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Traumatic dental injuries and experiences along the life course – a study among 16-yr-old pupils in western Norway

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The study assessed risk factors for traumatic dental injuries (TDI) using experiences along the life course. A retrospective longitudinal study, including historical clinical data, was conducted on 16-yr-old pupils in western Norway. All first-grade pupils born in 1997 and attending public high schools were invited to participate (n = 5,184). Participants responded to an electronically administered closed-ended questionnaire (39.6%, n = 2,055). Information on the occurrence of TDI and events during the life course (categorized as socio-economic, biological, psychosocial, and behavioural indicators) was collected. Variables with a significant bivariate association with three different dependent variables (TDI, severity of TDI, and multiple episodes of TDI) were tested in a hierarchical logistic regression analysis. Traumatic dental injuries were more frequent among boys, adolescents of higher socio-economic status, and adolescents with adverse psychosocial and behavioural scores. Moderate and severe TDIs were more frequent among adolescents with adverse psychosocial and behavioural scores and among adolescents participating in the sport of wrestling. Multiple episodes of TDI were more frequent among adolescents with adverse psychosocial and behavioural scores and among adolescents participating in sports activities. Incorporation of different life-course indicators is important in evaluating TDI severity and repeated incidents.

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Most studies on the epidemiology and risk factors related to traumatic dental injuries (TDIs) have traditionally been limited to factors such as gender, age, and oral and behavioural characteristics (1–4). Among the oral predisposing factors, overjet with protrusion and inadequate lip coverage are two of the earliest established direct causes of TDI (5). The main location for sustaining TDI is the patients' home (1) closely followed by school (1). Based on a Norwegian incidence study from 2003 including both urban and rural areas, Skaare & Jacobsen (6) reported that 48.0% of the TDIs in the age group 16–18 yr occurred during social events, while 23.0% occurred during sporting activities.

Material deprivation is a major environmental determinant of the prevalence of TDI, as shown in two studies from the UK (7,8). However, studies have reported conflicting results on the relationship between TDI and socio-economic status, as reported in a systematic review by Bendo *et al.* (9). In the UK in 1997, Hamilton *et al.* (7) showed that children of lower socio-economic status were more prone to TDI as a result of behaviour and environmental factors. By contrast, Marcenes *et al.* (10) reported, in a study from Brazil in 2001, that more privileged children had a higher occurrence of TDI because of their greater likelihood of participating in different sports activities.

The current aetiology of TDI shows a complex interaction between oral (e.g., overjet), environmental (e.g., material deprivation), and human (e.g., risk-taking) factors (4). Studies on TDI therefore have to consider a number of parameters to determine its occurrence and how it may be prevented. Violence, sports, traffic incidents, and falls are commonly cited in the literature as causes of TDI (1–4, 11). However, the 'causes of the causes' of TDI are rarely cited in the literature. Therefore, a life-course approach can be utilized to understand the circumstances that cause TDI. The life-course approach has been defined as the study of long-term effects on later health or disease risk of physical or social exposures during gestation, childhood, adolescence, young adulthood, and later adult life (12,13). Several life-course theoretical models have been developed. The chain-of-risk model refers to a sequence of linked exposures that raise disease risk (13). Social, biological, and psychological chains

of risk are possible and involve mediating and modifying factors (12,13).

Studies using the life-course approach have concluded that negative behaviour, socio-economic position, and adverse environmental conditions, both early and later in life, increase the risk of chronic disease and mortality (14,15). A few studies using the life-course approach have tested causative factors related to oral conditions, such as caries and periodontal disease (16,17). Traumatic dental injury is not a chronic pathological condition, but it is determined by some of the same risk factors as several chronic diseases (18). To date, only one study has tested a life-course model linking the chains of causation related to TDI, in which a range of causative factors related to TDI were tested (18). The study was conducted among 13-yr-old Brazilians and concluded that adolescents who experienced adverse psychosocial environments along their life course had a higher incidence of TDI than their counterparts who experienced more favourable environments. These adverse environments comprised living in non-nuclear families and experiencing high levels of paternal abuse (18).

As there are few studies exploring experiences, along the life course, that are related to TDI, the aim of the present study was to assess risk factors for TDI and related life-course experiences among Norwegian adolescents. It aimed to test the hypothesis that the occurrence of TDI in the permanent dentition is affected by socio-economic, biological, psychosocial, and behavioural experiences along the life course.

