress due to relations with management, colleagues, and unions.

**TABLE 1. Sources of Stress in the Air Traffic Controller (ATC) Job (Scale: 6—*very definitely a source of stress*; 1—*very definitely not a source*)**

| Source of Stress | *M* ± *SD* |
|---|---|
| Peak level of traffic load | 5.4 ± 0.9 |
| Amount of time spent at peak traffic load | 5.3 ± 0.9 |
| Noise and distractions in the control room | 4.7 ± 1.2 |
| Reliability of equipment | 4.5 ± 1.2 |
| Adequacy of equipment when functional | 4.4 ± 1.2 |
| Sound quality of radio and telecommunications | 4.4 ± 1.2 |
| Duration of unbroken duty period | 4.3 ± 1.2 |
| Sound quality of telephone | 4.3 ± 1.2 |
| Visual discomfort | 4.2 ± 1.3 |
| Finding extra help when traffic increases | 4.2 ± 1.3 |
| Total duration of a single shift | 4.2 ± 1.2 |
| Extraneous traffic (e.g., military, general aviation) | 4.2 ± 1.3 |
| Smoky atmosphere in the control room | 4.1 ± 1.6 |
| Average level of traffic load | 4.0 ± 1.1 |
| Shift pattern | 3.9 ± 1.2 |
| Adequacy of rest facilities | 3.7 ± 1.5 |
| Adequacy/currency of local instruction | 3.7 ± 1.1 |
| Financial difficulties | 3.7 ± 1.5 |
| Travel to work | 3.6 ± 1.5 |
| Sharing a tube with another controller | 3.5 ± 1.4 |
| Layout of equipment | 3.5 ± 1.2 |
| Local house prices | 3.4 ± 1.6 |
| Attitudes of non-smokers (if smoker) | 3.4 ± 1.5 |
| Lighting | 3.3 ± 1.3 |
| Adequacy of canteen facilities | 3.3 ± 1.4 |
| Public comment on ATC | 3.0 ± 1.5 |
| Seating | 2.9 ± 1.3 |
| Car parking at the unit | 2.8 ± 1.5 |
| Other sources of stress | |
| Relations with management, colleagues, unions (147 participants) | 5.4 ± 0.7 |
| Planning work and holiday periods (111 participants) | 5.2 ± 0.8 |

Shiftwork was not considered highly stressful; in fact, the ATCs' opinion was quite in favour both of the most used shift rota, characterised by backward fast rotation on a 6-day cycle, and of the starting and ending hours of the shifts. They had been working 48.5 ± 12.3 nights per year on average, ranging from a minimum of 12 and a maximum of 75 (only 3% worked more than 60 nights per year).

For the majority of them, the advantages associated with this shift schedule were mainly related to more free time available for personal needs, and this compensated for the disadvantages connected with the irregular life regime (Table 2). The night shift was not considered particularly stressful, thanks to the possibility of a short rest period (see section 2). For 106 persons (14.3%), shiftwork had a negative influence on sexual activity and marital relations, due to excessive tiredness and "out of phase" times with the partner.

**TABLE 2. Evaluation of Shiftwork (% of Participants)**

| Opinion | % |
|---|---|
| More advantages than disadvantages | |
| surely NO | 19.3 |
| probably NO | 18.0 |
| maybe | 15.0 |
| probably YES | 26.2 |
| surely YES | 21.5 |
| Main advantages | |
| More leisure time for personal and family needs | 56.6 |
| Higher variability of everyday life (less monotony) | 32.6 |
| Higher income | 4.8 |
| Main disadvantages | |
| Difficulties in planning family and social life | 67.4 |
| Irregular physiological rhythms and mealtimes | 17.4 |
| Interference with sexual life | 14.3 |
| Sleep problems | 8.3 |
| Least liked shift | |
| Morning | 26.1 |
| Afternoon | 38.5 |
| Night | 35.4 |

As can be seen from Table 3, the sleep hours of the ATCs during the 6-day cycle appeared quite well balanced in terms of duration, and fairly satisfactory in terms of quality. The delayed starting time of the morning shift (in general at 7:00, in some cases at 8:00) allowed the avoidance of a significant curtailment of the preceding sleep, to which many ATCs (17%) added a nap lasting about 1 1/2 hrs the following afternoon.

