Oral Hygiene Status in School Adolescents: A study of 20,000 School-age Adolescents in 66 Public and Private Schools Comparing Oral Hygiene Status by Gender and Ethnicity

Mohammed Al Nuaimi, Donald J. Ferguson, Anas Al-Mulla

Department of Orthodontics, European University College, Dubai Healthcare city, Block D, Bldg 27, office 302, PO Box. 53382, Dubai, UAE.

Abstract

Aims To compare and contrast oral health related data related to Simplified Oral hygiene index (OHI-S) in Dubai school-aged students as a function of the population demographics gender and ethnicity.

Methods A total of 20,880 subjects were screened in 66 public and private school located in Dubai, United Arab Emirates. The study sample was grouped according to seven geographic regions. The total sample included 9,765 females and 11,115 males. Ages ranged from 9.08 years to 24.4 years with an overall mean age of 14.5 years. Calibrated dentists scored all subjects for Debri, Calculus and Simplified Oral hygiene index (OHI-S). Upon completion, statistical comparison of the study variables by region and gender was applied.

Results Debri, calculus and OHI-S scores were calculated by Middle East and South Asia regions represented by countries with more than 100 subjects per country. OHI-S and debri scores were significantly higher in Middle East (0.90 and 0.78) subjects than South Asia (0.84 and 0.68, p=0.000). In contrast, Calculus score was higher in South Asia subjects compared to Middle East.

Conclusions

- Middle East subjects averaged significantly higher debri and OHI-S scores when compared to South Asia subjects overall.
- The highest debri score average was found in Middle East male (Egypt) and female (Palestine) subjects.
- The highest calculus score average was found in South Asia male and female (both Bangladesh) subjects.
- The highest OHI-S score average was found in South Asia male (Bangladesh) and female (Pakistan) subjects.

Debri and OHI-S scores were lowest for Middle East female Iran subjects.

Introduction

Population in the United Arab Emirates is estimated in 2014 to be 9.37 million and Dubai is the most populated city (2.1 million estimated). Dubai is home to a rapidly growing and diverse population with a large number of school-age children. The Dubai cultural mix is unique with estimates of over 75 percent of Dubai residents are expected to be expatriates. A strong majority of expatriate families move to Dubai before or after secondary education of their children and not during secondary education.

Health care policy and changes in health care policy are affected by the population of patients where such policy serves. When diverse populations change rapidly, health care policy is affected as well as access to health care. The oral health condition and needs of the school-age children in Dubai is virtually unknown. The incidence of oral hygiene levels and incidence of malocclusion provides the basis for an understanding for how the population is best served by the dental profession. Gingivitis, and more especially caries, is not the result of a single causative agent but the majority of studies of caries and of gingivitis in young children (where relationships may be clearest) in the Middle East have considered one or a relatively small number of factors. Epidemiological studies available in Dubai have attempted to describe the oral health status of mainly very young children. These surveys were carried out in schools where children were examined, and the available data regarding oral health status of Dubai based school age children are very scarce if not unknown.

A search of the related literature shows that there have been no studies on the prevalence of malocclusion on the Dubai population. There have not been to date any studies that have used simplified Oral hygiene index (OHI-S) in populations. The aim of this study was to generate a baseline figure of the oral hygiene status of school-age children in Dubai specifically from ages 12 years to 17 years old; to compare and contrast oral hygiene status among several Middle East nationalities and south Asian nationalities. It is the hope of this study that the clearer picture of the oral health status of school aged children in Dubai is generated by this study. And this in mind, the National government of Dubai may be able to formulate basic guidelines for oral health services.

Literature Review

A literature review on oral hygiene has been very limited to its correlation to periodontal disease and malocclusion. Thornton et al. concluded that plaque scores and periodontal disease levels were high among residents with mental retardation in a large traditional state institution, a small regional facility, and community group homes [1].

Shaw et al. reviewed the dental effects of malocclusion and indicated that the role of tooth malposition and periodontal disease was not clearly established [2]. Glickman and Manson pointed out numerous variables are considered predisposing and aggravate to gingival and periodontal disease [3,4]. Logically, bacterial plaque which is considered the major etiological factor in the development of chronic gingivitis may be more difficult to remove from malpositioned teeth, according to Loe et al., and that the greater patient dexterity required may not be achieved [5]. A number of studies have demonstrated a relationship between malocclusion and/or malposition of teeth and periodontal disease [6-10].

Corresponding author: Anas Al-Mulla, Department of Orthodontics, European University College, Dubai Healthcare city, Block D, Bldg 27, office 302, PO Box. 53382, Dubai, UAE; Tel: +97-143-624-787, Extn-5035; Fax: 0097143624793; e-mail: a.almulla@mac.com

There have been numerous studies supporting the link between malocclusion and oral hygiene. Gabris assessed the prevalence of malocclusion, associated caries experience, and level of oral hygiene in the Hungarian population using the World health organization (WHO) questionnaire which was designed to assess dentofacial anomalies [11]. The author found visible plaque index (VPI) scores of the 340 adolescents with malocclusion significantly higher. Buckley reported crowding had a low but statistically significant correlation with plaque, calculus and gingival inflammation [12]**.** Ngom investigated the association between orthodontic anomalies and periodontal conditions and reported a weak but significant correlation between certain parameters of intraarch and interarch relationship and some indices of periodontal conditions [13].

Other studies, however, did not find such a link or association between malocclusion and with plaque, calculus and gingival inflammation [14-20]. Many factors may account for these conflicting results [2,10]. In particular, gingival plaque and malocclusion scores have tended to be recorded as averages of whole mouth results and frequently there has been a failure to take into account individual tooth irregularities most likely to be associated with periodontal breakdown.

Some variables may mask any effect on plaque accumulation caused by tooth malposition alone. Ainamo suggested that the effect of tooth malposition was lost at the extremes of oral hygiene [21]. Furthermore, the author pointed out that distribution of plaque observed on different surfaces within the oral cavity would indicate that plaque removal by natural or mechanical cleansing is more difficult from some areas irrespective of the presence or absence of malpositioned teeth.

