Medical Hypotheses xxx (2013) xxx–xxx

Contents lists available at SciVerse ScienceDirect

Medical Hypotheses

journal homepage: www.elsevier.com/locate/mehy

Understanding the relationships between breastfeeding, malocclusion, ADHD, sleep-disordered breathing and traumatic dental injuries

Osman Sabuncuoglu *

Child and Adolescent Psychiatry, School of Medicine, Marmara University, Dept. Child and Adolescent Psychiatry, Istanbul, Turkey

ARTICLE INFO

Article history:
Received 3 May 2012
Accepted 13 December 2012
Available online xxxx

ABSTRACT

Attention-deficit/hyperactivity disorder (ADHD), one of the most common neuropsychiatric disorders that present at young age, may occasionally be associated with physical problems and disorders. Among them exists a group of oral-pharyngeal conditions with considerable clinical morbidity. Previous research that identified absence or short duration of breastfeeding in ADHD children has been reviewed. Essential nutritional factors in breast milk can affect brain development and regulate the manifestation of ADHD symptoms. Low ferritin levels caused by insufficient breastfeeding may contribute to ADHD susceptibility because of the role of iron in dopaminergic activity. Insufficient breast feeding and subsequently excessive bottle-feeding may lead to increased rates of non-nutritive sucking habits, such as pacifier use and thumb-sucking, all of which are associated with the risk of development of malocclusions. Malocclusion refers to an unacceptable deviation from the ideal relationship of the upper and lower teeth and necessitates orthodontic treatment. Sleep-disordered breathing in children may present with neurocognitive symptoms that resemble ADHD and abnormal craniofacial developments, as well as malocclusions, have been cited as part of the syndrome. Obesity, which is an outcome of insufficient breastfeeding, is a shared comorbidity of ADHD and sleep-disordered breathing. The risk of traumatic dental injury is higher in children with ADHD and presence of malocclusions further increases the likelihood of dental injuries.

In this review, certain oral-pharyngeal conditions relating to ADHD have been reviewed and links among them have been highlighted in a tentative explanatory model. More research that will provide increased awareness and clinical implications is needed.

Introduction

Most commonly presenting and diagnosed in childhood, attention-deficit/hyperactivity disorder (ADHD) is a lifelong neuropsychiatric disorder related to various clinically significant conditions. Based on the presentation of the core behavioral symptoms, which are inattention, hyperactivity and impulsivity, three sub-types of ADHD are identified according to the DSM-IV-TR: predominantly inattentive, predominantly hyperactive–impulsive, and a combined sub-type [1]. The onset of symptoms must be before the age of 7 years and impairment in two or more settings is required. About 3 to 8% of children population is affected and boys are more likely to be admitted to clinics than girls [2]. Since ADHD is associated with a high rate of coexisting developmental, psychiatric, genetic and medical disorders, an effective treatment program must be tailored to address all factors involved.

Research evidence has shown that there may be relationships between certain forms of oral-pharyngeal conditions and ADHD. However, although there is significant body of research, the findings are scattered and remain to be integrated into a plausible model. This paper aims to review relevant topics, namely breastfeeding, iron deficiency, malocclusion, traumatic dental injuries and sleep-disordered breathing, from an ADHD perspective and to reach a better understanding of different pathologies involved.

Breastfeeding and ADHD

There is no source of nutrition in early human life that is more crucial than human milk for the survival of the human being. The World Health Organization recommends initiating breastfeeding within the first hour of life, breastfeeding exclusively for the first 6 months and continuing breastfeeding (along with giving appropriate complementary foods) up to 2 years of age or beyond [3]. The benefits of breastfeeding are manifold, which include prevention of infant morbidity-mortality and chronic diseases, improvement of mental development, positive effects on maternal health and better economic costs, yet more remains to be explored.

A number of studies have focused on duration of breastfeeding in children with ADHD. In the study, which found low fatty acid concentrations in ADHD children, Stevens et al. [4] also noted absence or short duration of breastfeeding in the same subjects.

* Address: Halk Cad. Emin Ongan Sok. 11/15, 34672 Üsküdar, Istanbul, Turkey. Tel.: +90 216 6254619, mobile: +90 542 4253397.

E-mail address: sabuncuoglu2004@yahoo.com

0306-9877/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.mehy.2012.12.017

Over the last decade, researchers from different parts of the world have devoted more attention to the topic. In 2003, researchers from Turkey reported that the duration of breastfeeding in ADHD children was not only shorter but it adversely affected intelligence scores as well [5]. Following that study, Kadziela-Olech and Piotrowska-Jastrzebska [6] demonstrated significantly shorter duration of breastfeeding in ADHD children than controls and also an increase in the rate of children who were breastfed less than 3 months in the ADHD group. In another study conducted on two prospective population-based birth cohorts in Spain, long-term breastfeeding was found to be associated with fewer attention and hyperactivity symptoms and an improvement in related behavioral areas [7]. Recently, concordant findings were reported in a large epidemiological study of Korean children [8]. To the best of my knowledge, there is no other study that either accepted or rejected an association between ADHD and short duration of breastfeeding. Taken as a whole, the studies cited above indicate a highly significant link between the topics reviewed.

