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Salivary markers of work stress in an emergency team of urban police (1° step)

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ABSTRACT. INTRODUCTION. Stress is usually defined as the experience of negative events or the perceptions of distress and negative affect that are associated with the inability to cope with them. The parameter most suitable for large-scale field studies is the determination of endocrine activity by measurement of salivary cortisol. The aim of the present study is to identify the presence of sources of stress in an emergency team of urban police and to objective such stress using the PSS (Professional Stress Scale) test and bioumoral markers as salivary cortisol and interleukin 1 β (IL-1B). **MATERIALS AND METHODS.** We studied 30 policemen who belonged to an emergency team. Salivary samples were collected at the start and at the end of the work-shift. As control we used the same subjects during the holiday. T test was performed to evaluate the differences between the means, the Chi Square's Test was performed to determine the statistically significant association between PSS subscales and salivary cortisol and IL-1B concentrations. **RESULTS.** Thirty policeman were evaluated, their mean age was 44,5 years, their mean work experience was 17,1 years. The PSS test indicated high scores in three subscales, they were work load, organizational structure and processes and lack of resources. **SALIVARY CORTISOL:** The mean concentration at the start of work-shift was higher than at the end of shift-work ($p<0,05$). T test indicated a statistically significant difference between mean cortisol concentrations at the same hour during the work (start and end) and during the holiday ($P<0,05$). A statistically significant negative association was noted between the PERC1 and PSS subscale called "work load" ($p<0,05$). **SALIVARY IL-1B:** the mean concentration of IL-1B at the start of the work-shift resulted higher than at the end, such reduction was statistically significant ($P<0,05$). We verified a positive association between the subclass of PSS Test called "conflict with other professionals" and salivary IL-1B concentration at the start of shift-work ($p<0,05$). **DISCUSSION.** Several precedent studies agree with our results. Our study has suggested a work related stress in urban police employed in an emergency team. We might conclude that salivary IL-1B and cortisol are useful markers of stress. We think that our findings, surely preliminary, have been corroborated by the study of vegetative parameters (heart rate, heart rate variability) that is still current. It might be useful to evaluate again the cortisol and IL-1B variations after some structure organizational modifications and after training that will teach the workers coping strategies. We might conclude that the stress discovered in this study is not hazardous for the health, if the workers have adequate holidays.

Key words: cortisol, interleukin 1B, coping, workload.

RIASSUNTO. Lo stress è comunemente definito come l'esperienza di eventi negativi o la percezione di ansietà ed impressioni negative che si associano all'incapacità di convivere con loro. Sono stati effettuati molti tentativi per obiettivare le reazioni fisiologiche a stress psicomentali. Il nostro studio si propone di identificare la eventuale presenza di fonti di stress in una squadra di emergenza della polizia