Material and methods

The study was carried out in the County of Hordaland, western Norway, a county with almost 500,000 inhabitants from all socio-economic backgrounds (19). Each county government is responsible for public secondary education in their respective counties in Norway, and the Public Dental Health Service in each county is responsible for the dental health of all adolescents up to the age of 18, with all treatments performed free of charge (20). The study was conducted among high-school pupils in the County of Hordaland and was carried out in close collaboration with both the county government and the Public Dental Health Service.

There were 58 public high schools in Hordaland in 2014. Our target group was pupils born in 1997 (16 yr of age at the time of invitation). A total of 5,184 pupils in first grade, including both general studies and vocational studies, were invited to participate (i.e., a census approach). Data and information on school and educational structure, as well as the names of all registered pupils, were acquired from the School Administration. In this population, 52.1% were boys.

Sample size calculation

The sample size calculations are presented in a previous paper related to the prevalence of TDI (21). A response rate of 40% required 5,000 individual participants to provide an adequate sample. The 95% confidence limits for the expected prevalence (10%), based on a sample size of 2,000, would be approximately 8.7%–11.3%. The 95% confidence limit was considered to be sufficiently narrow to give a precise estimate of the prevalence of TDI in this population. The sample size was confirmed as satisfactory for estimating risk factors for TDI. In a 2×2 contingency table, a sample size of 2,000 will be sufficient to discover ORs higher than 1.48 for variables with an equal distribution between two categories ($n_1 = 1{,}000$ and $n_2 = 1{,}000$) with a power of 80% and a 5% level of significance. For variables with a skewed distribution, larger ORs would be needed to maintain the same power. In a logistic regression analysis, the same would apply for a single categorical variable. The calculations were performed in the statistical package 'R' using the Hmisc library (Hmisc: Harrell Miscellaneous; Frank E Harrell Jr, Nashville, TN, USA).

Recruitment and questionnaire

To collect data on socio-economic, biological, psychosocial, and behaviour-related indicators, a close-ended electronic questionnaire (SurveyXact; Rambøll, Oslo, Norway) was sent to each participant via e-mail and SMS. If the questionnaire was not opened or only partially completed, a reminder was sent out after 2 wk. In advance, information graphics were sent out to each school. In addition, three tablet computers were raffled among participating pupils to increase the response rate.

To explore the effect of experiences along the life course and their influence on TDI, the different topics from the questionnaire were grouped into different risk indicators. The questionnaire used in this study covered 51 topics, using a total of 135 questions, and collected relevant data from early childhood to the present day. The questionnaire assessed socio-economic indicators (parents' level of education ['lower' education defined as upper secondary education; 'higher' education defined as university or college degree]), number of family-owned vehicles, and frequency of family vacations), biological indicators (gender and anthropometric data), psychosocial indicators (relationship with parents, family structure, personality characteristics) and behavioural- and attitudinal-related indicators (school grades, degree of attendance to dentist appointments, frequency of exercise, participation in sports activities, experience with violence, sleeping habits, television viewing habits, experience with tobacco and alcohol, oral-hygiene routines, use of fluoride, experience with orthodontic treatment), as well as experience and cause of TDI.

The Big Five personality traits, also known as the five-factor model (FFM) comprise a taxonomy for personality traits (22). The five factors have been defined as openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism. The Big Five Inventory (BFI) uses short phrases based on the trait adjectives known to be prototypical markers of the Big Five (23). The format consists of short descriptive statements, such as 'is talkative' and 'worries a lot'. The purpose of this format is to limit ambiguity without losing relevance and becoming difficult to understand (23,24). The original questionnaire consists of 44 items designed to measure the five factors in the FFM without individual facets. A 20-item version of the BFI, validated in a Norwegian population (25), was incorporated in the questionnaire with the purpose of adequately measuring the participants' psychometric properties. Self-assessments were performed using a seven-point scale, with only the

extremes having verbal descriptions ('disagree strongly' and 'agree strongly').