As there is agreement that ADHD is best viewed as a gene–environment interaction [9,10], breastfeeding appears as one of the factors that regulate the course of the disorder. Therefore, several implications may be drawn ranging from prevention to treatment. For instance, preterm delivery may lead to both insufficient breastfeeding and ADHD symptoms in the child [11,12]. Based on the association demonstrated above, it is also worthwhile to go one step further and think about the impact of early-weaning adversities on ADHD.

Breastfeeding, iron deficiency and ADHD

Since iron plays a central role in the regulation of dopaminergic activity which is implicated in neurobehavioral disorders, there are grounds to look into iron status in ADHD. A number of studies have described deficient iron levels in children with ADHD and suggested iron supplementation during treatment [13–16]. Although some aspects of this topic is still under debate, there is a need to review factors associated with both conditions.

It has been reported that, among children in the developing world, iron is the most common single-nutrient deficiency and can have long-lasting detrimental effects [17]. There is general agreement that exclusive breastfeeding until age 6 months and continuation of breastfeeding after this age, combined with complementary feeding may provide sufficient iron stores to infants [18–20]. Early weaning is associated with early introduction of cow's milk which contributes to iron deficiency by preventing intake of adequate iron-rich foods and increasing gastrointestinal blood loss [21,22].

Although adverse developmental impact of iron deficiency in infancy on central nervous system has been noted by some authors and precautions have been made about the continuity of the effects, a particular emphasis on ADHD does not exist. Based on the research evidence it comes out that, children with ADHD, who have a history of absence or short duration of breastfeeding, might also be at risk for iron-deficiency. Furthermore, a causative role of iron deficiency for ADHD symptoms may be considered in those children. Definitely, more research is needed to identify the interrelatedness of the factors involved.

Relationship between duration of breastfeeding, bottle-feeding, non-nutritive sucking habits and development of malocclusions

Besides the positive aspects mentioned above, breastfeeding has been cited as one of the environmental factors leading to the correct development of dentofacial structures [23,24]. Absence or short duration of breastfeeding consequently results in longer duration of bottle-feeding which may negatively affect children's oral-facial development [25–27]. Malocclusion, an unacceptable deviation either and/or functionally from the ideal relationship of the upper and lower teeth, is one of the adverse outcomes [28]. Qualitative and quantitative classifications of malocclusion have been developed and many forms require costly and time-consuming orthodontic treatments. Bottle-feeding, even partial, was reported to be associated with changes in certain dimensions of the maxillary dental arch and in inter-arch relationships [29]. In addition to dental malocclusion, bottle-feeding was found to contribute to development of a dolichocephalic Steiner mandibular plane, while breast-fed children displayed a brachycephalic mandible arch [30].

Furthermore, the dyad of insufficient duration of breastfeeding and longer duration of bottle-feeding is significantly linked to non-nutritive sucking habits (NNSH) which refer to another group of factors leading to malocclusion of teeth. NNSH are mentioned when children satisfy their instinctive sucking urge with prolonged use of pacifiers or by sucking their thumbs [31]. Montaldo et al. [32] reported that children with bottle or complementary feeding showed a higher risk of acquiring NNSH after the first year of life which is associated with a greater risk of crossbite, open bite, Class II molar relationship.

Since some children with ADHD have insufficient duration of breastfeeding, there is ground to expect higher rates of dentofacial problems in those children. In a study conducted by Atmetlla et al. [33] although no statistically significant difference was found in relation to occlusal problems in ADHD children, the presence of a different pattern of facial biotype was noted. Following this, Katz-Sagi et al. [34] reported no statistical difference in occlusal relationship between ADHD and control groups. However, emphasizing the importance of awareness of such conditions, a recent study described an abnormal orofacial pattern in ADHD children and more common high arched palate, especially in combined sub-type [35]. In case a child with ADHD has malocclusion, the course of orthodontic treatment is more challenging than a typically developing child which indicates an independent factor for higher prevalences because of the relative increase of uncorrected cases [36]. Definitely more research is needed to fill the gap of knowledge in this field. Malocclusions are further associated with a group of oral-pharyngeal pathologies some of which have aspects relating to ADHD pathogenesis. For this reason, we again need to take steps forward and explore the issues related.

