Polysomnographic Aging in Normal Elderly Egyptians

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ABSTRACT

Background: Sleep disturbances interfere with all aspects of health and daily life. With aging, there are prominent sleep changes. Objectives: The aim of our work is to study polysomnographic changes in normal elderly Egyptians in relation to adult control group. Methods: This work was carried out on a group of 20 healthy elderly Egyptians (above 60 years), with a comparison group of adults (20-32 years). The history of sleep characteristics and patterns was evaluated. Radiological and laboratory tests were run as a routine part of the examination, and finally, an overnight polysomnography was performed to all subjects to analyze their sleep, to score all the sleep stages, and to detect any sleep disturbance. Results: The study revealed that sleep of the elderly becomes lighter with decreased percentage of slow wave sleep or deep sleep from the total sleep time. Sleep apnea/hypopnea syndrome was the most prevalent sleep disorder among the elderly subjects (90%); the interesting point is that the disorder was present even when the subject had no sleep complaint. Periodic limb movement disorder was also common among the subjects (25%) and all of the examined subjects were unaware of the disorder. REM sleep behavior disorder could not be detected in the study sample. In conclusion, by means of polysomnographic recording, many physiological changes in sleep were proved to occur with aging. (Egypt J. Neurol. Psychiat. Neurosurg., 2009, 46(2): 421-429)

Key words: polysomnography; sleep apnea/hypopnea syndrome; periodic limb movement disorder; REM sleep behavior disorder

INTRODUCTION

Sleep disturbance is an important health concern, especially in the elderly as lack of adequate sound sleep interferes with all aspects of person’s health and daily living activities¹.

The most prominent sleep changes in the elderly are the changes in stage 4 or electroencephalography (EEG) Slow Wave Activity (SWA). Other changes include timing of sleep and wakefulness, reduced nocturnal sleep consolidation and a reduction in Rapid Eye Movement (REM) sleep. With aging, sleep is generally lighter, showing less REM sleep and more arousals. Other sleep disturbances as sleep apnea and myoclonic jerks also become more prevalent². It has been observed that the elderly have a greater prevalence of sleep apnea than the young. Kripke and colleagues³ observed a prevalence of sleep apnea ranging from 24% to 62% in various elderly people.

Insomnia is also very common in the elderly. According to a large epidemiological study, at least 28% of elderly persons suffer from some type of insomnia, including sleep-onset insomnia (difficulties with sleep initiation), sleep maintenance insomnia (difficulties maintaining sleep during early, middle, or late part of the sleep period)⁴.

It has also been established that many elderly people develop periodic limb movement disorder (PLMS) ~ 34% of those were over 60 years old⁵.

Another disorder in the elderly is REM sleep behavior disorder (RBD), which is very rare, occurring most frequently in older men, the prevalence of RBD is 0.5%⁶.

The aim of our work is to study polysomnographic changes in normal elderly Egyptians in relation to adult control group.
METHODS

Subjects
- **Elderly Group:** The study included 20 healthy elderly subjects, 11 males (55%) and 9 females (45%), their ages ranged between 60 and 71 years with a mean age of 64.6±3.36 years.
- **Exclusion Criteria:** Cerebrovascular or cardiovascular disease, neurological illness as history of dementia, Parkinsonism … etc., psychological illness as depression, medical illness as severe hypertension, uncontrolled diabetes, renal, hepatic affection … etc., (Mini-Mental State Test (MMST) < 24.
- **Control Group:** The data of the adult control group was taken (after permission of the authors) from a recent study performed in the Neurophysiology Unit of Kasr Al-Aini Hospital, Cairo University by Abdel-Kader et al.\(^7\).

Methods:
All subjects were submitted to the following:
1) **Full history taking with special stress on:** Sleep history: any sleep complaint or change in sleep pattern with aging, total sleep time (TST), excessive daytime sleepiness (EDS), insomnia, respiratory complaints, and abnormal behaviors or sensations during sleep.
2) **Complete general and neurological examination:** It aimed at excluding cases with medical, neurological, and psychological illness.
3) **Laboratory investigations:** Complete blood picture, complete urine analysis, kidney function tests, liver function tests, complete lipid profile, and blood sugar (fasting and 2 hours post-prandial).
4) **Radiological examination:** Computed Topography (CT) brain aimed at excluding organic lesions.
5) **MMST:** Mini-Mental State Examination (MMSE)\(^8\) was done to exclude cases with score less than 24.
6) **Polysomnographic recording (PSG):** The PSG was carried out to all subjects over one night.