urbana e di obiettivare tale situazione attraverso la somministrazione di un test psicometrico, il Professional Stress Scale (PSS), e la valutazione di markers bioumoral di stress come il cortisolo e l'interleuchina 1 β (IL-1B) salivari. **MATERIALS AND METHODS.** Lo studio fu condotto su 30 vigili urbani che appartenevano ad una squadra di emergenza. Il campionamento salivare avvenne all'inizio e alla fine del turno di lavoro. Come gruppo di controllo furono utilizzati gli stessi soggetti durante le ferie. Per l'analisi statistica furono utilizzati il test t per la valutazione delle differenze tra le medie e il test del Chi quadro per evidenziare la significatività di associazioni tra le sottoscale del PSS e le concentrazioni salivari di cortisolo e IL-1B. **RISULTATI.** Le medie dell'età e dell'anzianità lavorativa della popolazione in studio risultarono rispettivamente 44,5 e 17,1 anni. Il PSS test evidenziò alti punteggi in tre sottoclassi: carico di lavoro, struttura organizzativa e mancanza di risorse. **CORTISOLO SALIVARE:** si evidenziò che la concentrazione media prima del lavoro era più alta rispetto a quella alla fine del turno ($p<0,05$). Il t test evidenziò una differenza statisticamente significativa tra le concentrazioni medie di cortisolo alla stessa ora durante il lavoro e durante le ferie ($p<0,05$). Il nostro studio ha evidenziato un'associazione negativa, statisticamente significativa, tra la percentuale di cortisolo (PERC1) e la sottoscala del PSS chiamata "carico di lavoro" ($p<0,05$). **IL-1B SALIVARE:** la concentrazione media di IL-1B prima del lavoro risultò più alta rispetto alla fine del turno, tale differenza è statisticamente significativa ($p<0,05$). Abbiamo riscontrato infine una positiva correlazione tra la sottoscala del PSS test chiamata "conflittualità con altri colleghi" e concentrazione salivare di IL-1B all'inizio del turno ($p<0,05$). **DISCUSSIONE.** Diversi studi effettuati in precedenza concordano con i nostri risultati. Il nostro studio ha evidenziato la presenza di uno stress lavoro-correlato in vigili urbani facenti parte di una squadra di emergenza. Lo stress lavoro-correlato fu evidenziato sia usando il PSS test sia attraverso la determinazione del cortisolo e dell'IL-1B. Riteniamo che i nostri risultati, senz'altro preliminari, debbano essere corroborati dallo studio dei parametri del Sistema Nervoso Vegetativo (frequenza cardiaca e sua variabilità) che è tutt'ora in corso. Per concludere riteniamo che IL-1B e cortisolo salivare siano degli affidabili markers di stress e che quindi permettano di oggettivare situazioni difficilmente obiettivabili solo con il test psicometrico in contesti lavorativi stressanti. Sarebbe oltremodo utile rivalutare i markers dello stress, dopo opportune modifiche migliorative nell'organizzazione dell'attività lavorativa dei vigili urbani da noi studiati, a tali interventi si potrebbe associare un programma di training dei lavoratori, durante il quale vengano insegnate delle opportune strategie di coping. Un'ultima considerazione ci pare opportuno fare, lo stress da noi osservato scompare al di fuori dell'attività lavorativa e questo lo identifica come meno pericoloso per la salute del lavoratore se sono assicurati adeguati periodi di ferie.

Parole chiave: cortisolo, interleuchina 1B, coping, workload.

Introduction

Stress is usually defined as the experience of negative events or the perceptions of distress and negative affect that are associated with the inability to cope with them (1).

During work individuals interactions (relationships), workload, organization, personal responsibility and conflict home/work can play a primary role. They are mentioned as sources of work stress (2).

It's known that stress can affect immunity (3). Particularly, stress has been shown to induce alterations in cell trafficking and functions and has also affected humoral immunity (4-7). Stress doesn't necessarily have to be viewed as a totally negative influence on immunity (8-10). Whilst mild, brief, and controlled states of challenge may be positive stimuli to emotional and intellectual growth; severe, protracted and uncontrollable situations may lead to disease states. It has also been suggested that immunosuppression correlates more closely with the individual's perception of stress, rather than with the life event itself and that the perception of external factors through psychological filters may alter physiological responses (11-14).

Working environments in the health care industry, particularly exposed to stress, are critical units (15). High turnover of staff has been attributed to stress and an increased incidence of burn-out (16). Many attempts have been made to objectify physiological reactions to psychomental stress by means of ambulatory monitoring of the autonomous nervous system parameter (e.g. by heart rate and heart rate variability), the hypothalamic-pituitary-adrenal axis (HPA-axis) and immune functions (e.g. by lymphocyte proliferation and natural killer cell cytotoxicity) (17). The parameter most suitable for large-scale field studies is the determination of endocrine activity by measurement of salivary cortisol (18). Salivary cortisol closely correlates to the biologically active, free circulating cortisol. Salivary levels rise within minutes in response to acute stress, peak after 15-30 min and decline with half-time of approximately 1 h (19). Psychological stress, such as extensive physical activity, trigger responses from the hypothalamic-pituitary-adrenal axis (HPA-axis) (18). Activation of HPA-axis results in transitory elevations of circulating cortisol (20).