Relationship between malocclusion, sleep-disordered breathing and ADHD

Sleep-disordered breathing (SDB) in children is a common and serious problem associated with significant morbidity. The spectrum of obstructive SDB may range from habitual snoring to partial or complete airway obstruction, termed obstructive sleep apnea (OSA) [37]. Symptoms may be either nocturnal, such as snoring, observed apnoeas, restless sleep, diaphoresis and enuresis, or diurnal, such as daytime sleepiness, academic problems, headaches and mouth breathing. The physical examination may be normal or may reveal failure to thrive, obesity, enlarged tonsils, adenoid face and hyponasal speech [38]. Questionnaires and scales, home monitoring, and polysomnography (PSG) are among the diagnostic tools used to confirm SDB in children and PSG is accepted as a gold standard evaluation method [38,39]. Although tonsillectomy and adenoidectomy remains the most commonly recommended treatment for pediatric patients with OSA, cautions have been made to define the role of nonsurgical treatments such as nasal continuous positive airway pressure, anti-inflammatory agents, and oral appliances [40,41]. Controversies still exist regarding diagnosis, evaluation and treatment in the field of SDB which warrant more research.

Abnormal craniofacial development is reported as one of the causes of OSA syndrome [42]. The craniofacial characteristics of OSA patients have been specified as follows: short anterior cranial base, less obtuse cranial base flexure angle, retro positioned mandible, small mandible, small maxilla, steep mandibular plane, long soft palate, decreased airway space, lowered position of hyoid bone and increased anterior facial height [42]. In regard to occlusion, previous research has identified important features. In a study by Cazzola et al. [43] a statistically significant association between snoring, cross-bite, open-bite and increased over-jet was found in a cohort of 495 school-aged children. A longitudinal study tracking the development of sleep disordered breathing and malocclusion found that cross-bites as well as narrower dental arches were more common among snoring children than non-snoring children, at 4, 6 and 12 years [44]. These findings indicate early-onset nature of malocclusions and the continuity of problem from primary to permanent teeth in SDB. Class II malocclusion was reported to be also more common in a sample of adult OSA patients [45]. Moreover, Miyao et al. [46] argued that as overjet was closely linked to the severity of SDB in adult non-obese patients, malocclusion plays a key role in the development of OSA. In regard to treatment, correction of mandibular retrognathism was found to increase airway space and improve nocturnal breathing in a group of adolescents [47].

Besides several positive effects on health, sufficient duration of breastfeeding has been shown to be associated with a decreased risk of habitual snoring in school-aged children [48]. In a PSG study of children with habitual snoring, those who had been breastfed for at least 2 months were found to have significantly reduced SDB severity on every measure assessed, including apnea-hypopnea index, oxyhemoglobin desaturation nadir, and respiratory arousal index [49]. On the other hand, the same study revealed that breastfeeding for longer than 5 months did not contribute additional benefits. In an interesting study that examined the relationship between breastfeeding, breathing pattern and deleterious oral habits, mouth breathing children not only had a short duration of breastfeeding, but they had significantly more frequent deleterious oral habits compared to nose breathers, as well [50]. This gives support to the view that seemingly different behaviors may be linked to contribute to pathology.

A significant body of research indicates that SDB is associated with neurocognitive impairment, particularly ADHD and learning disorders. In 2002, Chervin et al. [51] reported that inattention and hyperactivity among general pediatric patients are associated with increased daytime sleepiness and – especially in young boys-snoring and other symptoms of SDB. This was followed by another report of a 4-year long prospective cohort study that untreated snoring and sleep disordered breathing are strong risk factors for future emergence or exacerbation of hyperactive behavior [52]. In support of these findings, O'Brien et al. [53] showed that SDB in children can lead to mild ADHD-like behaviors that can be readily misperceived and potentially delay the diagnosis and appropriate treatment. A meta-analysis of 16 sleep studies indicated that children with ADHD had significantly higher night awakenings, sleep disordered breathing and daytime sleepiness compared with the controls [54]. As an objective measure, the apnea-hypopnea index was also significantly higher in ADHD children [54]. There is also PSG evidence that adults who have persistent symptoms of ADHD are more likely to have SDB and sleep fragmentation [55].

The mechanism through which SDB produces ADHD-like symptoms is postulated to be the impact of SDB specifically on "executive functions", which include cognitive flexibility, task initiation, self-monitoring, planning, organization, and self-regulation of affect and arousal [56]. In children with SDB who underwent PSG and neurocognitive assessment, increased arousal during sleep was described as a defensive mechanism that may preserve cognitive function by counteracting the respiratory events, at the expense of sleep maintenance and further, ADHD-like symptoms [57].

With regard to treatment effects, significant improvements on behavior after adenotonsillectomy have been reported by researchers. Using a screening questionnaire, Weber and colleagues [58] compared the impact of adenotonsillectomy on the domains of inattention, hyperactivity and impulsivity, and found significant improvements in particular in children aged 8 to 10. In a similar comparison study involving children who underwent adenotonsillectomy, the apnea-hypopnea index in PSG, attentional scores and 8 of 9 individual domains of the Child Behavior Checklist scores were found to have improved after surgery [59]. Likewise, on the Conner's Parent Rating Scale and Pediatric Sleep Questionnaire, 71 children diagnosed as having SDB were reported to have improved in both sleep and behavior after adenotonsillectomy [60]. Beyond the use of psychometric questionnaires and scales, children with clinically confirmed diagnosis of ADHD and comorbid SDB were compared for the effects of methylphenidate treatment and adenotonsillectomy [61]. Children who underwent surgery not only had lower post-surgery ADHD ratings, but they were also significantly better than the children who received only methylphenidate treatment and who had no treatment.

