M. Petrini*, M. Costacurta**, V. Biferi*, D. Benavoli**, R. Docimo**, G. Spoto*

*Department of Medical, Oral and Biotechnological Sciences, University of Chieti, Chieti, Italy
**Department of Surgical Science", University of Rome "Tor Vergata", Rome, Italy

email: micaela.costacurta@uniroma2.it

DOI: 10.23804/ejpd.2018.19.04.2

Correlation between halitosis, oral health status and salivary β-galactosidases and time spent in physical activities in children

ABSTRACT

Aim *The aim of this work was to evaluate the oral health status in children and to correlate it with time spent in physical activity per week.*

Materials and methods *Fifty children (mean age 9±2 years) attending the first visit at the Paediatric Dental Unit of the University of Rome "Tor Vergata" have been included in the study. The parents of all patients were interviewed about the medical history of the children and specific data, in particular, the time spent in physical activity per week. A trained dentist examined the oral cavity of the patients and the following clinical parameters were recorded: number of deciduous and permanent teeth, caries (on deciduous and permanent teeth), presence of gingivitis (0=no; 1=yes), tongue coating score (from 0=none to 3= > 2/3 tongue dorsum surface covered)", oral infections (0=no; 1=yes), oral hygiene index (0=insufficient, 1=sufficient, 2=good), presence of at least one incongruous restoration (0=no, 1=yes), oral breathing (0=no; 1=yes), fissured tongue (0=no, 1=yes), presence of aftous ulcers, herpetic lesions or candidiasis (0=no, 1=yes), food stagnation (0=no; 1=yes). The level of salivary β-galactosidases activity was measured spectrophotometrically. The subjects were classified into "Group 0": children who did not practice any sports beside physical education class; "Group 2": 2 hours per week; "Group 3": 3 hours; and "Group 4": 4 hours. Statistics: Statistical analysis was performed using SPSS for Windows version 21 (IBM SPSS Inc., Chicago, IL, USA). The Pearson's correlation coefficient (P) was used to evaluate the linear relationship between continuous variables, and the Spearman's correlation coefficient (S) was calculated for ordinal variables. Analysis of variance (ANOVA) and the Fischer's Least Significant Difference (LSD) test were used to compare the parameters analysed in the study. Data were analysed using linear regression and descriptive statistics. The significance threshold was set at 0.05.*

Results *A more physically active lifestyle was significantly associated with a better oral hygiene and a reduced level of salivary β-galactosidases, halitosis, gingivitis and tongue coating. Results of the organoleptic evaluation of halitosis performed by the parents and sport hours/week practiced have shown that Group 0 and 2 were characterised by statistically significant higher scores with respect to the other groups (Group 0 vs. Group 3, p=0.014; Group 2 vs. Group 3, p=0.030; Group 0 vs. Group 4, p=0.001; Group 2 vs. Group 4, p=0.002) (P=-0.458). The spectrophotometric quantification of salivary β-galactosidases has shown that increasing the hours of sports, the enzyme activity significantly decreases (S=-0,330); similar levels were found with 0 and 2 hours of sports, but an important decrease has been recorded with both 3 (Group 0 vs. Group 3, p=0,011; Group 2 vs. Group 3, p=0,006) and 4 hours of sports practiced (Group 0 vs. Group 4, p=0,014; Group 2 vs. Group 4, p=0,008). The level of significance between children who did not practice sport and those who did for 3 and 4 hours a week was 0.005 (Group 0 vs. Group 3) and 0.0018 (Group 2 vs. Group 4) with respect to tongue coating scores (P=-0,511) and 0.012 for both groups with respect to gingivitis (Group 0 vs. Group 3; Group 0 vs. Group 4) (P=-0,427).*

Conclusions *Children who practiced sport showed a better oral hygiene level and lower halitosis, with respect to those who did not.*

Keywords *β-galactosidases, Halitosis, Oral hygiene, Sport, Physical activity, Tongue coating.*

