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# Oral health status among newly arrived refugees in Germany: a cross-sectional study

Monzer Solyman[*] and Andrea-Maria Schmidt-Westhausen

## Abstract

**Background:** The objectives of this study were to determine the status of oral health among newly arrived refugees in Germany and to explore their knowledge, attitude and practices on oral hygiene.

**Methods:** All participants ($n = 386$) were adults, 18–60 years of age, coming from Syria and Iraq and registered as refugees in Germany within one year prior to the enrollment in the study. Clinical oral assessments in addition to a survey on knowledge, attitude and practice were carried out. The survey was conducted through a questionnaire translated into Arabic.

**Results:** Eighty seven point 5 % of the participants had untreated caries. The mean DMFT score was 6.38 with DT, MT and FT showing mean scores of 4.00, 1.46 and 0.92 respectively. Seventy nine percent had bacterial plaque in all six sextants, 60 % had calculus in at least three sextants and 6 % showed various magnitudes of enamel fluorosis. DMFT score was significantly associated with age (Regression Coefficient 0.031, $P$-value < 0.001) and with education (Regression Coefficient − 0.019, $P$-value 0.037) and females had significantly less missing teeth (Regression Coefficient-0.398, $P$-value 0.001) compared to males. The participants had in general high levels of knowledge and attitude on oral hygiene. The findings however showed a gap between their knowledge and practice.

**Conclusions:** The findings show high prevalence of untreated caries and poor oral hygiene among newly arrived refugees in Germany. The study recommends to lay emphasis on motivation in oral health promotion campaigns among refugees and to provide them with adequate guidance, preferably in their native language, on how to access oral health care in the host country.

**Keywords:** Oral health, Refugees, Decayed, missing and filled teeth index, Knowledge, attitude and practice survey

## Background

Since the beginning of the internal conflicts in Syria and Iraq, the humanitarian crisis along with the collapse of the health systems in these countries have led to a dramatic increase in the influx of refugees and asylum-seekers into the European Union [1]. Of those, Germany has received the highest number of asylum applications among the member states of the European Union according to the United Nations High Commissioner for Refugees [2].

Oral conditions including dental caries and periodontal diseases have a significant impact on the quality of life of the individuals and a high economic burden on the health system in the hosting country [3]. Accordingly, many studies were carried out within the last two decades to investigate the oral health of refugee populations including Somali refugees in the USA [4], African and Eastern European refugees in the USA [5], Vietnamese refugees in Australia [6], Liberian refugees in Ghana [7] and immigrants and refugees in Italy [8]. These studies have shown a high prevalence of dental caries, periodontal diseases and poor oral hygiene. Furthermore, the status of oral health appeared to considerably differ among different refugee populations depending on the geographical region of origin [6, 8]. The studies suggested pre-arrival conditions to be equally important as

\* Correspondence: monzersolyman@gmail.com; monzer.solyman@charite.de
Department of Oral Medicine, Dental Radiology and Oral Surgery, Charite
Universitatsmedizin Berlin, Assmannshauser Str. 4-6, 14197 Berlin, Germany

those during the arrival and post-arrival period in determining the state of oral health of refugees.

This study is among the first to be specifically conducted on the oral health of refugees coming from Syria and Iraq in Germany and Europe. The particularity of the study population, including the existence of a functioning health and educational system in the country of origin prior to the war and the behavioral and dietary cultural norms, mainly high sugar intake [9], high prevalence of tobacco smoking [10] and low alcohol consumption [11], may suggest particular needs. Therefore, the objective of this study was to determine the status of oral health among newly arrived refugees coming from Syria and Iraq in Germany and to explore their knowledge, attitude and practice regarding oral hygiene.

## Methods

A cross-sectional study was conducted between July and December 2016, in which clinical oral assessments of 386 newly arrived refugees from Syria and Iraq were carried out. Participants were recruited in refugee reception centers (174 participants), shelters (189 participants) and private practices (23 participants) in Berlin. The recruitments took place on site at the same day of the clinical examinations. Upon the informed consent of the participants, clinical oral examinations were carried out. These were directly followed by a structured interview conducted in their native language to identify the knowledge, attitude and practices (KAP) on oral hygiene. Participants were adults, 18–60 years of age, and registered as refugees in Germany within one year prior to the enrollment in the study. Children, adolescents and elderly were excluded.

### Sample size calculation

The sample size was determined using the following formula for cross-sectional studies [12]:

$$n = Z^2 \, P \, (1{-}P)/d^2$$

where n = sample size, Z = 1.96 (level of confidence 95%), $P$ = 0.5 (expected proportion in population) and d = 0.05 (precision).

The sample size ($n$ = 386) represented a proportion of 0.3% of the total number ($n$ = 115,647) of Syrians and Iraqis who had their application for asylum accepted in Germany in 2015 [13].

