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Oral health status and related risk factors among adolescents attending high schools in Khartoum, Sudan: A cross-sectional study

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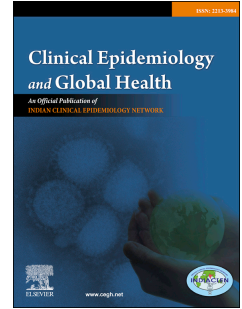Amal Elamin
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Amal Elamin: Software, Validation, Formal analysis, Data Curation, Writing - Original Draft, Writing - Review & Editing, Visualization and Supervision

1 **Oral health status and related risk factors among adolescents attending**

2 **high schools in Khartoum, Sudan: A cross-sectional study**

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17 **Authorship**

18 Hajir Omar has contributed to the design of the study, data collection, data analysis and

19 manuscript writing.

20   Amal Elamin has contributed to the data analysis and manuscript writing. All authors have

21   approved the final manuscript.

22

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1 **Oral health status and related risk factors among adolescents attending**

2 **high schools in Khartoum, Sudan: A cross-sectional study**

3 **Abstract**

4 Objectives: Effective dental services must be based on reliable evidence of oral diseases

5 status and treatment needs. The aim of this study was to assess oral health status and

6 associated risk factors among adolescents attending high school in Khartoum, Sudan.

7 Methods: A school-based survey was conducted among 420 adolescents (13-18 years old).

8 Participants completed a questionnaire about their socio-demographics and oral habits. They

9 received clinical examination, assessing their oral health status using the World Health

10 Organization (WHO) oral health survey for dentition and periodontal status; mean Decayed,

11 Missing and Filled Teeth (DMFT), and Community Periodontal Index (CPI).

12 Results: High dental caries prevalence of 91.1%, with mean DMFT of 3.3 ($\pm$ 1.8) and

13 Significant Caries index (SIC) of 5.2 were found among the participants. Untreated decayed

14 teeth dominated the DMFT scores (DT=3.06 $\pm$1.7). The results of CPI depicted that 96% of

15 participants had unhealthy periodontium, with majority of subjects (79.5%) having CPI

16 maximum scores of 2. Increased age and being enrolled in a public school were the main risk

17 factors associated with caries (p=0.01). Increased CPI scores were found to be significantly

18 higher among males (p=0.006) and among public schools' attendees (p=0.039). High

19 maternal education was associated with participants' healthier periodontium (p<0.01).

20 Conclusions: Sudanese adolescents have high prevalence of caries and unhealthy

21 periodontium, which imposes a need for preventive and treatment programs to improve their

22 oral health status. The significant associations between participants' oral health status and

23   their gender, school-type and age may suggest considering these when designing schools'

24   oral health programs.

25

26   **Introduction**

27   Oral health is an integral part, and has a close reciprocal associations with the

28   overall systemic well-being. [1] The WHO defines oral health as the standard of oral tissues

29   which enables an individual to eat, speak and socialize without active disease, discomfort or

30   embarrassment, thus contributing to general well-being. [2] This comprehensive definition

31   emphasizes the impact of oral diseases on the quality of life of the individual. [3] Several

32   factors play a role in determining the oral health status, including a) biological e.g. host

33   susceptibility; b) behavioural, e.g. toothbrushing, quality of the nutrition, tobacco use, and

34   dental services utilization; c) socioeconomic factors e.g. level of education and income;

35   and d) macro-ecological such as fluoridation and sealants and accessibility to dental

36   services.[4]

37   The American Academy of Paediatric Dentistry recognizes adolescence as a period requiring

38   specific oral health attention due to (1) a potentially high caries rate caused by increased intake

39   of cariogenic-substances; (2) a tendency for poor oral hygiene, and altered nutritional habits;

40   (3) hormonal changes; (4) increased risk for periodontal disease and traumatic injury; (4)

41   increased aesthetic desire; and (6) potential use of tobacco and other drugs.[5] Although these