Immunity and neuro-endocrine activity module themselves, the first modules the second and vice versa. Numerous reports indicate the existence of bidirectional communication between the immune and the endocrine systems through various interleukins (IL-1, IL-2 and IL-6) (21-22).

The aim of the present study is to identify the presence of sources of stress in emergency team of urban police and to objective such stress using biomoral markers as salivary cortisol and interleukin 1 β (IL1-B).

Then we want to evaluate an association between the subscales of a modified mental health Professional Stress Scale (PSS) and salivary cortisol and IL1-B concentrations. Particularly we want to evaluate the presence of "social" stressors and the association between IL1-B, cortisol and stressors.

Materials and methods

We studied 30 policemen who belonged to an emergence team, in fact they might be called to resolve several urban problems. Their shift-work started at 8.00 and finished at 13.30. Salivary samples were collected at the start and at the end of the shift work. As control we used the same subjects during the holiday.

The samples were collected at the same hour either during the work or during the holiday (8.00 and 13.30). In this article the samples collected during the holiday will be indicated below as "morning" if they were collected at 8.00, and "afternoon" if they were collected at 13.30.

The objectives of the study were explained to the policemen. Information on age, years of work experience in the policeman profession, illness history and socio-demographic characteristics were taken. The modified mental health Professional Stress Scale (PSS) was used to assess self-perceived work-related stress, it was modified to assess the work-related stress (23). The policemen were informed about the collection method of the salivary sample (Salivette-Sarstedt), they were asked to contribute two saliva samples. They were asked in advance not to eat or drink (except for water) 1 hour before saliva collection to minimize possible food debris and stimulation of salivation. After the collection, the samples were immediately brought to the laboratory and stored frozen at -20°C until required for assay. Salimetrics HS-Cort kit (Salimetrics LLC) was used for the quantitative measurement of salivary cortisol. Then, because salivary cortisol is not affected by salivary flow rate, only salivary concentration was used in the analysis (19). IL1-B was determined using an ELISA kit (Roche). Total proteins were assayed by the Bradford method using a commercial kit (Biorad). The results of IL1-B were expressed as IL1B/salivary protein concentration. We observed a intra- and inter-assay variability rates less than 8%.

Statistical analysis

The difference between the start and end of shift-work cortisol concentrations was calculated using the start shift-work concentration minus the end shift-work concentration. In this article we indicated DIFF1 as the difference during the work and DIFF2 as the difference during the holiday at the same hours of shift-work. The percentage of cortisol difference was calculated by dividing the difference between the start of shift-work concentration and end concentration by the end cortisol concentration. We indicated PERC1 as the percentage of cortisol difference during the shift-work and PERC2 as the percentage of cortisol difference during the holiday. The results of IL1-B were expressed as IL1B/salivary protein concentration.

The t test was performed to evaluate the differences between the means, the Chi Square Test was performed to determine the statistically significant association between PSS subscales and salivary cortisol and IL1-B concentrations.

Results

Thirty policeman were evaluated, their mean age was 44,5 years, their mean work experience was 17,1 years. (Table I). Only 7 were cigarette smokers. As regard the schooling, 1 had completed secondary school, 26 had obtained a diploma and three were graduates.

The mean arterial blood pressure (systolic and diastolic) was higher at the start and the end of shift-work than during the holiday in the same hours (Table II). This difference was statistically significant ($p < 0.05$).

Table I. Characteristic of study population: indexes of central tendency and dispersion.

INDEX	AGE	WORK EXPERIENCE
MEAN	44	17,1
MEDIAN	45	19
S. D.	5,8	6,4

Table II. Blood pressure: indexes of central tendency and dispersion

INDEX	START OF SHIFT-WORK	END OF SHIFT-WORK	AT 8.00 HOLIDAY	AT 13.30 HOLIDAY
MEAN	135,3/89	135,3/89	133,2/84	131,8/84
MEDIAN	136,5/90	135/90	130/80	130/83
S. D.	15,4/10,2	14,6/9,9	12,5/7,2	14,6/8,7

Professional Stress Scale and its subscales

The PSS test indicated high scores in three subscales, they were work load, organizational structure and processes and lack of resources. 28 policemen indicated a lack of resources, 25 reputed a deficient organizational structure and 21 considered the work load too much hard.