### Clinical oral assessments

The clinical examinations were carried out in artificial lighting with two mouth mirrors. All clinical examinations were done by one examiner MS (an Arabic native speaking dentist with a dental license in Germany). Participants were not explicitly asked to brush their teeth prior to the examination. The clinical assessment form

for adults was initially developed by WHO and was modified accordingly for the study [14]. In this regard, invasive diagnostic procedures including periodontal probing were excluded, as several studies have suggested that patients with periodontitis may be at high risk of bacteremia following periodontal probing without preceding antibiotic prophylaxis [15–17].

Decayed, Missing and Filled Teeth Index (DMFT) was used to explore caries prevalence. Bacterial plaque and calculus were recorded as present or not present, for which the labial and lingual surfaces of 6 index teeth (16 or 17, 11, 26 or 27, 36 or 37, 31 and 46 or 47) were examined. Cases with missing index teeth were excluded and the recordings were then transferred into two scales, one for plaque and another for calculus, each has 7 ordinal values, where 0 = not present and 6 = present in all 6 sextants.

Dental trauma was recorded upon presence, for which six categories were accordingly registered, where 0 = No sign of injury, 1 = Treated injury, 2 = Enamel fracture only, 3 = Enamel and dentine fracture, 4 = Pulp involvement and 5 = Missing tooth due to trauma [18].

Enamel fluorosis was recorded using Dean's index, for which six categories were accordingly registered, where 0 = Normal, 1 = Questionable "*slight aberrations from the translucency of normal enamel*", 2 = Very mild "*small, opaque, paper-white areas scattered irregularly over the tooth but involving less than 25% of the labial tooth surface*", 3 = Mild "*more extensive but covers less than 50% of the tooth surface*", 4 = Moderate "*marked wear and brown stain*" and 5 = Severe "*enamel surfaces are badly affected*" [18].

The intervention urgency was classified based on the clinical findings into five categories, where 0 = No treatment needed, 1 = Preventive or routine treatment needed, 2 = Prompt treatment (including scaling) needed, 3 = Immediate (urgent) treatment needed due to pain or infection of dental and/or oral origin and 4 = Referred for comprehensive evaluation or medical/dental treatment (systemic condition) [18].

The intra-rater reliability was examined in a convenience sample, for which twenty three participants, all of them recruited in private practices, were examined on two different occasions. The two examinations were carried out by the same examiner conducting the study. Both examinations were done in the standard study settings. The two examinations were then compared showing an intra-class correlation coefficient of 0.94.

### KAP survey on oral hygiene

The participants were interviewed immediately after the clinical assessments. The interviews were carried out in their native language (Arabic) following a questionnaire exploring their knowledge, attitude and practices on oral hygiene. Similar questionnaires were used and developed through previous studies on oral hygiene in children and

adolescents [19–22]. However, the questionnaire used in our study was proposed by WHO [23] for adults. The questionnaire was further adjusted for the purposes of this study and included eleven questions, among which:

Three question were on participants´ knowledge concerning tooth brushing and flossing:

- What should one use for cleaning his/her teeth?
- When should one brush his/her teeth?
- In addition to brushing, should one floss his/her teeth?

Four questions were on their attitude towards oral health:

- Do you think that brushing your teeth improves your dental health?
- Do you think dental problems can affect general health?
- How often should one visit a dentist?
- How would you describe the state of your teeth and gums?

Four questions were on their practices respecting oral hygiene:

- What do you use for cleaning your teeth?
- How do you brush your teeth?
- How often do you clean your teeth?
- Do you use toothpaste containing fluoride?

Participants´ answers were then scored, in which they were given + 1 for each correct answer, − 1 for each incorrect answer and 0 for giving no answer. This resulted in three scores (discrete variables accepting negative values), one for knowledge (ranging from − 3 to + 3), one for attitude (ranging from − 4 to + 4) and one for practice (ranging from − 4 to + 4).

With respect to their perception of own oral health, participants were asked to rate the state of their teeth and gums on a scale of 5 degrees, where 1 = Poor, 2 = Average, 3 = Good, 4 = Very good and 5 = Excellent. A comparison was then made between the self-perceived assessment and a clinical assessment made by the examiner on the same scale. Taking into consider the subjectivity involved in the examiner's clinical assessment and the participant's interpretation of the wording in the scale, the participant's answer was only considered incorrect (overestimation or underestimation) when it differed from the examiner's evaluation by two degrees or more.

### Statistical analysis

The primary data set was analyzed using Stata 13.0 software (Stata, Texas, USA). DMFT scores were presented in means and standard deviations while other indices were presented in percentages. Negative binomial regression model NBRM was used to test for the association of count outcomes including DMFT, DT, MT and FT with the socio-demographic characteristics of the study population including age, country of origin, gender and education. Upon the comparison of mean observed and predicted count of our DMFT data using the Akaike's information criterion AIC and Bayesian information criterion BIC, the test showed a preference of NBRM with a very strong evidence over other models usually used for count outcomes.

