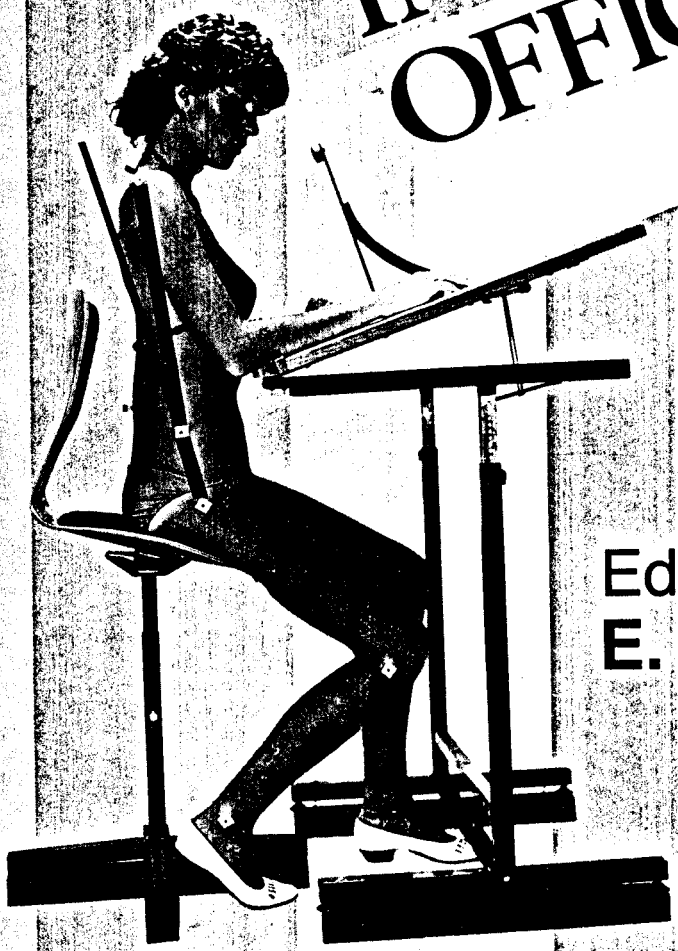
ERGONOMICS AND HEALTH IN MODERN OFFICES



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Posture Analysis and Evaluation at the Old and New Work Place of a Telephone Company

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Abstract

Using an originai method to analyse postures, an old and new (VDT) work station in a switchboard control room were examined. The spinai pathology of 300 workers was studied by means of an appropriate questionnaire. It was observed that the change from the old to the new work station produced an average decrease in lumbar load of 37 kg/h and a significane increase in postural fixity. The discussion of the results suggests how this disadvantage can be avoided.

1. *Introduction*

The increasing application of ergonomics is changing many work places, particularly those requiring sitting postures. In these cases, the use of correct ergonomic criteria has led to considerable improvements with a reduction in the arthro-muscular load, especially on the spine and shoulders.

Besides the need for quantifying the extent and quality of these improvements more precisely, our aim was also to verify if ergonomically designed work places increase postural fixity. A fixed posture, maintained throughout the whole working shift, can in itself be considered a risk factor, particularly for the lumbar spine, where correct intervertebral disc nutrition depends mainly on alternating hydrostatic pressures, above and below the 'criticai' value of 80 kg for optimum time periods not exceeding a few hours (Kroemer 1977).

The posture in which the disc pressures constantly exceed this 'criticai' value produce alterations of the disc nutrition mechanism, which lead to both short-terni disorders, such as numbness or a sense of heaviness in the lumbar region, and long-terni, distai degeneration

processes. Furthermore, if prolonged, supported sitting postures do not strengthen the spine fixing muscles, which are a protettive factor against degenerative disease of this region.

The present paper briefly describes an investigation carried out in the switchboard control room of the National Telephone Company (NTC) in Milan where a graduai transformation of work places from the traditional electromechanical switchboard to a VDT-operated switchboard is in progress. The new work stations have been designed and accomplished according to advanced ergonomic criteria with the advice of the Occupational Health Service of the USSL of Milan.

The purposes of the investigation were:

1. To quantify the damages to the locomotor apparatus in a population that had assumed unsuitable postures for several years.
2. To identify and quantify the differences in loads on joints between the old and new postures, particularly as regards the lumbar spine.
3. To verify whether the work stations designed according to ergonomic criteria increase postural fixity.

2. *Methods*

About 300 persons work in the NTC switchboard control room, of whom about 50% are males. At the present ali the workers use the saure traditional electromechanical switchboards that gradually Ovili be replaced by VDT.. The switchboard (Figure 1) consists of a fixed work surface and a vertical panel in which the operator inserts the jacks; the chairs have fixed backs and a rotating seating surface resting on a 4 point base; the leg area is not sufficient.