Salivary cortisol

In Fig. 1 and Fig. 2 we show the dot plot of cortisol concentrations of the samples collected at the start and end of shift-work and the cortisol concentrations during the holiday at the same hour of shift-work.

The mean concentration at the start of shift-work was higher than at the end of shift-work ($p < 0,05$). Instead, during the holiday, the morning concentration was higher than at the start of shift-work and it increased in the afternoon, but this

increment wasn't statistically significant. T test indicated a statistically significant difference between mean cortisol concentrations at the same hour during the work (start and end) and during the holiday ($P < 0,05$).

In table III we indicated mean, median and standard deviation of salivary cortisol concentration during the work day and during the holiday.

In table IV we showed the mean, median and standard deviation of the differences of salivary cortisol between the start and end of shift-work (DIFF1), the mean, median and standard deviation of the differences, during the holiday, between morning and afternoon cortisol concentration (DIFF2), the percentage of cortisol during the shift-work (PERC1), the percentage of cortisol during the holiday (PERC2).

In Fig. 3 we showed evidence of the different frequencies distribution of salivary cortisol concentrations at the start of shift-work and in the morning during the holiday. In Fig. 4 we matched the frequencies distribution of cortisol concentrations at the end of shift-work with those at the same hour during the holiday. The variability is more evident during the holiday than during the work day. On this day the values are slightly variable.

We divided the population into two groups according to the median value of PERC1. Particularly in the subgroup with PERC1 lower than the median we found 12 subjects (85%) who had a high score in PSS subclass called work-load, whereas in the subgroup with PERC1 higher than the median, only 6 (50%) had a high score in the same subclass. This association resulted statistically significant ($p < 0.05$).

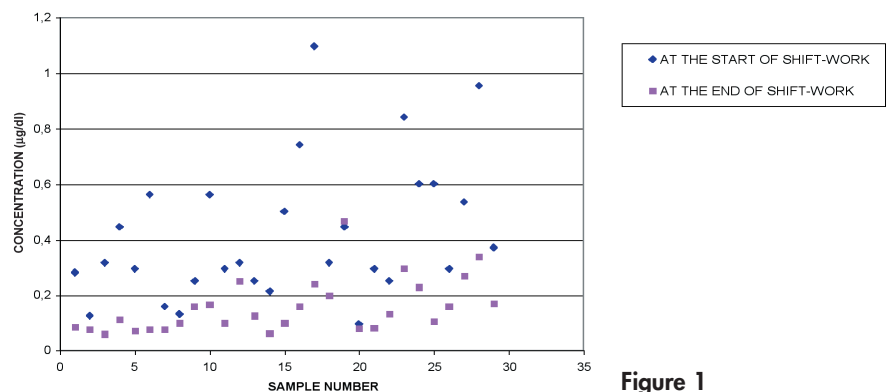


Figure 1

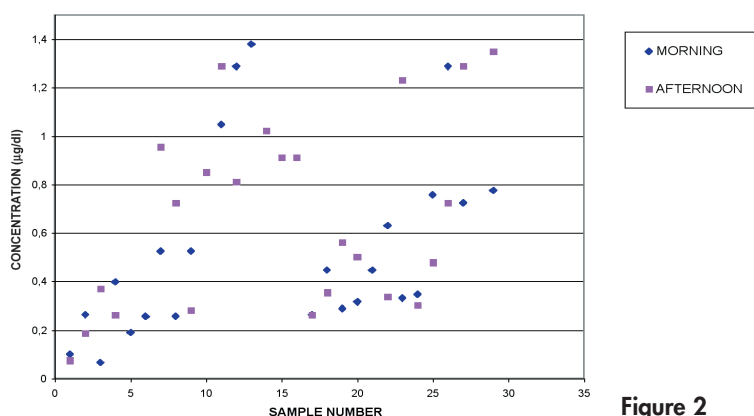


Figure 2

Table III. Cortisol concentrations ($\mu\text{g}/\text{dl}$)