Ashley et al. demonstrated no evidence of a relationship between incisor overlap and amount of plaque in the study

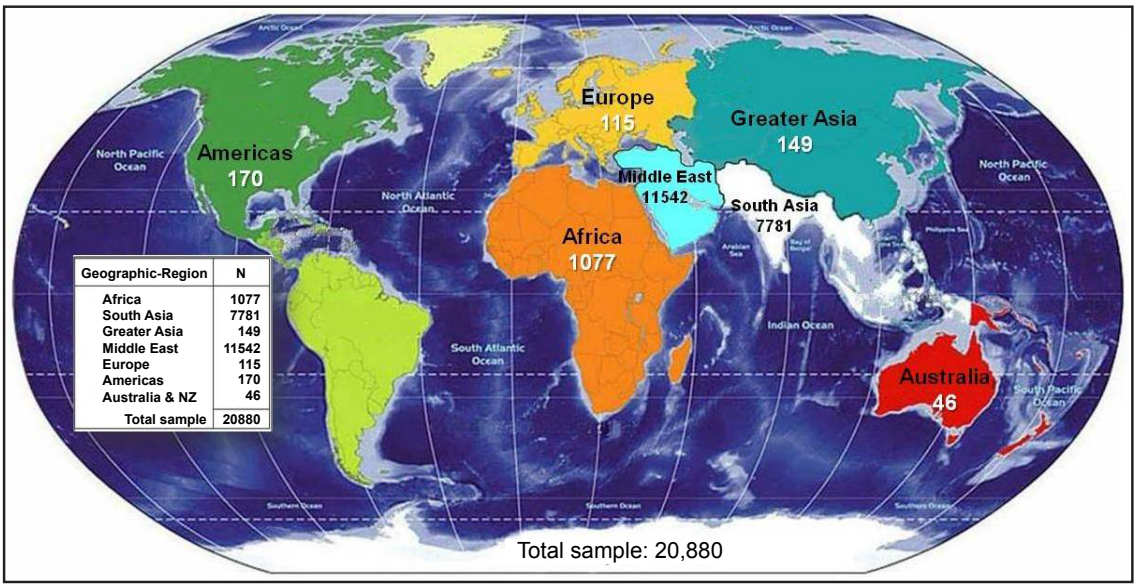


Figure 1. *Study sample representing seven geographic regions of the world ranging from Australia-New Zealand (48 subjects) to Middle East (11,542 subjects).*

Table 1. *Descriptive statistics of the study sample by age including sample number (N), percentage of sample (Percent), mean, and standard deviation (SD); breakdown is by gender, by Geographic-Region, and by Cultural-Region which comprised 94.1 percent of the total sample.*

AGE	N	Percent	Mean	SD
Gender				
Female	9765	46.8	14.55	2.02
Male	11115	53.2	14.54	2.10
Total	20880	100.0	14.55	2.02
Geographic-Region				
Africa	1077	5.2	14.74	1.90
South Asia	7781	37.3	14.06	1.84
Greater Asia	149	0.7	14.67	1.59
Middle East	11542	55.3	14.86	2.08
Europe	115	0.6	14.33	1.83
Americas	170	0.8	14.36	1.76
Australia & NZ	46	0.2	13.92	1.78
Total	20880	100.0	14.55	2.02
Cultural-Region				
Middle East	12022	58.6	14.84	2.07
South Asia	7610	37.3	14.06	1.84
Total	19632	94.1	14.54	2.02

subjects [22]. Griffiths found that the lower segments, whether aligned or malaligned, had significantly more plaque than upper anterior segments which were aligned or malaligned [23]. Ingervall demonstrated that in a group of young adults, crowding of teeth did not favor plaque accumulation on proximal tooth surfaces and crowding influenced the degree of gingival inflammation only to a minor extent [24]. Dalva evaluated the correlation between dental crowding and the periodontal index of gingival and plaque in development of gingivitis and concluded that dental crowding on the individuals examined was not a determining factor of gingivitis [25]. The purpose of this study was to compare and contrast oral health related data related to Simplified Oral hygiene index (OHI-S) in Dubai school-aged students as a function of the population demographics gender and ethnicity.

Materials and Methods

Sample

School aged students were screened in 66 public and private schools in Dubai between 1 May 2008 and 2 February 2009. Selection criteria for subject Inclusion for this study included the following:

1) Enrolled in a public or private primary or secondary school in Dubai.

2) Permanent dentition generally.

Specific criteria for subject exclusion for this study included the following:

1) Not enrolled in a public or private primary or secondary school in Dubai, 2) Greater than 3 primary teeth present in the mouth, and 4) presence of fixed orthodontic appliances or history of orthodontic treatment.

A total of 20,880 subjects were screened in 66 public and private school located in Dubai, United Arab Emirates. The study sample was grouped according to seven geographic regions as follows: Middle East (11,542 or 55.3%), South Asia (7,781 or 37.3%), Africa (1077 or 5.2%), Americas (170 or 0.8%), Greater Asia (149 or 0.7%), and Europe (115 or 0.6%), and Australia/New Zealand (46 or 0.2%). Overall, 19,323 (92.5%) of the sample subjects were from the geographic regions of Middle East and South Asia (*Figure 1*).

The total sample of 20,880 subjects included 9,765 females and 11,115 males. Ages ranged from 9.08 years to 24.42 years with an overall mean age of 14.55 + 2.02 years; average age of females (14.55 years) was nearly identical to males (14.54 years).The sample was then redistributed according to cultural region or identity wherein northern Africa countries (Egypt, Algeria, Libya, and Morocco) were moved from Africa to the Middle East to create a "Cultural-Region" Middle East sample. Finally, the "Cultural-Region" category was further restricted by including only countries represented by 100 study subjects; this resulted in only Egypt being added to the Middle East category. Final sample size for Middle East was 12,022 or 57.6% of initial sample and for South Asia was 7,610 or 36.5% of initial sample; combined Middle East and South Asia sample comprised 19,632 or 94.1% of total initial sample screened. This "right-sizing" method was performed to make statistical testing more reasonable and remainder of testing was based upon a 19,632 sample size *(Table 1)*.

Procedures

Ethical clearance for this study was obtained from the Research Committee of European University College. Permission to participate in the study was first granted from the public and private schools. At the schools where permission was granted, a participant information statement explaining the study written in the local language of Arabic and English was distributed to the students, and a questionnaire regarding social data on the child and family was sent to parents for completion.

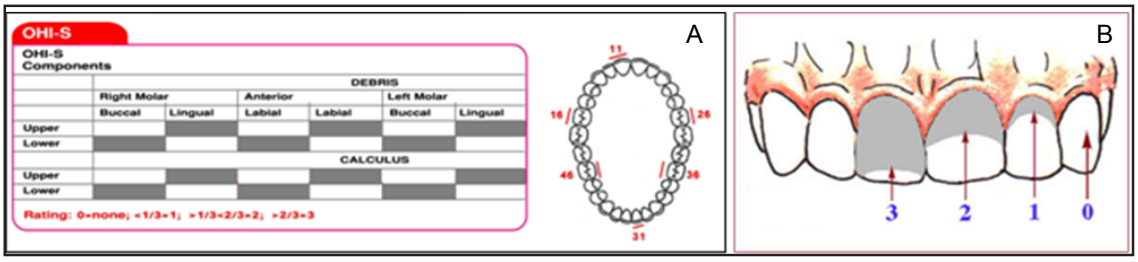


Figure 2. *Screening form used to collect OHI-S data by calibrated school screeners (A) and diagram illustrating how the plaque and calculus scores were derived (B) 0=none, 1 ≤ 1/3rd surface covered, 2 ≥ 1/3rd but <2/3rds, and 3 ≥ 2/3rds surface covered.*