The VDT work station was -recently designed according to ergonomic criteria (Figure 2). Ali the parameters and particularly the height and horizontal and sagittal planes of the VDT are easily adjustable. The position of the keyboard, which can be adjusted backwards and forwards, is such that the forearms can be supported. The keyboard is encased to avoid extreme wrist extension movements during typing.

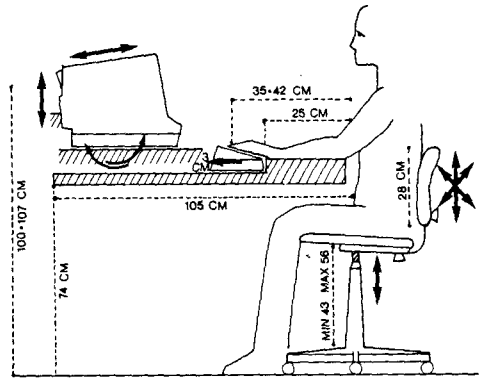
To satisfy the aims of the investigation an appropriate data sheet was developed in order to analyse the postures at old and new work stations with standardized criteria and record posture duration times (Figure 3).

The data sheet covers the possible postures of the trunk on horizontal, sagittal and frontal planes, the way of sitting on the seat, the position of the leg.. The cervical region, which is a substantially independent variable and the upper limbs, which almost always resi on the work surface, are not considered. To each variable was assigned a code number so that each posture is identified by 6 figures followed by the respective duration expressed in seconds.

The whole postural sequence of a subject is determined by the temporal succession of his different postures. The alteration of even only one variable was considered a 'change'.

FIGURE 1. *The old* work *piace.*

Figure 2. The new work piace (VDT).



The study was carried out on 4 subjects, 2 ferrale (A: 41 years, 54 kg, 170 cm; B: 37 years, 52 kg, 159 cm) and 2 males (C: 37 years, 82 kg, 170 cm; D: 44 years, 73 kg, 165 cm) who were not suffering from any serious disorder of locomotor apparatus. Tbcindividuala were

were unaware of the aim of the study. The observations were carried out by 4 different experts and 4 observations were made on each subject: 2 during work at the old switchboard, from 10 to 11 a.m. (the peck period for telephone traffic) and from 1 to 2 p.m. (at the end of the shift). The other 2 observations were carried out in the same perioda the following day at the VDT switchboard. Each subject was always observed by the same expert. Postures maintained for lesa than 5 seconds were not considered for analysis of postural sequences. To compare the number of postural changes in different subjects and in different work stations the number of observed changes was multiplied by 3600 seconds and divided by the real observation time.

To identify the prevalent postures wc rated each posture, on the basis of its duration, in the sequence observed.

Lastly, a study of spinai disease in ali the workers was carríed out by means of a suitably designed questionnaire, sìnce it was not possible to perform medicai examinations. The results of the questionnaire were analysed according to interpretativecriteria recently developed by the authors (Colombina *et al.* 1983).

The questionnaire was distributed to the 248 workers present at the time of the investigation and 201 answers (81%) were received. Age, sex and main anthropometríc charac teristics of the subjects examined are given in Table L

FIGURE 3. *Data sheet to register postural changes.*

TABLE I. *Main characteristics of the examined population.*

Age groups	Number		Age (x ± s)		Working ago		Height (x ± s)		Weight (x ± s)	
	M	F		F	M	F	M	F	M	F
26-35	13	9	32±4	32±3	9±6	13±5	171 ± 6	161 :t 6	61 ± 12	60 --t 13
36-45	64	62	40±3	41±3	15±3	17±4 4	172.t6	161:t6	73±11	58:t9
> 45	18	35	52:t4	50±3	16±7	24±5	170±7 7	161±6 6	78±14	62±9

3. *Results and Discussion*

3.1. Evaluation of Lumbar Spine Load

Not all the variables included in the data sheet are relevant, in our specific case, to the study of lumbar disc loads. Therefore we can limit observations to the following variables for the lumbar spine: supported, upright unsupported, kyphosis, beni. Although analysed, the variants 'bent sideways' and `twisted', were not considered for the synthesis because of their limited influente on the lumbar load (Schultz *et al. 1982):* these variants were therefore incorporateti with equivalent variants on the sagittal piane.

By means of the duration rating of the postures it was possible to calculate the duration of each postural variant for all *8* postural sequences examined at the old switchboard and for the *8* similar postural sequences at the VDT switchboard (Figure *4).* The duration is expressed as a percentage of the total observation time *(20 706* seconds at the old switchboard; *26 493* at the VDT).