Relationship between duration of breastfeeding, ADHD, SDB and obesity

Another dimension worth mentioning is the protective effect of breastfeeding on obesity and related health problems, as revealed by previous research [62–64]. There is also evidence that comorbidity exists between ADHD and obesity [65,66]. SDB appears to be one of the mechanisms that mediate the comorbidity between ADHD and obesity [67,68].

Relationship between traumatic dental injuries, ADHD and malocclusion

Traumatic dental injuries (TDI) constitute a prevalent and serious health problem among children worldwide. Previous epidemiological and hospital-based studies revealed that one third of all preschool children and one fourth of all school children may suffer from dental trauma [69]. Anterior teeth fractures, which account for the majority of cases, lead to both functional, aesthetic and emotional consequences [70]. Complications that may arise include tooth discoloration, loss of vitality, root resorption and/or abscess formation [71]. Falls and collisions during sports and games are the major causes of TDIs [72]. Among the structural determinants considered, incisor overjet of more than 3 mm and incompetent lips were described as significant factors predisposing to dental trauma [73]. The estimated cost of TDIs ranged from US$2–5 million per million inhabitants per year irrespective of age [74].

It is the Health Survey for England 1997 that provided the initial data regarding the association between hyperactivity as a symptom and major injuries affecting face and/or teeth [75]. Soon after this, Sabuncuoglu et al. [76] compared the frequency of TDIs among children with ADHD and non-ADHD diagnoses and found a significant association between TDIs and ADHD. This laid the ground for the proposal of an explanatory model for TDIs. Sabuncuoglu also reviewed previous studies in the field of dental traumatology which provided indirect evidence of ADHD [72]. Since

Please cite this article in press as: Sabuncuoglu O. Understanding the relationships between breastfeeding, malocclusion, ADHD, sleep-disordered breathing and traumatic dental injuries. Med Hypotheses (2013), http://dx.doi.org/10.1016/j.mehy.2012.12.017

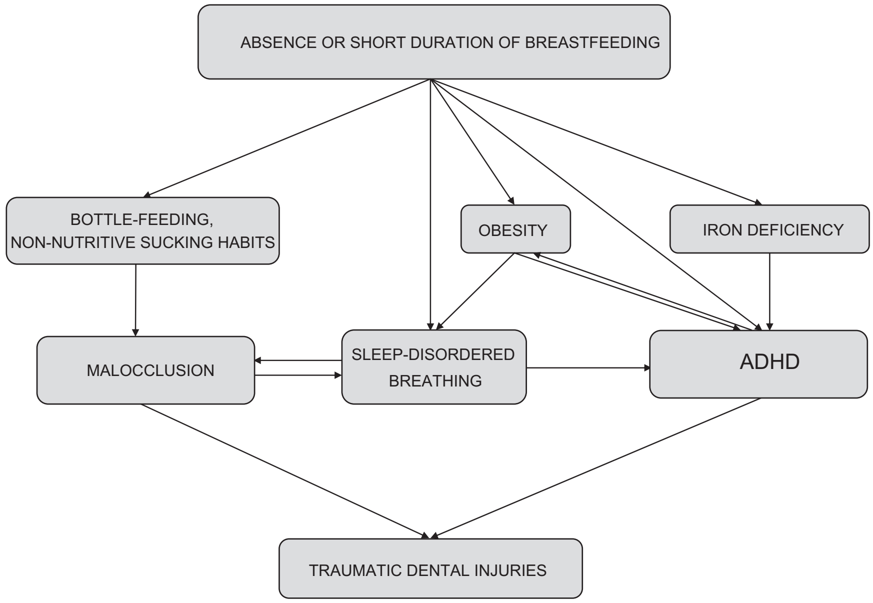

Fig. 1. Summary chart for the relationships between certain oral-pharyngeal conditions and ADHD symptoms.

then, controlled studies from different parts of the world have confirmed the link between ADHD and TDIs [34,77,78].

It is important to emphasize that incisor overjet, which is a structural predisposing factor for TDIs, is a form of malocclusion as highlighted in relation to various factors in the sub-section of this review. It is highly possible that ADHD, besides behavioral risk factors it poses, may also have a role in the occurrences of dental injuries through the structural risk factor it may be related to. Several developmental mechanisms that may link ADHD and malocclusions have been pointed out in this review. As pointed above, children with combined sub-type of ADHD, which is the most common sub-type, are more likely to present with high arched palate [35]. Prevalences of malocclusions and in particular, overjet are high in the general child population [79–81]. Despite the fact that we need more data regarding the association between malocclusions and ADHD, projected general population rates enable us to estimate that a significant percentage of ADHD children may be affected by malocclusions. To put it brief, malocclusion in a child with ADHD may not be simply a dental anomaly unrelated to the pathogenesis of ADHD.