In order to preserve the information contained in the ordering, ordered logistic regression OLR was used to test for the association of ordinal outcomes including calculus and plaque with socio-demographic characteristics. OLR may have cells that are too small for reliable estimates, nevertheless, two tests were applied to examine the goodness of fit of the model: an ordinal version of the Hosmer-Lemeshow test (P-value = 0.944 for calculus and P-value = 0.899 for plaque showing a good fit for both) and the Lipsitz test (P-value = 0.991 for calculus and P-value = 0.368 for plaque showing a good fit for both). In addition, a second model for ordinal outcomes, Multilevel mixed-effects generalized linear model (Family: ordinal, Link: complementary log-log), was added in order to enhance the validity of the analysis. The two models have shown matching significant associations for all characteristics (Table 4).

For discrete variables accepting negative values (KAP scores), multivariate linear regression was used to test for the association with socio-demographic characteristics of the study population.

A P-value of < 0.05 was considered significant.

## Results

### Socio-demographic characteristics of the study participants

Most of the participants were young males with 80.1% males and 42% between 18 and 24 years of age (Table 1). About 60 % were Syrians compared to 38.1% coming from Iraq. Concerning education, Only 5.4% had no education, 18.4% had primary education (1–6 years in school), 28.2% had preparatory education (7–9 years in school), 25.1% had secondary education (10–12 years in school) had 22.8% had at least one year of university.

### Oral health indices and KAP survey

The mean DMFT score was 6.38 with DT, MT and FT showing mean scores of 4.00, 1.46 and 0.92 respectively. In this context, only two participants were fully edentulous. The presence of bacterial plaque and calculus was abundant with almost 80 % of the participants having plaque in all six sextants and almost 60 % having

**Table 1** Socio-demographic characteristics of the study participants ($n = 386$)

| Characteristics | | Number (Percentage) |
|---|---|---|
| Country of origin | Syria | 239 (61.9) |
| | Iraq | 147 (38.1) |
| Gender | Male | 309 (80.1) |
| | Female | 77 (19.9) |
| Age group in years | 18–24 | 162 (42.0) |
| | 25–29 | 66 (17.1) |
| | 30–34 | 55 (14.2) |
| | 35–44 | 69 (17.9) |
| | more than 44 | 34 (8.8) |
| Educational level (years in school) | No education | 21 (5.4) |
| | Primary school (1–6) | 71 (18.4) |
| | Preparatory school (7–9) | 109 (28.2) |
| | Secondary school (10–12) | 97 (25.1) |
| | University (more than 12) | 88 (22.8) |

calculus in at least three sextants. Regarding the dental trauma, the vast majority of the participants (95.6%) had no sign of injury. Six percent of the participants showed various magnitudes of enamel fluorosis, among which only two (0.5%) were at severe stage. No participant had a systemic condition that required referral for comprehensive medical evaluation. Nonetheless, more than half needed prompt treatment and about one tenth had either pain or infection that required immediate treatment. With regard to KAP survey, most participants had good knowledge on tooth brushing. On the contrary, only one fifth answered that the additional use of dental floss is necessary. With regard to their attitude, less than one third believed in the relationship between oral and general health and less than half believed they should have regular checkups by a dentist. Almost two thirds had a proper perception of their own oral health compared to one third giving rather over or underestimations. The participants´ practices on oral hygiene were generally weak with more than half using the wrong method to brush their teeth and the majority cleaning their teeth less than twice a day. Detailed results on oral health indices and KAP survey are described in Table 2.

### Association between main oral health indices and socio-demographic characteristics

Age was found to have a significant association with DMFT score (*P*-value < 0.001) and its components DT, MT and FT (*P*-values 0.047, < 0.001 and < 0.001 respectively). Older participants had higher DMFT scores compared to their younger counterparts. On the contrary, there was no significant association of the country of origin or of gender with DMFT scores (*P*-value

0.873 and 0.975 respectively) although females had significantly less missing teeth (*P*-value 0.001) compared to males. With regard to education, a significant association was found with DMFT score (RC -0.019, *P*-value 0.037). The more years in school participants had, the less decayed (RC -0.021, *P*-value 0.047), the less missing (RC -0.069, *P*-value 0.003) and the more filled teeth (RC 0.050, *P*-value 0.045) they showed (Table 3). Concerning oral hygiene, the presence of bacterial plaque was found to be significantly less with younger age (OLR *P*-value 0.009) and higher education (OLR *P*-value 0.028). It was also found to be significantly less among females (OLR *P*-value 0.013) compared to males. On the other hand, there was a significant increase in calculus presence with age (OLR *P*-value < 0.001). Females showed significantly lower levels of calculus (OLR *P*-value < 0.001) compared to males, as well as Iraqis (OLR *P*-value 0.018) compared to Syrians. In addition, those with higher education had less calculus (OLR *P*-value 0.019) compared to those with lower education (Table 4).