	Region	N	Mean	SD	P value
Debri Score	Middle East	10579	0.78	0.63	
	South Asia	7015	0.68	0.52	0.000
Calculus Score	Middle East	10567	0.11	0.27	
	South Asia	7010	0.15	0.31	0.000
OHI-S Score	Middle East	10541	0.90	0.75	
	South Asia	7000	0.84	0.69	0.000

Table 2. *Results of statistical tests comparing South Asia and Middle East regions for debri, calculus and OHI-S scores including sample size (N), mean, standard deviation (SD), and probability (P) value. Note Middle East subjects had significantly higher OHI-S and debri scores and South Asia subjects had significantly higher calculus score.*

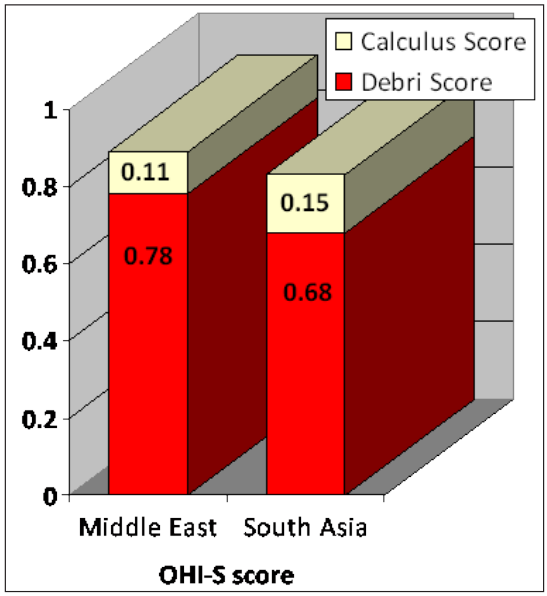


Figure 3. *Results of statistical tests comparing South Asia and Middle East regions for debri, calculus and OHI-S scores including sample size (N), mean, standard deviation (SD), and probability (P) value. Note Middle East subjects had significantly higher OHI-S and debri scores and South Asia subjects had significantly higher calculus score.*

In order to ensure data quality, all examinations were carried out by five licensed dentists-screeners. Training and calibration of the screeners initially were performed in the Dubai schools where the supervisor and the screeners jointly examined the subjects and discussed the findings. This process continued until examiner reliability was achieved. Following multiple calibration sessions, the five school screeners licensed to practice dentistry in Dubai examined students for Oral hygiene – simplified (OHI-S) parameters using a screening form developed to record and document OHI-S findings (*Figure 2A*).

The Simplified Oral hygiene index (OHI-S) utilized six tooth surfaces for scoring, four posterior and two anterior teeth [26]. In the posterior portion of the dentition, the first fully erupted tooth distal to the second bicuspid, usually the first molar but sometimes the second or third molar was examined. The buccal surfaces of the selected upper molars and the lingual surfaces of the selected lower molars were inspected. In the anterior portion of the mouth, the labial surfaces of the upper right and the lower left central incisors were scored. In the absence of either of these anterior teeth, the central incisor on the opposite side of the midline was used (*Figure 2A*).

The scoring system of the OHI-S consists of two components, the debris (plaque) index and the calculus index. Plaque is defined as a soft matter adhering to the tooth surface and consisting of bacteria in a matrix of bacterial and salivary polymers and cell remnants. Scoring was done after staining the teeth for plaque exposure with an erythrosin-based disclosing solution (FD & C Red Dye No. 3). Disclosing solution is typically not used in the OHI-S scoring but was used in this study to expedite scoring by enhancing the visual examination for plaque. A cotton pellet was saturated with the solution, then gently applied to the teeth.

The scoring for plaque was done according to the following criteria: 0 = no debris or stain present; 1 = soft debris not covering more than one-third of the tooth surface being examined; 2 = soft debris covering more than one-third, but not more than two-thirds, of the exposed tooth surface; 3 = soft debris covering more than two-thirds of the exposed tooth surface (*Figure 2B*).

	Gender	N	Mean	SD	P value
Debri	Female	8057	0.67	0.56	
	Male	9888	0.80	0.61	0.000
Calculus	Female	8053	0.12	0.28	
	Male	9875	0.14	0.29	0.006
OHI-S	Female	8034	0.80	0.70	
	Male	9858	0.94	0.74	0.000

Table 3. *Results of statistical tests comparing genders of subjects from South Asia and Middle East regions for debri, calculus and OHI-S scores including sample size (N), mean, standard deviation (SD), and probability (P) value. Note male subjects had significantly higher OHI-S, debri and calculus scores than female subjects.*

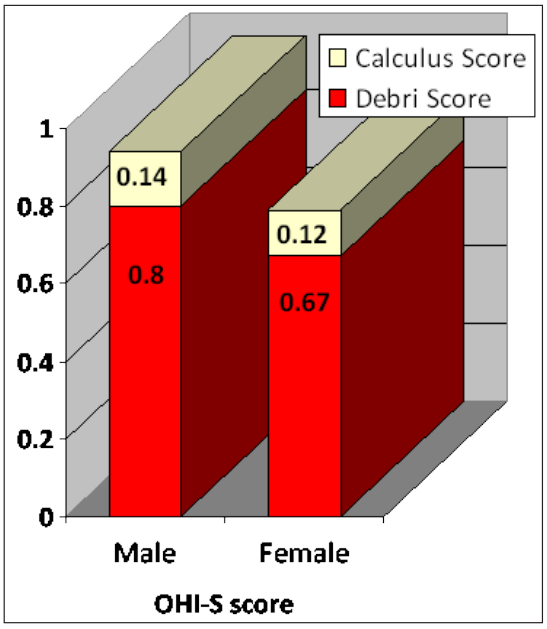


Figure 4. *Results of statistical tests comparing genders of subjects from South Asia and Middle East regions for debri, calculus and OHI-S scores including sample size (N), mean, standard deviation (SD), and probability (P) value. Note male subjects had significantly higher OHI-S, debri and calculus scores than female subjects.*

Calculus is a hard deposit of inorganic salts mixed in an organic matrix. There are two types of calculus differentiated by location: supragingival calculus above the gingival margin; and subgingival calculus below the gingival margin. Calculus was scored in the same manner as plaque, based on the extent of supragingival calculus coverage over the tooth surface (*Figure 2B*).

After scores for the plaque and calculus were recorded, index values were calculated by totaling the scores and dividing the sum by the number of sites examined. At least two of the six possible surfaces must have been examined for an individual score to be calculated. The average individual or group score is known as the Simplified debris index (DI-S). The same method was used to obtain the calculus scores or the Simplified calculus index (CI-S). The average individual or group debris scores plus the calculus scores were combined

to obtain the Simplified Oral Hygiene Index. The CI-S and DI-S values may range from 0 to 3 and the overall OHI-S score ranged from 0 to 6.