**TABLE 3. Sleep Quantity (Hours and Minutes) and Quality (Scale: 6—*not at all*, 30—*very much*)**

| Sleep | *M* ± *SD* |
|---|---|
| Sleep duration | |
| Night before afternoon shift | 8.19 ± 1.05 |
| Night after afternoon shift and before morning shift | 6.57 ± 0.53 |
| Nap after morning shift | 1.29 ± 0.35 |
| Night after morning and before night shift | 8.15 ± 1.08 |
| Night after night shift | 8.50 ± 1.45 |
| Nap after night shift | 1.37 ± 0.47 |
| Night between 2 rest days | 8.17 ± 1.04 |
| Sleep disturbances | |
| on morning shift | 17.5 ± 4.8 |
| on afternoon shift | 16.8 ± 4.4 |
| on night shift | 18.0 ± 4.8 |
| on rest day | 12.0 ± 3.4 |



On the other hand, in order to compensate for the sleep deficit associated with the night shift, ATCs adopted several strategies: Many (33.9%) took a nap before it, others (23.4%) a nap in the following morning or afternoon. Only 18 persons took sleeping pills habitually after the night shift.

As concerns the sleep disturbances, there was an obvious increase on working days, and particularly on night shift, but not statistically significant when compared to the other shifts; this confirmed the usefulness of having only one night shift including a 2-hr break. However, in order to keep alert during the night shift, 39.3% increased coffee drinking and 50.4% of the smokers increased cigarette consumption.

At the clinical examination, the vast majority of the ATCs appeared in very good health; half of them were doing regular and intensive sporting

activity, in order to maintain good physical fitness: On average, their height was 172.9 ± 5.9 cm and weight 77.2 ± 9.8 kg.

The illnesses suffered during their life concerned mainly the digestive, musculoskeletal, neuropsychic, and cardiovascular systems (Table 4). More

**TABLE 4. Illnesses Suffered During the Working Life (% of Participants)**

| Illnesses | % |
|---|---|
| Digestive disorders | |
| Gastritis, gastroduodenitis | 32.4 |
| Peptic ulcer | 9.4 |
| Colitis | 18.7 |
| Gallstones | 3.7 |
| Musculoskeletal disorders | |
| Low back pain | 23.0 |
| Arthritis/arthrosis | 11.7 |
| Cardiovascular disorders | |
| Hypertension | 15.0 |
| Angina pectoris | 1.2 |
| Myocardial infarction | 1.2 |
| Arrythmias | 8.7 |
| Haemorrhoids | 24.6 |
| Varicose veins | 3.7 |
| Metabolic disfunctions | |
| Hyperlipidaemia | 21.8 |
| Diabetes | 1.8 |
| Urogenital disorders | |
| Cystitis | 5.5 |
| Urolithiasis | 7.9 |
| Neuropyschic disorders | |
| Headache recurrent | 18.0 |
| Chronic anxiety | 10.2 |
| Depression | 8.7 |
| Various | |
| Tonsillitis/sinusitis | 15.0 |
| Conjunctivitis | 7.4 |
| Eczema | 4.6 |
| Asthma | 2.5 |
| Anaemia | 0.8 |

than 40% complained of having suffered from gastrointestinal disorders, in particular gastroduodenitis (1 in 3) and peptic ulcer (about 1 in 10); 19% also reported colitis. The musculoskeletal disorders referred mainly to low back pain (1 in 4) and migrant arthritis (1 in 9). About 1 in 5 also suffered from chronic anxiety or depression, and 18% complained of recurrent headache.

As concerns the cardiovascular system, 15% of ATCs had had a previous diagnosis of hypertension, and 1 in 4 of haemorrhoids; 9 participants had suffered from myocardial infarction, whereas 21.8% reported hyperlipidaemia.

During the 12 months preceding the enquiry, the ATCs had consulted their family doctor 3.3 times on average and reported 6.9 days of sick leave on average (50.4% had no sick leave and 21.1% less than 5 days).

Three hundred and eighty-eight participants (50.9%) reported one or more complaints at the medical examination. They concerned mainly the musculoskeletal (20.1%), neuropsychic (16.4%), and digestive (11.6%) systems, confirming what was stated in the medical history. However, the ATCs examined showed, at the SSI questionnaire, very low scores of chronic fatigue (mean 22.5; scale 10–50), digestive (mean 13.2; scale 8–32), cardiovascular (mean 11.5; scale 8–32) and minor psychic disorders (mean 11.6; scale 0–36), indicating a perception of good health conditions with regard to these aspects.