The adolescent–parent relationship was measured using validated questions derived from the study of Nicolau *et al*. (18). Items from their questionnaire were translated to Norwegian and cross-culturally validated. A back translation of the questionnaire was performed by colleagues not previously involved in the project and who did not have any prior knowledge of the study objectives and background. A pilot study was carried out among pupils ($n = 6$) in upper secondary education in the county with the purpose of testing the face validity and reliability (26,27) of the questionnaire. The items passed the face content validity during this phase. The average time spent on completing the questionnaire was less than 15 min. Additionally, a review of the questions and items in the questionnaire was undertaken by a select group of colleagues with competence in epidemiological research (construct validity testing) (27,28). As a result, two questions from the questionnaire were modified.

By responding to the electronic questionnaire, respondents also consented to the use of information from their electronic patient journals (EPJs) in the Public Dental Health Service. The Public Dental Health Service in Hordaland has used electronic patient records (EPR) since 1998 (Opus Dental; Opus Systemer, Oslo, Norway). From 2001, TDI registration has been covered in the EPR, using internationally accepted classifications of TDI (11). Thus, all TDIs registered in the permanent dentition for this selected age group were available and were extracted from their EPJ. Three different variables – presence of TDI, severity of TDI, and presence of multiple episodes of TDI – were used as measures of outcome. Data on TDI in the EPR covers all erupted permanent anterior teeth, thus, data include TDI experienced before 16 yr of age.

Data were collected from a total of 54 different public dental clinics where information related to TDI (time and place of injury, age at incidence, and dental clinic responsible for treatment) was collected. Information on TDIs for maxillary and mandibular incisors and canines ($n = 12$ teeth for each pupil) were registered. In addition, data on health status, caries experience [decayed, missing, and filled teeth (DMFT)], information on missed dental appointments, and orthodontic status were also collected from the EPJ. The data set was anonymized when all data were entered into the database. No clinical examination or intervention was conducted. Body mass index (BMI) was calculated from self-reported height and weight using the formula $y = w/h^2$, where w and h are weight (in kg) and height (in m), respectively (29). Body mass index calculations were adjusted for age (30). Traumatic dental injuries were divided into three different categories of severity – mild, moderate, and severe – according to Skaare & Jacobsen (6). The prevalence and frequency distribution of TDI and descriptive analyses have been presented in detail in a previous paper (21).

Ethical consideration

The study was carried out in close cooperation with the Public Dental Health Service and the Hordaland School Administration. The project was approved by the Regional Committees for Medical and Health Research Ethics (REK) (Regional etisk komité, REK-Vest 2014/67). As the questionnaire was electronic, exemption from the rules of informed and written consent to collect relevant data from patients' records in the Public Dental Health Service was given by REK. Pupils were informed of entry into the study in writing, and their acceptance of participation by responding to the questionnaire was considered an acceptable alternative to written consent. All pupils invited to participate in the study were above the age of 16 yr, and therefore according to Norwegian law are legally able to provide consent regarding health issues (31). The respondents were informed about the aim of the study and their right to withdraw from the study at any time, without reason.

Statistical analyses

Data were entered and analysed in STATA version 15.0 for Mac (StataCorp, College Station, TX, USA). The independent variables were grouped and tested (using the chi-square test) to select the best predictors at each level. Then, the variables were introduced in a hierarchical multiple regression analysis from distal to proximate determinants of TDIs. To estimate the OR for the each of the three TDI outcome variables (experienced TDI, severity of TDI, and multiple episodes of TDI), hierarchical multiple logistic regression (marginal model with robust variance estimates) was used to derive ORs, *P*-values, and 95% CIs for the effects of socio-economic, biological, psychosocial, and behavioural variables on the outcomes. R-squared values (32) are included in the tables. Pupils with multiple teeth involved in a trauma episode and pupils with multiple trauma episodes were controlled for. Statistical level of significance for all analyses was set at $P < 0.05$.

A hierarchical approach was used to explain the theoretical framework of the study (Fig. 1). The variables were subgrouped into four different steps (socio-economic, biological, psychosocial, and behavioural), with each step representing determinants of traumatic dental injuries. Each variable was tested against the dependent variables using the chi-square test, and variables with an association with the dependent variables were then tested in three separate hierarchical logistic regression analyses (presence of TDI, severity of TDI, and presence of multiple episodes of TDI). Gender was included as a biological indicator in all three regression analyses regardless of an existing association with the dependent variables.