The apparatus used is Schwarzer. Epos 32 Gmph, medical diagnostic polysomnogram. Schwarzer, Germany. The software used is Somnologica version 3.1. The sleep system is called Comlab and its amplifier is called Flaga.
- Recorded channels according to their order of appearance on the monitor, and as described by Rechtschaffen and Kales\(^9\): Two horizontal electro-oculography (EOG) channels (right and left), four electroencephalography (EEG) channels (C4-A1, O2-A1, C3-A2, O1-A2) applied according to the international 10-20 system of EEG electrode placement, submental electromyography (EMG) channel, electrocardiography (ECG) channel, left tibialis anterior EMG channel, one channel for airflow monitoring, two channels for ventilator effort monitoring, two channels for arterial oxygen (O\(_2\)) saturation and for pulse detection, one channel for body position detection, and one channel for upper airway sound detection.
- Around 6-8 hours overnight were recorded for each subject.
- Sleep stages were scored according to the standard scoring system for sleep stages done by Rechtschaffen and Kales\(^9\).

Statistical methods:
Data was entered onto SPSS version 11 for analysis. Simple frequencies were used for data checking. Descriptive statistics (arithmetic mean and standard deviation) were used for summary of quantitative data while percentages were used for qualitative data. Appropriate statistical tests of significance were used to test the null hypothesis in comparison of studied groups. Student’s t-test was used for comparison of means between groups. Chi-square test of significance was conducted for qualitative variables. P-value < 0.05 was used for detection of statistical significance in all tests.

RESULTS

Clinical results:
This study was carried out on 20 healthy elderly Egyptians, 13(65%) of which had positive history of EDS, while 7(35%) had not. As regards the nocturnal awakening (NA), 12(60%) had the complaint while 8(40%) had not. Concerning the TST pattern, 2 subjects only (10%) reported that their TST is not decreased, while the remaining 18(90%) reported decreased TST. 10 subjects (50%) reported early bedtime and early...
waking up while only one subject (5%) reported difficulty falling asleep (Fig. 1).

Results of PSG:
1) Architecture of sleep: The TST, the sleep onset, the sleep efficiency and the number of awakenings are shown in table (1).
2) Sleep stages: The latencies for sleep stage 1 (S1), sleep stage 2 (S2), slow wave sleep (SWS) and REM were shown in table (1). The percentages of these stages from TST were demonstrated in figure (2).
3) Sleep abnormalities: The periodic limb movement (PLM) index, the Apnea/Hypopnea Index (AHI) and the oxygen desaturation index are demonstrated in table (1). 5 of the subjects (25%) had pathological PLM i.e. PLM index>5/hr.

According to the American Academy of Sleep Medicine Task Force (1999) for classification of Sleep Apnea Hypopnea Syndrome (SAHS) as mild, moderate and severe, 2 of the subjects (10%) had normal values –less than 5/hr-, 3(15%) showed mild SAHS- 5.1-15/hr-, 9(45%) suffered from moderate SAHS- 15.1-30/hr- and 6(30%) had severe SAHS-more than 30/hr (Fig. 3).