42   physiological and socio-behavioural changes and practices may adversely affect adolescents'

43   oral health, but adolescence remains as an opportunity for improving oral health, as health

44   behaviours established during adolescence may last into adulthood, making this high risk age-

45   group an excellent target for oral screening and prevention programs. [6, 7]

46　Oral health surveillance is an essential approach to delineate diseases levels, trends, and

47　changes in prevalence and severity over time. [3, 8] The WHO recommends evaluating the oral

48　health status by assessing the dentition and periodontal status. The dentition status can be

49　assessed using dental caries indices on either the tooth or surface levels (dmft/s and or

50　DMFT/S), and the periodontal status using CPI in which periodontal indicators (gingival

51　bleeding, presence of calculus and periodontal pockets) are used for this assessment.[3] For

52　effective surveillance, the WHO suggests that clinical oral health surveys should be

53　conducted regularly every five to six years in the same community.[3]

54　Although dental caries and periodontal diseases are considered to be major oral health

55　problems globally, but they appear to be neither as prevalent nor as severe in African

56　countries as in the developed ones.[8] Regionally, the prevalence and severity of oral diseases,

57　among adolescents aged 10–14 years from Uganda, Tanzania and Kenya revealed low

58　prevalence of caries and mean DMFT ranging from 0.3 to 0.7.[9-11] Nevertheless the profile of

59　oral disease is not homogenous across Africa, with well-established epidemiological

60　disparities within and between countries and regions, suggesting the need for each country to

61　periodically assess its oral health status.[12]

62　Few studies have investigated the oral health status of Sudanese population in the past

63　decades.[13, 14] Untreated caries prevalence was found to be high (30.5% among the twelve

64　years old, and 87.7% among subjects ≥16 years old), and the periodontal status varied based

65　on the age group.[13, 14] Elamin et al. reported that 16.3% and 8.2% of Sudanese high school

66　adolescents had at least one tooth with ≥4 and ≥5 mm periodontal attachment loss,

67　respectively.[15] Overall, studies assessing Sudanese periodontal health status were

68　characterized by variations in assessment methodologies and findings (Table1).[13, 14, 16-20]

3

69 In Sudan, oral health services are combination of public and private providers, with

70 substantial maldistribution between urban and rural areas. The lack of regular school-linked

71 preventive oral health programs, and population-linked recording systems hinders the tasks of

72 understanding the oral health status and the associated factors needed to offer a basis for

73 developing effective oral health interventions.[8] Furthermore, similar to many developing

74 countries in Africa, oral health services are almost entirely curative and are poorly distributed

75 reaching only urban communities and those with higher income.[12]

76 In an effort to periodically assess the oral health profile of the Sudanese population, we

77 identified a gap in the literature related to the oral health status of Sudanese adolescents.

78 Therefore, the aim of this study was to assess oral health status and related factors among

79 Sudanese adolescent attending high schools in Khartoum, Sudan.

80

81 **Methods**

82 The target population was Sudanese adolescents aged 13 to 18 years old, attending public and

83 private high schools in Khartoum locality, Sudan. This locality consists of three

84 administrative units (Khartoum, Al-Shuhada and Khartoum-East), with a total population of

85 745.938 inhabitants. A total of 158 high schools; with 16410 students enrolled in the public

86 schools (55% boys and 45% girls), and 15343 students in the private schools (50% boys and

87 50% girls). A minimum sample size of 385 participants was calculated, using Cochran

88 formula ($n= Z^2pq/ e^2$).[21]

89   To obtain a representative sample of the study population, multistage stratified random

90 sampling design was performed.[3] To achieve this, a list of all high schools in the locality was

91 obtained from the Ministry of Education, Sudan. Primary sampling units consisted of schools

4

92   and were stratified by school type (private vs. public)/ (boys' schools vs. girls' schools).