INDEX	START OF SHIFT-WORK	END OF SHIFT-WORK	AT 8.00 HOLIDAY	AT 13,30 HOLIDAY
MEAN	0,419	0,157	0,774	0,895
MEDIAN	0,316	0,125	0,524	0,812
S. D.	0,249	0,096	0,645	0,630

Table IV. Cortisol indexes

INDEX	DIFF1	DIFF2	PERC1	PERC2
MEAN	0,262	- 0,121	2,076	0,075
MEDIAN	0,202	0,00	1,835	0,093
S. D.	0,213	0,722	1,600	0,711

DIFF1 = difference of salivary cortisol between the start and end of shift-work.
DIFF2 = difference of salivary cortisol, during the holiday, between morning and afternoon.

PERC1 = the percentage of cortisol during the shift-work (the percentage of cortisol difference was calculated by dividing the difference between the start of shift-work concentration and end concentration by the end cortisol concentration).

PERC2 = the percentage of cortisol during the holiday (the percentage of cortisol difference was calculated by dividing the difference between the morning concentration and afternoon concentration by the afternoon cortisol concentration).

We observed a difference between PERC2 and the professional subscale “called self-doubt”, but this difference wasn’t statistically significant.

We could suppose that the marker is useful only during the shift-work, because it is not correlated, during the holiday, with any subscale of PSS Test.

Salivary IL1-B

In table V we see mean, median and standard deviation of salivary IL1-B concentration during the shift-work and during the holiday.

The mean concentration of IL1-B at the start of the shift-work resulted higher than at the end, such reduction was statistically significant ($P<0.05$). It was verified a IL1-B reduction, during the holiday, but it wasn’t statistically significant.

In Figg. 5-6 we indicated the dot plot of salivary IL1-B concentrations during work and during the holiday, we can see which values are not similar.

We verified a positive association between the subclass of PSS Test called “conflict with other professionals” and salivary IL1-B concentration at the start of shift-work ($p<0,05$).

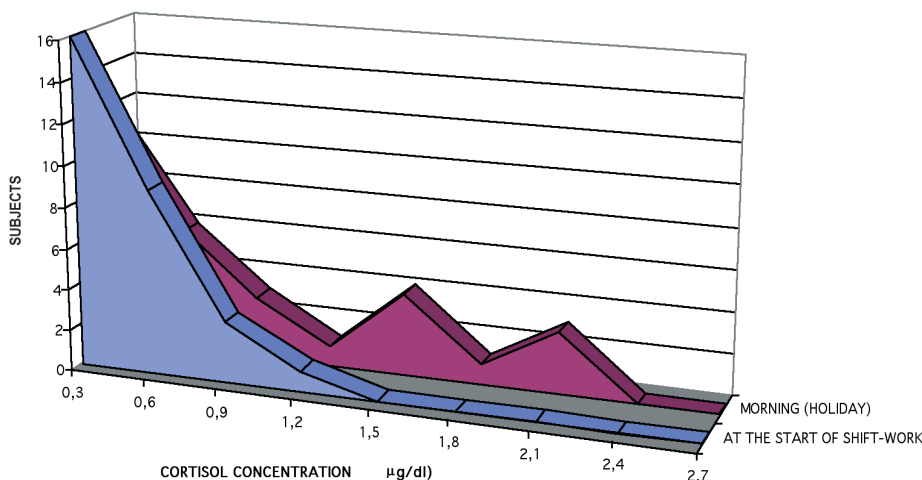


Figure 3.