Comparison between elderly and young adults: The two groups were named as follows:
Group 1: 20 elderly subjects
Group 2: 10 young adults
1) Age and sex distribution: The age of group (2) ranged between 20 to 32 years with a mean of 21.70±4.62. Statistical analysis of the age distribution between the two groups showed a highly significant statistical difference (P-value < 0.001). Concerning sex distribution, in group 2 there were 6(60%) males and 4(40%) females.
2) Results of PSG: PSG results of the elderly and young adults are compared in table (2).
   a. Sleep architecture: Statistical comparison of the two groups revealed no significant difference as regards the TST and sleep onset. As regards the sleep efficiency and number of awakenings the difference between the two groups was statistically significant. (P=0.01 and 0.02, respectively).
   b. Latencies to different sleep stages: On comparing the latencies to various sleep stages between the two groups, the only statistically significant difference was in the latency to SWS the longer latency was in Group 1 (P=0.001).
   c. Percentages of various sleep stages from TST: Concerning percentages of various sleep stages, Group 1 tended to have a decreased percentage of SWS from TST as compared to Group 2 with significant statistical difference (P-value = 0.01). Regarding the percentage of REM sleep from TST, Group 1 had an apparently decreased percentage as compared to Group 2, but the difference didn’t reach a significant correlation (P-value = 0.06). The percentages of S1 and S2 stages showed no statistically significant difference (P-value = 0.5 and 0.7, respectively).
   d. Sleep abnormalities: Concerning PLM index, no significant statistical correlation could be found between the two groups (P-value = 0.29). On comparing the PSG results for respiratory parameters, Group 1 tended to have a considerably higher AHI as compared to Group 2, with a high statistically significant difference (P-value < 0.001). In addition, Group 1 had a higher oxygen desaturation index than Group 2, and these results were also significant (P-value = 0.01). It is to be noted that Group 1 had statistically significant higher apnea index in REM, hypopnea index in REM and hypopnea index in non rapid eye movement (NREM) as compared to Group 2 (P-values = 0.02, 0.001 and 0.001, respectively). However, concerning the apnea index in NREM sleep, the results didn’t reach a statistically significant value (P-value = 0.2). It is also noted that while 18 of the subjects of Group 1(90%) had sleep apnea/hypopnea syndrome (SAHS), only 1 of the subjects of Group 2(10%) had SAHS, with a significant statistical difference (P-value < 0.001).
Table 1. Polysomnography values among the elderly subjects.

<table>
<thead>
<tr>
<th>PSG variables</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>TST (min)</td>
<td>81</td>
<td>448</td>
<td>300.82</td>
<td>96.23</td>
</tr>
<tr>
<td>Sleep onset (min)</td>
<td>1.5</td>
<td>85.5</td>
<td>46.52</td>
<td>25.85</td>
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<tr>
<td>Sleep efficiency %</td>
<td>29</td>
<td>92</td>
<td>68.54</td>
<td>15.54</td>
</tr>
<tr>
<td>Number of awakenings</td>
<td>5</td>
<td>182</td>
<td>39.25</td>
<td>38.35</td>
</tr>
<tr>
<td>Sleep latency to S1 (min)</td>
<td>1.5</td>
<td>116.5</td>
<td>52.7</td>
<td>30</td>
</tr>
<tr>
<td>Sleep latency to S2 (min)</td>
<td>1.8</td>
<td>120.5</td>
<td>59</td>
<td>32</td>
</tr>
<tr>
<td>Sleep latency to SWS (min)</td>
<td>10</td>
<td>326.5</td>
<td>158.8</td>
<td>87.7</td>
</tr>
<tr>
<td>REM latency from sleep onset (min)</td>
<td>0</td>
<td>340</td>
<td>124.34</td>
<td>104.47</td>
</tr>
<tr>
<td>PLM index (No/hr)</td>
<td>0</td>
<td>9</td>
<td>0.78</td>
<td>2</td>
</tr>
<tr>
<td>AH1 (No/hr)</td>
<td>1.5</td>
<td>78.2</td>
<td>27.84</td>
<td>19.24</td>
</tr>
<tr>
<td>Oxygen desaturation index (No/hr)</td>
<td>2</td>
<td>69</td>
<td>18.9</td>
<td>19</td>
</tr>
</tbody>
</table>

PSG: polysomnography, TST: total sleep time, PLM: periodic limb movement, AH1: apnea/hypopnea index, min: minute, No/hr: number per hour.

Table 2. Comparison between elderly and adult groups regarding the polysomnographic variables.