93   Twenty schools were randomly selected, as follows: five public boys' schools, five public

94   girls' schools, five private boys' schools and five private girls' schools. In the second stage,

95   21 students were randomly selected from the three academic grades in each school, seven

96   from each class, rounding the total sample size to 420 participants. The inclusion criteria for

97   this study were consenting, generally healthy students and who were also present at school on

98   the day of the examination. Students who had undergone prolonged use of medications or had

99   chronic diseases were excluded from this study.

100 Data were collected by means of questionnaires and clinical examinations. Participants were

101 interviewed to complete a full structured questionnaire which consisted of two sections: (a)

102 sociodemographic (e.g.: age, school type, parents' education levels and self-rated financial

103 status), and (b) oral health habits and practices (toothbrushing, oral hygiene aids, and dental

104 services visits).

105 For the oral health assessment, the WHO oral health survey guidelines and criteria (DMFT and

106 CPI) were used.[3] All dental examinations were performed at schools, by one experienced

107 calibrated dentist (HO). The examination was conducted under field-conditions with the

108 participant seated on an office chair facing a window with natural sunlight. The dental

109 examination was carried out using plane-faced dental mirror, and 0.5mm ball-ended

110 Community Periodontal Index Probe (CPI probe) (WHO-probe, YDM Ltd., Tokyo, Japan).

111 The following were recorded for each participant: a) the WHO caries-scoring index for

112 permanent dentition (DMFT) to describe the dental caries status, and CPI (score 0: healthy;

113 score 1: gingival bleeding observed with no pocket and no calculus; score 2: gingival calculus

114 present and no pocket > 3 mm; score 3: pocket present 4 or 5 mm deep; score 4: pocket > 6mm)

115 to describe the periodontal health status.

116   The statistical software package SPSS version 24.0 was used for statistical analyses. The CPI

117   data were analysed according to WHO recommendations whereby participants were

118   categorized by maximum CPI score and the mean number of sextants was computed. Mean

119   DMFT was used to determine the extent of caries. The SiC was calculated, according to the

120   WHO formula by selecting the one third of the study participants having the highest DMFT

121   values. [22] Chi square and Kruskal Wallis tests were used for testing associations between

122   indices and selected variables as appropriate. A multivariate logistic regression model was

123   applied and included variables that had shown statistical significance in univariate tests. A P-

124   value <0.05 was considered statistically significant.

125

126   **Results**

127   A total of 420 adolescents completed questionnaires and received clinical examinations.

128   Table 2 (A and B) describes the sample characteristics. Table 2A shows sociodemographic

129   characteristics of high school students participating in the study. Table 2B describes the

130   sample characteristics with regards to oral hygiene practices and dental habits. Majority of

131   participants brushed their teeth daily (61%), while 2.8% reported to brush their teeth

132   irregularly. Majority of participants (98.2%) were using toothbrush as the brushing tool,

133   whereas six participants reported to use Miswak and dental floss. Over third of the

134   participants (35.5%) never visited a dentist before and 38.1% of the participants self-rated

135   their oral health as good (Table 2B).

136   Tables 3 (A and B) describe the participants' periodontal health status. The percentage of

137   study participants with CPI maximum scores and the mean number of sextants with CPI-

138   scores is presented in Table 3A. Most of the subjects (79.5%) had a score of 2 (calculus) as

139   their highest CPI score, while only 6% had healthy periodontium (CPI = 0). When assessing

140   the participants' periodontal health status measured by CPI and divided by age group, gender

6

141 and school-type significant differences in CPI scores were found between genders, where

142 boys were found to have higher maximum CPI scores, i.e., scores 2 and 3, whereas girls were

143 found to have more of scores 0 and 1 (p=0.006) (Table 3B). Moreover, the percentage of

144 subjects affected by gingival bleeding and calculus (score 2) was significantly higher among

145 adolescents enrolled in public schools than those enrolled in private schools (82.7% vs 75.4%

146 respectively, p= 0.039) (Table 3B). Analysis of the association between the

147 sociodemographic characteristics, oral practices and CPI scores revealed that adolescents

148 with mothers having higher educational level (i.e., university degree or above), have

149 significantly healthier periodontium than those with mothers who have lower education (high

150 school education or below) (p<0.01) (Table 3B).