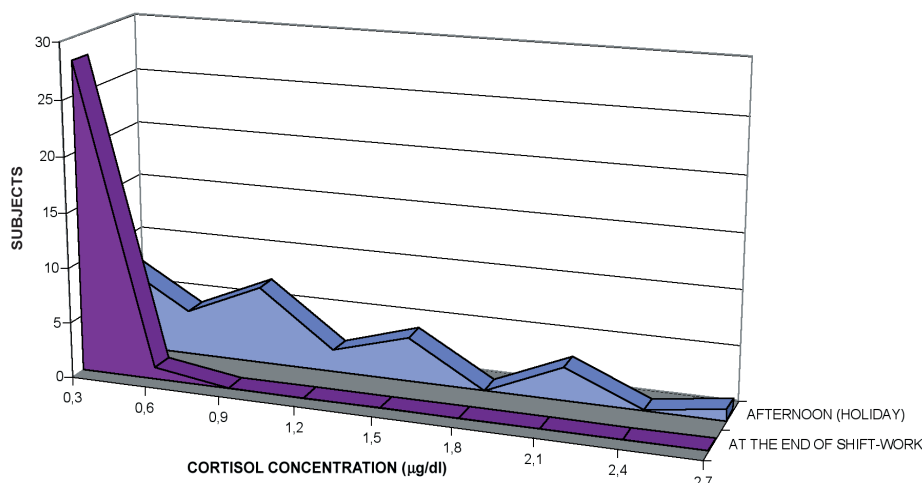


Figure 4

Discussion

Several precedent studies agree with our results. Yehuda et Al observed in a group of 35 adult offspring of holocaust survivors significantly lower 24-hour urinary cortisol excretion in respect of a control (24). Goenjan et Al evaluated 37 adolescents who were exposed to two levels of earthquake-related trauma. Lower cortisol levels were found in the more traumatized adolescents living in the city closest to the epicenter (25). Another study investigated the teachers. In particular the authors demonstrated lower salivary cortisol concentrations in the teachers scoring high on burn out and perceived stress (26). Yehuda indicated that in posttraumatic stress disorder there was a hyposecretion of corticotropin and cortisol under baseline conditions (27). Also Yang et Al demonstrated in the emergency department nurses a morning cortisol concentration lower than control (28).

Table V. IL1-B Concentrations (picog/dl)

INDEX	START OF SHIFT-WORK	END OF SHIFT-WORK	AT 8.00 HOLIDAY	AT 13,30 HOLIDAY
MEAN	3,682	2,824	4,474	3,286
MEDIAN	3,005	2,325	3,612	2,531
D. S.	2,860	1,922	3,303	2,492

