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VISUOMOTOR INTEGRATION SKILLS IN CHILDREN AFFECTED BY OBSTRUCTIVE SLEEP APNEA SYNDROME: A CASE-CONTROL STUDY

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ABSTRACT

Introduction*: Sleep related breathing disorders (SRBD) consist of frequent and repetitive episodes of pharyngeal obstruction during sleep, with consequent intermittent hypoxia, sleep architecture fragmentation, daytime sleepiness and/or behavioural problems and executive impairment in children. When untreated, SRBD and obstructive sleep apnea syndrome (OSA) mainly, may impact school performance, cognition, metabolism, and cardiovascular function.*

Aim of the present study is assessing the visuomotor integration skills in children affected by OSA.

Materials and methods*: 57 subjects affected by mild-to severe OSA, PSG diagnosed according to international diagnostic criteria, (31 males and 26 females) (mean age 10.8; SD ± 2.49) and 83 healthy children (45 males and 38 females) (mean age 9.95; SD ± 1.87; p = 0.725). All subjects underwent assessment of motor coordination skills with Movement-ABC tests and visual-motor integration ability with Visual Motor Integration (VMI) test.*

Results*: The subjects with OSA show a worse average performances in all items of Movement ABC (p <0.001) respect of controls. Specifically, children with OSAS show significantly higher values of total points (p <0.001), manual dexterity (p <0.001), ball skills (p <0.001) and balance (p <0.001). Accordingly, the average centile in OSA children at the MABC-test is significantly reduced compared with controls (p <0.001). (Table 1) On the other hand, the VMI test evaluation among children with OSAS shows worst result in total Visuo-Motor Integration (p <0.001), and in Motor Coordination sub-item (p <0.001) than controls. (Table 1).*

Conclusion*: Our results also support for children and adolescents the hypothesis that executive functioning deficits might be linked primarily to the degree of severity nocturnal hypoxemia rather than daytime sleepiness, although several other studies are needed.*

Keywords*: obstructive sleep apnea syndrome, OSA, visual-motor integration, visual-motor training skills.*

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Introduction

Sleep related breathing disorders (SRBD) consist of frequent and repetitive episodes of pharyngeal obstruction during sleep, with consequent intermittent hypoxia, sleep architecture fragmentation, daytime sleepiness and/or behavioural problems and executive impairment in children[(1-5)].

Moreover, when untreated, SRBD may impact school performance, cognition[(2)], metabolism, and cardiovascular function. In developmental age, the same alterations may be present in other pathological conditions such as migraine without aura[(6-17)], pinpointing once again the known close link between neurological impairment and sleep in children[(18-28)].

On the other hand, learning and neuropsychological ability seem to have a key role in quality of life and disease management in more neurological conditions in developmental age[29-31].

Specifically, some studies revealed a specific neuropsychological impairment both in adult[32] in children affected by obstructive sleep apnea syndrome (OSA)(2). In 2013, Esposito et al[33] reported a significant impairment in visuo-motor and motor-coordination competencies in a sample of enuretic children highlighting the role of sleep troubles in neuropsychological impairment. In this light, scarce attention has been reserved on visuo-spatial and visuo-motor integration skills in children affected by other sleep disorders such as OSA.

Herein, the aim of the present study is assessing the visuomotor integration skills in children affected by OSA.

Materials and methods

Study population comprised 57 subjects affected by OSA, diagnosed according to international diagnostic criteria, (31 males and 26 females) (mean age 10.8; SD ± 2.49) and 83 healthy children (45 males and 38 females) (mean age 9.95; SD ± 1.87; p = 0.725). All subjects underwent assessment of motor coordination skills with Movement ABC tests and visual-motor integration ability with Visual Motor Integration (VMI) test.

All subjects of both groups were recruited within the same urban area, all were Caucasian and homogeneous for socioeconomic stauts

Ethical approval from the local Research Ethics Center and informed parental consent were obtained.

Polysomnographic (PSG) Data

After reviewing and analyzing PSG data collected from inpatients children between January and June 2016 to establish the presence of OSA in the experimental group, OSA severity was determined according to the current guidelines specified by the American Academy of Sleep Medicine (AASM): mild OSA was defined by an obstructive apnea-hypopnea index (o AHI) of 1 to <5 events per hour; moderate OSA was defined as was defined as ≥5 to <10 events/hour, and severe OSA ≥10 events/hour.

Motor coordination skills evaluation

Movement assessment battery for children (M-ABC) The impairment of motor coordination performance relative to age expectations was determined using the Movement Assessment Battery for Children (Movement-ABC). This test is frequently used in both clinical and research settings to assess children for motor coordination impairment and has high reliability and validity[34]. In fact, it assesses fine and gross motor skills using three manual dexterity tasks, two ball skills tasks, and three balance tasks, each of which is scored on a five-point scale. The raw score of each item is then converted to a score scale ranging from zero to five. The higher score indicates a less-than-adequate performance.