Results

Among the 5,184 pupils invited to participate, 2,079 pupils accepted (39.6% response rate). For 24 pupils who had recently moved to the County of Hordaland, EPJ data were not available; therefore, these pupils were excluded from the analysis. The final sample comprised 2,055 pupils.

Based on drop-out analyses, the response rates differed statistically significantly according to both gender and education programme. Boys were less likely to participate than girls ($P < 0.005$), and pupils attending vocational studies were less likely to respond than those attending general studies ($P < 0.001$).

Sociodemographic characteristics of the sample are presented in Table 1. The study sample included 48.4% boys and 51.6% girls.

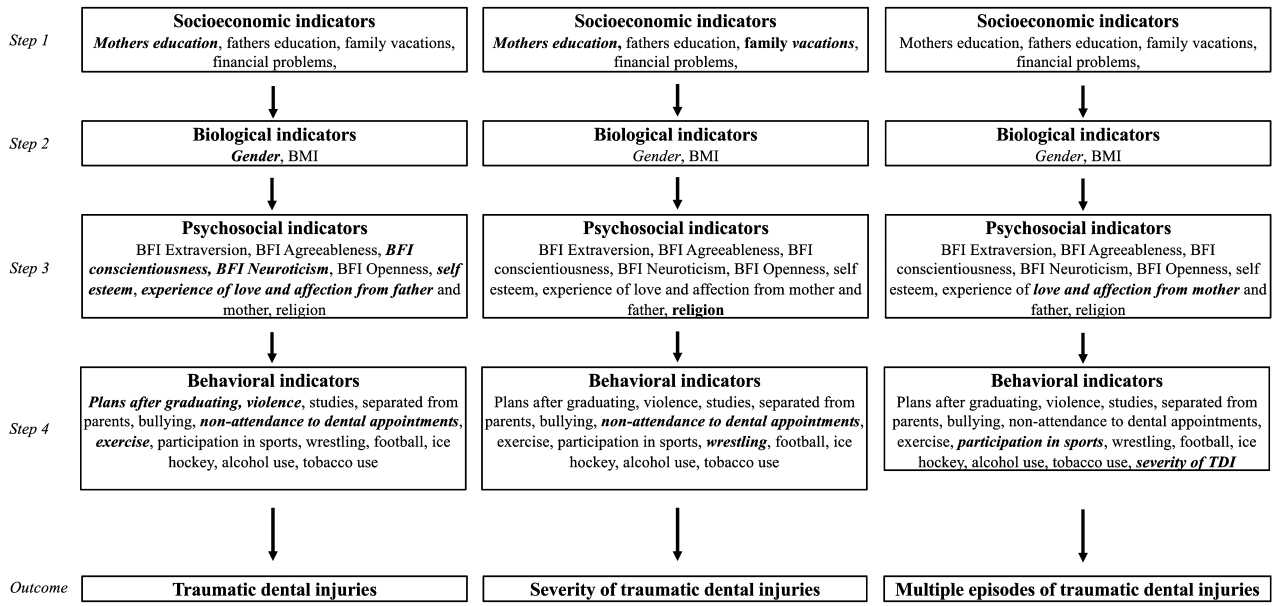

Fig. 1. Theoretical framework of the study. Indicators included in further statistical analysis are shown in italics. BFI, Big Five Inventory; BMI, body mass index; TDI, traumatic dental injury.

As presented in Table 2, hierarchical logistic regression, with or without TDI as the dependent variable (n = 2,055), showed that the experience of TDI was more frequent among adolescents responding 'yes' to the question 'I like being the way I am', among adolescents reporting lack of plans after graduating from high-school, among boys, among adolescents scoring low on conscientiousness (BFI), among adolescents reporting high frequency of exercise, and among those having mothers/female guardians with higher education.

In Table 3, the same analysis as described above was performed but was confined to those having experience with TDI (n = 338), this time contrasting moderate/severe versus mild TDI in the dependent variable. Traumatic dental injuries were classified as mild in 283 (83.7%) participants and as moderate/severe in 55 (16.3%). Logistic regression analyses showed that pupils reporting religion/beliefs as unimportant in their personal life, pupils who are active in wrestling, and pupils with four or more missed dental appointments have a significantly higher risk of severe TDI.