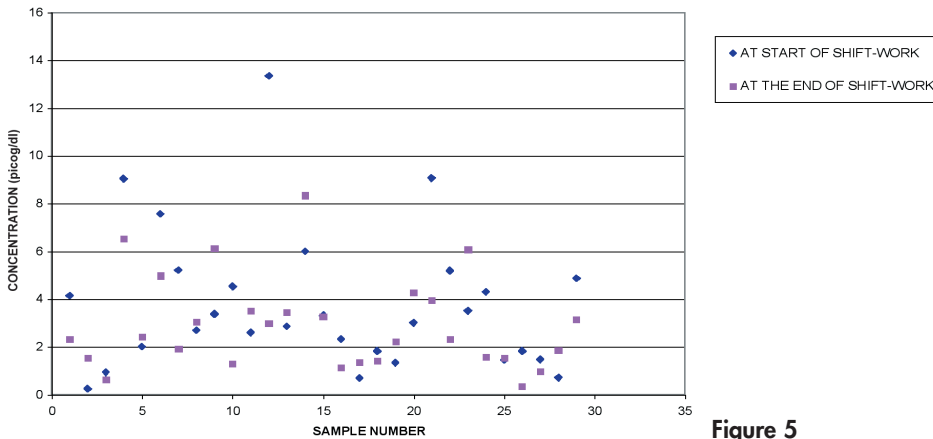


Figure 5

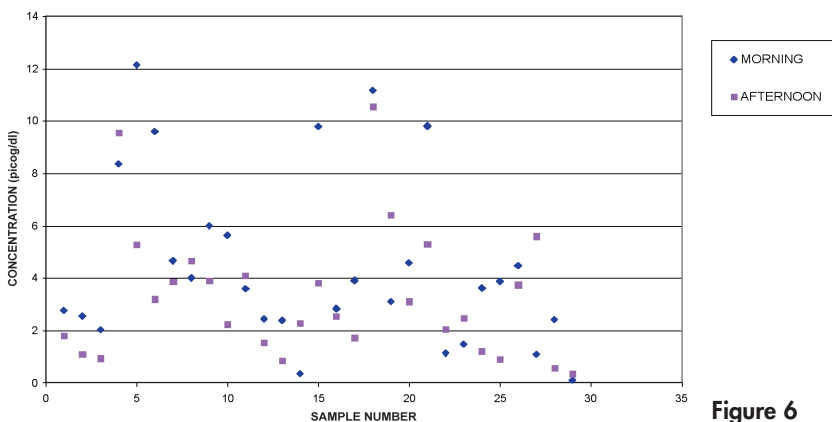


Figure 6

Our study is in variance with Shultz, he discovered in students who perceived chronic stress, a higher early morning cortisol increase after awaking than those who did not (29).

Another study evaluated in 60 unemployed subjects a higher morning and evening salivary cortisol concentration than 60 employed subject (30).

Probably the stress is slight in the students and the unemployed subjects compared with war veterans and others subjects indicated above as the policemen.

Our study has suggested a work related stress in urban police employed in an emergency team. Work related stress was discovered either using the PSS test or through salivary cortisol and IL1-B. The double sampling, during the holiday and during the work-shift, allowed to reduce control-related mistakes. The statistically significance differences and associations noted above might allow to conclude that salivary IL1-B and cortisol are useful markers of stress. The slight variations of cortisol concen-

trations at the start of the work-shift, evaluated using the frequencies distribution, might be evidence that the work related stress reduces the ordinary biological variability, such slight variations are also present at the end of work shift. Instead, during the holiday, it appears to return the ordinary biological variability.

We think that our findings, surely preliminary, have been corroborated by the study of vegetative parameters (heart rate, heart rate variability) that is still current.

Finally we think that determination of salivary cortisol and IL1-B might be used to evaluate the stressful working environments.

It might be useful to evaluate again the cortisol and IL1-B variations after some structure organizational modifications and after training that will teach to the workers coping strategies.

Then it would be useful to evaluate, through a replication of study, if the markers of stress reach, during the work, the same concentrations during the holiday.

Therefore we can add that the IL1-B and cortisol variations are not stable, because they reverse during the holiday.

We might conclude that the stress discovered in this study is not hazardous for the health, if the workers have adequate holidays.

References

- 1) Cohen S, Miller G.E, Rabin B. S. Psychological stress and antibody response to immunization: a critical review of the human literature. *Psychosomatic Medicine*. 2001; 63: 7-18.
- 2) Miller K, Greyling M, Cooper C, Lu L, Sparks K, Spector P. Occupational stress and gender: a cross-cultural study. *Stress Med* 2000; 16: 271-278.
- 3) Wade Ahmed A, Kuschke Reverie H, Kometz Smadar. Personality factors, stress and immunity. *Stress and Health* 2001. 17: 25-40.
- 4) Herbert TB, Cohen S. Depression and immunity: a metanalytic review. *Psychol. Bull.* 1993; 113: 472-486.
- 5) Kang DH, Coe Cl, McCarthy DO, Ershler WB. Immune responses to final exams in healthy and asthmatic adolescents. *Nurs Res* 1997; 46: 12-19.
- 6) Chrousos GP, Gold PW. The concept of stress and stress system disorders: overview of physical and behavioural homeostasis. *J. Am. Med. Assoc.* 1992; 267: 1224-1252.
- 7) Ader R, Felton DL, Cohen N (eds). *Psychoneuroimmunology* (2nd edn). Academic Press: San Diego, CA, 1991.
- 8) Jemmott JB, Locke SE. Psychosocial factors immunologic mediation and human susceptibility of infectious diseases: how much do we know? *J Am Psychol Assoc* 1984; 95:78-108.