The relationships between the factors highlighted in this article are shown in Fig. 1, which enables to grasp the complexity of the model at a glance.

Discussion

In this review, relationships and causality between symptoms of ADHD and certain oral-pharyngeal conditions have been investigated. A multidisciplinary approach has been employed which connects work from different disciplines such as pediatrics, child and adolescent psychiatry, otorhinolaryngology, pediatric dentistry, orthodontics and endodontics. At the beginning of the article, studies reporting an association between ADHD and insufficient breastfeeding duration has been highlighted and the need to understand the possible consequences of this finding has been underlined (Fig. 1). Early weaning leads to increased use of cow's milk which is thought to be a cause of early-life iron deficiency. Mentioning the role of iron in the pathogenesis of ADHD, this mechanism may be postulated as one of the factors that may affect the manifestation of ADHD. Absence or short duration of breastfeeding is highly associated with longer duration of bottle-feeding and higher frequency of non-nutritive sucking habits all of which lead to development of malocclusions. Although malocclusion seems to be an expected outcome in children with ADHD, there's only few research in the literature. In this review, studies reporting a high degree of correlation between SDB and malocclusion have also been cited. Furthermore, this point of evidence has been linked to the high rates of SDB in children with ADHD. In addition to this, research evidence suggesting an association between insufficient duration of breastfeeding and mouth breathing has been underlined. Obesity, which is related to insufficient breastfeeding, has been highlighted as a shared comorbidity of ADHD and SDB. As a further point of interest, previous work reporting a relationship between ADHD and TDIs has been reviewed. Having described incisor overjet as a form of malocclusion and a well-established risk factor for TDIs, how insufficient breastfeeding may relate to the development of both overjet and ADHD symptoms has been explained.

To the best of my knowledge, this is the first attempt to bring together existing studies and knowledge on various aspects of oral-pharyngeal conditions in a framework relating to ADHD. Besides the genetic explanation of ADHD, a parallel environmental model has been proposed based on previous research findings. It is very remarkable to see that how an early life experience, namely breastfeeding, may impact long-term mental and physical well-being.

For the professionals who are in clinical work with ADHD children, it is not uncommon to see children who have clinical features highlighted in this article. An important question worth raising is whether this complicated ADHD presentation constitutes a subtype. Definitely more research is needed for a thorough understanding of the topics reviewed and subsequent clinical implications for the betterment of children who are in need.

Conflict of interest statement

None.

References

[1] American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders, Text Revision. Washington, DC: American Psychiatric Association; 2000.

[2] Floet AM, Scheiner C, Grossman L. Attention-deficit/hyperactivity disorder. Pediatr Rev 2010;31:56–69.