Introduction

Physical activity has beneficial effects on general health and well-being and it has as a protective action of on the risk of coronary heart disease, diabetes mellitus, colon cancer, obesity, osteoporosis, arthritis, hypertension, and high cholesterol [Warburton et al., 2006]. Among older adults, regular physical activity has been reported to play a role in the management of anxiety and stress [Cooper et al., 1986; Paluska and Schwenk, 2000] and additionally, it has a significant impact on reducing health care costs by decreasing the number of hospitalisations and physician visits as well as reducing the need for medications [Pratt et al., 2000]. Physical activity in children has similar benefits

on adiposity levels, blood pressure, cardiovascular risk factors (inflammatory markers, endothelial function and heart rate variability), and several components of mental health (self-concept, anxiety and depression) [Janssen and LeBlanc, 2010]. Moreover, Howie et al. [2010] have shown that children with a more active lifestyle were characterised by higher social index scores. For this reason in 2002, the Canadian Government has suggested to reduce for all children - independently from their activity level - the non-active time spent on watching TV, playing computer games, and other sedentary activities in favour of a progressive increase of the time spent in physical activity from 30 to 90 minutes per day [Health Canada, 2002]. Several studies have suggested an anti-inflammatory role of physical activity: people with a more active life are characterised by lower CRP levels and white blood cells counts, with respect to more sedentary people [Abramson and Vaccarino, 2002; Ford, 2002]. These data are very important because the degree of inflammation of oral cavity is the results of local and systemic factors [D'Aiuto et al., 2004; Petrini et al., 2012a; Ferrante et al., 2013; Rajan et al., 2017] and, despite the importance given to physical activity by the scientific community, there is not a great evidence about its effects on the oral cavity. The investigation of the oral health status and influencing factors is also very important for the development of preventive measures and hygiene motivation strategies [Alyahya, 2016; Fernandez et al., 2016]: indeed acquiring appropriate oral health behaviours in childhood permit to reduce and maximise the chance of a caries- and periodontitis-free permanent dentition throughout the lifetime [American Academy on Pediatric Dentistry and American Academy of Pediatrics, 2008-2009; Giannattasio et al., 2015]. Similarly, the assessment and investigation of halitosis in children are fundamental because of the impact on social relationships and quality of life, that in extreme cases could lead to symptoms of depression or could be a manifestation of an extra-oral pathology [Díaz Rosas et al., 2018; McKeown, 2003; Suzuki et al. 2008]. Currently, the quantification of salivary β–galactosidases activity is considered an additional method for the evaluation of halitosis, and the organoleptic score is still the golden standard [Scully and Greenman, 2012]. However, considering the positive correlation between salivary β-galactosidases and halitosis and the ease in carrying out large-scale analysis even for very young children, we strongly believe that this method of halitosis evaluation should be further investigated [Petrini et al., 2014]. The aim of this work was to evaluate the correlation between salivary β-galactosidases and oral health status in children practicing sport.

Materials and methods

Fifty children attending the first visit at the Paediatric Dental Unit of the University of Rome "Tor Vergata" have been included in the study. Patients that assumed antibiotics in the 30 days before consultation and those in treatments with medications that could interfere with the oral malodour evaluation, like disulfiram and cysteamine were excluded from the study.

Parent interview

The parents were interviewed about the medical history of their children in order to collect anamnestic data. Further questions about life style and behaviours, such as: "Does your child play sport on a regular basis? How many hours per week?" have also been recorded. The parents were also interviewed by means of questionnaires about the presence and the intensity of halitosis in their children: a 0-5 scale was used to record the answers, with "0" indicating the absence of odor and "5" severe malodor [Rosenberg et al., 1991]. If the score was >1 they were asked to specify in what moment of the day the bad breath was more evident [Petrini et al., 2014].