151 Overall, only 37 subjects were found to be caries free (8.9%), indicating that the

152 prevalence of dental caries among high school students in Khartoum was 91.1%. A

153 significantly higher occurrence of caries was found among the older age group, i.e., the 16-18

154 years old (p=0.013) (Figure 1).

155 In the study sample, the mean DMFT was found to be 3.3 (± 1.8), and the SIC was 5.2.

156 Over 92% of the mean DMFT score was contributed by untreated decayed teeth (DT=3.06

157 ±1.7). Only 23 subjects were found to have teeth with restorations contributing to a low mean

158 FT (0.2±1.0), and 46 participants had undergone extractions (MT= 0.4± 0.9).

159 Table 4 shows the caries experience among study participants described by DT, MT, FT and

160 mean DMFT scores divided by gender, age, and school type. The mean DMFT scores for 13-

161 15- and 16–18-year-old participants were 3.0 (±1.7), 3.5 (±1.9) respectively (Table 4). This

162 indicates that as the age of the subjects increased from 13 to 18 years old, caries significantly

163 increased (p=0.01). Moreover, the mean DMFT was significantly higher among subjects

164 attending public schools (p=0.01). The DT was significantly higher among public schools'

165 attendees than private schools' attendees (p=0.007), while the MT component was

166 significantly higher among subjects ages 16-18 years old than the younger age group

167 (p=0.004). Analysis of the association between the oral practices and dental caries revealed

168 that adolescents who visited the dentist once or more that year had significantly higher mean

169 DMFT 2.93 (±1.78), than those who didn't have dental visits in the past year or never visited

170 a dentist before (p=0.002) (Table 4).

171 To examine the associations between the independent variables, multiple logistic regression

172 model was constructed, and the analysis found no statistical significant associations.

173

174 **Discussion**

175 In Sudan, like many other developing countries, oral diseases have been neglected and are

176 not prioritized by health planners, which may have been reflected on the overall oral health

177 status of the population.[8] We assessed the oral health status and associated risk factors among

178 high school adolescents, in Khartoum, Sudan. The present study reported concerning neglect

179 of oral health among Sudanese high school students in Khartoum, where a high caries

180 prevalence of 91.1% was found among the assessed high school students. Untreated decayed

181 teeth dominated the DMFT scores in this study, indicating a high rate of unmet treatment

182 needs. Moreover, the periodontal health status was also alarming with 96% of participants

183 having unhealthy and gingiva and periodontium with CPI maximum scores ranging 1-4.

184 Global trends of dental caries indicate that although caries rates are declining worldwide,

185 the prevalence of the disease is still rather high in some countries [23]. Over the past two decades

186 number of attempts -despite their scarcity- have been made to map the oral health status in

187 Sudan.[13] In this study the mean DMFT was of 3.3 and SiC of 5.2 were found to be higher than

188 those reported in a study assessing the oral health status of WHO index age of 12 years old

189 students in Khartoum state, where authors reported a mean DMFT of 0.42 with SiC of 1.4.[13]

190 Despite the present study assessing slightly older age groups, yet it is indicative of increased

8

191 caries experience among adolescents in Sudan. Furthermore, the prevalence of caries reported

192 in the current study was found to be higher than those reported among Sudanese adults aged ≥

193 16 years (91.1% vs. 87.7% respectively).[14] The alarming rise reported among the younger age

194 group in this study suggests an increasing trend of caries, with worsening of oral health

195 outcomes among adolescents in Khartoum over the past decade.[14] These are also in agreement

196 with reviews from the African region indicating that there is a marked increase in the

197 prevalence of caries affecting children as well as adults, and may be related to well-known

198 issues of socioeconomics, lack of preventive efforts and dietary changes.[8]

199 In this study, the DT accounted for 92% of the DMFT value as it had a 3.06 contribution

200 to the mean DMFT, which may indicate an under-utilization of dental healthcare services.