Table 4 shows the logistic regression analyses with multiple versus single episodes of TDI as the dependent variable (n = 338). A total of 43 (2.1%) pupils had experienced multiple episodes of TDI. Multiple episodes of TDI were more frequent among adolescents reporting lack of love and affection from mother/female guardian, among adolescents participating in sporting activities, and among adolescents with moderate/severe TDI.

Discussion

The present study assessed risk factors for TDI and related life-course events among Norwegian adolescents. For this purpose, a well-designed retrospective longitudinal census study was conducted. Gender and adverse scorings on behavioural and psychosocial parameters among the participants influenced the risk of TDI, which is in accordance with the study of Nicolau *et al.* (18). However, it is difficult to compare the results of these studies in view of the sociodemographic, cultural, and environmental differences in the study populations.

There are different life-course concepts and models described in the literature. Most models include positive and negative incidences and experiences over time. The questionnaire used in the present study collected relevant data from early childhood to the present day. Thus, the information collected (socio-economic, biological, psychosocial, and behavioural indicators) is useful in a life-course perspective. However, the outcome variables used (prevalence of TDI, severity of TDI, and multiple episodes of TDI) are covered over a period of time (data including TDI before 16 yr of age). As some TDIs sustained at an early age might not be explained by indicators measured at the present time, the results from the present study must be interpreted with caution. However, most mediating risks related to adolescents' health and well-being (i.e., socioeconomic, biological, psychosocial and behavioural) are established during childhood and early adolescence (33). Therefore, responses to the questionnaire should also be considered as representative for younger adolescents experiencing TDI in this study.

In regard to non-response bias in the present study, adolescents who had experienced TDI would be more likely to participate in the study compared with adolescents with no TDI experience. This may be a result of the effect of demand characteristics, whereby the participant in a study might form an interpretation of the purpose of the investigation and subconsciously change

Table 1

Sociodemographic characteristics of the study population (n = 2055)

Variables	Gender		
	Male (*n*)	Female (*n*)	Total (*n*)
TDI			
Yes	193	145	338
No	802	915	1717
Birth place			
Norway	943	979	1922
Outside Norway	52	81	133
Residence			
With parents	954	1018	1972
Away from parents	41	42	83
Studies			
General studies	478	685	1163
Vocational studies	517	375	892
Siblings			
≤2	715	771	1486
>2	280	289	569
Mother's education			
Lower (≤ secondary education)	414	449	863
Higher (university or college degree)	581	611	1192
Father's education			
Lower (≤ secondary education)	503	519	1022
Higher (university or college degree)	492	541	1033
Family vacations			
No	126	109	235
Yes	869	951	1820
BMI*			
<23.5	685	783	1468
23.5–27.9	242	222	464
>27.91	68	55	123
Participation in sports activities			
Yes	618	606	1224
No	377	454	831
Part-time job			
Yes	438	505	943
No	557	555	1112
Regular alcohol consumption			
Yes	132	149	281
No	863	911	1774
Regular tobacco use			
Yes	38	20	58
No	957	1040	1997
DMFT			
<4	646	656	1302
≥4	349	404	753

*World Health Organization classification of body mass index (BMI), adjusted for age (30).
DMFT, decayed, missing and filled teeth; TDI, traumatic dental injury.

their behaviour to suit that interpretation (34), which in turn would result in an inflated estimate of the prevalence of TDI in the study population. The drop-out analysis showed that girls were more likely than boys to respond to the questionnaire. In addition, there was a higher response rate among pupils attending general studies than among those following vocational studies. Low response rates can affect the validity of results; thus, assessment of response is important in the critical appraisal of health research. Therefore, strategies to increase response rate were implemented to improve the study quality (35). The participants in the study are considered as representative of 16-yr-old adolescents attending public school in Hordaland, as reported in a previous paper (21).

The low R-squared values in the logistic regression analyses may be explained by the factors studied. Studies trying to predict human behaviour typically have low R-squared values. The interpretations of the significant variables are the same for both high and low R-squared models (36).

As the Public Dental Health Service in Norway offers free dental care for children and adolescents from birth up to the age of 18 yr, and the children have regular dental check-ups, the trauma records in patients' EPJs are very likely to include all, or almost all, occurrences of injury. However, the prevalence of mild injuries to the periodontal tissue may be under-reported because of persons not seeking treatment for mild TDI (11,21). In addition, the data collected in this study were registered by calibrated dentists using internationally accepted classifications of TDI (11).