[3] World Health Organization. Infant and young child feeding: Model Chapter for textbooks for medical students and allied health professionals. Geneva: WHO; 2009. Available from: URL: http://whqlibdoc.who.int/publications/2009/9789241597494_eng.pdf.
[4] Stevens LJ, Zentall SS, Deck JL, et al. Essential fatty acid metabolism in boys with attention-deficit hyperactivity disorder. Am J Clin Nutr 1995;62:761–8.
[5] Yorbık Ö, Kırmızıgül P, Demirkan S, Söhmen T. Dikkat Eksikliği Hiperaktivite Bozukluğu olan çocuklarda anne sütü alma süreleri. Çocuk Ve Gençlik Ruh Sağlığı Dergisi 2003;10:115–20.
[6] Kadziela-Olech H, Piotrowska-Jastrzebska J. The duration of breastfeeding and attention deficit hyperactivity disorder. Rocz Akad Med Bialymst 2005;50:302–6.
[7] Julvez J, Ribas-Fitó N, Forns M, Garcia-Esteban R, Torrent M, Sunyer J. Attention behaviour and hyperactivity at age 4 and duration of breast-feeding. Acta Paediatr 2007;96:842–7.
[8] Kim HW, Cho SC, Kim BN, Kim JW, Shin MS, Kim Y. Perinatal and familial risk factors are associated with full syndrome and subthreshold attention-deficit hyperactivity disorder in a korean community sample. Psychiatry Invest 2009;6:278–85.
[9] Banerjee TD, Middleton F, Faraone SV. Environmental risk factors for attention-deficit hyperactivity disorder. Acta Paediatr 2007;96:1269–74.
[10] Daley D, Jones K, Hutchings J, Thompson M. Attention deficit hyperactivity disorder in pre-school children: current findings, recommended interventions and future directions. Child Care Health Dev 2009;35:754–66.
[11] Callen J, Pinelli J. A review of the literature examining the benefits and challenges, incidence and duration, and barriers to breastfeeding in preterm infants. Adv Neonatal Care 2005;5:72–88. quiz 89–92.
[12] Thapar A, Cooper M, Jefferies R, Stergiakouli E. What causes attention deficit hyperactivity disorder? Arch Dis Child 2012;97:260–5.
[13] Sever Y, Ashkenazi A, Tyano S, Weizman A. Iron treatment in children with attention deficit hyperactivity disorder. A preliminary report.. Neuropsychobiology 1997;35:178–80.
[14] Konofal E, Lecendreux M, Deron J, et al. Effects of iron supplementation on attention deficit hyperactivity disorder in children. Pediatr Neurol 2008;38:20–6.
[15] Oner P, Oner O. Relationship of ferritin to symptom ratings children with attention deficit hyperactivity disorder: effect of comorbidity. Child Psychiatry Hum Dev 2008;39:323–30.
[16] Calarge C, Farmer C, Disilvestro R, Arnold LE. Serum ferritin and amphetamine response in youth with attention-deficit/hyperactivity disorder. J Child Adolesc Psychopharmacol 2010;20:495–502.
[17] Baker RD. Committee on Nutrition American Academy of Pediatrics. Diagnosis and prevention of iron deficiency and iron-deficiency anemia in infants and young children (0–3 years of age). Pediatrics 2010;126:1040–50.
[18] Assis AM, Gaudenzi EN, Gomes G, Ribeiro Rde C, Szarfarc SC, Souza SB. Hemoglobin concentration, breastfeeding and complementary feeding in the first year of life. Rev Saude Publica 2004;38:543–51.
[19] Chaparro CM. Setting the stage for child health and development: prevention of iron deficiency in early infancy. J Nutr 2008;138:2529–33.
[20] Oliveira AS, Silva Rde C, Fiaccone RL, Pinto Ede J, Assis AM. Effect of length of exclusive breastfeeding and mixed feeding on hemoglobin levels in the first six months of life: a follow-up study. Cad Saude Publica 2010;26:409–17.
[21] Brotanek JM, Halterman JS, Auinger P, Flores G, Weitzman M. Iron deficiency, prolonged bottle-feeding, and racial/ethnic disparities in young children. Arch Pediatr Adolesc Med 2005;159:1038–42.
[22] Oliveira MA, Osório MM. Cow's milk consumption and iron deficiency anemia in children. J Pediatr (Rio J) 2005;81:361–7.
[23] Viggiano D, Fasano D, Monaco G, Strohmenger L. Breast feeding, bottle feeding, and non-nutritive sucking; effects on occlusion in deciduous dentition. Arch Dis Child 2004;89:1121–3.
[24] Medeiros AP, Ferreira JT, Felício CM. Correlation between feeding methods, non-nutritive sucking and orofacial behaviors. Pro Fono 2009;21:315–9.
[25] Howard CR, Howard FM, Lanphear B, et al. Randomized clinical trial of pacifier use and bottle-feeding or cupfeeding and their effect on breastfeeding. Pediatrics 2003;111:511–8.
[26] Camurdan AD, Ilhan MN, Beyazova U, Sahin F, Vatandas N, Eminoglu S. How to achieve long-term breast-feeding: factors associated with early discontinuation. Public Health Nutr 2008;11:1173–9.
[27] Carrascoza KC, Possobon Rde F, Tomita LM, Moraes AB. Consequences of bottle-feeding to the oral facial development of initially breastfed children. J Pediatr (Rio J) 2006;82:395–7.
[28] Heasman P, editor. Master Dentistry: Restorative Dentistry, Paediatric Dentistry and Orthodontics. Oxford: Churchill Livingstone, Elsevier; 2003.
[29] Diouf JS, Ngom PI, Badiane A, et al. Influence of the mode of nutritive and non-nutritive sucking on the dimensions of primary dental arches. Int Orthod 2010;8:372–85.
[30] Sánchez-Molins M, Grau Carbó J, Lischeid Gaig C, Ustrell Torrent JM. Comparative study of the craniofacial growth depending on the type of lactation received. Eur J Paediatr Dent 2010;11:87–92.
[31] Turgeon-O'Brien H, Lachapelle D, Gagnon PF, Larocque I, Maheu-Robert LF. Nutritive and nonnutritive sucking habits: a review. ASDC J Dent Child 1996;63:321–7.
[32] Montaldo L, Montaldo P, Cuccaro P, Caramico N, Minervini G. Effects of feeding on non-nutritive sucking habits and implications on occlusion in mixed dentition. Int J Paediatr Dent 2011;21:68–73.