Oral check-up

Standardised clinical criteria were based on the WHO format [World Health Organization, 2013] and Ainamo and Bay [1975]. The oral health status was recorded by a trained paedodontist as follows: number of deciduous and permanent teeth, number of decayed deciduous and permanent teeth, presence of gingivitis (0=no; 1=yes), oral infections (0=no; 1=yes), oral hygiene index (0=insufficient, 1=sufficient, 2=good), presence of at least one incongruous restoration (0=no, 1=yes), oral breathing (0=no; 1=yes), fissured tongue (0=no, 1=yes), presence of aftous ulcers, herpetic lesions or candidiasis (0=no, 1=yes), food stagnation (0=no; 1=yes). The presence of concomitant orthodontic therapy and the type of appliance (0= no orthodontic therapy, 1= mobile appliance, 2= fixed orthodontic therapy) was also recorded. The total area and thickness of the tongue coating were scored according to Oho et al. [2001]: 0 = no tongue coating; 1 = thin, with less than one-third covered; 2 = thin, with one-third to two-thirds covered or thick, with less than one-third covered; and 3 = thin with more than two-thirds covered, or thick with more than one-third covered. Saliva was collected using the spitting method. Samples were obtained from the participants between 09:00 a.m. and 11:00 a.m. to minimise the effects of diurnal variability in salivary composition. The salivary β-galactosidases activity was evaluated spectrophotometrically, as previously described [Petrini et al. 2012b, 2014]. Each sample was analysed three times, and the average value has been considered.

Statistical analysis

Statistical analysis was performed using SPSS for Windows version 21 (IBM SPSS Inc., Chicago, IL, USA). The Pearson's correlation coefficient was used to evaluate the linear relationship between continuous variables and the Spearman's correlation coefficient was calculated for ordinal variables. Analysis of variance (ANOVA) and the Fischer's Least Significant Difference (LSD) test were used to compare the parameters analysed in the study. Data were analysed using linear regression and descriptive statistics. The significance threshold was set at 0.05.

Results

Fifty children (25 males and 25 females) mean age 9±2 years (range 6 and 13; Table 1) attended the Paediatric Dental Unit of the University of Rome "Tor Vergata" came for dental consultation. Of those, 66% children practiced at least 2 hours of sport a week, in particular: 38% 2 hours, 14% 3 hours and 14% 4 hours. The 34% of the sample did not practice any sports, except for physical education class at school (Table 1). The baseline characteristics of the study population are summarised in Table 1. In order to improve the readability of this paper, "Group 0" refers to children who did not not practice any sport, "Group 2" refers to those who praticed 2 hours of sport per week, "Group 3" those who praticed 3 hours of sport per week, and "Group 4" those who praticed 4 hours of sport per week. The dental visit revealed that 56% of the participants included in this trial showed an insufficient oral hygiene, 34% sufficient and 10% good. Fourteen percent of children were affected by dentoalveolar infections, 24% by gingivitis, and food residues were found in 20% of participants. Tongue coating was found in 74%; in particular, 14 patients (28%) scored 1, 15 (30%) scored 2 and 8 (16%) scored 3. Fourteen percent of participants had fissured tongue and 12% incongruous restorations. No participants assumed drugs or halitogenic foods in the previous 24 hours, or were affected by sinusitis, respiratory, gastric or systemic diseases that could affect the organoleptic evaluation of halitosis. No cases of aphthous stomatitis, herpetic ulcerous or candidiasis weere recorded. Oral breathing was present in 10% of participants (Table 2). The Fisher's LSD test found no statistically significant differences between children who practiced or not sport and the number of teeth, decays, food stagnation, oral breath, fissured tongue. The parents of 12 children (n = 24%) did not report halitosis in their sons and daughters. Among the 38 children, those that were scored >1 in the 0-5 organoleptic scale by their parents, 11 children, were reported to have oral malodour always during the day (A = 22%), 7 in the afternoon (F = 14%), 1 in the evening (E = 2%) and 19 in the morning (M = 38%). The result of the questionnaire filled by the parents (Fig. 1) about halitosis showed that those children who spent less time in sport activities, about 1 hour per week, were characterised by greater complaint of halitosis during the whole day (n=11) or in the morning (n=19); on the contrary, children without halitosis (n=12) practiced sport more frequently (>2.5 hours/week). Crossing the results of the scores reported by parents regarding the halitosis of their children with the hours of sport practiced it was possible to see that: subjects in groups 0 and 2, i.e. children who practiced less than 2 hours of sport a week, were characterised by a statistically higher level of halitosis (p>0.05), compared to other groups. This trend was indirectly correlated with sports hours practiced during the week (Fig. 2). The Pearson analysis confirmed the significant negative correlation between sport hours practiced a week and the intensity of halitosis in children, as evaluated by their parents (P=-0,458). The spectrophotometric quantification of salivary β-galactosidases has shown that increasing the hours of sports, the enzyme activity significantly decreases (Spearman's correlation coefficient S=-0.330); similar levels were found with 0 and 2 hours of sports, but an important decrease has been recorded with both 3 (Group 0 vs. Group 3, p=0,011; Group 2 vs. Group 3, p=0,006) and 4 hours of sports practiced (Group 0 vs. Group 4, p=0,014; Group 2 vs. Group 4, p=0,008) (Fig. 3). A similar trend has been found for the level of tongue coatingindex (Pearson P=-0.511) and the presence of gingivitis (P= -0.427). When practicing sports for 4 hours a week, the level of tongue coating and gingivitis is close to zero (Fig. 4, 5). The tongue coating score (Fig. 4) and the presence of gingivitis (Fig. 5) were significantly lower in children who practiced sport more than 2 hours a week with respect to those who did not".