Only 9 persons presented minor cardiac arrhythmias, but 63 (8.2%) persons showed high values of blood pressure (systolic blood pressure [SBP] $\geq$ 160 mmHg or diastolic blood pressure [DBP] $\geq$ 95 mmHg), whereas 81 (10.6%) persons had borderline values (SBP between 140 and 160 mmHg, DBP between 90 and 95 mmHg); on the other hand, some persons with diagnosed hypertension presented normal values thanks to proper pharmaceutical treatment.

Taking into consideration that the prevalence of hypertension among ATCs is still controversial, some studies finding a prevalence 1.5 times higher, or an incidence 4 times higher, than the normal population (Cobb & Rose, 1973; Crump, 1979; Mohler, 1983; Rose, Jenkins, & Hurst, 1978), whereas others found no difference (Booze, 1978; Fisher, 1989; Maxwell, Crump, & Thorp, 1983), we investigated this aspect in more detail by means of a careful control of the blood pressure (BP) and related risk factors, and a monitoring of it during a working day.

Blood pressure, recorded during the clinical visit according to the World Health Organization (WHO) protocol, showed a significant positive correlation with weight ($r = .308$; $p < .001$), age ($r = .261$; $p < .001$), cardiovascular

symptoms ($r = .163$; $p < .001$), years of smoking ($r = .12$; $p < .01$), and somatic anxiety ($r = .089$; $p < .05$). However, a comparison between the ATCs and the general population, examined by the same protocol and divided by age groups (Cesana et al., 1991), showed that ATCs had lower mean levels of blood pressure, both systolic and diastolic (Table 5).

**TABLE 5. Mean and Standard Error (*SE*) of Systolic (SBP) and Diastolic (DBP) Blood Pressure in Air Traffic Controllers (ATCs) and Control Group**

| | | ATCs | | | Controls | | |
|---|---|---|---|---|---|---|---|
| Blood Pressure | Age | *n* | *M* | *SE* | *n* | *M* | *SE* |
| SBP | 25–34 | 62 | 119.93 | 1.02 | 200 | 122.52 | 0.91 |
| | 35–44 | 315 | 128.00 | 0.70 | 214 | 128.81 | 0.99 |
| | 45–54 | 323 | 130.96 | 0.81 | 199 | 138.41 | 1.27 |
| | 55–64 | 38 | 137.37 | 2.02 | 203 | 149.18 | 1.53 |
| DBP | 25–34 | 62 | 75.00 | 0.68 | 197 | 81.48 | 0.66 |
| | 35–44 | 315 | 82.64 | 0.54 | 213 | 85.39 | 0.70 |
| | 45–54 | 322 | 83.55 | 0.52 | 199 | 87.71 | 0.75 |
| | 55–64 | 38 | 83.92 | 1.35 | 203 | 89.96 | 0.70 |

Moreover, 80 volunteer ATCs, engaged in the most important Regional Centre in Northern Italy, and aged between 25 and 54 years (mean 39.7), were submitted to ambulatory monitoring of blood pressure for 24 hrs (see Sega et al. [1998] for details). During the conventional control before starting the monitoring, they showed significantly higher mean values than controls (216 participants of the general population) as concerns systolic BP ($133.7 \pm 16.0$ vs. $127.8 \pm 15.4$; $p < .01$) and heart rate ($80.8 \pm 11.4$ vs. $69.6 \pm 10.1$; $p < .001$), but not for diastolic BP ($84.6 < 10.7$ vs. $84.7 \pm 9.6$). During the following 24 hrs (that included the afternoon shift, the night rest, and the following morning shift) the ATCs did not show mean values significantly different from the controls, both during the working hours and at rest (Table 6); instead, they showed a normal fluctuation related to the wake/rest cycle.

As concerns the personality and behavioural characteristics, the ATCs examined appeared, on average, to be more prone to Morningness, whereas they reported intermediate scores for Flexibility of sleeping hours and Languidity to overcome drowsiness. On the other hand, they reported an average tendency for extraversion, but not for Neuroticism (Costa, Schallemberg, Ferracin, & Gaffuri, 1995).