[33] Atmetlla G, Burgos V, Carrillo A, Chaskel R. Behavior and orofacial characteristics of children with attention-deficit hyperactivity disorder during a dental visit. J Clin Pediatr Dent 2006;30:183–90.
[34] Katz-Sagi H, Redlich M, Brinsky-Rapoport T, Matot I, Ram D. Increased dental trauma in children with attention deficit hyperactivity disorder treated with methylphenidate–a pilot study. J Clin Pediatr Dent 2010;34:287–9.
[35] Rizwanulla T. Orofacial Abnormalities and Associated Behavior Pattern in Children with Attention Deficit Hyperactivity Disorder Subtypes. Doctoral dissertation. Bagalkot, Karnataka: Rajiv Gandhi University of Health Sciences, P.M.N.M. Dental College and Hospital; 2009.
[36] Pessah S, Montluc N, Bailleul-Forestier I, Decosse MH. Orthodontic treatment of children suffering from attention deficit disorder with hyperactivity (ADHD). Orthod Fr 2009;80:331–8.
[37] Vlastos IM, Hajiioannou JK. Clinical practice. diagnosis and treatment of childhood snoring. Eur J Pediatr 2010;169:261–7.
[38] Brooks LJ. Diagnosis and evaluation of obstructive sleep apnoea in children. Ann Acad Med Singapore 2008;37:701–5.
[39] Guilleminault C, Lee JH, Chan A. Pediatric obstructive sleep apnea syndrome. Arch Pediatr Adolesc Med 2005;159:775–85.
[40] Ray RM, Bower CM. Pediatric obstructive sleep apnea: the year in review. Curr Opin Otolaryngol Head Neck Surg 2005;13:360–5.
[41] Gozal D, Kheirandish-Gozal L. The multiple challenges of obstructive sleep apnea in children: morbidity and treatment. Curr Opin Pediatr 2008;20:654–8.
[42] Kikuchi M. Orthodontic treatment in children to prevent sleep-disordered breathing in adulthood. Sleep Breath 2005;9:146–58.
[43] Cazzolla AP, Lacarbonara V, Pellegrino B, Testa NF, Fidanza F, Lacaita MG. Sleep-disordered breathing in a sample of 495 children in Southern Italy. Eur J Paediatr Dent 2010;11:189–92.
[44] Hultcrantz E. Löfstrand Tideström B. The development of sleep disordered breathing from 4 to 12 years and dental arch morphology. Int J Pediatr Otorhinolaryngol 2009;73:1234–41.
[45] Banabilh SM, Samsudin AR, Suzina AH, Dinsuhaimi S. Facial profile shape, malocclusion and palatal morphology in Malay obstructive sleep apnea patients. Angle Orthod 2010;80:37–42.
[46] Miyao E, Noda A, Miyao M, Yasuma F, Inafuku S. The role of malocclusion in non-obese patients with obstructive sleep apnea syndrome. Intern Med 2008;47:1573–8.
[47] Schütz TC, Dominguez GC, Hallinan MP, Cunha TC, Tufik S. Class II correction improves nocturnal breathing in adolescents. Angle Orthod 2011;81:222–8.
[48] Li S, Jin X, Yan C, Wu S, Jiang F, Shen X. Habitual snoring in school-aged children: environmental and biological predictors. Respir Res 2010;11:144.
[49] Montgomery-Downs HE, Crabtree VM, Sans Capdevila O, Gozal D. Infant-feeding methods and childhood sleep-disordered breathing. Pediatrics 2007;120:1030–5.
[50] Trawitzki LV, Anselmo-Lima WT, Melchior MO, Grechi TH, Valera FC. Breast-feeding and deleterious oral habits in mouth and nose breathers. Braz J Otorhinolaryngol 2005;71:747–51.
[51] Chervin RD, Archbold KH, Dillon JE, et al. Inattention, hyperactivity, and symptoms of sleep-disordered breathing. Pediatrics 2002;109:449–56.
[52] Chervin RD, Ruzicka DL, Archbold KH, Dillon JE. Snoring predicts hyperactivity four years later. Sleep 2005;28:885–90.
[53] O'Brien LM, Holbrook CR, Mervis CB, et al. Sleep and neurobehavioral characteristics of 5- to 7-year-old children with parentally reported symptoms of attention-deficit/hyperactivity disorder. Pediatrics 2003;111:554–63.
[54] Cortese S, Faraone SV, Konofal E, Lecendreux M. Sleep in children with attention-deficit/hyperactivity disorder: meta-analysis of subjective and objective studies. J Am Acad Child Adolesc Psychiatry 2009;48:894–908.
[55] Surman CB, Thomas RJ, Aleardi M, Pagano C, Biederman J. Adults with ADHD and sleep complaints: a pilot study identifying sleep-disordered breathing using polysomnography and sleep quality assessment. J Atten Disord 2006;9:550–5.
[56] Owens JA. Neurocognitive and behavioral impact of sleep disordered breathing in children. Pediatr Pulmonol 2009;44:417–22.
[57] Miano S, Paolino MC, Urbano A, et al. Neurocognitive assessment and sleep analysis in children with sleep-disordered breathing. Clin Neurophysiol 2011;122:311–9.
[58] Weber SA, Lima Neto AC, Ternes FJ, Montovani JC. Hyperactivity and attention deficit syndrome in obstructive sleep apnea syndrome: is there improvement with surgical management? Braz J Otorhinolaryngol 2006;72:124–9.
[59] Li HY, Huang YS, Chen NH, Fang TJ, Lee LA. Impact of adenotonsillectomy on behavior in children with sleep-disordered breathing. Laryngoscope 2006;116:1142–7.
[60] Wei JL, Mayo MS, Smith HJ, Reese M, Weatherly RA. Improved behavior and sleep after adenotonsillectomy in children with sleep-disordered breathing. Arch Otolaryngol Head Neck Surg 2007;133:974–9.
[61] Huang YS, Guilleminault C, Li HY, Yang CM, Wu YY, Chen NH. Attention-deficit/hyperactivity disorder with obstructive sleep apnea: a treatment outcome study. Sleep Med 2007;8:18–30.
[62] Stettler N. Infant feeding practices and subsequent development of adipose tissue. Nestle Nutr Workshop Ser Pediatr Program 2011;68:215–21. discussion 222-5.
[63] Fewtrell MS. Breast-feeding and later risk of CVD and obesity: evidence from randomised trials. Proc Nutr Soc 2011;70:472–7.
[64] Oddy WH. Infant feeding and obesity risk in the child. Breastfeed Rev 2012;20:7–12.