We should like to emphasize that during work at the VDT we registered a considerable increase in the duration of the positions with the spine resting on the back-rest, while the duration of kyphosis and trunk bending, positions which were extensive during work at the old work place, dropped to nearly zero.

In Figure *4,* for each postural variant, we have expressed the load on L_3 disc (kg) calculated with an original biomechanical study method (Molteni *et al. 1983),* with due account taken of the results of recent experiments aimed at better evaluating loads in postures with upper Iimbs supported (Occhipinti *et al. 1983).* Finally we calculated a synthetic index, the weighted load on L3 per hour (kg/h), which was *97·5* at the old work place and *60·2* at the new work place. A11 values on L3 are referred to a standard subject weighing *70* kg.

3.2. **Evaluation of the Incidente of Postura! Changes**

The data pertinent to the number of postural changes per hour registered for each subject at the old and new switchboard are shown in Table *2. '*

FIGURE 4. *Average time of permanente in four different positions and load on lumbar spine (L_3) at the old and new work place.*

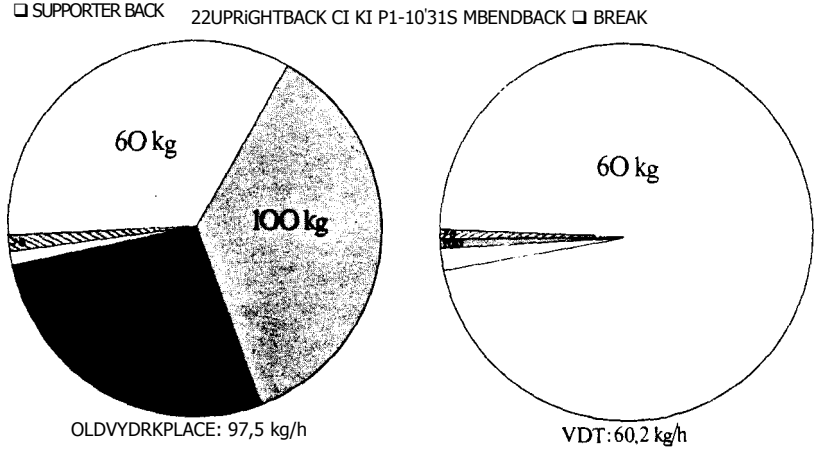


TABLE 2. *Number of postural changes per hour observed in 4 subjects at the old and new work piace.*

	Subject			
Old wórk place (h. 10-11)	31	83	22	14
Old work place (h. 13-14)	58	65.5	12	10
New work place (h. 10-11)	13	28	8	7.5
New work place (h. 13-14)	21	23.5	8	6

The differences in behaviour at various times during the work shift were not significant, which makes it possible to compare the data conceming the old and new switchboards independendy of the working hours.

Tests of statistical inferente were therefore carried out to compare the mean values and the variances of the data at the old and new switchboards. The results show a highly significant difference ($p < 0{\cdot}001$) between the mean values of the number of postural changes at the old and new work places (Table *3).* The difference between the variances were equally significant: in faci, whereas at the old switchboard a considerable dispersion of values around the mean was registered, at the VDT, behaviour was more homogeneous.

A significant difference was also observed between the behaviour of the females and males. But in view of the small number of observations further studies are needed. Since coupled data were available in this case, *we* studied the correlation between the number of changes per hour at the old and new switchboards. The correlation coefficient was higher than *0·99.* The equation of the regression lane is

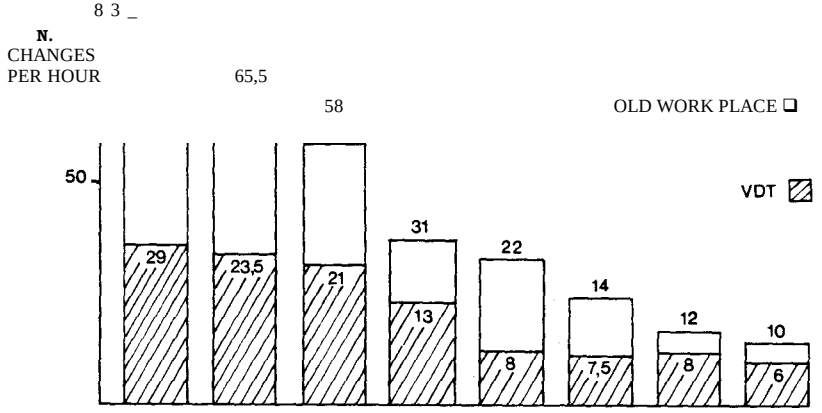
$$y = 2{\cdot}98 + 0{\cdot}31\,x.$$

TABLE 3. *Results of inferente teste for differences between means and variances of number of changes per hour in the old and new work piace.*