**TABLE 6. Mean Values (±*SD*) of Systolic (SBP) and Diastolic (DBP) Blood Pressure and Heart Rate (HR) During 24 Hours in Air Traffic Controllers (ATCs) and Control Group**

| Time Period | Parameter | ATCs | Controls |
|---|---|---|---|
| 24 hrs | SBP (mmHg) | 119.6 ± 16.4 | 121.1 ± 16.9 |
| | DBP (mmHg) | 75.2 ± 13.7 | 76.7 ± 13.9 |
| | HR (beats/min) | 75.0 ± 14.4 | 74.8 ± 15.6 |
| Wake/Work (07:00–21:00) | SBP (mmHg) | 125.0 ± 14.5 | 126.7 ± 15.4 |
| | DBP (mmHg) | 80.5 ± 11.4 | 81.6 ± 12.2 |
| | HR (beats/min) | 80.1 ± 13.4 | 80.0 ± 15.4 |
| Rest (21:00–07:00) | SBP (mmHg) | 110.7 ± 15.3 | 111.5 ± 15.0 |
| | DBP (mmHg) | 66.4 ± 12.6 | 67.3 ± 11.7 |
| | HR (beats/min) | 66.7 ± 11.8 | 66.0 ± 11.6 |



Morningness was inversely correlated with Languidity in overcoming drowsiness ($r = -.62$, $p < .001$) and with sleep disturbances on the morning shift ($r = -.35$, $p < .001$), but positively correlated with sleep duration both on the morning shift ($r = .22$, $p < .01$) and rest days ($r = .21$, $p < .01$). Flexibility of sleeping habits was slightly negatively correlated with sleep disturbances both on duty and rest days ($r = -.15$ and $-.20$ respectively; $p < .01$), but without a significant correlation with sleep duration on any occasion. On the other hand, Neuroticism was correlated with chronic fatigue ($r = .45$, $p < .001$), digestive ($r = .25$, $p < .001$) and cardiovascular ($r = .23$, $p < .01$) complaints, minor psychological disorders ($r = .25$, $p < .001$), cognitive ($r = .27$, $p < .001$) and somatic ($r = .25$, $p < .001$) anxiety, and sleep disturbances on rest days ($r = .35$, $p < .01$). However, no correlation arose between these personal characteristics and the amount of sick leave or the number of medical consultations.

Comparing the main positions at work, the formerly active controllers (F-ATC) showed worse health conditions (higher scores) in general than those engaged in Regional Centres (RATC) and those working in airport towers (TWR), particularly as concerns minor psychological disorders ($F = 4.45$; $p < .01$) and chronic fatigue ($F = 3.51$; $p < .05$; Table 7). This was probably due to their being significantly older and to the fact that among them there were 16 participants transferred to administrative or supervisory tasks because of health impairments; in particular: 6 for depressive syndromes; 4 for peptic ulcer; 4 for severe hypertension; 1 for myocardial infarction; 1 for angina pectoris and depression.

**TABLE 7. Mean Values (±*SD*) of Some Parameters Concerning Health Conditions in Three Groups of Air Traffic Controllers with Different Work Activity**

| Parameter | Scale | RATC | TWR | F-ATC | *F* |
|---|---|---|---|---|---|
| Age | years | 41.5 ± 7.0 | 43.9 ± 7.7 | 48.3 ± 6.0 | 31.4** |
| Shiftwork experience | years | 19.8 ± 7.4 | 21.8 ± 9.0 | 19.5 ±10.8 | 3.84 |
| Medical consultations per year | number | 3.0 ± 3.7 | 2.9 ± 2.8 | 3.3 ± 3.9 | 0.45 |
| Sick leaves | days/year | 6.9 ±14.5 | 5.1 ±10.7 | 7.8 ±18.9 | 1.37 |
| Chronic fatigue | 10–50 | 22.2 ± 5.3 | 20.9 ± 5.7 | 23.0 ± 5.1 | 4.45* |
| Digestive complaints | 8–32 | 13.1 ± 4.1 | 12.9 ± 4.0 | 13.6 ± 4.9 | 0.65 |
| Cardiovascular complaints | 8–32 | 11.1 ± 3.1 | 10.7 ± 2.8 | 11.3 ± 3.1 | 1.29 |
| Minor psychological disorders | 0–36 | 11.8 ± 4.3 | 11.1 ± 4.2 | 12.7 ± 5.0 | 3.51* |
| Cognitive anxiety | 7–35 | 13.1 ± 4.8 | 12.4 ± 4.8 | 13.7 ± 4.5 | 2.27* |
| Somatic anxiety | 7–35 | 13.7 ± 3.6 | 13.1 ± 3.4 | 13.4 ± 3.4 | 1.22 |

*Notes.* *$p < .05$; **$p < .01$; RATC—Regional Centres, TWR—Airport Towers, F-ATC—Formerly Active Controllers.

