

Cardiac Autonomic Profile in Remote Working Office Employee With and Without Children

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Abstract — Remote work is a novel job condition characterized by an overlap between working and domestic demands. The stress-related impact of this modality has been mainly evaluated qualitatively but not quantitatively. The aim of the study was to compare the cardiac autonomic profile of office employees with and without children during a day of remote work by means of power spectral analysis of heart rate variability extracted by a 24-hour Holter ECG recording. A visual analogue scale (VAS) was collected to measure the rate of the perceived level of stress while remotely working. Fifty subjects were enrolled: 23 with at least one child (CHILD group, 9 males) and 27 without (NO_CHILD group, 16 males). Vagal modulation was assessed as the power of the RR interval time series in the high frequency (HF_{RR}, from 0.15 to 0.40 Hz) band. The VAS was not significantly different in the two groups. HF_{RR} did not exhibit circadian rhythm in CHILD group, while it was higher during NIGHT compared to DAY in NO_CHILD group. During NIGHT, HF_{RR} was greater in NO_CHILD than in CHILD group. During remote working, CHILD group was characterized by a reduced nocturnal vagal modulation compared to NO_CHILD one. The latter result might be considered a risk factor for cardiovascular disease in the long-term period.

I. INTRODUCTION

Remote working has become a very common modality for many office employees to limit the spread of the COVID-19 pandemic, replacing the habitual office environment with the domestic one. This job condition blurred lines between working and domestic demands, introducing changes in familial relationships, job-related stress and productivity [1, 2]. Until now, some studies investigated the impact of the family burden on the psycho-social sphere during remote working conditions through qualitative questionnaires [3]. Very few studies explored the influence of these social and work environmental factors on cardiac neural regulation and, overall, cardiovascular risk. A previous study [4] compared female healthcare professionals with at least a child and childless colleagues in terms of their perceived level of work-

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related stress and their autonomic control profile. The study showed that the presence of children determined a reduced nocturnal cardiac vagal modulation, which in turn may represent an adaptive mechanism and/or a latent increased risk for cardiovascular disease [4]. Instead, a recent pilot study revealed that healthy office employees had a significant change in the autonomic control with an increase in the cardiac vagal modulation during nighttime and less perceived levels of stress while working remotely [5]. These factors could determine a general beneficial effect for the cardiovascular system and psychological state of the office employees [5]. However, the influence of parenting on autonomic control in office employees while working remotely was never investigated before. Therefore, the aim of the present study is to determine whether parenting factor might influence the perceived level of stress and the autonomic control during remote working. The study examined two groups of healthy office employees with and without children measuring the perceived level of job-related stress and the cardiac autonomic control profile.

II. EXPERIMENTAL PROTOCOL AND DATA ANALYSIS

A. Experimental Protocol

The study enrolled healthy office employees with and without children. A 3-lead 24-hour Holter electrocardiogram (360° eMotion FAROS, MegaElectronics, Finland; Sylco Srl, Monza, Italy), at a sampling rate of 500 Hz, was acquired during a day of remote work. A visual analogue scale (VAS) was completed by the participants to rate their perceived level of stress while working remotely. VAS consisted of an unmarked ruler with endpoints labeled as “no perceived stress” (0) and “very high perceived stress” (10).

The study adhered to the principles of the Declaration of Helsinki for medical research involving human subjects. All the participants signed a written informed consent and the protocol was approved by Istituti Clinici Scientifici Maugeri Research Ethics Committee (2467CE).

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B. Time Series Extraction and Power Spectral Analysis

Heart period was approximated as the time distance between two consecutive R-wave peaks (RR) as derived from lead II. A total of 5000 consecutive RRs were selected during daytime, when all participants declare to perform job-related activities (DAY, from 10 to 12 a.m.), and nighttime (NIGHT, from 1 to 4 a.m.). A window of 250 consecutive RRs was iteratively analyzed using an overlap of 200. The median of the whole distribution was taken as representative value [6]. Mean (μ_{RR}) and variance (σ^2_{RR}) of RRs were computed, and expressed in ms and ms^2 , respectively.