201 These results are similar to the other studies, finding the decayed component to be the

202 major contributor to caries index scores.[24, 25] In offering an explanation for the high DT

203 rates, it has been suggested that almost 90% of cases of caries go untreated among the

204 African people due to lack of financial affordability and unmet dental treatment needs.[8]

205 Moreover, it is suggested that the burden of African life outweigh the need to seek

206 treatments for dental caries.[8, 26]

207 In this study, the periodontal health was assessed using the highest CPI score and revealed

208 that the most frequently observed condition was calculus with or with-out bleeding. This is

209 comparable with results from different regions in Sudan, where calculus was found to be the

210 most prevalent periodontal manifestation among Sudanese adults using different periodontal

211 indices.[14, 16] What remains of great concerns is the high proportion of adolescents with

212 calculus in this study as well as the lower prevalence of those who have healthy periodontal

213 tissues compared to previous reports among the older age groups of 35-44 years (79.5% vs.

214 42.0% , and 6.0% vs. 36.1%, respectively) [14] marking a possible worsening of effective oral

215 hygiene practices among the Sudanese population. Furthermore, significantly poorer

9

216   periodontal health was reported among male participants and public schools' attendees in this

217   study. Others have reported male-gender as risk of poorer periodontal health, attributing it to

218   gender-related differences in hygiene behaviours and practices rather than true biological

219   differences between the sexes.[15] Maternal education was found to be a protective factor for

220   periodontal health in this population. Several studies have shown that parental educational

221   level, in particular the mother's education, to significantly influencer their children's oral

222   health status.[27] In theoretical framework involving predictors of children's oral health that

223   were grouped into community- family- and child-level influences, the authors demonstrated

224   the critical importance of the familial factors in determining the children's oral health.[27] The

225   participants' periodontal health status assessed by attachment loss in this study found fewer

226   young participants having shallow pockets (score 3), and no deep pockets (periodontal pocket

227    $\geq$6 mm) were recorded. This is in agreement with previous report assessing periodontal status

228   of 12 and 15-year-old Greek adolescents, where the majority had calculus with or without

229   gingival bleeding, and the occurrence of shallow and/or deep periodontal pockets was very

230   low (0.2%).[28] Conversely a higher prevalence of attachment loss were reported among 15- to

231   17-year-old students in Sudan, where 16.3% and 8.2% of the subjects had at least one tooth

232   with $\geq$4 and $\geq$5 mm attachment loss, respectively.[15] Nevertheless, it is argued that the CPI

233   system may either underestimate or overestimate the prevalence and severity of periodontal

234   parameters.[29] Hence the direct comparison of the present findings for bleeding and calculus

235   with findings from other studies must be interpreted with caution.[17]

236   Our finding that those who visit dentists regularly have a higher DMFT is in agreement with

237   studies suggesting that dental services utilization practices maybe more focused on treatment

238   rather than on dental caries prevention.[30] In this study, toothbrushing with toothpaste together

239   with the use of Misswak were the most common reported oral hygiene practices. The

240   affordability of toothbrushes and Misswak, and the fact that they don't require a high level of

241   skill compared to other modern methods such as a flossing may explains these oral hygiene

242   practices among the participants.

243   **Conclusion**

244   The oral health status of Sudanese high school students signals a pending oral public health

245   crisis. In this study, the main risk factor associated with dental caries was increased age,

246   while male-gender adolescents had significantly higher CPI scores. Public school attendees

247   had significantly higher rates of dental caries and CPI scores. The significant associations

248   between participants' oral health status and their gender, school-type and age may suggest

249   considering these risk groups when designing schools' oral health programs. The lack of

250   preventive efforts and collapsing oral health system raises considerable fears that the dental

251   caries is likely to rise, especially among adolescents. This imposes a need for adopting for a

252   school-based health promotion approaches that are cost-effective, sustainable and that

253   includes a mix of preventive and curative care.