The five study screeners were required to read WHO instructions on scoring by using the Simplified Oral hygiene index [27]. Classroom instruction was presented by PowerPoint showing appropriate intra-oral views of patients and screeners were asked to score using the OHI-S Index form (*Figure 2*). At the end of each case scoring session, score sheets were gathered and reviewed; results were discussed with the 5 screeners by identifying which scores were different from the others. Consensus scoring agreement was reached by the group for each case before scoring the next 4 cases. A week later, all screeners together scored sequentially 5 different patient cases presented by PowerPoint followed by discussion of deviating scores on each case and consensus agreement. On the third session a week later, all screeners were tested by scoring 5 different cases without any discussion; score sheets were statistically compared using the Dahlberg reliability formula with results demonstrating less than 5% deviation for each of the scoring parameters. After two months of screening students in schools, the calibration exercise was repeated using 2 different patient cases presented by PowerPoint with same scoring parameters outcome (<5%).

Statistical analysis

The data initially collected on screening forms was de-personalized and transferred to Excel spreadsheet format prior to converting to SPSS format for data processing. Using SPSS software, inter-group comparisons for OHI-S scores were made on the basis of ethnicity using non-parametric Mann-Whitney U and Kruskal Wallis H-testing. All tests of significance were completed at the 0.05 level.

Results

Debri, calculus and OHI-S scores were calculated by Middle East and South Asia regions represented by countries with more than 100 subjects per country. OHI-S and debri scores were significantly higher in Middle East (0.90 and 0.78) subjects than South Asia (0.84 and 0.68, p=0.000). In contrast, Calculus score was higher in South Asia (0.15) subjects compared to Middle East (0.11, p=0.000) subjects (*Table 2 and Figure 3*).

Debri, calculus and OHI-S scores were calculated by gender for subjects with the Middle East and South Asia regions represented by countries with more than 100 subjects per country. Males showed significantly increased values in all three scores (*Table 3 and Figure 4*).

Debri, calculus and OHI-S scores were calculated by gender-region. OHI-S score was significantly higher for males than for females regardless of region; OHI-S score for Middle East male (0.97) and South Asia male (0.88) subjects were significantly higher than their female (0.80 and 0.80, p<0.001) counterparts, respectfully. The same was true from debri scores; Middle East male (0.86) and South Asia male (0.72) subjects were significantly higher than their female

Table 4. *Results of statistical tests comparing gender-regions for debri, calculus and OHI-S scores including sample size (N), mean, standard deviation (SD), and probability (P) value. Note male subjects had significantly higher OHI-S and debri scores and South Asia males and female subjects had significantly higher calculus score.*

Score	Gender-Region	N	Mean	SD	P value
Debri	Female- ME	4577	0.69	0.60	p<0.001 vs M-ME & F-SA
	Male - ME	6002	0.85	0.64	p=0.000 vs all others
	Female - SA	3326	0.64	0.50	p<0.001 vs all others
	Male-SA	3689	0.72	0.54	p=0.001 vs M-ME & F-SA
Calculus	Female- ME	4573	0.10	0.25	p<0.005 vs all others
	Male - ME	5994	0.12	0.27	p<0.005 vs all others
	Female - SA	3326	0.15	0.30	p=0.001 vs M-ME & F-ME
	Male-SA	3684	0.16	0.31	p=0.001 vs M-ME & F-ME
OHI-S	Female- ME	4559	0.80	0.72	p=0.000 vs M-ME & M-SA
	Male - ME	5982	0.97	0.76	p=0.000 vs all others
	Female - SA	3321	0.80	0.67	p=0.000 vs M-ME & M-SA
	Male-SA	3679	0.88	0.71	p=0.000 vs all others

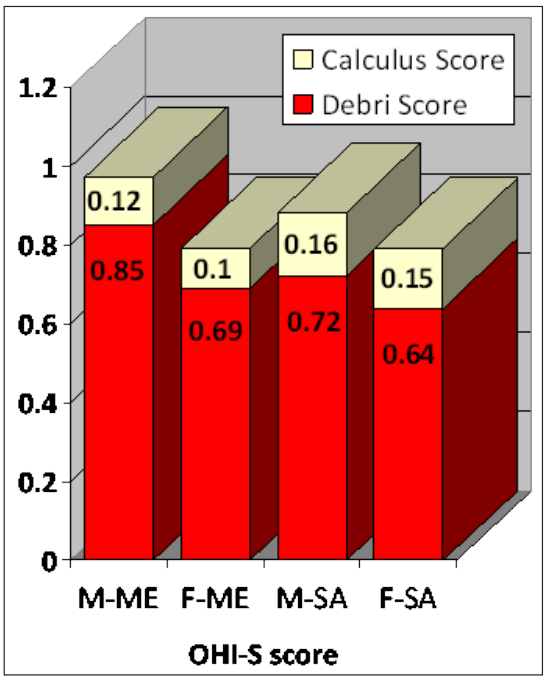


Figure 5. *Results of statistical tests comparing gender-regions for debri, calculus and OHI-S scores including sample size (N), mean, standard deviation (SD), and probability (P) value. Note male subjects had significantly higher OHI-S and debri scores and South Asia males and female subjects had significantly higher calculus score.*

Table 5. *Results of statistical tests comparing South Asia countries for debri, calculus and OHI-S scores including sample size (N), mean, standard deviation (SD), and probability (P) value. Note subjects representing Pakistan had significantly higher OHI-S score than India and that debri score was higher for Filipino and Pakistan subjects compared to India subjects.*

Score	South Asia	N	Mean	SD	P value
Debri	India	5429	0.67	0.52	p<0.041 vs Filipino & Pakistan
	Philippine	422	0.75	0.52	p=0.024 vs India
	Pakistan	1029	0.72	0.54	p=0.041 vs India
	Bangladesh	135	0.77	0.58	
Calculus	India	5426	0.15	0.30	
	Philippine	420	0.13	0.26	
	Pakistan	1029	0.17	0.32	
	Bangladesh	135	0.21	0.38	
OHI-S	India	5419	0.82	0.69	p=0.024 vs Pakistan
	Philippine	419	0.88	0.66	
	Pakistan	1027	0.89	0.71	p=0.024 vs India
	Bangladesh	135	0.97	0.83	