- 9) Dantzer R, Kelley DW. Stress and immunity: an integrated view of relationships between the brain and immune system. *Life Sci*. 1989; 44: 1995-2008.
- 10) O'Leary A. Stress emotion and human immune function. *Psychol Bull* 1990; 108: 363-382.
- 11) Sapolsky RM. Stress in the wild. *Sci Am* 1990; Jan: 106-113.
- 12) Dorian B, Garfinkel P, Brown G, Shore A, Gladman D, Keystone E. Aberrations in lymphocyte subpopulations and function during psychological stress. *Clin Exp Immunol* 1982; 50: 132-138.
- 13) Farne' MA, Boni P, Corallo A, Gnugnoli D, Sacco FL. Personality variables as moderators between hassles and objective indications of distress (s-IgA). *Stress Med* 1994; 10: 15-20.
- 14) Dantzer R. Stress and immunity: what have we learned from psychoneuroimmunology? *Acta Physiol Scand Suppl* 1997; 640: 43-46.
- 15) Oehler JM, Davidson MG. Job Stress and burnout in acute and nonacute pediatric nurses. *Am J Crit Care* 1992; 1: 81-90.
- 16) Oates RK, Oates P. Stress and mental health in neonatal intensive care units. *Arch Dis Child* 1995; 72: F107-F110.
- 17) Boyce WT, Adams S, Tschann JM, Cohen F, Wara D, Gunnar Mr. Adrenocortical and behavioral predictors of immune responses to starting school. *Pediatr Res* 1995; 38: 1009-1017.
- 18) Kirshbaum C, Hellhammer DH. Salivary cortisol in psychobiological research: an overview. *Neuropsychobiology* 1989; 22: 150-169.
- 19) Kirshbaum C, Hellhammer DH. Salivary cortisol in psychoneuroendocrine research: recent developments and applications. *Psychoneuroendocrinology* 1994; 19: 313-333.
- 20) Hellhammer DH, Kirshbaum C, Belkien L. Measurement of salivary cortisol under psychological stimulation. In: Hingtgen JN, Hellhammer DH, Huppmann G (eds) *Advanced methods in psychobiology*. Toronto: Hogrefe, 1987, 281-289.
- 21) Lumpkin MD. The regulation of ACTH secretion by IL-1. *Science* 1987; 238: 452-456.
- 22) Imura H, Fukare J, Mori T. Cytokines and endocrine secretion function: interaction between the immune and endocrine systems. *Clin Endocrinol* 1991; 35: 107-122.
- 23) Cushway D, Tyler PA, Nolan P. Development of a stress scale for mental health professionals. *Br J Clin Psychol* 1996; 35(part 2) : 279-295.
- 24) Yehuda R, Bierer LM, Schmeidler J, Aferiat DH, Breslau I, Dolan S. Low cortisol and risk for PTSD in adult offspring of holocaust survivors. *Am J Psychiatry* 2000; 157: 1252-1259.
- 25) Goenjian AK, Yehuda R, Pynoos RS. Basal cortisol, dexamethasone suppression of cortisol and MHPG in adolescents after the 1988 earthquake in Armenia. *Am J Psychiatry* 1996; 153: 929-934.
- 26) Pruessner JC, Hellhammer DH, Kirschbaum C. Burnout, perceived stress, and cortisol responses to awakening. *Psychosom Med* 1999; 61: 197-204.
- 27) Yehuda R. Long lasting hormonal alterations to extreme stress in humans: normative or maladaptive? *Psychosom Med* 1993; 55: 287-297.
- 28) Yang Y, Koh D, Lee FCY, Chan G, Dong F, Chia SE. Salivary cortisol levels and work-related stress among emergency department nurses. *JOEM* 2001; 43: 1011-1018.
- 29) Schultz P, Kirschbaum C, Pruessner J, Hellhammer D. Increased free cortisol secretion after awakening in chronically stressed individuals due to work over-load. *Stress Med* 1998; 14: 91-97.
- 30) Ockenfels MC, Porter L, Smyth J, Kirshbaum C, Hellhammer DH, Stone AA. Effect of chronic stress associated with unemployment on salivary cortisol: overall cortisol levels, diurnal rhythm, and acute stress reactivity. *Psychosom Med* 1995; 57: 460-467.

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