Temporal sleep patterns in adults using actigraph

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ABSTRACT

The aim of the present study was to characterize the temporal patterns of sleep and wakefulness in a sample of the adult subjects from São Paulo city. All subjects filled the Morningness/Eveningness Questionnaire (MEQ) and wore an actigraph for at least three consecutive days. A total of 359 subjects were considered for the analyses. The mean age was 43 ± 14 years, the mean body mass index was 26.7 ± 5.7 kg/m^2, and 60% were female. The mean MEQ score was 58.0 ± 10.7. The sleep pattern evaluated by the actigraphic analyses showed that 92% had a monophasic sleep pattern, 7% biphasic, and 1% polyphasic sleep pattern. Cluster analysis, based on time to sleep onset, sleep efficiency, sleep latency, and total sleep time, was able to identify three different groups denominated: morning type, evening type, and undefined type. Morning type subjects were more frequent, older, and had higher MEQ scores than evening type subjects. Our results showed that the actigraph objectively assessed the sleep-wake cycle and was able to discriminate between morning and evening type individuals. These findings suggest that the actigraph could be a valuable tool for assessing temporal sleep patterns, including the circadian preferences.

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1. Introduction

Few epidemiological studies have evaluated the pattern of sleep-wake cycle in the general population. Questionnaires or sleep logs, in addition to the objective evaluation of sleep-wake patterns by actigraphs, are typically used in these studies [1–5]. It is important to note that the results of actigraphic recording as an instrument to investigate sleep pattern has been compared with polysomnography, which is considered the gold standard for objective evaluation of sleep, showing good correlation [6,7]. Previous studies have shown that duration and quality of sleep, which have consequences for health, are strongly associated with race, gender, and socioeconomic status [1]. It has also been demonstrated that the self-reported sleep duration is longer than the sleep duration objectively evaluated using an actigraph [2] and that morningness/eveningness preference is largely independent of ethnicity, gender, and socioeconomic status, indicating that this preference may be better explained by endogenous factors [3]. However, past studies with young adults showed female had significantly stronger tendency toward the morningness preference, and the authors considered the role of social-cultural factors in the existence of gender differences [4,5].

Depending on the evaluated population, the sleep-wake cycle is influenced by external cues that can greatly change the quality of life and cause significant consequences to the health of the individual and collective. Many cultural, environmental and social stimuli are related to an increase in light intensity to which the individual is subjected. Depending on time of the day that these stimuli occur, they can act on the circadian system and cause a phase delay or advance [8,9]. We should propose that the characterization of the sleep-wake cycle of a population is not trivial because exogenous and endogenous characteristics influence the habits of sleeping and waking. In this context, the aim of this study was to characterize the temporal pattern of sleep and wakefulness in a sample of the adult subjects from São Paulo city. The study was based on questionnaire and actigraphic data.

2. Materials and methods

2.1. Study participants

The study protocol was approved by the Ethics Committee for Research at the Universidade Federal de São Paulo (CEP 0593/06) and was registered with ClinicalTrials.gov (Identifier NCT00596713). All subjects read and signed an informed consent form.

The study was conducted with individuals who participated in the São Paulo Epidemiologic Sleep Study (EPISONO) and agreed to wear an actigraph for at least three consecutive days. The study design and methodology of EPISONO have been described in detail previously [10]. Briefly, EPISONO was a population-based survey developed to establish the epidemiological profile of sleep disorders in the adult population of São Paulo. A total sample of 1101 volunteers were enrolled as a representative population sample based on gender, age (20–80 years) and socioeconomic status, with 3% precision in the prevalence estimates [11]. A three-stage cluster sampling technique was used with unequal selection probability [11]. Pregnant and lactating women, subjects with physical or mental impairments that prevent self-care, and subjects who work every night were not included in the household drawing. Data collection was performed between July and December 2007.

2.2. Data collection

2.2.1. Morningness/Eveningness questionnaire (MEQ)
The Portuguese version [12] of the MEQ, developed by Horne and Ostberg [13], was used to score the circadian preferences of the evaluated population.

2.2.2. Actigraph
The subjects were instructed to wear the actigraph (Actiwach-64°, Respironics, Inc. Co. USA) for a minimum of three consecutive days, regardless of whether it was during the week or on the weekend. Data were analyzed using the Actiware 5.0 software, which evaluates the parameters of the activity/rest cycle.

The following parameters were evaluated: total sleep time (TST) for each sleep episode ("main episode TST") and over

each 24-hour period (including naps) ("24 h TST"), sleep latency, sleep efficiency, wake after sleep onset (WASO), and time to sleep onset.

The study protocol allowed the volunteers to choose the most appropriate dates to wear the actigraph. A subsample of 92 volunteers wore the actigraph for at least three consecutive days during the weekdays and also during the weekend. Those data were analyzed and no significant differences ($p > 0.05$) were found in the main characteristics of sleep during the weekdays compared to the weekends (TST, sleep latency, sleep efficiency, WASO) (Table 1). Thus, data from both weekdays and weekends were included in the same test sample.

The number of episodes of sleep over each 24-hour period was classified as monophasic (predominantly a single episode of sleep), biphasic (presence of a second sleep episode during more than 50% of the days in the time series), and polyphasic (presence of more than two sleep episodes during more than 50% of the days in the time series).

2.3. Statistical analysis

For comparisons between groups as a function of demographics and actigraphic variables, chi-square or ANOVA with Tukey post-hoc test were used, depending of the level of measurement. For variables that were not normally distributed, the results were checked by the nonparametric Mann–Whitney and Kruskal–Wallis tests, and their results were presented only if they differed from the ANOVA results. One-way ANOVA tests were used to compare the data from subjects who used the actigraph both during the weekdays and on the weekend.

A two-step cluster analysis with two different sets of variables was performed. The first set included time to sleep onset, sleep efficiency, sleep latency, and TST. In the second set, the sleep efficiency was replaced by WASO. In both data sets, the first two components were sufficient to understand the relationships between the variables explaining 70% and 65% of the total proportion of the variability. The clusters were used as independent variables in comparison with the MEQ and a one-way ANOVA of this comparison was performed.

All results were considered significant when $p < 0.05$. The STATA 10.0 package was used to perform the analyses.

Table 1 – Analyses of the sleep characteristics evaluated by actigraph wore during weekdays and weekend in a sample of 92 volunteers. Data presented on average ± standard deviation.

	Weekdays	Weekends	p
Total Sleep Time ($_{min}$)	352.2 ± 48.4	364.4 ± 73.5	0.31
Sleep Efficiency (%)	81.2 ± 4.7	80.4 ± 5.3	0.54
Sleep Latency ($_{min}$)	12.2 ± 11.2	12.8 ± 12.6	0.91
WASO ($_{min}$)	57.1 ± 17.8	62.3 ± 22.8	0.23

WASO = wake after sleep onset.