Physical activity hours/week	Number	Percentage
0	17	34%
2	19	38%
3	7	14%
4	7	14%
Age		
6	11	22%
7	5	10%
8	8	16%
9	9	18%
10	7	14%
11	5	10%
12	2	4%
13	3	6%
Do you suffer from sinusitis?		
No	50	100%
Yes	0	0%
Do you have gastrointestinal problems?		
No	50	100%
Yes	0	0%
Do you have systemic diseases?		
No	50	100%
Yes	0	0%
Have you taken drugs in the last month?		
No	50	100%
Yes	0	0%

TABLE 1 Baseline characteristics of study population and results of the questionnaires.

Discussion

The results of this trial show that children that practice more sport are characterised by a lower level of gingivitis, tongue coating index, halitosis and lower level of salivary β-galactosidases. No differences were found with respect to other parameters such as decayed teeth, dental infection and BMI. The novelty of the present study resides in providing data about the correlation of sport, oral health status, and salivary β-galactosidases in children

	Average	St. Dev.
Number of deciduos teeth	10,1200	6,68425
Number of permanent teeth	13,4400	8,01061
Oral Hygiene Level	Number	Percentage
Insufficient	28	56,0%
Sufficient	17	34,0%
Good	5	10,0%
Tongue coating index		
No	13	26,0%
Moderate	14	28,0%
Severe	15	30,0%
Very severe	8	16,0%
Dental infections		
No	43	86,0%
Yes	7	14,0%
Presence of gingivitis		
No	38	76,0%
Yes	12	24,0%

	Average	St. Dev.
Decayed deciduos teeth	,7600	1,84678
Decayed permanent teeth	,4600	,93044
	Number	Percentage
Presence of incongruous restorations		
No	44	88,0%
Yes	6	12,0%
Oral breath		
No	45	90,0%
Yes	5	10,0%
Fissured tongue		
No	43	86,0%
Yes	7	14,0%
Aftous stomatitis/herpetic lesions/ candidiasis		
No	50	100,0%
Yes	0	0,0%
Food Starvation		
No	40	80,0%
Yes	10	20,0%

TABLE 2 Oral status of study population.