Among the active controllers, those engaged in regional centres (RATC) showed slightly higher scores than those engaged in airport towers (TWR) for all the parameters, with a statistically significant difference for chronic fatigue (Tukey test = 3.29; $p < .05$), although they were significantly younger (Tukey test = 5.23; $p < .01$) and had less years of shiftwork experience (Tukey test = 3.80; $p < .01$).

Considering the active controllers together, a small significant correlation between length of shiftwork experience and some health problems was noticed, in particular for cardiovascular ($r = .22$, $p < .001$) and digestive complaints ($r = .18$, $p < .001$), cognitive anxiety ($r = .15$, $p < .01$), minor psychological disorders ($r = .14$, $p < .01$), and sleep disturbances ($r = .14$, $p < .01$). However, the confounding effect of age must be taken into account, and this was highly correlated with the length of shiftwork experience ($r = .91$, $p < .001$).

As concerns sleep (Table 8), the RATC controllers showed higher mean scores for sleep disturbances, particularly on morning shift (Tukey test = 4.00; $p < .01$), probably due to the earlier start of their duty period (at 07:00) compared to those working in control towers (most starting at 08:00) and in offices (starting later than 08:00). In fact, the RATC controllers showed a slight but significant reduction of sleep length (Tukey test = 3.42, $p < .05$) related to their earlier wake up (at 05.36 on average vs. 06.27 [TWR] and 06.13 [F-ATC]; $F = 22.8$, $p < .001$). On the other hand, the RATC controllers showed longer sleep duration (and a larger interindividual

variability) in the night following the night shift ($t = 1.86$, $p < .06$), probably as a consequence of the higher and more variable workload at night in regional centres than in towers.

**TABLE 8. Mean Values (±*SD*) of Sleep Length (Hours and Minutes) and Sleep Disturbances (Scale: 6—*not at all*, 30—*very much*) in Three Groups of Air Traffic Controllers With Different Work Activity**

| Sleep | RATC | TWR | F-ATC | *F* |
|---|---|---|---|---|
| Nocturnal sleep length | | | | |
| Before morning shift | 6.48 ± 0.50 | 7.01 ± 0.56 | 7.10 ± 0.47 | 5.31** |
| Before afternoon shift | 8.23 ± 1.08 | 8.20 ± 0.54 | | |
| Before night shift | 8.06 ± 1.18 | 8.01 ± 0.57 | | |
| After night shift | 10.17 ± 5.33 | 8.54 ± 1.11 | | |
| On days off | 8.20 ± 1.07 | 8.26 ± 0.56 | 8.05 ± 1.16 | 1.14 |
| Sleep disturbances | | | | |
| Morning shift | 18.2 ± 4.9 | 16.9 ± 4.9 | 15.7 ± 4.5 | 8.11** |
| Afternoon shift | 16.9 ± 4.6 | 16.2 ± 4.4 | | |
| Night shift | 18.1 ± 4.7 | 17.4 ± 4.9 | | |
| Days off | 12.0 ± 3.6 | 11.5 ± 3.3 | 13.0 ± 3.6 | 3.98* |

*Notes.* *$p < .05$; **$p < .01$; RATC—Regional Centres, TWR—Airport Towers, F-ATC—Formerly Active Controllers.

Comparing the 417 ATCs engaged in radar work positions with the 340 engaged in non-radar positions, no statistically significant differences appeared for any of the parameters investigated by SSI, except the fact that the radar controllers presented slightly worse scores for chronic fatigue (22.6 ± 5.8 vs. 21.7 ± 5.5; $t = 2.09$, $p < .05$), psychic (11.9 ± 4.5 vs. 11.3 ± 4.1; $t = 1.89$, $p < .06$), and digestive (13.4 + 4.2 vs. 12.8 + 4.1; $t = 1.88$, $p < .06$) complaints. As concerns health disorders, the "radar" group showed, in general, slightly worse conditions than the "non-radar" group, with significant differences as concerns low back pain (27.6 vs. 17.8%; $t = 9.59$, $p < .01$) and gastroduodenitis (36.6 vs. 28.7%; $t = 4.87$, $p < .05$). However, it must be taken into account that the former were slightly older (45.1 ± 5.6 vs. 41.8 ± 8.3; $t = 6.53$; $p < .01$), as the ATCs on non-radar positions inside the Regional Centres were significantly younger than the other three groups ($F = 31.3$; $p < .01$; Table 9). On the other hand, the radar ATCs inside the Regional Centres showed higher (that means worse) scores for all the health indicators than the others. The differences were statistically significant for sleep disturbances ($F = 4.96$; $p < .01$) and minor psychic disorders