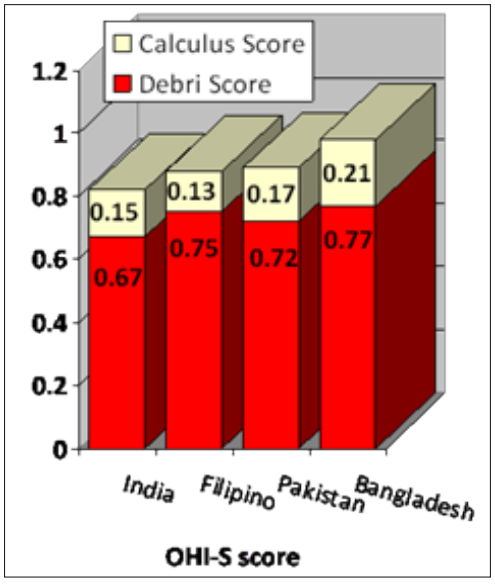


Figure 6. *Results of statistical tests comparing South Asia countries for debri, calculus and OHI-S scores including sample size (N), mean, standard deviation (SD), and probability (P) value. Note subjects representing Pakistan had significantly higher OHI-S score than India and that debri score was higher for Filipino and Pakistan subjects compared to India subjects.*

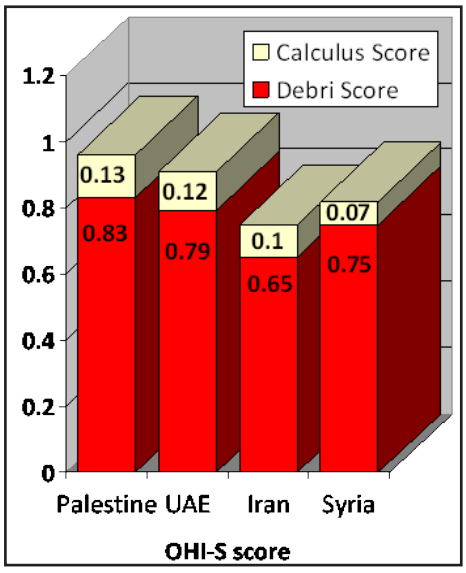


Figure 7. *Results of statistical tests comparing Middle East countries for debri, calculus and OHI-S scores including sample size (N), mean, standard deviation (SD), and probability (P) value. Note subjects representing Palestine and UAE had significantly higher OHI-S score than Iran, UAE and Palestine was higher than Iran for debri score, and UAE was higher than Syria for calculus score.*

(0.69 and 0.64, p<0.001) counterparts. In contrast, calculus score was higher for South Asia male (0.16) and female (0.15) subjects compared to Middle East male and female (0.12 and 0.10, p<0.005) subjects (*Table 4 and Figure 5*).

Debri, calculus and OHI-S scores were calculated by South Asia country with greater than 100 subjects per country. OHI-S score was significantly higher for Pakistan (0.89) subjects compared to India (0.82, p=0.024). For debri scores, Filipino (0.75) and Pakistan (0.72) subjects were higher than India (0.67, p=0.041) subjects. No significant differences in calculus scores were found (*Table 5* and *Figure 6*).

Debri, calculus and OHI-S scores were calculated by Middle East country with greater than 100 subjects per country. OHI-S score was significantly higher for Palestine (0.96) subjects compared to Iran (0.75, p=0.03) subjects and UAE (0.91) subjects compared to Iran and Iraq (0.77, p>0.036) subjects. For debri scores, Palestine (0.83) and UAE (0.79) subjects were higher than Iran (0.65, p=0.022) subjects. Calculus score was higher for UAE (0.12) subjects compared to Syria (0.07, p=0.022) subjects (*Table 6 and Figure 7*).

Debri, calculus and OHI-S scores were calculated by gender-South Asia country. OHI-S score was significantly higher for male subjects representing Bangladesh (1.05), Pakistan (0.90), and India (0.87) compared to female India (0.78, p<0.01) subjects. Debri score differences were similar to OHI-S score and significantly higher for male subjects representing Bangladesh (0.84), Pakistan (0.74), Philippines (0.77) and India (0.71) as well as female Bangladesh (0.66) compared to female India (0.63, p<0.008) subjects. No differences in calculus score were found (*Table 7 and Figure 8*).

Debri, calculus and OHI-S scores were calculated by gender-Middle East country. OHI-S score was significantly higher for male subjects representing UAE (0.99), Egypt (0.98), and Palestine (1.02) compared to most female subjects. Debri score differences were similar to OHI-S score and significantly higher for male subjects representing UAE

Table 6. Results of statistical tests comparing Middle East countries for debri, calculus and OHI-S scores including sample size (N), mean, standard deviation (SD), and probability (P) value. Note subjects representing Palestine and UAE had significantly higher OHI-S score than Iran, UAE and Palestine was higher than Iran for debri score, and UAE was higher than Syria for calculus score.

Score	Middle East	N	Mean	SD	P value
Debri	Egypt	582	0.77	0.64	
	UAE	7772	0.79	0.63	P=0.002 vs Iran
	Iran	322	0.65	0.57	P<0.022 vs UAE & Palestine
	Syria	329	0.75	0.63	
	Lebanon	122	0.73	0.66	
	Iraq	298	0.69	0.62	
	Jordan	308	0.74	0.63	
	Palestine	253	0.83	0.60	P=0.022 vs Iran
	Yemen	593	0.76	0.63	
Calculus	Egypt	585	0.11	0.24	
	UAE	7755	0.12	0.27	P=0.022 vs Syria
	Iran	324	0.10	0.28	
	Syria	328	0.07	0.18	P=0.022 vs Syria
	Lebanon	123	0.09	0.21	
	Iraq	298	0.08	0.20	
	Jordan	310	0.11	0.26	
	Palestine	252	0.13	0.35	
	Yemen	592	0.10	0.24	
OHI-S	Egypt	581	0.88	0.75	
	UAE	7742	0.91	0.75	P<0.036 vs Iraq & Iran
	Iran	322	0.75	0.73	P<0.03 vs UAE & Palestine
	Syria	328	0.82	0.68	
	Lebanon	122	0.82	0.73	
	Iraq	298	0.77	0.70	P=0.036 vs UAE
	Jordan	306	0.85	0.76	
	Palestine	251	0.96	0.81	P=0.03 vs Iran
	Yemen	591	0.86	0.73	

(0.86), Egypt (0.86), and Palestine (0.86) compared to most female subjects. The only significantly different calculus score was male Palestine (0.17) subjects was significantly different from male Syria (0.07) subjects (*Table 8 and Figure 9).*

Debri, calculus and OHI-S scores were compared for all Middle East and South Asia countries represented by more than 100 subjects per country. OHI-S scores for Palestine (0.96) and UAE (0.91) subjects were significantly higher than India (0.82) and Iran (0.75) subject scores. In general, debri scores were similar to OHI-S scores with Palestine (0.83) and UAE (0.79) subject scores higher than India (0.67) and Iran (0.65) subject scores. South Asia calculus scores for Bangladesh (0.21) and Pakistan (0.17) subjects were significantly higher than most Middle East country scores including UAE (0.12) and Syria (0.07) subjects *(Table 9, Figure 10A and 10B).*

The 3 study variables, debri, calculus and OHI-S scores, were compared by gender-country with all Middle East and South Asia countries combined. Univariate analysis of variance was used to examine how the factors region (Middle East vs South Asia), gender (male vs female), and country (13 countries of the sample) explained the results. Testing results demonstrated that the combination factor gender-region explained differences (p=0.000) in debri and OHI-S scores but not calculus score.