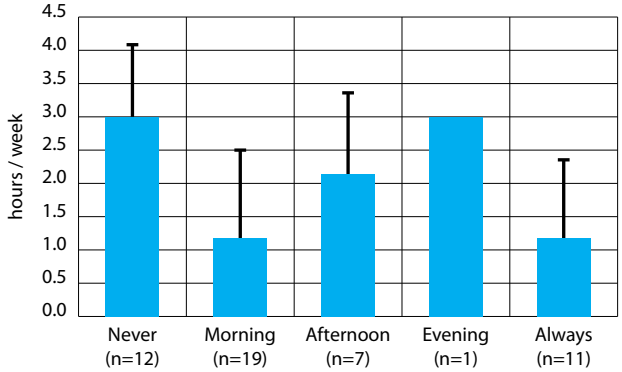

FIG. 1 Halitosis organoleptic value compliant during the day and sport hours/week practiced; n = numbers of children.

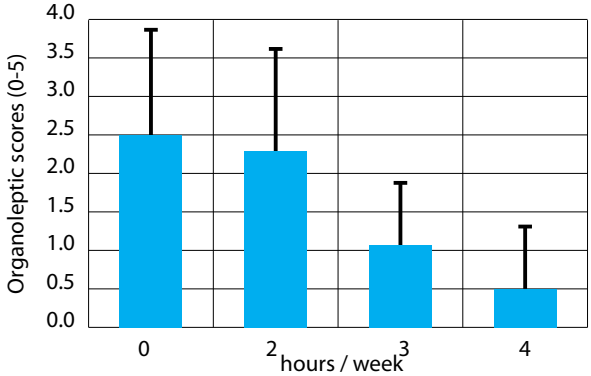

FIG. 2 Halitosis organoleptic value (results of the scores reported by parents regarding the halitosis of their children) and. sport hours/week practiced; (*) = significant at $p < 0,05$; Pearson's correlation coefficient (P) = -0,458 LSD: Group 0 vs Group 3 p= 0,014* Group 0 vs Group 4 p= 0,001* Group 2 vs Group 3 p= 0,030* Group 2 vs Group 4 p= 0,002*

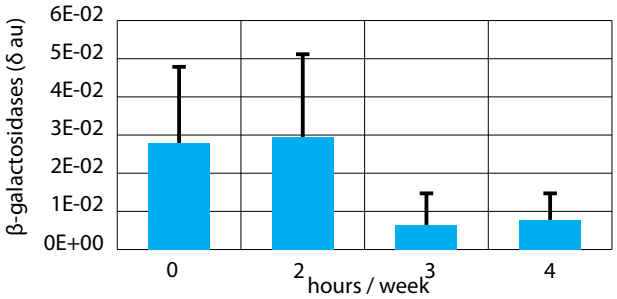

FIG. 3 Level of β-galactosidases associated with sport hours/week practiced; (*) = significant at $p < 0,05$; Spearman's correlation coefficient (S) = -0,330 LSD: Group 0 vs Group 3 p= 0,011* Group 0 vs Group 4 p= 0,014* Group 2 vs Group 3 p= 0,006* Group 2 vs Group 4 p= 0,008*

(mean age 9±2 years) (Table 1) and for this reason, there are no previous studies for comparison. There is a vast literature about the association between sport and oral health, but little clear evidence. In a review published in 2015 athletes were characterised by a poor oral health: the 75% were affected by dental caries or other conditions like periodontitis and erosion, despite having excellent general health [Ashley et al., 2015]. The main explanation was represented by the frequent dietary intake of carbohydrates, decreased salivary flow and drying of the mouth during exercise and immune suppression induced by prolonged bouts of strenuous exercises [Gleeson, 2007]. However the participants of our study cannot be considered as athletes, but children who practice sports activity compared to those who do not. The positive effects of regular physical activity on systemic and oral inflammation have been largely stated: people that practice more frequently and more intense physical activity are characterised by lower inflammatory biomarkers [Beavers et al., 2010]. The correlation between physical activity and inflammatory oral disease is extremely important and an influence of oral diseases on sport performance has been proposed [Ashley et al., 2015; Hoppe et al., 2017]. Wakai et al. [1999] showed that adult people that practiced sport were characterised by a better periodontal health, evaluated through CPITN scores. The possible explanation was that physical activity could enhance the immune system to defend from bacterial invasion. The same correlation has been confirmed in another study that showed that the amount of physical activity was significantly associated