<table>
<thead>
<tr>
<th>PSG variables</th>
<th>Group 1 (20)</th>
<th>Group 2 (10)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Mini</td>
<td>Maxi</td>
</tr>
<tr>
<td>TST (min)</td>
<td>300.82</td>
<td>81</td>
<td>448</td>
</tr>
<tr>
<td>Sleep onset (min)</td>
<td>46.52</td>
<td>1.5</td>
<td>85.5</td>
</tr>
<tr>
<td>Sleep efficiency %</td>
<td>68.54</td>
<td>29</td>
<td>92</td>
</tr>
<tr>
<td>Number of awakenings</td>
<td>39.25</td>
<td>5</td>
<td>182</td>
</tr>
<tr>
<td>Sleep latency to S1</td>
<td>52.7</td>
<td>1.5</td>
<td>116.5</td>
</tr>
<tr>
<td>Sleep latency to S2</td>
<td>59</td>
<td>1.8</td>
<td>120.5</td>
</tr>
<tr>
<td>Sleep latency to SWS</td>
<td>158.75</td>
<td>10</td>
<td>326.5</td>
</tr>
<tr>
<td>Sleep latency to REM</td>
<td>124.34</td>
<td>0</td>
<td>340</td>
</tr>
<tr>
<td>PLM index (/hr)</td>
<td>0.78</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>% of S1 from TST</td>
<td>14.51</td>
<td>1.2</td>
<td>83.2</td>
</tr>
<tr>
<td>% of S2 from TST</td>
<td>55.3</td>
<td>34.1</td>
<td>86.2</td>
</tr>
<tr>
<td>% of SWS from TST</td>
<td>16.17</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>% of REM from TST</td>
<td>16.32</td>
<td>0</td>
<td>46.8</td>
</tr>
<tr>
<td>PLM index (/hr)</td>
<td>0.78</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>AH1 (/hr)</td>
<td>27.85</td>
<td>1.5</td>
<td>78.2</td>
</tr>
<tr>
<td>Apnea index in REM (/hr)</td>
<td>7.88</td>
<td>0</td>
<td>36.3</td>
</tr>
<tr>
<td>Apnea index in NREM (/hr)</td>
<td>5.1</td>
<td>0</td>
<td>58.8</td>
</tr>
<tr>
<td>Hypopnea index in REM (/hr)</td>
<td>30.66</td>
<td>0</td>
<td>81</td>
</tr>
<tr>
<td>Hypopnea index in NREM (/hr)</td>
<td>23.34</td>
<td>1.9</td>
<td>78.9</td>
</tr>
</tbody>
</table>
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| Oxygen desaturation index (/hr) | 18.9 | 2 | 69 | 0 | 0 | 0 | 0.001 * |

PSG: polysomnography, TST: total sleep time, min: minute, PLM: periodic limb movement, SWS: slow wave sleep, REM: rapid eye movement, NREM: non rapid eye movement, /hr: per hour.

Fig. (1): Percentage of elderly subjects with history suggestive of sleep disturbance.
Fig. (2): Percentage of different sleep stages from TST in the elderly group.

Fig. (3): Percentage of SAHS in subjects according to the American Academy of Sleep Medicine Task Force (1999).
DISCUSSION

It has been widely approved that sleep undergoes many changes from infancy to adulthood with special changes occurring during aging \(^\text{10}\).

The complaint of EDS among elderly people is well documented a long time ago. 13 subjects of the current study (65%) complained of EDS. This percentage is much higher than what had been reported by Young et al.\(^\text{11}\), who found that EDS in 22% of their subjects and therefore recommended that it is important to consider all possible risk factors when evaluating a patient with EDS.

The mechanism of EDS is multifactorial. For example, EDS has been shown to be associated with obesity in the absence of sleep-disordered breathing (SDB). Furthermore, EDS has been reported to be more common in women and especially in those with mental health disorders and even more those with depression \(^\text{12,13}\).

According to the present study, history suggestive of EDS had no significant correlation with the number of awakenings or the AHI, but could be correlated to the hypopnea index in NREM sleep and oxygen desaturation index, suggesting that the consideration of EDS as the cardinal sign of SDB is questioned. Bixler et al.\(^\text{14}\), couldn’t observe a strong association between EDS and sleep apnea while Baldwin et al.\(^\text{15}\) reported weak association between AHI and EDS. This finding may explain to some extent why continuous positive airway pressure at times fails to improve EDS in patients with sleep apnea \(^\text{16}\).