### Association between KAP scores and socio-demographic characteristics

No significant association was found of age, neither with knowledge nor with practice. However, the older the participants were, the higher scores on attitude they showed (*P*-value 0.005). Iraqis showed significantly lower scores on attitude compared to their Syrian counterparts (*P*-value 0.005). Yet, the differences in knowledge and practice were insignificant. Females had significantly higher scores on knowledge (*P*-value 0.034) and practice (*P*-value 0.001), nonetheless, no significant difference between males and females on

**Table 2** Oral health status and KAP survey (n = 386)

| Oral health index | | Number |
|---|---|---|
| Caries prevalence, mean (SD) | DMFT | 6.38 (5.058) |
| | DT | 4.00 (3.352) |
| | MT | 1.46 (3.388) |
| | FT | 0.92 (1.694) |
| Presence of bacterial plaque, n (%) | No plaque observed | 2 (0.55) |
| | Plaque observed on one sextant | 20 (5.49) |
| | Plaque observed on two sextants | 7 (1.92) |
| | Plaque observed on three sextants | 41 (11.26) |
| | Plaque observed on four sextants | 1 (0.27) |
| | Plaque observed on five sextants | 6 (1.65) |
| | Plaque observed on six sextants | 287 (78.85) |
| Presence of calculus, n (%) | No calculus observed | 35 (9.59) |
| | Calculus observed on one sextant | 107 (29.32) |
| | Calculus observed on two sextants | 4 (1.10) |
| | Calculus observed on three sextants | 107 (29.32) |
| | Calculus observed on four sextants | 1 (0.27) |
| | Calculus observed on five sextants | 2 (0.55) |
| | Calculus observed on six sextants | 109 (29.86) |
| Dental trauma, n (%) | No sign of injury | 369 (95.60) |
| | Treated injury | 4 (1.04) |
| | Enamel fracture only | 7 (1.81) |
| | Enamel and dentine fracture | 5 (1.30) |
| | Pulp involvement | 0 (0.0) |
| | Missing tooth due to trauma | 1 (0.26) |
| Enamel fluorosis, n (%) | Normal | 363 (94.04) |
| | Questionable | 4 (1.04) |
| | Very mild | 3 (0.78) |
| | Mild | 9 (2.33) |
| | Moderate | 5 (1.30) |
| | Severe | 2 (0.52) |
| Intervention urgency, n (%) | No treatment needed | 18 (4.66) |
| | Preventive or routine treatment | 124 (32.12) |
| | Prompt treatment (including scaling) | 202 (52.33) |
| | Immediate treatment due to pain or infection | 42 (10.88) |
| | Referred for comprehensive evaluation | 0 (0.0) |

**Table 2** Oral health status and KAP survey (n = 386) *(Continued)*

| KAP Questionnaire | | |
|---|---|---|
| Question | Answer | Number |
| What should one use for cleaning his/her teeth? n (%) | Toothbrush a | 379 (98.19) |
| | Miswak b | 7 (1.81) |
| | Others (finger, charcoal or wooden toothpicks) b | 0.0 (0.0) |
| When should one brush his/her teeth? n (%) | Once or less a day b | 74 (19.17) |
| | Twice or more a day a | 312 (80.83) |
| In addition to brushing, should one floss his/her teeth? n (%) | Yes a | 76 (19.69) |
| | No b | 267 (69.17) |
| | I don't know | 43 (11.14) |
| Do you think that brushing your teeth improves your dental health? n (%) | Yes a | 352 (91.19) |
| | No b | 26 (6.74) |
| | I don't know | 8 (2.07) |
| Do you think dental problems can affect general health? n (%) | Yes a | 249 (64.51) |
| | No b | 115 (29.79) |
| | I don't know | 22 (5.70) |
| How often should one visit a dentist? n (%) | Regularly a | 175 (45.34) |
| | Whenever there is a problem b | 207 (53.63) |
| | I don't know | 4 (1.04) |
| How would you describe the state of your teeth and gums? n (%) | Participant's answer showed a proper perception of his/her own oral health a | 239 (61.92) |
| | Participant's answer showed a considerable over or underestimation of his/her own oral health b | 141 (36.5) |
| | Participant answered: I don't know | 6 (1.55) |
| What do you use for cleaning your teeth? n (%) | Toothbrush a | 382 (99.22) |
| | Miswak b | 3 (0.78) |
| | Others (finger, charcoal or wooden toothpicks) b | 0.0 (0.0) |
| How do you brush your teeth? n (%) | Up and down circular motion, involving gums a | 176 (45.60) |
| | Left to right, horizontal direction b | 204 (52.85) |
| | I don't know | 6 (1.55) |
| How often do you clean your teeth? n (%) | Once or less a day b | 158 (40.93) |
| | Twice or more a day a | 228 (59.07) |
| Do you use toothpaste containing fluoride? n (%) | Yes a | 11 (2.85) |
| | No b | 8 (2.07) |
| | I don't know | 367 (95.08) |

*DMFT* Decayed Missing or Filled Teeth, *DT* Decayed Teeth, *MT* Missing Teeth, *FT* Filled Teeth, *SD* Standard Deviation, (%) All percentages in this table are valid percentages (cases with missing index teeth were excluded)
a Correct answer
b Incorrect answer

attitude was found. Education was significantly associated with KAP scores; the higher education the participants had, the higher the level of knowledge, attitude and practice (*P*-value < 0.001) they presented (Table 5).