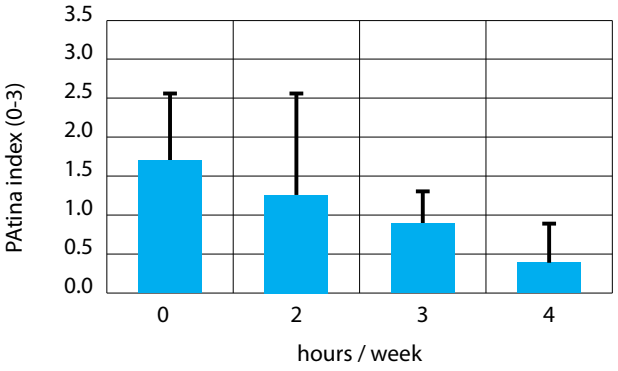

FIG. 4 Tongue coating scores associated with sport hours/week practiced; (*) = significant level at $p < 0,05$; Pearson's correlation coefficient (P) = - 0,511 LSD: Group 0 vs Group 3 p= 0,005* Group 2 vs Group 4 p= 0,0018*

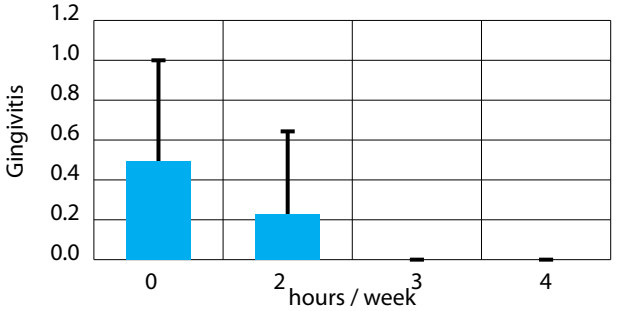

FIG. 5 Gingivitis associated with sport hours/week practiced; (*) = significant level at $p < 0,05$; Pearson's correlation coefficient (P) = -0,427 LSD: Group 0 vs Group 3 p= 0,012* Group 0 vs Group 4 p= 0,012*

with lower periodontitis prevalence (OR=0,58, 95% CI, 0,35–0,96) [Al-Zahrani et al., 2005]. Men who practiced more sport were characterised not only by a lower prevalence of periodontitis, but also by a 13% significantly lower risk to future development (RR = 0,87; 95% CI: 0,76-1,01, p-value, test for trend = 0,02) [Merchant et al., 2003]. However, these data are hardly comparable with our results because our sample was composed only of children and none of them had periodontal disease. The only link we could find is the decrease of gingivitis prevalence in children who practiced sport (Fig. 5). It is true that this value is also correlated to a decrement of the tongue coating index and a better oral hygiene, but the trend is less evident (Fig. 4). For this reason, we hypothesised that the lower gingivitis prevalence in children who practiced sport more frequently could be a consequence of both lower inflammation and better oral hygiene. The physical activity has been also correlated with the moment of the day during which parents indicated as more evident the bad breath in their children: those who suffered halitosis during the whole day were the more sedentary ones. The decrease of tongue coating index, gingivitis, and salivary β-galactosidases activity, together with the improvement of oral hygiene level in children who practice more sport hours could be a consequence of better oral hygiene habits: indeed many habitual behaviours, like eating, sleeping, and screen-viewing could influence oral health behaviours in childhood [Tsuchiya et al., 2017]. Tsuchiya et al. [2017] have investigated, through questionnaires, the impact of children behaviours on tooth brushing: children characterised by excessive video-game playing were associated with poorer toothbrushing behaviours with respect to those spending more time on watching TV, probably because they had less free time due to the choice to engage in game playing. Limitations of this study are represented by the lack of data about the type of physical activity (intensity, type of sport, duration of each session and number of sessions a week) performed by the participants: we have only data about the total amount of hours of sport practiced per week. Additional studies should focus also on the impact of different sports on oral health.