Consequently, 0 reflects a complete success by the candidate on the task examined, while 5 reflects a failure in the execution of the task, in fact a failed (F), an inappropriate (I), or refused (R) performances are transformed into 5. The sum of the eight scores of items corresponds to the total score of disability, ranging between 0 and 40, where a lower score is a result of implementing the best move. The content of the items differs depending on the age of the child examined, with increasing difficulty according to age, so that the battery is made up of four different types of activities considered to be made in relation to age (4-6 years, 7-8 years, 9-10 years, and 11-12 years). Each subject was assessed individually in about 20-40 min[34]. The total impairment score was calculated from these individual tasks and is used to generate a centile score compared to the standardization sample.

Visual-Motor Integration skills evaluation

The fine motor coordination and the visual-motor integration was assessed with the Beery Visual Motor Integration task[35], a paper-and pencil test where children have to imitate or copy up to 27 geometric forms with increasing complexity using paper and pencil. Copying errors were marked if they reflected problems in fine motor coordination, rather than a pure visuo-spatial problem. The task is specifically designed for children and takes about 10 min. The Beery VMI scores were standardized for age and gender using normative data for the Italian general population[35]. The centile scores were used for diagnosing the visual-motor abnormalities in our sample, and a value ≤5^{th} was considered for visual motor integration impairment.

Statistical analysis

For comparison between the two groups (OSAS and controls) it was applied t- testing and Chi-square test, where appropriate. P values<0.05 were considered statistically significant.

For statistical analysis it used the software STATISTICA (data analysis software system, version 6, StatSoft, Inc. (2001). For the comparison between the groups the t-test was applied. P values<0.05 were considered statistically significant.

Results

For the present study we selected only children affected by mild-to severe OSA (57 subjects). The two groups of subjects (57 vs 83 controls OSAS) were statistically comparable for age (10.08 ± 2:49 vs. 9.95 ± 1.87; p = 0.725) and gender (p = 0.878).

The subjects with OSAS show a worse average performances in all items of Movement ABC (p <0.001) respect of controls. Specifically, children with OSAS show significantly higher values of total points (33,078 ± 12,422 vs. 7,906 ± 2,514; p <0.001), manual dexterity (13.068 ± 2.419 vs 2.947 ± 2.526, P <0.001), ball skills (8.501 ± 1.914 vs 2.067 ± 1.839) and balance (11,892 ± 1.756 vs 1.801 ± 1.044, p <0.001). Accordingly, the average centile in OSAS children at the MABC-test is significantly reduced compared with controls (9.445 ± 5.973 vs 45,590 ± 20,789; p <0.001) (Table 1).

On the other hand, the VMI test evaluation among children with OSAS shows worst result in total Visuo-Motor Integration (13,819 ± 8,061 vs. 56,431 ± 11,018; p <0.001), and in Motor Coordination sub-item (18,623 ± 7,439 vs 52,820 ± 15,788; p <0.001) than controls (Table 1).

	OSA N=57	Controls N=83	p
M-ABC Dexterity	13.068± 2.419	2.947±2.526	<0.001
M-ABC Ball skills	8.501±1.914	2.067±1.839	<0.001
M-ABC Balance	11.892± 1.756	1.801±1.044	<0.001
M-ABC Total score	33.078± 12.422	7.906±2.514	<0.001
M-ABC Centile	9.445± 5.973	45.590±20.789	<0.001
Visual Motor Integration Total Score	13.819±8.061	56.431±11.018	<0.001
VMI Visual Task	46.891±21.712	51.703±22.186	0.206
VMI Motor Task	18.623±7.439	52.820±15.788	<0.001

Table 1: shows the comparison of performance at the Movement-ABC and the VMI tests evaluation in children with obstructive sleep apnea syndrome (OSA) and controls. For the comparison between the groups the t-Test was applied. P values <0.05 were considered statistically significant.

Discussion

OSA in children can cause significant consequences, affecting the CNS, the cardiovascular systems, metabolic, and somatic growth, resulting a general reduction in daytime life activities and in quality of life[(36)]. Actually, the pathogenetic mechanism involved in OSA consequences seems to be the intermittent hypoxia, related consequent hypercapnia, repeated intrathoracic pressure swings, and frequent arousal. These mechanisms can contribute to the oxidative stress and pro-inflammatory status, particularly in obese children[(37; 38)].

According to the research hypothesis, a significant difference has been reported in visuomotor-coordinative skills in subjects with OSAS than in control subjects. The scores of the balance of skill, dexterity and skill with the ball have shown that children with OSA have visuomotor skills really lower than normal, indicating and emphasizing once again the importance of precocious diagnosis. In order to manage pediatric OSA in the better manner, medical, surgical, orthodontic and pharmachological interventions are disposable, but in this light also rehabilitative treatment such as behavioural/psychomotor therapy may be included in therapeutic management[(39)].

In general, children affected by OSA appears to be dominated by the slow pace of development concepts which, however, do not seem to be related to degree of severity of the respiratory disorder. Several studies have focused on the role of prefrontal areas as possible relay zones between OSA and cognitive impairment, linked to reported reduction in frontal-parietal regions and hippocampal gray matter by MRI studies[(40)].

Our results, therefore, suggest the presence of a close relationship between nocturnal breathing troubles and prefrontal cortex areas activity, underlined by the particular efficiency reduction in subjects presenting a higher AHI.

Our results also support for children and adolescents the hypothesis that executive functioning deficits might be linked primarily to the degree of severity nocturnal hypoxemia rather than daytime sleepiness, although several other studies are needed.

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