Highest and smallest scores per gender-country were identified for each of the three study variables. For debri score, highest male was UAE and Egypt (both 0.86) and highest female was Palestine (0.78); smallest male was India (0.71) and smallest female was Iran (0.51). For calculus score, highest male was Bangladesh (0.21) and highest female was Bangladesh (0.20); smallest male was Syria (0.07) and smallest female was (Iraq). For OHI-S score, highest male was Bangladesh (1.05) and highest female was Pakistan (0.87); smallest male was Iraq (0.80) and smallest female was in Iran (0.59) subjects *(Figure 11).*

Discussion

Tooth brushing is considered as the most reliable means of plaque control provided thorough and regular cleaning is accomplished. Nowadays, a wide variation of tooth brush designs, brushing techniques, frequency, and times of tooth brushing are taught; the oral hygiene habits of the school age children are reflected in oral hygiene instruction.

An individual was considered to have good oral hygiene when he presented a clean mouth without accumulations of debris around the crowns of the teeth. Since, toothbrushing information was not solicited from the subjects, oral hygiene

Table 7. Results of statistical tests comparing Middle East countries for debri, calculus and OHI-S scores including sample size (N), mean, standard deviation (SD), and probability (P) value. Note subjects representing Palestine and UAE had significantly higher OHI-S score than Iran, UAE and Palestine was higher than Iran for debri score, and UAE was higher than Syria for calculus score.

Score	Gender-South Asia	N	Mean	SD	P value
Debri	Female-India	2584	0.63	0.50	P<0.008 vs M-I, M-F, M&F-B
	Male-India	2845	0.71	0.53	P=0.000 vs M-I
	Female-Philippines	187	0.71	0.50	
	Male-Philippines	235	0.77	0.54	P=0.001 vs F-I
	Female-Pakistan	499	0.69	0.52	
	Male-Pakistan	530	0.74	0.56	P=0.000 vs F-I
	Female-Bangladesh	56	0.66	0.53	
	Male-Bangladesh	79	0.84	0.61	P=0.008 vs F-I
Calculus	Female-India	2584	0.15	0.29	
	Male-India	2842	0.16	0.31	
	Female-Philippines	187	0.14	0.27	
	Male-Philippines	233	0.13	0.26	
	Female-Pakistan	499	0.18	0.34	
	Male-Pakistan	530	0.15	0.31	
	Female-Bangladesh	56	0.20	0.37	
	Male-Bangladesh	79	0.21	0.39	
OHI-S	Female-India	2580	0.78	0.66	P<0.01 vs M-I, M-P, M-B
	Male-India	2839	0.87	0.70	P=0.000 vs F-I
	Female-Philippines	187	0.85	0.64	
	Male-Philippines	232	0.90	0.67	
	Female-Pakistan	498	0.87	0.70	
	Male-Pakistan	529	0.90	0.72	P=0.004 vs F-I
	Female-Bangladesh	56	0.86	0.79	
	Male-Bangladesh	79	1.05	0.85	P=0.01 vs F-I

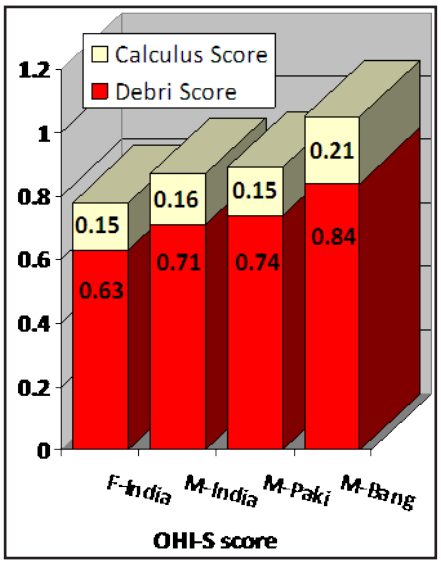


Figure 8. *Results of statistical tests comparing Middle East countries for debri, calculus and OHI-S scores including sample size (N), mean, standard deviation (SD), and probability (P) value. Note subjects representing Palestine and UAE had significantly higher OHI-S score than Iran, UAE and Palestine was higher than Iran for debri score, and UAE was higher than Syria for calculus score.*

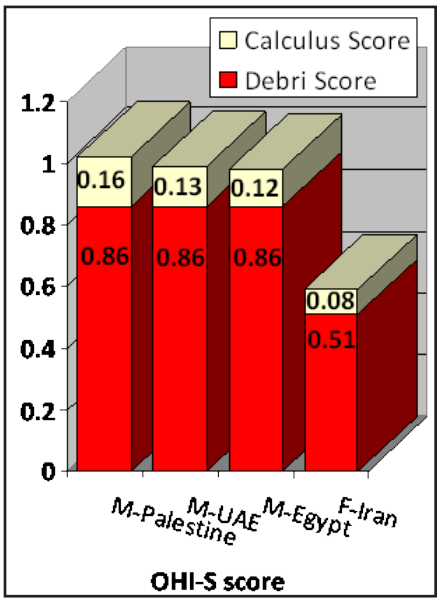


Figure 9. *Results of statistical tests comparing gender-Middle East countries for debri, calculus and OHI-S scores including sample size (N), mean, standard deviation (SD), probability (P) value, female (F) and male (M). Note male subjects representing UAE and Egypt had significantly higher OHI-S score than most female subjects with female Iran was smallest; there was a similar finding for debri score.*

status at time of examination in the present study was likely due to mechanical self-cleansing factors, such as type of dental arch, tooth form, and type of food consumed.

The role of diet and plaque as direct causes of oral disease has been extensively reported. It is also widely accepted that oral health status is closely linked to socioeconomic factors that are understood to be strongly associated with oral health knowledge, attitudes and behaviors [13-18]. Attempts have

Table 8. Results of statistical tests comparing gender-Middle East countries for debri, calculus and OHI-S scores including sample size (N), mean, standard deviation (SD), probability (P) value, female (F) and male (M). Note male subjects representing UAE and Egypt had significantly higher OHI-S score than most female subjects with female Iran was smallest; there was a similar finding for debri score.