Conclusion

This study is important because it allows to investigate the relationship between halitosis and oral health to sports. Children who practice more than 3 hours of sport a week are characterised by a better oral hygiene and statistically significant lower level of salivary β-galactosidases, halitosis, tongue coating index and gingivitis.

References

› Abramson JL, Vaccarino V. Relationship between physical activity and inflammation among apparently healthy middle-aged and older US adults. Arch Intern Med 2002 Jun 10;162(11): 1286–92.
› Ainamo J, Bay I. Problems and proposals for recording gingivitis and plaque. Int Dent J 1975;25(4):229–35.
› Alyahya L. Parental knowledge and practices regarding their children's oral health in Kuwait. Eur J Paediatr Dent 2016 Dec;17(4):267-273.
› Al-Zahrani MS, Borawski EA, Bissada NF. Increased physical activity reduces prevalence of periodontitis. J Dent 2005 Oct;33(9):703–10.
› American Academy on Pediatric Dentistry, American Academy of Pediatrics. Policy on early childhood caries (ECC): classifications, consequences, and preventive strategies. Pediatr Dent 2008-2009;30(7 Suppl):40–3.
› Ashley P, Di Iorio A, Cole E, Tanday A, Needleman I. Oral health of elite athletes and association with performance: a systematic review. Br J Sports Med 2015 Jan;49(1):14–9.
› Beavers KM, Brinkley TE, Nicklas BJ. Effect of exercise training on chronic inflammation. Clin Chim Acta 2010 Jun;411(11-12):785–93.
› Cooper KH, Gallman JS, McDonald JL. Role of aerobic exercise in reduction of stress. Dent Clin North Am 1986 Oct;30(4 Suppl):S133-42.
› D'Aiuto F, Parkar M, Andreou G, Suvan J, Brett PM, Ready D, Tonetti MS. Periodontitis and systemic inflammation: control of the local infection is associated with a reduction in serum inflammatory markers. J Dent Res 2004 Feb;83(2):156-60.
› Díaz Rosas CY, Cárdenas Vargas E, Castañeda-Delgado JE, Aguilera-Galaviz LA, Aceves Medina MC. Dental, periodontal and salivary conditions in diabetic children associated with metabolic controlvariables and nutritional plan adherence. Eur J Paediatr Dent 2018 Jun;19(2):119-126.
› Fernandez C, Descamps I, Fabjanska K, Kaschke I, Marks L. Treatment needs and predictive capacity of explanatory variables of oral disease in young athletes with an intellectual disability in Europe and Eurasia. Eur J Paediatr Dent 2016 Mar;17(1):9-16.
› Ferrante M, Petrini M, Trentini P, Perfetti G, Spoto G. Effect of low-level laser therapy after extraction of impacted lower third molars. Lasers Med Sci 2013 May;28(3):845-9.
› Ford ES. Does exercise reduce inflammation? Physical activity and C-reactive protein among U.S. adults. Epidemiology 2002 Sep;13(5):561–8.
› Giannattasio A, Poggi E, Migliorati M, Mondani PM, Piccardo I, Carta P, Tomarchio N, Alberti G. The efficacy of Italian guidelines in promoting oral health in children and adolescents. Eur J Paediatr Dent. 2015 Jun;16(2):93-8.
› Gleeson M. Immune function in sport and exercise. J Appl Physiol (1985) 2007 Aug;103(2):693-9.
› Health Canada, C.S. for E.P., Canada's Physical Activity Guideline for Children 2002.