TABLE 9. Mean Values (±*SD*) of Some Parameters Concerning Work and Health Conditions in "Radar" and "Non-Radar" Air Traffic Controllers (ATCs), Operating in Regional Centres (RATC) and Airport Towers (TWR)

| | | RATC | | TWR | |
|---|---|---|---|---|---|
| Parameter | Scale | Radar ($n$ = 281) | Non-Radar ($n$ = 124) | Radar ($n$ = 104) | Non-Radar ($n$ = 211) |
| Age | years | 44.1 ± 5.5 | 38.5 ± 8.1 | 46.6 ± 5.0 | 43.5 ± 7.8 |
| Work experience | years | 21.8 ± 5.9 | 17.1 ± 9.1 | 25.1 ± 6.8 | 21.5 ± 9.3 |
| Job satisfaction | 1–7 | 5.5 ± 1.5 | 5.5 ± 1.4 | 5.5 ± 1.4 | 5.6 ± 1.4 |
| Job engagement | 4–20 | 11.8 ± 2.6 | 11.7 ± 2.7 | 12.7 ± 2.6 | 12.3 ± 2.6 |
| Job disengagement | 4–20 | 9.8 ± 2.9 | 9.7 ± 3.0 | 9.8 ± 2.9 | 9.7 ± 3.2 |
| Medical consultations per year | number | 3.4 ± 6.1 | 3.7 ± 5.6 | 2.8 ± 2.6 | 3.3 ± 3.4 |
| Sick leaves | days/year | 8.1 ±22.8 | 8.6 ±16.2 | 4.8 ±12.6 | 6.0 ±11.0 |
| Chronic fatigue | 10–50 | 22.8 ± 5.6 | 22.3 ± 5.2 | 22.1 ± 6.2 | 21.3 ± 5.6 |
| Sleep disturbances (total) | 24–120 | 66.3 ±13.5 | 62.5 ±14.2 | 61.3 ±14.1 | 62.8 ±13.7 |
| Digestive complaints | 8–32 | 13.5 ± 4.2 | 12.7 ± 4.3 | 13.2 ± 4.0 | 12.9 ± 4.0 |
| Cardiovascular complaints | 8–32 | 11.6 ± 3.2 | 11.5 ± 3.7 | 11.5 ± 3.1 | 11.3 ± 2.8 |
| Minor psychic disorders | 0–36 | 12.1 ± 4.5 | 11.5 ± 4.4 | 11.4 ± 3.9 | 11.1 ± 3.9 |
| Cognitive anxiety | 7–35 | 13.5 ± 5.0 | 12.8 ± 4.8 | 12.6 ± 5.0 | 12.7 ± 4.7 |
| Somatic anxiety | 7–35 | 13.8 ± 3.5 | 13.5 ± 4.1 | 12.8 ± 3.4 | 13.4 ± 3.5 |

($F = 2.39$; $p < .05$). They also reported a higher absenteeism for sick leave than their colleagues inside the towers ($t = 3.3$; $p < .07$), even though they were slightly younger.

## 4. CONCLUSIONS

The health of the ATCs examined appeared quite satisfactory in general. The disorders most frequently complained of had a prevalent psychosomatic component, in particular the digestive, cardiovascular, and neuropsychic ones—ones where work stress (and also shiftwork) can have a significant influence.

However, the prevalence of such disorders among our ATCs was mostly lower than, or similar to, that recorded in samples of general population (reported in Terracini [1991]. In particular, diabetes (3.79% in ATCs aged 40–59 years vs. 5.58% in the general population), neuropsychic syndromes (19.7 vs. 20–34.5%), recurrent headache (19.4 vs. 34.7%) and peptic ulcer (9.4 vs. 9.9%), besides hypertension, mentioned already. Only in the case of ischaemic heart disease was a higher prevalence found among ATCs (2.4 vs. 1.32% in men aged 30–59), with a progressive increase with age (and work seniority). In particular, 2.19 versus 0.92% (40–44 age group); 2.59 versus 1.30% (45–49 age group); 4.26 versus 1.19% (50–54 age group); 5.26 versus 1.88% (55–59 age group).