Score	Gender-Middle East	N	Mean	SD	P value
Debri	Female - Egypt	259	0.65	0.59	P<0.012 vs M-E, M-U & M-Y
	Male - Egypt	323	0.86	0.66	P<0.005 vs F-E, F-U, F-Iran & F-Y
	Female - UAE	3483	0.71	0.61	P<0.007 vs M-E, M-U, M-Y
	Male - UAE	4289	0.86	0.64	P<0.023 vs F-E, F-U, F-Iran, F-S, F-J & F-Y
	Female - Iran	118	0.51	0.53	P<0.0003 vs all male EXCEPT Iran, Leb & Iraq
	Male - Iran	204	0.73	0.58	
	Female - Syria	111	0.64	0.61	P=0.023 vs M-U
	Male - Syria	218	0.81	0.64	P=0.003 vs F-Iran
	Female - Lebanon	44	0.67	0.69	
	Male - Lebanon	78	0.77	0.64	
	Female - Iraq	118	0.67	0.63	
	Male - Iraq	180	0.71	0.61	
	Female - Jordan	146	0.65	0.61	P=0.006 vs M-U
	Male - Jordan	162	0.83	0.65	P=0.003 vs F-Iran
	Female - Palestine	98	0.78	0.57	
	Male - Palestine	155	0.86	0.62	P<0.025 vs F-Iran & F-Y
	Female - Yemen	200	0.61	0.58	P<0.025 vs M-E, M-U, M-P & M-Y
	Male - Yemen	393	0.84	0.63	P<0.012 vs F-E, F-U, F-Iran & F-Y
Calculus	Male - Syria	217	0.07	0.17	P=0.032 vs M-P
	Male - Palestine	153	0.17	0.40	P=0.032 vs M-S
OHI-S	Female - Egypt	259	0.75	0.71	P<0.033 vs M-E, M-U, M-P
	Male - Egypt	322	0.98	0.76	P<0.03 vs F-E, F-U, F-Iran, F-S & F-Y
	Female - UAE	3467	0.82	0.73	P<0.03 vs M-E &M-U
	Male - UAE	4275	0.99	0.77	P<0.029 vs all female EXCEPT Leb & Pal
	Female - Iran	118	0.59	0.68	P<0.006 vs all male EXCEPT Iran, Syr, Leb & Iraq
	Male - Iran	204	0.84	0.74	
	Female - Syria	111	0.72	0.67	P=0.019 vs M-U
	Male - Syria	217	0.87	0.68	
	Female - Lebanon	44	0.75	0.73	
	Male - Lebanon	78	0.86	0.73	
	Female - Iraq	118	0.74	0.70	P=0.029 vs M-U
	Male - Iraq	180	0.80	0.70	
	Female - Jordan	145	0.72	0.69	P=0.003 vs M-U
	Male - Jordan	161	0.96	0.80	P=0.006 vs F-Iran
	Female - Palestine	98	0.86	0.66	
	Male - Palestine	153	1.02	0.89	P<0.033 vs F-E, F-Iran & F-Y
	Female - Yemen	199	0.71	0.69	P<0.047 vs M-E, M-U, M-P & M-Y
	Male - Yemen	392	0.94	0.73	P<.047 vs F-Iran & F-Y

been made, for example, to explain the variations in both caries experience and gingivitis through differences in oral hygiene habits and the use of fluoride in differing social classes [19-21]. Demographic and social factors may exert their influence particularly through diet and especially the place of sugars in the diet. Sugar consumption in developing countries is increasing and is higher in the Middle East than in other developing areas [22,28]. Although not investigated directly in Dubai, studies of food habits of nutritive value of the diet and types of food consumption in relation to caries prevalence have been carried out in neighboring Saudi Arabia [22,23,29].

In general, males had significantly higher scores than females for the three study variables. Debri and OHI-S scores were significantly higher in subjects representing the Middle East compared to South Asia subjects, but calculus scores were higher for South Asia subjects, and the same observation was made by gender region with calculus scores higher for male and female South Asia subjects.

Within the four South Asia countries, OHI-S and debri scores were higher in Pakistan subjects compared to India. Within the nine Middle East countries, OHI-S and debri scores were higher in Palestine and UAE subjects compared to Iran; for calculus score, UAE subjects were higher than Syria subjects.

Evaluation by gender-country revealed that for South Asia, female India subjects had significant lower OHI-S and debri scores and the male Bangladesh subjects had the highest

Table 9. *Results of statistical tests comparing all Middle East and South Asia countries with greater than 100 subjects per country for debri, calculus (A) and OHI-S (B) scores including sample size (N), mean, standard deviation (SD), and probability (P) value.*

Score	Country	N	Mean	SD	P Value
Debri	Egypt	582	0.77	0.64	P=0.011 vs India
	UAE	7772	0.79	0.63	P<0.007 vs India, Pakistan, Iran
	India	5429	0.67	0.52	P<0.007 vs Egypt, UAE, Palestine & Yemen
	Philippines	422	0.75	0.52	
	Pakistan	1029	0.72	0.54	P=0.007 vs UAE
	Bangladesh	135	0.77	0.58	
	Iran	322	0.65	0.57	P<0.019 vs UAE & Palestine
	Syria	329	0.75	0.63	
	Lebanon	122	0.73	0.66	
	Iraq	298	0.69	0.62	
	Jordan	308	0.74	0.63	
	Palestine	253	0.83	0.60	P<0.019 vs India & Iran
	Yemen	593	0.76	0.63	P=0.015 vs India
Calculus	Egypt	585	0.11	0.24	P<0.018 vs India, Pakistan & Bangladesh
	UAE	7755	0.12	0.27	P<0.021 vs India, Pakistan & Bangladesh
	India	5426	0.15	0.30	P<0.018 vs Egypt, UAE, Syria, Iraq & Yemen
	Philippines	420	0.13	0.26	
	Pakistan	1029	0.17	0.33	P<0.018 vs all Middle East EXCEPT Leb & Pal
	Bangladesh	135	0.21	0.38	P<0.037 vs all Middle East EXCEPT Palestine
	Iran	324	0.10	0.28	P=0.018 vs Pakistan & Bangladesh
	Syria	328	0.07	0.18	P=0.000 vs India, Pakistan & Bangladesh
	Lebanon	123	0.09	0.21	P=.037 vs Bangladesh
	Iraq	298	0.08	0.20	P<0.001 vs India, Pakistan & Bangladesh
	Jordan	310	0.11	0.26	P<0.043 vs Pakistan & Bangladesh
	Palestine	252	0.13	0.35	
	Yemen	592	0.10	0.24	P<0.003 vs India, Pakistan & Bangladesh
OHI-S	Egypt	581	0.88	0.75	
	UAE	7742	0.91	0.75	P<0.005 vs India & Iran
	India	5419	0.82	0.69	P=0.000 vs UAE
	Philippines	419	0.88	0.66	
	Pakistan	1027	0.89	0.71	
	Bangladesh	135	0.97	0.83	
	Iran	322	0.75	0.73	P<0.042 vs UAE & Palestine
	Syria	328	0.82	0.68	
	Lebanon	122	0.82	0.73	
	Iraq	298	0.77	0.70	
	Jordan	306	0.85	0.76	
	Palestine	251	0.96	0.81	P=0.042 vs Iran
	Yemen	591	0.86	0.73	