**Table 3** Association of DMFT and its components with socio-demographic characteristics (Negative binomial regression model, $n = 386$)

| Variables | DMFT | DT | MT | FT |
|---|---|---|---|---|
| | Regression Coefficient (Standard error), P-value | | | |
| Increase in age per year (continuous variable) | 0.031 (0.003), < 0.001 | 0.008 (0.004), 0.047 | 0.089 (0.010), < 0.001 | 0.043 (0.013), < 0.001 |
| Country of origin (ref. Syrians) | −0.013 (0.078), 0.873 | − 0.165 (0.091), 0.069 | 0.657 (0.203), 0.112 | 0.001 (0.222), 0.997 |
| Gender (ref. Male) | 0.003 (0.091), 0.975 | 0 .070 (0.106), 0.507 | −0.398 (0.250), 0.001 | 0.382 (0.246), 0.121 |
| Increase in education per year (continuous variable) | −0.019 (0.009), 0.037 | −0.021 (0.010), 0.047 | − 0.069 (0.023), 0.003 | 0.050 (0.025), 0.045 |
| Overall model Pseudo R-squared value, P-value | 0.035, < 0.001 | 0.006, 0.022 | 0.093, < 0.001 | 0.012, 0.001 |

*DMFT* Decayed Missing or Filled Teeth, *DT* Decayed Teeth, *MT* Missing Teeth, *FT* Filled Teeth

## Discussion

In accordance with previous studies on refugees in other western countries [5, 6, 8, 24, 25], the findings have shown high prevalence of dental caries and poor oral hygiene among newly arrived refugees in Germany.

Seventy nine percent of the participants had untreated caries while 78.8% showed bacterial plaque in all 6 sextants and 60% showed calculus in at least three sextants. However, the participants have surprisingly presented a lower DMFT mean score (6.99) in comparison with the mean national index (DMFT 11.2) for the comparable age group (35–44 years) in Germany [26]. Nonetheless, the magnitude of DMFT score among Germans owed its height to a rather high number of filled teeth (FT 8.6 compared to 1.10 in refugees) while it owed its height among refugees to a rather high number of untreated caries (DT 3.81 compared to 0.5 in Germans). Both had an almost equal number of missing teeth (MT 2.07 in refugees to 2.1 in Germans).

The high prevalence of untreated caries among refugees may be attributed to pre-arrival conditions, as well as to limited access to oral health care after arrival in the host country. Studies have suggested various factors contributing to the limited access, among which, not being able to afford treatment, lacking orientation within the new health system, being socially isolated, facing language barriers and a general low emphasis on oral health and promotion during the resettlement period [6, 24, 25, 27–29]. According to the German law [30], refugees in Germany have full access to dental care as German citizens after the official acknowledgment of their asylum status. During the period preceding the acceptance of their application for asylum, they are only eligible for primary care for acute conditions or pain [31].

Within the resettlement period, the priority of refugees clearly lies on the reestablishment in the host country. This would most likely lead to consequences on their oral health behavior including the low utilization of dental services [6, 8]. Therefore, it is important for decision-makers in the host country to target this population at risk as early as possible. This could be achieved through providing access to immediate oral assessment and treatment upon arrival. Likewise, it is important to establish an active inclusion of refugees in the existing health structures.

Available data on fluorosis have suggested a prevalence of about 7.1 to 11.3% among German adolescents. In comparison, our study showed a prevalence of 6%

**Table 4** Association of calculus and plaque with socio-demographic characteristics ($n = 365$[a])

| Variables | Model 1 (OLR) | | Model 2 (Multilevel mixed-effects GLM) | |
|---|---|---|---|---|
| | Calculus | Plaque | Calculus | Plaque |
| | Odds ratios (95% Confidence Interval), P-value | | Regression Coefficient (Standard error), P-value | |
| Increase in age per year [b] | 1.060 (1.035–1.085), < 0.001 | 1.046 (1.011–1.082), 0.009 | 0.028 (0.006), < 0.001 | 0.018 (0.007), 0.008 |
| Country of origin (ref. Syrians) [b] | 0.610 (0.410–0.917), 0.018 | 0.856 (0.496–1.477), 0.576 | − 0.350 (0.126), 0.006 | −0.053 (0.123), 0.667 |
| Gender (ref. Male) [b] | 0.298 (0.182–0.487), < 0.001 | 0.471 (0.260–0.852), 0.013 | −0.658 (0.151), < 0.001 | − 0.332 (0.144), 0.021 |
| Increase in education per year [b] | 0.946 (0.904–0.991), 0.019 | 0.930 (0.872–0.992), 0.028 | −0.031 (0.013), 0.018 | − 0.032 (0.013), 0.019 |
| Pseudo R-squared value, P-value | 0.048, < 0.001 | 0.029, 0.002 | | |
| Wald Chi-squared, P-value | | | 42.02, < 0.001 | 15.70, 0.003 |
| Hosmer-Lemeshow test: Estimate, P-value [c] | 37.729, 0.944[d] | 40.382, 0.899[d] | | |
| Lipsitz test: Estimate, P-value [c] | 2.022, 0.991[d] | 9.787, 0.368[d] | | |