[65] Cortese S, Angriman M, Maffeis C, et al. Attention-deficit/hyperactivity disorder (ADHD) and obesity: a systematic review of the literature. Crit Rev Food Sci Nutr 2008;48:524–37.
[66] Davis C. Attention-deficit/hyperactivity disorder: associations with overeating and obesity. Curr Psychiatry Rep 2010;12:389–95.
[67] Cortese S, Maffeis C, Konofal E, et al. Parent reports of sleep/alertness problems and ADHD symptoms in a sample of obese adolescents. J Psychosom Res 2007;63:587–90.
[68] Yoon SY, Jain U, Shapiro C. Sleep in attention-deficit/hyperactivity disorder in children and adults: past, present, and future. Sleep Med Rev 2012;16:371–88.
[69] Glendor U. Epidemiology of traumatic dental injuries–a 12 year review of the literature. Dent Traumatol 2008;24:603–11.
[70] Alonge OK, Narendran S, Williamson DD. Prevalence of fractured incisal teeth among children in Harris County. Texas Dent Traumatol 2001;17:218–21.
[71] Fried I, Erickson P. Anterior tooth trauma in the primary dentition: incidence, classification, treatment methods, and sequelae: a review of the literature. ASDC J Dent Child 1995;62:256–61.
[72] Sabuncuoglu O. Traumatic dental injuries and attention-deficit/hyperactivity disorder: is there a link? Dent Traumatol 2007;23:137–42.
[73] Glendor U. Aetiology and risk factors related to traumatic dental injuries–a review of the literature. Dent Traumatol 2009;25:19–31.
[74] Borum MK, Andreasen JO. Therapeutic and economic implications of traumatic dental injuries in Denmark: an estimate based on 7549 patients treated at a major trauma centre. Int J Paediatr Dent 2001;11:249–58.
[75] Lalloo R. Risk factors for major injuries to the face and teeth. Dent Traumatol 2003;19:12–4.
[76] Sabuncuoglu O, Taser H, Berkem M. Relationship between traumatic dental injuries and attention-deficit/hyperactivity disorder in children and adolescents: proposal of an explanatory model. Dent Traumatol 2005;21:249–53.
[77] Bimstein E, Wilson J, Guelmann M, Primosch R. Oral characteristics of children with attention-deficit hyperactivity disorder. Spec Care Dentist 2008;28:107–10.
[78] Schmied K, Heinrich-Weltzien K. Der Einfluss psychischer Störungen auf die Mundgesundheit von Kindern und Jugendlichen. ZWR 2009;118:26–31.
[79] Gelgör IE, Karaman AI, Ercan E. Prevalence of malocclusion among adolescents in central anatolia. Eur J Dent 2007;1:125–31.
[80] Perinetti G, Cordella C, Pellegrini F, Esposito P. The prevalence of malocclusal traits and their correlations in mixed dentition children: results from the Italian OHSAR Survey. Oral Health Prev Dent 2008;6:119–29.
[81] Sidlauskas A, Lopatiene K. The prevalence of malocclusion among 7–15-year-old Lithuanian schoolchildren. Medicina (Kaunas) 2009;45:147–52.

Please cite this article in press as: Sabuncuoglu O. Understanding the relationships between breastfeeding, malocclusion, ADHD, sleep-disordered breathing and traumatic dental injuries. Med Hypotheses (2013), http://dx.doi.org/10.1016/j.mehy.2012.12.017