Boys were discovered to have higher rates of TDI than girls (Table 2), which is widely supported in the literature (37–39). The male/female ratio related to TDI in this population was 1.33:1, as reported in a previous paper (21). The male/female ratio related to TDI ranges from 1.3–2.5:1 according to a recent review (1) in which some studies report a recent ratio decline (5,40). This decline has, in Brazil, been explained by the increased interest in different sports activities among girls (41). In Norway, the number of girls participating in sporting activities increased by 7.8% from 2010 to 2016, while the increase was only 2.5% among boys (42). This trend could be explained by the fact that Norway is one of the highest-ranking countries in the world in regard to gender equality (43). Skaare & Jacobsen (6) reported that 40.0% of sports-related TDIs among Norwegian adolescent girls occurred during team handball.

In this study, TDIs were more frequent among adolescents with mothers/female guardians with a high level of education. High frequency of exercise was also linked to a high level of education among mothers/female guardians. This emphasizes the significance of mothers/female education as an important socio-economic risk factor for TDI. Conversely, there are inconsistent findings in relation to socio-economic status and TDI (9,44). This may be a result of the heterogeneity of the methods and the small number of published papers, making comparison difficult. The higher risk of TDI among children from families of higher socio-economic status in developing countries, such as Brazil, may be related to greater access to sporting equipment, swimming pools, skateboarding, roller-skating, and horseback riding compared with children from low socio-economic status families (44). In Norway, one study suggested that greater differences in participation of sports by adolescents according to occupation and education level are a result of increasing costs and increased professionalization of different sports (45).

Table 2

Hierarchical logistic regression (marginal model with robust variance estimates) for the association between life-course indicators and traumatic dental injuries (TDIs) (experienced TDI or not) in a population of 16-yr-old adolescents in western Norway (n = 2055). Independent variables with a statistically significant effect on the outcome are shown in bold

Indicators	Step 1 (Socio-economic) OR (95% CI)	Step 2 (Biological) OR† (95% CI)	Step 3 (Psychosocial) OR† (95% CI)	Step 4 (Behavioural) OR† (95% CI)
Education, female guardian				
Lower education (≤ secondary education)	1	1	1	1
Higher education (university or college degree)	1.34 (1.01–1.77)*	1.33 (1.01–1.76)*	1.41 (1.05–1.89)*	1.40 (1.05–1.88)*
	R^2 = 0.01			
Gender				
Female		1	1	1
Male		1.89 (1.45–2.48)**	1.70 (1.27–2.28)**	1.64 (1.22–2.20)**
		R^2 = 0.01		
Big Five Inventory–20: Sum of 'Conscientiousness'				
High (16–28)			1	1
Low (4–15)			1.57 (1.11–2.23)*	1.58 (1.11–1.26)*
Big Five Inventory–20: Sum of 'Neuroticism'				
Low (4–25)			1	1
High (26–28)			1.48 (0.91–2.40)	1.37 (0.83–2.27)
I worry a lot				
Yes			1	1
No			0.98 (0.71–1.35)	0.96 (0.70–1.32)
I like being the way I am				
No			1	1
Yes			1.79 (1.13–2.83)*	1.77 (1.12–2.82)*
Love and affection (father)				
A little to a great deal			1	1
Not at all			1.62 (0.93–2.76)	1.56 (0.88–2.78)
Plans after graduating high school				
Plans			1	1
I don't know/no point in planning			1.65 (1.16–2.35)**	1.68 (1.18–2.39)**
Reason/motivation for violence?				
No			1	1
Yes			1.25 (0.90–1.73)	1.24 (0.89–1.71)
Do you know violent persons?				
No			1	1
Yes. Some			0.87 (0.64–1.18)	0.85 (0.62–1.16)
Yes. Quite a few			1.44 (0.81–2.55)	1.38 (0.77–2.45)
			R^2 = 0.03	
Non-attended dental appointments				
≤3 times				1
3 times				1.38 (0.94–2.04)
How often do you exercise?				
≤4 times a wk				1
5–7 times a wk				1.47 (1.07–2.01)*
				R^2 = 0.03

†Adjusted OR.
*$P < 0.05$, **$P < 0.01$.