*OLR* Ordered logistic regression, *GLM* Generalized linear model
[a] Cases with missing index teeth were excluded
[b] The two models are showing matching significant associations
[c] Goodness of fit test for ordinal logistic regression model
[d] P-value is showing the model to be a good fit

**Table 5** Association of knowledge, attitude and practice with socio-demographic characteristics (Multivariate linear regression) (n = 386)

| Variables | Knowledge | Attitude | Practice |
|---|---|---|---|
| | Regression Coefficient (Standard error), P-value | | |
| Increase in age per year (continuous variable) | − 0.002 (0.006), 0.729 | 0.029 (0.010), 0.005 | −0.010 (0.008), 0.187 |
| Country of origin (ref. Syrians) | −0.157 (0.124), 0.206 | −0.595 (0.213), 0.005 | − 0.132 (0.160), 0.408 |
| Gender (ref. Male) | 0.312 (0.146), 0.034 | 0.093 (0.250), 0.710 | 0.633 (0.189), 0.001 |
| Increase in education per year (continuous variable) | 0.055 (0 .0140), < 0.001 | 0.0920 (0.024), < 0.001 | 0.086 (0.018), < 0.001 |
| Overall model R-squared value, P-value | 0.064, < 0.001 | 0.089, < 0.001 | 0.096, < 0.001 |

among adult refugees coming from Syria and Iraq. Fluorosis among Germans was mainly attributed to the early start of tooth brushing [32], On contrary, Fluorosis among refugees is probably due to a high-level exposure to fluoride in drinking water back in the country of origin as Syria and Iraq belong to the known fluoride belts according to WHO [33].

In general, there were no significant differences between Syrians and Iraqis on oral health indices including the prevalence of caries and bacterial plaque. Iraqis however had significantly less calculus accumulations. Although Iraq was for a longer period of time affected by war in comparison with Syria, yet most of the Iraqi refugees in Germany came from the northern part of the country. This part was until recent years relatively stable and the health system there showed similar indices to that of Syria before the eruption of the current civil conflict [34]. On the other hand, the findings have demonstrated that other socio-demographic factors including age, gender and education were statistically relevant to the status of oral health among refugees. Older and less educated participants presented more caries and poorer oral hygiene. Females had significantly less missing teeth and better oral hygiene. Previous studies on oral health in refugee populations were mostly concerned with children and adolescents. The few examining adults have shown similar trends to our study. In this context, a study in Italy [8] found a significant increase in mean DMFT scores for Moroccan and Yugoslavian refugees with age. The study has also shown a significant increase in mean Oral Hygiene Index (OHI-S) for Yugoslavian refugees with age. Another study in Australia [6] found that the decayed, missing and filled surface (DMFS) index was significantly higher in older and less educated refugees. Females showed significantly higher mean number of filled surfaces (FS) compared to males. The study used the Community Periodontal Index (CPI) to evaluate the periodontal health and oral hygiene. The results showed that older, less educated and male refugees tend to have higher CPI scores. However, the authors were not able to test for statistical significance due to the small numbers of participants in each group.

Among the purposes of this study was to assess the knowledge, attitude and practice of refugees on oral health. The participants had in general a high level of knowledge, however, an emphasis should be put on the importance of tooth flossing as a complimentary method to clean the inter-dental embrasures and the proximal tooth surfaces in addition to the tooth brushing. On average, the participants showed high scores on attitude, still they should be more informed about the established relationship between oral and general health and the importance of regular dental checkups even when they have no pain or acute complaint. On the other hand, participants have generally shown lower scores on practice presenting a gap between their knowledge and practice. This gap could be related to the adversities surrounding the pre- and post-arrival conditions. Nonetheless, it is important for health promotion campaigns to bridge the gap between knowledge and practice and to concentrate more on oral hygiene motivation among refugees in order to establish or re-establish the norms of tooth brushing at least twice a day with preferably fluoride-containing toothpaste.

This study was among the first attempts to tackle the oral health status of refugees in Germany. The study however had certain limitations, among which:

- The use of convenience sampling instead of randomized cluster sampling making the study sample less representative. In addition, the sampling procedure may have led to a selection bias, as study participants recruited in private practices may tend to have a higher occurrence of dental disease in comparison to those recruited in refugee shelters.
- The sensitivity of field oral examinations (for obtaining DMFT scores in particular) without the use of extra diagnostic methods like bitewing radiographs. This may have led to underestimating the prevalence of caries and to increased false negative values especially for caries on the proximal surfaces. In addition, it was only feasible to examine the intra-rater reliability for participants recruited in private practices (a convenience

sample). This may have put the resulting intra-class correlation coefficient at risk of bias.

- The social desirability bias with regard to KAP survey, as participants may tend to satisfy the examiner with their answers rather than to express what they believe or practice in their daily life reality.
- The study has examined the association of oral health status with certain socio-demographic characteristics. However, there are other import-ant characteristics that were not analyzed in our study. Some of these could be associated with the population of origin like sugar intake and smoking, others are related to the post arrival adversities like waiting times associated with asy-lum application and linguistic barriers. These and similar potential associations could be investi-gated in future studies.