› Hoppe CB, Oliveira JAP, Grecca FS, Haas AN, Gomes MS. Association between chronic oral inflammatory burden and physical fitness in males: a cross-sectional observational study. Int Endod J 2017 Aug;50(8):740-49.
› Howie LJD, Lukacs SL, Pastor PN, Reuben CA, Mendola P. Participation in activities outside of school hours in relation to problem behavior and social skills in middle childhood. J Sch Health 2010 Mar;80(3):119-25.
› Janssen I, LeBlanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int J Behav Nutr Phys Act 2010 May 11;7:40.
› McKeown L. Social relations and breath odour. Int J Dent Hyg 2003 Nov;1(4):213-7.
› Merchant AT, Pitiphat W, Rimm EB, Joshipura K. Increased physical activity decreases periodontitis risk in men. Eur J Epidemiol 2003;18(9):891-8.
› Oho T, Yoshida Y, Shimazaki Y, Yamashita Y, Koga T. Characteristics of patients complaining of halitosis and the usefulness of gas chromatography for diagnosing halitosis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001 May;91(5):531-4.
› Paluska SA, Schwenk TL. Physical activity and mental health: current concepts. Sports Med 2000 Mar;29(3):167-80.
› Petrini M, Costacurta M, Ferrante M, Trentini P, Docimo R, Spoto G. Association between the organoleptic scores, oral condition and salivary βgalactosidases in children affected by halitosis. Int J Dent Hyg 2014 Aug;12(3):213-8.
› Petrini M, Ferrante M, Ciavarelli L, Brunetti L, Vacca M, Spoto G. Prostaglandin E2 to diagnose between reversible and irreversible pulpitis. Int J Immunopathol Pharmacol 2012a Jan-Mar;25(1):157-63.
› Petrini M, Trentini P, Ferrante M, D'Alessandro L, Spoto G. Spectrophotometric assessment of salivary β-galactosidases in halitosis. J Breath Res 2012b Jun;6(2):021001.
› Pratt M, Macera CA, Wang G. Higher direct medical costs associated with physical inactivity. Phys Sportsmed 2000 Oct;28(10):63-70.
› Rajan TS, Scionti D, Diomede F, Grassi G, Pollastro F, Piattelli A, Cocco L, Bramanti P, Mazzon E, Trubiani O. Gingival Stromal Cells as an In Vitro Model: Cannabidiol Modulates Genes Linked With Amyotrophic Lateral Sclerosis. J Cell Biochem 2017 Apr; 118(4):819–28.
› Scully C, Greenman J. Halitology (breath odour: aetiopathogenesis and management). Oral Dis 2012;18(4):333–45.
› Suzuki N, Yoneda M, Naito T, Iwamoto T, Hirofuji T. Relationship between halitosis and psychologic status. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008 Oct;106(4):542-7.
› Tsuchiya M, Momma H, Sekiguchi T, Kuroki K, Kanazawa K, Watanabe M, Hagiwara Y, Nagatomi R. Excessive Game Playing Is Associated with Poor Toothbrushing Behavior among Athletic Children: A Cross-Sectional Study in Miyagi, Japan. Tohoku J Exp Med 2017 Feb;241(2):131-8.
› Wakai K, Kawamura T, Umemura O, Hara Y, Machida J, Anno T, Ichihara Y, Mizuno Y, Tamakoshi A, Lin Y, Nakayama T, Ohno Y. Associations of medical status and physical fitness with periodontal disease. J Clin Periodontol 1999 Oct;26(10):664-72.
› Warburton DER, Nicol CW, Bredin SSD. Health benefits of physical activity: the evidence. CMAJ 2006 14;174(6):801-9.
› World Health Organization. Oral Health Surveys: Basic Methods. 2013, 5th Edition.