The strongest predictor for experiencing TDI was adolescents responding positively to the question 'I like being the way I am' and adolescents reporting lack of plans after high school or not seeing the point in planning (Table 2). These items from the questionnaire were used to describe the participants' self-concepts and personality. These items were similar to those in the study by Nicolau *et al*. (18). An explanation for the higher risk of TDI in these pupils could be an indirect association through development of risky and spontaneous behaviour, which increases the risk of TDI (18).

The BFI is among the most widely used personality tests based on the FFM (23). The shortened version of BFI used in the present study achieves satisfactory levels in measurements of psychometric properties, which is useful in this setting as optimal measurement of personality is not required (25). Adolescents reporting low levels of conscientiousness were more at risk of TDI. Persons with low scores on conscientiousness are described as being more disorganized, reckless, and laid back, and prefer not to make long-term plans (46). The link between a low-level conscientious personality and a higher risk of different types of injuries, accidents,

Table 3

Hierarchical logistic regression (marginal model with robust variance estimates) for the association between life-course indicators and severity of traumatic dental injuries (TDIs) (mild vs. moderate/severe) in a population of 16-yr-old adolescents in western Norway (n = 338). Independent variables with a statistically significant effect on the outcome are shown in bold

Indicators	Step 1 (Socio-economic) OR (95% CI)	Step 2 (Biological) OR† (95% CI)	Step 3 (Psychosocial) OR† (95% CI)	Step 4 (Behavioural) OR† (95% CI)
Family vacations last 12 months				
None	1	1	1	1
≥1	2.18 (0.96–4.94)	2.19 (0.96–5.00)	2.17 (0.93–5.03)	1.88 (0.83–4.27)
Education, female guardian				
Lower education (≤ secondary education)	1	1	1	1
Higher education (university or college degree)	0.93 (0.47–1.83)	0.94 (0.48–1.85)	0.89 (0.45–1.75)	0.99 (0.49–2.01)
	R^2 = 0.01			
Gender				
Female		1	1	1
Male		1.27 (0.69–2.41)	1.30 (0.69–2.46)	1.26 (0.67–2.34)
		R^2 = 0.02		
Religion, important part in life				
Yes			1	1
No			4.31 (1.53–12.18)**	4.54 (1.61–12.78)**
			R^2 = 0.04	
Non-attended dental appointments				
≤3 times				1
>3 times				2.58 (1.28–5.17)**
Wrestling				
No				1
Yes				4.13 (1.91–8.96)**
				R^2 = 0.07

†Adjusted OR.
*$P < 0.05$, **$P < 0.01$.

Table 4

Hierarchical logistic regression (marginal model with robust variance estimates) for the association between life-course indicators and experience of multiple episodes of traumatic dental injuries (TDIs) (one episode vs. multiple episodes) in a population of 16-yr-old adolescents in western Norway (n = 338). Independent variables with a statistically significant effect on the outcome are shown in bold

Indicators	Step 1 (Socio-economic) OR (95% CI)	Step 2 (Biological) OR† (95% CI)	Step 3 (Psychosocial) OR† (95% CI)	Step 4 (Behavioural) OR† (95% CI)
Not applicable	1	1	1	1
Gender				
Female	1	1	1	1
Male		1.66 (0.84–3.26)	1.64 (0.83–3.25)	1.49 (0.74–2.98)
		R^2 = 0.01		
Love and affection (mother)				
A little, to a great deal			1	1
Not at all			2.72 (1.17–6.31)*	2.77 (1.17–6.55)*
			R^2 = 0.03	
Severity of TDI				
Mild				1
Moderate/severe				2.24 (1.05–4.80)*
Participation in sports activities				
No				1
Yes				2.25 (1.05–4.82)*
				R^2 = 0.06

†Adjusted OR.
*$P < 0.05$, **$P < 0.01$.

and mortality, is supported in the literature (47,48). Surprisingly, there was no association observed between the occurrence of TDI and the other factors in the FFM. In addition to a low score on conscientiousness, extraversion and a low score on agreeableness are reported to be valid and generalizable predictors of

accident involvement (47). Clarke & Robertson (47) argued, in a meta-analytic review, that neuroticism might be related to occupational accident involvement because of its strong association with stress and greater distractibility from the ongoing task. Personality aspects of TDI are rarely discussed in the literature. Further development of research questions linking personality and TDI would add significantly to our knowledge of the risks and causes of TDI.