## Conclusions
The present study shows a high prevalence of untreated caries and poor oral hygiene among newly arrived refugees in Germany. It suggests that socio-demographic factors in-cluding age, gender and education are associated with the oral health status of the refugees and partly with their knowledge, attitude and practice on oral hygiene. It is im-portant to put emphasis on motivation in oral health pro-motion campaigns among refugees and to provide them with adequate guidance, preferably in their native language, on how to access oral health care in the host country.

### Abbreviations
AIC: Akaike's information criterion; BIC: Bayesian information criterion; CPI: Community Periodontal Index; DMFS: Decayed, Missing and Filled Surface Index; DMFT: Decayed, Missing and Filled Teeth Index; DT: Decayed Teeth; FS: Filled Surfaces; FT: Filled Teeth; GLM: Generalized linear model; KAP: Knowledge, Attitude and Practice; MT: Missing Teeth; NBRM: Negative binomial regression model; OHI-S: Oral Hygiene Index; OLR: Ordered logistic regression; RC: Regression Coefficient; SD: Standard Deviation; WHO: World Health Organization

### Availability of data and materials
The data analyzed in the current study are available from the corresponding author on reasonable request.

### Authors' contributions
MS and AMSW designed the study. MS implemented the study (Clinical oral assessments and KAP survey). MS and AMSW analyzed the data. MS drafted the manuscript. AMSW critically revised the manuscript. Both authors have approved the final manuscript.

### Ethics approval and consent to participate
Written informed consents (both in Arabic and German) were obtained from all individual participants before the enrollment in the study. In addition, they were handed a study information sheet that included a data privacy statement. The final study design, informed consent and participants' information sheet were approved by the ethics committee at Charite Universitatsmedizin Berlin (Ethics committee vote EA1/081/16).

### Consent for publication
Not applicable.

### References
1. United Nations High Commissioner for Refugees. Europe. 2017. http://www.unhcr.org/europe.html. Accessed 28 Dec 2017.
2. United Nations High Commissioner for Refugees. UNHCR Global Appeal 2015 Update, Northern, Western, Central and Southern Europe 2015. http://www.unhcr.org/5461e60d155.pdf. Accessed 28 Dec 2017.
3. World Health Organization. WHO Oral Health Fact Sheet, Oral Health, Fact sheet Fact sheet N°318. 2012. https://www.mah.se/CAPP/Oral-Health-Promotion/WHO-Oral-Health-Fact-Sheet1/. Accessed 28 Dec 2017.
4. Geltman PL, Adams JH, Cochran J, Doros G, Rybin D, Henshaw M, et al. The impact of functional health literacy and acculturation on the oral health status of Somali refugees living in Massachusetts. Am J Public Health. 2013; 103:1516–23.
5. Cote S, Geltman P, Nunn M, Lituri K, Henshaw M, Garcia RI. Dental caries of refugee children compared with US children. Pediatrics. 2004;114:e733–40.
6. Marino R, Wright FAC, Minas IH. Oral health among Vietnamese using a community health Centre in Richmond Victoria. Aust Dent J. 2001;46:208–15.
7. Ogunbodede EO, Mickenautsch S, Rudolph MJ. Oral health care in refugee situations: Liberian refugees in Ghana. J Refugee Stud. 2000;13:328–35.
8. Angelillo IF, Nobile CGA, Pavia M. Oral health status and treatment needs in immigrants and refugees in Italy. Eur J Epidemiol. 1996;12:359–65.
9. World Health Organization. Policy statement and recommended actions for lowering sugar intake and reducing prevalence of type 2 diabetes and obesity in the Eastern. 2017. http://www.emro.who.int/nutrition/strategy/policy-statement-and-recommended-actions-for-lowering-sugar-intake-and-reducing-prevalence-of-type-2-diabetes-and-obesity-in-the-eastern-mediterranean-region.html. Accessed 28 June 2018.
10. World Health Organization. WHO Report on the global tobacco epidemic, Appendix II, Tobacco use prevalence. 2017. http://www.who.int/tobacco/global_report/2017/appendix_II.pdf?ua=1. Accessed 28 June 2018.
11. World Health Organization. Global alcohol report. 2014. http://www.who.int/substance_abuse/publications/global_alcohol_report/msb_gsr_2014_2.pdf?ua=1. Accessed 28 June 2018.
12. Naing L, Winn T, Rusli BN. Practical issues in calculating the sample size for prevalence studies. Arch Orofac Sci. 2006;1:9–14.
13. BAMF-Bundesamt für Migration und Flüchtlinge (Federal Office for Migration and refugees). Aktuelle Zahlen zu Asyl (Current data of Asylum). 2015. http://www.bamf.de/SharedDocs/Anlagen/DE/Downloads/Infothek/Statistik/Asyl/201512-statistik-anlage-asyl-geschaeftsbericht.html?nn=7952222. Accessed 28 June 2018.
14. World Health Organization. Annex 1, WHO oral health assessment form for adults, 2013. 2013. http://www.who.int/oral_health/publications/pepannex1formadulttooth.pdf?ua=1. Accessed 28 Dec 2017.
15. Daly C, Mitchell D, Grossberg D, Highfield J, Stewart D. Bacteraemia caused by periodontal probing. Aust Dent J. 1997;42:77–80.
16. Daly CG, Mitchell DH, Highfield JE, Grossberg DE, Stewart D. Bacteremia due to periodontal probing: a clinical and microbiological investigation. J Periodontol. 2001;72:210–4.
17. Ito HO. Infective endocarditis and dental procedures: evidence, pathogenesis, and prevention. J Med Investig. 2006;53:189–98.
18. World Health Organization. Oral Health Surveys, Basic Methods, 4th Edition. 1997. http://apps.who.int/iris/bitstream/handle/10665/41905/9241544937.pdf?sequence=1&isAllowed=y. Accessed 28 June 2018.
19. Zhu L, Petersen PE, Wang HY, Bian JY, Zhang BX. Oral health knowledge, attitudes and behaviour of children and adolescents in China. Int Dent J. 2003;53:289–98.
20. D'Cruz AM, Aradhya S. Impact of oral health education on oral hygiene knowledge, practices, plaque control and gingival health of 13- to 15-year-old school children in Bangalore city. Int J Dent Hygiene. 2013;11:126–33.