60% of our elderly subjects reported sleep fragmentation in the form of recurrent nocturnal awakenings, 50% reported early bedtime and early waking up. One of the most common changes in the elderly is the occurrence of frequent awakenings during night and many elderly people are surprised that they fall asleep earlier in the evening and may awaken before sunrise \(^\text{17,18}\). Other typical symptoms of sleep problems in the elderly include difficulty falling asleep and maintaining sleep (13%), early morning awakening (15%), EDS and frequent nocturnal awakenings (40%) \(^\text{19}\).

As for insomnia, only one subject (5%) -of our healthy elderly with no medical or psychiatric illness- reported history of difficulty in falling asleep. These results are less than those reported by Montgomery\(^\text{17}\) who stated that about 12-25% of healthy elderly people reported chronic insomnia, with higher rates among those with coexisting medical or psychiatric illness. Also in 2005, Vij and Gentili\(^\text{20}\) reported that approximately 15% of the adult population in the United States has insomnia of significantly enough severity to seek medical attention. Marchi et al.\(^\text{21}\), in their analysis of the prevalence of insomnia in the adult population in Brazil, have found that older people are more common to have insomnia than the younger adults (P-value = 0.000).

In our study, no significant decrease in the TST of the elderly group was found in relation to the young adult one, however there was a highly significant increased latency to SWS (P = 0.001) or the deep sleep, together with a significant decreased percentage of SWS from TST (P = 0.001). The number of awakening (P = 0.02) and % of sleep efficiency (P = 0.01) were also affected.

Jean-Louis et al.\(^\text{22}\), reported that stages 3 and 4 (SWS) decrease markedly with age, and in extreme old age (>90 years), stages 3 and 4 disappear completely, and relative amounts of REM sleep are maintained until extreme old age, when they start to show some decline.

The depth and continuity of sleep change with age, with a lower percentage of sleep spent in the deepest stages of NREM sleep \(^\text{23}\), in elderly persons, where the time spent in stages 3 and 4 decreases by 10-15% compared to young adults, representing an overall decrease in total sleep duration \(^\text{24}\).

The influence of age on sleep stages was strongly significant, the older the patient, the more the tendency to shallow sleep on the expense of deep sleep.

In this study 90% of the elderly subjects had sleep apnea/hypopnea syndrome (SAHS), among those 15% showed mild form, 45% suffered moderate form, while the remaining 30% had severe SAHS, while none of the young adult group had SAHS. Roland\(^\text{25}\) (2001) reported AHI >5/hr in 84% of his elderly study group and >10/ hr in 70%. Redline\(^\text{26}\) had higher prevalence of sleep apnea in patients over 60 years of age (2 - 3 times higher than in middle-aged participants of the study). The age of the subjects had a significant positive correlation with the AHI, the older the subject, the more AHI he has.
There is significant positive correlation between the elderly group and the apnea and hypopnea index in REM. This suggests that REM-related sleep-disordered breathing (REM-SDB) is a well known state-specific sleep disorder expression of sleep fragmentation limited to REM sleep.32

On the contrary, the study done by Rubio et al.,34 to evaluate the prevalence of REM-related disordered breathing among the non-treated patients with proved SAHS showed that only 36.4% of the patients presented with REM SDB while 63.6% were considered as having a SDB non-dependant on sleep stage-NREM SDB-, with a significantly lower AHI-REM than AHI-NREM (P-value < 0.001) for the NREM SDB group. They also reported that the two groups differed significantly in all parameters of sleep continuity and sleep fragmentation, with NREM SDB patients having lower amounts of SWS and REM sleep.

In this study 25% of the elderly subjects had periodic limb movement disorder (PLMD) in face of only 10% of the young adult group, in concordance with Rothdach et al.,39 population-based survey of the elderly people in Germany; where the overall prevalence of Restless Leg Syndrome (RLS) was 9.8%. Dobson also found that 34% of those above 60 years old develop PLMD, even those who don’t suffer from RLS and who have no other sleep complaint. Ronald reported 24% of the elderly group had PLM index > 5 and that sleepiness showed statistically significant association with lower PLM index.

In conclusion, by means of polysomnographic recording, many physiological changes in sleep were proved to occur with aging. Elderly people have shallower sleep on the expense of deep sleep and the majority of this population group have evident sleep disturbance even if they are not aware of it. Sleep apnea syndrome and periodic limb movement disorder are the most common sleep disorders among elderly people who may not primarily have any sleep complaints.

REFERENCES