Adolescents reporting frequent participation in sports activities were also found to be more at risk of TDI. These findings are supported in the literature (6,49). In addition, frequent participation in sports activities was also associated with multiple episodes of TDI.

Adolescents reporting religion as less important in their personal life were more prone to moderate/severe TDI. These findings are difficult to interpret as no data are available for comparison. Reports have shown that Norway is one of the least religious countries in western Europe, with only 22.0% of the population believing in a god or deity (50), and this number is further declining (51). In this study, 17.4% of all the participants reported religion as an important aspect in their personal life, which confirms the above-mentioned trends. This may be explained both by the relatively young age of the participants (52), and the relationship with religious salience and risky behaviour (53). However, regarding church ceremonies, a total of 57.9% of all 15-yr-old adolescents in Norway were confirmed according to the Church of Norway. The Church of Norway covers 70.6% of Norway's total population (51). It is important to remember that questions regarding these sensitive topics are considered as intrusive by some (54), and should be interpreted with caution.

Moderate/severe TDI was associated with a high number of non-attended dental appointments. This particular finding should be interpreted with caution as the results were merely a count of non-attendance. Adolescents sustaining TDI are subject to a high number of compulsory dental appointments (treatment and follow-up etc.), which in turn may lead to a higher chance of non-attendance than for a person without TDI who is only required to attend once a year at most. However, from a socio-economic perspective, high levels of non-attendance in relation to TDI treatment could increase societal costs and could also impact tooth and treatment prognosis (55,56). Higher DMFT in addition to higher non-attendance is used as an indicator of 'lack of awareness and neglect' by the Norwegian Child Welfare Services (57,58). The association between non-attendance and higher DMFT suggests that this group requires additional resources in terms of follow-up and preventive measures (57).

Wrestling was found to be associated with the occurrence of moderate/severe TDI. The general injury rates in wrestling are very high (59,60), and there is no reason for dental trauma rates to be any different. A reasonable explanation for the greater risk of moderate/severe TDI in wrestling is the high-energy impacts of the sport. One study reported that 16.5% of the injuries sustained among wrestlers affected the head and/or face (60).

A few studies have reported data on multiple episodes of TDI (55,61). However, there are a limited number of published papers on risk factors related to multiple episodes of TDI. Multiple episodes of TDI lead to a high number of follow-up appointments and treatments required (55), which in turn increases individual and societal costs. Participants reporting lack of love and affection from their mother/female guardian were more at risk of experiencing multiple episodes of TDI (Table 4). Severity of TDI was also associated with multiple episodes of TDI, which may be explained by inadequate lip coverage, increased horizontal overjet with protrusion (5,62), and high-energy impacts.

The findings from this and other studies may give health authorities in Norway (and elsewhere) important information on strategies for preventing TDI. The life-course perspective on health and well-being has played a significant role in the change from curative to preventive medicine (33). Information related to prevention and treatment of TDI of different levels of severity may improve the prognosis for treatment. Educational campaigns can help the public to comprehend the importance of oral health, and dentists treating TDIs will also have a better fundament for their preventive strategies. Information on safety (such as the use of mouth guards and helmets), and preventing risk-seeking behaviour in general when playing sports, may help reduce the risk of TDI.

To conclude, TDIs were found to be more frequent among boys, adolescents reporting a higher socio-economic level, and adolescents with adverse scorings on behavioural and psychosocial parameters. Moderate and severe TDIs were more frequent among adolescents reporting religion as unimportant in their personal life, adolescents with higher non-attendance to dental appointments, and adolescents participating in the sport of wrestling. Lastly, multiple episodes of TDI were more frequent among adolescents reporting little or no love affection from their mother/female guardian, adolescents sustaining moderate or severe TDI, and adolescents participating in sports activities. Findings from this study confirm the hypothesis that the risk of experiencing TDI in the permanent dentition is affected by some experiences along the life course. Rather than causes of TDI alone, incorporation of life-course experiences is important in the evaluation of risk indicators related to TDI.

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