21. Ji Y, Zhang Y, Wang Y, Chang C. Association between family factors and children's oral health behaviors – a cross-sectional comparative study of permanent resident and migrant children in large cities in China. Community Dent Oral Epidemiol. 2016;44:92–100.

22. Kumar S, Tadakamadla J, Zimmer-Gembeck MJ, Kroon J, Lalloo R, Johnson NW. Parenting practices and children's dental caries experience: a structural equation modelling approach. Community Dent Oral Epidemiol. 2017;45:552–8.

23. World Health Organization. Annex 7, WHO Oral Health Questionnaire for Adults. 2013. http://www.who.int/oral_health/publications/pepannex7sohqbasicmethods.pdf?ua=1. Accessed 28 Dec 2017.

24. Davidson N, Skull S, Calache H, Murray S, Chalmers J. Holes a plenty: oral health status a major issue for newly arrived refugees in Australia. Aust Dent J. 2006;51:306–11.

25. Davidson N, Skull S, Chaney G, Frydenberg A, Isaacs D, Kelly P, et al. Comprehensive health assessment for newly arrived refugee children in Australia. J Paediatr Child Health. 2004;40:562–8.

26. Jordan RA, Micheelis W. In: Institut der Deutschen Zahnärzte IDZ (English translation: Institute of the German dentists) I, editor. The fifth German oral health study (DMS V): IDZ materialienreihe; 2016. p. 35.

27. Selikowitz HS. Acknowledging cultural differences in the care of refugees and immigrants. Int Dent J. 1994;44:59.

28. Selikowitz HS. The relationship between periodontal conditions and perceptions of periodontal health among Pakistani immigrants in Norway. J Clin Periodontol. 1987;14:340–4.

29. Zimmerman M, Bornstein R, Martinsson T. Attitudes and knowledge about preventive dental care in Chilean refugees in Sweden. Community Dent Health. 1993;10:343–51.

30. Bundesministerium der Justiz und für Verbraucherschutz (Federal Ministry of Justice and Consumer Protection). Asylbewerberleistungsgesetz (AsylbLG) § 4 Leistungen bei Krankheit, Schwangerschaft und Geburt (Asylum Seekers Benefits Act (AsylbLG) § 4 Benefits in case of illness, pregnancy and childbirth). http://www.gesetze-im-internet.de/asylblg/__5.html. Accessed 28 Dec 2017.

31. Wenner J, Razum O, Schenk L, Ellert U, Bozorgmehr K. Gesundheit von Kindern und Jugendlichen aus Familien mit ungesichertem Aufenthaltsstatus im Vergleich zu Kindern mit und ohne Migrationshintergrund: Auswertung der KiGGS-Daten 2003–06 (the health of children and adolescents from families with insecure residence status compared to children with permanent residence permits: analysis of KiGGS data 2003). Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz. 2016;59:627–35.

32. Momeni A, Neuhäuser A, Renner N, Heinzel-Gutenbrunner M, Abou-Fidah J, Rasch K, et al. Prevalence of dental fluorosis in German schoolchildren in areas with different preventive programmes. Caries Res. 2007;41:437–44.

33. World Health Organization. Water sanitation hygiene, Water-related diseases, Fluorosis. 2017. http://www.who.int/water_sanitation_health/diseases-risks/diseases/fluorosis/en/. Accessed 28 Dec 2017.

34. Abdallah L, Abdel Aziz T, Ali NI, Ali SHT, Alkhoja GN, Bahnson C, et al. The Kurdistan region of Iraq : assessing the economic and social impact of the Syrian conflict and ISIS. World Bank Group http://documents.worldbank.org/curated/en/579451468305943474/The-Kurdistan-region-of-Iraq-assessing-the-economic-and-social-impact-of-the-Syrian-conflict-and-ISIS. Accessed 28 Dec 2017.