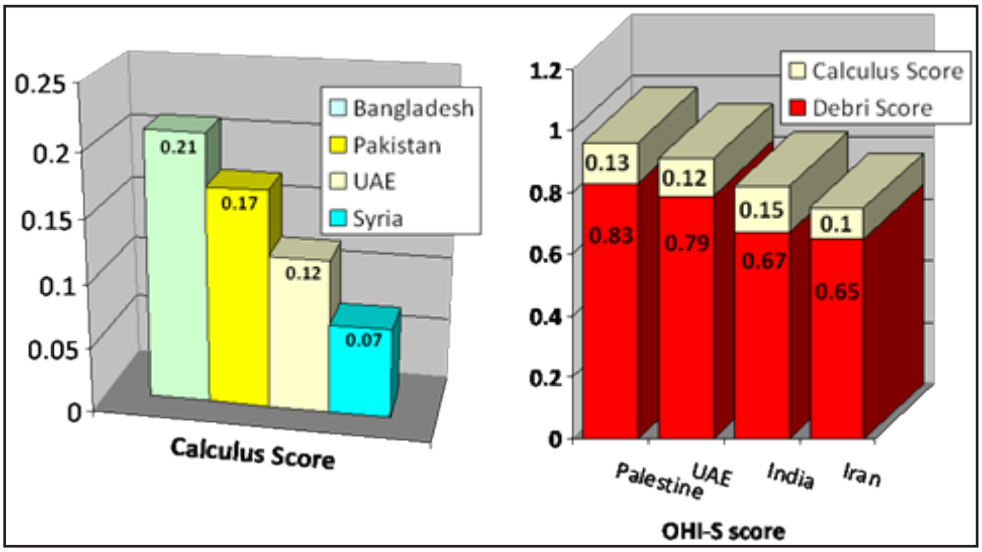
scores for OHI-S and debri. Within the Middle East, UAE, Egypt, and Palestine male scores were significantly higher than most female scores; only male Palestine calculus score was higher than male subjects from Syria.

With all countries in the Middle East and South Asia combined, OHI-S and debri scores were the highest for the Middle East countries UAE and Palestine. In contrast, calculus scores were highest in South Asia countries Bangladesh and Pakistan. Debri and OHI-S scores were influenced by gender and region factors but calculus was not; debri and OHI-S scores were dominated by male subjects from the Middle East.

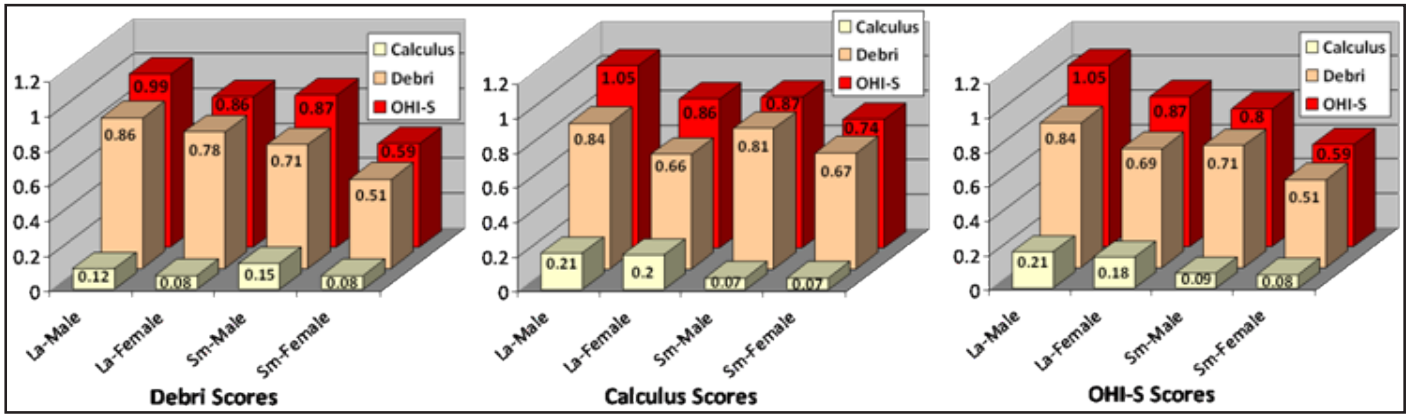
Conclusions

Study variables debri, calculus and OHI-S scores were compared in Middle East and South Asia countries represented by more than 100 subjects. Complete oral hygiene score data was obtained for 17,594 adolescent Dubai school aged students representing 66 public and private schools. The study sample reflected students from of 13 countries: 4 South Asia countries (India, Pakistan, Philippines, and Bangladesh), and 9 Middle East countries (UAE, Yemen, Egypt, Syria, Iran, Jordan, Iraq, Palestine, and Lebanon).

After statistical comparison of the study variables by region and gender, the following results were found:



Figures 10A & 10B. *Results of statistical tests comparing all Middle East and South Asia countries with greater than 100 subjects per country for debri, calculus (A) and OHI-S (B) scores including sample size (N), mean, standard deviation (SD), and probability (P) value. Note that Palestine and UAE subjects had significantly higher OHI-S (Figure B) scores than India and Iran subjects and the finding was similar for debri scores. Calculus (Figure A) scores were higher for South Asia countries Bangladesh and Pakistan compared to subjects from most Middle East countries.*



Figures 11 A, 11B & 11C. *Univariate anova testing demonstrated that differences in debri (A) and OHI-S (C) scores were explained by gender-region but in calculus (B) score differences. Graphic representation of the largest and smallest scores by gender for each of the 3 study variables are illustrated; note that the distribution of scores for debri and OHI-S follow a different pattern than calculus score distribution.*

1. Middle East subjects averaged significantly higher debri and OHI-S scores when compared to South Asia subjects overall.
2. The highest debri score average was found in Middle East male (Egypt) and female (Palestine) subjects.
3. The highest calculus score average was found in South Asia male and female (both Bangladesh) subjects.
4. The highest OHI-S score average was found in South Asia male (Bangladesh) and female (Pakistan) subjects.
5. Debri and OHI-S scores were lowest for Middle East female Iran subjects.

In Dubai public schools, it may be concluded that oral hygiene status as measured by debri score is poorest in male students from the Middle East. Although calculus contributes substantially less to the overall oral hygiene (OHI-S) score, calculus formation is higher in South Asia students. Overall oral hygiene, as measured by OHI-S score, is higher in Middle East male students, especially male students from UAE, Egypt, and Palestine.

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