254

255   **Declaration of competing interest, and funding statement**

256   The authors declare no conflicts of interests. This research received no specific grant from

257   any funding agency.

258

259   **Ethical approval**

260   This study received full ethical approval from Sudan Medical Specialization Board (SMSB).

261   Approvals were also obtained from schools' managements. Prior to participation written

262   consents were obtained from all participants, and parents/guardians. Only consenting

263   participants were included in the study.

264

265

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269

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Table 1

Periodontal health status of adolescents and adults in Sudan reported in the literature (1966-2012).

Author/s and year	Region	Study sample (*n*)	Age (years)	Assessment method of periodontal health (Index)	Main periodontal health status findings
Emslie 1966 (20)	Butana, Gezira, Khartoum city and Kordofan river	995	4-60	Russell index (PI)	High prevalence of periodontal disease associated with poor oral hygiene. Three cases of periodontosis (currently known as periodontitis) were found among 645 (age group 15-19 years), yielding a prevalence of 0.47%.
Ali and Lie 1994 (18)	Khartoum city and El-Obeid city	264	15-64	CPITN	High prevalence of periodontal diseases among adolescents. 95.2% having pockets 4-5 mm. 4% having pocket depths 6 mm.
Yousif et al. 2008 (16)	Gezira Province (urban and rural) Central Sudan	649	Adults (age not specified)	Periodontal Index (PI)	Calculus was the most predominant periodontal problem in both the urban and rural areas. Periodontitis is a least prevalent condition in urban and rural areas (12.4% and 13.1% respectively).
Elamin et al. 2010 (15)	Khartoum State	1200	13-19	Gingival recession, probing depth, gingival bleeding and periodontal attachment loss was calculated. *	16.3% and 8.2% of the subjects had at least one tooth with ≥ 4 and ≥ 5 mm attachment loss, respectively. A significantly higher percentage of subjects of African tribal ethnicity had attachment loss ≥ 4 and ≥ 5 mm compared to Afro-Arab tribes (19.8% vs. 14.7%, P = 0.02; and 12% vs. 6.4%, P = 0.004, respectively).
Khalifa et al. 2012 (14)	Khartoum State	1888	adults aged ≥ 16	community periodontal index (CPI), and a validated tooth wear index.	In the 35-44 years age group 36.1% had healthy periodontal tissues, 10.9% bleeding, 42.0% calculus, 8.5% 4-5-mm periodontal pockets, 0.7% periodontal pockets of ≥ 6 mm, and 1.8% excluded sextants.

*Using the recommendation of the International Workshop for Classification of Periodontal Diseases and Conditions

Table 2A

Sample characteristics: The sociodemographic characteristics of high school students, Khartoum, Sudan (*n*=420).

Variable	n	%
Age group (in years)		
13-15	192	45.7
16-18	228	54.3
Sex		
Boys	222	52.9
Girls	198	47.1
School type		
Public	237	56.4
Private	183	43.6
Father's education		
No formal education	15	3.6
Elementary education	21	5.0
Secondary education/high school	131	31.2
Bachelor's degree	163	38.8
Post graduate studies	90	21.4
Mother's education*		
No formal education	18	4.1
Elementary education	71	16.2
Secondary education/high school	280	64
Bachelor's degree	51	11.6
Post graduate studies	18	4.1
Self-rated household financial status		
Poor	11	2.6
Average	307	73.1
Wealthy	102	24.3

*Two subjects did not report the mother's level of education.

Table 2B

Sample characteristics: oral hygiene practices and dental visits among high school students, Khartoum, Sudan (*n*=420).