In order to evaluate these findings properly it has to be taken into account that air traffic controllers are a highly selected population of workers and, in accord with the International Civil Aviation Organisation standards, they are submitted to a highly selective medical assessment before employment, and then periodically during their careers (every 2 years for ACTs under 40 years of age and every year for ATCs over 40) in order to keep their licence. This obliges them to take particular care of their psychophysical conditions, as the fear of losing the licence (even temporarily) is one of the perceived stress factors, not only for economic but also for professional reasons. This might be indicated by the high values of systolic blood pressure and heart rate recorded before ambulatory monitoring (like "white coat hypertension"); however, a "healthy worker effect" has been found in the participants transferred to administrative tasks for health reasons.

Moreover, different working conditions in terms of workload, equipment, specific task (e.g., radar/non-radar; regional/tower centres, working schedules,

etc.), can have different impact on health. On the other hand, individual characteristics related to family background, life styles, and coping styles (e.g., sleep), as well as to personality traits and behaviours (e.g., Neuroticism and Morningness) can all have some influence on such effects.

As concerns shiftwork itself, in our case the favourable organisation of the shift schedules according to ergonomic criteria (Knauth, 1996) was certainly a useful support for better coping with the stress of the work.

All these interactions, associated with different methodologies and concepts of healthcare, may explain the somewhat discordant findings reported by the surveys carried out on ATCs in the last decades. For example, peptic ulcer was found to be more frequent in ATCs by Dougherty (1967), Cobb and Rose (1973), and Mohler (1983), but not by Singal et al. (1977) and Fisher (1989); also ischaemic heart disease was found higher in ATCs by Lategola et al. (1971), but not by Booze (1978) and Maxwell et al. (1983). As concerns hypertension, besides the already cited epidemiological studies, the comparison of our data with those reported in a similar enquiry carried out among American ATCs by Rose et al. (1978), showed that there were less hypertensive (8.5 vs. 19.5%) and borderline (18.7 vs. 44.3%) participants among the Italian ATCs, despite their being significantly older (43.2 vs. 36.2 years on average).

Therefore, a careful evaluation of all these factors can have important implications from the preventive point of view as regards, on one hand, a better control and promotion of the ATCs physical and mental conditions and, on the other hand, a continuous improvement of their working situations, specifically aimed at promoting peak performance at work.



## REFERENCES

Akerstedt, T. (1996). *Wide awake at odd hours*. Stockholm, Sweden: Swedish Council for Work Life Research.

Ammerman, H.L., Bergen, L.J., Davies, D.K., Hostetler, C.M., Inman, E.E., & Jones, G.W. (1987). ARTCC/HOST En route controller. In *FAA Air traffic control operations concepts. Volume VI* (Report No. DOT/FAA/AP/86-01). Washington, DC, USA: Federal Aviation Administration.

Barton, J., Folkard, S., Smith, L.R., Spelten, E.R., & Totterdell, P.A. (1990). *The Standard Shiftwork Index and manual* (SAPU/Memo No. 1159). Sheffield, UK: MERC/ESRC Social & Applied Psychology Unit.

Booze, C.F. (1978). *The morbidity experience of air-traffic control personnel* (Report No. FAA-AM-78-21). Washington, DC, USA: Federal Aviation Administration.

Cesana, G.C., De Vito, G., Ferrario, M., Libretti, A., Mancia, G., Mocarelli, P., Sega, R., Valagussa, F., & Zanchetti, A. (1991). Ambulatory blood pressure normalcy: The PAMELA study. *Journal of Hypertension, 9*(suppl 3), 17–23.

Cobb, S., & Rose, R.M. (1973). Hypertension, peptic ulcer and diabetes in air traffic controllers. *Journal of the American Medical Association, 224*, 489–492.

Colquhoun, W.P. (1971). Circadian variations in mental efficiency. In W.P. Colqhuoun (Ed.), *Biological rhythms and human performance* (pp. 39–107). London, UK: Academic Press.