Autoregressive power spectral decomposition was applied after optimizing the model order with Akaike information criterion. The sum of the power spectral components whose central frequency dropped in the range of the high frequency (HF) band (0.15-0.4 Hz) [7] was labeled as HF_{RR} , expressed in absolute units (i.e. ms^2) and taken as an index of the cardiac modulation directed to the heart [8, 9].

B. Statistical Analysis

Results were reported as mean \pm standard deviation. Participants' characteristics were compared between the two groups using χ^2 test, t-test or Mann-Whitney rank sum test, as appropriate. Two-way repeated measures analysis of variance (one factor repetition, Holm-Sidak test for multiple comparisons) was applied to check the differences between the two groups (i.e. CHILD and NO_CHILD) within the same experimental conditions (i.e. DAY and NIGHT) and the differences between experimental conditions within the same group. Sigmaplot software (Systat Software, Inc., Chicago, IL, version 11.0) was exploited to perform the statistical analysis. A $p < 0.05$ was considered significant.

III. RESULTS

Out of the 50 subjects (age 39 ± 11 yrs, 25 male), 23 (46%) were in the CHILD (9 males, 14 females) and 27 were in the NO_CHILD (16 males, 11 females) group. The CHILD group was older than the NO_CHILD one (age 48 ± 8 vs age 32 ± 6 years respectively, $p < 0.001$). The VAS was not significantly different in the two groups, even if a tendency toward lower values was observed in the CHILD group compared to the NO_CHILD one (5.2 ± 1.8 vs. 6.0 ± 2.6 , $p = 0.060$). Table 1 shows the results of the heart rate variability analysis. μ_{RR} increased during NIGHT both in CHILD and NO_CHILD groups. HF_{RR} was similar during NIGHT and DAY in the CHILD group, while it was higher during NIGHT compared to DAY in the NO_CHILD group. During NIGHT, HF_{RR} was higher in NO_CHILD compared to CHILD. σ^2_{RR} did not exhibit variations across groups and experimental conditions.

IV. DISCUSSION AND CONCLUSION

In the last few years the social context linked to the widespread use of technology and the contemporary dissemination of the SARS-CoV2 infection substantially modified the daily life approach to work. We examined the impact of remote working by recording the cardiac autonomic profile in one of the most involved categories of workers also taking into account their environmental and familial setting. In office employees with children working remotely, the

TABLE I. RESULTS OF HEART RATE VARIABILITY ANALYSIS

Index	CHILD		NO_CHILD	
	DAY	NIGHT	DAY	NIGHT
μ_{RR} [ms]	821.7 \pm 114	982 \pm 107#	847 \pm 140	996 \pm 167#
σ^2_{RR} [ms^2]	2903 \pm 1982	3810 \pm 3446	5212 \pm 4119	5945 \pm 5765
HF_{RR} [ms^2]	297 \pm 396	568 \pm 474	599 \pm 1029	1584 \pm 2289*#

CHILD: participants with at least one child; NO_CHILD: participants without children; DAY: daytime period; NIGHT: nighttime period; RR: heart period; μ_{RR} : mean RR; σ^2_{RR} : RR variance; HF: high frequency; HF_{RR} : HF power of the RR series. The symbol * indicates $p < 0.05$ CHILD vs. NO_CHILD. The symbol # indicates a $p < 0.05$ DAY vs. NIGHT.

cardiac neural regulation was characterized by a reduced nocturnal vagal modulation in absence of a perceived different level of work-related stress compared to office employees without children. This is partly in contrast with the conclusion of a previous pilot study describing an increase in the cardiac vagal modulation during night-time [5] but in line with the results observed in female healthcare professionals with children [4]. The effect of different age of CHILD and NO_CHILD should be deepened in future studies. This finding introduces the need of a careful evaluation of the home social environment in order to correctly consider new factors that could potentially contribute to the risk to develop work-related complications including cardiovascular diseases.

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