Variable	n	%
Tooth brushing frequency		
irregularly or never	12	2.8
Once a day	256	61.0
≥Twice daily	152	36.2
Mouth cleaning/brushing device used		
Toothbrush	412	98.2
Wooden toothpicks	1	0.2
Dental floss	3	0.7
Miswak	3	0.7
Mouth wash	1	0.2
Type of toothpaste used		
Fluoride-free toothpaste	38	9.0
Fluoride toothpaste	382	91.0
Dental visits frequency (during the past 12 months)		
Never visited or received dental care before	149	35.5
Had not visited the dentist during the past 12 months	130	31.0
Once	69	16.4
Twice	26	6.2
≥3 time Three times	25	5.9
Self-rated oral health		
Poor	65	15.5
Average	7	1.7
Good	160	38.1
Excellent	63	15.0
Do not know	125	29.8

Table 3A

The periodontal health status of Sudanese high schools' participants: The percentage of CPI maximum scores and the mean number of sextants with CPI-scores (*n=420*)

CPI scoring Variables	n	CPI max (%)	Mean no. of sextants
Score 0 (Healthy)	25	6.0%	1.88
Score 1 (Bleeding)	56	13.3%	1.52
Score 2 (Calculus)	334	79.5%	2.58
Score 3 (pocket 4-5 mm)	5	1.2%	0.01

*None of the participants were score 4 (periodontal pocket ≥6mm).

Table 3B
The periodontal health status of Sudanese high schools' participants measured by Community
Periodontal Index (CPI) and divided by age group, gender, and school type (*n=420*).

Characteristic	CPI scores*				P-value
	Score 0 n (%)	Score 1 n (%)	Score 2 n (%)	Score 3 (n (%)	
Age group					
13-15 years	12 (6.3)	19 (9.9)	159 (82.8)	2 1.0)	0.292
16-18 years	13 (5.7)	37 (16.2)	175 (76.8)	3 (1.3)	
Sex					
Boys	10 (4.5)	21 (9.5)	186 (83.8)	5 (2.3)	0.006
Girls	15 (7.6)	35 (17.7)	148 (74.7)	0 (0.0)	
School type					
Public	12 (5.1)	29 (12.2)	196(82.7)	0 (0.0)	
Private	13 (7.1)	27 (14.8)	138 (75.4)	5 (2.7)	0.039

*None of the participants were CPI score 4 (periodontal pocket ≥6mm).

Table 4

Caries experience among study participants described by DT, MT, FT and mean DMFT scores, divided by gender, age and school type (*n*=420).

	Decayed (DT)				Missing (MT)				Filled (FT)				DMFT score			
	n (%)	x̄	SD	*P**	n (%)	x̄	SD	*P**	n (%)	x̄	SD	*P**	n (%)	x̄	SD	*P**
Gender																
Boys	193 (86.9)	2.9	1.9		24 (10.8)	0.2	0.5		12 (5.4)	0.1	0.4		195 (87.8)	3.2	1.9	
				0.17				0.93				0.9				0.1
Girls	188 (94.9)	3.2	1.6		22 (11.1)	0.2	0.5		11 (5.6)	0.1	0.6		188 (94.9)	3.4	1.7	
Age (years)																
13-15	170 (88.5)	3.2	1.7		12 (6.2)	0.2	0.3		9 (4.7)	0.1	0.4		171 (89.1)	3.0	1.7	
				0.12				0.004				0.5				0.01
16-18	211 (92.5)	3.2	1.8		34 (14.9)	0.2	0.6		14 (6.1)	0.1	0.6		212 (93.0)	3.5	1.9	
School type																
Public	215 (90.7)	3.3	1.9		30 (12.7)	0.2	0.6		9 (3.8)	0.1	0.3		216 (91.1)	3.5	1.9	
				0.007				0.18				0.08				0.01
Private	166 (90.7)	2.8	1.6		16 (8.7)	0.1	0.4		14 (7.7)	0.2	0.7		167 (91.3)	3.0	1.6	

 Abbreviations: x̄, Mean. SD, standard deviation
P Significance evaluated by the chi-square test

Caries experience divided by gender, age and school type among high school students in Khartoum, Sudan (n=420)