X = 3 6 9 3	SX = 26,25	Y=14,5	SX = 8,23
DIFFERENCES BETWEEN MEANS		DIFFERENCES BETWEEN VARIANCES	
ó x - y. 22,43	S_{x_Y} - 18.1	!s~. F - 5 ~ - Y - 1 0 , 1	
t- 3,5	p X0'01	p ,0, 01	

Figure 5 reports the number of changes per hour at the old and new switchboards. It can be observed that the change from the old to the new work station produced a reduction in the number of changes (and therefore an increase of fixity) that is much more marked for the subjects who showed a high index at the old switchboard: that is to say, the mean decrease per cent in the number of changes per hour was 71% in subject B, *62%* in subject A, 53% in subject C and *44%* in subject D.

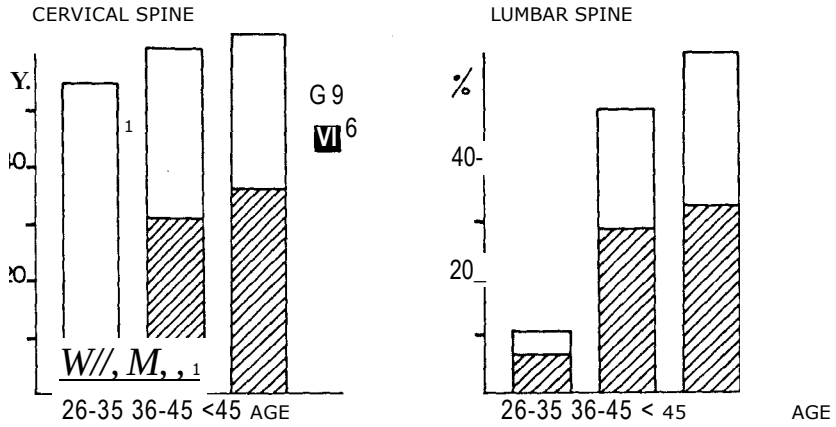
FIGURE s. *Number of postural changes per hour observed in the subjects at the old and new work piace.* &



3.3. **Study of Prevalence of Spinai Disorders in thePopulation Under Study**

Figure 6 reports the prevalente of anamnestic cervical and lumbar osteoarthro-muscular pathology, divided by age and sex. Besides an age-related trend, attention is drawn to a constane higher prevalente of this pathology in females.

FIGURE 6. *Prevalence of anamnestic cervical and lumbo-sacral osteoarthro-muscular pathology in relation to age and sex.*



4. *Conclusione*

We can draw the following conclusione:

1. The p revalence of anamnestic spinal disorders was similar to that which we have observed in other groups of workers exposed to a similar risk. It is, however, fairly high thus confirming the diffusion of spinal disorders in relatively young people. Nevertheless, in this case, the results do not permit a precise interpretation of the relationship between the previous postural risk and the observed damage.
2. We utilize methods to quantify the loads on different segments of the body, especially on the spine, which also take account of the time and mode of exposure to postural risk. By means of these methods, in the observed situation, we recorded an average decrease in lumbar load of about 37 kg/hour changing from the old to the new work station.
3. We found that the new work station produced a significane increase in postural fixity. To avoid this disadvantage ergonomic improvements musi be applied both to machines and work organization. In our case, the introduction of new work stations was accompanied by the introduction of a 15-minute break every 2 hours. For similar cases a break of between 5 and 15 minutes every 2 hours maximum is suggested as a suitable measure to prevent the disadvantage due to excessive postural fixity.

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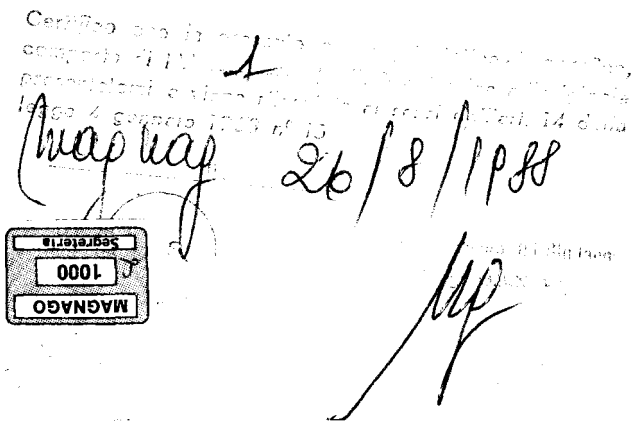
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