Costa, G. (1991). Shiftwork and circadian variations of vigilance and performance. In J.A. Wise, V.D. Hopkin, & M.L. Smith (Eds.), *Automation and systems issues in air traffic control* (NATO ASI Series, Vol. F73, pp. 267–280). Berlin, Germany: Springer-Verlag.

Costa, G. (1993). Evaluation of workload in air traffic controllers. *Ergonomics, 36*, 1111–1120.

Costa, G. (1996). The impact of shift and night work on health. *Applied Ergonomics, 27*, 9–16.

Costa, G., Schallemberg, G., Ferracin, A., & Gaffuri, E. (1995). Psychophysical conditions of air traffic controllers evaluated by the standard shiftwork index. *Work & Stress, 9*(2/3), 281–288.

Crump, J.J. (1979). Review of stress in air traffic control: Its measurement and effects. *Aviation, Space, and Environmental Medicine, 50*, 243–248.

Dougherty, J.D. (1967). Cardiovascular findings in air traffic controllers. *Aerospace Medicine, 38*, 26–30.

Farmer, E.W., Belyavin, A.J., Berry, A., Tattersall, A.J., & Hockey, G.R.J. (1990). *Stress in air traffic control. 1: Survey of NATS controllers* (IAM Report No. 689). Farnborough, UK: Royal Air Force.

Fisher, M.G.P. (1989). *Stress and illness in air traffic controllers* (Report to Committee on Regulation of Air Traffic Controllers' Hours). London, UK: Civil Aviation Authority.

Folkard, S. (1990). Circadian performance rhythms: Some practical and theoretical implications. *Philosophical Transactions of the Royal Society of London, B 327*, 543–553.

Hurst, M.W., & Rose, R.M. (1978). Objective workload and behavioural response in airport radar control rooms. *Ergonomics, 21*, 559–565.

Kalsbeek, J.W.H. (1976). Some aspects of stress measurement in air traffic control officers at Schiphol Airport. In *Symposium on Stresses of the Air Traffic Control Officers* (pp. 39–42). Manchester, UK: University of Manchester, Department of Postgraduate Medical Studies.

Karson, S. (1969). Some relations between personality factors and job performance rating in radar controllers. *Aerospace Medicine, 40*, 823–826

Klein, E.K., & Wegmann, H.M. (1979). Circadian rhythms of human performance and resistance: Operational aspects. In *Sleep, wakefulness and circadian rhythm* (AGARD Lectures Series No. 105, pp. 2.1–2.17). Neuilly sur Seine, France: AGARD (Advisory Group for Aerospace Research & Development), NATO.

Knauth, P. (1996). Designing better shift systems. *Applied Ergonomics, 27*, 39–44.

Lategola, M.T. (1971). *Changes in cardiovascular health parameters over an eight year interval in an ATC population segment* (Report No. AM-71-19). Washington, DC, USA: Federal Aviation Administration.

Maxwell, V.B., Crump, J.H., & Thorp, J. (1983). The measurement of risk indicators for coronary heart disease in air traffic control officers: A screening study in a healthy population. *Aviation, Space, and Environmental Medicine, 54*(3), 246–249.

Melton, C.E., Smith, R.C., & McKenzie, J.M. (1978). Stress in air traffic personnel: Low density towers and flight service stations. *Aviation, Space, and Environmental Medicine, 49*(10), 724–728.

Mohler, S.R. (1983). The human element in air traffic control: Aeromedical aspects, problems, and prescriptions. *Aviation, Space, and Environmental Medicine, 54*(6), 511–516.

Rose, R.M., Jenkins, C.D., & Hurst, M.W. (1978). *Air traffic controller health change study* (Report No. FAA-AM-78-39). Washington, DC, USA: Federal Aviation Administration.

Sega, R., Cesana, G.C., Costa, G., Ferrario, M., Bombelli, M., & Mancia, G. (1998). Ambulatory blood pressure in air traffic controllers. *American Journal of Hypertension, 11*, 208–212.

Singal, M., Smith, M.J., Hurrell, J.J., Bender, J., Kramkowski, R.S., & Salisbury, S.A. (1977). *Hazard evaluation and technical assistance report: O'Hare International Airport* (Report No. TA 77-67). Cincinnati, OH, USA: National Institute for Occupational Safety and Health.

Terracini, B. (Ed.). (1991). *Epidemiologia & Prevenzione*, 48/49.